WEST

Technical Documentation

POS-321-P

Universal positioning module with power output stage,
Start-Up Assistant, script programming
and integrated option for simulation of the controlled loop

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1 General Information

1.1 *Product Name*

POS-321-P	with integrated power stage, analoge sensor interface, commissioning assistent and script programming

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), required version for script programming >= 4.1.2.5

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*

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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 has been developed for controlling inexpensive hydraulic positioning drives, for applications with standard proportional valves (no OBE and no spool position feedback).

The internal profile generation is optimized for stroke-dependent deceleration or the NC control mode. The controller and the controller settings are adapted to typical requirements and thus permit rapid and uncritical optimization of the control behavior. The optimized control function offers a high degree of precision together with high stability for hydraulic drives.

Additionally, an **A**utomatic **C**ommissioning **A**ssistance (**ACA** Function) to support the start-up procedure is implemented. Polarity, sensor scaling, deadband compensation, speed and dynamic parameter measuring for setting the closed loop control parameter can be selected.

In order to be able to flexibly realise further requirements on the function of the unit without external control, the unit has a simple but far-reaching programming option via a script. With this, the input and output signals of the positioning algorithm can be influenced and thus the function of the unit can be adapted to the special requirements of the application.

In addition, the device offers the option of verifying the control and also the system design by means of a simulation of the controlled system that can be activated. The underlying model is physically oriented, it is based on a numerical integration of the relevant differential equations for the pressure build-up and the cylinder movement. Parameterisation is carried out without specialist knowledge using the available data sheet information.

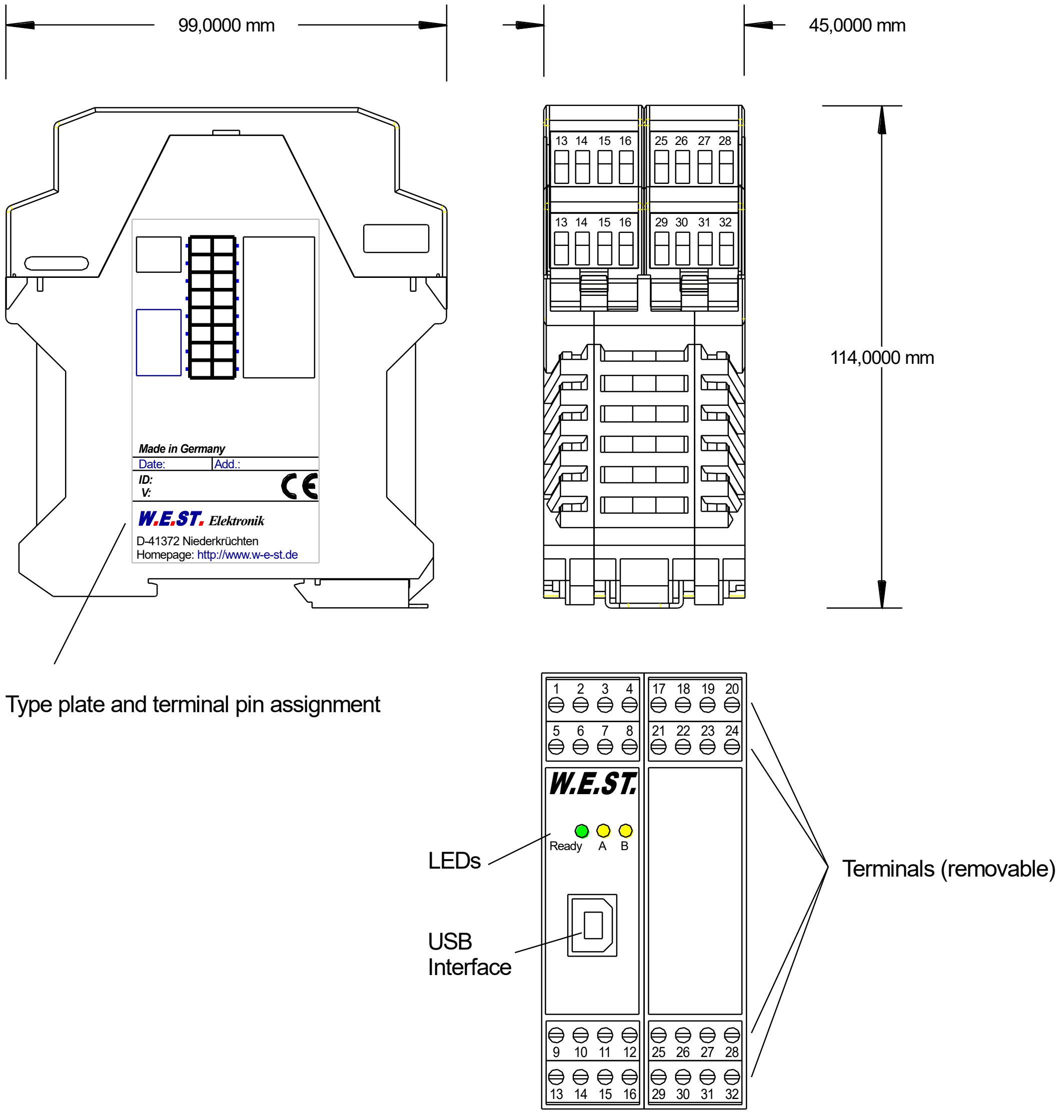
Setting up this module is simple and easy to handle with our WPC-300 start-up software.

Typical applications: general positioning drives, control of process valves (gas and oil industry), fast transport drives, handling systems, speed-controlled axes and also tracer control.

Features

- **Analog position and speed inputs**
- **Analog feedback sensors**
- **Integrated power output stage**
- **Free configuration option, function can be adapted as desired via script programming**
- **Integrated simulation model**
- **Start-Up Assistant for simple and fast commissioning**
- **Motion command values in mm resp. mm/s**
- **Internal profile definition by acceleration, velocity and deceleration**
- **Principle of stroke-dependent deceleration for shortest positioning times**
- **NC profile generator for constant speed**
- **Optimized closed loop control technology**
- **Fault diagnosis and extended function checking**
- **Reworked parameter adjustments for simplified parameterization with WPC-300 software**

2.1 *Device description*



2.2 *Use and application*

2.2.1 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 analog 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.
  - Analog 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 cables (> 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.

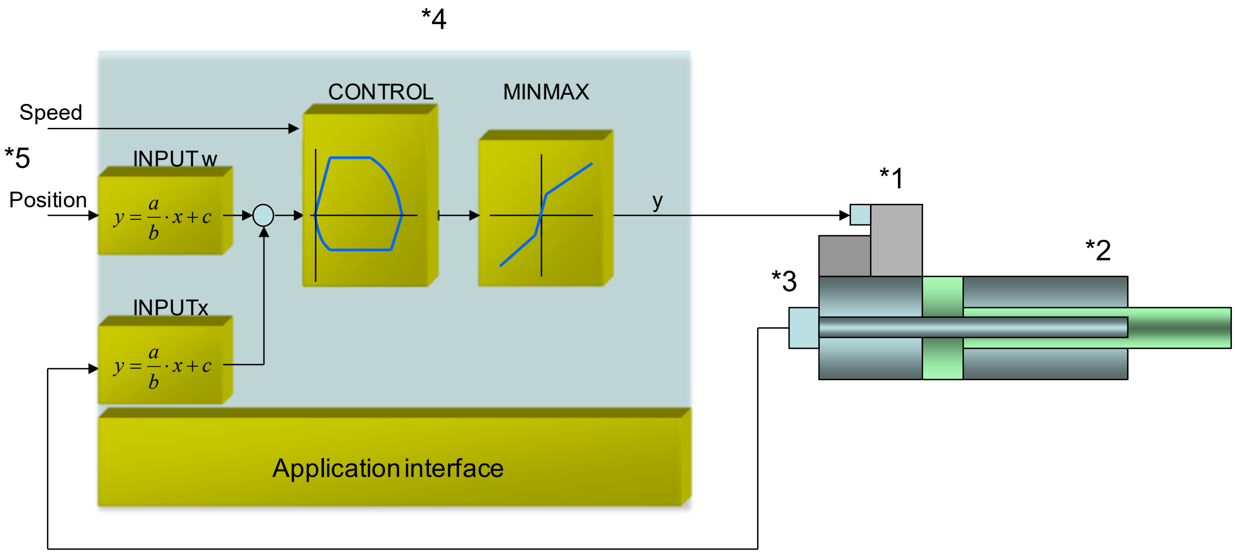
- A low-resistance connection between PE and the mounting rail should be provided. Transient interference is transmitted from the module directly to the mounting rail and from there to the local earth.

- 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.

2.2.2 Typical system structure

This minimal system consists of the following components:

(*1) Proportional valve (or control valve): the valve type determines the precision. It is expedient to use control valves with integrated electronics.
(*2) Hydraulic cylinder
(*3) Integrated analog position sensor (alternatively also with external position sensor)
(*4) POS-321-P control module
(*5) Interface to PLC with analog and digital signals



2.2.3 Method of operation

This control module supports simple point-to-point positioning with hydraulic drives. The system works on the principle of stroke-dependent deceleration, i. e. the control gain (deceleration stroke) is set via parameters **D:A** and **D:B**. Alternatively the loop gain will be used in NC mode. In this mode the velocity is controlled and the profile ist defined by the velocity and the acceleration.

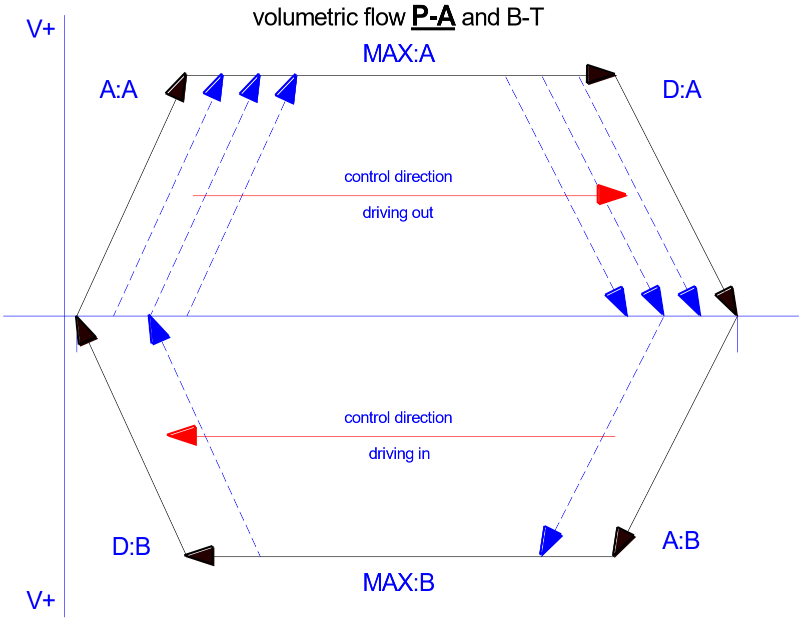
The deceleration characteristics / closed-loop-gain can be set linearly (**LIN**) or approximately quadratically (**SQRT1**) via the **CTRL** parameter. For normal proportional valves **SQRT1** is set.

For control valves with a linear flow curve it depends on the application. If **LIN** is selected for these valves, a significantly shorter deceleration distance can often be set (**D:A** and **D:B**).
LIN is recommended in case of NC-mode.

Positioning sequence:

The positioning procedure is controlled by the switching inputs. After the *ENABLE* signal is applied, the required position equal to the actual position is set in the module and the drive remains stationary under control at the current position. The general readiness for operation is now reported via the *READY* output. The *START* signal activates the analog demand value input (PIN 13) which is accepted as the new required position. The drive moves directly to the new required position and reports the reached position via the *InPos* output. The *InPos* output remains active as long as the position is maintained and as long as the *START* signal remains applied.

In manual mode (*START* disabled) the drive can be moved by means of *HAND+* or *HAND-*. The drive moves under open-loop control at the programmed manual speeds.



When the *HAND (+* or *-)* signal is switched off, the current actual position is accepted as the required position and the drive comes to a controlled stop.

The HAND mode can be used – in case of a sensor failure or the axis is out of the normal working range – to drive the axis manually.

2.2.4 Interaction between the script program and the standard module

Script programming is used here as a supplement to the predefined control function of a positioning module. The script can be seen as a flexible framework in which the standard function is embedded. The input and output signals of the positioning function run through the script program and can thus be influenced in the desired way. These possibilities are very far-reaching.

The block diagram (section 4.3) shows the frame of the script signals. The signals that pass through this frame must be assigned in the script.

In order to enable a quick start and to be able to use the unit without using the script function if necessary, it is equipped with a standard script in the delivery state, which is also restored when it is set to "DEFAULT".

The unit can be used directly for positioning without adapting the standard script and then corresponds in its function as far as possible to the POS-123-P or POS-323-P units.

A more detailed description of the possibilities and use of script programming can be found in chapter 6 and 7.

2.2.5 The positioning accuracy

Which influences are decisive for the positioning accuracy?

1. The valve and the correct hydraulic design essentially determine positioning accuracy in this kind of systems. It should be remembered that we are dealing here with relatively simple valves and there are natural limits to the positioning accuracy.

   Typical positioning accuracies are:
   0.05 ... 0.10 mm at 50 mm/s theoretical maximum speed
   0.10 ... 0.20 mm at 100 mm/s theoretical maximum speed
   0.20 ... 0.40 mm at 200 mm/s theoretical maximum speed
   0.50 ... 1.00 mm at 500 mm/s theoretical maximum speed
   1.00 ... 2.00 mm at 1000 mm/s theoretical maximum speed

   These data are to be understood as guideline values and can be significantly de- or exceeded in practice. On a real drive (vmax = 220 mm/s and a stroke of 300 mm) an accuracy of +/- 0.02 mm could be **reproducibly** achieved.
   Significantly higher accuracies are possible with valves with spool position control or with control valves and our modules POS-124-U or UHC-126-U-PFN.

2. Another limitation is the signal resolution and linearity of analog positioning sensors. However, this only becomes noticeable at longer strokes. If the position error due to the valve and the speed in relation to the signal resolution of the sensor is considered, this signal resolution of the sensor is usually the less critical factor.

3. The positioning accuracy is decisively influenced by the positive overlap of the valve and the quality of the compensation. The accuracies mentioned under point 1 only apply if the MIN parameters are set sufficiently well.
   This dead zone (overlap) is in the range of 20 ... 35 % for many valves and is compensated by the MIN setting. This setting should be done experimentally or through our **ACA** function.

3 Commissioning

The commissioning of a hydraulic closed loop controlled position drive with the POS- 321-P is relatively easy, since most of the time a smooth and good-natured behavior can be assumed. Nevertheless, a few general points should be noted.

3.1 *Preparatory measures*

These measures include in particular the compilation of the electrical data of command and actual signals and of the proportional valve. The most important points are summarized in the following checklist.

Table 1 (Necessary for the first start-up)

Point	Info
Valve data	Solenoid current (**CURRENT**), the DITHER / PWM adjustment and - if available - the degree of overlapping.
Sensor data	Length of the sensor (**N_RANGE**) and the signal type (**SIGNAL:14**)
System data	Useful are: - The maximum speed (alternatively the full stroke time). - Requirements about the positioning accuracy and the dynamic behavior (natural frequency of the cylinder drive). A cross check about the speed, the maximum flow rate of the valve and the pump flow/power should always be done.

Table 2 (General procedure for the first time start-up)

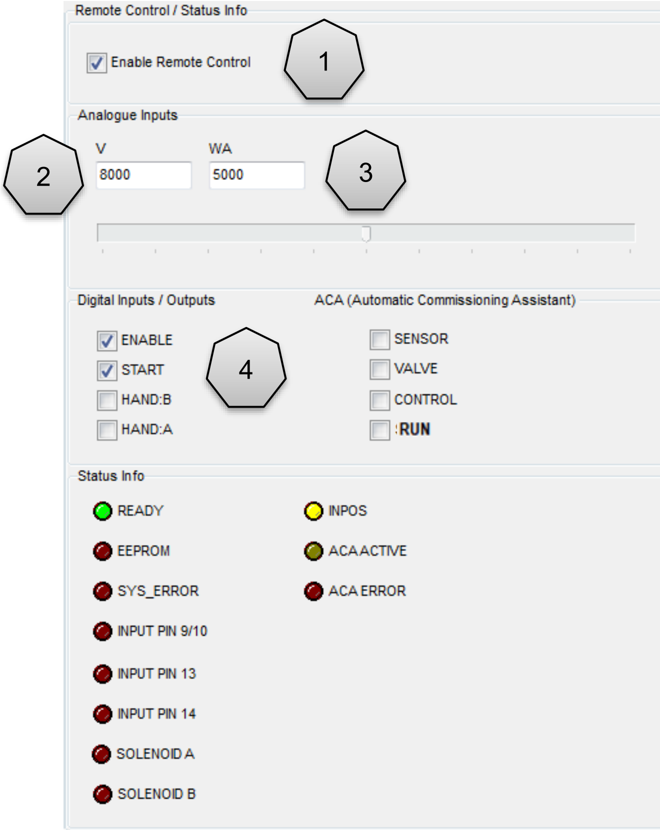
Step	*Task*
Installation	Install the device in accordance with the circuit diagram. Ensure it is wired correctly and the signals are well shielded. The device must be installed in a protective housing (control cabinet or similar).
Switching on for the first time	Ensure that no unwanted movement is possible 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.

Basis parameterization	Pre-parameterization is the first and most important step.
	Following data / parameters should be available:
	• *Manual speed in % of maximum speed*
	• *Cylinder stroke (**SYS_RANGE**)*
	• *Required positioning accuracy (**POSWIN**)*
	• *Signal definition of the analog command input (**SIGNAL:13**)*
	• *Signal definition of the analog feedback (**SIGNAL:14, N_RANGE:X**)*
	• *Polarity of the output (**POL:U**)*
	• *Valve data*
	  • *Maximum output current (**CURRENT**)*
	  • *Dither adjustment / PWM-frequency (if available)*

Step	*Task*
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 should drift slightly (leaves 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).
Automatic Commissioning	
ACA	Please read chapter 3.3.
Manual Commissioning	
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 EOUT is active, do not use the manual operation.
Activating START	With the start signal, the demand value of the analog 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 (CONTROL) according to your application and your requirements.

3.2 *Remote Control*

For starting-up independent of the PLC (machine control unit) a REMOTE CONTROL mode is implemented. In this mode (**Enable Remote Control (1)**), switching inputs and analog inputs can be simulated by the WPC commissioning software.



Analog inputs are:

V **(2)** to limit the maximum speed (A value must be entered, so that the axis can drive at all). If the speed is zero, the valve is not activated.

WA **(3)** the command position, 0… 10000 is corresponding to 0… 100 % of the full stroke.

Digital inputs **(4)** are:

ENABLE:
Enable of the controller and activation of the output.

START:
The command value WA is taken over and the axis is driving to the target position.

HAND:A and HAND:B:
At deactivated START, the axis can be driven by the two HAND input signals.

The axis can be simply driven via these inputs signals. The behavior is monitored by the different process values.

3.3 *ACA – automatic commissioning assistance*

The assistance system described here is used to simplify commissioning of hydraulic positioning controllers. The analysis and automatic setting of various parameters should help the user to parametrize the system more quickly with the aim of getting a robust hydraulic axis.
The commissioning assistant offers various functions that can be used individually, in combination or as a complete one. These include polarity detection, sensor scaling (optimal working range), compensation for positive overlap and dynamic analysis (velocity measurements and determination of control gains). Prerequisite is the correct presetting of the data for the sensor signal and the valve control (solenoid data).

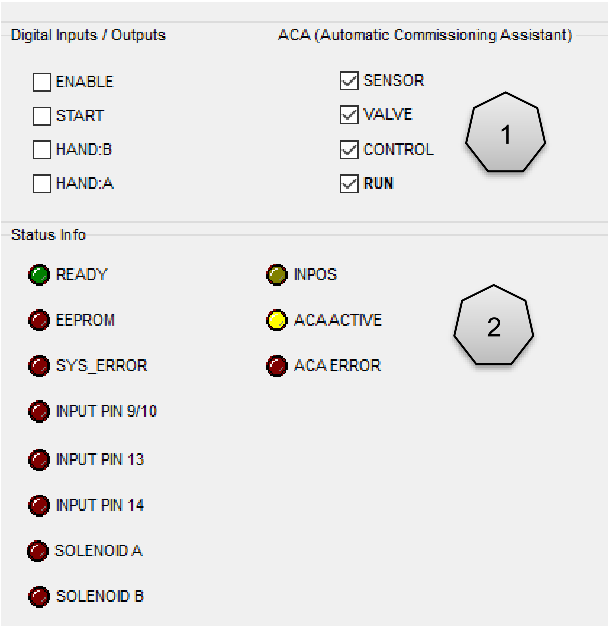
Features

- **Assistant for automatic commissioning**
- **Only basic data are required**
- **A time saving procedure to get a running axis**
- **Robust system behavior**
- **Selectable functionality**

3.3.1 Optimisation steps

The assistance system takes over four subtasks, which can be selected via the switches (1).

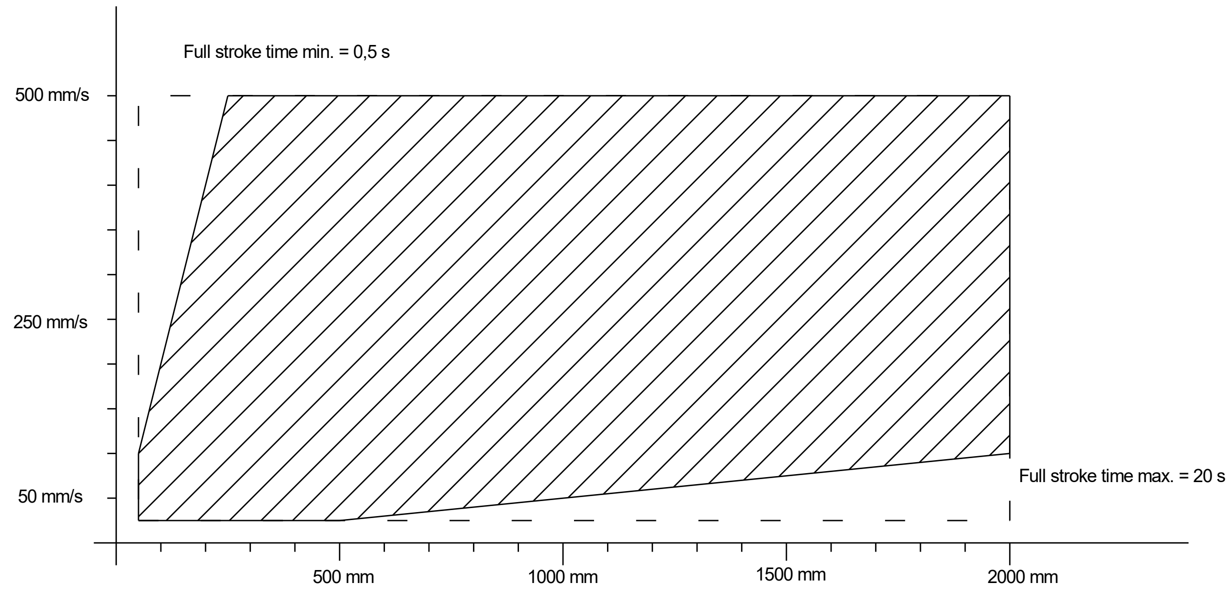
1. The polarity is checked and corrected if necessary. This is done automatically each time.
2. The sensor scaling can be activated via the switch **SENSOR**. If the sensor scaling is active, the drive automatically moves to the two end positions, saves the values and scales the analog input.
3. Valve measurement (**VALVE**) refers to the automatic measurement of the positive overlap. Once the measurement has been made, the values are stored in MIN:A and MIN:B.
4. The dynamic measurements (CONTROL) determine the maximum speed and the closed loop control parameters of the system.



The running assistant is displayed via status / error LEDs (2) in the monitor of the WPC program, and if optimization was stopped via an abort criterion.
After completion of the optimization, the determined parameters are transferred to the parameter list and the new parameters are activated. If carried out correctly, the system is automatically enabled. If an abort criterion has been generated, the axis remains locked and must be released manually.
The parameters that were set automatically are not stored permanently. To store the parameter permanently, the SAVE button has to be pressed.

3.3.2 Limitations

The automatic parameterization has been specified for the following working area. Outside of this range, measurement errors can occur because of limited signal and time resolution.



3.3.3 Start of the ACA function

Step	Activity
ACA:POS1 ACA:POS2	The two positions determine the range of the axis in which the measurements are made for setting the control parameters. These should be chosen with enough distance from the axis ends. Without input, 25 % and 75 % of the axis are selected (only if the sensor measurement has been activated).
ACA:MCORR	This parameter can be used to set a correction value for the automatic overlay measurement. This makes sense in case of low positioning accuracy, but a high insensitivity about disturbances.
START CONDITION	- **External ENABLE must be active** - **REMOTE CONTOL must be active** - **ENABLE in the REMOTE CONTROL input must be deactivated.** - **START should be deactivated** - A speed > 0 should be specified via "v". This is of no importance for the assistant, but after completion of the process the axis should stop in a controlled manner, which does not work with v = 0.
RUN	The automatic optimization can now be carried out via the RUN switch. If a point has been processed, the hook is removed. Optimization can be stopped by not fulfilling the start condition (e.g. disabling RUN). - The yellow LED "ACA_ACTIVE" indicates that the optimization is working. - The red LED "ACA_ERROR" indicates that ACA is aborted by an error. The red LED can only be cleared by restarting the ACA function.
ST_ACA	Request status report. Enter this command in the terminal window.

3.3.4 Parameter overview

The following parameters are measured and parameterized automatically.

Parameter	Description	ACA Function
SIGNAL:U	Polarity of the output signal (this point will always be measured)	BASIC FUNCTION
SYS_RANGE	Working stroke of the axis	SENS
OFFSET:X	Zero point of the sensor	SENS
MIN:A	Deadband compensation at extending	VALVE
MIN:B	Deadband compensation at retracting	VALVE
MAX:A[1]	Maximum speed at extending	CONTROL
MAX:B[1]	Maximum speed at retracting	CONTROL
VMAX	Maximum speed used in NC mode	CONTROL
ACCEL	Acceleration in NC mode	CONTROL
A:A	Acceleration at extending (SDD mode)	CONTROL
A:B	Acceleration at retracting (SDD mode)	CONTROL
D:A	Deceleration stroke at extending (SDD mode)	CONTROL
D:B	Deceleration stroke at retracting (SDD mode)	CONTROL
V0:A	Closed loop gain at extending (NC mode)	CONTROL
V0:B	Closed loop gain at retracting (NC mode)	CONTROL

[1] No automatic adjustment, ST_ACA provides a recommendation for adjustment. The MAX parameters only need to be reduced if the system pressure collapses when a full control is applied to the valve.

4 Technical description

4.1 *Input and output signals*

Preliminary note: The script allows a free assignment of the signals to the pins, therefore the assignment is described here according to the standard script.

Connection	**Supply**
PIN 3	Power supply of the control module (see technical data)
PIN 4	0 V (GND) connection
PIN 22	Power supply of the power stage
PIN 24	0 V (GND) of the power stage
Connection	**Analog signals**
PIN 6	Freely usable analog input
PIN 9 (-) / 10 (+)	External speed specification (V), signal range 0... 10 V or 4... 20 mA **Not connected in the default script.**
PIN 13	Position setpoint (W), signal range 0... 10 V or 4... 20 mA, scalable (SIGNAL:13)
PIN 14	Position actual value (X), signal range 0... 10 V or 4... 20 mA, scalable (SIGNAL:14)
PIN 29	Freely usable analog input, only 0... 10 V possible.
PIN 11	0 V (GND) connection for analog signals
PIN 12	10 V reference voltage output
PIN 15 / 16	Scaled monitor outputs, command signal (PIN 15) and feedback signal (PIN 16): 0… 10 V or 4… 20 mA
Connection	**Solenoid outputs**
PIN 17 / 19	Control of solenoid A
PIN 18 / 20	Control of solenoid B1
PIN 21 / 23	Control solenoid B2, no use in standard script
Connection	**Digital inputs**
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. The actual position is accepted as the command position and the drive remains stationary under control at this position. If the input is disabled, the output (control signal) is switched off (disabled). Take care of the EOUT command!
PIN 7	**START (RUN) input:** The position controller is active and the external analog demand position is accepted as the demand value. If the input is disabled during the movement, the system is stopped within the set emergency stopping distance (D:S).
PIN 25 / PIN 26	**HAND + / HAND - input:** Manual operation (START = OFF): the drive moves at the programmed speed in the programmed direction. After deactivation, the actual current position is accepted as the demand position. The START (RUN) input has priority over the HAND inputs. If the sensor signal is missing (external ENABLE signal = ON), the drive can be operated in manual mode.
PIN 5	Freely usable switching input

Connection	Digital outputs
PIN 1	**READY output:** **ON:** The module is enabled; there are no discernable errors. **OFF:** Enable (PIN 8) is disabled or an error (sensor or internal error) has been detected (depending on SENS command).
PIN 2	**STATUS output:** **ON:** **INPOS message.** The axis is within the INPOS window. **OFF:** **INPOS message.** The axis is outside the INPOS window.

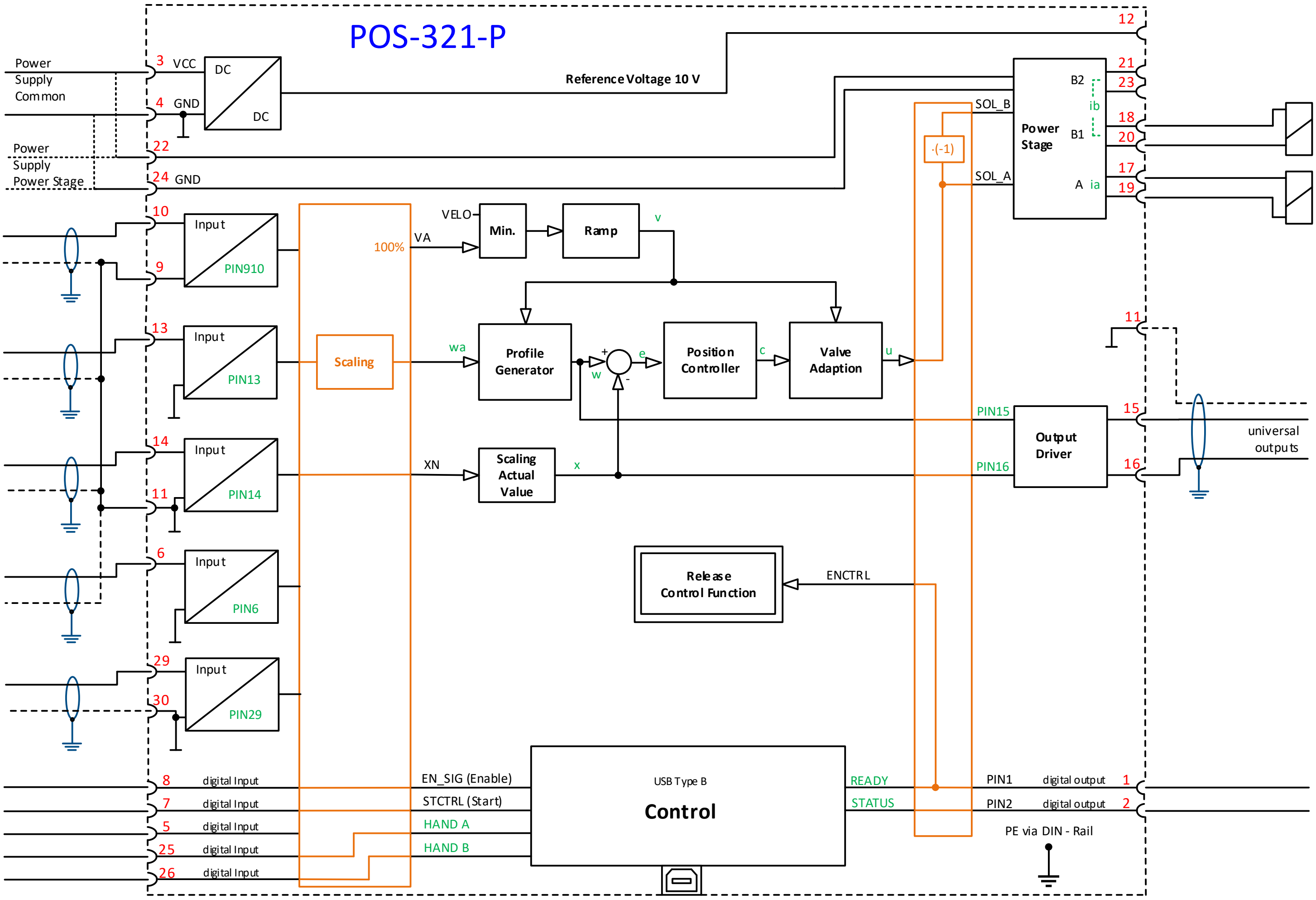
4.2 *LED Definitions*

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 INPOS window. **ON:** The axis is within the INPOS window.
GREEN + YELLOW A + YELLOW B	**All LEDs flash three times briefly every 6 seconds:** An internal system error has been detected. To acknowledge the error message, the power supply to the module must be briefly switched off once.
YELLOW A + YELLOW B	**Both yellow LEDs flash oppositely every 1 s:** The non-volatile stored parameter data was inconsistent and was therefore reset to the factory settings. To acknowledge this error, the data must be saved using the SAVE command / button in the WPC.

4.3 *Circuit diagram*

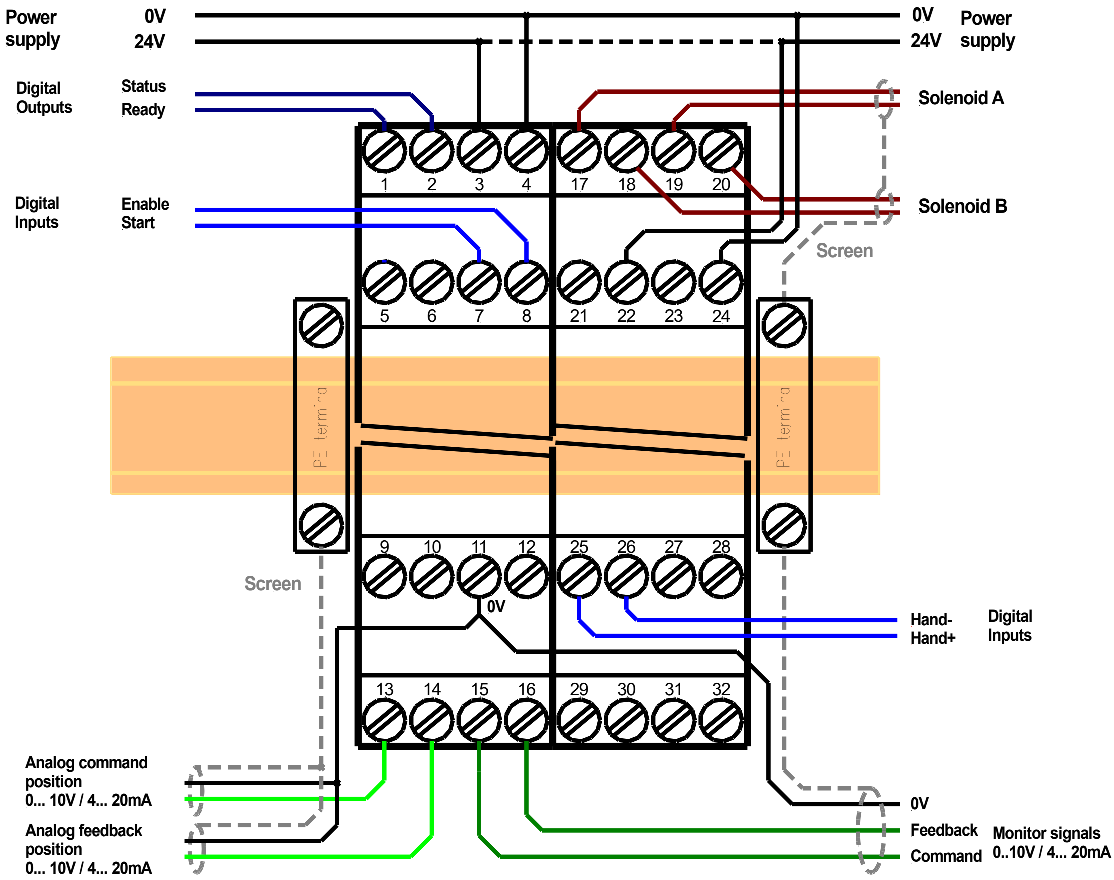
This illustration shows the connections realised by the standard script with a coloured background.

Variables that you can observe in the monitor window of the WPC as process values or status information are marked in green.



4.4 *Typical wiring*

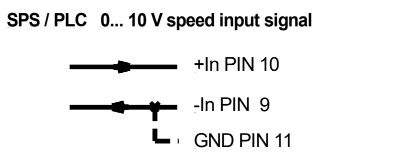
The following sketch shows the signals which are being used in the standard script.

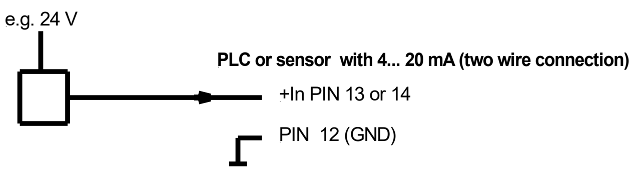


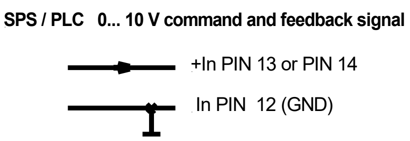
CAUTION: The solenoid cables should be screened due to electro-magnetic emissions.

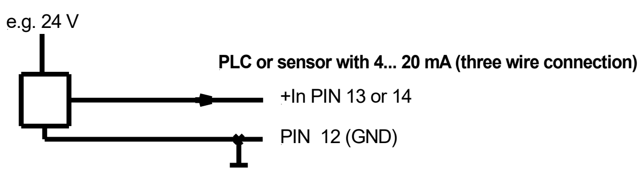
CAUTION: Plugs with free-wheeling diodes and LED indicators cannot be used with current-controlled power outputs. They interfere with the current control and can destroy the output stage.

4.5 *Connection examples*









4.6 *Technical Data*

Supply voltage (U_b)	**[VDC]**	12… 30 (incl ripple)
Power consumption	**[W]**	max. 1.2 + Power of the connected coils
External protection	**[A]**	3 medium time lag
Digital inputs		
OFF	**[V]**	< 2
ON	**[V]**	> 10
Input resistance	**[kOhm]**	25
Digital outputs		
OFF	**[V]**	< 2
ON	**[V]**	max. (U_b)
Maximum current	**[mA]**	50
Analog inputs		Unipolar / Differential
Voltage	**[V]**	0… 10 / -10… 10
Input resistance	**[kOhm]**	32
Signal resolution	**[%]**	0.003 incl. Oversampling
Current	**[mA]**	4… 20
Burden	**[Ohm]**	240 Ohm
Signal resolution	**[%]**	0.006 incl. Oversampling
Analog outputs		
Voltage	**[V]**	0… 10, unipolar
Maximum load	**[mA]**	10
Current	**[mA]**	4… 20
Maximum load	**[Ohm]**	390
Signal resolution	**[%]**	0.007
PWM output		Wire break and short circuit monitored
Max. output current	**[A]**	2.6
Frequency	**[Hz]**	61… 2604 selectable in defined steps
Controller cycle times		
Solenoid current control	**[µs]**	125
Signal processing	**[ms]**	1
Serial interface	**-**	USB - virtual COM Port
Transmission rate	**[kBaud]**	9.6… 115.2
Housing		Snap -on module acc. EN 50022
Material	**-**	PA 6.6 polyamide
Flammability class	**-**	V0 (UL94)
Weight	**[kg]**	0.25
Protection class	**[IP]**	20
Temperature range	**[°C]**	-20… 60
Storage temperature	**[°C]**	-20… 70
Humidity	**[%]**	< 95 (non-condensing)
Connections	**-**	
Communication		USB type B
Plug connectors		7 x 4-pole terminal blocks
PE		via the DIN mounting rail
EMC	**-**	EN61000-6-4: 2007 +A1:2011 EN61000-6-2: 2005

5 Parameters

5.1 *Parameter overview*

The indices given in this table can be used in the script command "SPAR" to read or write the parameters script-controlled.

Please note: In older WPC versions, the numerical values are sometimes entered with a comma shift, for example: 100.00 % - > enter "10000". This can be seen from the comment text displayed there, in this case e.g. [0.01 %].

Group	Command	Default	Unit	Description	Index
Basic parameter (Group SYSTEM)					
	LG	EN	-	Language switching	
	SENS	ON	-	Malfunction monitor	5000
	EOUT	0	%	Output signal if not ready	5001
	HAND:A **HAND:B**	33.33 -33.33	% %	Output signal in manual mode	5002 5003
	VMODE	SDD	-	Positioning method	5004
	POSWIN	200	µm	Range of the in-position-monitoring	5005
	PAR1...15	0.0		Free parameters (use in script)	5011 - 5025
	MON:A/:D	0	-	M-number of the signal SC:A ... SC:D	
Signal adaptation (Group IO_CONFIG)					
Analog inputs					
	SIGNAL:6	OFF	-	Analog input type	5100
	SIGNAL:910	OFF	-	Analog input type	5101
	SIGNAL:13	U0-10	-	Analog input type	5102
	SIGNAL:14	U0-10	-	Analog input type	5103
Scaling					
	SYS_RANGE	100	mm	Working stroke of the axle	5110
	N_RANGE:X	100	mm	Nominal length of the sensor	5111
	OFFSET:X	0	µm	Offset of the sensor	5112
Analog outputs					
	SIGNAL:15	U0-10	-	Analog output type	5120
	SIGNAL:16	U0-10	-	Analog output type	5121
Power stage					
	CURRENT	1000	mA	Nominal solenoid current	5130
	DFREQ	125	Hz	Dither frequency	5131
	DAMPL	5.0	%	Dither amplitude	5132
	PWM	2604	Hz	PWM frequency	5133
	ACC	ON	-	Automatic solenoid current controller adjustment (PPWM and IPWM), depending on PWM frequency	5134
	PPWM	7	-	P gain of the current loop	5135
	IPWM	40	-	I gain of the current loop	5136
	SET:A	OFF	-	Activate separate parameters for channel A	5137
	…:A			Second parameter set for channel A	5140 ff

Automatic commissioning assistant (Group START-UP)					
	ACA:POS1	25	mm	Lower limit position	5200
	ACA:POS2	75	mm	Upper limit position	5201
	ACA:CYCLE	0	ms	Cycle time of the square wave generator when the system is in RC mode	5202
Controller (Group CONTROL)					
	VELO	100.0	%	Internal speed limitation	5250
	VRAMP	200	ms	Ramp time for external speed	5300
Controller setting SDD					
	A:A **A:B**	100 100	ms ms	Acceleration times in SDD mode	5301 5302
	D:A **D:B** **D:S**	25 25 10	mm mm mm	Braking distance and emergency stop distance in SDD mode	5303 5304 5305
Controller setting NC					
	ACCEL	250	mm/s^2	Acceleration	5310
	VMAX	250	mm/s	Maximum speed	5311
	V0:RES	1	-	Resolution of the loop gain	5312
	V0:A **V0:B**	8 8	1/s 1/s	Closed loop gain in NC mode	5313 5314
	PT1	1	ms	Time constant PT1 -filter	5315
Valve adaption					
	CTRL	SQRT1	-	Control characteristics	5320
	MIN:A **MIN:B**	0.0 0.0	% %	Deadband compensation or flow characteristic linearization	5321 5322
	MAX:A **MAX:B**	100.0 100.0	% %	Output signal scaling	5323 5324
	TRIGGER	0.5	%	Deadband compensation trigger point	5325
	OFFSET	0.0	%	Output offset	5326
	POL:U	+	-	Polarity of the output signal	5327
Group SIMULATION					
	SIM	OFF	-	Activation of the internal simulation	
	The parameters of the simulation model are visible if SIM is switched to ON or EXT. These are described in detail in a separate manual.				
Special Commands (Terminal)					
	DIAG	-	-	Output of the last shutdown causes	
	ST_ACA	-	-	Status report of the commissioning assistant	
	SC:CLEAR	-	-	Resetting the script (factory setting)	
	SC:LIST	-	-	Display of all active script lines	
	SC:I	-	-	Entering a single script line	
	ECYCLE	-	J	Energy consumed (simulated system)	

5.2 *System parameters*

General note:

For selection parameters, a number is given in brackets in the listing of the parameter values. This corresponds to the numerical value of the corresponding selection when the parameter is queried or set by the script command "SPAR".

5.2.1 LG (Changing the language)

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

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 SENS (monitoring of the modul functions)

Command	Parameter	Unit	Group
SENS x	x= ON(1)|OFF(2)|AUTO(3)	-	SYSTEM

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 does not 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.

5.2.3 EOUT (Output signal: READY = OFF)

Command	Parameters	Unit	Group
EOUT x	x= -100.0… 100.0	%	SYSTEM

Output value in case of a detected error or a deactive ENABLE input (not READY). A value (degree of valve opening) for use in the event of a sensor error (or the module is disabled) can be defined here. This function can be used if, for example, the drive is to move to one of the two end positions (at the specified speed) in case of a sensor error.

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

In older WPC versions, the numerical value is entered with a decimal point shift in the unit 0.01%.

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.

5.2.4 HAND (Manual speed)

Command	Parameters	Unit	Group
HAND:I X	I= A|B X= -100.0… 100.0	 %	SYSTEM

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 the manual function. The output will be switched off when hand signals are turned off.

In older WPC versions, the numerical values are entered with a decimal point shift in the unit 0.01%.

The manual speed is also limited by the (internal or external) 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.

5.2.5 VMODE (Method of positioning)

Command	Parameter	Unit	Group
VMODE x	x= SDD(1)|NC(2)		SYSTEM

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.

5.2.6 POSWIN (In-Position-Window)

Command	Parameters	Unit	Group
`POSWIN x`	`x= 2… 200000`	µm	**SYSTEM**

This parameter is entered in µm.
The INPOS command defines a range for which the INPOS message is generated. This function monitors the failure between the command and actual position. If the failure is less than the programmed value, an INPOS message at the status output is generated (see Pin description). The positioning process is not influenced by this message.
PIN 7 (START) muss be acivated to activate the INPOS messages.

The positioning process is not affected by this message, the control remains active. The typical control error can be significantly smaller than the parameterised value.

5.2.7 PAR (free parameters)

Command	Parameter	Unit	Group
`PAR:I X`	`I= 1... 15`	-	**SYSTEM**

The parameters entered here are available for free use in the script.

In older WPC versions, the numerical value is entered with decimal shifting for the parameters 1... 10. The parameters 11... 15, on the other hand, are also interpreted directly there, but it is not possible to enter decimal places.

5.2.8 MON (definition of the monitor signals)

Command	Parameter	Unit	Group
`MON:I X`	`I= A, B, C, D` `X= 0... 30`	-	SYSTEM

These parameters do not influence the function of the module, but merely select which M-signals can be observed in the monitor and oscilloscope of the WPC.

The value "0" as the basic setting does not correspond to any selection, as the M-numbers start with "1". The corresponding SC value in the WPC monitor is then permanently displayed as "999.99".

5.3 *Signal adaptation (IO_CONF)*

5.3.1 SIGNAL (type of input signals)

Command	Parameter	Unit	Group

`SIGNAL:i x`	`i= 6|910|13|14`
	`x= OFF (1)`
	`U0-10 (2)`
	`I4-20 (3)`
	`I0-20 (4)`
	`U+-10 (5)`
		-	IO_CONFIG

This command defines the type of input signals (current or voltage).

This command is available for Analog inputs except for the non-switchable input at pin 29. In OFF mode, the corresponding Analog input is deactivated.

The setting option U+-10 (bipolar voltage input) is only available for PIN910.

Since the function of the inputs can be freely assigned via the script, the number is used here for identification. An inversion of the signal can be done in the script, for this reason this possibility does not exist here.

Current signals:

Error detection in case of underrange or overrange is only carried out for signal type I4-20. If you do not want to use this for a current signal or realise it in the script, the input must be set to I0-20 (mA) and a rescaling must be carried out in the script.

5.3.2 SYS_RANGE (Working stroke)

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

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.

This parameter is also available in the script as an input variable. Included in the standard script is the conversion of the Analog input value for the setpoint at PIN13 in the range 0-100% into the process variable WA in [mm] using the SYS_RANGE parameter.

However, this is not the only place where this elementary parameter is used; among others, it is also used in the commissioning assistant and in speed measurement.

5.3.3 N_RANGE:X (Nominal range of the sensor)

Command	Parameters	Unit	Group
N_RANGE:X x	x= 10… 10000	mm	IO_CONFIG

N_RANGE (nominal range or nominal stroke) is used to define the length of the sensor.

5.3.4 OFFSET:X (Sensor offset)

Command	Parameters	Unit	Group
OFFSET:X x	x= -10000000… 10000000	µm	IO_CONFIG

Adjustment of the zero point of the sensor.

OFFSET:X is internal limited by the values of SYS_RANGE.

5.3.5 Using the commands SYS_RANGE, N_RANGE:X and OFFSET:X[2]

These commands are used to scale the sensor for the application. In the example below, the sensor has a length of 120 mm and the cylinder a stroke of 100 mm. The mounting creates an offset (zero point of the sensor to the zero point of the cylinder) of 5 mm. This data only has to be entered in this form, and with an input signal of 0... 10 V, the stroke of 0... 100 mm (at the sensor of 5... 105 mm) can be covered.

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

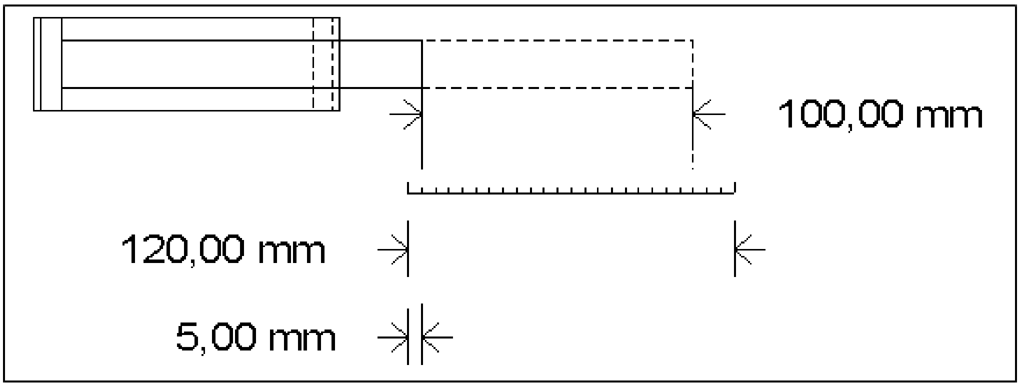


Figure 1 (Input scaling of the position sensor)

5.3.6 SIGNAL:15/16 (type of Analog output signals)

Command	Parameter	Unit	Group
`SIGNAL:15 x` `SIGNAL:16 x`	`x= U0-10(1)|I4-20(2)`	-	**IO_CONFIG**

These commands define the type of Analog output signals (current = I4-20 and voltage = U0-10).

[2] The first and most important step in commissioning is the correct definition and scaling of the input signals (in particular of the sensor). Normally the working stroke (SYS_RANGE) is smaller than the length of the sensor (N_RANGE). In the simplest case, SYS_RANGE is parameterized to the same value as N_RANGE.

5.3.7 Parameters of the power stage

The unit has a total of 3 outputs. Channel B is divided (B1/B2). Usually, channel A and channel B1 are used and the settings are identical for channel A and B(1/2).

However, if you need different settings, the SET:A ON command can be used to activate a second set of parameters for this channel. See below.

5.3.7.1 CURRENT (Nominal solenoid current)

Command	Parameters	Unit	Group
CURRENT x	x= 500… 2600	mA	IO_CONFIG

The nominal output current is set. Dither and also MIN/MAX always refer to this current range.

5.3.7.2 DAMPL (Dither amplitude)

5.3.7.3 DFREQ (Dither frequency)

Command	Parameters	Unit	Group
DAMPL x DFREQ x	x= 0… 30.0 x= 60… 400	% Hz	IO_CONFIG

The dither[3] can be defined with these commands. Different amplitudes or frequencies may be required depending on the valve.

The dither amplitude is defined in % (peak to peak value) of the nominal output current[4] (see: CURRENT command). In older WPC versions, the amplitude is entered with a decimal point shift in the unit 0.01%.

The dither frequency is defined in Hz.

CAUTION: *The PPWM and IPWM parameters influence the effect of the dither setting. These parameters should not be altered again after the dither has been optimized.*

CAUTION*: If the PWM frequency is less than 500 Hz, the dither amplitude DAMPL should be set to zero.*

[3] The dither is a ripple signal, which is superimposed on the current set point and is defined by the amplitude and frequency: the dither frequency and the PWM frequency. The dither frequency should not be confused with the PWM frequency. In some documentations, the PWM frequency is described as a dither. This can be recognized by the lack of the dither amplitude.

[4] The dither amplitude is a command signal. Derivations between the commanded amplitude and the real amplitude are possible, depending on the dynamic of the solenoid.

5.3.7.4 PWM (PWM frequency)

Command	Parameters	Unit	Group
PWM x	x= 61… 2604	Hz	IO_CONFIG

The frequency can be defined in predefined steps (61 Hz (1), 72 Hz (2), 85 Hz (..), 100 Hz, 120 Hz, 150 Hz, 200 Hz, 269 Hz, 372 Hz, 488 Hz, 624 Hz, 781 Hz, 976 Hz, 1201 Hz, 1420 Hz, 1562 Hz, 1736 Hz, 1953 Hz, 2232 Hz, 2604 Hz (20)). The optimal frequency depends on the valve.

Attention: *The PPWM and IPWM parameters should be adapted when using low PWM frequencies because of the longer dead times which force a reduced stability of the closed loop control.*

Attention: If the PWM frequency is less than 500 Hz, the dither amplitude should be set to zero.

5.3.7.5 ACC (Current loop, automatic adjustment)

Command	Parameter	Unit	Group
ACC x	x= ON(2)|OFF(1)	-	IO_CONFIG

Operation mode of the closed loop current control.

ON: In automatic mode, PPWM and IPWM are calculated depending on the preset PWM frequency.
OFF: Manual adjustment.

5.3.7.6 PPWM (Solenoid current controller P element)

5.3.7.7 IPWM (Solenoid current controller I element)

Command	Parameters	Unit	Group
PPWM x IPWM x	x= 0… 30 x= 1… 100	- -	IO_CONFIG

The PI current controller for the solenoids is parameterized with these commands.

CAUTION: These parameters should not be changed without adequate measurement facilities and experience.

Attention, if the parameter ACC is set to ON, these adjustments are done automatically.

Typical settings:

If the PWM frequency is < 250 Hz, the dynamic of the current controller has to be decreased.
Typical values are: PPWM = 1… 3 and IPWM = 40… 80.

If the PWM frequency is > 1000 Hz, the default values of PPWM = 7 and IPWM = 40 should be chosen.

5.3.7.8 SET:A (Activation of a separate parameter set)

Command	Parameter	Unit	Group
`SET:A x`	`x= OFF(0)|ON(1)`	-	IO_CONFIG

Channel setting: common or separate parameterisation

OFF: The parameters of the solenoid current controller apply to both channels

ON: A second set of parameters can be entered for channel A, the settings are completely independent of channel B1/2.

5.4 *Automatic Commissioning ACA*

5.4.1 ACA:POS1 (Lower position)

5.4.2 ACA:POS2 (Upper position)

Command	Parameters	Unit	Group
ACA:POS1 x ACA:POS2 x	x= 1… 10000 x= 1… 10000	mm mm	ACA

These two parameters define the workspace for the commissioning assistant. This is needed for the speed and dynamics measurements. Ideally, the values map the area in which the axis will be predominantly used later. The values must be within the working range for the assistance system to perform the functions.

Attention! In the measurements, the axis is in an uncontrolled state. The specified positions are therefore not fixed limits. It should therefore be paid to a sufficient difference to the axis end.

Attention! Always enter these values last (after N_RANGE and SYS_RANGE). If no change is made by the user, the start-up assistant sets the positions (with active sensor measurement) automatically to 25 % and 75 % of the predetermined or measured stroke. If the usable stroke of the axis (according to SYS_RANGE) is less than 75% of the sensor measuring range (N_RANGE), a manual input of position 2 is necessary before starting, otherwise the assistant cannot reach the position.

5.4.3 ACA:CYCLE (Square wave generator)

Command	Parameters	Unit	Group
ACA:CYCLE x	x= 0… 30000	ms	ACA

The square wave generator is an auxiliary function for oscillating the drive between the two predetermined positions. This parameter sets the cycle time. The generator is going to be active if ENABLE and START are ON and this parameter is not equal to zero. At "0" the generator is inactive.

5.5 *Controller parameterisation*

5.5.1 Speed setpoint

Only in NC mode can the actual speed of the axis be specified via the profile generator. The controller calculates this specification from the parameter VMAX [mm/s], which is scaled with the set speed of the process variable V [%].

In SDD mode, the speed setting is used to limit the control signal and is therefore only indirectly related to the physical speed of the axis.

For the formation of the speed setpoint V, this unit provides the parameter VELO in combination with the value "VA" as the output variable of the script programme. These two values are combined in a minimum value selection. In this respect, this unit differs from positioning modules POS-123/323, where the VELO parameter is only used if no external speed input has been activated.

The default setting of the script signal VA is 100 (%). If you want to use an input for speed setting, you can create a link to the analogue input in the script, e.g. via "VA=DIR PIN910".

In RC mode, i.e. with remote control from the WPC, the position of the slider available there is used for speed setting instead of the script variable VA. The VELO parameter has no influence in RC mode.

The speed setpoint formed in this way is fed into a ramp function in the fixed programme of the positioning algorithm, the output signal V of which is used for further processing. See block diagram.

5.5.1.1 VELO (Internal speed limitation)

Command	Parameters	Unit	Group
`VELO x`	`x= 1… 100.0`	`%`	CONTROL

In older WPC versions, the numerical value is entered with a decimal point shift in the unit 0.01%.

5.5.1.2 VRAMP (Ramp time for speed demand)

Command	Parameters	Unit	Group
`VRAMP x`	`x= 10… 5000`	`ms`	CONTROL

5.5.2 ACCEL (Acceleration)

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

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

The maximum acceleration must be set - to ensure a stable behavior - smaller than the technically possible acceleration. Experience shows that a factor of 3 ... 5 should be taken into account.

5.5.3 VMAX (Maximum speed in NC Mode)

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

Setting of the maximum speed in NC mode. This value is defined by the hydraulic 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.

If the speed of the drive differs between retraction and extension, the lower speed must be set.

The VMAX parameter is a system variable and is based on the maximum possible speed of the hydraulics. The customer's setpoint speed is limited / set via the VELO parameter or the Analog input V (percentage value).

5.5.4 A (Acceleration ramp time)

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

Ramp function for the 1st and 3rd quadrants.

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

5.5.5 D (Deceleration / braking distance)

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

This parameter is specified in mm.

The specification of the braking distance is an alternative way to determine the gain. Compared to the typical input of the closed loop gain, this value does not depend on the maximum velocity (VMAX parameter) and thus easier to optimize.

It is important that the smaller the braking distance is set, the faster the system brakes and the greater is the control gain. This means that you start with optimization rather with longer braking distances and reduce them systematically.

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.

$$G_{Intern} = \frac{SYS\_RANGE}{D_i}$$ 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.

5.5.6 V_0 (Loop gain setting)

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

This parameter is specified in s^{-1} (1/s).

In NC Mode normally the loop gain is specified rather than the deceleration stroke.

The internal gain is calculated from this gain value together with the parameters VMAX and SYS_RANGE.

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

$$G_{Intern} = \frac{SYS\_RANGE}{D_i}$$

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.

5.5.7 V0:RES (Resolution of the loop gain input)

With very small loop gains, it can happen that a value smaller than 4 * 1/s must be set. For this case, the resolution of the input can then be switched.

If it is necessary to set these very low loop gains, it is also a direct indication that the dynamic behaviour of the drive is problematic. The system design of the hydraulics should be checked in any case.

Command	Parameters	Unit	Group
`V0:RES x`	`x= 1(1)|1/100(2)`	-	CONTROL + NC

V0:RES = 1 loop gain in s^{-1} (1/s) units.

V0:RES = 1/100 loop gain in 0.01 s^{-1} units.

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

5.5.8 PT1 (Transfer function of the controller)

Command	Parameters	Unit	Group
`PT1 x`	`x= 1… 300`	ms	CONTROL

This parameter can be used to adapt the transfer function of the control function. Hydraulic drives are often critically to control, especially in case of very fast valves. The PT1 filter can be used to improve the damping rate and allows therefore higher loop gains or shorter braking distances.

Requirement for the use is: The natural frequency of the valve should be equal or higher than the natural frequency of the drive. With the inexpensive proportional valves used here, this is only the case if the latter is relatively low. The PT1 function can be used in both NC and SDD mode.

5.5.9 CTRL (Deceleration characteristics)

Command	Parameters	Unit	Group
`CTRL x`	`x=` `LIN(1)|SQRT1(2)|SQRT2(3)`	-	CONTROL

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 function.

The proportional valves used with this module almost always have a progressive characteristic, so SQRT1 (default setting) can be used as a basis. This braking characteristic enables fast and accurate travel to the target position.

In case of zero lapped valves (control valves and servo valves), the LIN or SQRT1 function should be used regardless of the application. The progressive characteristic of the SQRT1 function has 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.

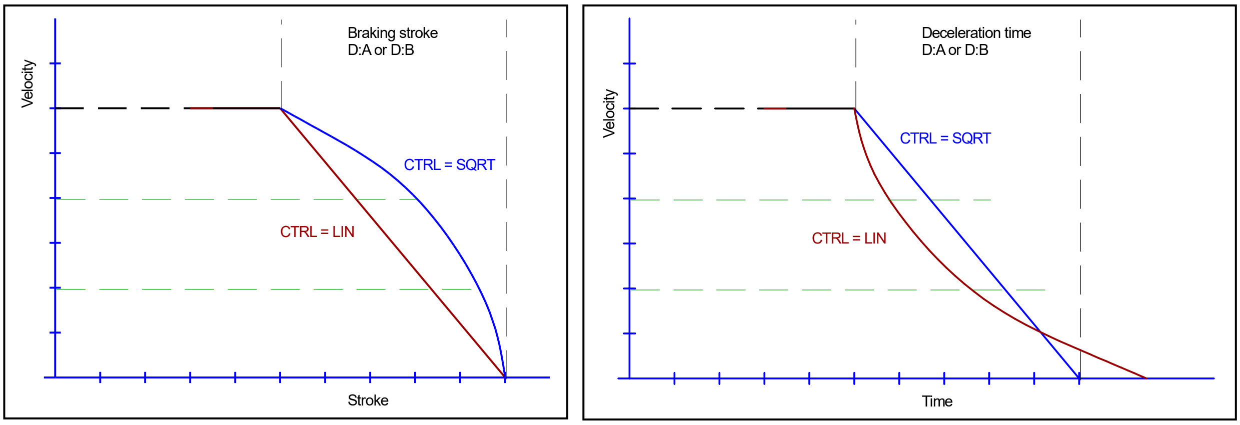


Figure 2 (Comparison of the braking behaviour over the stroke or over time)

5.6 ***Output signal adaptation***

5.6.1 MIN (Deadband compensation)

5.6.2 MAX (Output scaling)

5.6.3 TRIGGER (Response threshold for the MIN parameter)

Command	Parameters	Unit	Group
	I= A|B	-	**CONTROL**
MIN:I X	X= 0.0… 60.0	%	
MAX:I X	X= 30.0… 100.0	%	
TRIGGER X	X= 0.0… 40.0	%	

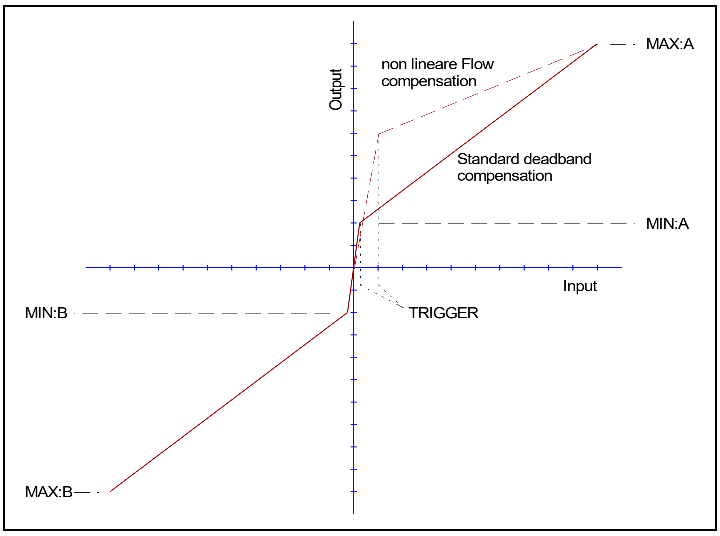
The output signal to the valve is adjusted by means of these commands. A kinked volume flow characteristic is used instead of the typical overlap step for the position controls.

There are various advantages associated with this output signal adaptation. Due to the kinked characteristic curve (instead of an overlap jump), a more stable positioning behaviour is achieved with simultaneous low valve wear, since the valve is no longer stimulated so strongly to jump over the overlap.

If the MIN setting (overlap compensation) has been carried out well, the accuracy can be further improved by reducing the trigger value to 0.2... 0.5%.

In the case of zero-overlapped valves (which are relatively rarely found as simple proportional valves), small values for the TRIGGER improve the positioning behaviour.

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.



In older WPC versions, the numerical values are entered with a decimal point shift in the unit 0.01%.

5.6.4 OFFSET (zero point correction of the output signal)

Command	Parameter	Unit	Group
`OFFSET x`	`x= -40.0... 40.0`	`0.01 %`	**POSITION**

This parameter is entered in 0.01 % units.
The offset value is added to the actuating signal at the output. This parameter can be used to compensate for zero point shifts of the actuator (valve).
In older WPC versions, the numerical value is entered with a decimal point shift in the unit 0.01%.

5.6.5 POL:U (polarity of the output signal)

Command	Parameter	Unit	Group
`POL:U x`	`x= +(1)|-(2)`	-	**CONTROL**

This command switches the polarity of the output signal, i.e. the assignment of the solenoids to the directions of movement.

5.7 *Simulation*

5.7.1 Sim (Activation of the internal simulation)

Command	Parameter	Unit	Group
`SIM x`	`x= OFF|ON|EXT`	-	**SIMULATION**

This command is used to activate the integrated control loop simulation.

OFF: The simulation is switched off

ON: The simulation is activated. All outputs of the device are deactivated so that the real actuator is not operated.

EXT: The simulation is activated. The outputs of the device remain active. This can be used, for example, to test the connection to a higher-level system (monitor signals, Ready and InPos feedback). The device can also be used as a universal HIL simulator of a hydraulic axis for an external controller if the signals are linked accordingly in the script.

5.7.2 Further parameterisation of the simulation model

Please read the associated "Drive simulation" manual, which is available on our homepage.

5.8 ***Special functions***

These commands are only accessible via the terminal:

5.8.1 DIAG (query of the last shutdown causes)

If this command is entered in the terminal window, the last 10 shutdowns (loss of *Ready with Enable* applied) are displayed. However, the shutdown causes are not saved when the supply voltage is switched off. The last cause is displayed in the bottom line of the list. Entries "---" indicate unused memory cells.

Finally, a special error code of the unit's internal self-diagnosis is output ("System Faillure State"). A value of "0" indicates that there are currently no system errors.

Example:

```
>DIAG
---
---
---
---
---
---
---
---
INPUT PIN 13
INPUT PIN 14
System Faillure State:
0
>
```

5.8.2 SC:CLEAR

This command resets the script to the factory setting and thus deletes individual programming. Please note that after power recovery, the last state saved via "SAVE" is still present, i.e. not only the parameters but also the script are read back from the EEPROM of the unit.

5.8.3 SC:LIST

Outputs the current script in the terminal window. Only the lines with content are displayed.

5.8.4 SC:I

Manual input option for script lines.

If you want to make minor changes without the "WestScript" programme, you can use this command in the terminal window.

Handling:

Enter the command SC:I, followed by a space, then specify the line to be defined, followed by an equal sign, function, then the parameters, these separated by spaces.

Example:

```
>SC:I M1=ADD PIN13 PIN14
```

5.8.5 ST_ACA (Commissioning Assistant Status Report)

This command is entered in the terminal window. Warnings may have been generated despite successful completion of the Start-Up Assistant. These are displayed here in plain text, as well as possible error causes in the event of an abort.

5.8.6 ECYCLE

If simulation is activated and the setpoint is provided via the square wave generator (ACA:CYCLE/POS1/POS2), this command indicates the power consumed over the cycle time, i.e. the energy used by the pump. In this way, the efficiency of different system configurations can be compared.

5.9 *Process data (Monitoring)*

Command	Parameters	Unit
WA	Demand value (input signal)	mm
W	Demand value (according to the profile generator)	mm
V	Speed input	%
X	Actual value	mm
E	Error value	mm
C	Output of the controller	%
U	Output signal of the module	%
IA	Solenoid current A	mA
IB	Solenoid current B	mA
VACT	Actual measured speed	mm/s
SC:A/B/C/D	M-signals defined by the user	%
PIN x[5]	Hardware input and output signals	%
DT	Processing time of the control, the script program and the simulation	µs

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

Additional values if simulation is activated:

Command	Parameters	Unit
P_P	Supply pressure	bar
P_A	Pressure at cylinder port A	bar
P_B	Pressure at cylinder port B	bar
PPU	Current power consumption of the pump	kW
FL	Load force	kN

[5] The differential input at PIN9 (-) and PIN10 (+) is designated PIN10 here.

6 Script programming

The basics of script programming are described in the appendix, paragraph 7.3.

In this chapter, the focus will be on the interaction between the script programme and fixed components of the software, the explanation of the standard script and typical adaptations.

6.1 *Interface between script and firmware*

As you can see in the block diagram, the script is a frame around the control application.

There are signals...

1.) ...which come from the hardware (inputs) and which are passed on to the script.
2.) ...which are transferred from the script to the positioning firmware (e.g. setpoint values).
3.) ...which are passed back to the script by this part of the programme before output.
4.) ...that go from the script to the hardware outputs or the power amplifier.
5.) ...pass some parameters of the standard firmware to the script

From the script's point of view, 1), 3) and 5) are input signals and 2) and 4) are output signals.

Input signal script	**Meaning**	**Value range**
PIN6	Analog input at PIN 6, 0...10V or 4...20 mA	-5.0 (0.0) ... 105.0
PIN910	Analog differential input at PIN 9/10, -10...0...10V or 4...12...20 mA	-105.0 ...0.0 ... 105.0
PIN13	Analog input at PIN 13, 0...10V or 4...20 mA	-5.0 (0.0) ... 105.0
PIN14	Analog input at PIN 14, 0...10V or 4...20 mA	-5.0 (0.0) ... 105.0
PIN29	Analog input at PIN 29, 0...10V	0.0 ... 105.0
PIN7	Switching input at PIN 7	0.0 or 1.0
PIN8	Switching input at PIN 8	0.0 or 1.0
PIN5	Switching input at PIN 5	0.0 or 1.0
PIN25	Switching input at PIN 25	0.0 or 1.0
PIN26	Switching input at PIN 26	0.0 or 1.0
READY	Ready for operation (output of the error processing)	0.0 or 1.0
ERFL	Flashing signal in the "Error & ENABLE active" state	0.0 or 1.0
STATUS	Status (InPos - Monitoring)	0.0 or 1.0
V, U, X, W, E	Process data (cf. 5.8)	% or mm
EOUT	Setting value of the parameter EOUT	%
SYSRNG	Setting value of the SYS_RANGE parameter	mm
Simulation signals (see also separate documentation)		
PPSIM	Pump pressure	bar
PASIM	Pressure cylinder port A	bar
PBSIM	Pressure cylinder port B	bar

Output signal script	Meaning	Value range
VA	Preset speed setpoint	%
WA	Preset target position	mm
XN	Raw signal of the current position	%
ENCTRL	Release of the position controller	On: value >= 1.0
STCTRL	Start of the positioning process	On: value >= 1.0
HAND_A	Manual command in direction A	On: value >= 1.0
HAND_B	Manual command in direction B	On: value >= 1.0
PIN15	Analog output at PIN 15, 0...10V or 4...20 mA	0.0 ... 100.0
PIN16	Analog output at PIN 16, 0...10V or 4...20 mA	0.0 ... 100.0
PIN1	Switching output at PIN 1	On: value >= 1.0
PIN2	Switching output at PIN 2	On: value >= 1.0
LED_GN	Green LED on the front of the module	On: value >= 1.0
LED_YM	Middle yellow LED on the front of the module	On: value >= 1.0
LED_YR	Right yellow LED on the front of the module	On: value >= 1.0
EN_SIG	External enable to error processing	On: value >= 1.0
SNAP	Trigger a snapshot of the script variables	On: value >= 1.0
SOL_A	Control value of the output stage channel A	0.0 ... 100.0
SOL_B	Control value of the output stage channel B	-100.0 ... 0.0 ... 100.0
PWA	Enable output stage channel A	On: value >= 1.0
PWB1	Enable output stage channel B1	On: value >= 1.0
PWB2	Enable output stage channel B2	On: value >= 1.0
SCERR	Error switch-off from the script	Error: value >= 1.0
Simulation signals (see also separate documentation)		
SIMU	Control of the simulated directional control valve	+/- 100.0 %
SIMDB	Control of the simulated pressure relief valve	0.0… 100.0%
SIMN	Control of a simulated frequency converter	0.0… 100.0%

The assignment of these outputs in the standard script is explained in the next section.

Control of the solenoid outputs:

It is necessary to enable the relevant channel via the logical signal PW... and to control it by means of the Analog setpoint via SOL.... 100.0 corresponds to the nominal current specified for CURRENT; exceeding the range is prevented by a signal limitation.

Channel B can be controlled bipolar, a negative signal acts on output B2 (PIN 21/23). As soon as a channel is controlled via enable (PW…) and corresponding setpoint specification (SOL…), the output is monitored for wire breakage. If an output is to remain open, it must not be enabled because a detected wire break leads to an error shutdown (READY changes to "0").

In the standard script, no use is intended for output channel B2, therefore the line PWB2 remains empty and negative setpoints, which can occur with SOL_B, do not lead to an activation of this output.

Generation of an error switch-off from the script program:

If the script program should generate a shutdown of the module that is to be processed like one of the other monitored error sources, the "SCERR" signal can be used for this purpose. If the content of this line contains a value >= 1.0, the SCERR error is generated, which leads to the READY message being cancelled and generally also to the outputs being switched off. The error status is reset via the error processing function, as set via the SENS parameter. This means that the error status is retained even if the SCERR line is reset.

Sequence of processing:

To ensure delay-free signal processing, it is important that the parts of the script that process the input variables for the position controller are evaluated before it is processed and the output variables afterwards. Therefore, the lines above the dividing line are processed in a first pass (incl. the M - lines 26-30) before the positioning algorithm, the rest afterwards. All manipulations of the actual value (XN) should take place in this area in any case. The setpoint specification and other functions (logic or similar) are less critical and can be placed as desired.

6.2 ***Standard script***

In the delivery state, or if the module is reset to this state via "DEFAULT" or "SC:CLEAR", the script is reset to the function of a usual positioning module:

```
VA       DIR      100.0    -        -
WA       DMUL     PIN13    SYSRNG   100.0
XN       DIR      PIN14    -        -
ENCTRL   DIR      READY    -        -
STCTRL   DIR      PIN7     -        -
HAND_A   DIR      PIN25    -        -
HAND_B   DIR      PIN26    -        -
PIN15    DMUL     W        100.0    SYSRNG
PIN16    DMUL     X        100.0    SYSRNG
SOL_A    DIR      U        -        -
SOL_B    MUL      U        -1.0     -
PIN1     DIR      READY    -        -
PIN2     DIR      STATUS   -        -
LED_GN   OR       READY    ERFL     -
LED_YM   DIR      STATUS   -        -
PWA      GT       SOL_A    0.0      -
PWB1     GT       SOL_B    0.0      -
EN_SIG   DIR      PIN8     -        -
SIMU     DIR      U        -        -
```

An explanation of the lines highlighted in grey:

WA: The setpoint is transferred to the positioning algorithm in mm. In this line, the conversion is made from the % - signal of the input.

PIN15/PIN16: These are monitor signals formed from the process variables. Normalisation to the % range of the output is done by dividing the internal variables by the nominal stroke and multiplying by 100(%).

SOL_B: Channel B is used for negative output signals. Thus, the inversion takes place here. Since B2 is not enabled, channel B is inactive with positive U values, i.e. negative SOL_B.

LED_GN: The green LED on the front of the unit shall indicate by steady light when the unit is ready for operation (READY) and flash when it is activated but there is an error. This flashing is provided by the input variable "ERFL".

PWA/PWB1: Activation of the two power amplifier channels used whenever there is a positive setpoint for the channel in question. A connection with "READY" would also be possible, but this would block manual operation in the event of a fault.

SIMU: The control signal of the controller used for the internal simulation. See also the documentation on this topic. This assignment has no meaning in normal operation.

6.3 *Typical adaptations*

6.3.1 Use of a speed input

This is the simplest change. Instead of the fixed 100(%), the input signal from PIN9/10 is to be processed as the speed setpoint.

Thus, the DIR assignment parameter must be changed from "100.0" to the input:

```
VA DIR PIN910 - -
```

The input can be done via the WestScript - programme or directly in the terminal via the command:

SC:I VA=DIR PIN910

Furthermore, please note that the input at PIN9/10 must of course be activated (factory setting SIGNAL:910 = OFF).

6.3.2 Residual speed mode

The POS-323-P module contains a so-called residual speed mode which is used e.g. for the safe closing of process valves. For reasons of simplification, this function has not been adopted here, but it can be reproduced relatively easily via a script.

Function description from the manual of the POS-323-P:

" The function is activated via the digital inputs at PIN25 / PIN26 (for the respective direction).

Function description:
If the actual value undershoots or overshoots the limit value (relative residual velocity position) and the corresponding digital input is set, the output of the controller is taken from the speed of the HAND parameter.

...

The yellow LED "B" indicates that the system is in the residual speed. The status output PIN 2 is also activated in the state of an active residual speed."

The partial function for the residual speed in retracting direction (B) is to be programmed here.

The conditions for activation are:

- Device READY (implicit, not mentioned above)
- START is set
- Digital input set at PIN5
  (PIN 25 and 26 are used for the hand signals on this unit).
- Setpoint < RVP
- Controller output in direction B is smaller than the residual speed

Realisation:

1. Formation of the limit value
   ```
   M1      LT      WA      PAR1    -
   ```
   PAR1 is used as parameter RVP. WA is calculated in another script line and can also be used as an input parameter here.

2. Another limit value: Is the control of B smaller in amount than the residual speed (PAR2)?
   Since it is a negative control value, a negative number is entered as PAR2 and compared to greater (!).
   ```
   M2      GT      U       PAR2    -
   ```

3. Linking the conditions in two lines:
   ```
   M3      AND     READY   STCTRL PIN5
   M4      AND     M1      M2      M3
   ```

4. Switch the output signal for B depending on the result:
```
M5      SEL     M4      U       PAR2
```
5. Injecting the new signal
```
SOL_B  MUL     M5      -1.0    -
```
6. Control LED
```
LED_YR DIR     M4      -       -
```

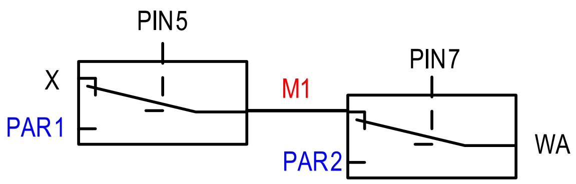
6.3.3 Retrievable setpoints

In this example, the target position is not to be specified by the Analog input at pin13, but a movement to two parameterisable target positions is to be triggered via the switching inputs at PIN5 and PIN7. PIN7 should therefore have a different function and the internal start signal should no longer depend only on this input.

PAR1 = Target position 1 when setting PIN5

PAR2 = Target position 2 when setting PIN7

Realisation by two switches:



If neither signal is set, the current actual value is set as the setpoint.

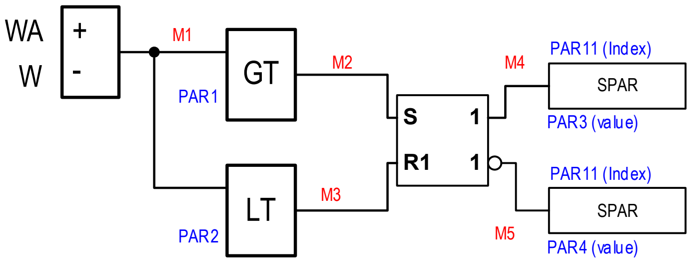
Script:
```
M1      SEL     PIN5    X       PAR1
WA      SEL     PIN7    M1      PAR2
STCTRL OR      PIN5    PIN7    -
```

6.3.4 Parameter switching

In NC mode, the movement is specified via the profile generator. The ACCEL parameter determines the acceleration. The parameter works in both directions.

If you want to specify different accelerations for the two directions of the movement, the ACCEL parameter at the start of the movement must be changed according to the desired direction. The script function "SPAR" can be used for this purpose.

The function can be programmed like this, for example:



In M1, the difference between the current target position and the output of the profile generator is formed. A movement in direction "A" has been started if the difference exceeds a (positive) limit value PAR1. A movement in direction "B" causes M1 to be below a (negative) limit value PAR2. The flip-flop therefore remembers the last initiated direction of movement.

The parameter setting function "SPAR" already evaluates edges so that the output of the flip-flop can be directly connected to the setting function for the parameter at extension and inverted to that for the parameter at retraction. Parameter 11 (index) is the same for both cases and has the value "5310"; according to the parameter table, this index stands for "ACCEL".

Realisation of the script:

```
M1      SUB     WA      W       -
M2      GT      M1      PAR1    -
M3      LT      M1      PAR2    -
M4      RS      M2      M3      -
M5      NOT     M4      -       -
M6      SPAR    M4      PAR11   PAR3
M7      SPAR    M5      PAR11   PAR4
```

7 Appendix

7.1 *Failure monitoring*

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

Source	Fault	Characteristic
Analog inputs in the I4-20 range	Out of range or broken wire	The power stage will be deactivated by the standard script.
Solenoids on PIN 17-20	Wrong cabling, broken wire	The power stage will be deactivated by the standard script.
EEPROM (when switching on)	Data error	The output is deactivated. The module can only be activated by saving the parameters again!
Error output from the script	The script sets the SCERR signal to a value >= 1.0 This allows the user to realise special monitoring	The power stage will be deactivated by the standard script.

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

7.2 *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 flashes.	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. • A broken cable or incorrect cabling to the solenoids (in the P version only). • 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 by the command POL:U or by changing of the solenoid plugs.
ENABLE is active, the READY LED is on, 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[6])? • In the case of a proportional valve, the valve overlap which may be present should be compensated for with the MIN parameters. Typical values are to 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 or deceleration stroke). • 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 the 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?
	  • Setting of the deceleration stroke in relation to the cylinder stroke should be checked?

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)

[6] The stability criterion of the hydraulic axes must be taken into account.

7.3 *Scripting Language*

7.3.1 Basic concept

A script consists of a list in which predefined memory cells are listed. For each of these cells, one can specify a function with which the content of the memory cell is calculated.

During runtime, these functions are called cyclically and the cell content is recalculated.

There are two types of cells, namely freely usable (M1 ... Mxx) and cells permanently connected to outputs. The content of the latter is either passed directly to physical outputs of the unit or serves as an input signal into a fixed defined internal function, for example as the setpoint of a controller.

The naming and function of the cells depends on the device, M... cells always exist.

The called functions can have up to three parameters, which are themselves memory cells or physical input signals.

An example:

Consider the following script:

```
M1        = GT   PIN14   PAR1
M2        = LT   PIN14   PAR2
...
LED_YR    = RS   M1      M2
```

The first line (M1) checks whether the input signal at PIN14 is greater than a parameterisable fixed value (PAR1).

The second line (M1) checks whether the input signal at PIN14 is lower than a second parameter.

The output signal, with which the right yellow LED of the unit is controlled, is the switching state of an RS - flipflop, which is connected to the results of these comparisons.

As can be seen, the memory cells can have the meaning of an analogue value as well as a boolean variable. The script interpreter evaluates a content >= 1.0 as logically "TRUE" and functions that provide a logical output value set the corresponding memory cell to 0 or 1.0.

Analogue input and output signals are always scaled in the range 0 ... 100%.

So, in the above example, if you set the parameter PAR1 to the value 50.0 and PAR2 to 40.0, you get a comparator with hysteresis. A voltage > 5 V at PIN 14 will switch on the right yellow LED. The LED lights up until the voltage has dropped below 4 V again.

7.3.2 Command overview

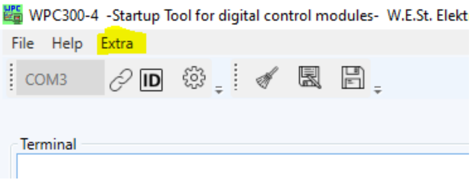
Command:	Meaning:	Operand 1:	Operand 2:	Operand 3:
Mathematics				
DIR	direct assignment	Source	-	-
ADD	Addition	Summand 1	Summand 2	Summand 3 (optional)
SUB	Subtraction	Minuend	Subtrahend	-
MUL	Multiplication	Factor 1	Factor 2	Factor 3 (optional)
DMUL	Multiplication + Division	Factor 1	Factor 2	Divisor
LIM	Limitation	Input value	Lower limit	Upper limit
SQRT	Square root function	Input value	-	-
SIN	Sine function	Input value	-	-
ABS	Absolute value	Input value	-	-
NORM(L)	Normalisation to a range	Input value	Supporting point X1	Supporting point X2
UNORM	Scaling	Normalised value (u)	Supp. point Y1 (u=0)	Supp. point Y2 (u=1)
INTEG	Integrator	Input value	Reset	Reset value (optional)
PT1	1st order low pass	Input value	Time constant	Reset
MIN	Minimum value selection	Value 1	Value 2	Value 3 (optional)
MAX	Maximum value selection	Value 1	Value 2	Value 3 (optional)
Logic				
SEL	Signal selector	Switching input (OP1)	Value at OP1 < 1	Value with OP1 >=1
GT	Comparison: OP1 > OP2	Value 1 (OP1)	Value 2 (OP2)	-
LT	Comparison: OP1 < OP2	Value 1	Value 2	-
GE	Comparison: OP1 >= OP2	Value 1	Value 2	-
LE	Comparison: OP1 <= OP2	Value 1	Value 2	-
AND	logical "and"	Value 1	Value 2	Value 3 (set "1" if necessary)
OR	logical "or"	Value 1	Value 2	Value 3 (optional)
NOT	logical negation	Input value	-	-
RS	RS - Flipflop	Set input	Reset input	-
Time functions				
RAMP	1 - Quadrant ramp	Input value	Ramp time	Reset
TE	Switch-on delay	Input value	Time	-
TA	Switch-off delay	Input value	Time	Reset
FP	Edge detection (rising)	Input value	-	-
FN	Edge detection (falling)	Input value	-	-
FUR	Square wave generator	Frequency	Amplitude	Reset
FUS	Sine wave generator	Frequency	Amplitude	Reset
FUT	Triangular wave generator	Frequency	Amplitude	Reset
Miscellaneous (not available with every device)				
FUN2	Secondary function value	-	-	-
SPAR	Read / write parameters	Trigger function	Index	Write value (- for read)

7.3.3 Programming software

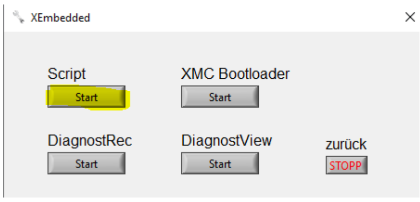
The programming environment for script editing is included in the WPC software package (from version 4.1.2.5). With this software you can load and save the script, display it clearly and edit it comfortably. At this point, only the basic information on operation is to be given. Further information can be found in the programme documentation, see below.

7.3.3.1 Connect and read out data

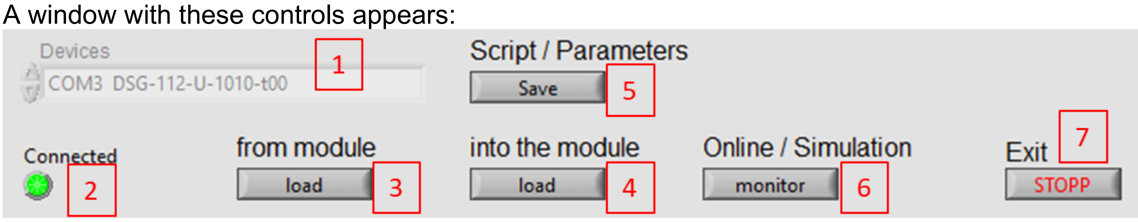
Connect the module in the WPC and then select the menu item "Extras":



A submenu opens from which you can start the environment:

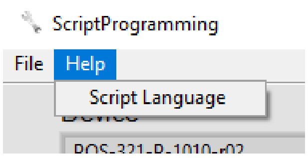


A window with these controls appears:



1.) Display of the active connection with the module identification.
2.) The green indicator confirms the successfully established connection.
3.) This button reloads the current script program on the module to the editor.
4.) Transfer of the script from the editor to the module. Attention: The change is effective immediately.
5.) This button causes both the script and the currently set parameters to be permanently stored in the EEPROM of the unit. It corresponds to the homonymous button in the WPC – main window.
6.) Activation of the observation mode (see below)
7.) The sub-programme should only be terminated via this button. You return to the WPC main window and the module is automatically re-identified. This may take a short moment.

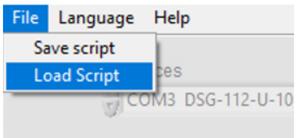
In the menu line you can also call up a comprehensive description of the script language:



7.3.3.2 Load script created offline or enter script with connected module

If you want to transfer a script file from your computer to the unit, this is done in several steps:

1. Load the script from the file into the editor:



Save: Saves the displayed script table to a file

Load: Loads the script from a file into the table

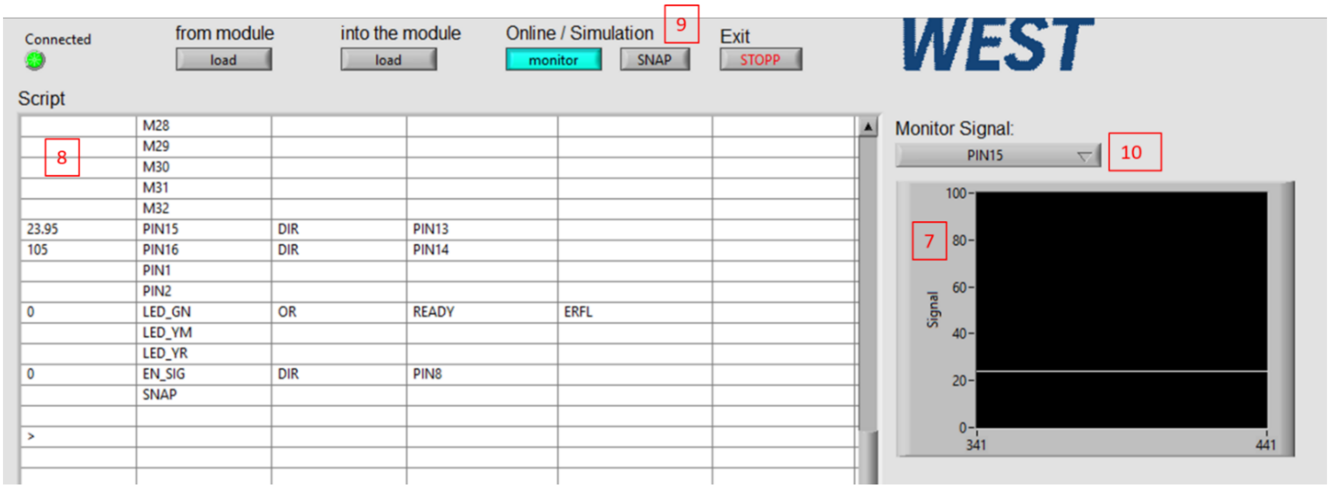
2. Use button 4 (see above) to transfer the contents of the table to the unit.
   If there are faulty commands, the transmission stops at this point.

3. After successful transfer, the changed script is immediately active. You can now make further settings (e.g. parameters) and test the function. However, do not forget to permanently save the data in the non-volatile memory of the unit to complete the activities via the Save button in this software (5) or WPC.

Direct editing of a script in online mode:
After connecting a module, the data of the module definition is automatically read from the unit. As described in chapter 5, one can change the script directly in the displayed table. The context menus can also be activated accordingly via a right click. However, this is only enabled if no observation mode has been activated (see the following section). After changing, the script is loaded into the module by clicking on button 4.

7.3.3.3 Observation mode

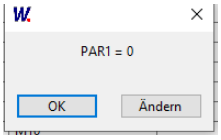
The observation mode is used for commissioning and checking the script function. If one activates this mode via button 6, the current values for each line are displayed in the "Online" column of the script table (8):



Pressing button 6 again deactivates the observation mode.

Special function possible in observation mode:

- **Parameter display and change**
  When (left) - clicking on a free parameter "PAR..." in the table, a dialogue window appears in which the current value is displayed and the possibility to change it is offered:



- **Signal recorder**
  In the observation mode, a strip chart (7) is visible in which the temporal course of one of the signals can be displayed. To do this, select a signal of interest via the pull-down menu 10. The scaling of the Y-axis can be changed by right-clicking on its scale: Deactivate autoscaling, then it is possible to change the lower and upper limit in the diagram by clicking directly on the value and entering a number there. The signal recorder at this point is intended as a tool for quick assessment of individual signals. If you want to record several signals, save the result, etc., the oscilloscope function in WPC is a much more comprehensive and convenient tool.

- **Snapshot**
  If you want to reconstruct the situation in case of sporadic events, it is helpful if you can create a copy of the online values at the time in question. There is a special memory cell "SNAP" for this purpose. If the value of this variable rises >= 1.0, a snapshot of the online values is saved at that time. This snapshot can be viewed by pressing the "SNAP" button (9). The snapshot is overwritten with every rising edge of the variable "SNAP" in the table. If you want to save only one state, you can enter e.g. the function RS and connect only the set input. If you select the snapshot view and find only zeros in the online column (including the SNAP line), this means that no recording has been triggered after the unit was started.

8 Notes