WEST

Technical Documentation

POS-323-P

Positioning module with integrated power output stage

Electronics
Hydraulics meets
meets Hydraulics
Electronics

Contents

1 General Information

1.2 Order number

POS-323-P - with integrated power output stage and analog sensor interface

1.3 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.

1.4 Accessories

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

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

1.5 Symbols used

General information

Safety-related information

1.6 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.

1.7 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.

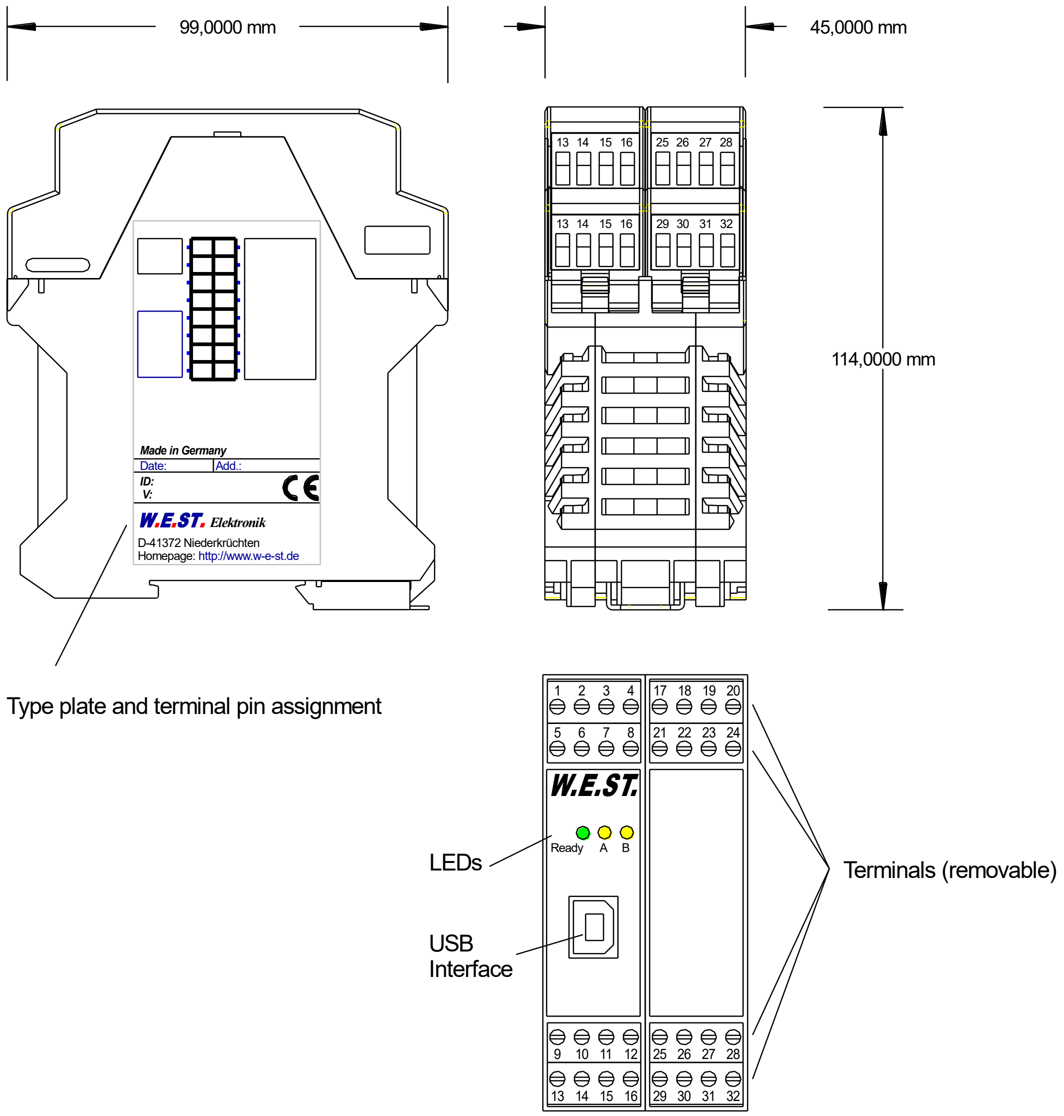
Setting up this module is simple and easy to handle with our WPC-300 start-up software.

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**
- **Residual speed mode (closing with force)**
- **Input current limiting for supporting explosion proof applications**
- **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.

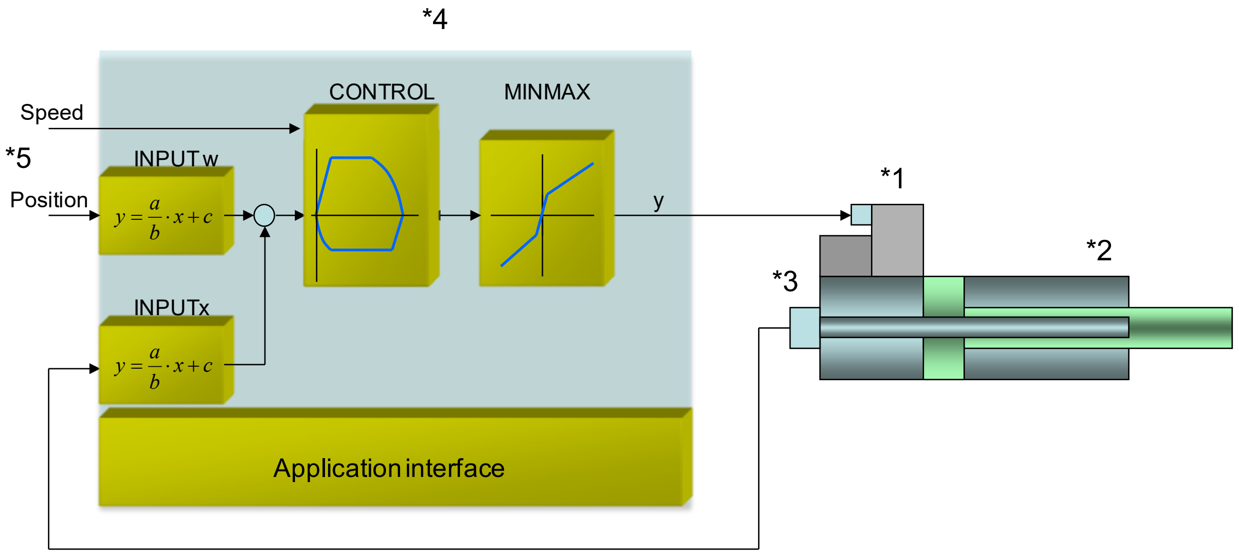
- A low-resistance connection between PE and the mounting rail should be provided. Transient interference is transmitted from the module directly to the mounting rail and from there to the local earth.

- 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 or SSI position sensor (alternatively also with external position sensor)
(*4) POS-323-* 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.

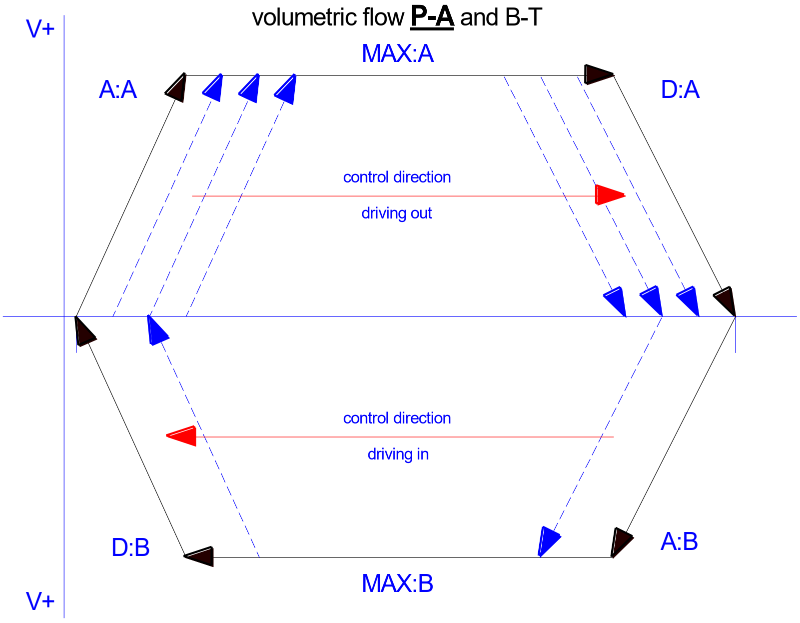
The deceleration characteristics / closed-loop-gain can be set linearly (**LIN**) or approximately quadratically (**SQRT1**) via the **CTRL** parameter. For normal proportional valves **SQRT1** is set.

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 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- 323-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.

3.2 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:X**)
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:W**)*
	• *Signal definition of the analog feedback (**SIGNAL:X, N_RANGE:X**)*
	• *Polarity of the output (**SIGNAL: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 3.4.
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.

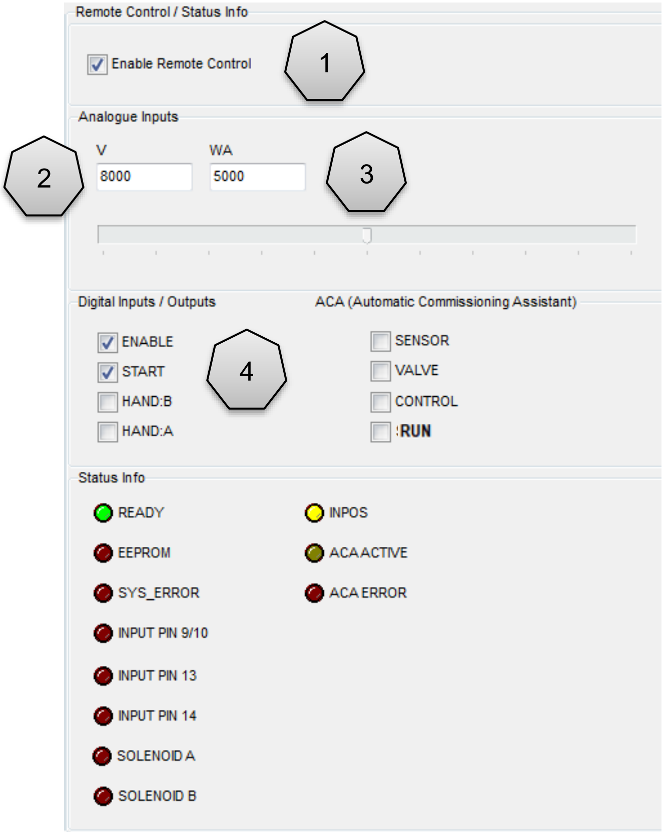
3.3 Remote Control

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.

Analogue 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.

3.4 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).

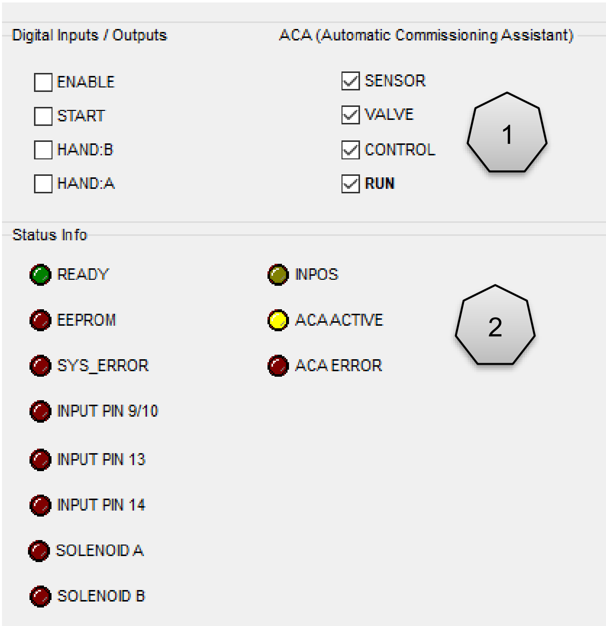
Features

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

3.4.1 Optimisation steps

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

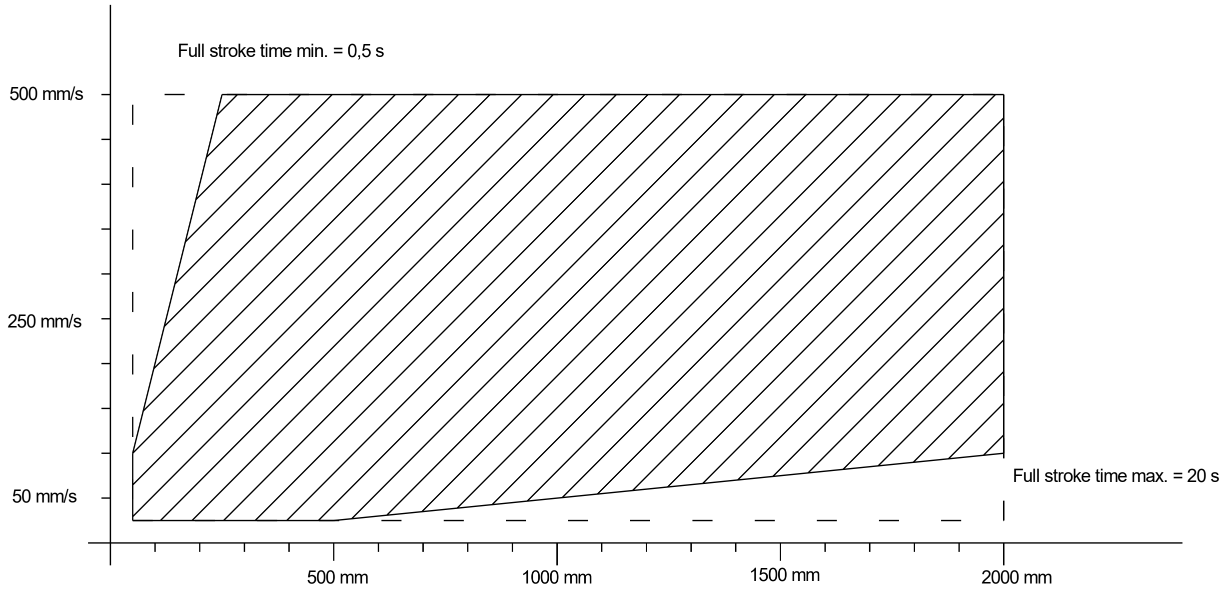
1. The polarity is checked and corrected if necessary. This is done automatically each time.
2. The sensor scaling can be activated via the switch **SENSOR**. If the sensor scaling is active, the drive automatically moves to the two end positions, saves the values and scales the analog input.
3. Valve 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.

3.4.2 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.



3.4.3 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.

3.4.4 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

4.2 Input and output signals

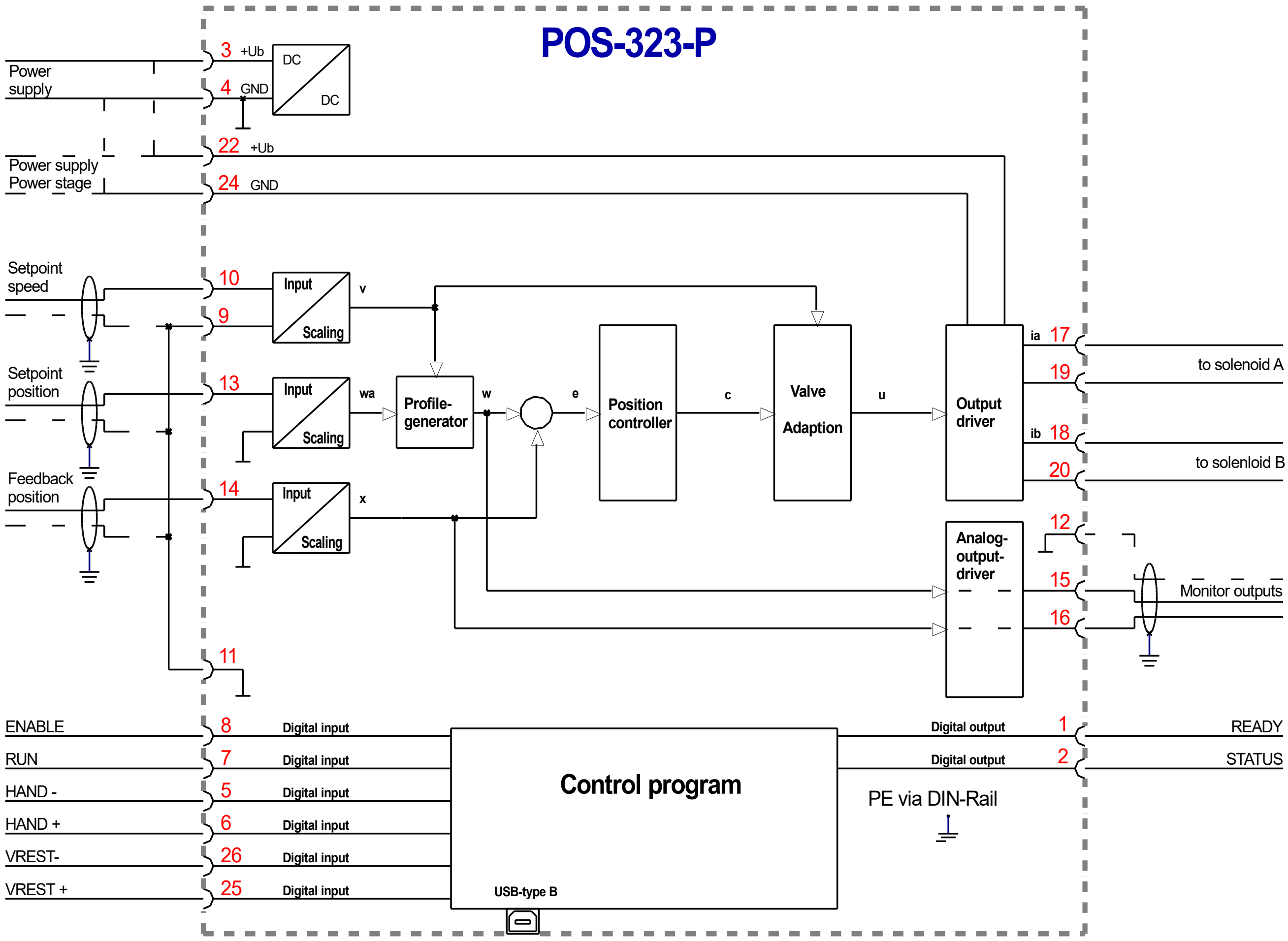
Connection	Supply
PIN 3	Power supply (see technical data)
PIN 4	0 V (GND) connection
PIN 22	Power supply of the power stage
PIN 24	0 V (GND) of the power stage
Connection	**Analogue signals**
PIN 9 / 10	External speed demand (V), range 0… 10 V or 4… 20 mA (scalable)
PIN 13	Position demand value (W), range 0… 10 V or 4… 20 mA (scalable)
PIN 14	Analog position actual value (X), range 0… 10 V or 4… 20 mA (scalable)
PIN 11 / PIN 12	0 V (GND) connection for analog signals
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 B
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 6 / PIN 5	**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+ input. If the sensor signal is missing (external ENABLE signal = ON), the drive can be operated in manual mode.
PIN 25 / PIN 26	**Residual speed mode for extending and retracting:** **ON:** The axis is driving (with manual speed) to the end positions. **OFF:** The corresponding direction is not activated.

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.

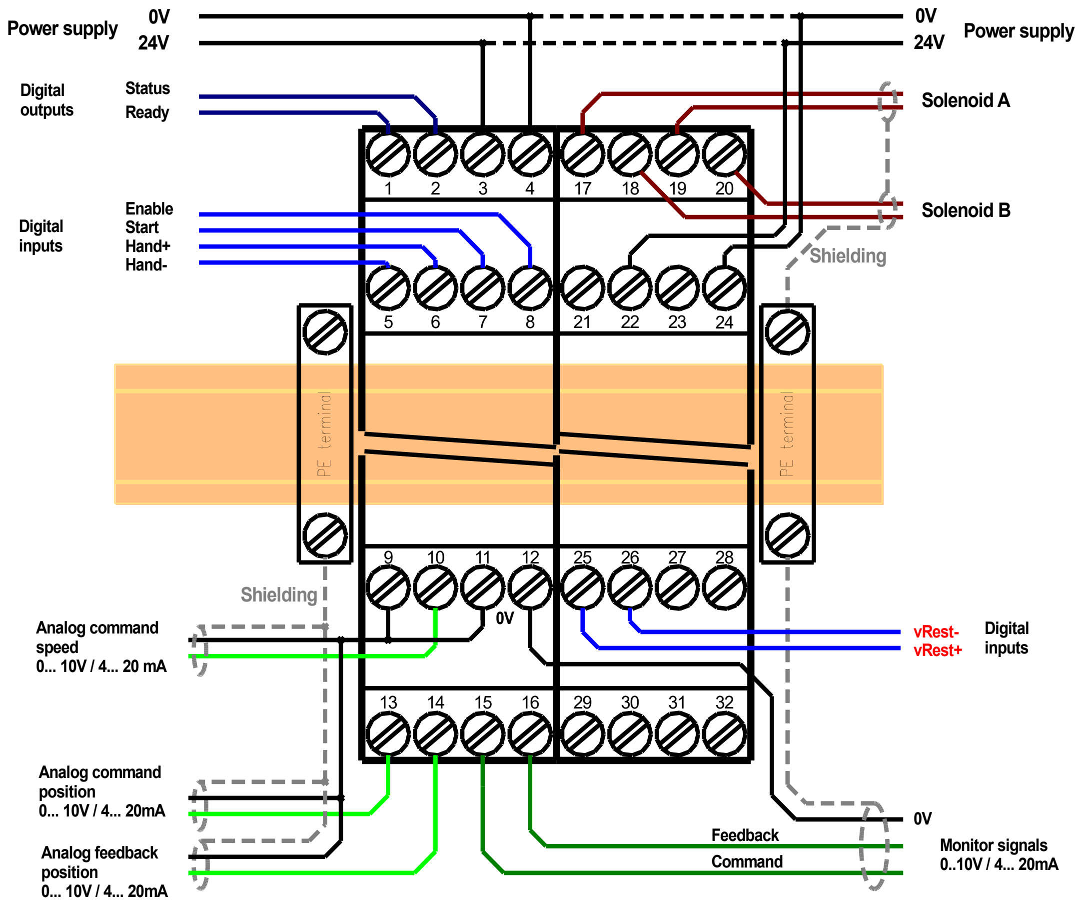
4.3 LED Definitions

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.
YELLOW B	Residual speed **OFF:** Normal positioning mode **ON:** The axis drives within the residual speed area up to the mechanical stop.
GREEN + YELLOW A	1. **Chasing light (over all LEDs):** The bootloader is active. No normal functions are possible. 2. **All LEDs flash shortly every 6 s:** An internal data error was detected and corrected automatically! The module still works regularly. To acknowledge the error, the module has to be cycle powered.
YELLOW A + YELLOW B	**Both yellow LEDs flash oppositely every 1 s:** The nonvolatile stored parameters are inconsistent! To acknowledge the error, the data have to be saved with the SAVE command or the corresponding button in the WPC. If the function of the module has changed via the FUNCTION parameter, all parameters are deleted purposely and set to default values. In this case, the LEDs indicate no error, but a desired state. To acknowledge please save.

4.4 Circuit diagram



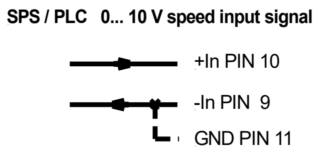
4.5 Typical wiring

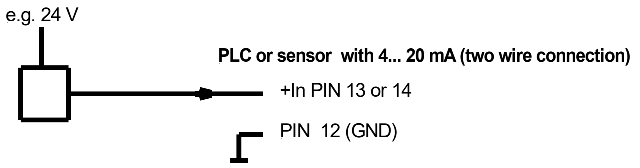


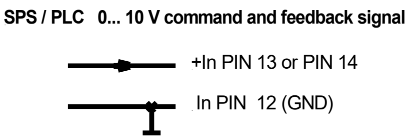
CAUTION: The solenoid cables should be screened due to electro-magnetic emissions.

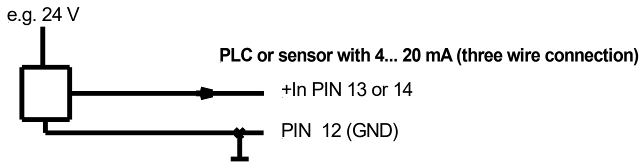
CAUTION: Plugs with free-wheeling diodes and LED indicators cannot be used with current-controlled power outputs. They interfere with the current control and can destroy the output stage.

4.6 Connection examples









4.7 Technical Data

Supply voltage (U_b)	**[VDC]**	12… 30 (incl ripple)
Power consumption	**[W]**	max. 2.5 + 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
Analogue inputs		Unipolar
Voltage	**[V]**	0… 10
Input resistance	**[kOhm]**	min. 25
Signal resolution	**[%]**	0.003 incl. Oversampling
Current	**[mA]**	4… 20
Burden	**[Ohm]**	240 Ohm
Signal resolution	**[%]**	0.006 incl. Oversampling
Analogue 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]**	0.28
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

Group	Command	Default	Unit	Description
Basic parameter (Group SYSTEM)				
	LG	EN	-	Changing language help texts
	USER	STD	-	Parameter view
	SENS	ON	-	Malfunction monitor
	EOUT	0	0,01 %	Output signal if not ready
	HAND:A **HAND:B**	3330 -3330	0,01 % 0,01 %	Output signal in manual mode
	VMODE	SDD	-	Positioning method
	ACCEL	250	mm/s^2	Acceleration in NC mode
	VMAX	250	mm/s	Maximum speed in NC mode
	V0:RES	1	-	Resolution of the loop gain parameters (1 s^{-1} or 0,01 s^{-1})
	POSWIN	200	µm	Range of the in-position-monitoring
	RVP	0	mm	Relative residual speed position
	IMS	2600	mA	Limitation of the maximum input current
Signal adaptation (Group IO_CONFIG)				
Sensor scaling				
	SYS_RANGE	100	mm	Axis working stroke
	SIGNAL:X	U0-10	-	Type of input
	N_RANGE:X	100	mm	Nominal range of sensor
	OFFSET:X	0	µm	Offset of sensor
Input scaling				
	SIGNAL:W	U0-10	-	Type of input
Speed input				
	SIGNAL:V	OFF	-	Type of input signals (OFF = parameter VELO is active)
	RAMP:V	200	ms	Ramp time for the external speed input
Output signals / Power stage				
	SIGNAL:M	OFF	-	Monitor outputs (PIN 15 and PIN 16)
	SIGNAL:U	+	-	Output polarity
	CURRENT	1000	mA	Nominal solenoid current
	DFREQ	125	Hz	Dither frequency
	DAMPL	500	0,01 %	Dither amplitude
	PWM	2604	Hz	PWM frequency
	ACC	ON	-	Automatic adjustment of PPWM and IPWM parameters, dependent on PWM frequency
	PPWM	7	-	P gain of the current loop
	IPWM	40	-	I gain of the current loop

Group	Command	Default	Unit	Description
Automatic commissioning assistant (Group START-UP)				
	ACA:POS1	25	mm	Lower position
	ACA:POS2	75	mm	Upper position
	ACA:CYCLE	0	ms	Cycle time of the square wave generator, active in REMOTE CONTROL mode.
Controller (Group CONTROL)				
	VELO:V	10000	0,01 %	Internal speed limitation
	OFFSET	0	µm	Position offset
	A:A **A:B**	100 100	ms ms	Acceleration time (SDD mode)
	D:A **D:B** **D:S**	25 25 10	mm mm mm	Deceleration stroke and NOT stop stroke
	V0:A **V0:B**	8 8	1/s 1/s	Closed loop gain in NC mode
	CTRL	SQRT1	-	Control characteristics
	MIN:A **MIN:B**	0 0	0,01 % 0,01 %	Deadband compensation or flow characteristic linearization
	MAX:A **MAX:B**	10000 10000	0,01 % 0,01 %	Output scaling
	TRIGGER	50	0,01 %	Deadband compensation trigger point
Special commands				
	AINMODE			
	AINMODE	EASY	-	Input scaling mode
	AIN:I	**I= W|X|V** A: 1000 B: 1000 C: 0 X: V	 - - 0,01 % -	Free scaling of the analog inputs (MATH)

5.2 System parameters

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 USER (Scope of parameters)

Command	Parameters	Unit	Group
USER x	x= STD|EXP	-	SYSTEM

This command changes the operating mode. Various commands (defined via STD/EXP) are blanked out in Standard Mode. The commands in "Expert" mode activate functions that are needed less frequently.

5.2.3 SENS (monitoring of the modul functions)

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

5.2.4 EOUT (Output signal: READY = OFF)

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

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

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

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

5.2.5 HAND (Manual speed)

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

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.

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

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.

5.3 Signal adaptation (IO_CONF)

5.3.1 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.

5.3.2 SIGNAL (Type of input)

Command	Parameters	Unit	Group
SIGNAL:i x	i= W|X|V x= OFF U0-10 I4-20 U10-0 I20-4	-	EASY + IO_CONFIG

This command can be used to change the type of input signal (voltage or current) and to define the direction of the signal. This command is available for all analog inputs (W, X, and V).
OFF= Deactivation of the input[3].

[3] The deactivation can be used to deactivate the velocity (speed) input PIN_9/10 (the VELO value is active).

5.3.3 N_RANGE:X (Nominal range of the sensor)

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

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

5.3.4 OFFSET:X (Sensor offset)

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

Adjustment of the zero point of the sensor.

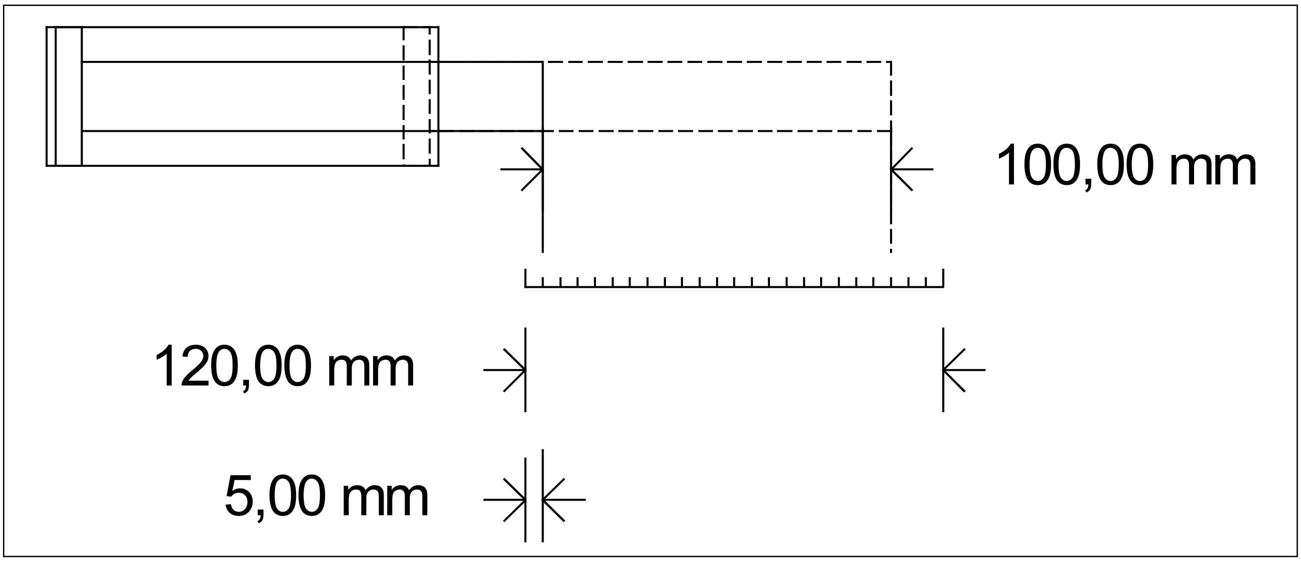
OFFSET:X is internal limited by the values of SYS_RANGE.

5.3.5 Using the commands SYS_RANGE, N_RANGE:X and OFFSET:X[4]

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

[4] 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.

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



5.3.6 Speed commands

The SIGNAL:V command is used to switch over between external or internal speed limitation.
SIGNAL:V = OFF Internal speed limitation (VELO command)
SIGNAL:V = U0-10 External speed limitation

PIN 9/10 is used for external speed limitation.

5.3.6.1 VELO:V (Internal speed demand value)

Command	Parameters	Unit	Group
VELO x	x= 1… 10000	0,01 %	IO_CONFIG + SIGNAL = OFF

Setting of the internal speed limitation if the external input V at terminal 9/10 is not used:
In SDD mode, the VELO parameter limits the control signal and thus the speed.
In NC mode, the VELO parameter does not limit the output signal, but the speed of the profile generator. The lowest possible speed is 0.01 mm/s (VMAX = 1 mm/s, VELO = 1 %).

5.3.6.2 RAMP:V (Ramp time for external speed demand)

Command	Parameters	Unit	Group
`RAMP:V x`	`x= 10… 5000`	`ms`	IO_CONFIG + SIGNAL:V <> OFF

The rate of change of the external speed demand can be limited by this ramp time. The command is only active if external speed demand has been parameterized.

5.3.7 Parameters of the power stage

5.3.7.1 SIGNAL:U (output polarity)

Command	Parameters	Unit	Group
`SIGNAL:U x`	`x= +|-`	-	IO_CONFIG

Changing of the output polarity.

5.3.7.2 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.

5.3.7.3 DAMPL (Dither amplitude)

5.3.7.4 DFREQ (Dither frequency)

Command	Parameters	Unit	Group
`DAMPL x` `DFREQ x`	`x= 0… 3000` `x= 60… 400`	`0,01 %` `Hz`	IO_CONFIG

The dither[5] can be defined with these commands. Different amplitudes or frequencies may be required depending on the valve.

[5] 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.

The dither amplitude is defined in % (peak to peak value) of the nominal output current[6] (see: CURRENT command).
The dither frequency is defined in Hz. Depending on the internal calculations; the frequency is adjustable in steps only.

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.*

5.3.7.5 PWM (PWM frequency)

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

The frequency can be changed in defined steps (61 Hz, 72 Hz, 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 and 2604 Hz). The optimum 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.

5.3.7.6 ACC (Current loop, automatic adjustment)

Command	Parameters	Unit	Group
ACC x	x= ON|OFF	-	EXP + 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.

[6] 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.

5.3.7.7 PPWM (Solenoid current controller P element)

5.3.7.8 IPWM (Solenoid current controller I element)

Command	Parameters	Unit	Group
`PPWM x` `IPWM x`	`x= 0… 30` `x= 1… 100`	- -	**EXP + 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.

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.

5.3.7.9 SIGNAL:M (Type of the monitor output signal)

Command	Parameters	Unit	Group
`SIGNAL:M x`	`x= U0-10|I4-20`	-	**EXP + IO_CONFIG**

This command is used to define the output signal (voltage = U0-10 or current = I4-20).

5.4 Profile generator

5.4.1 VMODE (Method of positioning)

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

5.4.2 ACCEL (Acceleration in NC Mode)

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

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.

5.4.3 VMAX (Maximum speed in NC Mode)

Command	Parameters	Unit	Group
`VMAX x`	`x= 1… 2000`	`mm/s`	**EXP + SYSTEM**

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 analogue input V (percentage value).

5.5 Control parameter

5.5.1 A (Acceleration (ramp) time)

Command	Parameters	Unit	Group
`A:i x`	`i= A|B` `x= 1… 5000`	`ms`	**CONTROL + VMODE=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.

5.5.2 D (Deceleration / braking distance)

Command	Parameters	Unit	Group
`D:i x`	`i= A|B|S` `x= 1… 10000`	`mm`	**CONTROL + VMODE = 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.

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

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

5.5.3 V_0 (Loop gain setting)

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

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

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

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

Calculation of the internal control gain

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

5.5.4 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|100`	-	**EXP + SYSTEM**

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

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

5.5.5 CTRL (Deceleration characteristics)

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

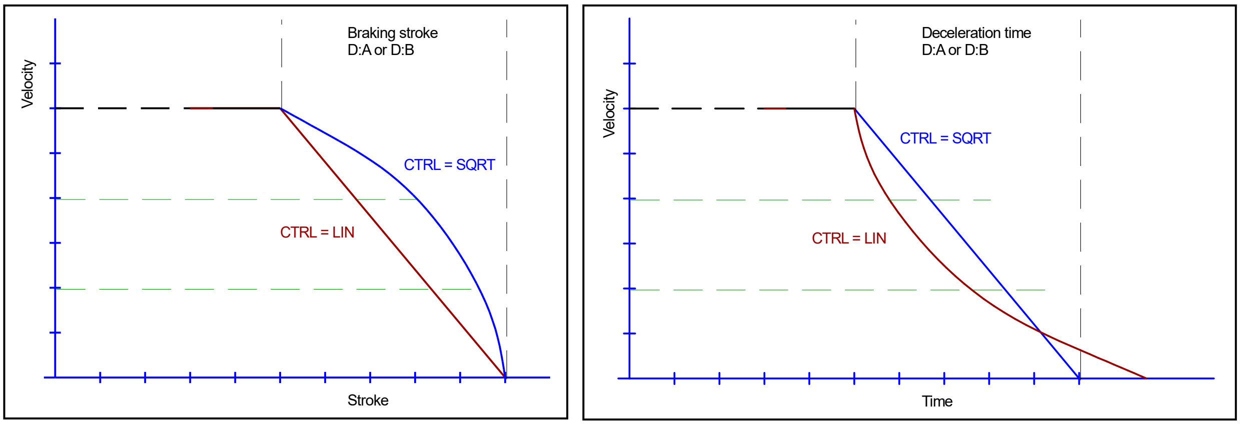
The proportional valves used with this module almost always have a progressive characteristic, so SQRT1 (default setting) can be used as a basis. This braking characteristic enables fast and accurate travel to the target position.

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.



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… 6000	0,01 %	
MAX:i x	x= 3000… 10000	0,01 %	
TRIGGER x	x= 0… 4000	0,01 %	

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

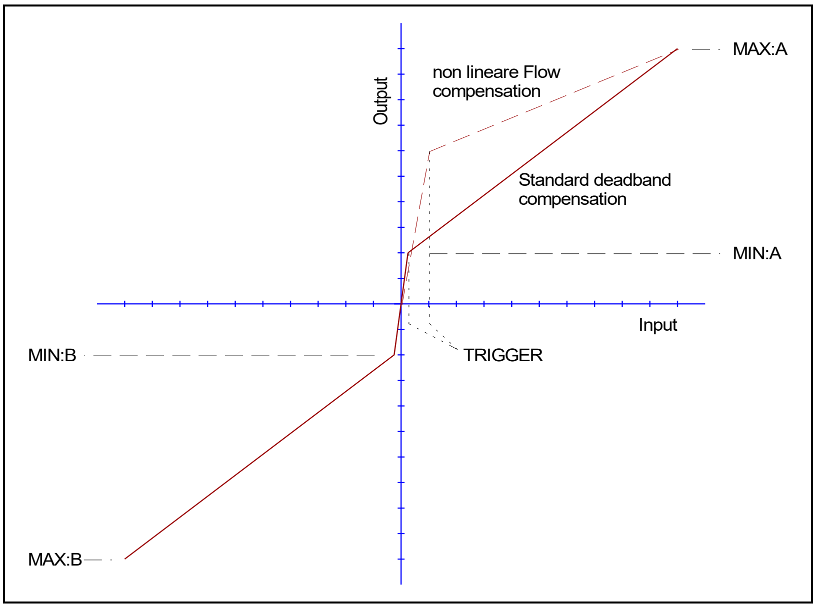
There are various advantages associated with this output signal adaptation. Due to the kinked characteristic curve (instead of an overlap jump), a more stable positioning behaviour is achieved with simultaneous low valve wear, since the valve is no longer stimulated so strongly to jump over the overlap.

If the MIN setting (overlap compensation) has been carried out well, the accuracy can be further improved by reducing the trigger value to 20... 50.

In the case of zero-overlapped valves (which are relatively rarely found as simple proportional valves), small values for the TRIGGER of 0... 5 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.



5.7 Automatic Commissioning ACA

5.7.1 ACA:POS1 (Lower position)

5.7.2 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.

5.7.3 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.

5.8 Special functions

5.8.1 Residual speed mode

This function can be used to move the drive to one of the both mechanical stops. This is often required, for example in process fittings (control valves, dampers, etc.) and blow molding machines.

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.

5.8.1.1 RVP (Closing point / fix speed point)

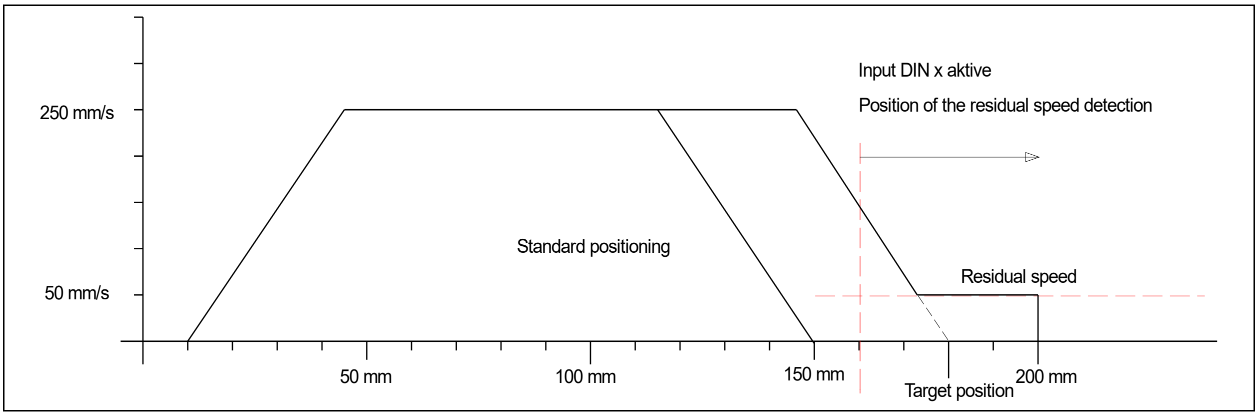
Command	Parameters	Unit	Group
`RVP x`	`x= 0… 500`	`mm`	**EXP + SYSTEM**

RVP This parameter is used to determine the response threshold measured from the stroke ends. Example: SYS_RANGE = 200 mm, RV: P = 20 mm -> triggers the function at setpoint < 20 mm and / or at setpoint > 180 mm. The value "0" deactivates the function.

If this function is used for process valves, the parameter RVP should be set to small values (1 ... 3 mm), so that a tight closing is only activated at the end of the stroke.

This function should be used in SDD mode only.

Example: Residual speed when extending from 160 mm stroke (**RVP** = 40 mm)



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.

5.8.2 IMS (Theoretical maximum current drain)

In order to offer a safe protection against overheating of the coil in case of a hardware failure, the use of an up-stream electronic overload protection may be required.
Further information about this topic can be taken from the document AN-102: „Proportional valves in explosive areas".
With the IMS parameter, it is possible to limit the current drain of the power amplifier in a way that even under adverse conditions the overload protection will not trigger if there is no hardware fault. The function does not delimit the dynamics of the system and the full solenoid current is preserved as long as possible. The limiting function calculates the current drain by considering the solenoid current and the duty cycle of the PWM signal. Therefore, its precision is affected by the PWM frequency, but it is always sufficient in order to avoid triggering the protection switch.

Preset value of the parameter is 2600 mA and this means it is inactive. Activation of the function is achieved by setting IMS < CURRENT. The rated current of the protection switch should be entered.

Command	Parameters	Unit	Group
`IMS x`	`x= 500 … 2600`	`mA`	**SYSTEM + EXP**

5.8.3 AINMODE

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

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

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

In MATH mode, the **Automatic Commissioning Assistant** can only be used to a very limited extent.

5.8.3.1 AINMODE (Input scaling mode)

Command	Parameters	Unit	Group
`AINMODE x`	`x= EASY|MATH`	-	STD

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

5.8.3.2 AIN (Analog input scaling)

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

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

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

The ***"c" value*** is the offset (e. g. to compensate the 4 mA in case of a 4… 20 mA input). The variables ***"a"*** and ***"b"*** define the gain factor.

e.g.: 2.345 correspond to: ***a*** = 2345, ***b*** =1000

The internal measuring resistor for measuring the current (4… 20 mA) is activated via the **x** value and the evaluation switched over accordingly.

Typical settings:

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

5.9 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

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

6 Appendix

6.2 Failure monitoring

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

Source	Fault	Characteristic
Command signal PIN 13 4... 20 mA	Out of range or broken wire	The output will be switched off.
Feedback signal PIN 14 4… 20 mA	Out of range or broken wire	The output will be switched off.
Solenoids on PIN 17-20	Wrong cabling, broken wire	The power stage will be deactivated.
EEPROM (when switching on)	Data error	The output is deactivated. The module can only be acti-vated by saving the parameters again!

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

6.3 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 SINGAL: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[7])? • 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)

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

7 Notes