W.E.S.T. Elektronik GmbH

Technical Documentation

POS-123-P-PFN

Universal position control module with integrated power stage and Profinet interface

CONTENTS

1 General Information

1.1 Product Name

POS-123-P-PFN-2040[1] positioning control module with analog sensor interface, integrated power stage and Profinet interface

Alternative products:

POS-123-P standard device with analog command signals

1.2 Scope of supply

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

1.3 Accessories

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

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

[1] The number of the version consists of the hardware version (first two digits) and the software version (last two digits). Because of the development of the products these numbers can vary. They are not strictly necessary for the order. We will always deliver the newest version.

1.4 Symbols used

General information

Safety-related information

1.5 Legal notice

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Date: 31.03.2021

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 hydraulic positioning drives. The demands are given via Profinet. Proportional valves with up to 2.6 Ampere nominal current can be controlled directly. The advantage of the integrated power output stage is based on the integrated control behavior without additional dead times. The setpoint is specified via a Profinet interface, the position feedback of the cylinder is read in as an analog signal.

The position controller 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. The movement cycle is controlled via the external position and speed demands in SDD mode or via the internal profile generator in NC mode.

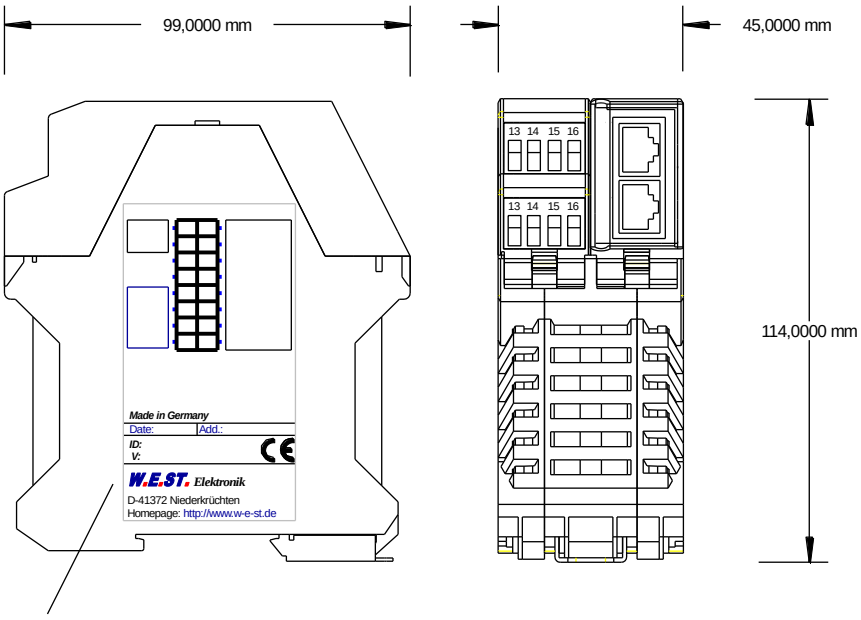
Our start-up tool WPC-300 supports the parameterising and trouble shooting. The fieldbus interface provides a continuous monitoring of actual values and operating states. Control parameters can also be changed via Profinet.

Typical applications: general positioning drives, fast transport drives, handling systems, speed-controlled axes and also tracer control.

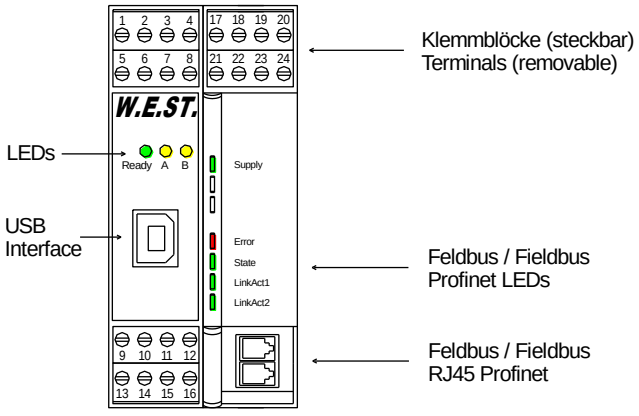
Features

- **Control via Profinet interface**
- **Analog free scalable sensor input**
- **Real physical units like mm or mm/s**
- **Principle of stroke-dependent deceleration for fast and robust positioning**
- **NC profile generator for constant speed**
- **Application oriented parameterising**
- **Controlling and monitoring via fieldbus**
- **Integrated power stage**
- **Individual profile demand by speed, acceleration and delay**
- **Fault diagnosis and extended function checking**
- **Simplified parameterisation with WPC-300 software**

2.1 Device description



Typenschild und Anschlussbelegung
Type plate and terminal pin assignment



3 Use and application

3.1 Installation instructions

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

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

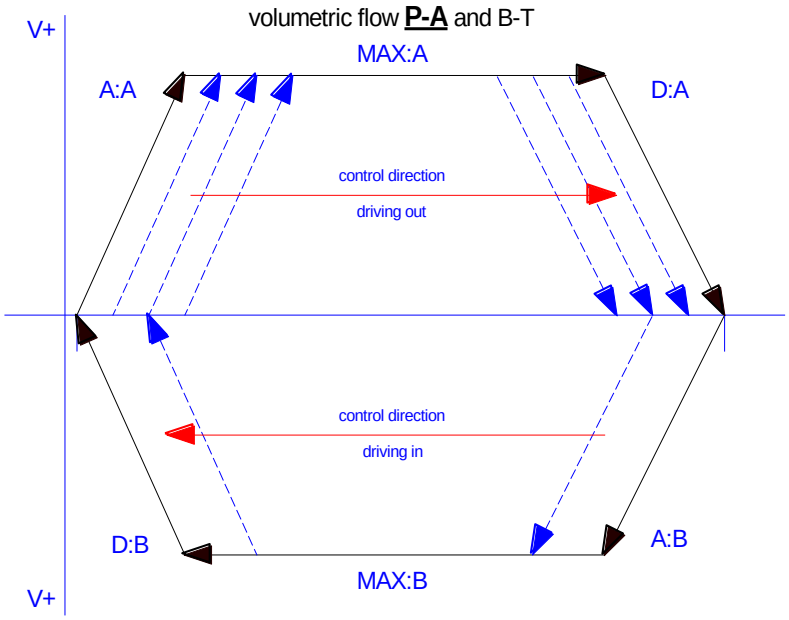
- The module should be installed and wired in accordance with the documentation bearing in mind EMC principles. If other consumers are operated with the same power supply, a star-shaped ground wiring scheme is recommended. The following points must be observed when wiring:
  - The signal cables must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

- A low-resistance connection between PE and the mounting rail should be provided. Transient interference is transmitted from the module directly to the mounting rail and from there to the local earth.
- Power should be supplied by a regulated power supply unit (typically a PELV system complying with IEC 60364-4-41 / VDE 0100-410, 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 always be provided with appropriate overvoltage protection directly at the coil.

3.2 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 **V0:A** and **V0:B** 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 can be set linearly (**LIN**) or approximately quadratically (**SQRT1**) via the **CTRL** parameter. For normal proportional valves **SQRT1** is the standard setting. In NC mode normally the **LIN** variation is the better fitting one.



3.2.1 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 transmitted position setpoint. This happens either only on the rising edge of the *START* signal or continuously if the *DIRECT* control bit is set.

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-to drive the axis manually.

3.2.2 Influences on positioning accuracy

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

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

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

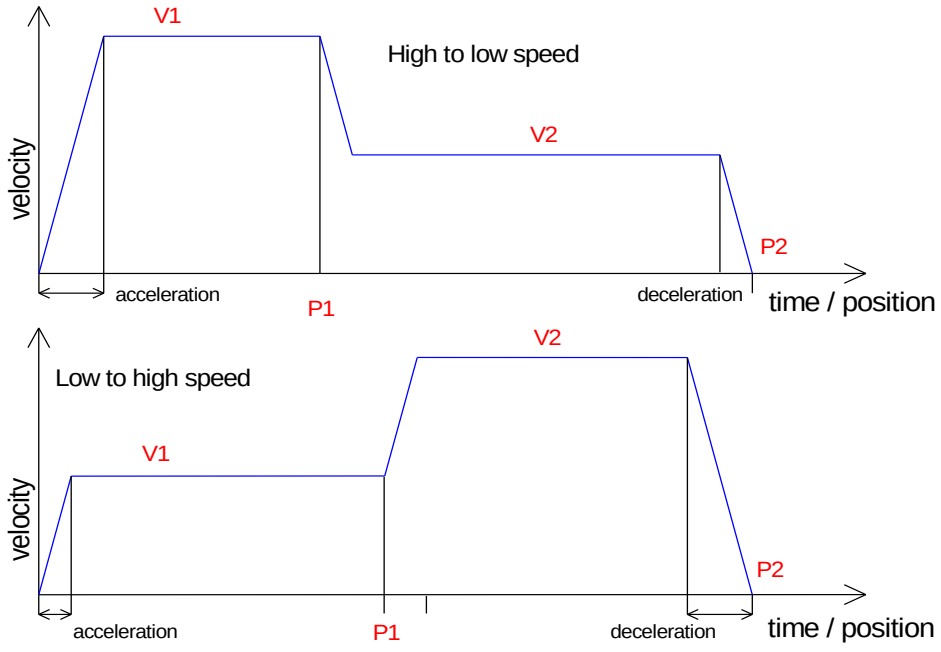
3.2.3 Optional additional function: motion profile with second speed

Because of the input of a second position and speed, the axis can be driven to this position with the second velocity. This mode is only activated when the velocity command value V2 is not equal to zero.

The following features have to be noticed:

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

The following illustrations show two possible speed profiles, which result depending on the choice of speed V2 in relation to V1:



3.3 Commissioning

Step	Task
Installation	Install the device in accordance with the circuit diagram. Ensure it is wired correctly and that the signals are well shielded. The device must be installed in a protective housing (control cabinet or similar).
Switching on for the first time	Ensure that no unwanted movement is possible in the drive (e. g. switch off the hydraulics). Connect an ammeter and check the current consumed by the device. If it is higher than specified, there is an error in the wiring. Switch the device off immediately and check the wiring.
Setting up communication	Once the power input is correct the PC (notebook) should be connected to the serial interface. Please see the WPC-300 program documentation for how to set up communication. The operating software supports further commissioning and diagnosis. Afterwards the fieldbus communication can be established. For defining the interface the relating GSDML file should be provided to the fieldbus master
Pre-parameterisation	Now set up the following parameters (with reference to the system design and circuit diagrams): The SYS_RANGE, SENSOR SETTING, OUTPUTSIGNAL, ACCELERATION and DECELERATION. Pre-parameterisation is necessary to minimize the risk of uncontrolled movements. Parameterize specific settings for the control element (MIN for deadzone compensation and MAX for maximum velocity). Reduce the speed demand to a value which is uncritical for the application.
Control signal	Check the control signal to the valve. At the current state no current should flow to the solenoids.
Switching on the hydraulics	The hydraulics can now be switched on. The module is not yet generating a signal, means there should no (unwanted) reaction occur.
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.
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.
Activating START	With the start signal the demand value of the analogue demand value input is accepted and the axis moves to the predefined target position. If START is disabled, the axis stops in the preset deceleration distance D:S.
Controller optimization	Now optimize the control parameters according to your application and its requirements.

4 Technical description

4.1 Input and output signals

Connection	Supply
PIN 3	Power supply (see technical data).
PIN 4	0 V (GND) connection.
PIN 22	Supply (see technical data) of the power stage.
PIN 24	0 V (GND) connection of the power stage.
Connection	**Analogue signals**
PIN 11	0 V (GND) reference potential for analogue input signals.
PIN 14	Position Feedback, signal range 0… 10 V or 4… 20 mA, scalable.
Connection	**Digital inputs and outputs**
PIN 8	**ENABLE input:** Generally enabling of the application.
PIN 1	**READY output:** **ON:** The module is enabled; there are no discernable errors. **OFF:** ENABLE is not available or an error has been detected.
Connection	**Valve outputs**
PIN 17 / 19	Solenoid A
PIN 18 / 20	Solenoid B

4.2 LED definitions

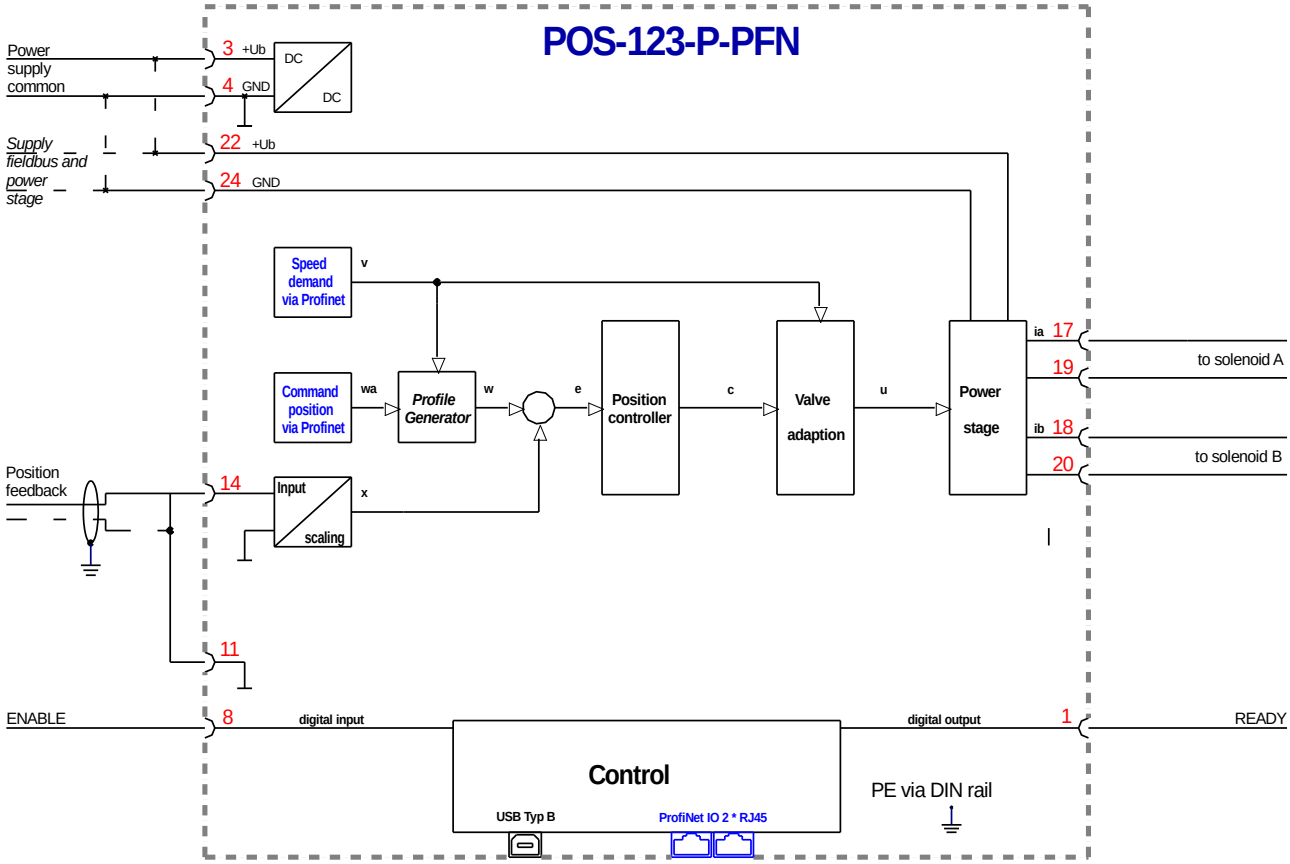
4.2.1 First section (left part of module)

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 (depending on the SENS command)
YELLOW A	Identical to the status bit "POSWIN:S" **OFF:** The axis in not inside the monitoring window **ON:** Target position within the monitoring window
YELLOW B	Identical to the status bit "POSWIN:D" **OFF:** The axis in not inside the monitoring window **ON:** Following distance within the monitoring window
GREEN + YELLOW	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, data has to be saved with the SAVE command or the corresponding button in the WPC.

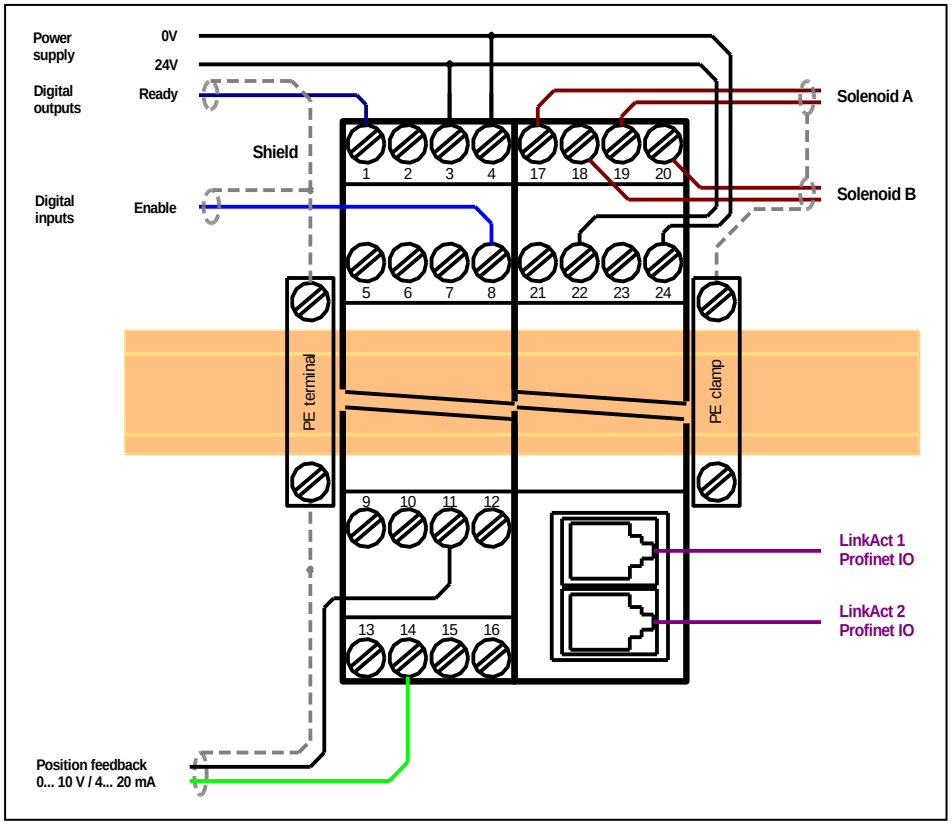
4.2.2 **Second section (right part of module)**

LEDs	**Description of the LED functionality (device)**
GREEN	Supply: **OFF:** No power supply for the fieldbus module. **ON:** 3.3 V system voltage is available.
LEDs	**Description of the LED functionality (fieldbus)**
RED	Error: **OFF:** No fieldbus error. **ON:** Error at the fieldbus communication. **FLASHING:** Participant flash test of the Profinet.
GREEN	State: **OFF:** Bus not started yet. **ON:** Connection established. **FLASH 2Hz:** Configuration mode (bus was started, waiting for connection). **FLASH 10Hz:** Error state.
GREEN	LinkAct1: **OFF:** No connection at port 1. **ON (Pulse):** Working network connected to port 1. **FLICKERING:** Data traffic with network at port 1.
GREEN	LinkAct2: **OFF:** No connection at port 2. **ON (Pulse):** Working network connected to port 2. **FLICKERING:** Data traffic with network at port 2.

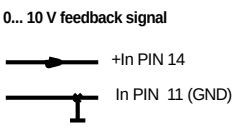
4.3 Circuit diagram

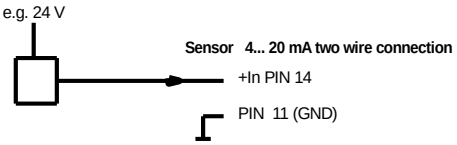


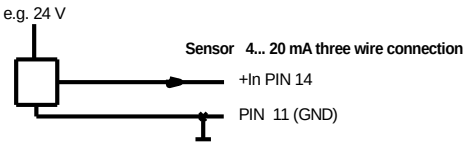
4.4 Typical wiring



4.5 Connection examples







4.6 Technical data

Supply voltage (Ub)	**[VDC]**	12… 30 (incl. ripple)
Power consumption	**[W]**	max. 1,2 + consumption 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. Ub
Maximum current	**[mA]**	50
Analogue input		Unipolar
Voltage	**[V]**	0… 10
Input resistance	**[kOhm]**	min. 25
Signal resolution	**[%]**	0,003 incl. Oversampling
Current	**[mA]**	4… 20
Burden	**[Ohm]**	240
Signal resolution	**[%]**	0,006 incl. Oversampling
PWM output		Wire break and short circuit monitored
Max. output current	**[A]**	2,6
Frequency	**[Hz]**	60… 2941 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]**	0,340
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		4 x 4-pole terminal blocks
PE		via the DIN mounting rail
EMC	**-**	EN 61000-6-2: 8/2005 EN 61000-6-4: 6/2007 + A1:2011

5 Parameter

5.1 Parameter overview

Group	Command	Default	Unit	Description
	MODE	SYSTEM	-	Visible parameter group
Basic parameters				
	LG	EN	-	Selecting language
	SENS	ON	-	Malfunction monitoring
	PASSFB	0	-	Password for fieldbus parameterisation
	EOUT	0	0.01 %	Output signal if no ready
	HAND:A **HAND:B**	3330 -3330	0.01 % 0.01 %	Output signal in manual mode
	POSWIN:S **POSWIN:D**	200 200	µm µm	Ranges of the in-position monitoring
Input signal adaption				
	SYS_RANGE	100	mm	Axis working stroke
Sensor scaling				
	SIGNAL:X	U0-10	-	Type of input signal
	N_RANGE:X	100	mm	Nominal pressure of the sensor
	OFFSET:X	0	µm	Sensor Offset
Position controller				
	VRAMP	200	ms	External speed ramp time
	VMODE	SDD	-	Method of positioning
Profile generator NC				
	ACCEL	250	mm/s²	Acceleration in NC mode
	VMAX	50	mm/s	Maximum speed in NC mode
	V0:A **V0:B** **V0:RES**	10 10 1	1/s 1/s -	Closed loop gain in NC mode Switchover of the resolution.
Control parameter SDD				
	A:A **A:B**	100 100	ms ms	Acceleration (ramp times) in SDD mode
	D:A **D:B** **D:S**	25 25 10	mm mm mm	Deceleration stroke in SDD mode
Common				
	PT1	1	ms	PT1 time constant
	CTRL	SQRT1	-	Control characteristics

Group	Command	Default	Unit	Description
Output signal adaption				
	MIN:A **MIN:B**	0 0	0.01 % 0.01 %	Deadband compensation
	MAX:A **MAX:B**	10000 10000	0.01 % 0.01 %	Output scaling
	TRIGGER	200	0.01 %	Deadband compensation trigger point
	OFFSET	0	0.01 %	Output offset value
	SIGNAL:U	+	-	Polarity of the control signal
Power stage				
	CURRENT	2600	mA	Rated solenoid current
	DFREQ	121	Hz	Dither frequency
	DAMPL	400	0.01 %	Dither amplitude
	PWM	2941	Hz	PWM frequency
	ACC	ON	-	Current loop auto adjustment
	PPWM **IPWM**	7 40	- -	Closed loop current controller
	IMS	2600	mA	Maximum current limitation
Special commands				
Ainmode				
	AINMODE	EASY	-	Input scaling mode
	AIN:I	**I= X** A: 1000 B: 1000 C: 0 X: V	 - - 0.01 % -	Free scaling of the analogue inputs (MATH)

5.2 System parameters

5.2.1 MODE (Parameter view)

Command		Parameters	Unit	Group
MODE	x	x= SYSTEM|IO_CONFIG| CONTROL|POWERSTAGE|ALL	-	-

This command changes the actual view on the parameter list. For a better overview only the parameters of the selected group are displayed. Alternatively all active parameters can be shown.

5.2.2 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.

5.2.3 SENS (Malfunction monitor)

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 doesn't exist anymore, the module automatically resumes to work.

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

5.2.4 PASSFB (Password for fieldbus)

Command	Parameters	Unit	Group
PASSFB x	x= 0… 10000000	-	**SYSTEM**

The value inputted here serves as password for the parameterising function via fieldbus. In order to enable a parametrization, it has to be sent via fieldbus to the relating address. If **PASSFB** is “0” (factory setting) the password protection is not active.

5.2.5 EOUT (Output signal if READY = OFF)

Command	Parameters	Unit	Group
EOUT x	x= -10000… 10000	0.01 %	**SYSTEM**

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

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

5.2.6 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.

5.2.7 POSWIN:S (Static position monitoring)

5.2.8 POSWIN:D (Dynamic position monitoring)

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

This parameter is entered in µm.
The POSWIN command defines a range for which the relating status message is generated. This function monitors the deviation between the command and actual position. The positioning process is not influenced by this function.

START must be activated to generate the messages.

POSWIN:S Reporting reaching the target position with the parameterized accuracy.

POSWIN:D Reporting continuously the actual deviation (following error in NC mode).

5.3 Input signal adaptation

5.3.1 SYS_RANGE (System stroke)

Command	Parameter	Einheit	Gruppe
SYS_RANGE x	x= 10… 10000	mm	**IO_CONFIG**

This command sets the nominal working stroke which is 100 %. The axis can be moved via a set value specification of 0 mm up to the position entered here. Wrong settings may lead to incorrect system settings and depending parameters cannot be calculated correctly.

5.3.2 SIGNAL (Type of input signal)

Command	Parameters	Unit	Group
SIGNAL:X x	x= OFF U0-10 I4-20 U10-0 I20-4	-	**IO_CONFIG (EASY)**

This command is used to define the type of the input signal (voltage or current) and to set the direction of the signal. This is available for the analogue sensor input.

5.3.3 N_RANGE:X (Sensor nominal pressure)

Command	Parameter	Unit	Group
N_RANGE:X X	x= 10… 10000	mm	**IO_CONFIG (EASY)**

This command defines the nominal working range of the feedback sensor. Wrong parameterisation causes wrong system settings. The control parameters cannot be calculated correctly in case of wrong values.
N_RANGE always has to be equal or higher than SYS_RANGE.

5.3.4 OFFSET:X (Sensor offset)

Command	Parameter	Unit	Group
OFFSET:X X	x= -100000… 100000	µm	**IO_CONFIG (EASY)**

Adjustment of the zero point of the sensor.

5.4 Position Controller

5.4.1 VRAMP (Ramp time for external speed demand)

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

The rate of change of the external speed demand can be limited by this ramp time.

5.4.2 VMODE (Methode of positioning)

Command	Parameters	Unit	Group
VMODE x	x= SDD|NC		**CONTROL**

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.

5.4.3 ACCEL (Acceleration)

Command	Parameters	Unit	Group
ACCEL x	x= 1… 20000	mm/s²	**CONTROL (NC)**

Specification of the setpoint acceleration in NC mode. The maximum acceleration must - in order to ensure stable and vibration-free behaviour - be set smaller than the technically possible acceleration. Experience shows that a factor of 3... 5 should be taken into account.

5.4.4 VMAX (Maximum speed in NC mode)

Command	Parameters	Unit	Group
VMAX x	x= 1… 2000	mm/s	**CONTROL (NC)**

Specification of the maximum speed in NC mode. This value is defined by the drive system and should be specified as exactly as possible (not too high under any circumstances). The speed is scaled by means of 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.

5.4.5 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[2].
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.

5.4.6 V0:RES (Resolution of the Loop Gain Input)

Command	Parameters	Unit	Group
V0:RES x	x= 1|100	-	**CONTROL (NC)**

V0:RES = 1 The loop gain is specified in the unit s^{-1} (1/s)
V0:RES = 100 The loop gain is specified in the unit 0.01 s^{-1}.

This switchover to 100 should only be carried out for very small values (V0 < 4), as the input range is limited to 400.

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

5.4.7 A (Acceleration 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 depends on the direction. “A” corresponds to terminals 17/19 and “B” corresponds to terminals 18/20 (with positive polarity).
Normally the directions are: 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.

5.4.8 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 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

5.4.9 PT1 (Time constant of the controller)

Command	Parameter	Unit	Group
PT1 x	x= 0… 300	ms	**CONTROL**

This parameter can be used to active an internal Low-pass filter in the control loop.
Hydraulic drives are often critical to control especially in case of high speeds and very fast valves. The PT1 filter can be used to improve the damping rate and allows therefore higher loop gains. Requirements for the use are: The natural frequency of the valve should be equal or higher than the natural frequency of the drive.

5.4.10 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[3] function.

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.

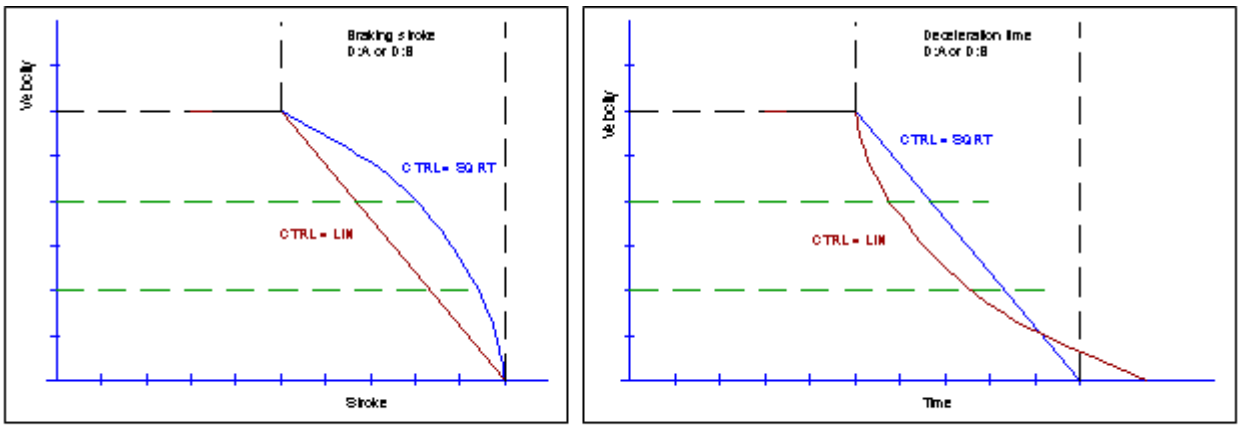


Figure 2 (Braking function with respect to stroke and time)

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

5.5 Output signal adaptation

5.5.1 MIN (Deadband compensation)

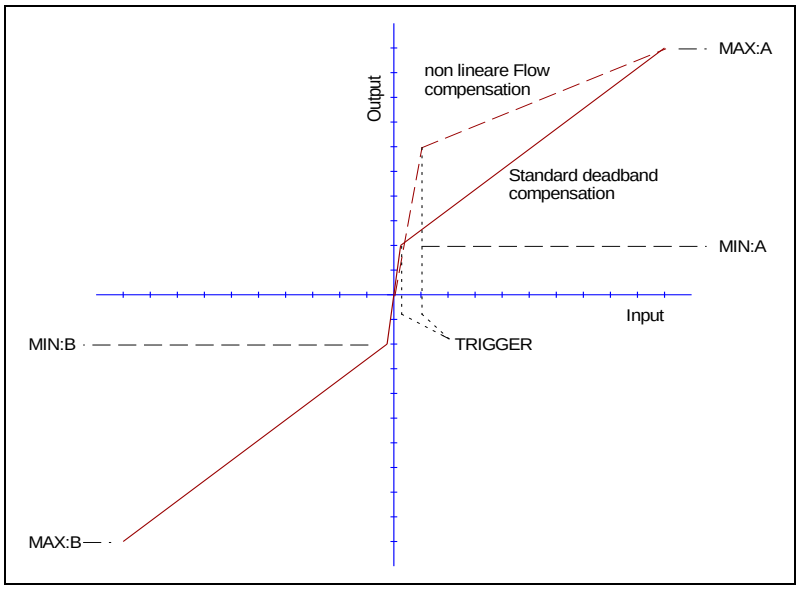
5.5.2 MAX (Output scaling)

5.5.3 TRIGGER (Response threshold for the MIN parameter)

Command	Parameter	Unit	Group
	i= A|B		**IO_CONFIG**
MIN:I X	x= 0… 6000	0.01 %	
MAX:I X	x= 5000… 10000	0.01 %	
TRIGGER X	x= 0… 3000	0.01 %	

The output signal to the valve is adjusted by means of these commands. A kinked volume flow characteristic is used for the swivel angle control valve instead of the typical overlap step. The advantage is better and more stable (positioning) behavior. At the same time, kinked volume flow characteristics can also be adjusted with this compensation[4].

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 valve opening, which can then no longer be adjusted. In extreme cases this leads to oscillation around the controlled position.



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

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

5.5.4 OFFSET (Zero correction)

Command	Parameters	Unit	Group
OFFSET x	x= -4000… 4000	0.01 %	**IO_CONFIG**

This parameter is entered in 0.01% units.
The offset value is added to the output value. Valve zero offsets can be compensated with this parameter.

5.5.5 SIGNAL:U (Polarity of the output signal)

Command	Parameter	Unit	Group
SIGNAL:U x	x= +|-	-	**IO_CONFIG**

This command is used to switch the polarity of the control signal.

5.6 Power stage

5.6.1 CURRENT (Rated output current)

Command	Parameters	Unit	Group
CURRENT x	x= 500… 2600	mA	**POWERSTAGE**

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

5.6.2 DAMPL (Dither amplitude)

5.6.3 DFREQ (Dither frequency)

Command		Parameter	Unit	Group
DFREQ	X	x= 60… 400	Hz	**POWERSTAGE**
DAMPL	X	x= 0… 3000	0.01 %	

The dither signal[5] 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[6]. The dither frequency is defined in Hz. Depending on the internal calculations, the frequency is adjustable in steps only[7].

CAUTION: *The PPWM and IPWM parameters influence the effect of the dither setting. These parameters should not be changed 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.*

5.6.4 PWM (PWM Frequency)

Command		Parameter	Unit	Group
PWM	X	x= 60… 2941	Hz	**POWERSTAGE**

The frequency can be changed in defined steps (60 Hz, 70 Hz, 80 Hz, 90 Hz, 100 Hz, 110 Hz, 120 Hz, 130 Hz, 150 Hz, 199 Hz, 230 Hz, 280 Hz, 336 Hz, 405 Hz, 511 Hz, 1069 Hz, 1470 Hz, 1960 Hz, 2352 Hz, 2941 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 forces a reduced stability of the closed loop control. This settings are done automatically if ACC is set to ON.*

[5] The dither is a square wave 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.

[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.

[7] The lower the dither frequency, the smaller the steps. Therefore no practical problems are expected.

5.6.5 ACC (Current loop auto adjustment)

Command		Parameter	Unit	Group
ACC	X	x= ON|OFF	-	**POWERSTAGE**

Operation mode of the closed loop current control.

ON: In automatic mode PPWM and IPWM are calculated depending on the PWM-frequency.
OFF: Manual adaption by the user is necessary.

5.6.6 PPWM (P gain of the current loop)

5.6.7 IPWM (I gain of the current loop)

Command		Parameter	Unit	Group
PPWM	X	x= 0… 30	-	**POWERSTAGE**
IPWM	X	x= 1… 100	-	

The PI current controller for the solenoid control is parameterized with these commands.
A higher P-gain increases the dynamic of the closed current loop and so its influence on the dither. The I-gain should only be changed if having detailed knowledge about the current control.

CAUTION: These parameters should not be changed without adequate measurement facilities and experience. Changes are only possible if ACC is set to OFF.

If the PWM frequency is < 250 Hz, the current controller dynamics must be reduced.
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 selected.

5.6.8 **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 magnet coils in Ex-protection areas".
With the parameter IMS 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	Parameter	Unit	Group
IMS x	x= 500 … 2600	mA	**POWERSTAGE**

5.7 Special commands

5.7.1 **AINMODE**

Command	Parameter	Unit	Group
AINMODE x	x= EASY|MATH	-	**TERMINAL**

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

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

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

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

5.7.2 AIN (Analogue input scaling)

Command	Parameters	Unit	Group
AIN:X			**IO_CONF (MATH)**
A	a= -10000… 10000	-	
B	b= -10000… 10000	-	
C	c= -10000… 10000	0.01 %	
X	x= V|C	-	

This command offers an individual scalable input. The following linear equation is used for the 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 signal).
The variables ***A*** and ***B*** are defining the gain factor with which the signal range is scaled up to 100 % (e.g. 1.25 if using 4… 20mA input signal, defined in default current settings by A = 1250 and B = 1000). The internal shunt for the current measuring is activated with switching the ***X*** value.

The gain factor is calculated by setting the usable range (***A***) in relation to the real used range (***B***) of the input signal. Usable are 0… 20mA, means (***A***) has the value **20**. Really used are 4… 20mA, means (***B***) has a value of **16** (20-4). Not used are 0… 4mA. In a range of 20mA this is an offset of 20%, means a value of **2000** for (***C***). Last but not least (***X***) has to be set to **C** choosing current signal.

In this case AIN command would look like this:

AIN:I 20 16 2000 C or AIN:I 1250 1000 2000 C (see below)

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 parameterisation for 4… 20 mA is setting the range to 0… 100 %.

5.7.3 **ST (Status Report)**

Commando	Parameter	Unit	Group
ST	-	-	**TERMINAL**

The control words, status words and demands which are send via the fieldbus as well as the state of the hardware enable of the module are displayed by this command. It can only be issued in the terminal window.
The message is structured as follows:

	(high byte / low byte)
control word 1 :	0000 0000 / 0000 0000
control word 2 :	0000 0000 / 0000 0000
status word 1 :	0000 0000 / 0000 0000
status word 2 :	0000 0000 / 0000 0000
position setpoint 1:	00000000
speed setpoint 1:	0x0000
position setpoint 2:	00000000
speed setpoint 2:	0x0000
HW-enable :	disabled
para address :	0x0000
para value :	0000

5.8 PROCESS DATA (Monitoring)

Command	Description	Unit
WA	Position Setpoint (input signal)	mm
W	Internal Setpoint	mm
V	Speed input	%
X	Actual value	mm
E	Error value	mm
C	Output of the controller	%
U	Control Signal	%
IA	Solenoid current A	mA
IB	Solenoid current B	mA
VACT	Measured Speed	mm/s

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

6 Appendix

6.1 Failure monitoring

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

Source	Fault	Characteristics
Analogue input 14 4… 20 mA	Out of range or broken wire	The power stage and the READY output will be deactivated.
Solenoid A on PIN 17 + 19	Wrong cabling, broken wire	The power stage and the READY output will be deactivated.
Solenoid A on PIN 18 + 20	Wrong cabling, broken wire	The power stage and the READY output will be deactivated.
EEPROM (when switching on)	Data error	The power stage and the READY output will be deactivated. Module can be activated by saving the parameters.
Profinet	Interruption of the connection Livebit error Internal data processing (buffer overflow, checksum)	The power stage and the READY output will be deactivated.

CAUTION: Take EOUT settings into consideration, changes have influence on the behaviour.

6.2 Troubleshooting

It is assumed that the device is in an operable state and there is communication between the module and the WPC-300. Furthermore, the valve control parameterisation 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 one of the ENABLE signals is not present. If there is no power supply, there is also no communication via our operating program. If a connection to WPC-300 has been made, then a power supply is also available. The same is applied to the Profinet connection. In this case in monitor window the ENABLE input can be checked.
ENABLE is active, the READY LED is flashing.	The flashing READY LED signals that a fault has been detected by the module. The fault could be: • A broken cable or bad signal at the sensor input if 4… 20 mA signal are used. • A broken cable or incorrect cabling to the solenoids. • Internal data error: press the command/SAVE button to delete the data error. The system reloads the DEFAULT data. • The field bus communication is faulty.
ENABLE is active; the READY LED is on, the system moves to an end position.	The control circuit polarity is incorrect. The polarity can be changed with the SIGNAL:U command or maybe by reversing the sensor signal (SIGNAL:X).
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 parameterisation or incorrect system design. • Are working range and nominal sensor range correct? • Is the gain high enough (to start the system the deceleration distances should be set to approx. 20… 25 % of the cylinder position and decreased if necessary)? • Is there an overlapping of the valve to be compensated? Values should be mentioned in the datasheet of the valve.
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 parameterisation is not yet adjusted to the system (gain too high). • There is severe interference on the power supply. • Very long sensor cables (> 40 m) and sensor signal interference. • The MIN setting to compensate the valve overlap is too high. As a basic principle, the parameterisation 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. be reduced.
Speed too low	The drive may be able to move to position but the speed is too low. • Check the controller signal to the valve whether C reaches 100%. If not parameterisation (e.g. gain) should be adapted. • Check If the control signal U reaches 100%. If not maybe there is a speed limitation. • Check the solenoid current. If the needed value is not reached, the valve adaption may has to be adapted (CURRENT/MAX) • In case of all values are correct, measure the solenoid current. If the setpoint is not reached, the wiring including the valve plugs should be checked. • In the case of all is correct, the cause is a hydraulic problem, for example a wrong dimension of a used component.
Speed too high	The drive moves in and out too fast leading to uncontrolled behavior. Reducing the speed demand has very little or no effect. - The hydraulic system is over-sized. The entire parameterisation of the movement cycle cannot be reproduced (overlap and deceleration distance settings)

7 PROFINET IO RT interface

7.1 Functions

PROFINET is the standard for Industrial Ethernet based on IEEE 802.xx. PROFINET is based on the 100 Mb/s-version of full duplex and switched Ethernet. PROFINET IO is designed for the fast data exchange between Ethernet-based controllers (master functionality) and field devices (slave functionality) with cycle times down to 8 ms.

7.2 Address assignment

All the PROFINET IO slave devices need name and IP address to initiate communication. The IP address is assigned to the device by the ProfiNet-IO-controller (PLC). For it, the gateway has a device name on which it is addressed. The IP address of the PROFINET IO device is stored in persistent memory in the device. An IO controller can modify it. Take care that the IP address is not same as any other device on the network.

Default address:	
IP Address:	0.0.0.0
Subnet-Mask:	0.0.0.0
IP Address Gateway:	0.0.0.0

Address Example.:	
IP Address:	192.168.1.111
Subnet-Mask:	255.255.255.0
IP Address Gateway:	192.168.1.111

7.3 Device data file (GSDML)

The characteristics of an IO Device are described by the device manufacturer in a General Station Description (GSD) file. The language used for this purpose is the GSDML (GSD Markup Language) - an XML based language. For I/O data, the GSDML file describes the structure of the cyclic input and output data transferred between the Programmable Controller and the PROFINET IO device. Any mismatch between the size or structure of the input and output data and the actual internal device structure generates an alarm to the controller.

In the configuration of transmission, 32 bytes for input and 32 bytes for output must be pre-adjusted.

7.4 IO Description

The relative demand values are set in a range up to 0x3FFF (16383 for 100%). Position values have a resolution of 0.001 mm. For the control and status bits “1” means activation respective activity. Error bits are displayed inverted because a “0” reports an active error.

The module is controlled with two control words consisting of following bits

ENABLE	General activation of the system linked with the hardware enable. The output stage is activated, the current position is adopted as the target position.
START	Activation of the position controller. The transmitted position value is taken over as command position and the position is approached.
HAND:A	Open loop manual movement. If START is not active the axis is driven with the below HAND:A programmed speed.
HAND:B	Open loop manual movement. If START is not active the axis is driven with the below HAND:B programmed speed.
DIRECT	In direct mode new command positions are taken over directly from the controller while START signal is available. No new rising edge of START is needed.
PARAREAD	Reads out the value of the parameter which is determined by PARA ADDRESS and returns this value in PARA VALUE of the data sent to the fieldbus. If the address is not valid the function will return „0xffffffff“.
READLLIM	PARAREAD returns the lower limit for the selected parameter instead of the value. This function is primarily used for the automatic initialisation of a PLC parameterisation module.
READULIM	ditto, but output of the lower range limit.
PARAMODE	Enables the ability to set parameters.
PARA VALID	Parameter value is transmitted at the rising edge of this control bit.
LIVEBIT IN	Monitoring of the fieldbus communication: If this bit gets activated in the “ready”-state of the module, an internal watchdog function will be activated. In the further course it is monitored if there is a data change at least once per second. If there is a period longer than 1s without data change, the “ready”-state of the module will be deactivated.

Further data words to the module:

COMMAND POSITION	Target Position for standard positioning process
DEMAND SPEED	Nominal respectively limit speed for movement
COMMAND POSITION 2	End position for positioning process if two profile segments are used
DEMAND SPEED 2	Nominal/limit speed for movement in the second profile segment (Entering this value activates the second profile segment)
PARAMETER ADDRESS	Address of the parameter which should be changed or read out
PARAMETER VALUE	Value of the parameter to be transmitted

Feedback is given via a status word including following bits:

READY	Common readiness of the system (enable available and no error occurred)
POSWIN:S	Static position monitoring, position reached target window
POSWIN:D	Dynamic position monitoring, following distance within the window
SEGMENT 2	Second profile segment is active, axis moves within it
X ERROR	Error at position sensor
IA ERROR	Error at solenoid A
IB ERROR	Error at solenoid B
DERROR	Internal data error (parameters have to be saved)
BUS ERROR	Error in the processing of the field bus data (buffer overflow, checksum- or livebit error)
PARA ACTIVE	Parameterisation is active
PARA READY	Parameter value was transferred correctly. This bit will be reset by resetting the PARAVALID bit.
LIVEBIT OUT	Monitoring of the fieldbus communication. Return of the **LIVEBIT IN** signal (description at control bits below LIVEBIT IN).

Further feedback values to the fieldbus:

POSITION FEEDBACK	Measured position singnal from sensor (X)
ACTUAL COMMAND POSITION	Actual active command value for the controller after adaption (W)
CONTROL DEVIATION	Deviation between command and actual position (E)
CONTROLLER OUTPUT	Output value of the position controller (C)
CONTROL SIGNAL	Control signal to the power stage (U)
SPEED	The current speed of the axis (VACT)
SOLENOID CURRENT A	Current at solenoid A (IA)
SOLENOID CURRENT B	Current at solenoid B (IB)
PARAMETER VALUE	Parameter value, requested by PARA READ

7.5 Commands via Profinet

7.5.1 Overview

Nr.	Byte	Funktion	Typ	Bereich	Einheit
1	0	Control word 1 High Control word 1 Low	UINT16		
2	1				
3	2	Control word 2 High Control word 2 Low	UINT16		
4	3				
5	4	Position demand 1 High (MSB)	UINT32	0… 10000000	0.001 mm
6	5				
7	6				
8	7	Position demand 1 Low (LSB)			
9	8	Speed demand 1 High Speed demand 1 Low	UINT16	0… 16383	% 100 % = 0x3FFF
10	9				
11	10	Position demand 2 High (MSB)	UINT32	0… 10000000	0.001 mm
12	11				
13	12				
14	13	Position demand 2 Low (LSB)			
15	14	Speed demand 2 High Speed demand 2 Low	UINT16	0… 16383	% 100 % = 0x3FFF
16	15				
17	16	---			
18	17	---			
19	18	---			
20	19	---			
21	20	---			
22	21	---			
23	22	---			
24	23	---			
25	24	---			
26	25	---			
27	26	Parameter value High (MSB)	long	Depending on selected parameter	Depending on selected parameter
28	27				
29	28				
30	29	Parameter value Low (LSB)			
31	30	Parameter address High Parameter address Low	int	0… 0x2200	-
32	31				

7.5.2 Definition control word 1

Byte 0-control word High			
No.	**Bit**	**Function**	
1	0	DIRECT	Directly processing of new position demands
2	1	---	
3	2	---	
4	3	---	
5	4	HAND:B	Manual movement
6	5	HAND:A	Manual movement
7	6	START	Activation of the positioning process
8	7	ENABLE	General enabling of the system

Byte 1-control word Low			
No.	**Bit**	**Function**	
1	0	---	
2	1	---	
3	2	---	
4	3	---	
5	4	---	
6	5	---	
7	6	---	
8	7	---	

7.5.3 **Definition control word 2**

Byte 2-control word High			
No.	**Bit**	**Function**	
1	0	LIVEBIT IN	(Start of the) fieldbus monitoring
2	1	---	
3	2	---	
4	3	---	
5	4	---	
6	5	---	
7	6	---	
8	7	---	

Byte 3-control word Low			
No.	**Bit**	**Function**	
1	0	---	
2	1	---	
3	2	---	
4	3	READLLIM	PARAREAD returns the lower limit for the selected parameter
5	4	READULIM	PARAREAD returns the upper limit for the selected parameter
6	5	PARA READ	Reading out the selected address
7	6	PARA VALID	Transmitting parameterisation
8	7	PARA MODE	Activation of the parameterising mode

7.6 Feedback via Profinet

7.6.1 Overview

Nr.	Byte	Funktion	Typ	Bereich	Einheit
1	0	Status word 1 High Status word 1 Low	UINT16		
2	1				
3	2	Status word 2 High Status word 2 Low	UINT16		
4	3				
5	4	Position feedback High	UINT32	0… 10000000	0.001 mm
6	5				
7	6				
8	7	Position feedback Low			
9	8	Actual Command position High	UINT32	0… 10000000	0.001 mm
10	9				
11	10				
12	11	Actual Command position Low			
13	12	Control deviation High	INT32	0… 10000000	0.001 mm
14	13				
15	14				
16	15	Control deviation Low			
17	16	Controller output signal High Controller output signal Low	INT16	+/- 10000	0.01 %
18	17				
19	18	Control signal to amplifier High Control signal to amplifier Low	INT16	+/- 10000	0.01 %
20	19				
21	20	Solenoid current A High Solenoid current A Low	UINT16	0… 2600	mA
22	21				
23	22	Solenoid current B High Solenoid current B Low	UINT16	0… 2600	mA
24	23				
25	24	Measured Speed High Measured Speed Low	INT16	+/- 30000	0.1 mm/s
26	25				
27	26				
28	27				
29	28	Parameter value High (MSB)	long	Depending on selected parameter	Depending on selected parameter
30	29				
31	30				
32	31	Parameter value Low (LSB)			

7.6.2 **Definition status word 1**

Byte 0-status word High			
No.	**Bit**	**Function**	
1	0	---	
2	1	---	
3	2	---	
4	3	---	
5	4	SEGMENT 2	Second profile segment is active
6	5	POSWIN:S	Target position within the monitoring window
7	6	POSWIN:D	Following distance within the monitoring window
8	7	READY	System is enabled and no errors were detected

Byte 1-status word Low			
No.	**Bit**	**Function**	
1	0	---	
2	1	---	
3	2	---	
4	3	---	
5	4	---	
6	5	---	
7	6	---	
8	7	---	

7.6.3 **Definition status word 2**

Byte 2-status word High			
No.	**Bit**	**Function**	
1	0	$\overline{\text{IB ERROR}}$	Current error solenoid B
2	1	$\overline{\text{IA ERROR}}$	Current error solenoid A
3	2	---	
4	3	$\overline{\text{X ERROR}}$	Position sensor error
5	4	---	
6	5	$\overline{\text{BUS ERROR}}$	Field bus communication error
7	6	---	
8	7	$\overline{\text{DERROR}}$	Internal data error

Byte 3-status word Low			
No.	**Bit**	**Function**	
1	0	LIVEBIT OUT	Monitoring of the communication
2	1	---	
3	2	---	
4	3	---	
5	4	---	
6	5	---	
7	6	PARA READY	Parameterisation successfully transmitted
8	7	PARA ACTIVE	Parameterisation via fieldbus is active

7.7 Parameterisation via Profinet

Preliminary remark:

If you use an S7 controller configured with TIA Portal, we offer a free and very powerful function block for remote parameterisation via the PLC. There is a separate manual for this.

The following description shows an alternative procedure that can be implemented with any control system.

7.7.1 **Procedure**

Preparation:

- Power supply of the different sections has to be available.
- For safety issues the system should not be active.

  If active, the ENABLE bit in the control word has to be reset.

  Attention: Parameterisation via fieldbus can also be done having an active system. In this case it should be done very carefully because changes are directly operative.

Parameterisation :

- At first the **PARA MODE** bit has to be set to enable parameterising via ProfiNet.

  This will be reported via the **PARA ACTIVE** bit.
- Provide **address** and new **value** of the parameter which should be changed.
- Setting the **PARA VALID** bit to high will transmit the data.

  The **PARA READY** bit will report a successful parameterisation .

  Attention: A missing **para ready** bit means parameterisation was not performed.

Storing:

- Same procedure as parameterising standard parameters.
- Selecting **2100** as **address**, written **value** does not matter (below 60000).

Password protection:

- If a password was set this has to be entered first for enabling parameterisation . Procedure is the same as if parameterising standard parameters.
- Select **2200** as **address** and send the password (PASSFB) as **value**.
- After **PARA READY** reports success, subsequently parameterising can be done as long as **PARA MODE** stays active. If is reset, the protection becomes active again. This means, in order to change more parameters after setting **PARA MODE** first the password itself needs to be send. See above.

If the password was transferred incorrectly three times, the parameterisation mode gets locked (reported by deactivated **PARA ACTIVE** bit). Only restarting the device enables three new attempts.

Please note that a storage of the parameterisation via Profinet is limited in the number of writing cycles. This means it should be done only when necessary.

7.7.2 **Parameter List**

Parameter Table			
Nr.	**Index**	**Parameter**	**Description**
1	0x2001	SENS	Error monitoring: 1 = ON, 2 = OFF, 3 = AUTO
2	0x2002	EOUT	Output signal in the case of missing activation
3	0x2003	HAND:A	Control value in manual mode, direction A
4	0x2004	HAND:B	Control value in manual mode, direction B
5	0x2005	POSWIN:S	Window for status message Target position
6	0x2006	POSWIN:D	Window for status message contouring error
7	0x2007	SYS_RANGE	Working Stroke
8	0x2008	SIGNAL:X	Type of the input signal: 1 = OFF, 2 = U0-10 , 3 = I4-20, 4 = U10-0 , 5 = I20-4
9	0x2009	N_RANGE:X	Nominal Sensor Length [mm]
10	0x200A	OFFSET:X	Sensor Offset [µm]
11	0x2011	VRAMP	Speed demand ramp time
12	0x2012	VMODE	Positioning Method, 1 = SDD, 2 = NC
13	0x2013	VMAX	Maximum speed of the axis
14	0x2014	ACCEL	Acceleration for the profile generator (NC)
15	0x2021	A:A	Acceleration direction A (SDD)
16	0x2022	A:B	Acceleration direction B (SDD)
17	0x2023	D:A	Deceleration direction A
18	0x2024	D:B	Deceleration direction B
19	0x2025	D:S	Stop distance
20	0x2026	V0:A	Loop gain direction A
21	0x2027	V0:B	Loop gain direction B
22	0x2028	V0:RES	Resolution of the loop gain, 1 = 1, 2 = 1/100
23	0x2031	PT1	PT1 Filter for the position controller
24	0x2032	CTRL	Deceleration behaviour, 1 = LIN; 2 = SQRT1, 3 = SQRT2
25	0x2041	MIN:A	Deadband compensation A
26	0x2042	MIN:B	Deadband compensation B
27	0x2043	MAX:A	Maximum control direction A
28	0x2044	MAX:B	Maximum control direction B
29	0x2045	TRIGGER	Threshold for the Deadband compensation
30	0x2046	OFFSET	Zero-point correction for the output signal
31	0x2047	SIGNAL:U	Polarity of the output signal 1 = +, 2 = -
32	0x2051	CURRENT	Rated current of the magnet
33	0x2052	DFREQ	Dither frequency
34	0x2053	DAMPL	Dither amplitude
35	0x2054	PWM	PWM frequency, preset in steps according to table in 5.6.4,. 1 = 60 Hz, ..,, 20 = 2941 Hz
36	0x2055	IMS	Maximum current limit
37	0x2100	SAVE	Saving the data set
38	0x2200	PW	Password for parameterisation

8 Profinet-Driver Blocks for Simatic-Controllers

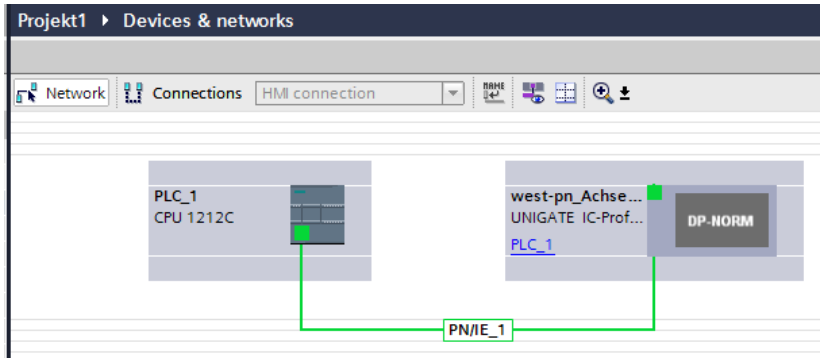
8.1 Integration of the Block into the PLC program

For use within the „TIA Portal“ software we provide two driver blocks that enable a convenient access out of the application program:

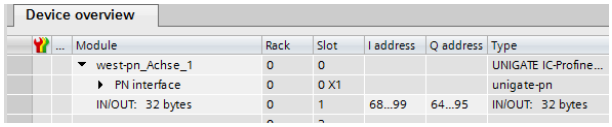
a) The source WEST_POS_123_P_PFN.scl for controllers of the S7-1200 and -1500 series
b) The source WEST_POS_123_P_PFN_TIA_KLASSIK.scl for controllers of the S7-300 and -400 series

Below their integration in the TIA project and the interconnections are explained.

c) Import the GSDML-file
d) Project the connection between PLC and controller card via Profinet:

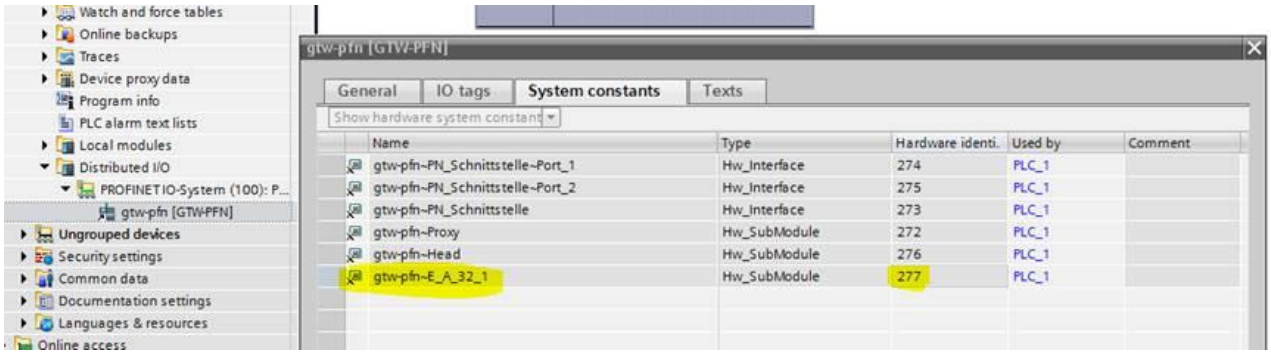


1.) In the device a module „IN/OUT 32 bytes“ has been assembled by the system:

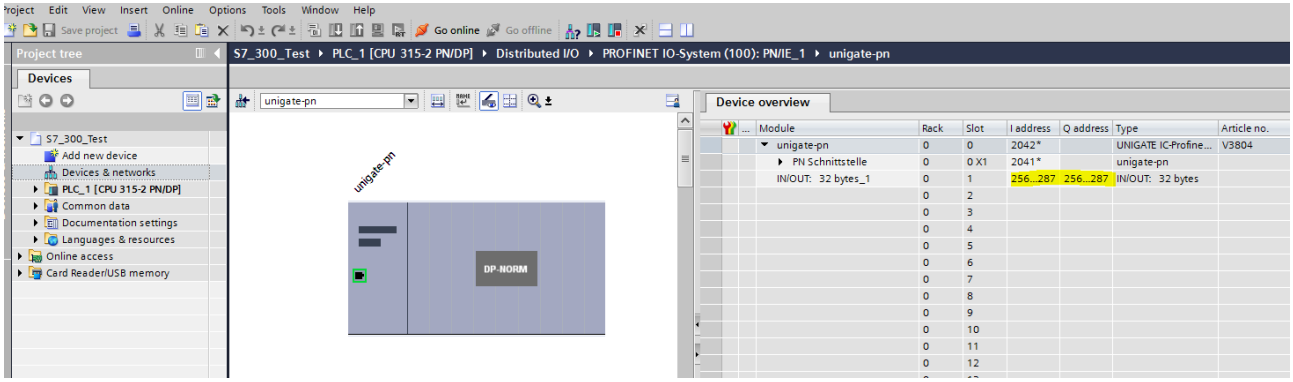


The addresses will be assigned automatically. Important for the link of the program block is the hardware identifier, which is also assigned automatically. This only applies if a S7-1200 / -1500 controller is used.

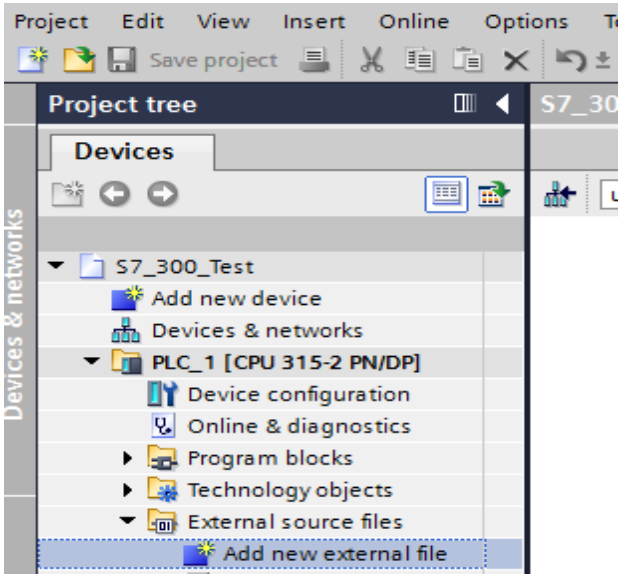
To determine the identifier right-click in the project tree on the device, choose “properties” and take over the number which is displayed in the tab “System constants”:



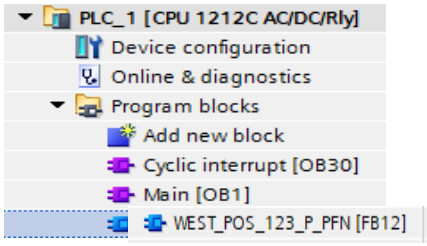
If a controller of the S7-300 and -400 series is used, the input and output addresses of the I/O-Module are the required information for the driver block, see over.



2.) The driver block is supplied as SCL-source. In order to assemble it into the project, the file has to be added to the TIA-Portal as “new external file”:

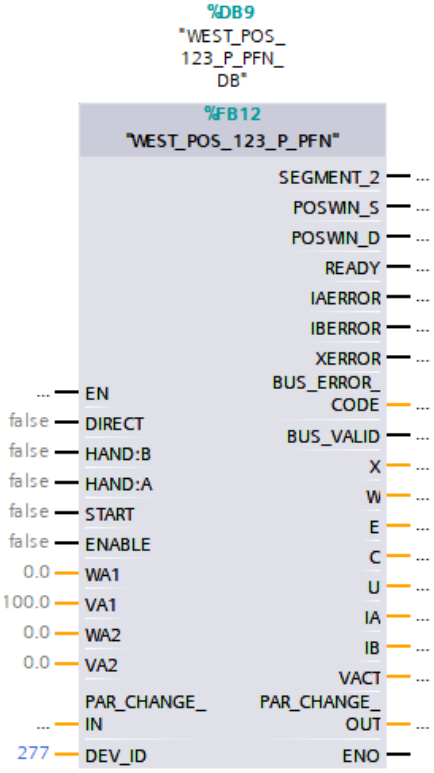


3.) Subsequently click on the imported file and chose “generate blocks from source”. After this step the driver block can be found in the “blocks” folder. Its number may differ.

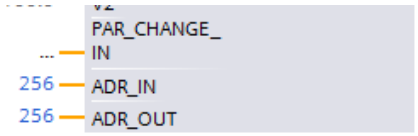


This FB can now be called out of the application program. This should happen in a cyclic interrupt with an execution time >= 8 ms.

View of the block in FUP without interconnection:



Address designation for S7-300 / -400 (example):



8.2 Function

The connectors of the driver block correspond as far as possible to the description in the previous chapter. The following differences have to be considered:

- Transmission of setpoint positions in the number format “real” and unit [mm]
- Transmission of the speed setpoints in the number format “real” and [%] related to the parametrised value.
- The Signals allowing to change parameters are bundled in structures. This serves as an interface to a parameterisation module that is described in another manual and is also provided free of charge.
- As parameter „DEV_ID“ the Hardware Identifier of the IO Module has to be entered (TIA)
- As parameters ADR_IN / ADR_OUT the starting addresses (see HW config.) have to be entered (TIA_KLASSIK).
- The values IAERROR, IBERROR, XERROR are not inverted, which mean “TRUE” indicates the presence of an error.
- The bit “BUS_VALID” signals the operation of the bus data transfer.
- If needed, the output „BUS_ERROR_CODR“ yields detailed diagnostic information:

BUS ERROR CODE		
Nr.	**Bit**	**Funktion**
1	0	Internal data error (DERROR)
2	1	
3	2	Internal data overflow or checksum error (BUS ERROR)
4	3	Receiving error (access to the input addresses, module -> PLC)
5	4	Transmitting error (access to the output addresses, PLC -> module)
6	5	No data exchange (Watchdog)
7	6	
8	7	

Feedback of the actual position, the control deviation and the internal setpoint is given in the number format “real” in the unit [mm].

The control signals are output in "real" format as percentage values.

If the bus data exchange is faulty, the fed back values are not reliable. In most cases they will be frozen in that case. If the output values are processed and used to control further functions, the valid bit has also to be considered. In case of a bus failure adequate fall-back values have to be used so that the complete system in kept in a safe state.

9 Notes