WEST

Technical Documentation

PAM-199-P-IO

Universal power amplifier with IO-Link interface

Electronics
Hydraulics meets
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CONTENTS

1 General Information

1.1 Product Name

PAM-199-P-IO	universal power amplifier for directional valves or two pressure or throttle valves with IO-Link interface

Alternative products

PAM-199-P-PFN	universal power amplifier for directional valves or two pressure or throttle valves with Profinet interface
PAM-199-P-PDP	universal power amplifier for directional valves or two pressure or throttle valves with ProfibusDP interface
PAM-199-P-ETC	universal power amplifier for directional valves or two pressure or throttle valves with EtherCat interface
PAM-190-P-IO	plug amplifier for proportional valves with I/O - link interface connected via an M12 connector
PAM-199-P	universal power amplifier for directional valves or two pressure or throttle valves with analogue inputs

1.2 Scope of supply

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

1.3 Accessories

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

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

1.4 Symbols used

General information

Safety-related information

1.5 Legal notice

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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 module is used for the control of a directional valve with two solenoids or up to two (pressure or throttle) valves with one solenoid. Various adjustable parameters allow for an optimized adaptation to the respective valve.

Operation Modes

DIR (comparable with PAM-195, PAM-199-P in mode „195“):

The amplifier can be used to control a directional control valve. The setpoint value is specified via a bipolar numerical value in the IO-Link setpoint value channel A.

Negative values lead to activation of solenoid B.

IND (comparable with PAM-196, PAM-199-P in mode „196“):

The amplifier can be used to control one/two throttle or pressure control valves. The setpoint value is specified via two positive numerical values in the IO-Link setpoint value channels A and B.

The output current of the PAM-199-P-IO is closed loop controlled and therefore independent from the power supply and the solenoid resistance. The output stage is monitored for cable breakdown, is short circuit proof and disables the power stage in case of an error.

RAMP, MIN and MAX, the DITHER (frequency and amplitude) and the PWM frequency are programmable.

In addition, the valve characteristics can be linearized via 10 XY-points. For example: using pressure valves a linear behavior between input signal and pressure can be reached.

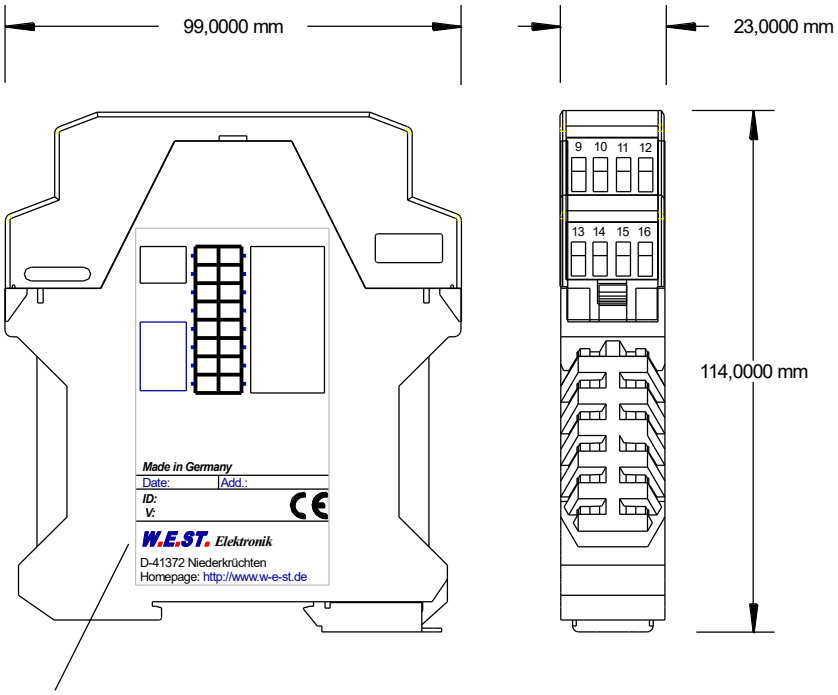
Typical applications: Control of directional, throttle and pressure valves, which need a flexible adaptation of the solenoid control. All typical proportional valves of the different manufactures (BOSCH, REXROTH, PARKER, EATON ...) can be controlled.

The device is intended for control via IO-Link and has a port compatible with the Class A.

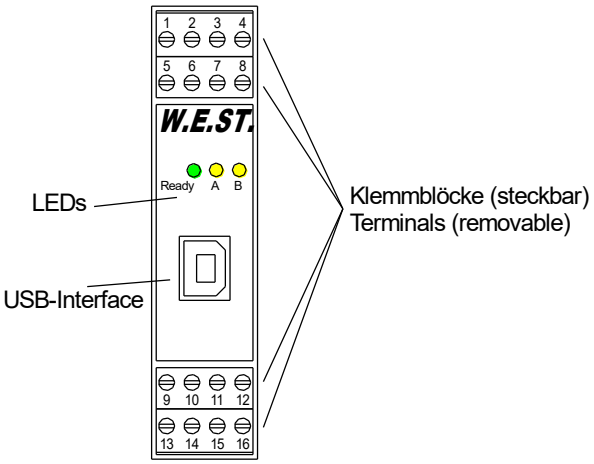
Features

- **Control of directional valves or up to two pressure or throttle valves**
- **IO-Link port class A, with internal galvanic isolation of the additional supply voltage for the output stage**
- **Meets specification V1.1, data rate COM3 = 230.4 kBaud**
- **Digital reproducible adjustments**
- **Free parameterization of ramps, MIN and MAX, DITHER (frequency, amplitude) and PWM frequency**
- **Current ranges (parameterisable via software) up to 2.6 A**
- **Characteristics linearization via 10 XY-points per direction**
- **Application orientated parameter settings**
- **Simplified parameterization with WPC-300 software or via IO-Link**
- **Two analogue inputs are also available, signal transmission via IO-Link**

2.1 Device description



Typenschild und Anschlussbelegung
Type plate and terminal pin assignment



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.

- The wiring with the master must be carried out according to the IO-Link specification. The unit is connected to the master via a maximum of 20m of unshielded standard cable with a cross-section >= 0.34mm².

- 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.

2.2.2 Typical system structure

2.2.2.1 Function DIR

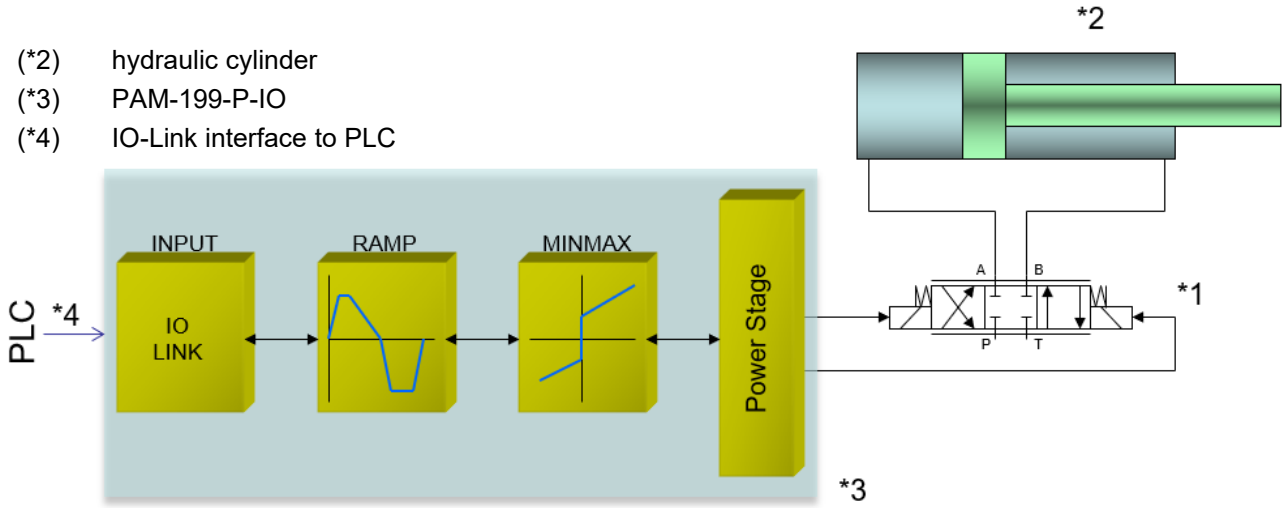
This minimal system consists of the following components:

(*1) proportional (directional) valve

(*2) hydraulic cylinder

(*3) PAM-199-P-IO

(*4) IO-Link interface to PLC



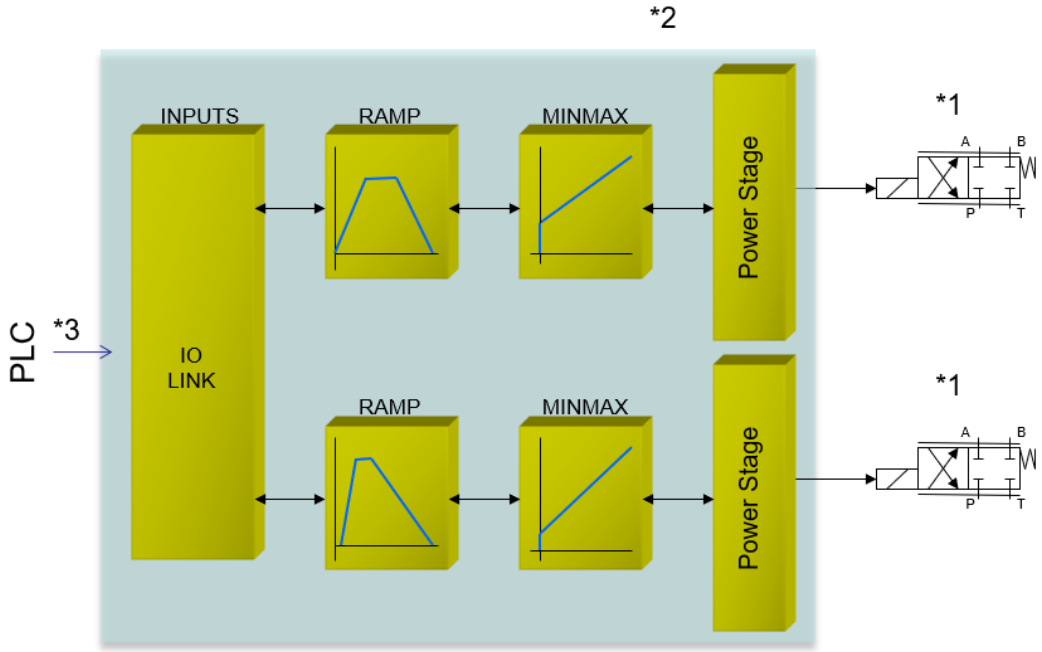
2.2.2.2 Function IND

This minimal system consists of the following components:

(*1) proportional valve(s)

(*2) PAM-199-P-IO

(*3) IO-Link interface to PLC



2.3 Method of operation

The command value for this power amplifier is transmitted via IO-Link. The power stage and ramp function are getting activated with an ENABLE signal. This signal consists of a hardware unlocking (digital input) and a software unlocking (bit on IO-Link). An error free operating is reported by a READY signal (digital output and bit on IO-Link). If the malfunction monitoring is active (SENS), the power stage and the READY signal will be deactivated when a failure is detected. Depending on the setting of SENS the failure has to be erased by re-setting ENABLE.

If function "DIR" is selected, a setpoint of ±100% should be provided. In the event of an error, the unit is deactivated. If function "IND" is selected, two setpoints of 0... 100% are specified. There is a separate ENABLE bit from the IO-Link for each channel so that both channels can be operated independently of each other. In the event of a solenoid error, only the faulty channel is deactivated. The READY signal is switched off due to the error, but the error-free channel remains functional.

The unit offers the option of reading in two analogue signals at PINs 9 and 10 independently of the power amplifier function and transmitting their signals to the PLC via IO-Link.

2.4 Start-up procedure

Step	Task
Installation	Install the device in accordance with the circuit diagram. Ensure it is wired correctly. The module 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 immediately off and check the wiring.
Setting up communication	Once the power input is correct, the PC (notebook) should be connected to the serial interface. Please have a look at the WPC-300 program documentation for how to set up communication. Further commissioning and diagnosis are supported by this software. Now the IO-Link communication can be established. To define the interface, the master must be provided with the appropriate IODD file.
Pre-parameterization	Now set the following parameters (based on the system design and the circuit diagrams): The OUTPUT CURRENT and the valve typical parameters like DITHER or alternatively the PWM - frequency (depending on the specification). This pre-parameterization is necessary to minimize the risk of uncontrolled movement.
Switching on the hydraulics	**CAUTION!** Drives may now leave their position and move to an end position at full speed or the pressure may reach maximum values. Take safety measures to prevent personal injury and damage to property.
Activating ENABLE	**CAUTION!** The output stages are activated when ENABLE is activated via the hardware signal and additionally via IO - Link.
Remote control mode	If IO-Link is not available at first commissioning of the system, the amplifier can be controlled via the WPC program. For that the remote control mode In the monitor view of the WPC program can be activated. **CAUTION!** The WPC program will take the whole control over the device then. The Enable signal at PIN 6 and the bus interface are inoperable in this case.

2.5 Remote Control

For starting-up independent of the PLC (machine control unit), a REMOTE CONTROL mode is implemented. In this mode (released by “Enable Remote Control”, text changes to “Disable Remote Control” when enabled (1)), switching inputs and analog inputs can be simulated by the WPC commissioning software.

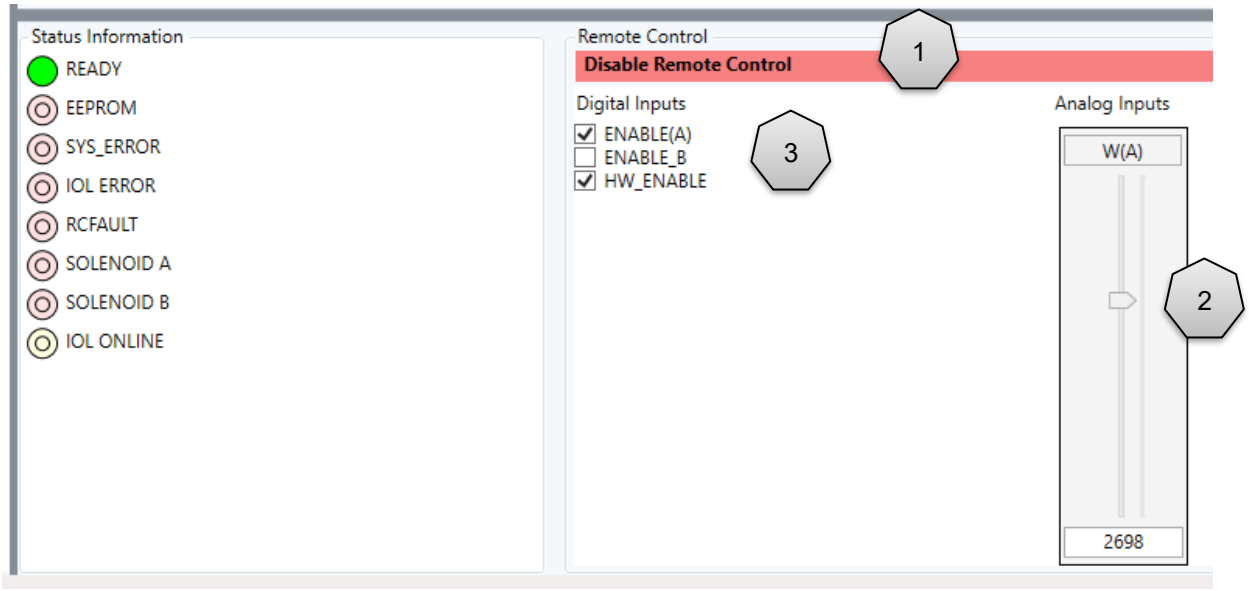


Figure 1 Example of the RC function

The setpoints are:

W(A) (2) bipolar setpoint for DIR mode or unipolar for channel A in IND mode.

WB - Setpoint for channel A in IND mode, only shown if this mode has been parameterised.

Control bits **(3)** are:

ENABLE(A)/B

Enable the control and activate the output.

In IND mode, channel B is enabled separately.

HW_ENABLE

This simulates the input at PIN6.

In addition to the ENABLE(A)/B, this signal is required for the release.

The device can be simply controlled via these input signals.

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.

3 Technical description

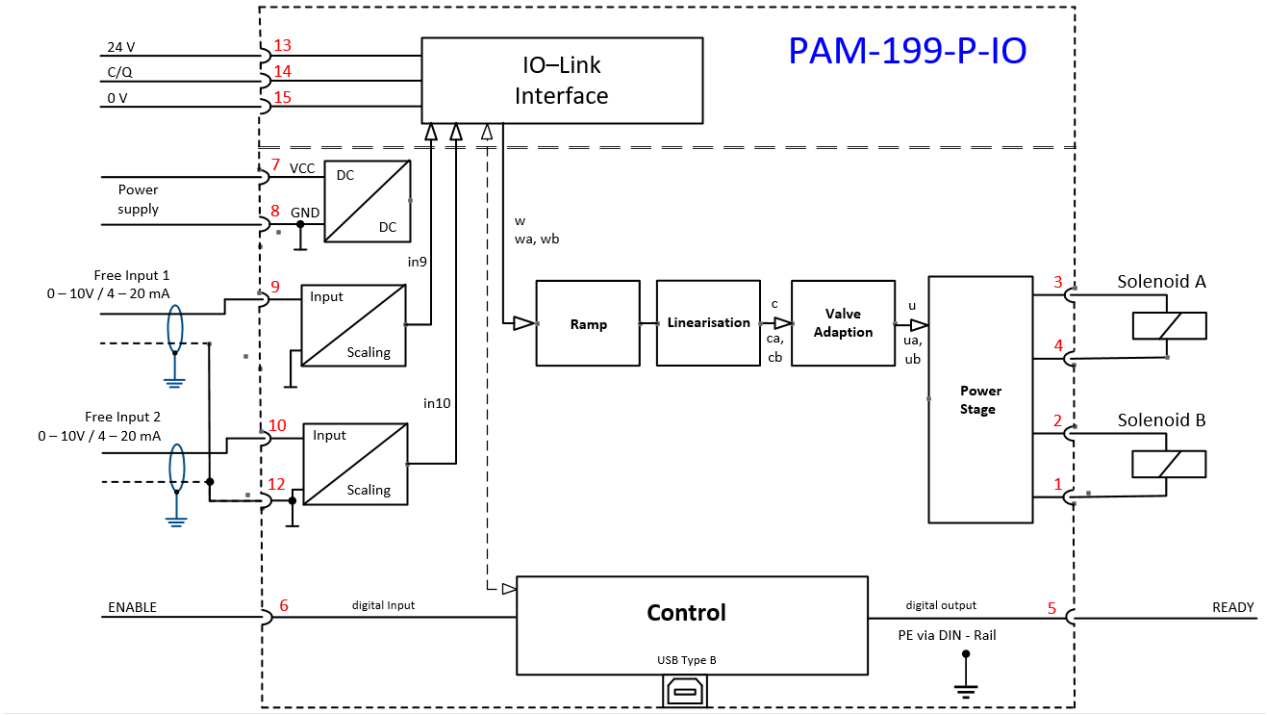
3.1 Input and output signals

IO - Link	Port class „A“, isolated
PIN 13	Power supply 24 V
PIN 14	Communication line (C/Q)
PIN 15	0 V (GND)
Connector	**Supply Power Stage**
PIN 7	Power supply (see technical data)
PIN 8	0 V (GND)
Connector	**Analog Signals**
PIN 9	Free analog input, signal range 0...10 V or 4...20 mA.
PIN 10	Free analog input, signal range 0...10 V or 4...20 mA.
PIN 12	0 V (GND) for the signal inputs
PIN 3 / 4	PWM output for driving the solenoid, channel A
PIN 2 / 1	PWM output for driving the solenoid, channel B
Connector	**Digital IO**
PIN 6	**ENABLE Input:** General enabling of the device, additionally "AND"-linked to the enable via IO-Link.
PIN 5	**READY Output:** **ON:** At least one channel is enabled, there is no recognisable error. **OFF:** Enable is deactivated or an error (solenoid error, current input error or internal error) has been detected.

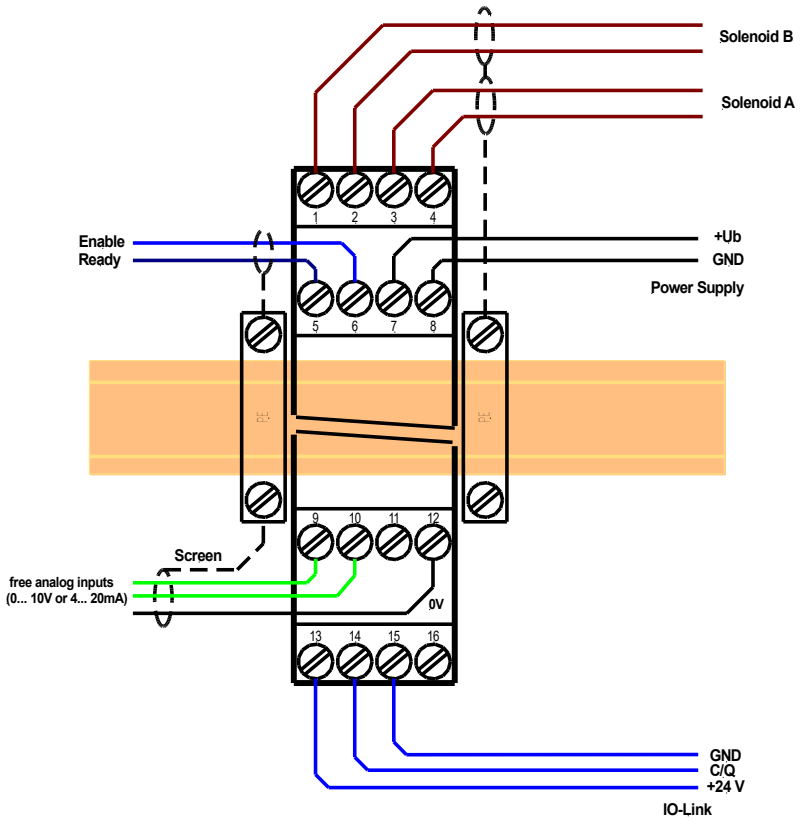
3.2 LED definitions

LEDs	Description of the LED function
GREEN	**OFF:** No power supply or ENABLE is not activated **ON:** System is ready for operation with at least 1 channel ***Flashing:*** Error condition (e.g. valve solenoid). Not active if SENS = OFF.
YELLOW (MIDDLE)	**ON:** The IO-Link interface is connected. ***Flashing:*** Power supply IO-Link present, but no data connection.
YELLOW (RIGHT)	**ON:** At least one channel is driven with a signal > 5%.
GREEN + 2 X YELLOW	***All LEDs flashing:*** Bootloader is active! No normal functions are possible.
2 X YELLOW	**The two yellow LEDs flash alternately in 1 s cycles:** The non-volatile stored parameter data is inconsistent! To acknowledge this error, the data must be saved in the WPC using the SAVE command / button.

3.3 Block diagram



3.4 Typical wiring



3.5 Technical data

Supply voltage (U_b) Current requirement External protection	**[VDC]** **[mA]** **[A]**	12… 30 (incl. ripple) 30 + solenoid current 3 medium time lag
IO - Link Port Data rate	 **[kBaud]**	according to specification V1.1 Class A with internal galvanic isolation 230.4 (COM3)
Electrical isolation of control functions + output stage / bus connection		500 V AC 50 Hz 1 min
Digital input OFF ON Input resistance	 **[V]** **[V]** **[kOhm]**	 < 9.5 > 12.5 46
Digital output OFF ON Max. output current	 **[V]** **[V]** **[mA]**	 < 2 max. V_{cc} 50
Analog inputs: Voltage Input resistance Current Burden Signal resolution	 **[V]** **[kOhm]** **[mA]** **[Ohm]** **[%]**	Unipolar 0… 10 min. 32 4… 20 240 0.006
PWM output Max. output current Frequency	 **[A]** **[Hz]**	Wire break and short circuit monitored 2,6 61… 2604 selectable in defined steps
Controller cycle times Solenoid current control Signal processing	 **[µs]** **[ms]**	 125 1
Serial interface Transmission rate	**-** **[kBaud]**	USB-virtual COM Port 9.6… 115.2
Housing Material Flammability class	 **-** **-**	Snap-on module acc. EN 50022 PA 6.6 polyamide V0 (UL94)
Weight	**[kg]**	0.19
Protection class Temperature range Storage temperature Humidity	**[IP]** **[°C]** **[°C]** **[%]**	20 -20… 60 -20… 70 < 95 (non-condensing)
Connections Communication Plug connectors PE	 **-**	 USB type B 4 x 4-pole terminal blocks via the DIN mounting rail
EMC		EN 61000-6-2: 8/2005 EN 61000-6-3: 6/2007 + A1:2011

4 Parameters

4.1 Parameter overview

Group	Command	Default Value	Unit	Description	IO-Link Index / Byte Length
Basic parameters					
	MODE	STD	–	Scope of the parameter view	
System parameters					
	LG	EN	–	Language switching	
	SENS	AUTO	–	Malfunction monitoring	1000/1
	FUNCTION	DIR	–	Operation mode	1001/1
	CCMODE	OFF	–	Activation of the characteristic linearization	1002/1
Input parameters					
Ramp parameters of the function DIR					
	AA:1 **AA:2** **AA:3** **AA:4**	100 100 100 100	ms ms ms ms	Command signal four quadrant ramp times	1010/4 1011/4 1012/4 1013/4
Ramp parameters of the function IND					
	AA:UP **AA:DOWN**	100 100	ms ms	Ramp times of channel A	1014/4 1015/4
	AB:UP **AB:DOWN**	100 100	ms ms	Ramp times of channel B	1016/4 1017/4
Free analog inputs (optionally usable)					
	SIGNAL:9	OFF	–	Type of the input signal	1020/1
	SIGNAL:10	OFF	–	Type of the input signal	1021/1
Output signal adaption					
Function DIR					
	CC	X Y	– –	Characteristic curve, X - coordinates (ascending), Y - coordinates	12288 – 12329[1]/2
	SIGNAL:U	+	–	Changing output polarity	1022/1
Function IND					
	CCA	X Y	– –	Characteristic curve channel A, X - coordinates (ascending), Y - coordinates	12372[2] – 12393/2
	CCB	X Y	– –	Characteristic curve channel B, X - coordinates (ascending), Y - coordinates	12436 – 12457/2
Min./Max. parameters (common)					
	MIN:A **MAX:A**	0.0 0.0	% %	Deadband compensation Output scaling	1024/2 1025/2
	MIN:B **MAX:B**	100.0 100.0	% %	Deadband compensation Output scaling	1026/2 1027/2
	TRIGGER	2.0	%	Deadband compensation trigger point	1028/2

[1] The indices of the coordinates for the bipolar characteristic are assigned in the order X-10/Y-10/X-9/Y-9...X10/Y10.

[2] The indices of the coordinates for the unipolar characteristics are assigned in the order X0/Y0/X1/Y1...X10/Y10.

The output stage parameters for "FUNCTION = DIR" are displayed in the WPC without the ":A" suffix.

Power stage parameters				
Channel A (IND) or both channels (DIR)				
CURRENT:A	1000	mA	Nominal solenoid current	1031/2
DFREQ:A	121	Hz	Dither frequency	1032/2
DAMPL:A	5.0	%	Dither amplitude	1033/2
PWM:A	2604	Hz	PWM frequency	1034/2
ACC:A	ON	-	Automatic solenoid current controller adjustment	1035/1
PPWM:A **IPWM:A**	7 40	- -	P gain solenoid current controller I gain solenoid current controller	1036/2 1037/2
Channel B in function IND				
CURRENT:B	1000	mA	Nominal solenoid current	1131/2
DFREQ:B	121	Hz	Dither frequency	1132/2
DAMPL:B	5.0	%	Dither amplitude	1133/2
PWM:B	2604	Hz	PWM frequency	1134/2
ACC:B	ON	-	Automatic solenoid current controller adjustment	1135/1
PPWM:B **IPWM:B**	7 40	- -	P gain solenoid current controller I gain solenoid current controller	1136/2 1137/2

Please note: The numerical values in floating point format (with decimal point) are sometimes entered in older WPC versions with a decimal point shift of two places, example: 100.00 % - > input "10000". This also applies to the IO-Link parameterisation. In most programming environments, however, these parameter values, as defined in the IODD file, are also displayed correctly as a floating point number.

4.2 Basic parameters

4.2.1 MODE (Switching between parameter groups)

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

This command changes the parameter mode. Various commands (defined via STD/EXP) are blanked out in standard mode. The several commands in expert mode have more significant influence on the system performance. Therefore they should be changed with care.

4.3 System Parameters

4.3.1 LG (Language switching)

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

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

4.3.2 SENS (Malfunction monitoring)

Command	Parameters	Unit	Group
SENS x	x= ON(1)[3]|OFF(2)|AUTO(3)	-	**STD**

This command is used to activate/deactivate the monitoring functions (output current, 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.

[3] Text selection parameters are transmitted coded as integers via IO-Link. The parameter descriptions contain these numerical equivalents as information, marked in blue colour.

4.3.3 FUNCTION (Choosing operation mode)

Command	Parameters	Unit	Group
FUNCTION X	x= DIR(0)|IND(1)	-	**STD**

This parameter allows you to setup the amplifier for up to two valves with one solenoid (e.g. throttle or pressure valves) or to one valve with two solenoids (directional valve).

DIR	-	Controlling a directional valve with two solenoids
IND	-	Up to two independent channels for controlling one solenoid each

4.3.4 CCMODE (Activation of the characteristic linearization)

Command	Parameters	Unit	Group
CCMODE X	ON(1)|OFF(0)	-	**EXP**

This command will be used for activation or deactivation of the characteristics linearization (CC). Through deactivating this parameter a simple and quick estimation of the linearization is possible.

CAUTION: If CC command is used, parameters MIN, MAX and TRIGGER have to be considered. CC and those commands affect each other. Pay attention to that if it is necessary to use both kind of settings at the same time.

4.4 Signal adaption

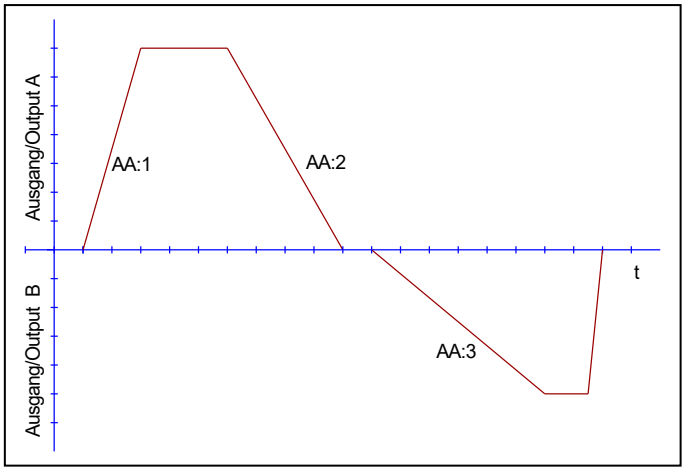
4.4.1 A (Ramp function)

Command		Parameters	Unit	Group	
AA:I	X	i= 1… 4 x= 1… 120000	- ms	**STD**	**DIR**
AA:I AB:I	X X	i= UP|DOWN x= 1… 120000	- ms	**STD**	**IND**

4.4.1.1 Four quadrants ramp function in mode DIR

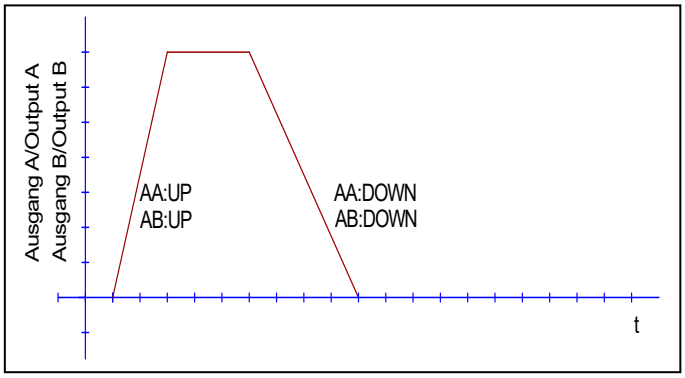
The first quadrant means the acceleration ramp for solenoid A and the second one stands for the deceleration ramp of solenoid A. According to this the third quadrant represents the acceleration ramp for solenoid B so that the fourth quadrant remains for the deceleration ramp for solenoid B.

ATTENTION: Because of internal calculations rounding errors may be occur on the display.



4.4.1.2 Two quadrants ramp function in mode IND

The first quadrant means the ramp up and the second quadrant means the ramp down time. The ramp time is related to 100 % signal step. The ramp function is adjustable independently for each channel.



4.4.2 SIGNAL:9/:10 (Type of free input signals)

Command	Parameters	Unit	Group
SIGNAL:9/:10	OFF(1)|U0-10(2)|I4-20(3)|U10-0(4)|I20-4(5)	V|mA	**EXP**

This command defines the type of sensor signals (current or voltage). The signal direction can be reversed as well.

The analog inputs at terminals 9 and 10 can be used optionally to read in signals and make their values available to the PLC via IO-Link. They have no direct influence on the function of the power amplifier.

4.4.3 SIGNAL:U (Output polarity)

Command	Parameters	Unit	Group
SIGNAL:U	+(0)|-(1)	-	**STD / DIR**

This command enables direction switching of the output signal in directional valve mode.

+ A positive setpoint leads to control of solenoid A, a negative one acts on solenoid B

- A negative setpoint leads to control of solenoid A, a positive one acts on solenoid B

4.4.4 (Characteristics linearization)

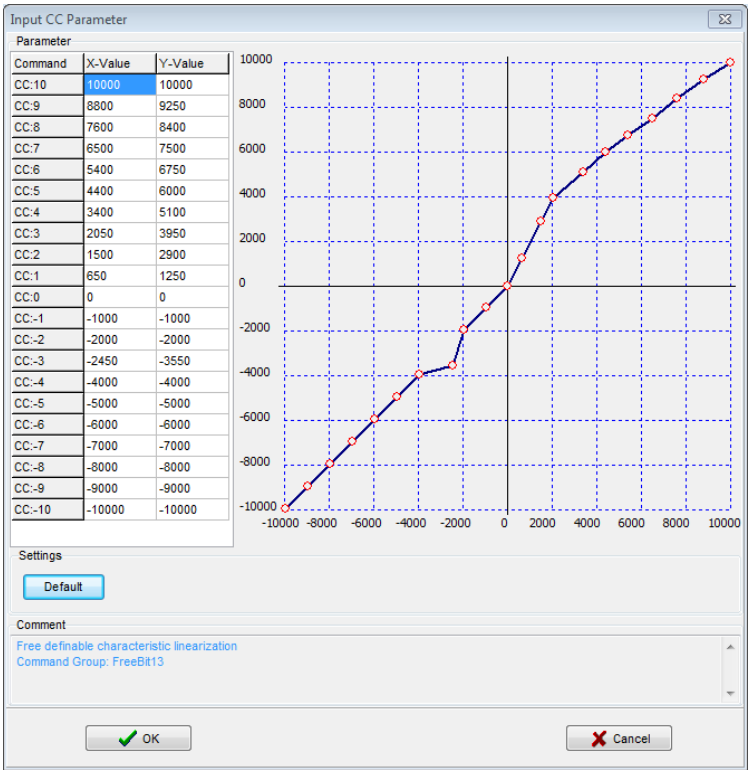
Command	Parameters	Unit	Group
CC:I X Y	i= -10… 10	-	**CCMODE=ON**
	x= -10000… 10000	0.01%	**EXP**
	y= -10000… 10000	0.01%	**DIR**
CCA:I X Y CCB:I X Y	i= 0… 10	-	**CCMODE=ON**
	x= -10000… 10000	0.01%	**EXP**
	y= -10000… 10000	0.01%	**IND**

A user defined signal characteristic can be set by this function. For activating the parameter CCMODE has to be switched to ON.

4.4.4.1 Function DIR, two solenoids

The positive indexes stand for the solenoid A, the negative ones represent the solenoid B. The curve is calculated according to the equation of the linear interpolation: **y=(x-x1)*(y1-y0)/(x1-x0)+y1**.
The influence of the linearization can be estimated via the process data on the monitor or on the oscilloscope.

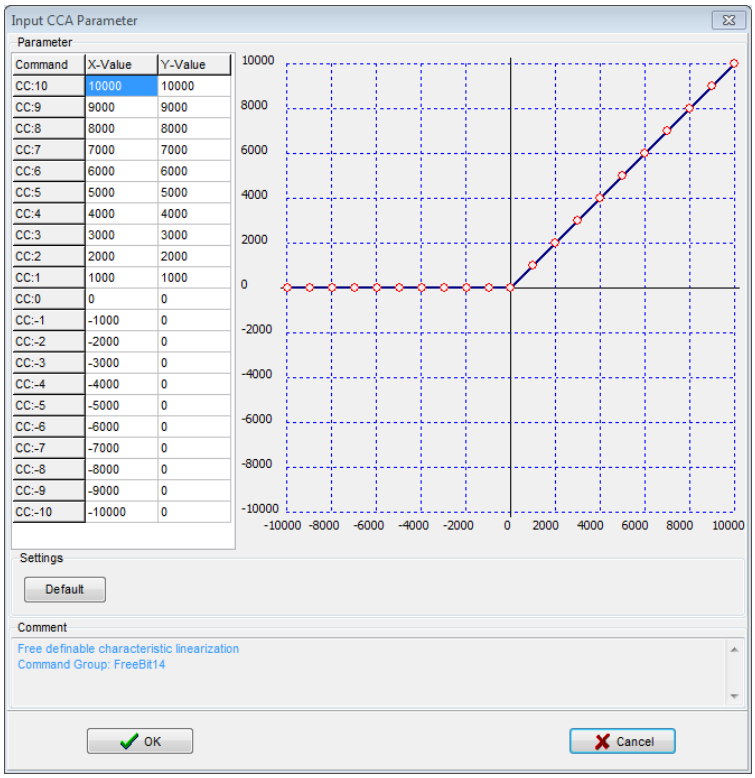
For the input of the characteristics linearization, the WPC-300 program provides a table and a graphic data input. The input signal is mapped on to the X-axis and the output signal is mapped on to the Y-axis.



4.4.4.2 Function IND, one solenoid each

In case of using single solenoid valves, only the first quadrant is active. The curve is calculated according to the equation of the linear interpolation **y=(x-x1)*(y1-y0)/(x1-x0)+y1**.
The influence of the linearization can be estimated via the process data on the monitor or on the oscilloscope.

For the input of the characteristics linearization, the WPC-300 program provides a table and a graphic data input. The input signal is mapped on to the X-axis and the output signal is mapped on to the Y-axis.



4.4.5 MIN (Overlap compensation)

4.4.6 MAX (Output scaling)

4.4.7 TRIGGER (Threshold value of MIN function)

Command		Parameters	Unit	Group
		i= A|B	-	**STD**
MIN:I	X	x= 0… 60.0	%	
MAX:I	X	x= 40.0… 100.0	%	
TRIGGER	X	x= 0.0… 30.0	%	

The output signal is adapted to the valve by these commands. With the MAX value the output signal (the maximum valve current) will be defined. With the MIN value the overlap (dead band of the valve) will be compensated. Via the TRIGGER the activation point of the MIN function is set and so a non-sensitive range around the zero-point[4] can be specified.

CAUTION: If the MIN value is set too high, it influences the minimal velocity, which cannot be adjusted any longer.

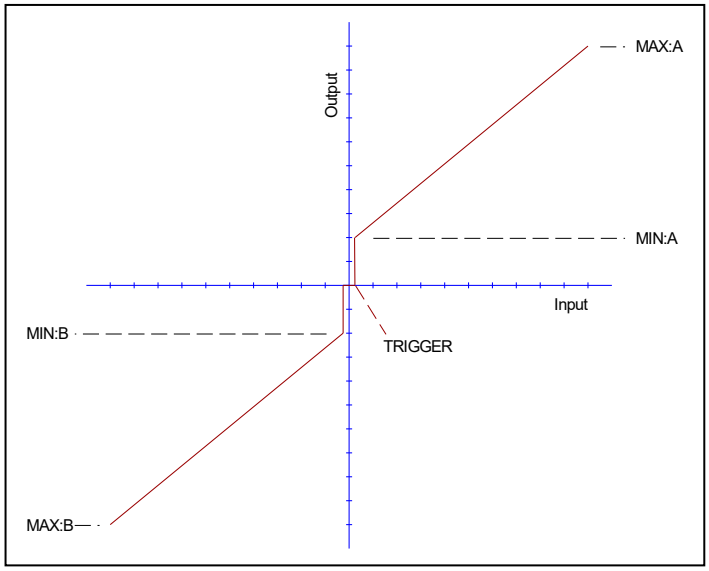


Fig.1: mode DIR, directional valve with 2 solenoids

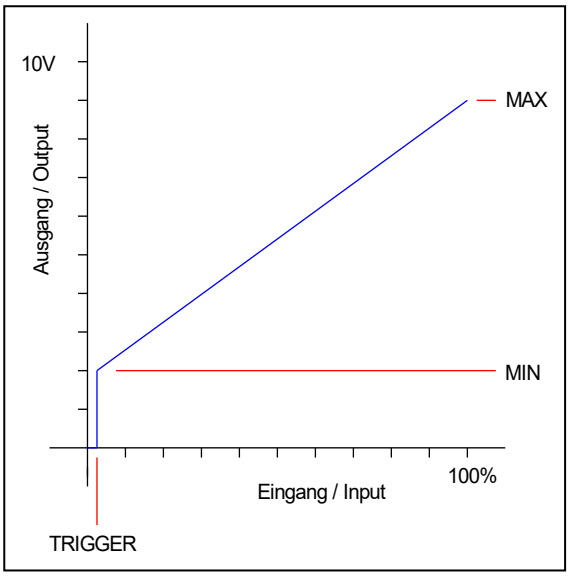


fig.2: mode IND, one solenoid each channel

[4] This dead band is necessary, in order to avoid unrequested activations caused by small variations of the input signal. If this module is used in a position controls, the TRIGGER value should be reduced (typical: 1…10).

4.5 Parameters of the power stage

4.5.1 CURRENT (Nominal output current)

Command	Parameters	Unit	Group
CURRENT X	x= 500… 2600	mA	STD DIR
CURRENT:I X	i= A|B x= 500… 2600	 mA	STD IND

The nominal solenoid current is set with this parameter. The DITHER and also the MIN/MAX parameters always refer to the rated current.

4.5.2 DAMPL (Dither amplitude)

4.5.3 DFREQ (Dither frequency)

Command	Parameters	Unit	Group
DAMPL X DFREQ X	x= 0… 30.0 x= 60… 400	% Hz	STD DIR
 DAMPL:I X DFREQ:I X	i= A|B x= 0… 30.0 x= 5… 400	 % Hz	STD IND

The dither[5] can be defined freely with this command. Different amplitudes or frequencies may be required depending on the respective valve. The dither amplitude is defined in % of the nominal current (see: CURRENT command). Depending on internal calculations the setting at higher frequencies is only possible in steps. Always the next higher step is chosen.

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

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

[5] The DITHER is a superimposed signal to reduce the hysteresis. This function is defined by the amplitude and frequency. The DITHER frequency should not be confused with the PWM frequency. In some proportional valve documentations a mistake is done by the definition of the DITHER / PWM frequency. It is recognizable by missing information about the DITHER amplitude.

4.5.4 PWM (PWM frequency)

Command	Parameters	Unit	Group
PWM X	x= 61… 2604	Hz	**STD** **DIR**
PWM:I X	i= A|B x= 61… 2604	Hz	**STD** **IND**

The frequency can be selected out of the following defined steps (61 Hz (1), 72 Hz (2), 85 Hz (3), 100 Hz (4), 120 Hz (5), 150 Hz (6), 200 Hz (7), 269 Hz (8), 372 Hz (9), 488 Hz (10), 624 Hz (11), 781 Hz (12), 976 Hz (13), 1201 Hz (14), 1420 Hz (15), 1562 Hz (16), 1736 Hz (17), 1953 Hz (18), 2232 Hz (19), 2604 Hz (20)). 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.*

4.5.5 ACC (Auto adaptation of the closed loop current controller)

Command	Parameters	Unit	Group
ACC/:A/:B x	x= ON(2)|OFF(1)	-	**EXP**

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.

4.5.6 PPWM (Solenoid current controller P gain)

4.5.7 IPWM (Solenoid current controller I gain)

Command	Parameters	Unit	Group
PPWM X IPWM X	x= 0… 30 x= 1… 100	- -	**ACC=OFF**
PPWM X IPWM X	i= A|B x= 0… 30 x= 1… 100	- -	**ACC=OFF**

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

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

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.

4.6 PROCESS DATA (Monitoring)

Command	Description	Unit	Function
W	Command value after input scaling	%	**DIR**
C	Command value after ramp function	%	
U	Command value to current controller	%	
WA	Command value after input scaling channel A	%	**IND**
CA	Command value after ramp function channel A	%	
UA	Command value to current controller channel A	%	
WB	Command value after input scaling channel B	%	
CB	Command value after ramp function channel B	%	
UB	Command value to current controller channel B	%	
IA	Output current to solenoid A	mA	**DIR + IND**
IB	Output current to solenoid B	mA	
PIN9	Free input signals (display only available if the associated input has been activated)	%	
PIN10		%	

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

5 IO–Link Interface

The process data are the variable values that are cyclically exchanged via IO-Link.

The process data length is 6 bytes in the direction from master to device and 10 bytes in the direction from device to master.

5.1 Setpoints from master to device

Nr.	Byte	Function	Range	Unit
1	0	Control word High Control word Low	-	-
2	1			
3	2	Setpoint (A) High (Function DIR & IND) Setpoint (A) Low	-10000 … 0 - 10000	0.01 %
4	3			
3	2	Setpoint B High (Function IND only) Setpoint B Low	0 - 10000	0.01 %
4	3			

Definition of the control word:

Byte 0 – Control word 1 High			
Nr.	**Bit**	**Function**	
1	0	---	
2	1	---	
3	2	---	
4	3	---	
5	4	---	
6	5	---	
7	6	---	
8	7	ENABLE(A)	Enable the unit (DIR) or channel A

Byte 1 – Control word 1 Low			
Nr.	**Bit**	**Funktion**	
1	0	---	
2	1	---	
3	2	---	
4	3	---	
5	4	---	
6	5	---	
7	6	---	
8	7	ENABLE B	Enable channel B (IND)

5.2 Process data from the device to the master

Nr.	Byte	Function	Type	Range	Unit
1	0	Status word High Status word Low	int	-	-
2	1				
3	2	Analog input PIN9 High Analog input PIN9 Low	int	0 - 10000	0.01 %
4	3				
5	4	Analog input PIN10 High Analog input PIN10 Low	int	0 - 10000	0.01 %
6	5				
7	6	Solenoid current A High Solenoid current A Low	int	0 - 2600	mA
8	7				
9	8	Solenoid current B High Solenoid current B Low	int	0 - 2600	mA
10	9				

Definition of the status word:

Byte 0 – Status Word High			
Nr.	**Bit**	**Function**	
1	0	!IA ERROR	No error solenoid A
2	1	PIN9 VALID	No error analog input PIN9, also "0" if input not activated
3	2	!APILOWVERR	Supply voltage of the power stage too low (1 = no error)[6]
4	3	!ERROR	Common error flag (1 = no error)
5	4	---	reserved
6	5	---	reserved
7	6	---	reserved
8	7	READY A	General operational readiness message, channel A or unit (DIR)
Byte 1 – Status Word Low			
Nr.	**Bit**	**Function**	
1	0	!IB ERROR	No error solenoid B
2	1	PIN10 VALID	No error analog input PIN10, also "0" if input not activated
3	2	!DERROR	No internal data error
4	3	!SYSERROR	No system error
5	4	---	reserved
6	5	---	reserved
7	6	---	reserved
8	7	READY B	General operational readiness message, channel B

Important: Error flags are inverted. Logical "1" means "no error".

[6] The criterion is working data communication between the processors for the IO link and the power amplifier. Higher voltages (see technical data) are required to operate the power stage. This means that a set !APILOWVERR flag alone cannot be used to conclude that the voltage is sufficient to energise the solenoids.

5.3 Parameterisation via IO-Link

The device can be fully parameterised via the IO-Link as well as via the USB interface with the WPC programme.

It should be noted that these two methods are not locked against each other, i.e. if both variants are used at the same time, the offline project of the PLC or a WPC file may not reflect the correct content of the online parameters if the procedure is used incorrectly.

If parameters are written via IO-Link while WPC is connected, the parameter table in this progam will not update itself automatically. The change of a parameter written via IO-Link will only be reflected in the WPC after pressing the "ID" button again, possibly also after changing the parameter groups.

Each write operation of the IO-Link interface leads to the entire parameterisation being saved in the EEPROM, as otherwise only happens after pressing the "SAVE" button. If you change parameters in the WPC and then write other values via IO-Link, you should proceed with particular care and consideration.

Conclusion: It is recommended not to use the two methods of parameterisation simultaneously, even if this is theoretically possible.

For parameterisation via IO-Link, either the engineering system of the master can be used, or index-based access to individual parameters from the PLC software via corresponding system functions is possible.

If you want to use the latter variant, the parameter indices and their byte length can be taken from the table in Chapter 5.1 / Parameter overview.

The numerical values of the selection parameters are assigned in colour to the respective selection options in the descriptions of the previous chapters, for example "(1)".

In the case of numerical parameters, the units and value ranges specified there apply in each case.

6 Appendix

6.1 Failure monitoring

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

Source	Fault	Behaviour
IO-Link	Communication failure	Both output stages are deactivated.
Analog inputs PIN 9, PIN10, 4...20 mA	Current loop error	No influence on the function
Solenoid A PIN 3 / 4, Mode IND	Solenoid current error	Output stage A is deactivated.
Solenoid B PIN 1 / 2, Mode IND	Solenoid current error	Output stage B is deactivated.
Solenoid A or Solenoid B, Mode DIR	Solenoid current error	Both output stages are deactivated.
RC-Fault	Error in remote control operation, e.g. loss of USB connection or termination of WPC before remote control operation is switched off.	Both output stages are deactivated.
EEPROM (when switching on)	Data error	Both output stages are deactivated. The module can only be activated by saving the parameters again!

6.2 Troubleshooting

It is assumed that the device is in an operable state and that 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.

ATTENTION: When working with the RC (Remote Control) mode, all safety aspects must be thoroughly checked. In this mode, the module is controlled directly and the machine control cannot exert any influence on the module.

FAULT	CAUSE / SOLUTION
ENABLE is active, the module does not respond and the READY LED is off.	Probably the power supply is not available or the ENABLE signal (PIN 6 and at the same time the control bit belonging to the channel via IO - Link) is not present. Other faults are signalized with a flashing READY LED.
ENABLE is active, the READY LED is flashing.	The flashing READY LED signals that a fault is detected by the module. The fault could be: • A cable break or an incorrect cabling to the solenoids. • Internal data error: press the 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 active; no current to the solenoid.	• No command input is available or the parameterization is incorrect. With the WPC-tool you can check if a command input (W) is available. If not, check the IO link connection or the setpoint setting. • If the command input is correct, you have to check the valve control parameter. If the current is set too low (parameter CURRENT), the output current and the expected pressure are too low. • The valve is controlled correctly (the output is going up to the nominal current). In this case, you may have a hydraulic problem or you are using free-wheeling-diodes in the solenoid plug. Please remove the free-wheeling-diodes to allow a correct current measurement.
ENABLE is active, the READY LED is active and the control is instable.	In many cases you may have a hydraulic problem. Electrical problems may be: • Electrical noise at the wire of the power supply. • Very long solenoid wiring (> 40 m), disturbance in the current control loop. • Instable current control loop. The adjustments of the PWM frequency and the dither (frequency and amplitude) have to be checked carefully. Good experiences are made with: a. PWM frequency = 2600 Hz (higher frequency), the dither has to be aligned to the valve (amplitude and frequency). b. PWM frequency = 100… 400 Hz (lower frequency), the dither amplitude is set to 0 % (disabled).

7 Notes