

## Technical Documentation

### PAM-199-P-PDP

Universal power amplifier with ProfibusDP interface



*Electronics  
Hydraulics meets  
meets Hydraulics  
Electronics*

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## 1 General Information

### 1.1 Order Number

**PAM-199-P-PDP** - universal power amplifier for directional valves or two pressure or throttle valves with ProfibusDP interface

#### Special versions

**PAM-199-P-PDP-S1** - universal power amplifier for directional valves or two pressure or throttle valves with ProfibusDP interface and separate power supply for the Profibus interface and the power stage

#### Alternative products

**PAM-199-P-PFN** - universal power amplifier for directional valves or two pressure or throttle valves with ProfinetIO interface

**PAM-199-P-ETC** - universal power amplifier for directional valves or two pressure or throttle valves with EtherCat interface

**PAM-199-P** - universal power amplifier for directional valves or two pressure or throttle valves with analogue interface and digital inputs

### 1.2 Scope of supply

The scope of supply includes the module plus the terminal blocks which are a 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](http://www.w-e-st.de).

### 1.3 Accessories

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

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

## 1.4 Symbols used



General information



Safety-related information

## 1.5 Legal notice

**W.E.St.** Elektronik GmbH

Gewerbering 31  
D-41372 Niederkrüchten

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

Homepage: [www.w-e-st.de](http://www.w-e-st.de)  
EMAIL: [contact@w-e-st.de](mailto:contact@w-e-st.de)

Date: 07.01.2025

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

This document is protected by copyright.

## 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. The integrated power amplifier with a short cycle time of 0,125 ms for the current loop is an inexpensive and space-saving solution.

Controlling the amplifier is realized here via a ProfibusDP interface. Furthermore, this provides changing most of the parameters via the bus. This device replaces the previous amplifiers PAM-195-P-PDP and PAM-196-P-PDP. With the parameter FUNCTION the operation mode can be switched.

The output current 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.

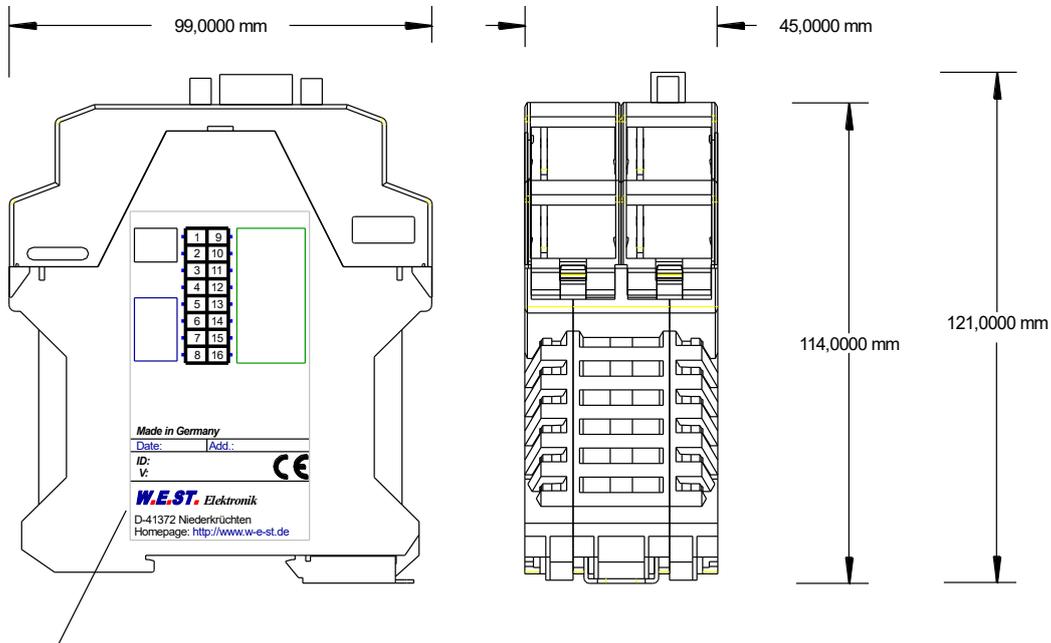
In addition, the valve characteristics can be linearized via 10 XY-points. For example: using pressure valves a linear behavior between input signal and pressure can be reached.

**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, BUCHER, DUPLOMATIC, PARKER...) can be controlled.

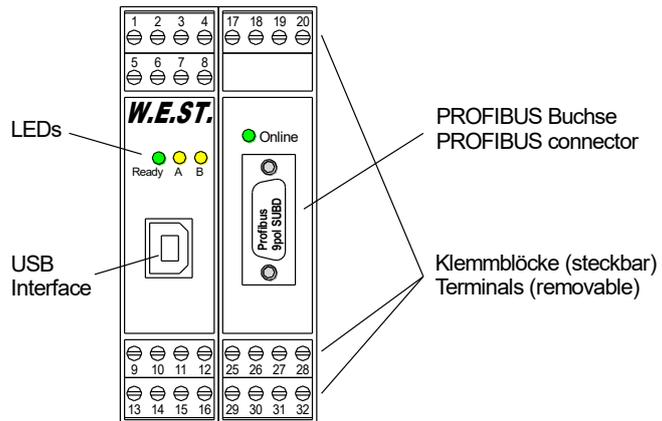
## Features

- **Control of directional, pressure or throttle valves**
- **Compact housing**
- **Digital reproducible adjustments**
- **Controlling via Profibus**
- **Parameterization via Profibus**
- **Characteristics linearization via 10 XY-points per direction**
- **Free parameterization of RAMPS, MIN / MAX, PWM, output current and DITHER**
- **Range of the rated output current: 0.5... 2.6 A**
- **Simple and application orientated parameter settings via WPC-software**
- **Failure monitoring and extended function check**

## 2.1 Device description



Typenschild und Anschlussbelegung  
 Type plate and terminal pin assignment



## 3 Use and application

### 3.1 *Installation instruction*

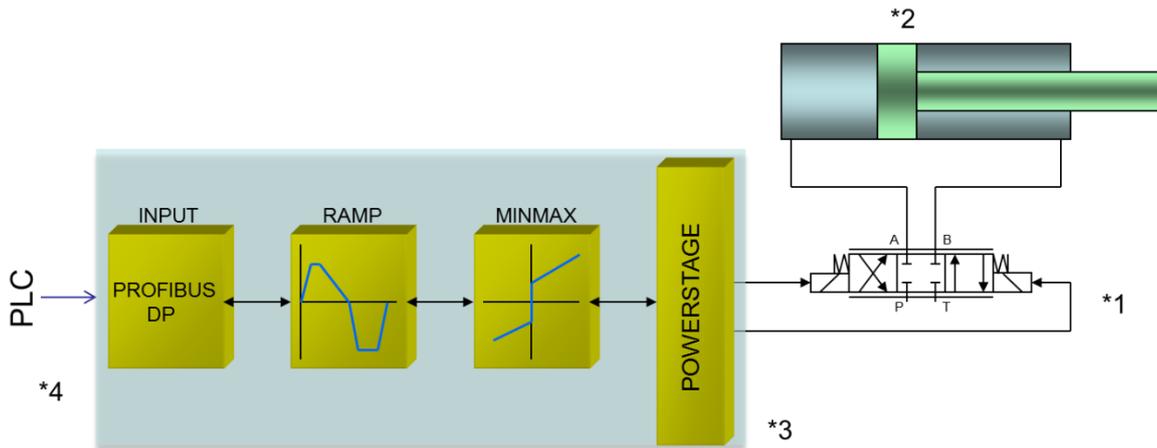
- This module is designed for installation in a shielded EMC housing (control cabinet). All cables which lead outside must be screened; complete screening is required. It is also a requirement that no strong electro-magnetic interference sources are installed nearby when using our open and closed loop control modules.
- **Typical installation location:** 24V 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 space close to the PLC (24 V area) is most suitable. All digital and analogue inputs and outputs are fitted with filters and surge protection 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-connected 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 > 3m. 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.
  - With 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). Particular care is required with cables of over 40 m in length – the manufacturer should be consulted if necessary.
- A low-resistance connection between PE and the mounting rail should be provided. Transient interference is transmitted from the module directly to the mounting rail and from there to the local earth.
- Power should be supplied by a regulated power supply unit (typically a PELV system complying with IEC364-4-4, secure low voltage). The low internal resistance of regulated power supplies gives better interference voltage dissipation, which improves the signal quality of high-resolution sensors in particular. Switched inductances (relays and valve coils connected to the same power supply) must always be provided with appropriate overvoltage protection directly at the coil.

## 3.2 Typical system structure

### 3.2.1 Function 195

This minimal system consists of the following components:

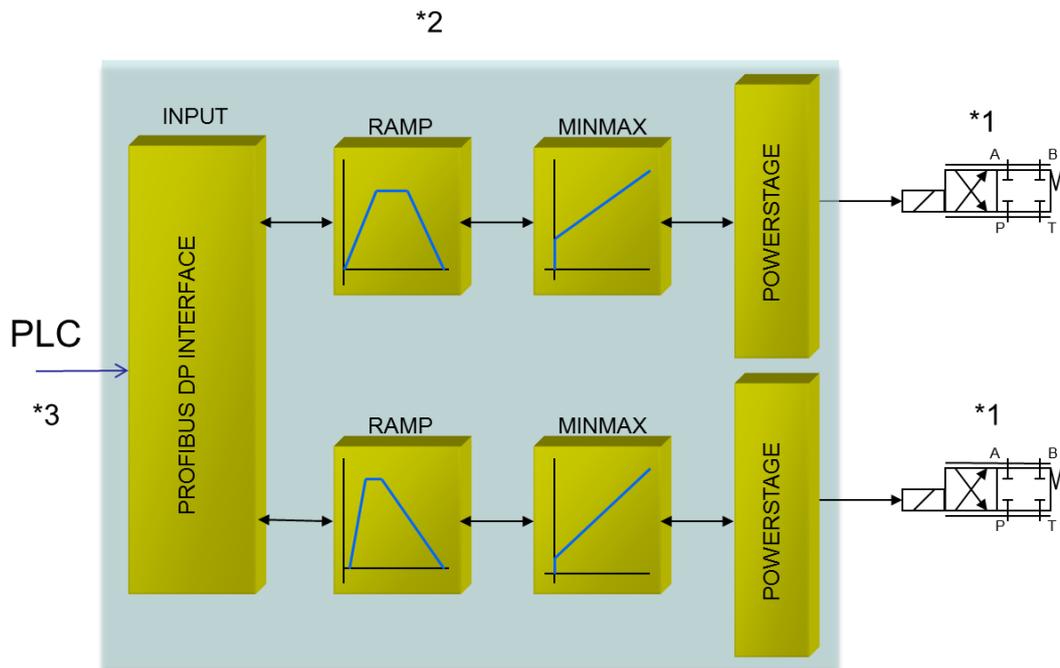
- (\*1) proportional (directional) valve
- (\*2) hydraulic cylinder
- (\*3) PAM-199-P-PDP
- (\*4) interface to PLC with ProfibusDP and digital signals



### 3.2.2 Function 196

This minimal system consists of the following components:

- (\*1) proportional valve(s)
- (\*2) PAM-199-P-PDP
- (\*3) interface to PLC with ProfibusDP and digital signals



## 3.3 Method of operation

The command value for this power amplifier is transmitted via Profibus. The power stage gets activated with an ENABLE signal. This signal consists of a hardware unlocking (digital input) and a software unlocking (bit on Profibus). An error free operating is reported by a READY signal (digital output and bit on Profibus). 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 resetting ENABLE.

In mode 195 a command value of  $\pm 100\%$  is affected. In case of a detected error the device gets deactivated.

In mode 196 two command values of 0... 100% are affected. Each channel has its own ENABLE bit on the Profibus for using both channels independently from each other. If a solenoid error occurs only the defective channel will be deactivated. The READY signal will be switched off because of this error, but the error free second channel stays in operation.

## 3.4 Commissioning

Step	Task
Installation	Install the device in accordance with the circuit diagram. Ensure it is wired correctly and that the signals are well shielded. The device must be installed in a protective housing (control cabinet or similar).
Switching on for the first time	Ensure that no unwanted movement is possible in the drive (e.g. switch off the hydraulics). Connect an ammeter and check the current consumed by the device. If it is higher than specified, there is an error in the wiring. Switch the device off immediately and check the wiring.
Setting up communication	Once the power input is correct the PC (notebook) should be connected to the serial interface. Please see the WPC-300 program documentation for how to set up communication. Further commissioning and diagnosis are supported by the operating software. <b>ATTENTION!</b> The COMPORT (in WPC-300) has to be closed before the USB plug is to be disconnected. Otherwise the WPC-300 is going to be instable.
Pre-parameterization	Now set up the following parameters (with reference to the system design and circuit diagrams): The nominal output CURRENT and the typical valve parameters such as DITHER and MIN/MAX. Pre-parameterization is necessary to minimize the risk of uncontrolled movements.
Control signal	Check the control signal with an amp meter. The control signal (the current of the solenoid) is within the range of 0... 2, 6A. In the actual status it should show approximately 0 A. <b>ATTENTION!</b> You can also monitor the solenoid current in the WPC-300 program.
Switching on the hydraulics	The hydraulics can now be switched on. The module is not yet generating a signal. Drives should be at a standstill or drift slightly (leave its position at a slow speed) if it is a proportional valve.
Setting up Profibus	Establish the connection with GSD file and configuration of the data bytes. The slave address can be set via Profibus or preset fix via the WPC program.
Activating ENABLE	<b>CAUTION!</b> The drive can now leave its position and move to an end position with full speed or the pressure can reach maximum. Take safety measures to prevent personal injury and damage.
Remote control mode	<i>If the Profibus 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.</i> <b>CAUTION!</b> The WPC program will take the whole control over the device then. The Enable signal at PIN 8 and the bus interface are inoperable in this case.

## 4 Function modes and technical description

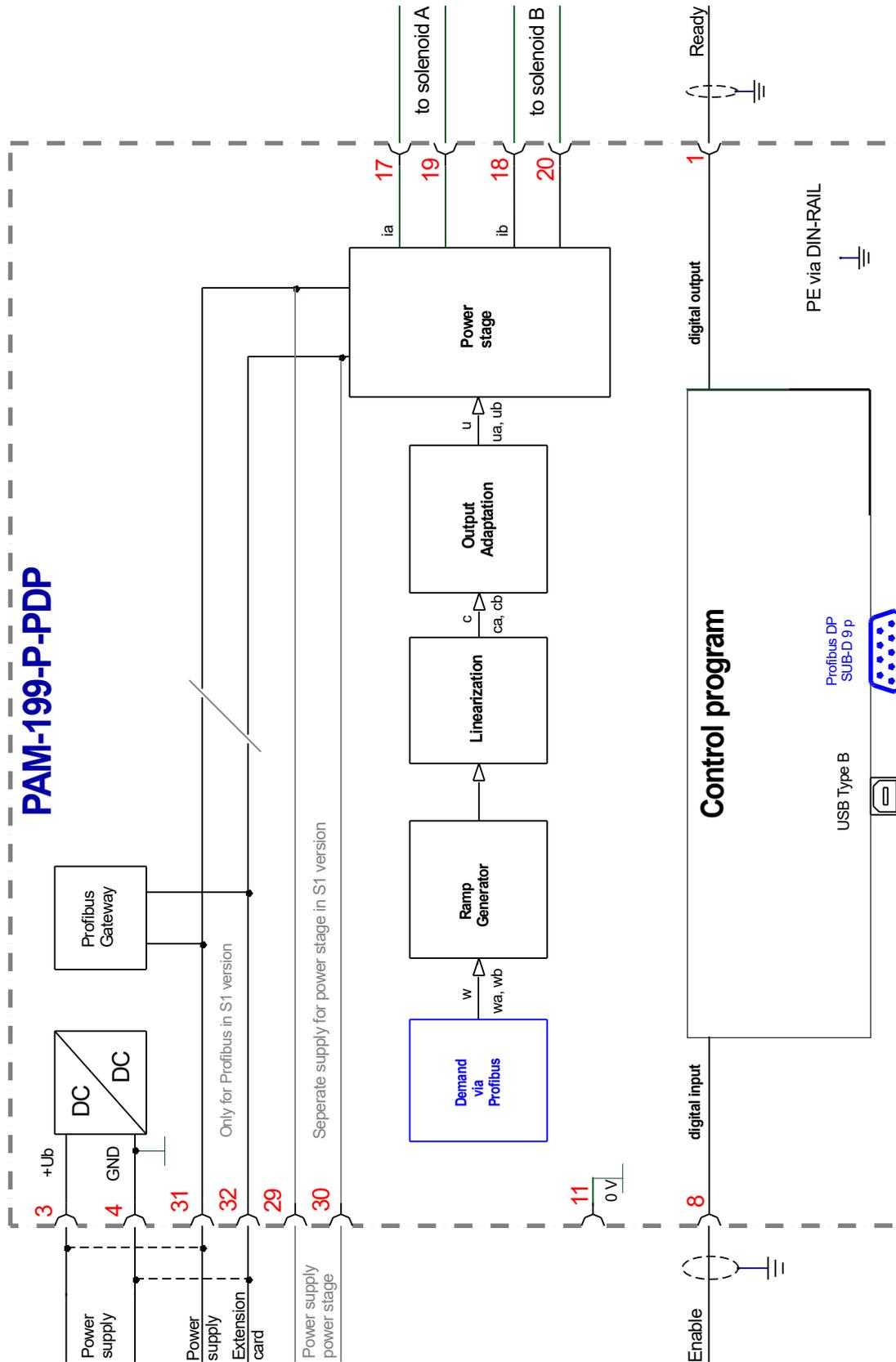
### 4.1 LED Indications

LEDs	Description of the LED function
GREEN + YELLOW	<ol style="list-style-type: none"> <li><b>Chasing light (over all LEDs):</b> The bootloader is active. No normal functions are possible.</li> <li><b>All LEDs flash shortly every 6 s:</b> 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.</li> </ol>
YELLOW + YELLOW	<b>Both yellow LEDs flash oppositely every 1 s:</b> The nonvolatile stored parameters are inconsistent! To acknowledge the error the data have to be saved with the SAVE command or the corresponding button in the WPC. If the function of the module has changed via the FUNCTION parameter, all parameters are deleted purposely and set to default values. In this case the LEDs indicate no error, but a desired state. To acknowledge please save.
GREEN	Identical to the READY output. <b>OFF:</b> No power supply or ENABLE is not activated <b>ON:</b> System is ready for operation  <b>Flashing:</b> Error detected (e. g. valve solenoid or 4... 20 mA). Not active when SENS = OFF.
YELLOW	LED in the middle position = Activity of solenoid A. LED in the right position = Activity of solenoid B.
PDP GREEN	Online LED Profibus – communication is active.

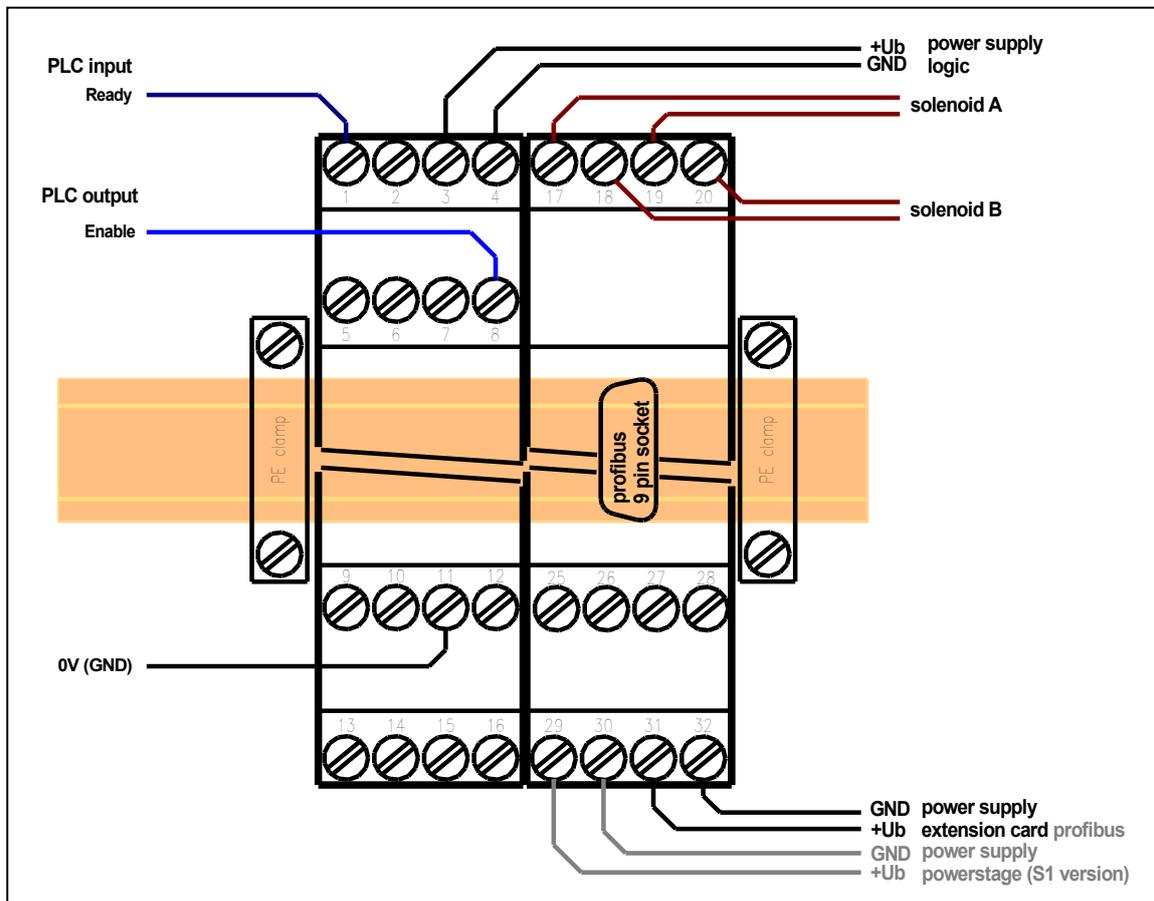
## 4.2 Input and output signals

Connection	Supply
PIN 3	Power supply (see technical data)
PIN 4	0 V (GND) Power supply. <b>Attention</b> , PIN 4 and PIN 11 are connected internally.
PIN 29	Power supply for the power stage, only active in S1 version.
PIN 30	0 V (GND) supply connection for the power stage, only active in S1 version.
PIN 31	Power supply for the extension board, in S1 version only for the Profibus interface.
PIN 32	0 V (GND) supply connection for the extension board, in S1 version only for ProfibusDP.
Connection	PWM output
PIN 17 / 19	Current controlled PWM outputs for solenoid A.
PIN 18 / 20	Current controlled PWM outputs for solenoid B.
Connection	Analogue input signals
PIN 11	0 V reference for the signal in- and outputs.
Connection	Digital inputs and outputs
PIN 8	<b>Enable Input:</b> This digital input signal linked with the software enabling initializes the application.
PIN 1	<b>READY output:</b> <b>ON:</b> Module is ready, no errors are detected <b>OFF:</b> ENABLE is deactivated or an error was detected.

## 4.3 Circuit diagram



## 4.4 Typical wiring



## 4.5 Technical data

Power supply (U <sub>b</sub> ) Power consumption max. External fuse	<b>[VDC]</b> <b>[W]</b> <b>[A]</b>	12... 30 (incl. ripple) max. 2.5 + Power of the connected coils 3 medium time lag
Digital inputs OFF ON Input resistance	<b>[V]</b> <b>[V]</b> <b>[kOhm]</b>	< 2 > 10 25
Digital outputs OFF ON Maximum current	<b>[V]</b> <b>[V]</b> <b>[mA]</b>	< 2 max. U <sub>b</sub> 50
PWM output Max. output current Frequency	<b>[A]</b> <b>[Hz]</b>	Wire break and short circuit monitored 2.6 61... 2604 selectable in defined steps
Sample time Solenoid current control Signal processing	<b>[μs]</b> <b>[ms]</b>	125 10
Profibus DP interface data rate ID-number	<b>[kbit/s]</b> -	9.6, 19.2, 93.75, 187.5, 500, 1500, 3000, 6000, 12000 1810h
Serial interface Transmission rate	- <b>[kBaud]</b>	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	<b>[kg]</b>	0.310
Protection class Temperature range Storage temperature Humidity	<b>[IP]</b> <b>[°C]</b> <b>[°C]</b> <b>[%]</b>	20 -20... 60 -20... 70 < 95 (non-condensing)
Connections Communication Profibus Plug connectors PE	-	USB type B D-SUB p pin 4-pole terminal blocks via the DIN mounting rail
EMC	<b>EN</b> <b>EN</b>	61000-6-2: 8/2005 61000-6-4: 6/2007 ; A1:2011

## 5 Parameter

### 5.1 Parameter list 195

Group	Command	Default	Unit	Description
<b>Basic parameters</b>				
	LG	EN	-	Changing language help texts
	MODE	STD	-	Parameter view
	PDPADR	126	-	Profibus device address
	SENS	AUTO	-	Malfunction monitor
	FUNCTION	195	-	Operation mode
	CCMODE	OFF	-	Activation and deactivation of the characteristic linearization
<b>Input signal adaptation</b>				
	AA:1	100	ms	Command signal four quadrant ramp times
	AA:2	100	ms	
	AA:3	100	ms	
	AA:4	100	ms	
<b>Output signal adaptation</b>				
	CC	X Y	-	Free definable characteristic linearization
	MIN:A	0	0.01 %	Deadband compensation
	MIN:B	0	0.01 %	
	MAX:A	10000	0.01 %	Output scaling
	MAX:B	10000	0.01 %	
	TRIGGER	200	0.01 %	Deadband compensation trigger point
	SIGNAL:U	+	-	Changing output polarity
<b>Parameters of the power stage</b>				
	CURRENT	1000	mA	Rated solenoid current
	DAMPL	500	0.01 %	Dither amplitude
	DFREQ	121	Hz	Dither frequency
	PWM	2604	Hz	PWM frequency
	ACC	ON	-	Current loop auto adjustment
	PPWM	7	-	P-Gain of the current loop
	IPWM	40	-	I-Gain of the current loop

## 5.2 Parameter list 196

Group	Command	Default	Unit	Description
<b>Basic parameters</b>				
	LG	EN	-	Changing language help texts
	MODE	STD	-	Parameter view
	PDPADR	126	-	Profibus device address
	SENS	AUTO	-	Malfunction monitor
	FUNCTION	196	-	Operation mode
	CCMODE	OFF	-	Activation and deactivation of the characteristic linearization
<b>Input signal adaptation</b>				
	AA:UP	100	ms	Command signal ramp times channel A
	AA:DWN	100	ms	
	AB:UP	100	ms	Command signal ramp times channel B
	AB:DOWN	100	ms	
<b>Output signal adaptation</b>				
	CCA	X Y	-	Free definable characteristic linearization
	CCB	X Y	-	
	MIN:A	0	0.01 %	Deadband compensation
	MIN:B	0	0.01 %	
	MAX:A	10000	0.01 %	Output scaling
	MAX:B	10000	0.01 %	
	TRIGGER	200	0.01 %	Deadband compensation trigger point
<b>Parameters of the power stage</b>				
	CURRENT	1000	mA	Rated solenoid current
	DAMPL:A	500	0.01 %	Dither amplitude
	DAMPL:B	500	0.01 %	
	DFREQ:A	121	Hz	Dither frequency
	DFREQ:B	121	Hz	
	PWM:A	2604	Hz	PWM frequency
	PWM:B	2604	Hz	
	ACC	ON	-	Current loop auto adjustment
	PPWM:A	7	-	P-Gain of the current loop
	PPWM:B	7	-	
	IPWM:A	40	-	I-Gain of the current loop
	IPWM:B	40	-	

## 5.3 Basic parameters

### 5.3.1 LG (Changing the language for the help texts)

Command	Parameters	Unit	Group
LG	X	x= DE EN	STD

Either German or English can be selected for the help texts in the WPC-300 program.

### 5.3.2 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.

### 5.3.3 PDPADR (Profibus address)

Command	Parameters	Unit	Group
PDPADR	X	x= 1... 126	STD

With this command the address of the module for the communication with the Profibus is determined. If the addressing shall be done via the Profibus, address 126 has to be chosen.



**CAUTION:** If the address is changed via the Profibus, the "126" remains in the parameter list. The actual address for communicating with the module is still the one which was chosen via the Profibus.

## 5.3.4 SENS (Failure monitoring)

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

This command is used to activate/deactivate the monitoring functions (output current and internal failures) of the module.

**ON:** All monitoring functions are active. Detected failures can be reset by deactivating the ENABLE input. This mode should be used in case of active enabling and monitoring by a PLC (READY signal).

**OFF:** No monitoring function is active.

**AUTO:** Auto reset mode. All monitoring functions are active. If the failure does not exist anymore, the module automatically resumes to work.



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



**AUTO MODE:** The module checks each second the actual failure status, which will (in case of a persistent error) trigger the LED and the READY output for a short time.

## 5.3.5 FUNCTION (Choosing operation mode)

Command	Parameters	Unit	Group
FUNCTION X	x= 195 196	-	STD

This parameter allows you to adapt the amplifier to valves with one solenoid (e.g. pressure valves) or to such with two solenoids (directional valves).

## 5.3.6 CCMODE (Activation of the characteristic linearization)

Command	Parameters	Unit	Group
CCMODE X	x= ON OFF	-	EXP

This command will be used for activation or deactivation of the characteristics linearization (CC, CCA and CCB). 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.

## 5.4 Input signal adaption

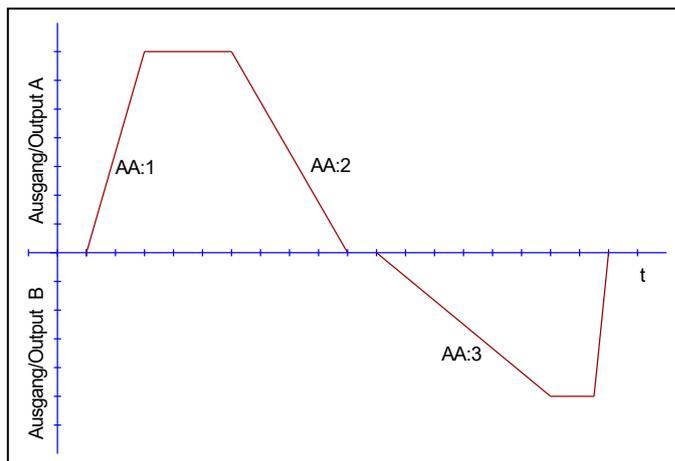
### 5.4.1 AA / AB (Ramp function)

Command	Parameters	Unit	Group
AA:I X	i= 1... 4 x= 1... 120000	- ms	<b>STD 195</b>
AA:I X AB:I X	i= UP DOWN x= 1... 120000	- ms	<b>STD 196</b>

#### 5.4.1.1 Four quadrants ramp function.

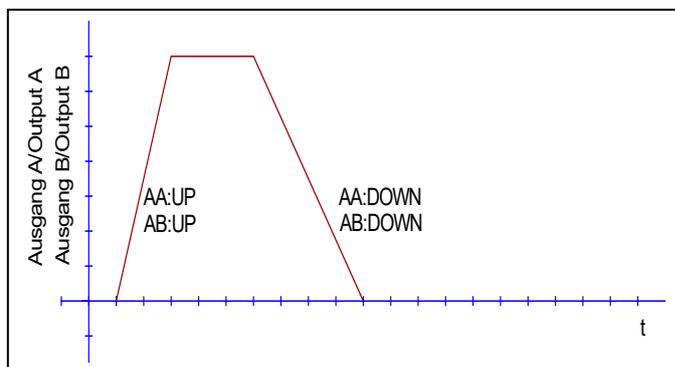
The first quadrant means the acceleration ramp for solenoid A and the second one stands for the deceleration ramp of solenoid A. According to this the third quadrant represents the acceleration ramp for solenoid B so that the fourth quadrant remains for the deceleration ramp for solenoid B.

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



#### 5.4.1.2 Two quadrants ramp function.

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.



## 5.5 Output signal adaption

### 5.5.1 CC (Characteristics linearization)

Command	Parameters	Unit	Group
CC:I X Y	i= -10... 10 x= -10000... 10000 y= -10000... 10000	- 0.01% 0.01%	<b>CCMODE=ON</b>  <b>195</b>
CCA:I X Y CCB:I X Y	i= 0... 10 x= -10000... 10000 y= -10000... 10000	- 0.01% 0.01%	<b>CCMODE=ON</b>  <b>196</b>

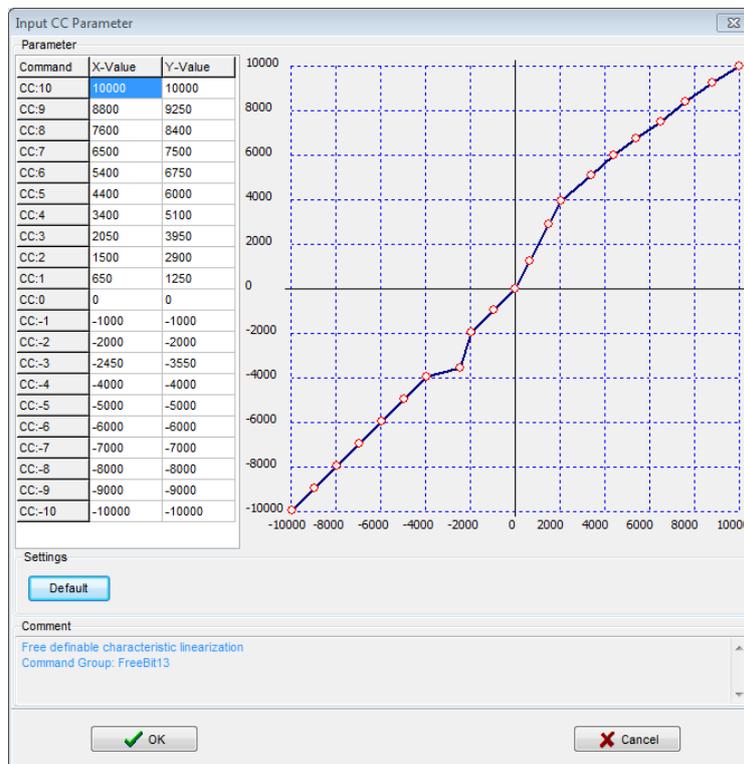
A user defined signal characteristic can be set by this function. For activating the parameter CCMODE has to be switched to ON.

#### 5.5.1.1 Mode 195, 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:  $y=(x-x_1)*(y_1-y_0)/(x_1-x_0)+y_1$ .

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.

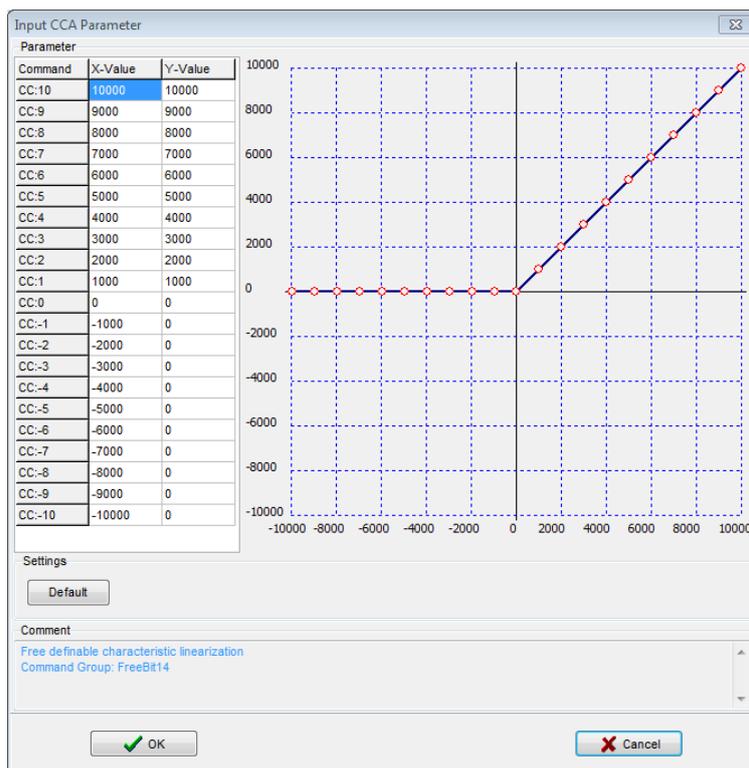


## 5.5.1.2 Mode 196, one solenoid each

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  $y=(x-x_1)*(y_1-y_0)/(x_1-x_0)+y_1$ .

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.



## 5.5.2 MIN (Overlap compensation)

## 5.5.3 MAX (Output scaling)

## 5.5.4 TRIGGER (Threshold value of MIN function)

Command	Parameters	Unit	Group
	$i = A B$	-	<b>STD</b>
MIN:I X	$x = 0 \dots 6000$	0.01%	
MAX:I X	$x = 5000 \dots 10000$	0.01%	
TRIGGER X	$x = 0 \dots 3000$	0.01%	

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<sup>1</sup> can be specified.



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

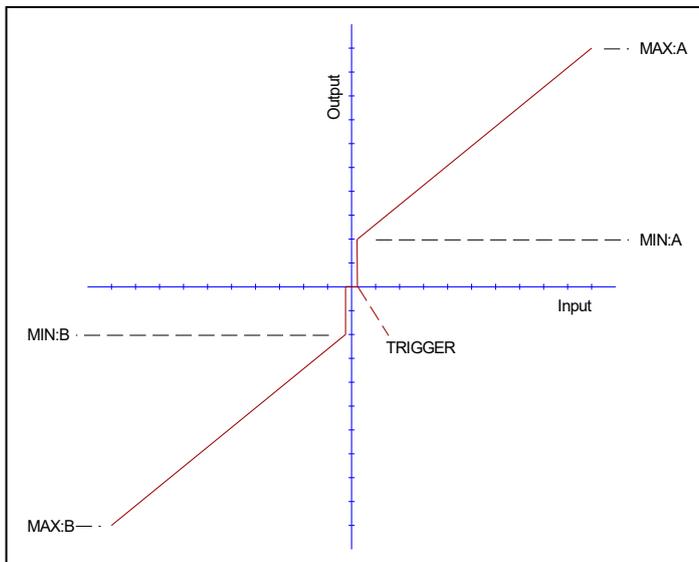


Fig.1: mode 195, directional valve with 2 solenoids

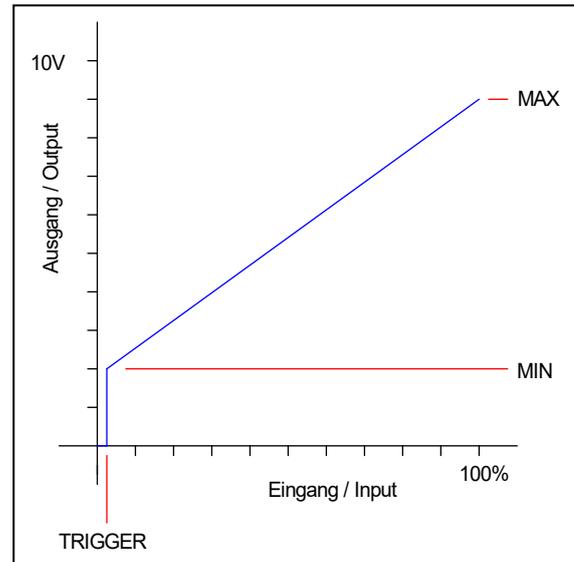


fig.2: mode 196, one solenoid each channel

<sup>1</sup> 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).

## 5.6 Parameters of the power stage

### 5.6.1 CURRENT (Nominal output current)

Command	Parameters	Unit	Group
CURRENT X	x= 500... 2600	mA	STD

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

### 5.6.2 DAMPL (Dither amplitude)

### 5.6.3 DFREQ (Dither frequency)

Command	Parameters	Unit	Group
DAMPL X	x= 0... 3000	0.01 %	STD 195
DFREQ X	x= 60... 400	Hz	
DAMPL:I X	i= A B x= 0... 3000	0.01 %	STD 196
DFREQ:I X	x= 60... 400	Hz	

The dither<sup>2</sup> 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.

<sup>2</sup> 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.

## 5.6.4 PWM (PWM frequency)

Command		Parameters	Unit	Group
PWM	X	x= 61... 2604	Hz	<b>STD 195</b>
PWM:I	X	i= A B x= 61... 2604	Hz	<b>STD 196</b>

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



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

## 5.6.5 ACC (Auto adaptation of the closed loop current controller)

Command		Parameters	Unit	Group
ACC	x	x= ON OFF	-	<b>EXP</b>

Operation mode of the closed loop current control.

**ON:** In automatic mode PPWM and IPWM are calculated depending on the preset PWM-frequency.

**OFF:** Manual adjustment.

## 5.6.6 PPWM (Solenoid current controller P gain)

## 5.6.7 IPWM (Solenoid current controller I gain)

Command		Parameters	Unit	Group
PPWM	X	x= 0... 30	-	<b>EXP 195</b>
IPWM	X	x= 1... 100	-	<b>ACC=OFF</b>
		i= A B		<b>EXP 196</b>
PPWM	X	x= 0... 30	-	<b>ACC=OFF</b>
IPWM	X	x= 1... 100	-	

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.

## 5.6.8 ST (Status request)

Kommando	Parameter	Einheit	Gruppe
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 requested in the terminal window.

The message is textured as follows:

```

( high byte / low byte )
Control word   :           0000 0000 / 0000 0000
Status word    :           0000 0000 / 0000 0000
Setpoint A     :           0000 (übermittelter HEX Wert)
Setpoint B     :           0000 (übermittelter HEX Wert)
Enable input   :           disabled (Schalteingang an PIN 8)
Para address   :           0000 (Adresse für Busparametrierung)
Para value     :           0000 (Parameterwert für Busparametrierung)
    
```

## 5.7 Process data (Monitoring)

Command	Description	Unit	Function
W	Command value after input scaling	%	<b>195</b>
C	Command value after ramp function	%	
U	Command value to current controller	%	
WA	Command value after input scaling channel A	%	<b>196</b>
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	<b>195</b>
IB	Output current to solenoid B	mA	<b>196</b>

The process data are the variable values which can be continuously observed 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
Solenoid A PIN 3 / 4 Solenoid B PIN 1 / 2	Broken wire	The power stage is deactivated.
EEPROM (monitored during power on procedure)	Data error	The power stage is deactivated. The module can be activated by saving new parameters (pressing of the SAVE Button).

### 6.2 Troubleshooting

Initial situation is an operable status of the device and existing communication between the module and the WPC-300 program. Furthermore, the parameterization of the valve control has to be done with the assistance of the valve data sheets.

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



**CAUTION:** If using the RC (Remote Control) mode, all safety aspects have to be checked solidly. In this mode the module is actuated directly and the machine control has no 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 disconnected or the ENABLE signal is not present. If there is no power supply there is also no communication via our operating program. If the connection to the WPC-300 exists, the power supply is also available. In this case the availability of the ENABLE signal can be checked via the monitor.
ENABLE is active, the READY LED is flashing.	The flashing READY LED indicates that a fault is detected by the module. The fault could be: <ul style="list-style-type: none"> <li>• Failure detection in case of current input. Input signal below 3 mA.</li> <li>• A broken cable or incorrect wiring to the solenoids.</li> <li>• Internal data error: execute the command / press the button SAVE to delete the data error. The system reloads the DEFAULT data.</li> </ul> With the WPC-300 operating program the failure can be localized directly via the monitor.

## 6.3 Status information

In the monitor view of the WPC program you can find status information for the states of inputs, outputs, closed loop controllers and the device itself. Active green displays indicate messages of readiness, yellow ones report reaching defined monitoring limits and the red ones announce detected error sources. Moving the mouse pointer on one of them will show a relating helping text. This amplifier contains the following displays:



READY – Common readiness respectively activity of the amplifier

EEPROM – Data error of the memory, SAVE should be executed

SYS\_ERROR – Internal error

SOLENOID A – Error (e.g. broken wire) at output A

SOLENOID B – Error (e.g. broken wire) at output B

## 7 Profibus interface

### 7.1 Profibus function

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

### 7.2 Installation

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

### 7.3 Device data file (GSD)

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

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

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

The GSD-file is available at the address: [http://www.w-e-st.de/files/software/hms\\_1810.gsd](http://www.w-e-st.de/files/software/hms_1810.gsd)

File: **hms\_1810.gsd**

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

## 7.4 Commands via Profibus

16 Bytes are send to the module.

Byte	Function	Remark
1	Control word High	
2	Control word Low	Not used here
3	Demand value channel A High	...0xc001 / ...0x3fff for +/- 100 %
4	Demand value channel A Low	0x0000... 0x3fff for 0... 100 %
5	Demand value channel B High	0x0000... 0x3fff for 0... 100 %
6	Demand value channel Low	
7	Parameter adress High	0x2001 to 0x2035
8	Parameter adress Low	
9	-	
10	-	
11	Parameter value MSB	Not used here
12	Parameter value ...	0x0000...0x1D4C0 depending on the parameter
13	Parameter value ...	
14	Parameter value LSB	
15	-	
16	-	

Coding of the control word:

Byte 1 – Control word Hi		
Bit	Function	
7	Enable channel A <sup>3</sup>	1 = Enable
6	Enable channel B	1 = Enable
5		
4		
3	PARAMODE	1 = active
2	PARAVALID	Rising edge
1		
0		

<sup>3</sup> Hardware and software ENABLE are linked with each other. Means the system is only ready if both signals are available.

## 7.5 Feedback via Profibus

16 Bytes are sent from the module.

Byte	Function	Remark
1	Status word High	
2	Status word Low	Not used here
3	Control signal UA High	0xc001... 0x3fff for +/- 100 %
4	Control signal UA Low	0x0000... 0x3fff for 0... 100%
5	Command signal CA High	0xc001... 0x3fff for +/- 100 %
6	Command signal CA Low	0x0000... 0x3fff for 0... 100%
7	Control signal UB High	0x0000... 0x3fff for 0... 100%
8	Control signal UB Low	
9	Command signal CB High	0x0000... 0x3fff for 0... 100%
10	Command signal CB Low	
11	Solenoid current IA High	0x0000... 0xA28
12	Solenoid current IA Low	for 0... 2600mA
13	Solenoid current IB High	0x0000... 0xA28
14	Solenoid current IB Low	for 0... 2600mA
15	-	
16	-	

Coding of the status word:

Byte 1 – Status word Hi		
Bit	Funktion	
8	READY	1 = Common readiness
7	PARA_RDY	1 = Parameterization OK
6	PARA_ACT	1 = Parameter transmitted
5		
4	$\overline{\text{IA ERROR}}$	Error at solenoid A
3	$\overline{\text{IB ERROR}}$	Error at solenoid B
2	READY A	1 = Channel A ready
1	READY B	1 = Channel B ready

## 7.6 Parameterizing via Profibus

### 7.6.1 Funktionsweise

For this power amplifier the control and the demand value setting are taken over by the Profibus. Additionally there is the possibility to change several parameters for adjusting the valve and the ramp times with it. In return the operator activity (READY-signal), the acknowledgement of a successful parameterization and the demand signals will be given back by the Profibus.

 Please note that a storage of the parameterization via the Profibus is not possible. This is only possible with the start-up-tool via the serial interface.

 If the PWM frequency gets changed possibly the closed loop current controller has to be adapted. This happens automatically and is only possible via bus by setting the parameter ACC to OFF before.

 This device is compatible to the former versions as far as possible. But the parameterization via the bus has changed slightly. There are no indices anymore, every parameter has its own address. So the relating addresses have to be adapted. An overview is listed in the following tables.

### 7.6.2 Parameter list mode 195

Nr.	Adresse	Parameter	Wertebereich
1	0x2001	AA:1	0x0001... 0x1D4C0
2	0x2002	AA:2	0x0001... 0x1D4C0
3	0x2003	AA:3	0x0001... 0x1D4C0
4	0x2004	AA:4	0x0001... 0x1D4C0
5	0x2010	MIN:A	0x0000... 0x1770
6	0x2011	MIN:B	0x0000... 0x1770
7	0x2012	MAX:A	0x1388... 0x2710
8	0x2013	MAX:B	0x1388... 0x2710
9	0x2014	TRIGGER	0x0000... 0x0BB8
10	0x2020	CURRENT	0x01F4... 0x0A28
11	0x2021	DAMPL	0x0000... 0x0BB8
12	0x2024	DFREQ	0x003C... 0x0190
13	0x2027	PWM	0x0001... 0x0014
14	0x2030	PPWM	0x0000... 0x001E
15	0x2031	IPWM	0x0001... 0x0064

## 7.6.3 Parameter list mode 196

Nr.	Adresse	Parameter	Wertebereich
1	0x2005	AA:UP	0x0001... 0x1D4C0
2	0x2006	AA:DOWN	0x0001... 0x1D4C0
3	0x2007	AB:UP	0x0001... 0x1D4C0
4	0x2008	AB:DOWN	0x0001... 0x1D4C0
5	0x2010	MIN:A	0x0000... 0x1770
6	0x2011	MIN:B	0x0000... 0x1770
7	0x2012	MAX:A	0x1388... 0x2710
8	0x2013	MAX:B	0x1388... 0x2710
9	0x2014	TRIGGER	0x0000... 0x0BB8
10	0x2020	CURRENT	0x01F4... 0x0A28
11	0x2022	DAMPL:A	0x0000... 0x0BB8
12	0x2023	DAMPL:B	0x0000... 0x0BB8
13	0x2025	DFREQ:A	0x003C... 0x0190
14	0x2026	DFREQ:B	0x003C... 0x0190
15	0x2028	PWM:A	0x0001... 0x0014
16	0x2029	PWM:B	0x0001... 0x0014
17	0x0032	PPWM:A	0x0000... 0x001E
18	0x0033	PPWM:B	0x0000... 0x001E
19	0x0034	IPWM:A	0x0000... 0x001E
20	0x0035	IPWM:B	0x0000... 0x001E

## 7.7 Realization / Example

To work with the module the ENABLE Bit in control word byte has to be set. The control word looks as follows: 1000 0000 / 0000 0000.

On the right side of the slash the not used Lo-byte can be found.

With the READY bit the status word reports the readiness, means the availability of both enable signals, hardware and software.

The status word looks like that in this case: 1000 0000 / 0000 0000.

For the parameterization via the Profibus the parameterization mode (PARAMODE) must be activated. The amplifier should be **deactivated** before, if possible. Thereof follows this control word: 0000 1000 / 0000 0000. The input of the data looks like that:

Example: The MIN-Value for solenoid B shall be set to 2200 (0x898 in HEX)

Address:	0x2011	Byte 7: 20, Byte 8: 11
Value:	0x0898	Byte 13: 08, Byte 14: 98

For taking over the parameters into the device the PARAVALID-bit has to be set. The taking over happens in the moment of setting, on the rising edge. Control word: 0000 1100 / 0000 0000.

As possible monitoring the command ST in the terminal window of the Start-up-tool WPC can be used. This shows the control word, the status word, the command value, the status of the hardware enable input and the last sent parameters on the screen as follows:

```
CMD>ST
control word:      0000 1100 / 0000 0000
status word:      0100 0000 / 0000 0000
setpoint 1:      3fff
setpoint 2:      0
command-code:     2011
command-parameter: 898
Pin_8 Enable:    enabled
CMD>
```

With the rising edge of the PARAVALID bit the data will be transmitted and receiving will be acknowledged by the PARA\_ACT bit. The PARA\_RDY bit confirms correct parameterizing in the permitted value range.

Setpoint 1 gives the demand value for Channel A. 3fff shows controlling 100 %.

Setpoint 2 gives the demand value for Channel B. This is only active in mode 196 and here not controlled at the moment.



Notice that parameterizing the PWM frequency is special. It can be set only in defined exact steps. To simplify parameterizing via bus only the step has to be chosen, not the exact frequency. The lowest possible frequency is 61 Hz on step 1 and the highest possible frequency is 2604 Hz on step 20. The adjustable values are described in chapter PWM 5.6.4.



**Caution:** Changed parameter settings are directly active. So if parameterizing at a running system (enable is set) is necessary, it has to be done carefully.



## 8 Notes