WEST

Technical Documentation

PAM-199-P-PFN

Universal power amplifier with PROFINET IO interface

Electronics
Hydraulics meets
meets Hydraulics
Electronics

Contents

1 General Information

1.1 Order Number

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

Alternative products

PAM-199-P-IO	- universal power amplifier for directional valves or two pressure or throttle valves with IO - Link interface
PAM-199-P-PDP	- universal power amplifier for directional valves or two pressure or throttle valves with Profibus DP 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 demand 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.

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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Date: 07.01.2025

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. With the parameter FUNCTION the operation mode can be switched. Various adjustable parameters allow for an optimized adaptation to the respective valve. The integrated power amplifier is an inexpensive and space-saving solution.

Controlling the amplifier is realized here via a PROFINET IO interface. Furthermore this provides changing most of the parameters via the bus.

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.

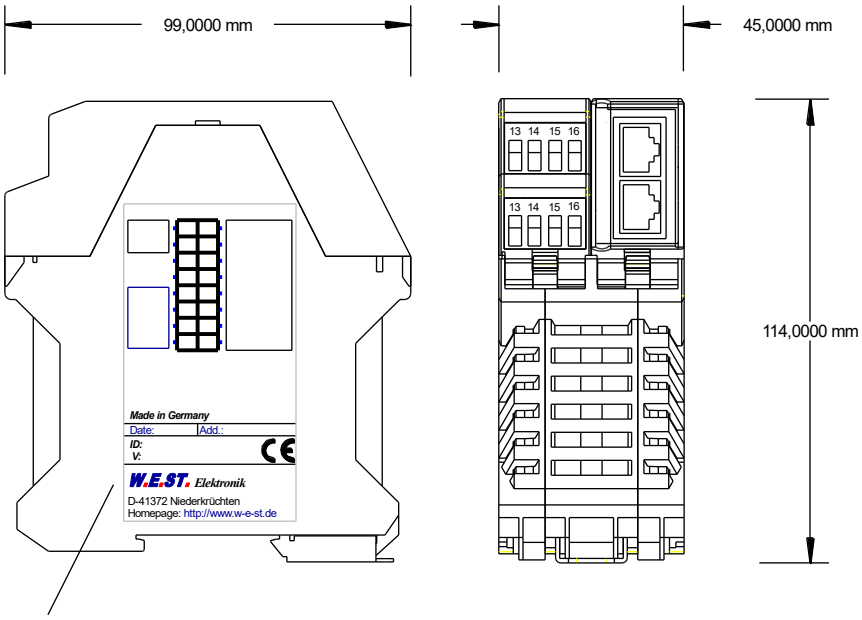
In addition, the valve characteristics can be linearized via 10 XY-points. For example: using pressure valves a linear behavior between input signal and pressure can be reached.

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.

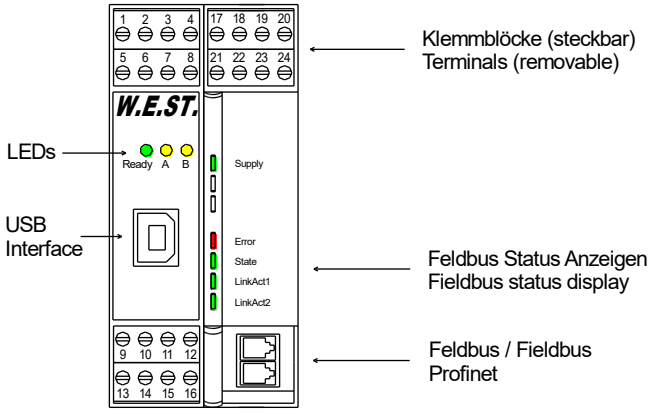
Features

- **Control of directional, pressure or throttle valves**
- **Compact housing**
- **Digital reproducible adjustments**
- **Controlling via Profinet**
- **Parameterization via Profinet**
- **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 up to 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.

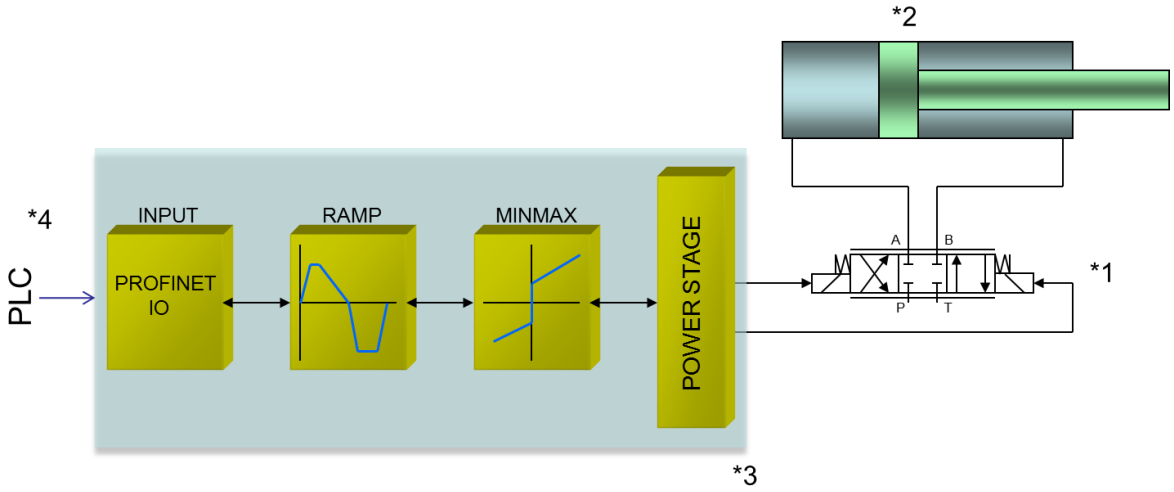
- Power should be supplied by a regulated power supply unit (typically a PELV system complying with IEC364-4-4, secure low voltage). The low internal resistance of regulated power supplies gives better interference voltage dissipation, which improves the signal quality of high-resolution sensors in particular. 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:

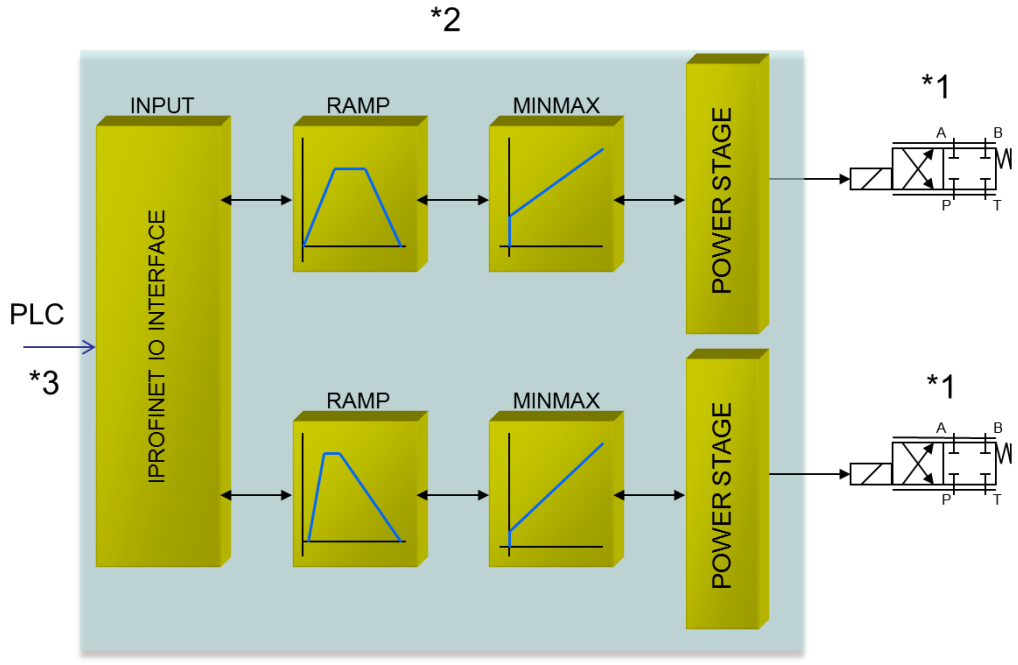
(*1) proportional (directional) valve
(*2) hydraulic cylinder
(*3) PAM-199-P-PFN
(*4) interface to PLC with PROFINET IO and digital signals



3.2.2 Function 196

This minimal system consists of the following components:

(*1) proportional valve(s)
(*2) PAM-199-P-PFN
(*3) interface to PLC with PROFINET IO and digital signals



3.3 Method of operation

The command value for this power amplifier is transmitted via Profinet. 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 Profinet). An error free operating is reported by a READY signal (digital output and bit on Profinet). 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.

In mode 195 a command value of ±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 Profinet 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. Now the fieldbus communication can be established. For the definition of the interface the GSDML file has to be provided to the master.
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 PWM, 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. **ATTENTION!** You can also monitor the solenoid current in the WPC-300 program or at the fieldbus status.
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.
Activating ENABLE	**CAUTION!** 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	*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.* ***CAUTION!** 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 standard (first section)

LEDs	Description of the LED function application
GREEN	Identical to the READY output. **OFF:** No power supply or ENABLE is not activated **ON:** System is ready for operation ***Flashing:*** Error detected (e.g. valve solenoid or 4… 20 mA). Not active when SENS = OFF.
YELLOW A	**OFF:** Solenoid A is not controlled **ON:** Solenoid A is active
YELLOW B	**OFF:** Solenoid B is not controlled **ON:** Solenoid B is active
LEDs	**Error messages**
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 + YELLOW	**Both yellow LEDs flash oppositely every 1 s:** The nonvolatile stored parameters are inconsistent! To acknowledge the error the data have to be saved with the SAVE command or the corresponding button in the WPC.

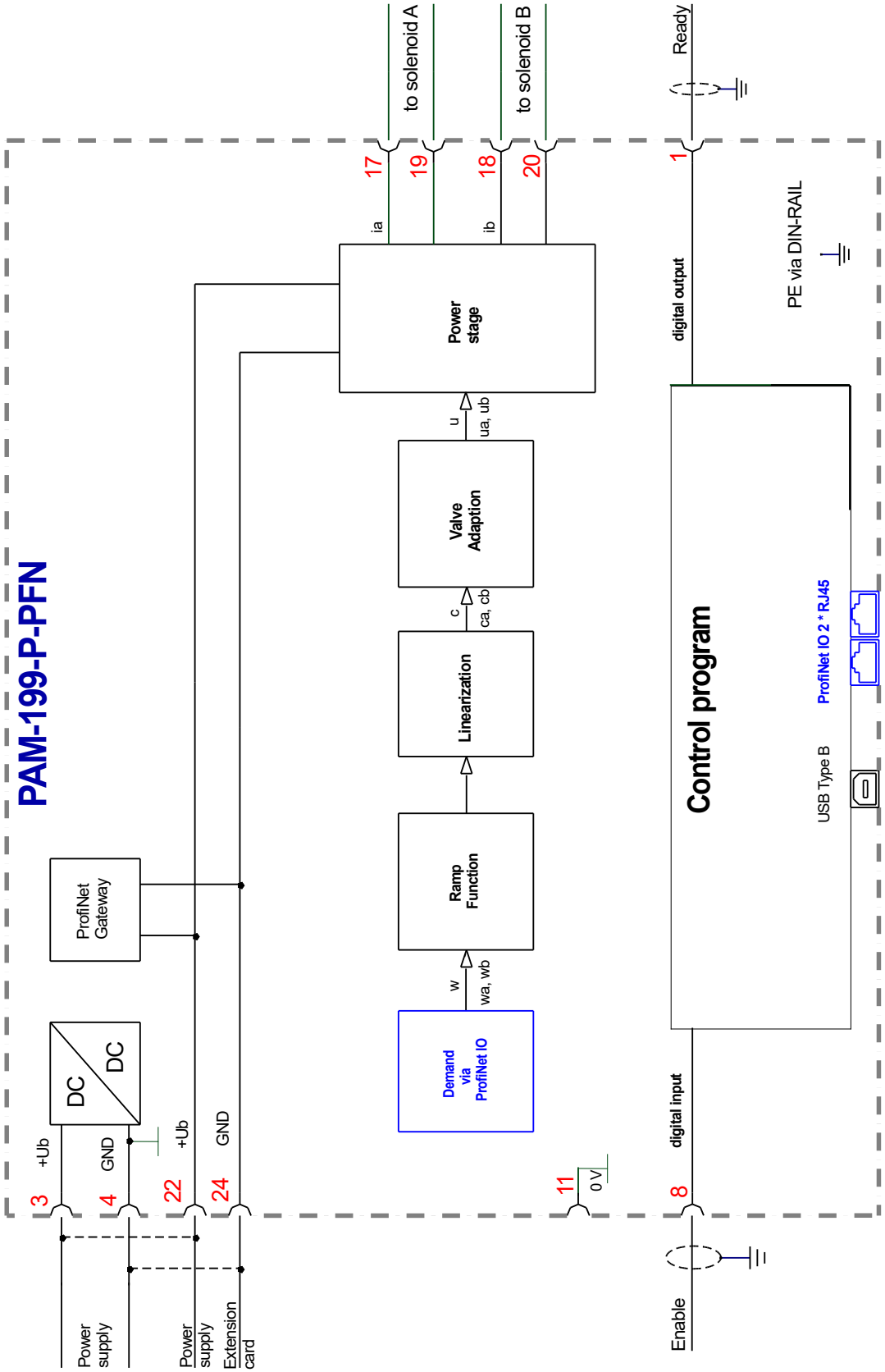
4.2 LED indications fieldbus (second section)

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: The red ERR LED indicates an error status. **OFF:** No fieldbus error. **ON:** Error at the fieldbus communication.
GREEN	The green RUN LED shows the status of the central communication node. **OFF:** Bus not started yet **FLASHING:** PROFINET Initialisation **ON:** Connection established
GREEN	LinkAct1: The green LED indicates data access via the data network at the corresponding port. **OFF:** No connection **ON:** Working network connected to port **FLASHING:** PROFINET device flash test
GREEN	LinkAct2: The green LED indicates data access via the data network at the corresponding port. **OFF:** No connection **ON:** Working network connected to port **FLASHING:** PROFINET device flash test

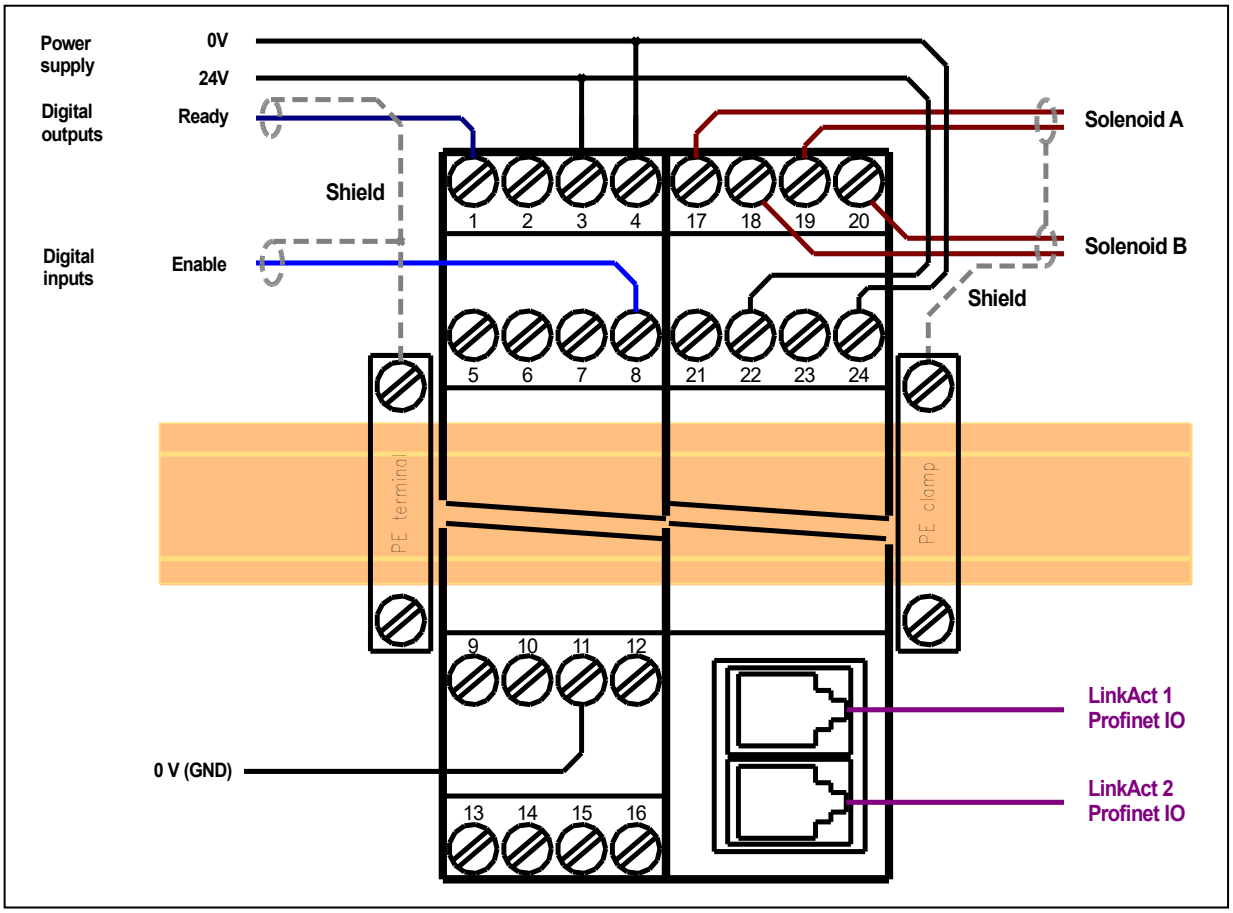
4.3 Input and output signals

Connection	Supply
PIN 3	Power supply (see technical data)
PIN 4	0 V (GND) Power supply.
PIN 31	Power supply for the extension board.
PIN 32	0 V (GND) supply connection for the extension board.
Connection	**PWM output**
PIN 17 / 19	Current controlled PWM outputs for solenoid A.
PIN 18 / 20	Current controlled PWM outputs for solenoid B.
Connection	**Digital inputs and outputs**
PIN 8	**ENABLE Input**: This digital input signal linked with the software enabling initializes the application and releases the ramp function and power stage.
PIN 1	**READY output**: **ON:** Module is ready, no errors are detected **OFF:** ENABLE is deactivated or an error was detected.

4.4 Circuit diagram



4.5 Typical wiring



4.6 Technical data

Power supply (U_b) Power consumption max. External fuse	**[VDC]** **[W]** **[A]**	12… 30 (incl. ripple) max. 2.5 + Power of the connected coils 3 medium time lag
Digital inputs OFF ON Input resistance	 **[V]** **[V]** **[kOhm]**	 < 2 > 10 25
Digital outputs OFF ON Maximum current	 **[V]** **[V]** **[mA]**	 < 2 max. Ub 50
PWM output Max. output current Frequency	 **[A]** **[Hz]**	Wire break and short circuit monitored 2.6 60… 2941 selectable in defined steps
Sample time Solenoid current control Signal processing	 **[µs]** **[ms]**	 125 1
Profinet IO Data rate Conformance class Redundancy (optionally usable)	 **[Mbit/s]** **-** **-**	 100 CC-B S2
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]**	0.310
Protection class Temperature range Storage temperature Humidity	**[IP]** **[°C]** **[°C]** **[%]**	20 -20… 60 -20… 70 < 95 (non-condensing)
Connections Communication Ethernet Plug connectors PE	**-**	 USB type B RJ45 4-pole terminal blocks 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 list 195

Group	Command	Default	Unit	Description
Basic parameters				
	LG	EN	-	Changing language help texts
	MODE	STD	-	Parameter view
	SENS	AUTO	-	Malfunction monitor
	PASSFB	0	-	Password for fieldbus parameterization
	FUNCTION	195	-	Operation mode
	CCMODE	OFF	-	Activation and deactivation of the characteristic linearization
Input signal adaptation				
	AA:1 **AA:2** **AA:3** **AA:4**	100 100 100 100	ms ms ms ms	Command signal four quadrant ramp times
Output signal adaptation				
	CC	X Y	-	Free definable characteristic linearization
	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
	SIGNAL:U	+	-	Changing output polarity
Parameters of the power stage				
	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 **IPWM**	7 40	- -	P-Gain of the current loop I-Gain of the current loop

5.2 Parameter list 196

Group	Command	Default	Unit	Description
Basic parameters				
	LG	EN	-	Changing language help texts
	MODE	STD	-	Parameter view
	SENS	AUTO	-	Malfunction monitor
	PASSFB	0	.	Password for fieldbus parameterization
	FUNCTION	196	-	Operation mode
	CCMODE	OFF	-	Activation and deactivation of the characteristic linearization
Input signal adaptation				
	AA:UP AA:DWN	100 100	ms ms	Command signal ramp times channel A
	AB:UP AB:DOWN	100 100	ms ms	Command signal ramp times channel B
Output signal adaptation				
	CCA CCB	X Y X Y	- -	Free definable characteristic linearization
	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
Parameters of the power stage				
	CURRENT:A CURRENT:B	1000 1000	mA mA	Rated solenoid current
	DAMPL:A DAMPL:B	500 500	0.01 % 0.01 %	Dither amplitude
	DFREQ:A DFREQ:B	121 121	Hz Hz	Dither frequency
	PWM:A PWM:B	2604 2604	Hz Hz	PWM frequency
	ACC	ON	-	Current loop auto adjustment
	PPWM:A PPWM:B	7 7	- -	P-Gain of the current loop
	IPWM:A IPWM:B	40 40	- -	I-Gain of the current loop

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 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.

5.3.4 PASSFB (Password for fieldbus)

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

The value inputted here serves as password for the parameterizing via fieldbus. For enabling parametrization it has to be send via fieldbus to the relating address. For a value of “0” the password protection is deactivated.

5.3.5 FUNCTION (Choosing operation mode)

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

This parameter allows you to setup the amplifier for up to two valves with one solenoid (e.g. pressure valves, function 196) or to one valve with two solenoids (directional valve, function 195).

195	-	Controlling a directional valve with two solenoids
196	-	Two independent channels for controlling one solenoid each

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

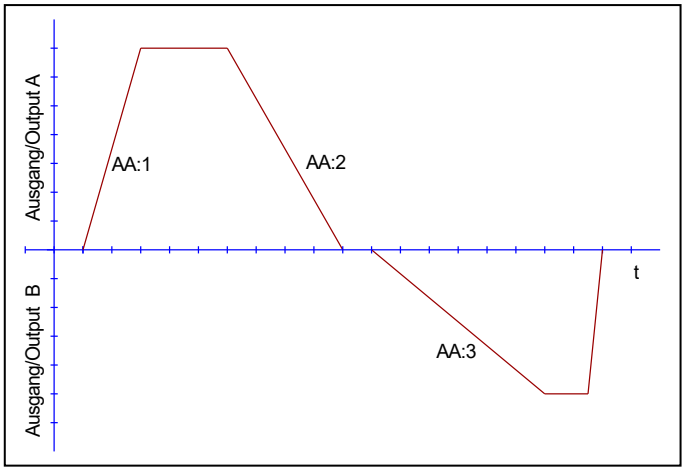
5.4.1 A (Ramp function)

Command		Parameters	Unit	Group	
AA:I	X	i= 1… 4 x= 1… 120000	- ms	**STD**	**195**
AA:I AB:I	X X	i= UP|DOWN x= 1… 120000	- ms	**STD**	**196**

5.4.1.1 Four quadrants ramp function in mode 195.

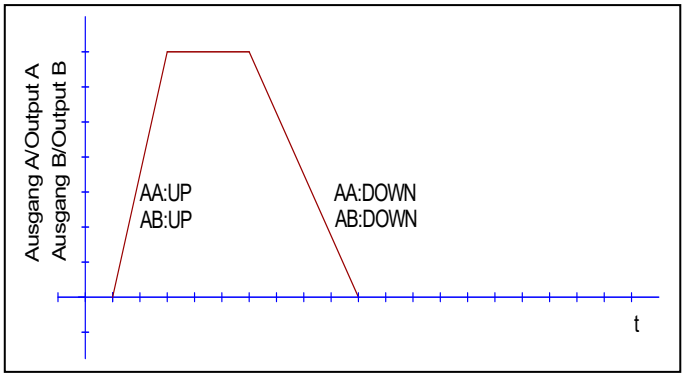
The first quadrant means the acceleration ramp for solenoid A and the second one stands for the deceleration ramp of solenoid A. According to this the third quadrant represents the acceleration ramp for solenoid B so that the fourth quadrant remains for the deceleration ramp for solenoid B.

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



5.4.1.2 Two quadrants ramp function in mode 196.

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%	**CCMODE=ON** **195**
CCA:I X Y CCB:I X Y	i= 0… 10 x= -10000… 10000 y= -10000… 10000	- 0.01% 0.01%	**CCMODE=ON** **196**

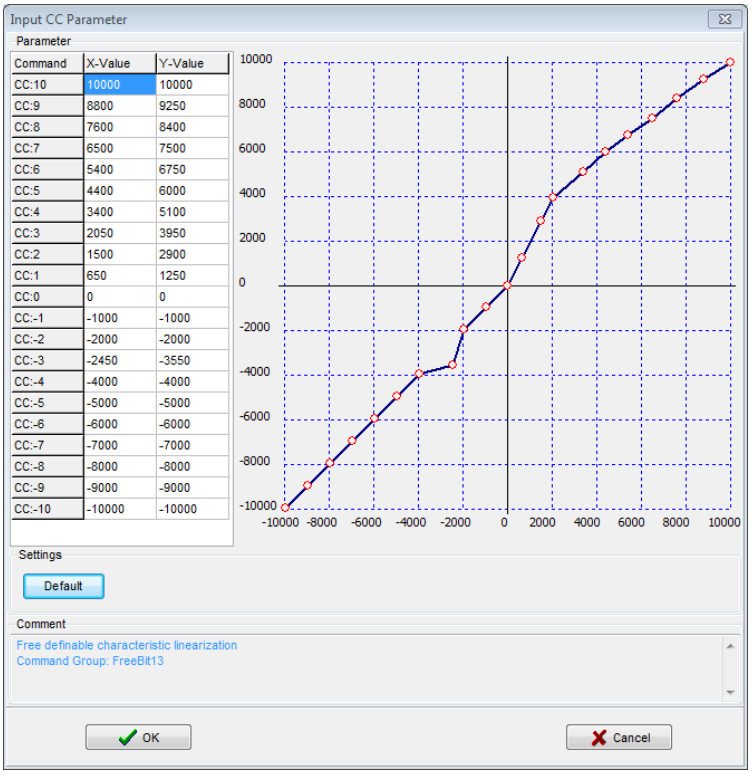
A user defined signal characteristic can be set by this function. For activating the parameter CCMODE has to be switched to ON.

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-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.

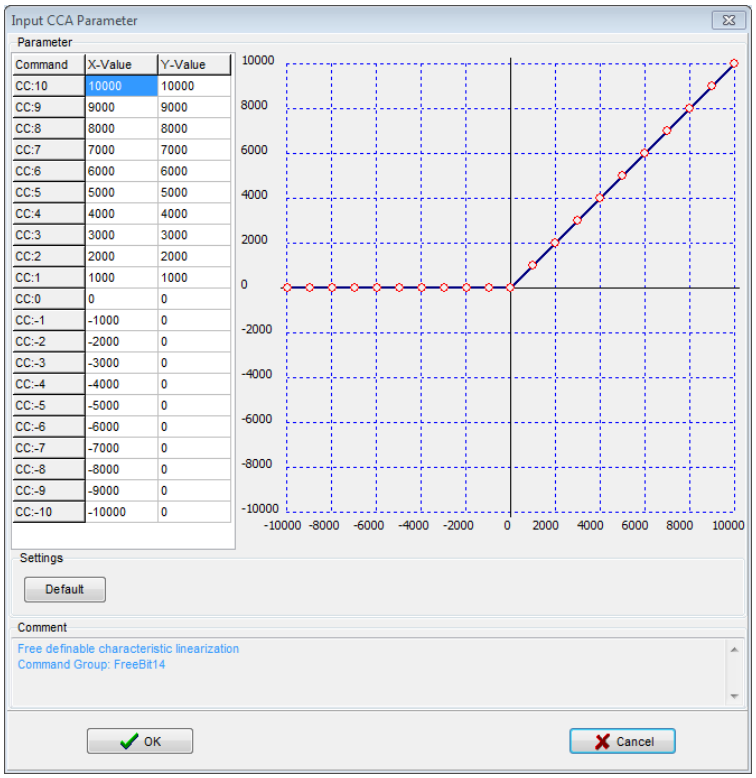
For the input of the characteristics linearization, the WPC-300 program provides a table and a graphic data input. The input signal is mapped on to the X-axis and the output signal is mapped on to the Y-axis.



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-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.



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	-	**STD**
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 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[1] can be specified.

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

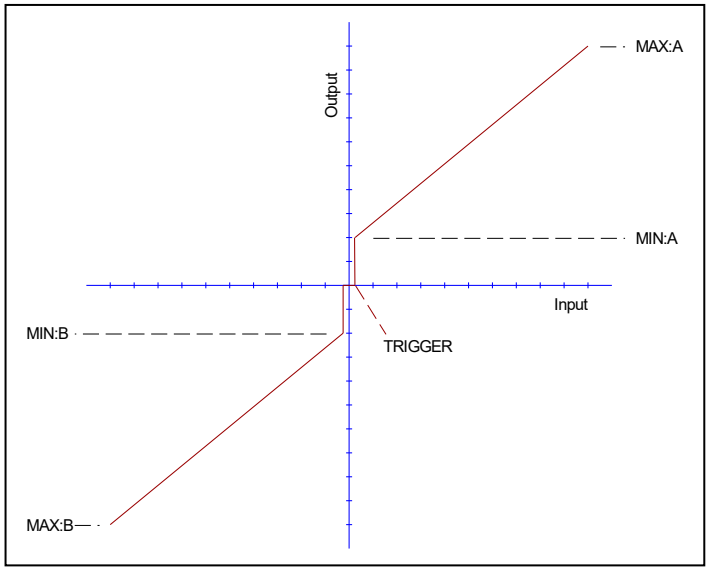


Fig.1: mode 195, directional valve with 2 solenoids

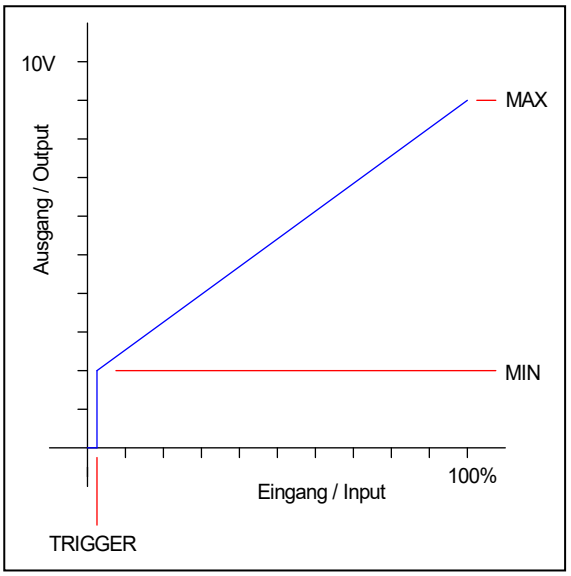


fig.2: mode 196, one solenoid each channel

[1] 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** **195**
CURRENT:I X	i= A|B x= 500… 2600	 mA	**STD** **196**

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 DFREQ X	x= 0… 3000 x= 60… 400	0.01 % Hz	**STD** **195**
 DAMPL:I X DFREQ:I X	i= A|B x= 0… 3000 x= 60… 400	 0.01 % Hz	**STD** **196**

The dither[2] 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.*

[2] 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	**STD 195**
PWM:I X	i= A|B x= 61… 2604	Hz	**STD 196**

The frequency can be selected out of the following 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, 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.*

Attention: Changed values compared to older product versions. After loading a WPC file that was saved in a previous version, check whether the value has been adopted. If necessary, set a value that is closest to the frequency of the previous version.

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

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

5.6.6 PPWM (Solenoid current controller P gain)

5.6.7 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.

5.7 Process data (Monitoring)

Command	Description	Unit	Function
W C U	Command value after input scaling Command value after ramp function Command value to current controller	% % %	**195**
WA CA UA WB CB UB	Command value after input scaling channel A Command value after ramp function channel A Command value to current controller channel A Command value after input scaling channel B Command value after ramp function channel B Command value to current controller channel B	% % % % % %	**196**
IA IB	Output current to solenoid A Output current to solenoid B	mA mA	**195** **196**

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).
Fieldbus	Faulty communication	The device is deactivated.
RC - Mode	The WPC connection (from WPC-V4.0) is disconnected during RC operation, e.g. by ending the application or unplugging the USB connector.	The power stage is deactivated.

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: • Failure detection in case of current input. Input signal below 3 mA. • A broken cable or incorrect wiring to the solenoids. • Internal data error: execute the command / press the button SAVE to delete the data error. The system reloads the DEFAULT data. With the WPC-300 operating program the failure can be localized directly via the monitor.

6.3 Description of the command structure

The command structure:

[nnnn:i x] or
[nnnn x]

Meaning:

nnnn - used for an arbitrary command name
nnnn: - used for an arbitrary command name, expandable by an index.
Indexed commands are indicated by the sign ":"
I or I - `i`=dummy is for the index. E.g.an index can be „A"or„B", depending on the direction.
x - parameter value, in case of special commands more than one parameter are possible.

Examples:

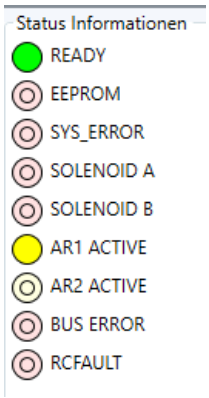
MIN:A 2000 nnnn = "MIN", i = "A" and x = "2000"

OFFSET 50 nnnn = „OFFSET" and x = „50"

C:IC 2000 nnnn = "C", i = "IC" and x = "2000"

6.4 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
AR1 ACTIVE – PROFINET Master coupling 1 is active
AR2 ACTIVE – PROFINET Master coupling 2 is active (S2 – Redundancy)
BUS ERROR – PROFINET Gateway error
RCFAULT – RC - Connection cancellation

7 PROFINET IO RT interface

7.1 PROFINET IO function

PROFINET is one 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 up to 10 ms.

7.2 Profinet installation instructions

The Profinet field devices are connected exclusively via switches as network components. A Profinet network can be set up in a star, tree, line or ring topology. Profinet is based on Fast Ethernet standard transmission at 100 Mbit/s. CAT5 copper cables are approved as transmission media.
For the IP20 environment in the control cabinet, the CAT5 RJ45 connector is used in accordance with EN 50173 or ISO / IEC 11801. The contact assignment is compatible with the Ethernet standard (ISO / IEC 8802-3).

The connection between Profinet participants is referred to as a Profinet channel. In most cases, Profinet channels are set up with copper cables in accordance with IEC 61784-5-3 and IEC 24702. The maximum length of a PROFINET channel that is built with copper cables is 100 metres.

7.3 PROFINET address assignment

All PROFINET IO slave devices must be given a unique IP address and a name to enable communication. The IP address is assigned to the device by the PROFINET IO controller (PLC). The device can be addressed with a name via the "gateway". The name of the PROFINET IO device is stored in the permanent memory of the device. It can be modified by an IO supervisor. This is usually the engineering system of the PLC used. Make sure that the IP address is not assigned twice during manual modification.

Standard address:	
IP Address:	0.0.0.0
Subnet mask:	0.0.0.0
IP Address Gateway:	0.0.0.0
Example address:	
IP address:	192.168.1.111
Subnet mask:	255.255.255.0
IP Address Gateway:	192.168.1.111

7.4 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.

Attention: Version differences
Devices of the version up to 2040 require the GSDML file
GSDML-V2.33-W.E.St.-GTW-PFN-20180226.xml
Devices from version 3050 require the GSDML file
GSDML-V2.43-W.E.St-GTW_PFN_v6-20240116.xml

7.5 IO Description

The demand values are set in a range up to 0x3FFF (16383 for 100%) and reported the same way.

For the control and status bits “1” means activation respective activity.

Error bits are displayed inverted because a “0” reports an active error.

Some bits and bytes depend on the function mode of the device. So there are demand and feedback values in the range +/- 100% in mode 195 which are used in the range 0… 100% for channel A in mode 196 when having additional same signals for channel B. Similar behavior with control and status bits. The changes and additional data, only active in two channel mode 196, are marked grey in the following description.

The module is controlled with a control word consisting of following bits

ENABLE (A)	General activation of the system (of channel A in mode 196) linked with the hardware enable.
ENABLE B	Activation of channel B in mode 196 linked with the hardware enable.
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“.
PARAMODE	Enables the ability to set parameters
PARA VALID	Parameter value is transmitted at the rising edge
LIVEBIT IN	If this Bit is set 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 value change in the data received by the bus at least once per second. This could be e.g. this bit. If there is a period longer than 1s without data change, the “Ready” – State of the module will be deactivated. The value read here will be returned by the bit “LIVEBIT OUT” in the status word, so the connected PLC can also monitor the status of the communication.

Further data words to the module:

DEMAND VALUE (A)	Target value for controlling the valve (for channel A in mode 196)
DEMAND VALUE B	Target value for controlling the valve for channel B in mode 196
PARA VALUE	Parameter value which should be transmitted
PARA ADDRESS	Address of the parameter which should be changed or read out

Feedback takes place with a status word including following bits:

READY	Common readiness of the system (enable available and no error occurred)
READY A	Readiness of channel A in mode 196
READY B	Readiness of channel B in mode 196
IA ERROR	Error at solenoid A
IB ERROR	Error at solenoid B
DERROR	Internal data error (parameters have to be saved)
BUSERROR	Error of the fieldbus communication
PARA ACTIVE	Parameterization via fieldbus was enabled
PARA READY	Parameter value was transferred correctly. This bit will be reset by resetting the control bit PARAVALID likewise.
LIVEBIT OUT	Monitoring of the fieldbus communication. Return of the **LIVEBIT** IN signal.

Further feedback values to the fieldbus:

COMMAND VALUE C (A)	Command value after ramp and linearization function (channel A in mode 196)
COMMAND VALUE CB	Command value after ramp and linearization function channel B in mode 196
CONTROL SIGNAL U (A)	Control signal to the valve (at channel A in mode 196)
CONTROL SIGNAL UB	Control signal to the valve at channel B in mode 196
SOLENOID CURRENT A	Actual current at solenoid A
SOLENOID CURRENT B	Actual current at solenoid B
PARAMETER VALUE	With PARA READ requested parameter value

7.6 Commands via Profinet

7.6.1 Overview

Nr.	Byte	Function	Type	Range	Unit
1	0	Steuerwort 1 High Steuerwort 1 Low	int		
2	1				
3	2	Steuerwort 2 High Steuerwort 2 Low	int		
4	3				
5	4	Demand value WA High Demand value WA Low	int	+/- 16383 0… 16383	% 100% = 0x3FFF -100% = 0xC001
6	5				
7	6	Demand value WB High Demand value WB Low	int	0… 16383	% 100 % = 0x3FFF
8	7				
9	8	---			
10	9	---			
11	10	---			
12	11	---			
13	12	---			
14	13	---			
15	14	---			
16	15	---			
17	16	---			
18	17	---			
19	18	---			
20	19	---			
21	20	---			
22	21	---			
23	22	---			
24	23	---			
25	24	---			
26	25	---			
27	26	Parameterwert Hi (MSB)	long	Abhängig vom gewählten Parameter	Abhängig vom gewählten Parameter
28	27				
29	28				
30	29	Parameterwert Lo (LSB)			
31	30	Parameterindex (Adresse) Hi Parameterindex (Adresse) Lo	int	0… 0x2035	-
32	31				

7.6.2 Definition control word 1

Byte 0 – control word 1 High			
No.	**Bit**	**Function**	
1	0	---	
2	1	---	
3	2	---	
4	3	---	
5	4	---	
6	5	---	
7	6	ENABLE B	Enabling of channel B
8	7	ENABLE (A)	Enabling of the controller (channel A)

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

7.6.3 Definition control word 2

Byte 2 – control word 1 High			
No.	**Bit**	**Function**	
1	0	LIVEBIT IN	Monitoring option for the driver module: The LIVEBIT_OUT status bit reports back the status of this bit so that the driver can use this to monitor the life of the PROFINET communication[3].
2	1	---	
3	2	---	
4	3	---	
5	4	---	
6	5	---	
7	6	---	
8	7	---	

Byte 3 – control word 1 Low			
No.	**Bit**	**Function**	
1	0	---	
2	1	---	
3	2	---	
4	3	---	
5	4	---	
6	5	PARA READ	Reading out the selected address
7	6	PARA VALID	Transmitting parameterization
8	7	PARA MODE	Activation of the parameterizing mode

[3] If the bus communication fails, the received control bits and setpoints are reset to zero. This stops all movements; RC mode is not affected. When the bus communication is restored, the axis may restart unintentionally if the PLC program does not recognise the status and resumes control. We therefore recommend monitoring the status of the PROFINET communication there. In the simplest case, this is done via the "BUS_VALID" output parameter of the S7 driver module.

7.7 Feedback via Profinet

7.7.1 Overview

Nr.	Byte	Function	Type	Range	Unit
1	0	Status word 1 High Status word 1 Low	int		
2	1				
3	2	Status word 2 High Status word 2 Low	int		
4	3				
5	4	Control signal UA High Control signal UA Low	int	+/- 16383 0… 16383	% 100% = 0x3FFF -100% = 0xC001
6	5				
7	6	Command value CA High Command value CA Low	Int	+/- 16383 0… 16383	% 100% = 0x3FFF -100% = 0xC001
8	7				
9	8	Control signal UB High Control signal UB Low	Int	0… 16383	% 100 % = 0x3FFF
10	9				
11	10	Command value CB High Command value CB Low	Int	0… 16383	% 100 % = 0x3FFF
12	11				
13	12	Solenoid current A High Solenoid current A Low	Int	0… 2600	mA
14	13				
15	14	Solenoid current B High Solenoid current B Low	Int	0… 2600	mA
16	15				
17	16				
18	17				
19	18				
20	19				
21	20				
22	21				
23	22				
24	23				
25	24				
26	25				
27	26				
28	27				
29	28	Parameter value High … … Parameter value Low	long	Depending on Parameter	Depending on Parameter
30	29				
31	30				
32	31				

7.7.2 Definition status word 1

Byte 0 – status word High			
No.	**Bit**	**Function**	
1	0	READY B	Readiness of channel B
2	1	READY A	Readiness of channel A
3	2	---	
4	3	---	
5	4	---	
6	5	---	
7	6	---	
8	7	READY	System is enabled and no errors are detected

Byte 1 – status word Low			
No.	**Bit**	**Function**	
1	0	---	
2	1	---	
3	2	---	
4	3	---	
5	4	---	
6	5	---	
7	6	$\overline{\text{IB ERROR}}$	Error at solenoid B
8	7	$\overline{\text{IA ERROR}}$	Error at solenoid A

7.7.3 Definition status word 2

Byte 2 – status word High			
No.	**Bit**	**Function**	
1	0	---	
2	1	---	
3	2	---	
4	3	---	
5	4	---	
6	5	1	This bit is permanently set for reasons of compatibility with older versions
7	6	$\overline{\text{BUSERROR}}$	PROFINET Gateway error
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	Parameterization successful
8	7	PARA ACTIVE	Parameterization via fieldbus active

7.8 Parameterizing via Profibus

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

Parameterization:

- At first the **PARA MODE** bit has to be set to enable parameterizing via ProfiNet.
  This will be reported via the **PARA ACTIVE** bit.
- Pretend **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 parameterization.
  Attention: A missing **para ready** bit means parameterization was not done.

Storing:

- Same procedure as parameterizing 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 parameterization. Procedure is the same as when parameterizing standard parameters.
- Select **2200** as **address** and send the password (PASSFB) as **value**.
- After **PARA READY** reports success, subsequently parameterizing can be done as long as **PARA MODE** stays active. After resetting it password has to be renewed when it gets activated again.

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

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

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 as well as manually via WPC by setting the parameter ACC to OFF before.

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.

7.8.2 Parameter list mode 195

Nr.	Address	Parameter	Value range Hex	Value range Dez
1	0x2001	AA:1	0x0001… 0x1D4C0	1… 120000
2	0x2002	AA:2	0x0001… 0x1D4C0	1… 120000
3	0x2003	AA:3	0x0001… 0x1D4C0	1… 120000
4	0x2004	AA:4	0x0001… 0x1D4C0	1… 120000
5	0x2010	MIN:A	0x0000… 0x1770	0… 6000
6	0x2011	MIN:B	0x0000… 0x1770	0… 6000
7	0x2012	MAX:A	0x1388… 0x2710	5000… 10000
8	0x2013	MAX:B	0x1388… 0x2710	5000… 10000
9	0x2014	TRIGGER	0x0000… 0x0BB8	0… 3000
10	0x2020	CURRENT	0x01F4… 0x0A28	500… 2600
11	0x2023	DAMPL	0x0000… 0x0BB8	0… 3000
12	0x2026	DFREQ	0x003C… 0x0190	60… 400
13	0x2029	PWM[4]	0x0001… 0x0014	1… 20
14	0x2032	PPWM	0x0000… 0x001E	0… 30
15	0x2033	IPWM	0x0001… 0x0064	1… 100
16	0x2100	SAVE	(0x0000… 0xEA60)	(0… 60000)
17	0x2200	PW	0x0001… 0x989680	1… 10000000

[4] Specification of the frequency step, not the real value.

7.8.3 Parameter list mode 196

Nr.	Address	Parameter	Value range Hex	Value range Dez
1	0x2005	AA:UP	0x0001… 0x1D4C0	1… 1200000
2	0x2006	AA:DOWN	0x0001… 0x1D4C0	1… 1200000
3	0x2007	AB:UP	0x0001… 0x1D4C0	1… 1200000
4	0x2008	AB:DOWN	0x0001… 0x1D4C0	1… 1200000
5	0x2010	MIN:A	0x0000… 0x1770	0… 6000
6	0x2011	MIN:B	0x0000… 0x1770	0… 6000
7	0x2012	MAX:A	0x1388… 0x2710	5000… 10000
8	0x2013	MAX:B	0x1388… 0x2710	5000… 10000
9	0x2014	TRIGGER	0x0000… 0x0BB8	0… 3000
10	0x2021	CURRENT:A	0x01F4… 0x0A28	500… 2600
11	0x2021	CURRENT:B	0x01F4… 0x0A28	500… 2600
12	0x2024	DAMPL:A	0x0000… 0x0BB8	0… 3000
13	0x2025	DAMPL:B	0x0000… 0x0BB8	0… 3000
14	0x2027	DFREQ:A	0x003C… 0x0190	60… 400
15	0x2028	DFREQ:B	0x003C… 0x0190	60… 400
16	0x2030	PWM:A[5]	0x0001… 0x0014	1… 20
17	0x2031	PWM:B[5]	0x0001… 0x0014	1… 20
18	0x2034	PPWM:A	0x0000… 0x001E	0… 30
19	0x2035	PPWM:B	0x0000… 0x001E	0… 30
20	0x2036	IPWM:A	0x0001… 0x001E	1… 100
21	0x2037	IPWM:B	0x0001… 0x0064	1… 100
16	0x2100	SAVE	(0x0000… 0xEA60)	(0… 60000)
17	0x2200	PW	0x0001… 0x989680	1… 10000000

[5] Specification of the frequency step, not the real value.

8 PROFINET driver module for Simatic controllers

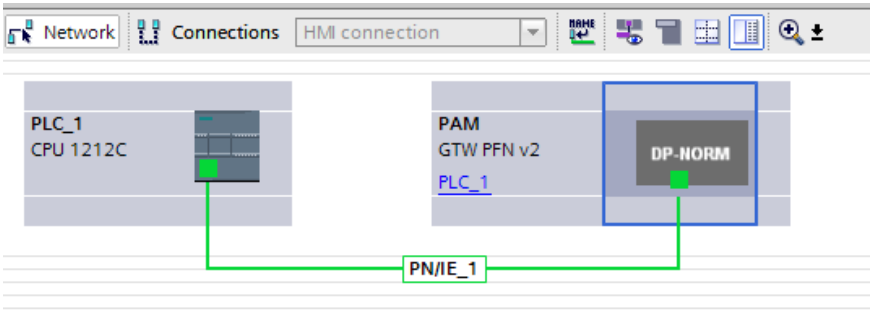
8.1 Integration into the project

For the "TIA Portal" software, we provide two driver modules for convenient access from the user program:

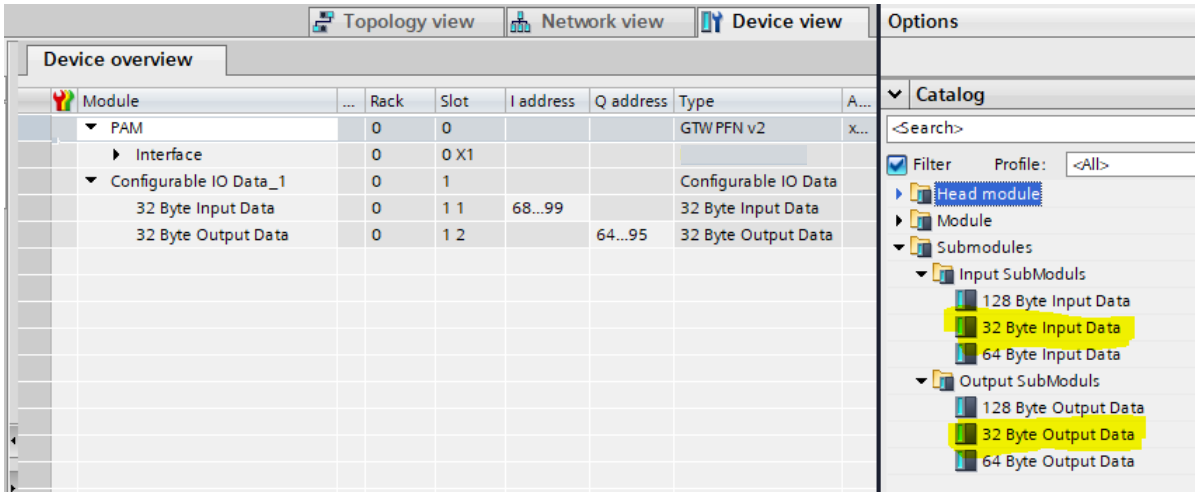
a) The WEST_PAM_199_P_PFN.scl source for S7-1200 and -1500 series controllers
b) The WEST_PAM_199_P_PFN_KLASSIK.scl source for S7-300 and -400 series controllers

Their installation in the user project and the wiring are explained below.

1.) GSDML - Import file
2.) Configure the connection between the control unit and the controller via PROFINET:



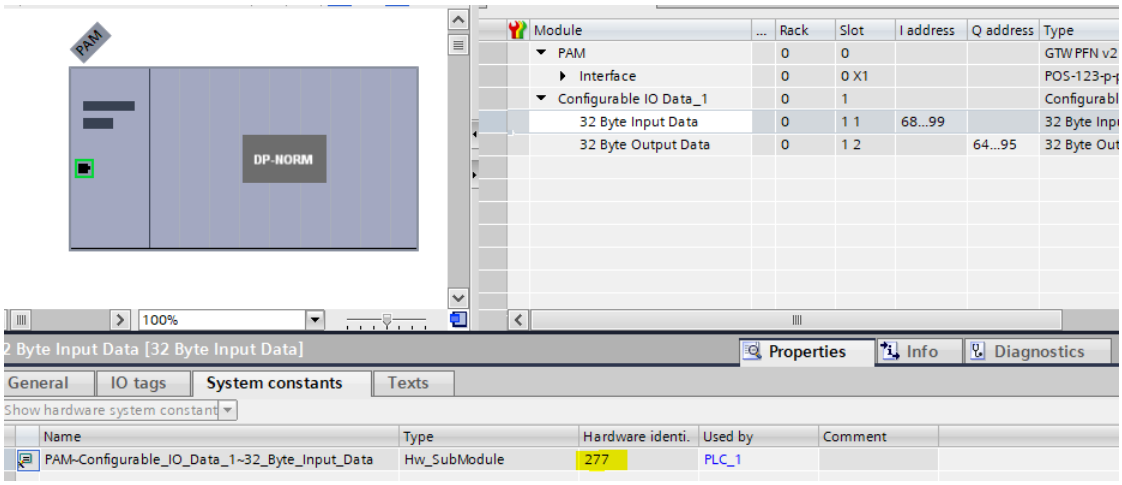
3.) Install two submodules in the device:
32 byte output data
32 byte input data



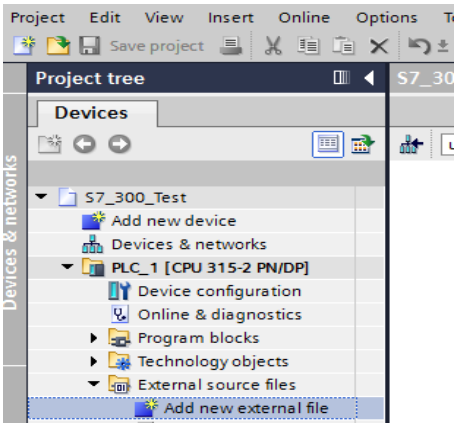
The addresses are assigned automatically. The automatically assigned *hardware identifiers* are also important for connecting the program module when using the S7-1200 / -1500. These can be determined by right-clicking on the two modules in the device overview and selecting the context menu item "Properties":

These numbers are different and must be noted separately for the input and output data.

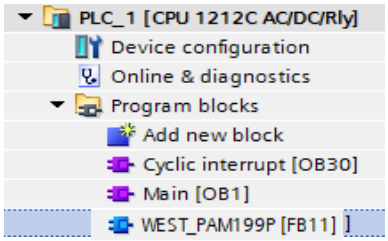
If an S7-300 / -400 is used, the start values of the addresses (E address / A address) are required.



4.) The driver module is provided as an SCL source. This file must be added as a "new external file" in the TIA portal for installation in the project:

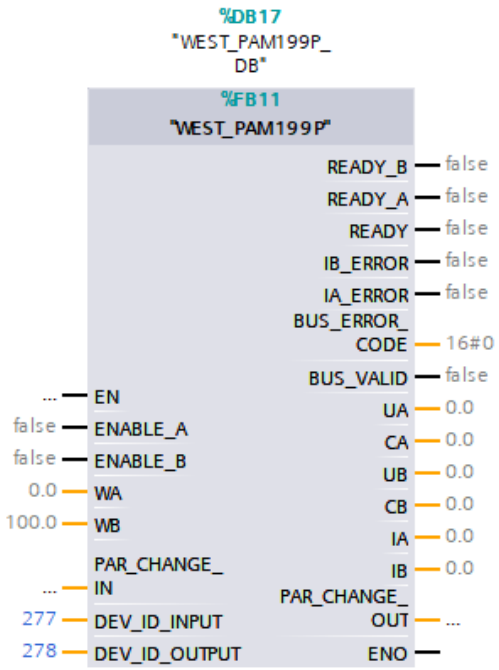


5.) Then right-click on the imported file and select the option "Generate blocks from source". After translation, the driver block is available in the block folder. The number may also differ.



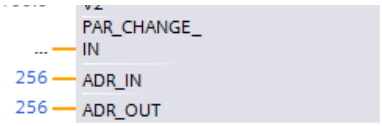
This FB can now be called up in the user program. This should be done in a wake-up alarm OB with a cycle time >= 4 ms.

View of the module in the FBD without wiring:



The error bits are negated in the driver before the output, i.e. for the output parameters of the block, the set status corresponds to an active error.
The HW identifiers previously read out are shown at the bottom. These must be adjusted accordingly.

Address specification for S7-300 / -400 (values may differ):



The start addresses of the input and output data are specified here rather than the hardware identifiers.

BUS_ERROR_CODE:
This output parameter contains various error bits of the fieldbus communication and the device in bit-coded form. In the good state, the number is "0". The meaning is as follows:

	Bit - Number	Valence (decimal)	Valence (hex.)
Data Error (DERROR)	0	1	0x01
Bus Error	2	4	0x04
Driver error when receiving data	3	8	0x08
Driver error when sending data	4	16	0x10
Livebit Error	5	32	0x20

If several errors occur at the same time, several bits are set and the number output is the sum of these.

9 Notes