WEST

Technical Documentation

DSG-111-U
DSG-111-P

Digital demand value module, alternatively with power output stage

Electronics
Hydraulics meets
meets Hydraulics
Electronics

CONTENTS

1 General Information

1.1 Order number

DSG-111-U[1] - with ±10 V differential output or 4… 20 mA output, analogue input, bit pattern inputs for recalling 16 preset command values and linking functionality for the inputs.

DSG-111-P - with integrated power output stage up to 2,6 A (*see additional information*)

Alternative devices

DSG-164 - 4 digital selectable demand values, adjustable via potentiometers.

PAM-199-P - 8 digital demand values, with integrated power stage up to 2,6 A.

DSG-112 - Completely freely scriptable module

1.2 Scope of supply

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

1.3 Accessories

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

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

[1] Compared with older versions (ordering code **A** for voltages output and **I** for current output) the code **U** (universal) is used for programmable outputs.

1.4 Symbols used

General information

Safety-related information

1.5 Using this documentation

Structure of the documentation:
The standard product is descibed up to chapter 6. The extensions like POWER STAGE or SSI-INTERFACE are described in the chapters ADDITIONAL INFORMATION.

1.6 Legal notice

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Date: 03.01.2025

1.7 Safety instructions

Please read this document and the safety instructions carefully. This document will help to define the product area of application and to put it into operation. Additional documents (WPC-300 for the start-up software) and knowledge of the application should be taken into account or be available.
General regulations and laws (depending on the country: e. g. accident prevention and environmental protection) must be complied with.

These modules are designed for hydraulic applications in open or closed-loop control circuits. Uncontrolled movements can be caused by device defects (in the hydraulic module or the components), application errors and electrical faults. Work on the drive or the electronics must only be carried out whilst the equipment is switched off and not under pressure.

This handbook describes the functions and the electrical connections for this electronic assembly. All technical documents which pertain to the system must be complied with when commissioning.

This device may only be connected and put into operation by trained specialist staff. The instruction manual must be read with care. The installation instructions and the commissioning instructions must be followed. Guarantee and liability claims are invalid if the instructions are not complied with and/or in case of incorrect installation or inappropriate use.

CAUTION!
All electronic modules are manufactured to a high quality. Malfunctions due to the failure of components cannot, however, be excluded. Despite extensive testing the same also applies for the software. If these devices are deployed in safety-relevant applications, suitable external measures must be taken to guarantee the necessary safety. The same applies for faults which affect safety. No liability can be assumed for possible damage.

Further instructions

- The module may only be operated in compliance with the national EMC regulations. It is the user's responsibility to adhere to these regulations.
- The device is only intended for use in the commercial sector.
- When not in use the module must be protected from the effects of the weather, contamination and mechanical damage.
- The module may not be used in an explosive environment.
- To ensure adequate cooling the ventilation slots must not be covered.
- The device must be disposed of in accordance with national statutory provisions.

2 Characteristics

This electronic module was designed to control hydraulic proportional valves. 16 programmable demand values and relating ramp times are selectable by four digital switching inputs (binary coded).

Alternative a 4Q-ramp can be parameterized. The ramp generator is realized with optional jerk limitation allows flexible adjustments depending on the applications and soft behavior.

A programmable function allows linking the analogue input signal and the internal demand values together.

Adaptable to nearly all proportional valves by deadband compensation as step function for characteristic linearization.

Proportional valves with integrated or external electronics can be controlled by the differential output such as two chopper plugs.

Typical applications: Rapid traverse and creeping speed, selectable velocities and pressure values, flow curve adjustments, ramp generation and analogue signal monitoring.

Features

- **16 selectable demand values**
- **Four quadrant ramps or 16 selectable ramp times**
- **Jerk free ramp generating**
- **Simple and intuitive parameterizing of the analogue input**
- **Analogue input and demand values are combinable with following functions:**
  + , - , * , / , min and max
- **Deadband compensation step or flexed gain characteristics**
- **Parameter for valve adaptation (MIN, MAX, POL)**
- **Fault diagnosis and extended function checking**
- **Simplified parameterization with WPC-300 software**
- **Optionally:**
  - **Integrated power output stage (P version)**

2.1 Compatibility

As a result of further developments some smaller changes have to be taken in consideration.

Functionality:

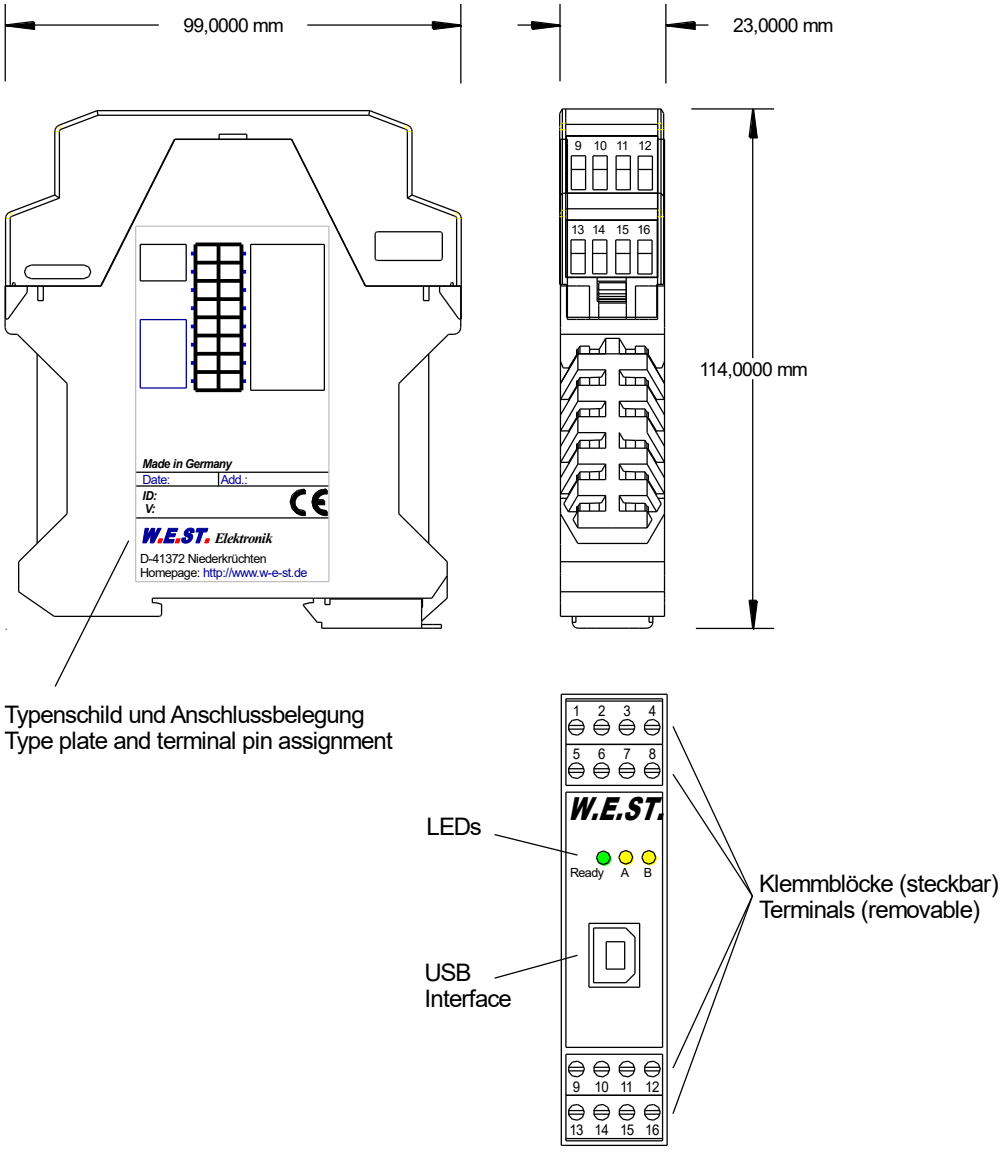
1. Downward compatible to the older modules.
2. 100 % wiring compatible.
3. **Baud rate**: The default baud rate has changed from 9600 baud to 57600 baud. This is adaptable in WPC-300: OPTIONS/SETTINGS/INTERFACE.
   FIXBAUDRATE = 57600 and/or AUTO BAUDRATE DETECTION = 57600
4. Technical enhancements:
   a. Programmable analogue output: simplifies stock-keeping because only one version (**U** instead **A** and **I**) is necessary.
   b. Process data assimilation: Digital command values are named with DW now instead of the X in former versions because this is used for feedback values in our other devices.

Parameterization:

1. Standardizing of parameter names
2. Simplified and intuitive parameterization of the analogue inputs and sensors
3. Compatibility mode of the input scaling (**AINMODE**), if necessary
4. Adaptation of the output signal (current or voltages) and the polarity with the command **SIGNAL:U** (the **POL** commando is removed)

2.2 Device description

Standard module – for the P-Version look at point 7.2



3 Use and application

3.1 Installation instructions

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

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

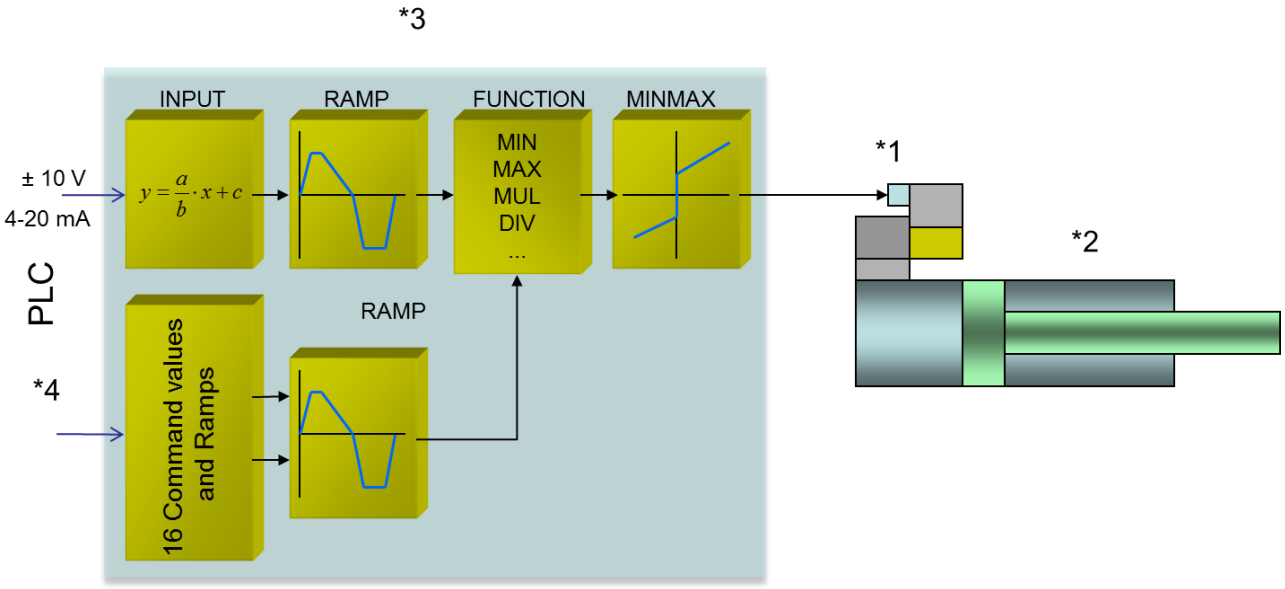
- The module should be installed and wired in accordance with the documentation bearing in mind EMC principles. If other consumers are operated with the same power supply, a star-shaped ground wiring scheme is recommended. The following points must be observed when wiring:
  - The signal cables must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

- A low-resistance connection between PE and the mounting rail should be provided. Transient interference is transmitted from the module directly to the mounting rail and from there to the local earth.
- Power should be supplied by a regulated power supply unit (typically a PELV system complying with IEC364-4-4, secure low voltage). The low internal resistance of regulated power supplies gives better interference voltage dissipation, which improves the signal quality of high-resolution sensors in particular. Switched inductances (relays and valve coils) which are connected to the same power supply must always be provided with appropriate overvoltage protection directly at the coil.

3.2 Typical system structure

This minimal system consists of the following components:

(*1) Proportional valve (or control valve): the valve type determines the precision. It is expedient to use control valves with integrated electronics.
(*2) Hydraulic cylinder
(*3) DSG-111-U control module
(*4) Interface to PLC with analogue and digital signals



3.3 Method of operation

This module can be used as a universal demand signal generator for different applications. The activation of the internal programmed demand values can be realized by the binary inputs. Alternatively, the activation of the demand values is also possible by the input **S-VALID**. Therefore, a synchronization with the PLC is not so difficult.

Because of the mathematical linking function of the internal demand value and the external analogue output there exists a further possibility to support signal adaptations.

Consequently, this module is useful for signal adaptations, flow curve adjustments of control valves, rapid traverse and creeping speed with several selectable velocities and accelerations as well as a universal valve amplifier with integrated power stage.

ENABLE: This digital input signal initializes the application and error messages are deleted. The controller and the **READY** signal are activated. The output signal to the valve is getting enabled.

If Enable input is deactivated the output is switched off. **Attention:** Take care off the **EOUT**-command!

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.
Pre-parameterization	Now set up the following parameters (with reference to the system design and circuit diagrams): The command signal selection (MF), specific settings for the control element (MIN for deadzone compensation and MAX for maximum velocity) and the requested output signal (SIGNAL:U). Pre-parameterization is necessary to minimize the risk of uncontrolled movements. Start with a speed value which is uncritical for the application.
Control signal	Check the control signal with a voltmeter. The control signal (PIN 15 to PIN16) lies in the range of ± 10 V. In the current state it should be 0 V. Alternatively, if current signals of 4… 20 mA are used (PIN 15 to PIN 11), approx. 0 mA should flow.
Switching on the hydraulics	The hydraulics can now be switched on. Since the module is not yet generating a signal, the drive should be at a standstill or drift slightly (leave its position at a slow speed).
Activating ENABLE	**CAUTION!** The drive can now leave its position and move to an end position at full speed. Take safety measures to prevent personal injury and damage. The drive can now be moved by the analogue command input and/or the digital inputs with the preset demand values.
Setting command value	Pretend a command value, relating to the chosen functionality, via the analogue input and/or the digital inputs.
Optimize settings	Now optimize the control parameters according to your application and your requirements.

4 Technical description

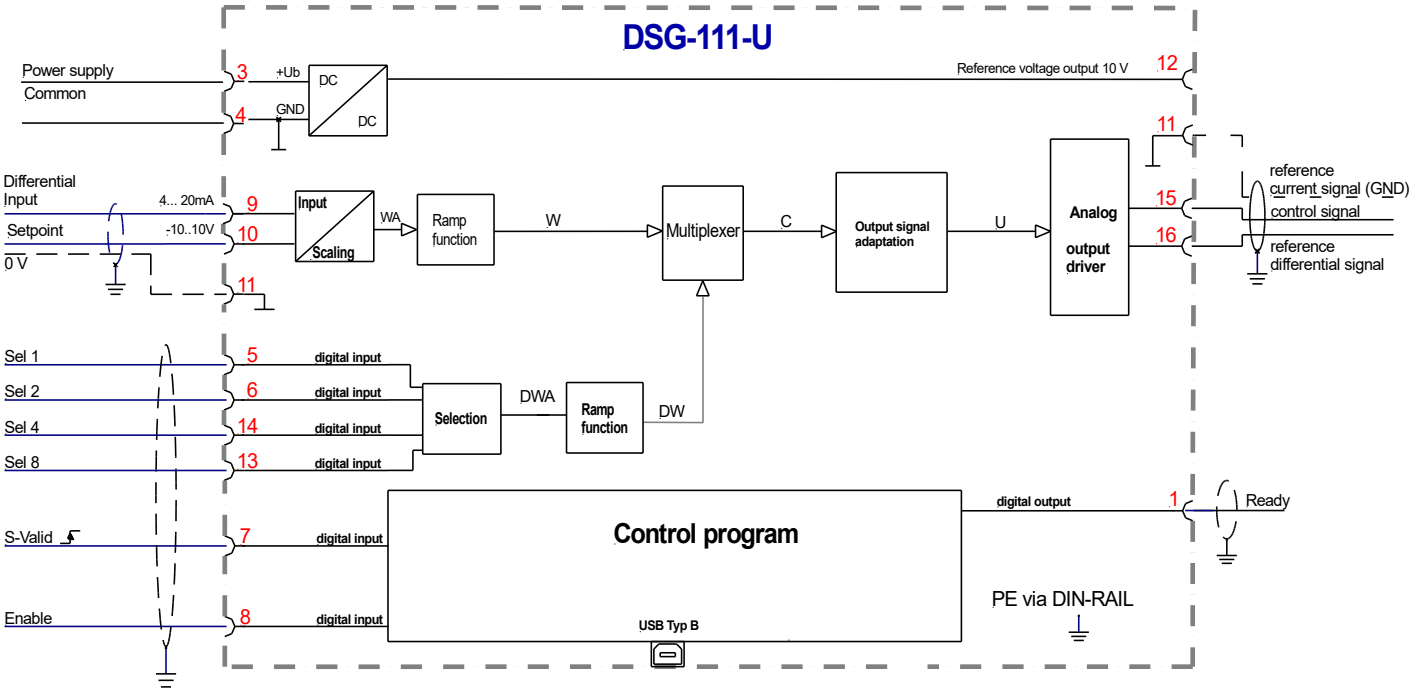
4.1 Input and output signals

Connection	Supply
PIN 3	Power supply (see technical data)
PIN 4	0 V (GND) connection.
Connection	**Analogue signals**
PIN 9 / 10	Analogue command value (WA), range -10… 10 V or 4… 20 mA, scalable
PIN 11	GND
PIN 12	10V reference voltage output
PIN 15 / 16 (PIN 15 / 11)	Valve control signal. Signal range of +/- 10V or 4… 20mA. Type of signal and polarity can be selected by the parameter SIGNAL:U.
Connection	**Digital inputs and outputs**
PIN 8	**Enable input:** Generally enabling of the application.
PIN 7	**S-valid input:** When *DSEL = OFF* the selected value of the bit pattern is taken over when setting this input from low to high.
PIN 5, 6, 13, 14	**Switching inputs:** Binary coded selection of one of the 16 preset demand values. Significance as following: PIN 5 = 1 / PIN 6 = 2 / PIN 14 = 4 / PIN 13 = 8.
PIN 1	**READY output:** **ON:** The module is enabled; there are no discernable errors. **OFF:** Enable (PIN 8) is missing or an error (current input or internal error) has been detected (depending on SENS command).

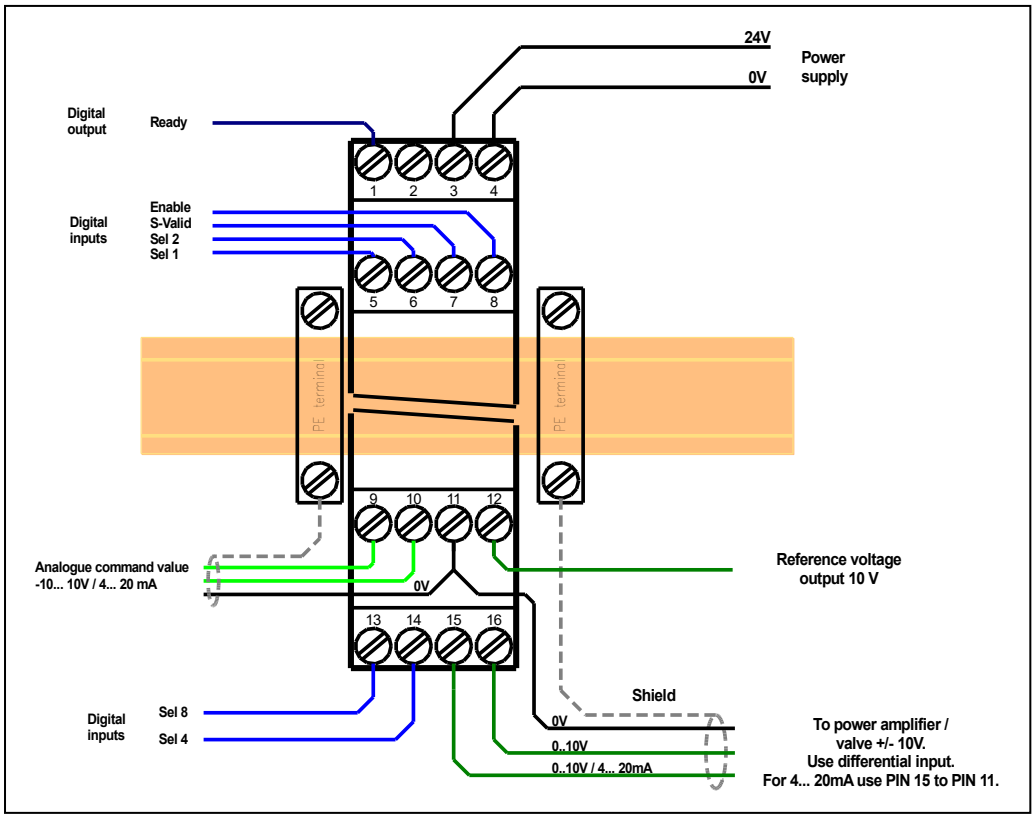
4.2 LED definitions

LEDs	Description of the LED function
GREEN	Identical to the READY output. OFF: No power supply or ENABLE is not activated ON: System is ready for peration **Flashing:** Error discovered Only active when SENS = ON
GREEN + YELLOW A+B	1. **Chasing light (over all LEDs):** The bootloader is active. No normal functions are possible. 2. **All LEDs flash shortly every 6 s:** An internal data error was detected and corrected automatically! The module still works regularly. To acknowledge the error the module has to be cycle powered.
YELLOW A + YELLOW B	**Both yellow LEDs flash oppositely every 1 s:** The nonvolatile stored parameters are inconsistent! To acknowledge the error, the data have to be saved with the SAVE command or the corresponding button in the WPC.

4.3 Circuit diagram

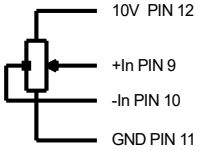


4.4 Typical wiring



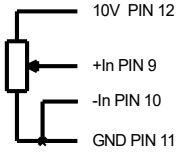
4.5 Connection examples

Joystick



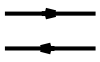
AIN:W 2000 1000 5000 V (for +/- 100%)

Potentiometer / Joystick



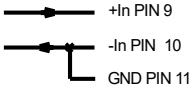
AIN:W 1000 1000 0 V (for 0... 100%)
AIN:W 2000 1000 5000 V (for +/-100%)

SPS / PLC 0... 10 V / +/- 10 V



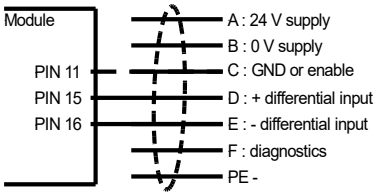
AIN:W 1000 1000 0 V (for +/-100%)

SPS / PLC 4... 20 mA

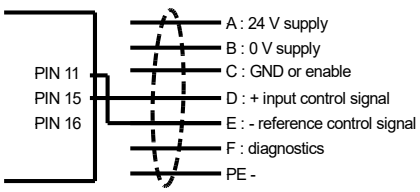


AIN:W 2500 1000 6000 V (for +/-100%)

Valve (6 + PE plug) with OBE electronics



Valve (6 + PE plug) with OBE elektronics, current signal 4-20 mA oder 4-12-20 mA



4.6 Technical data

Supply voltage (U_b) Current requirement External protection	**[VDC]** **[mA]** **[A]**	12… 30 (incl. ripple) <100 1 medium time lag
Digital inputs OFF ON Input resistance	 **[V]** **[V]** **[kOhm]**	 OFF : < 2 ON : > 10 25
Digital outputs OFF ON Maximum output current	 **[V]** **[V]** **[mA]**	 OFF: < 2 ON: max. U_b 50
Analogue inputs Voltage Input resistance Signal resolution Current Burden Signal resolution	 **[V]** **[kOhm]** **[%]** **[mA]** **[Ohm]** **[%]**	Unipolar / differential 0… 10 / -10… 10 min. 25 0,003 incl. Oversampling 4… 20 240 0,006 incl. Oversampling
Analogue outputs Voltage Maximum load Current Maximum load Signal resolution	 **[V]** **[mA]** **[mA]** **[Ohm]** **[%]**	 0… 10, +/- 10 differential 10 4… 20 390 0,007
Controller sample time	**[ms]**	1
Serial interface Transmission rate	 **[kBaud]**	USB - virtual COM Port 9,6… 115,2
Housing Material Flammability class		Snap-on module to EN 50022 PA 6.6 polyamide V0 (UL94)
Weight	**[kg]**	0,15
Protection class Temperature range Storage temperature Humidity	**[IP]** **[°C]** **[°C]** **[%]**	IP20 -20… 60 -20… 70 < 95 (non-condensing)
Connections Communication Plug connectors PE		 USB type B 4 x 4-pole terminal blocks via the DIN mounting rail
EMC		EN 61000-6-2: 8/2005 EN 61000-6-4: 6/2007 + A1:2011

5 Parameters

5.1 Parameter overview

Group	Command	Default	Unit	Description
Basic parameters				
	LG	EN	-	Changing language for the help texts
	MODE	STD	-	Parameter view
	SENS	ON	-	Malfunction monitoring
	EOUT	0	0,01 %	Output signal when not ready
	DSEL	ON	-	Directly overtaking of demand value without S-Valid
Command signal generation				
	MF	DW	-	Mathematic function / Selecting command signal
Analogue demands				
	SIGNAL:W	U+-10	-	Type of input signal
	RW:1… 4	100	ms	Ramp times for the analogue command signal
Digital demands				
	S:0… 15	0	0,01 %	Digital command values
	RA:0… 15	100	ms	Ramp times for the digital command values
	RMODE	SD	-	Selection of the ramp type
Output signal adaptation				
	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	U+-10	-	Type and polarity of the output signal
Special commands				
	AINMODE	EASY	-	Input scaling mode
	AIN:W	A: 1000 B: 1000 C: 0 X: V	-	Free scaling of the analogue inputs. Replaces the SIGNAL:W command if AINMODE is set to MATH.

5.2 Basic parameters

5.2.1 LG (Changing the language)

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

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

CAUTION: After changing the language settings, the ID button (SPEED BUTTON) in the menu bar (WPC-300) must be pressed (module identification).

5.2.2 MODE (Parameter view)

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

This command changes the operating mode. Various commands are blanked out in Standard mode (STD). The commands in Expert mode (EXP) have more significant influence on the system behavior and should accordingly be changed with care.

5.2.3 SENS (Malfunction monitoring)

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

This command is used to activate/deactivate the monitoring functions (4… 20 mA input, output current and internal failures) of the module.

ON: All monitoring functions are active. Detected failures can be reset by deactivating the ENABLE input.

OFF: No monitoring function is active.

AUTO: Auto reset mode. All monitoring functions are active. If the failure doesn't exist anymore, the module automatically resumes to work.

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

5.2.4 EOUT (Output signal if not READY)

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

Output value in case of a detected error or a deactive ENABLE input. A value (degree of valve opening) for use in the event of a sensor error (or the module is disabled) can be defined here. This function can be used if, for example, the drive is to move to one of the two end positions (at the specified speed) in case of a sensor error.

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

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

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

5.2.5 DSEL (Directly overtaking of demand value without S-Valid)

Command	Parameters	Unit	Group
DSEL x	x= ON|OFF	-	**EXP**

The command value activation will be switched over with the DSEL command.

DSEL= OFF: A new command value (Bit combination via S* inputs) will be active after a signal change (low to high) at input S-VALID.

DSEL= ON: A new command value is immediately active.

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

5.3 Command signal generation

5.3.1 MF (Mathematic function / selecting command signal)

Command	Parameters	Unit	Group
MF x	x= W|DW|ADD|SUB|MUL| DIV|MIN|MAX|MUL10	-	**STD**

With this function the source of the command signal is chosen. Furthermore it offers the possiblity to combine the external analogue command value with the chosen internal one via several mathematical operations.
Available are:

W: Only external analogue command value is used.
DW: Only internal preset and digital selected command value is used.
ADD: Both values will be added (DW + W).
SUB: One values will be substracted from the other (DW – W).
MUL: Both values will be multiplied with each other (DW * W).
DIV: One value will be divorced by the other (DW / W).
MAX: The higher one of both values will be taken.
MIN: The lower one of both values will be taken.
MUL10: Both values will be multiplied with each other and with 10 (DW * W * 10).

5.3.2 SIGNAL (Type of input)

Command	Parameters	Unit	Group
SIGNAL:W x	x= OFF|U+-10|I4-12-20| U-+10|I20-12-4	V|mA	**EASY**

This command can be used to change the type of input signal (voltages or current) and to define the direction of the signal. This command is available for the analogue command input (W). Mode OFF means deactivation of the input.

5.3.3 RW (Ramp times for the analogue command signal)

Command	Parameters	Unit	Group
RW:i x	i= 1… 4 x= 1… 600000	ms	**STD**

Four quadrant ramp function for the analogue command signal input at PIN 9 and 10.

5.3.4 S (Digital command values)

Command	Parameters	Unit	Group
S:i x	i= 0… 15 x= -10000… 10000	0,01 %	**STD|EXP**

Depending on MODE it is possible to parameterize between 5 and 16 demand values which can be binary selected with the digital inputs at PIN 5, 6, 14 and 13 and taken over as command value.

In STANDARD mode only S:0, S:1, S:2, S:4 and S:8 are displayed. These are the values which can be chosen directly with the input PINs without combining them. For using all values with the whole bit pattern MODE has to be set to EXPERT.

5.3.5 RA (Ramp times for the digital command values)

Command	Parameters	Unit	Group
RA:i x	i= 0… 15 x= 1… 60000	-	**STD**

To each programmed command value a separate ramp time can be assigned.

In STANDARD mode only R:0, R:1, R:2, R:4 and R:8 of the relating command values are displayed. These are the values which can be chosen directly with the input PINs without combining them. For using all values with the whole bit pattern MODE has to be set to EXPERT.

The ramp times will be used different depending on the RMODE function. If using the four-quadrant ramp, the values of RA:1... RA:4 are used for quadrants 1... 4.

5.3.6 RMODE (Selection of the ramp type)

Command	Parameters	Unit	Group
RMODE x	x= 4Q|SD|SDR	-	EXP

There are three operation modes available for the ramp function.

4Q: A four-quadrant ramp is active. If this option is selected, the ramp times RA:1, RA:2, RA:3 and RA:4 are active for the relating quadrant.

SD: Command signal related ramp time. Depending on the input combination one of the 16 ramp times is selected relating to its command value.

SDR: Jerk limited ramp time. This ramp function is used for smooth acceleration and deceleration of hydraulic axis. The max ramp time is limited by 5 s. This function cannot be used if DSEL is set to ON. Ramp time is selected as in option **SD.**

5.4 Output signal adaptation

5.4.1 MIN (Deadband compensation)

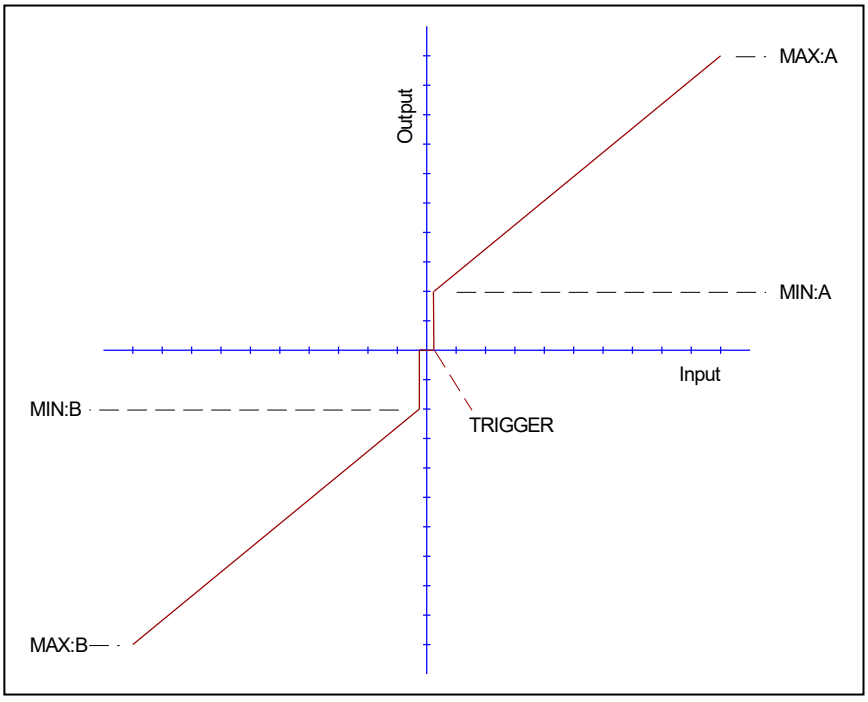
5.4.2 MAX (Output scaling)

5.4.3 TRIGGER (Deadband compensation trigger point)

Command	Parameters	Unit	Group
	i= A|B	-	**STD**
MIN:i x	x= 0… 6000	0,01 %	
MAX:i x	x= 3000… 10000	0,01 %	
TRIGGER x	x= 0… 4000	0,01 %	

The output signal to the valve is adjusted by 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[3] can be specified.

CAUTION: If the MIN value is set too high, it influences the minimal velocity, which cannot be adjusted any longer. In extreme case this causes to an oscillating around the closed loop controlled position.



[3] 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).

5.4.4 SIGNAL:U (Type and polarity of the output signal)

Command	Parameters	Unit	Group
SIGNAL:U x	x= U+-10|I4-12-20| U-+10|I20-12-4	V|mA	**STD**

This command is used to define the output signal (voltage or current) and to change the polarity[4].

Differential output ± 100 % corresponds with ± 10 V (0… 10 V at PIN 15 and PIN 16).
Current output ± 100 % corresponds with 4… 20 mA (PIN 15 to PIN 11). 12 mA (0 %) = center point of the valve.

An output current of << 4 mA indicates an error and the module is disabled. The current input of the proportional valves should be monitored by the valve. The valve have to be deactivated in case of < 4 mA input signal. Otherwise the EOUT command can be used to get a defined output signal.

5.5 Special commands

5.5.1 AINMODE (Input scaling mode)

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

The AINMODE is used to define the kind of parameterizing of the analogue inputs. The EASY mode (DEFAULT) supports a simple and application oriented input scaling.
The MATH mode supports the free input scaling by a linear equation (AIN:W). This mode is compatible to our older modules if an existing scaling should be used.

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

[4] The older POL command is removed.

5.5.2 AIN (Analogue input scaling)

Command	Parameters	Unit	Group
AIN:W			**MATH**
a	a= -10000… 10000	-	
b	b= -10000… 10000	-	
c	c= -10000… 10000	0,01 %	
x	x= V|C	-	

This command offers an individually scalable input. The following linear equation is used for the scaling.

$$Output = A/B \cdot (Input - C)$$

The ***"C" value*** is the offset (e.g. to compensate the 4 mA in case of a 4… 20 mA input signal).
The variables ***A*** and ***B*** are defining the gain factor with which the signal range is scaled up to 100 % (e.g. 1.25 if using 4… 20mA input signal, defined in default current settings by A = 1250 and B = 1000). The internal shunt for the current measuring is activated with switching the ***X*** value.

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

In this case AIN command would look like this:

AIN:I 20 16 2000 C or AIN:I 1250 1000 2000 C (see last example of FUNCTION = 196 below)

Typical settings:

Command	Input	Description
AIN:I 20 20 0 V ODER **AIN:I 1000 1000 0 V**	-10… 10 V	Voltages input: Usable -10… 10V (20V) for a working range of -100… 100% (**two solenoids**).
AIN:I 20 10 0 V ODER **AIN:I 2000 1000 0 V**	-5… 5 V	Voltages input: Usable -10… 10V (20V) for a working range of -100… 100% (**two solenoids**). Really used are -5… 5V (10V).
AIN:I 20 10 0 V ODER **AIN:I 2000 1000 0 V**	0… 10 V	Voltages input: Usable -10… 10V (20V) for a working range of -100… 100% (**two solenoids**). Really used are *only* 0… 10V for **both solenoids** with **5V zero point** setting (e.g. for joystick use).
AIN:I 40 16 6000 C ODER **AIN:I 20 8 6000 C** ODER **AIN:I 2500 1000 6000 C**	4… 20 mA	Current input: *theoretically* usable range -20… 20mA (40mA) for a working range of -100… 100% (**two solenoids**). Really usable are *only* 4… 20mA (16mA) for both solenoids with 12mA zero point setting.
AIN:X 20 8 5000 V ODER **AIN:X 2500 1000 5000 V**	1… 5… 9 V	Voltages input: Usable -10… 10V (20V) for a working range of -100… 100% (**two solenoids**). Really used are *only 1*… 9V (8V) for **both solenoids** with **5V zero point** (5000) setting (e.g. for joystick use).
AIN:X 20 16 2000 C ODER **AIN:X 2000 1600 2000 C** ODER **AIN:X 1250 1000 2000 C**	4… 20 mA	Current input: *theoretically* usable range 0… 20mA. Target working range of 0… 100% (**one solenoids**). Really usable are 4… 20mA (16mA). 4mA (20%) are Offset (2000).

5.6 PROCESS DATA (Monitoring)

Command	Description	Unit
WA	Analogue command value (input signal)	%
W	Analogue command value (after ramp function)	%
DWA	Digtial command value (bit pattern value)	%
DW	Digital command value (after ramp function)	%
C	Control signal after MF	%
U	Output control signal	%
IA	Solenoid current A	mA (P Version only)
IB	Solenoid current B	mA (P Version only)

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

6 Appendix

6.1 Failure monitoring

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

Source	Fault	Characteristic
Command signal PIN 9 4... 20 mA	Out of range or broken wire	The output will be switched off.
P-VERSION Solenoids on PIN 17-20	Wrong cabling, broken wire	The power stage will be deactivated.
EEPROM (when switching on)	Data error	The output is deactivated. The module can only be activated by saving the parameters again!

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

6.2 Troubleshooting

It is assumed that the device is in an operable state and there is communication between the module and the WPC-300. Furthermore, the valve control parameterization has been set with the assistance of the valve data sheets.

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

CAUTION: All safety aspects must be thoroughly checked when working with the RC (Remote Control) mode. In this mode the module is controlled directly and the machine control cannot influence the module.

FAULT	CAUSE / SOLUTION
ENABLE is active, the module does not respond and the READY LED is off.	There is presumably no power supply or the ENABLE signal (PIN 8) is not present. If there is no power supply, there is also no communication via our operating program. If a connection has been made to the WPC-300, then a power supply is also available.
ENABLE is active, the READY LED is flashing.	The flashing READY LED signals that a fault has been detected by the module. The fault could be: • A broken cable or no signal at the input PIN 9, if 4… 20 mA signals are parameterized. • A broken cable or incorrect cabling to the solenoids (in the P version only). • Internal data error: press the command/SAVE button to delete the data error. The system reloads the DEFAULT data. With the WPC-300 operating program the fault can be localized directly via the monitor.

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 oder **I** - is a dummy 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"

7 ADDITIONAL INFORMATION: Power output stage

7.1 General function

The power output stages have been developed for controlling proportional valves without spool position feedback. The output stage is controlled by the microcontroller on the basic module by means of pulse width modulated signals, and the current is continuously controlled. The cycle time for the controller is 0,125 ms.

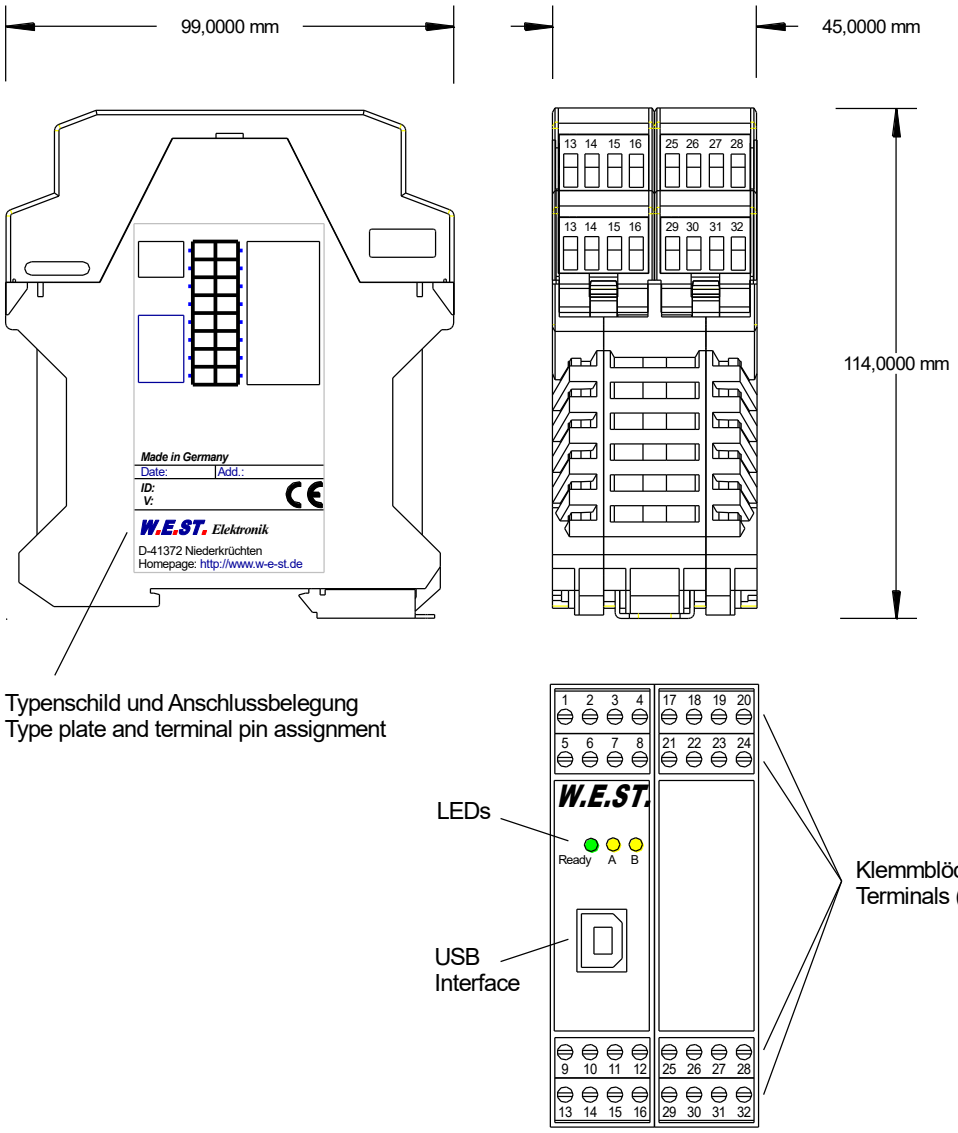
The output stage can be ideally adjusted to dynamic requirements via internal parameters.

Valve technology: Proportional valves manufactured by REXROTH, BOSCH, DENISON, EATON, PARKER, FLUID TEAM, ATOS and others.

Features

- **Two power output stages with maximum output range of 0.5 A to 2,6 A**
- **Hardware short-circuit protection with 3 µs response time**
- **Adjustable PWM frequency, dither frequency and dither amplitude**
- **High current signal resolution**
- **No additional delay times between the control function and the power stage**
- **Separate power supply for safety-relevant applications**
- **Integrated into the standard controller, no additional wiring necessary**

7.2 Device description

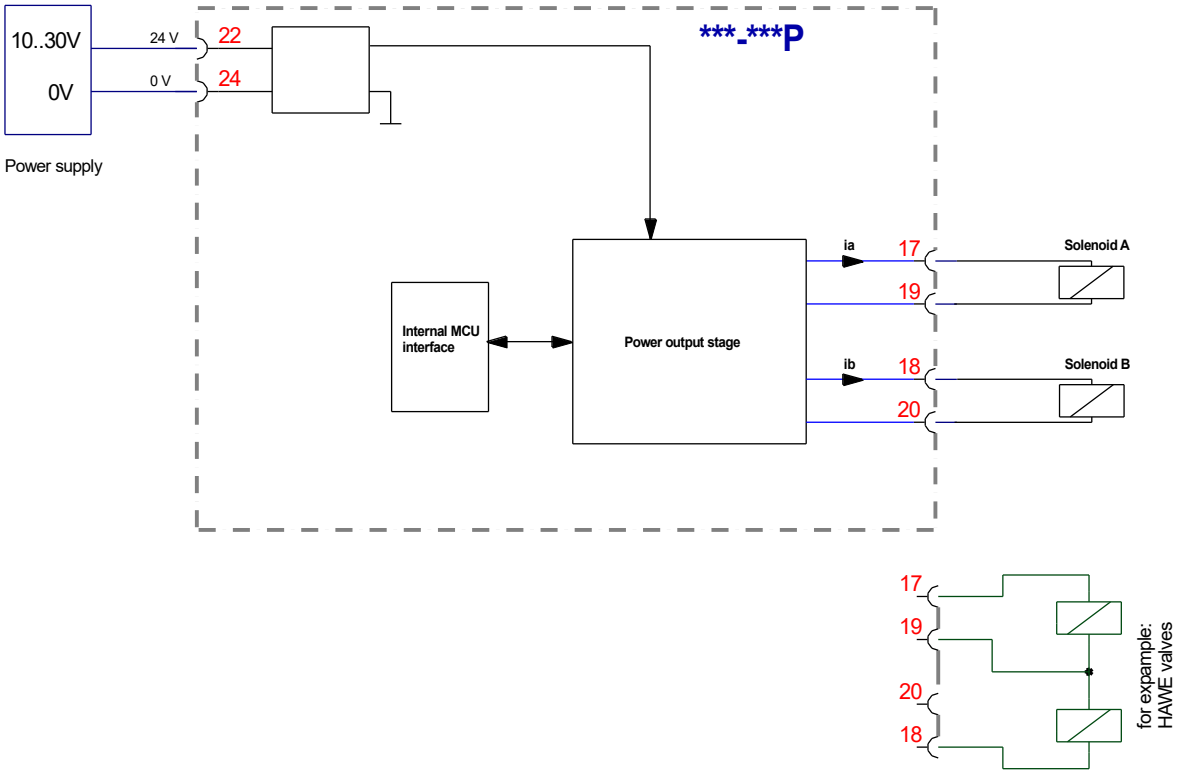


Typenschild und Anschlussbelegung
Type plate and terminal pin assignment

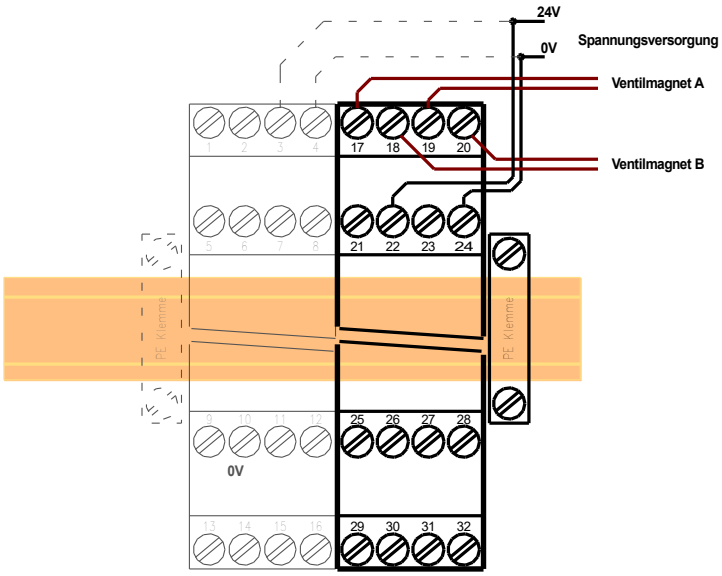
7.3 Inputs and outputs

Connection	Signal description
PIN 22 + PIN 24 -	**Power supply: 10… 30 VDC:** For safety-related applications, the output stage can be deactivated thanks to the separate power supply inputs.
PIN 17+19	Solenoid current output A
PIN 18+20	Solenoid current output B
Connection	**Signals modified from the standard (A and I version)**
PIN 15	Omitted, 0 V
PIN 16	Omitted, 0 V

7.4 Circuit diagram



7.5 Typical wiring



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

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

7.6 Technical data

Supply voltage Power consumption max. Fuse protection	**[VDC]** **[W]** **[A]**	10... 30 60 (depending on the solenoid) 3 (medium time lag)
PWM output PWM frequency	**[A]** **[Hz]**	0,5, to 2,6 (step less selectable); broken wire and short circuit monitored 61… 2604
Sample time solenoid current control	**[ms]**	0,125
Temperature range	**[°C]**	-20… 60
Housing		Snap-on module EN 50022 Polyamide PA 6.6 Flammability class V0 (UL94)
Weight	**[kg]**	0,250 (incl. standard module)
Connections		3 x 4-pole terminal blocks

7.7 Parameter overview

Command	Default	Unit	Description
CURRENT	1000	mA	Rated solenoid current
DFREQ	121	Hz	Dither frequency
DAMPL	500	0,01 %	Dither amplitude
PWM	2604	Hz	PWM frequency
ACC	ON	-	Current loop auto adjustment
PPWM **IPWM**	7 40	- -	Manual PI-adjustment of the current loop
SIGNAL:U	+	-	Output polarity

The standard parameterization has been used with a large number of proportional vales from various manufacturers. This parameterization has proved to be good as long as no special demands concerning the application have to be fulfilled.

7.8 Parameters of the power stage

7.8.1 CURRENT (Rated solenoid current)

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

The nominal current of the solenoid is set with this parameter. Dither and also MIN/MAX always refer to this value.

7.8.2 DFREQ (Dither frequency)

7.8.3 DAMPL (Dither amplitude)

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

The dither[5] can be defined with this commands. Different amplitudes or frequencies may be required depending on the valve. The dither amplitude is defined in % (peak to peak value) of the nominal output current[6] (see: CURRENT command).

The dither frequency is defined in Hz. Depending on the internal calculations, the frequency is adjustable in steps only (the next higher value will be selected)[7].

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

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

7.8.4 PWM (PWM frequency)

Command	Parameter	Unit	Group
PWM x	x= 61… 2604	Hz	**EXP**

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

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

[5] The dither is a ripple signal which is superimposed on the current set point and is defined by the amplitude and frequency: the dither frequency and the PWM frequency. The dither frequency should not be confused with the PWM frequency. In some documentations the PWM frequency is described as a dither. This can be recognized by the lack of the dither amplitude.

[6] The dither amplitude is a command signal. Derivations between the commanded amplitude and the real amplitude are possible, depending on the dynamic of the solenoid.

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

7.8.5 ACC (Current loop auto adjustment)

Command	Parameter	Unit	Group
ACC x	x= ON|OFF	-	EXP

Operation mode of the closed loop current control.

ON: AUTOMATIC mode: PPWM and IPWM are calculated depending on the preset PWM-frequency.
OFF: Manual adjustment: PPWM and IPWM can be adjusted manually.

7.8.6 PPWM (P gain of the current loop)

7.8.7 IPWM (I gain of the current loop)

Command	Parameters	Unit	Group
PPWM x	x= 0… 30	-	EXP
IPWM x	x= 4… 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 experience.

Attention, if the parameter ACC is set to ON, these adjustments are done automatically.

If the PWM frequency is < 250 Hz, the dynamic of the current controller has to be decreased.
Typical values are: PPWM = 1… 3 and IPWM = 40… 80.

If the PWM frequency is > 1000 Hz, the default values of PPWM = 7 and IPWM = 40 should be chosen.

7.9 Changed parameters from U-version

7.9.1 SIGNAL:U (Polarity of the output signal)

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

In P-version this command provides switching the polarity of the output signal.

8 Notes