WEST

Technical Documentation

PAM-193-H

Power amplifier for proportional valves

Electronics
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CONTENTS

1 General Information

1.1 Order number

PAM-193-H - Analogue adjustable power amplifier for single-channel proportional valves with GND potential connection (current ranges: 1.2 A and 2.6 A)

Alternative products

PAM-140-P-A - Power amplifier for proportional valves with 0…10 V input in IP65-version

PAM-140-P-I - Power amplifier for proportional valves with 4...20 mA input in IP65-version

PAM-190-P - Power amplifier (plug) for proportional valves with M12 connection

PAM-390-P - Single channel plug amplifier for proportional valves with USB interface

1.2 Scope of supply

The scope of supply includes the module plus the terminal blocks which are a part of the housing.
This documentation can be downloaded as a PDF file from www.w-e-st.de.

1.3 Symbols used

General information

Safety-related information

1.4 Legal notice

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

1.5 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 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 developed to control single-channel hydraulic proportional valves. Various parameters can be adjusted using potentiometers to adapt the module to the individual valve. Thanks to control sensors on the magnetic line feed, the magnetic current return conductor no longer needs to be routed through the module. Alternatively, it can be connected to a GND busbar. The valve magnets are controlled by pulse-width-modulated voltage bursts. These can be controlled either as a direct PWM signal or as a higher-frequency PWM signal with overlapped dither.

The amplifier can be controlled via various voltage or current signals. The output current is regulated and therefore independent of the supply voltage and the magnetic resistance.

Typical applications: Current-controlled actuation of throttle or pressure valves.

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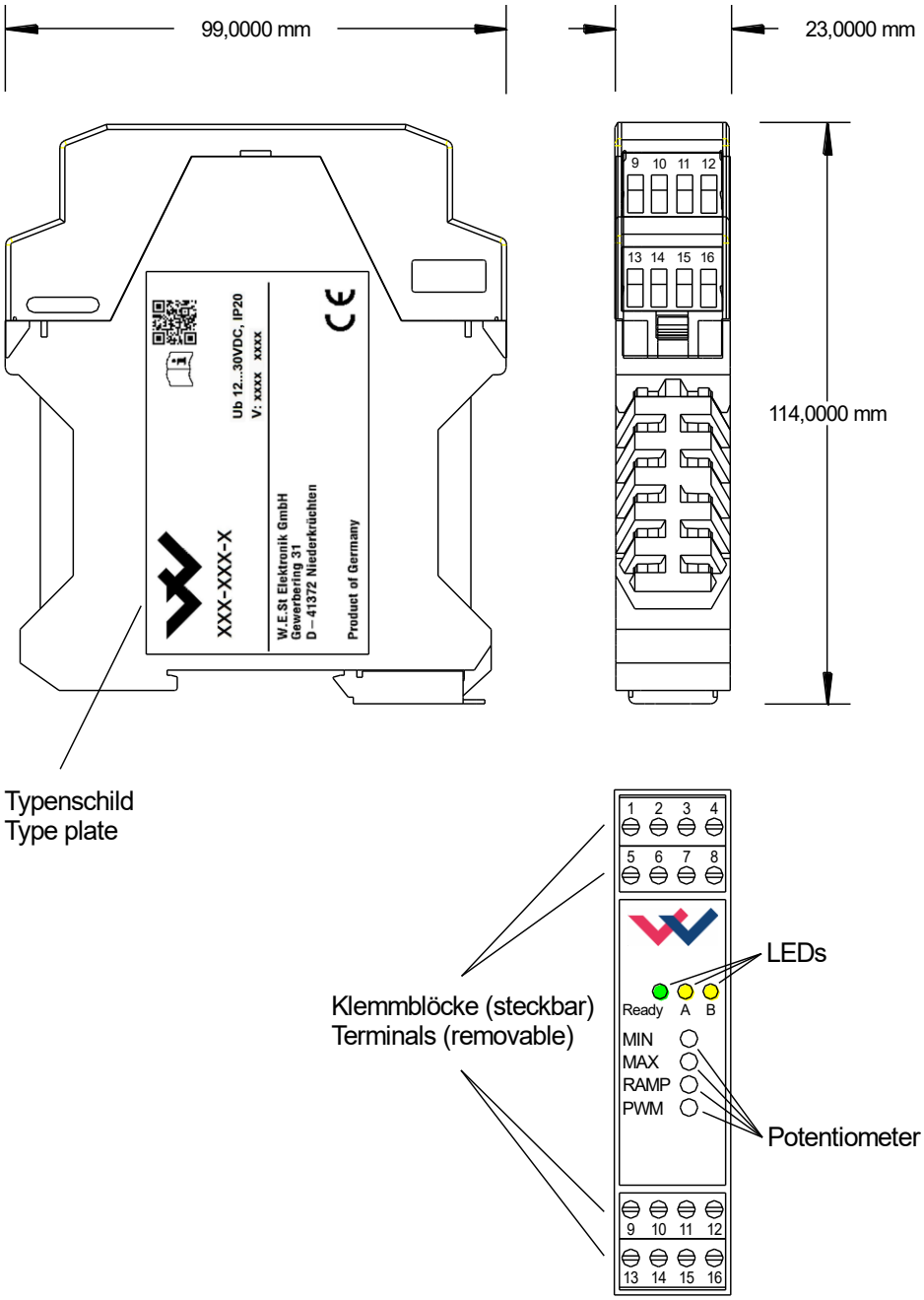
Features

- **The magnetic current return path does not need to be routed across the assembly**
- **Power amplifiers for proportional throttle or pressure valves**
- **Compact housing**
- **Adjustment via potentiometer**
- **Voltage and current command signals**
- **Adjustment via potentiometer**
- **Parameterisation of ramps, MIN and MAX, dither and PWM frequency**
- **Output current in two resolution ranges up to 2.6 A**

2.1 Device description



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 shielded; complete shielding 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:** 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 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.

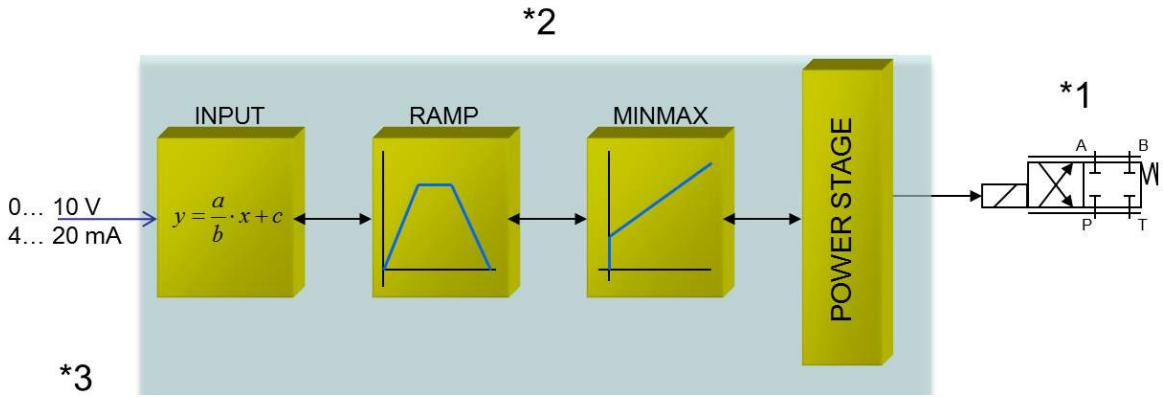
- The module should be installed and wired in accordance with the documentation bearing in mind EMC principles. If other consumers are operated with the same power supply, a star-connected ground wiring scheme is recommended. The following points must be observed when wiring:
  - The signal cables must be laid separately from power cables.
  - Analogue signal cables **must be shielded**.
  - All other cables must be shielded 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 shield should be connected to PE (PE terminal) as close to the module as possible. The local requirements for shielding must be taken into account in all cases. The shield 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 shielding 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

This minimal system consists of the following components:

(*1) proportional valve
(*2) power amplifier
(*3) interface to PLC with analogue and digital signals



3.3 Method of operation

This power amplifier will be controlled via an analogue signal (from the SPS, from a joystick or a potentiometer). An ENABLE signal (24 V typical) activates the function and the READY output indicates the active module, if no internal or external error was detected.

The integrated standard functions will be configured via different potentiometers.

In case of a fault the power output stage will be deactivated and the fault will be indicated via deactivating the READY output and the flashing READY LED.

The output current is controlled whereby a high accuracy and a good dynamic will be obtained. All customary proportional valves (up to 2.6 A) could be controlled with this power amplifier.

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.
Pre-parameterization	Set the DIL switches and potentiometers to your requirements: The output current and valve-specific parameters such as DITHER and MIN/MAX. This pre-calibration is necessary to minimise the risk of uncontrolled movement.
Control signal	Check the control signal with a voltmeter. The control signal (the current of the solenoid is within the range of 0... 2.6 A). In the actual status it should show approximately 0 A.
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).
Activating ENABLE	**CAUTION!** Drives can now leave their position and move to an end position at full speed. Take safety measures to prevent personal injury and damage. The hydraulic axis can be moved over the analogue input value.
Optimize settings	Now optimize the remaining parameters (MIN function and RAMP time) according to your application and your requirements.

4 Technical description

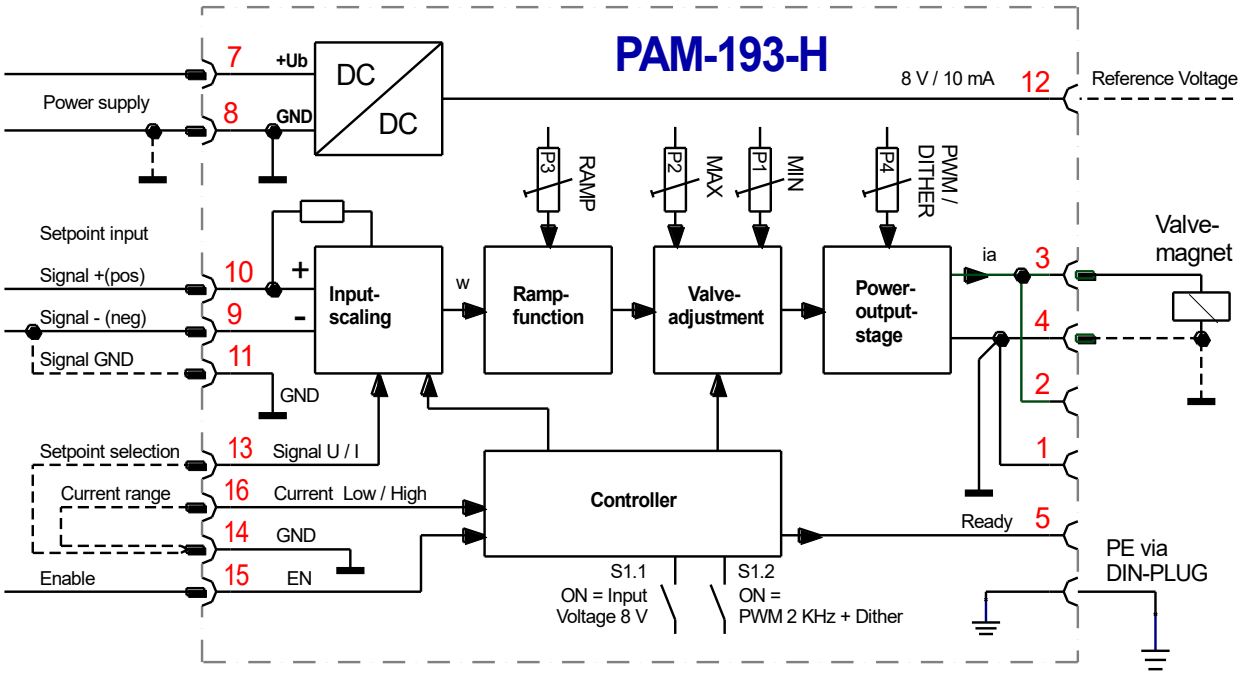
4.1 Input and output signals

Connection	Supply
PIN 7	Power supply (see technical data).
PIN 8	0 V (GND) Power supply (ground).
Connection	**Analogue signals**
PIN 10 / 9	Command (input) signal (W), range +/-100 % corresponds with +/-10 V or 4… 20 mA.
PIN 11	0 V (GND) for the signal inputs (identical with PIN 8).
PIN 12	Reference voltage (output) for supplying potentiometers.
Connection	**PWM outputs**
PIN 3 (2) / 4 (1)	Solenoid of the valve
Connection	**Digital inputs and outputs**
PIN 15	**ENABLE Input**: Initializes the application and activates the power stage.
PIN 13	**U/I INPUT-Selection** Unconnected (default) sets the setpoint input to voltage 0…10 (8) V. Connection to GND / PIN 14 selects the setpoint input to 4…20 mA.
PIN 16	**OUTPUT-CURRENT-Range** Unconnected (default) sets the output current range to 1.2 A. Connection to GND / PIN 14 sets the output current range to 2.6 A.
PIN 14	Reference potential (GND) to PIN 13 and PIN 16 (potential identical to PIN 8).
PIN 5	**READY output**: **ON:** No internal or external errors are detected **OFF:** ENABLE is deactivated or an error was detected.

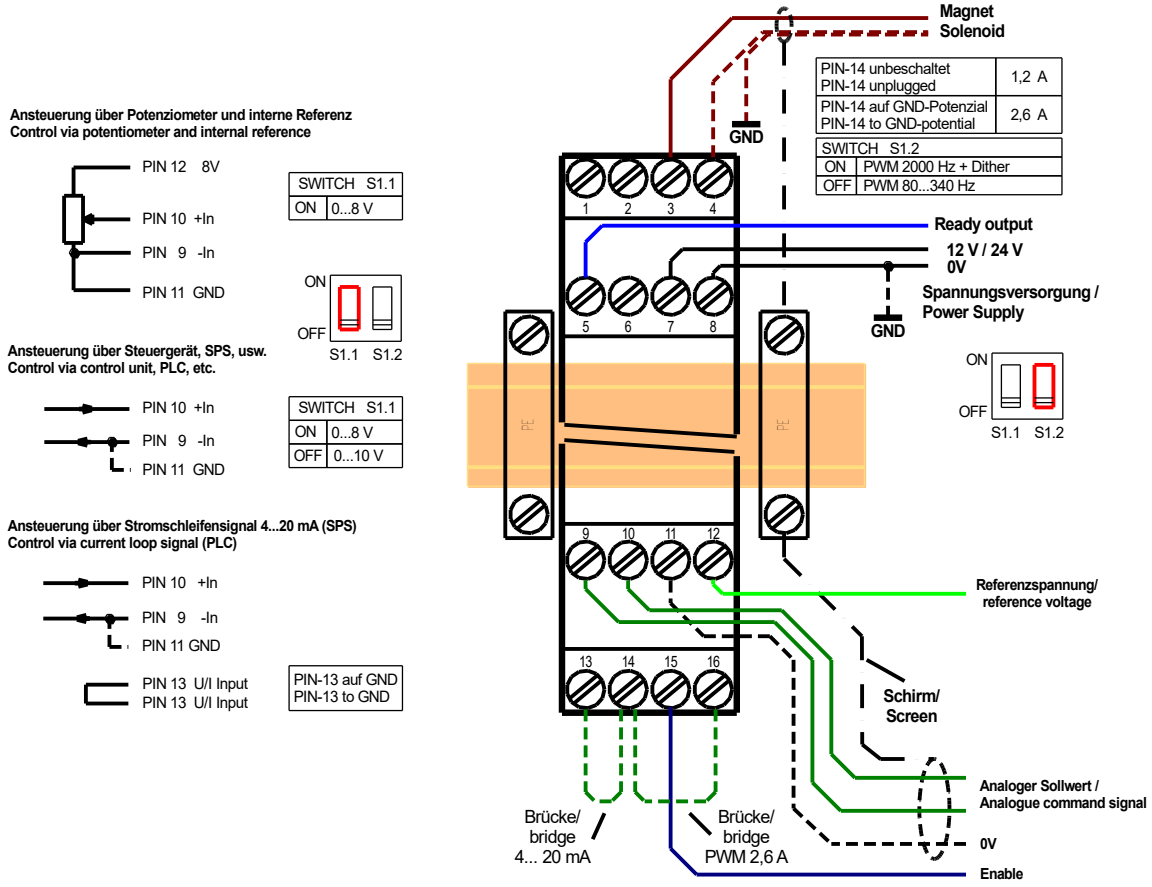
4.2 LED definitions

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 operation **Flashing:** Error detected.
YELLOW A	**ON:** Related solenoid is activated. **OFF:** Solenoid not active.
YELLOW B	**ON:** The magnetic flux is built up or reduced via a ramp. **OFF:** Ramps are not traversed.

4.3 Circuit diagram



4.4 Typical wiring



If a current signal (4… 20 mA) is used, connect PIN 13 and PIN 14.
For unipolar voltage signals or current loop signals, connect PIN 9 to PIN 11.
The solenoid valve return line does not necessarily have to be routed through the device.

4.5 Technical data

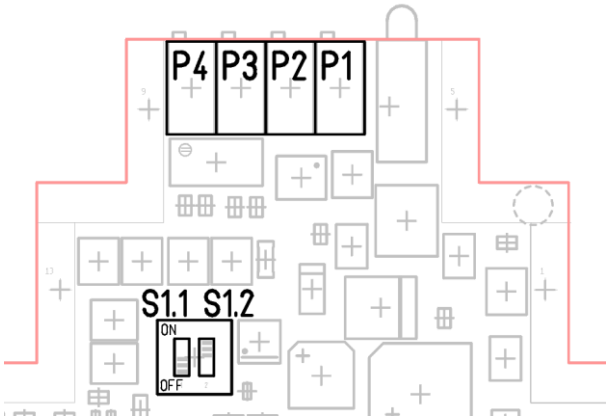
Supply voltage (Ub) Current consumption External fuse	**[VDC]** **[mA]** **[A]**	12… 30 (incl. ripple) 30 + solenoid current 3 medium time lag
Reference output Voltage Max. load	 **[V]** **[mA]**	 8 10
Digital inputs OFF ON Input resistance	 **[V]** **[V]** **[kOhm]**	 < 2 > 10 25
Digital outputs OFF ON Max. output current	 **[V]** **[V]** **[mA]**	 < 2 max. Ub 50
Analog inputs: Voltage Input resistance Signal resolution Current Burden Signal resolution	 **[V]** **[kOhm]** **[%]** **[mA]** **[Ohm]** **[%]**	Unipolar / differential 0… 10 / -10… 10 min. 90 0.1 4… 20 390 0.135
PWM output Max. output current Frequency	 **[A]** **[Hz]**	Wire break and short circuit monitored 2.6 80… 340 or 2000
Sample times Solenoid current control Signal processing	 **[µs]** **[ms]**	 167 1
Housing Material Flammability class	 **-** **-**	Snap-on module acc. EN 50022 PA 6.6 polyamide V0 (UL94)
Weight	**[kg]**	0,13
Protection class Temperature range Storage temperature Humidity	**[IP]** **[°C]** **[°C]** **[%]**	20 -20… 60 -20 …70 <95 (not condensing)
Connections Plug connectors PE		 4pol. screw terminals direct via DIN rail
EMC		EN IEC 61000-6-4: 2020-09 EN IEC 61000-6-2: 2019-11

5 Parameters

5.1 Parameter list

Parameter	Default	Unit	Description
AIN	+/- 10	V	Selecting the analogue input signal.
RAMP	100	ms	Ramp time for the setpoint.
MIN:A MIN:B	0 0	% %	Compensation of the dead band.
MAX:A MAX:B	100 100	% %	Scaling of the current output.
CURRENT	0	-	Output current range: 0 = 1.2 A / 2 = 2,6 A
DITHER	60	Hz	Dither function.
DAMPL	0	%	Dither amplitude.
PWM	340	Hz	PWM frequency

5.2 Positions of the potentiometers and the DIL switches



P1 : MIN	→	Adjustment of valve overlap (0… 60 %)
P2 : MAX	→	Adjustment of the output current (40… 100%)
P3 : RAMP	→	Adjustment of ramp times (50… 15000 ms)
P4 : PWM | (S1.2 = OFF)	→	Adjustment of PWM frequency (80… 340 Hz)
P4: DAMPL | (S1.2 = ON)	→	Adjustment of Ditheramplitude (0… 20%)
S1.1	→	OFF: Input voltage scaling to 8V for 100%
	→	ON: Input voltage scaling to 10V for 100%
S1.2	→	OFF: Variable PWM-frequency (80… 340 Hz)
	→	ON: PWM-frequency = 2 kHz with variable amplitude

5.3 Parameter description

5.3.1 AIN (Analogue input scaling)

S1.1	Connection	Setpoint signal
OFF	None	0… 10 V forr 0… 100%
ON	None	0… 8 V forr 0… 100%
X	PIN 13 zu Pin 14	4... 20 mA for 0… 100%

The kind of command signal is selected by the different combinations of the DIL switches.

5.3.2 RAMP (Ramp function)

Parameter	Potentiometer	Range	Unit
Setpoint ramp	P3	50… 15000	ms

Turning the potentiometer clockwise increases the ramp time for accepting setpoint changes.
Ascending and descending ramp times are identical.
A status LED on the front panel indicates the activity of the ramp function.

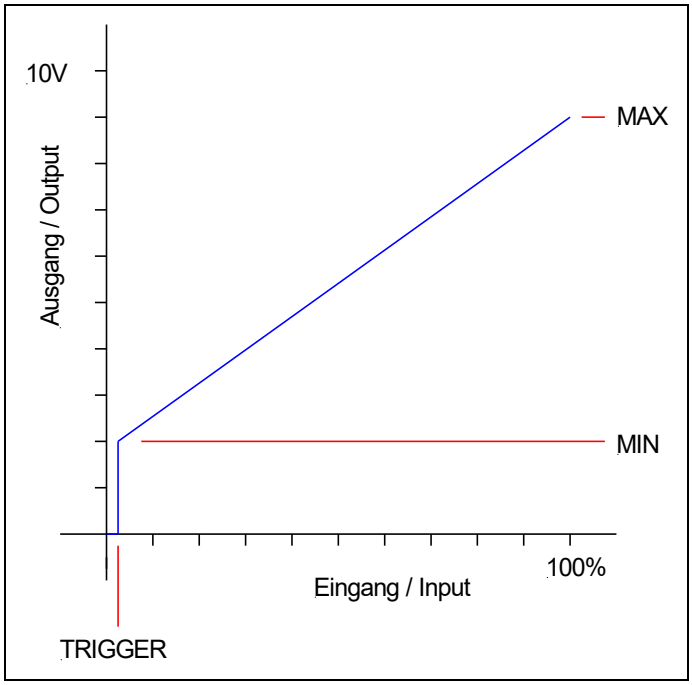
5.3.3 MIN (Dead band compensation)

5.3.4 MAX (output scaling)

Parameter	Potentiometer	Range	Unit
MIN	P1	0… 60	%
MAX	P2	40… 100	%

The output signal to the valve is adjusted by these parameters. 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. Because of the fact, that the MAX settings influence the MIN value, the MAX should be set first before adjusting the MIN. The percentage values depend on the nominal current range (MAX) respective on the with MAX adjusted solenoid current (MIN).

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



5.3.5 CURRENT (Current range switch)

Range	Connection	Nominal (maximum) current	Unit
0	None	1	A
1	PIN 16 to PIN14	2,6	A

The nominal current range is set by connecting pin 16 to pin 14. Dither and MIN/MAX always refer to the selected current range.

5.3.6 DITHER (Dither function)

5.3.7 DAMPL (Dither amplitude)

5.3.8 PWM (PWM frequency)

The amplifier can be used with an PWM output current in a frequency range of 80 Hz to 340 Hz, or with a fix value of 2000 Hz. If 2000 Hz are chosen, an additional Dither signal with 60 Hz can be modulated on it.

DIL S1.2	P4	PWM-frequency	Dither frequency	Ditheramplitude
ON	Dither amplitude	2000 Hz	60 Hz	0… 20 %
OFF	PWM frequency	80… 340 Hz	Not active	Not active

6 Start up

6.1 Procedure

Because of the type these valves have relatively great tolerances in comparison to the electronics. The adjustment can vary from valve to valve.

MAX: Maximum current adjustment (P2). The maximum output current can be set from about 40% to 100% of the rated current range..

MIN: Zero- / deadband adjustment (P1). The MIN-adjustment should be carried out after the MAX-adjustment. The presetting is 0 (fully anti-clockwise). According to valve adjustments approx.0 % to 60 % of the rated current are necessary.
Preset a small input signal of nearly 3 % to 5 %. Increase the MIN value (rotate clockwise) continuously until the drive moves. From there you reduce the value (anti-clockwise) until the drive came to standstill again.

Caution: By changing of the MAX-adjustment also the MIN-adjustment changes.

RAMP: The ramp time is preset on roughly 50 ms (P3, smallest value, fully anti-clockwise). It will be prolonged by turning clockwise up to approx. 15 s. All ramp times are identical.
Caution: Long ramp times and simultaneously short cycle times (cycle time < ramp time) can result in a hardly understandable behaviour because all movements are carried out strongly delayed.

PWM/ DITHER: With the adjustment of PWM / DITHER the valve hysteresis can be reduced clearly.

PWM frequency (pre-adjusted): The PWM frequency (S1.2 = OFF) can be chosen within the range of 80… 340 Hz. For many valves PWM frequency adjustment is best way trying to reduce the hysteresis.

DITHER Amplitude: The dither amplitude (S1.2 = ON) can be adjusted between 0… 20 %. If this mode is activated the PWM frequency is about 2000 Hz and the DITHER frequency nearly 60 Hz.

Caution: the best setting please take out of the valve data specification.

6.2 General behaviour:

Power ON: After switching on the input signal (4… 20 mA) is checked and the system is gets activated. When ENABLE is active (ENABLE directly connected with the supply voltage) the current is activated by an internally defined ramp (smooth starting) in order to drive onto the demand value with the pre-set ramp time.

If an error is detected the module changes over into error status.

ENABLE: By this switching-input the internal signal processing and the power stage are enabled. While activating the input the valve current will be driven up the pre-set ramp. In case of deactivating the current is switched off immediately. PIN 5 monitors the state of readiness.

Caution: This input is not suitable for stopping power stage in security relevant systems.

LEDs: Green LED ON = ready for operation.

Green LED flashes if command signal is lower than 2mA (4… 20mA adjustment) and in case of detected cable break to the solenoid. The output current is switched off immediately.

7 Appendix

7.1 Failure monitoring

Following possible error sources are monitored continuously:

Source	Fault	Characteristic
Command signal PIN 9 / 10 4...20 mA	Out of range	The power stage is deactivated.
Solenoid PIN 3 (2) / 4 (1) / GND	Broken wire	The power stage is deactivated.

7.2 Troubleshooting

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.
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: • No signal at the input, if 4… 20 mA signal is chosen • A broken cable or incorrect wiring to the solenoids.

8 Notes