WEST

# Technical Documentation

**PAM-193-P**
**PAM-193-L**

Power amplifier for directional valves




Electronics
Hydraulics meets
meets Hydraulics
Electronics

## CONTENTS


1 General Information ... 3
1.1 Order number ... 3
1.2 Scope of supply ... 3
1.3 Symbols used ... 4
1.4 Legal notice ... 4
1.5 Safety instructions ... 5
2 Characteristics ... 6
2.1 Device description ... 7
3 Use and application ... 8
3.1 Installation instructions ... 8
3.2 Typical system structure ... 9
3.3 Method of operation ... 9
3.4 Commissioning ... 10
4 Technical description ... 11
4.1 Input and output signals ... 11
4.2 LED definitions ... 11
4.3 Circuit diagram ... 12
4.4 Typical wiring ... 13
4.5 Technical data ... 14
5 Parameters ... 15
5.1 Parameter list ... 15
5.2 Positions of the potentiometers and the DIL switches ... 15
5.3 Parameter description ... 16
5.3.1 AIN (Analogue input scaling) ... 16
5.3.2 RAMP (Ramp function) ... 16
5.3.3 MIN (Dead band compensation) ... 17
5.3.4 MAX (output scaling) ... 17
5.3.5 CURRENT (Current range switch) ... 18
5.3.6 DITHER (Dither function) ... 18
5.3.7 DAMPL (Dither amplitude) ... 18
5.3.8 PWM (PWM frequency) ... 18
6 Start up ... 19
6.1 Procedure ... 19
6.2 General behaviour: ... 20
7 Appendix ... 21
7.1 Failure monitoring ... 21
7.2 Troubleshooting ... 21
7.3 Replacements / compatibility ... 22
7.3.1 PAM-191 ... 22
7.3.2 PAM-192 ... 23
7.3.3 Special versions ... 23
8 Notes ... 24

# 1 General Information

## 1.1 Order number

**PAM-193-P** - for single or double solenoid valves (max output current: 1.2 A and 2.6 A)
**PAM-193-L** - for single or double solenoid valves (max output current: 0.6 A and 1.2 A)

**Alternative products**

**PAM-199-P** - universal power amplifier for directional, pressure or throttle valves with one or two solenoids

## 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 Symbols used



General information



Safety-related information

## 1.4 Legal notice

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Date: 07.01.2025

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

This document is protected by copyright.

## 1.5 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 module is used for the control of proportional valves with one or two solenoids. Various adjustable parameters enable an optimized adaptation to the respective valve. This power amplifier is inexpensive and a space-saving solution.

The amplifier is controlled by voltage input or current input signals.
The output current is closed loop controlled and therefore independent from the supply voltage and the solenoid resistance.

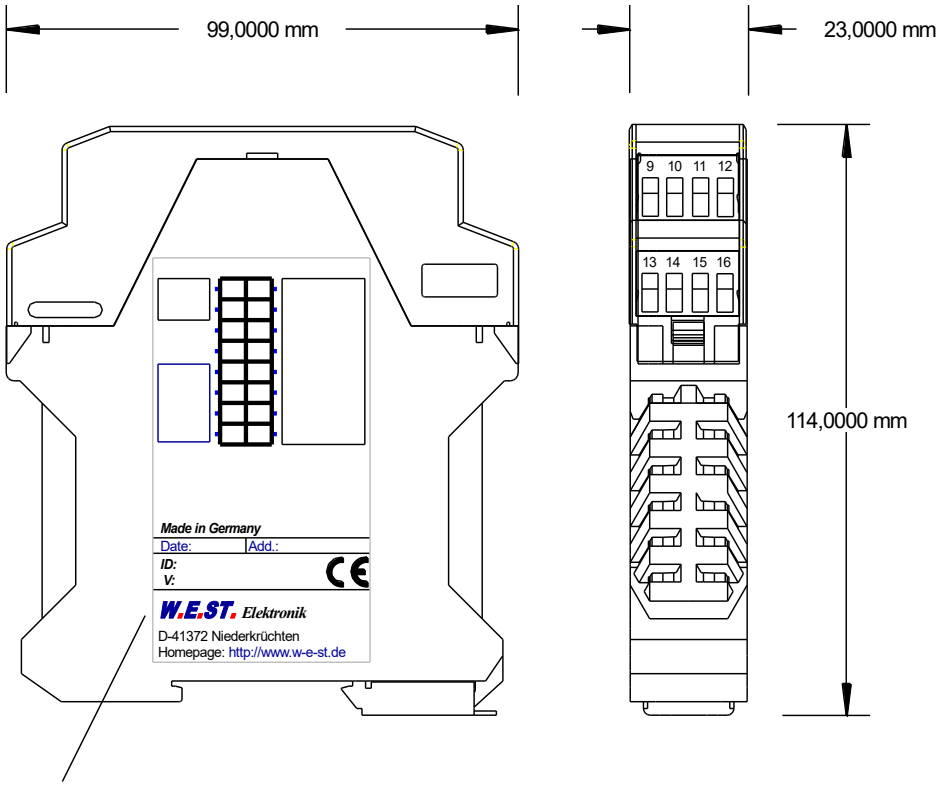
Several potentiometers and DIL switches allow the adaption to valves of the various producers.

**Typical applications**: Control of proportional valves in different applications.

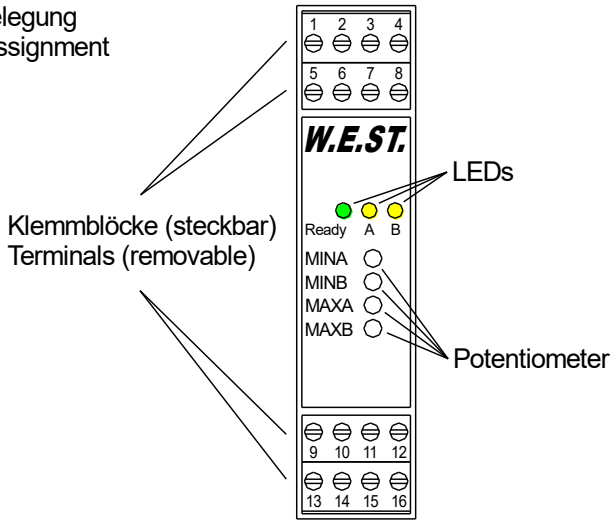
# Features

- **Power amplifier for proportional directional valves**
- **Various voltage and current command signals**
- **Compact housing**
- **Adjustment via potentiometer**
- **MIN-, MAX-, RAMP- and PWM-frequency adjustment via potentiometer**
- **Current range up to 2.6 A**

## 2.1 Device description




Typenschild und Anschlussbelegung
Type plate and terminal pin assignment




Klemmblöcke (steckbar)
Terminals (removable)

# 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 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.

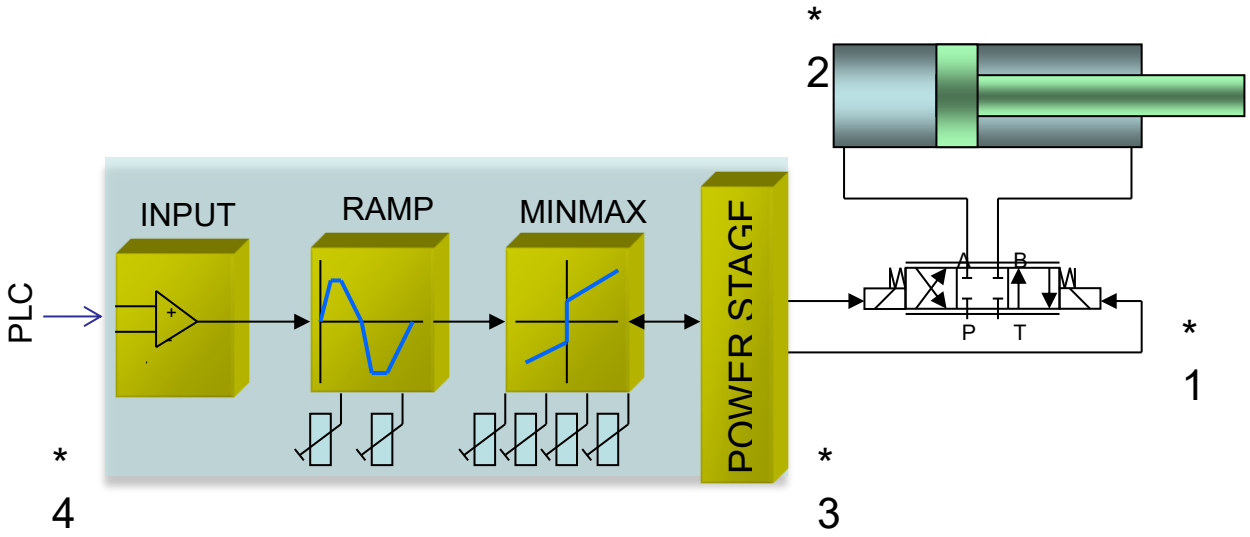
- The module should be installed and wired in accordance with the documentation bearing in mind EMC principles. If other consumers are operated with the same power supply, a star-connected ground wiring scheme is recommended. The following points must be observed when wiring:
  - The signal cables must be laid separately from power cables.
  - Analogue signal cables **must be 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.
  - 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

This minimal system consists of the following components:

(*1) proportional valve
(*2) hydraulic cylinder
(*3) power amplifier PAM-193
(*4) 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. Solenoid errors have to be quit by resetting ENABLE.

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 | Now set up the following parameters (with reference to the system design and circuit diagrams):<br>The output current and the typical input function (DIL switches) |
| 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.<br>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

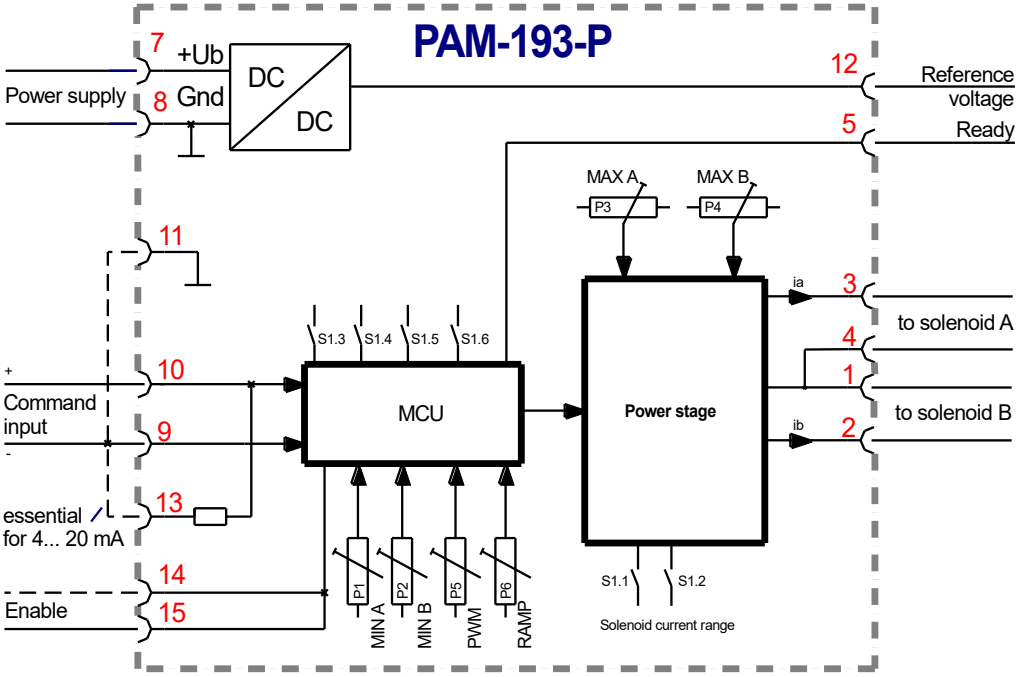
## 4.1 Input and output signals

| Connection | Supply |
|---|---|
| PIN 7 | Power supply (see technical data) |
| PIN 8 | 0 V (GND) Power supply (ground). |
| **Connection** | **Analogue signals** |
| PIN 9 / 10 | 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 output voltage (8 V). |
| PIN 13 | Input resistor (390 Ohm) used for 4… 20 mA. PIN 13 have to be connected with PIN 9. |
| **Connection** | **PWM outputs** |
| PIN 3 / 4 | Solenoid A |
| PIN 1 / 2 | Solenoid B |
| **Connection** | **Digital inputs and outputs** |
| PIN 14 or PIN 15 | **ENABLE Input**:<br>Initializes the application and activates the power stage. |
| PIN 5 | **READY output**:<br>**ON:** No internal or external errors are detected<br>**OFF:** ENABLE is deactivated or an error was detected. |

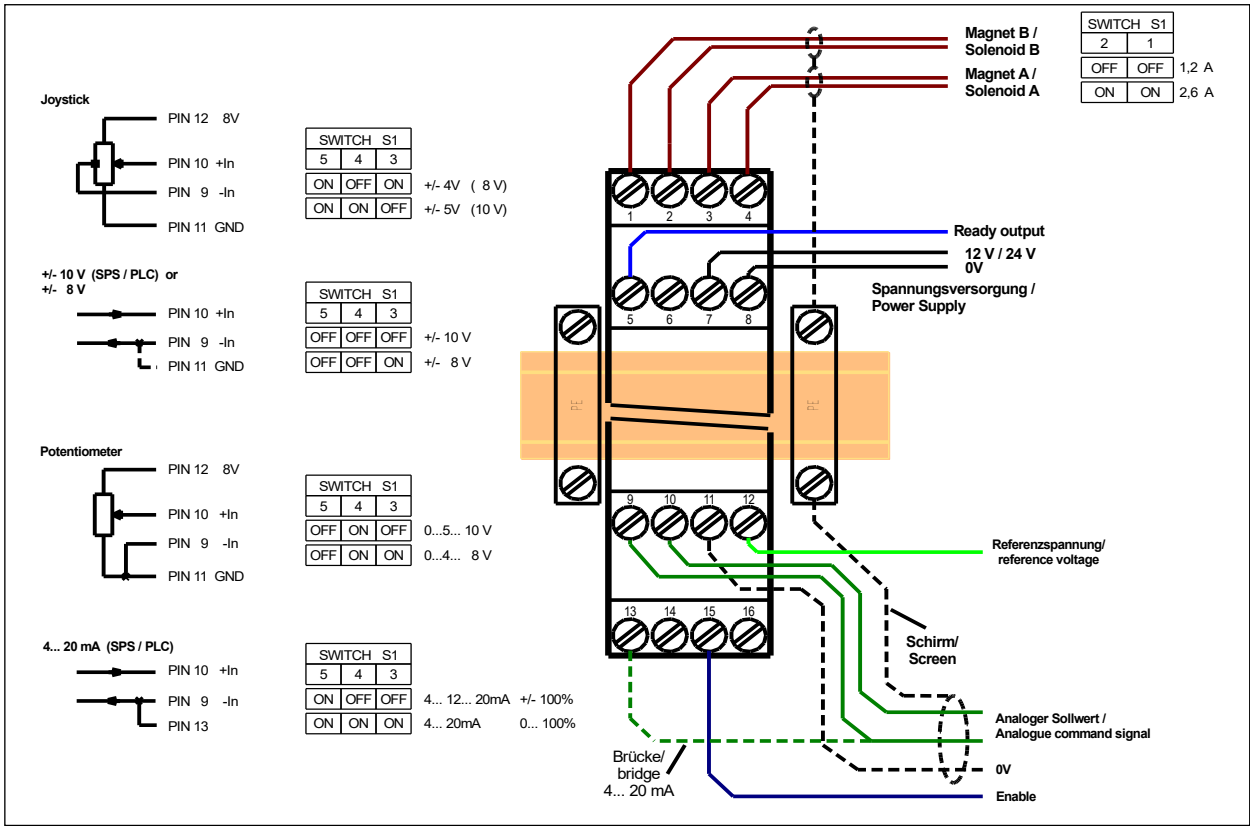
## 4.2 LED definitions

| LEDs | Description of the LED function |
|---|---|
| GREEN | Identical to the READY output.<br>**OFF:** No power supply or ENABLE is not activated<br>**ON:** System is ready for operation<br>**Flashing:** Error detected. |
| YELLOW A / B | **ON:** Related solenoid is activated.<br>**OFF:** Solenoid not active. |

## 4.3 Circuit diagram



## 4.4 Typical wiring




Caution: if using 4… 20 mA command signal PIN 9 has to be connected to PIN 13.

For unipolar voltage signal PIN 9 has to be connected to PIN 11.

## 4.5 Technical data

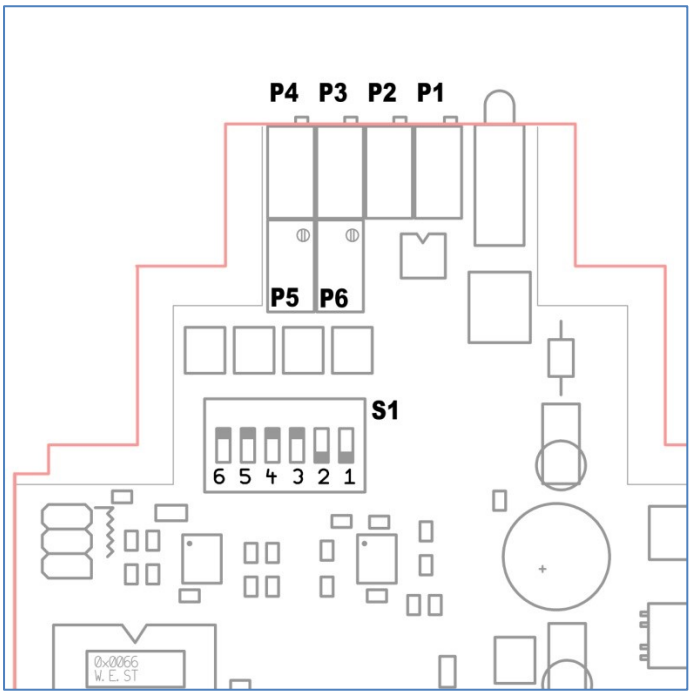
| | | |
|---|---|---|
| Supply voltage (Ub)<br>Current consumption<br>External fuse | **[VDC]**<br>**[mA]**<br>**[A]** | 12… 30 (incl. ripple)<br>30 + solenoid current<br>3 medium time lag |
| Reference output<br>Voltage<br>Max. load | <br>**[V]**<br>**[mA]** | <br>8<br>10 |
| Digital inputs<br>OFF<br>ON<br>Input resistance | <br>**[V]**<br>**[V]**<br>**[kOhm]** | <br>< 2<br>> 10<br>25 |
| Digital outputs<br>OFF<br>ON<br>Max. output current | <br>**[V]**<br>**[V]**<br>**[mA]** | <br>< 2<br>max. Ub<br>50 |
| Analog inputs:<br>Voltage<br>Input resistance<br>Signal resolution<br>Current<br>Burden<br>Signal resolution | <br>**[V]**<br>**[kOhm]**<br>**[%]**<br>**[mA]**<br>**[Ohm]**<br>**[%]** | Unipolar / differential<br>0… 10 / -10… 10<br>min. 90<br>0.1<br>4… 20<br>390<br>0.135 |
| PWM output<br>Max. output current<br>Frequency | <br>**[A]**<br>**[Hz]** | Wire break and short circuit monitored<br>2.6<br>80… 340 or 2000 |
| Sample times<br>Solenoid current control<br>Signal processing | <br>**[µs]**<br>**[ms]** | <br>167<br>1 |
| Housing<br>Material<br>Flammability class | <br>**-**<br>**-** | Snap-on module acc. EN 50022<br>PA 6.6 polyamide<br>V0 (UL94) |
| Weight | **[kg]** | 0,170 |
| Protection class<br>Temperature range<br>Storage temperature<br>Humidity | **[IP]**<br>**[°C]**<br>**[°C]**<br>**[%]** | 20<br>-20… 60<br>-20 …70<br><95 (not condensing) |
| Connections<br>Plug connectors<br>PE | | <br>4pol. screw terminals<br>direct via DIN rail |
| EMC | | EN 61000-6-2: 8/2005<br>EN 61000-6-4: 6/2007 + A1:2011 |

# 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<br>MIN:B | 0<br>0 | %<br>% | Compensation of the dead band. |
| MAX:A<br>MAX:B | 100<br>100 | %<br>% | 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



## 5.3 Parameter description

### 5.3.1 AIN (Analogue input scaling)

| S1.3 | S1.4 | S1.5 | Input signal |
|---|---|---|---|
| OFF | OFF | OFF | ± 10 V for ± 100% |
| ON | OFF | OFF | ± 8 V for ± 100% |
| OFF | ON | OFF | 0… 5… 10 V for -100%… 0… 100% |
| ON | ON | OFF | 0… 4… 8 V for -100%… 0… 100% |
| OFF | OFF | ON | 4… 12… 20 mA for -100%… 0… 100% |
| ON | OFF | ON | ± 4 V for ± 100% |
| OFF | ON | ON | ± 5 V for ± 100% |
| ON | ON | ON | 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 | P6 | 100… 15000 | ms |

Turning clockwise will effect longer time for taking over a new command value.

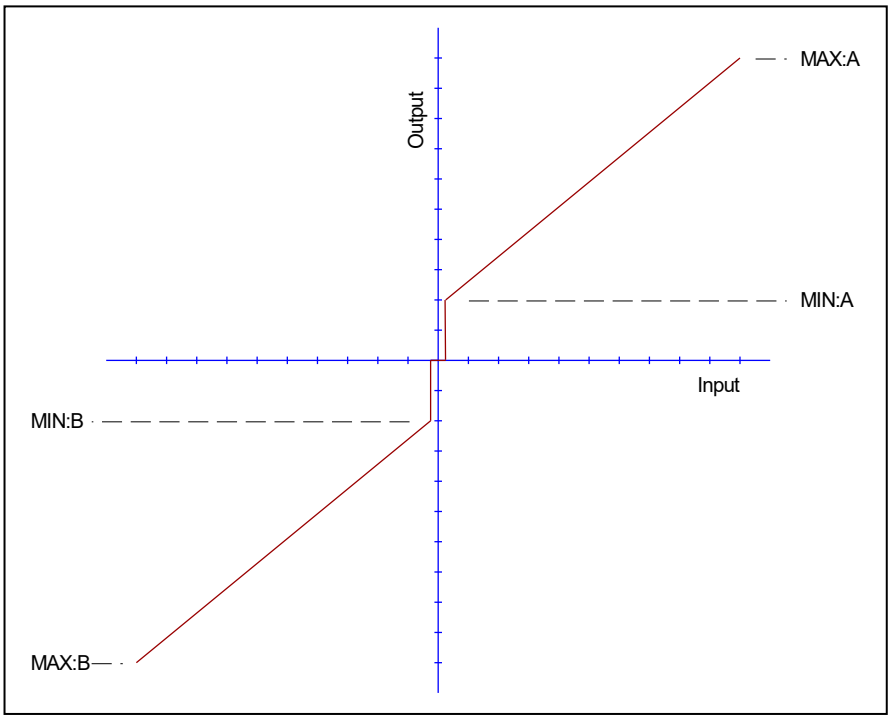
### 5.3.3 MIN (Dead band compensation)

### 5.3.4 MAX (output scaling)

| Parameter | Potentiometer | Range | Unit |
|---|---|---|---|
| MIN:A | P1 | 0… 60 | % |
| MIN:B | P2 | 0… 60 | % |
| MAX:A | P3 | 40… 100 | % |
| MAX:B | P4 | 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 | S1.1 | S1.2 | Nominal (maximum) current | Unit |
|---|---|---|---|---|
| 0 | OFF | OFF | 1 | A |
| 1 | ON | ON | 2,6 | A |

The nominal current range is set by these DIL switches. The DITHER and also the MIN/MAX parameter 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 S1.6 | P5 | PWM-Frequenz | Ditherfrequenz | 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 (P3 and P4). The maximum output current can be set from about 40% to 100% of the rated current range..

**MIN:** Zero- / deadband adjustment (P1 and P2). 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 (P6, 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 (S1.6 = 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 (S1.6 = 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<br>4...20 mA | Out of range | The power stage is deactivated. |
| Solenoid A PIN 3 / 4<br>Solenoid B PIN 1 / 2 | Broken wire | The power stage is deactivated. |

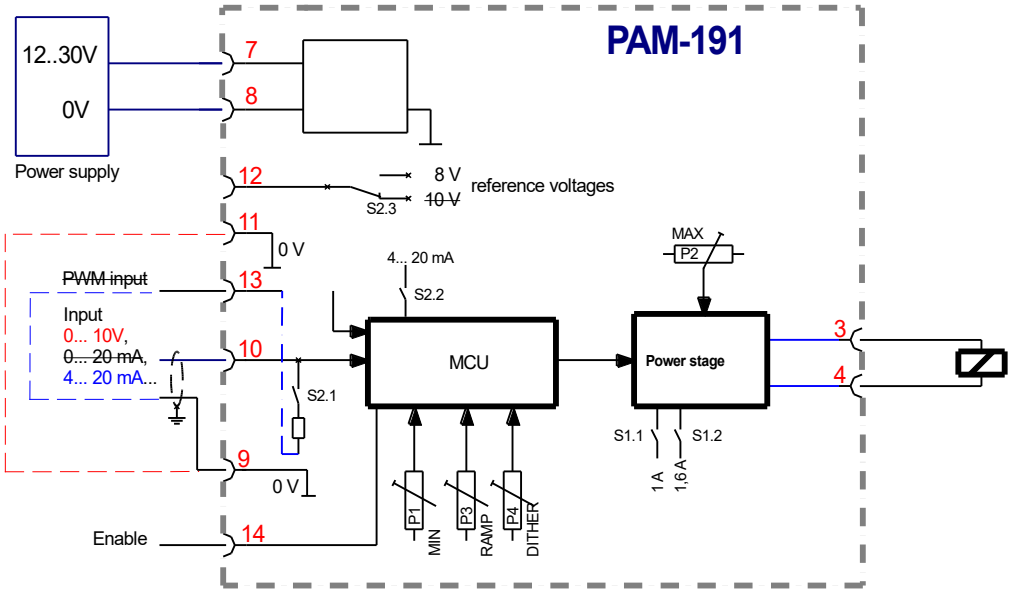
## 7.2 Troubleshooting

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

## 7.3 Replacements / compatibility

The PAM-191 and the PAM-192 are replaced by the PAM-193. If using the module as spare parts for older ones the wiring has to be adapted. It also has to be paid attention to the different configuration of the DIL-switches and potentiometers.

### 7.3.1 PAM-191




Changes (PAM-193 / PAM-191)

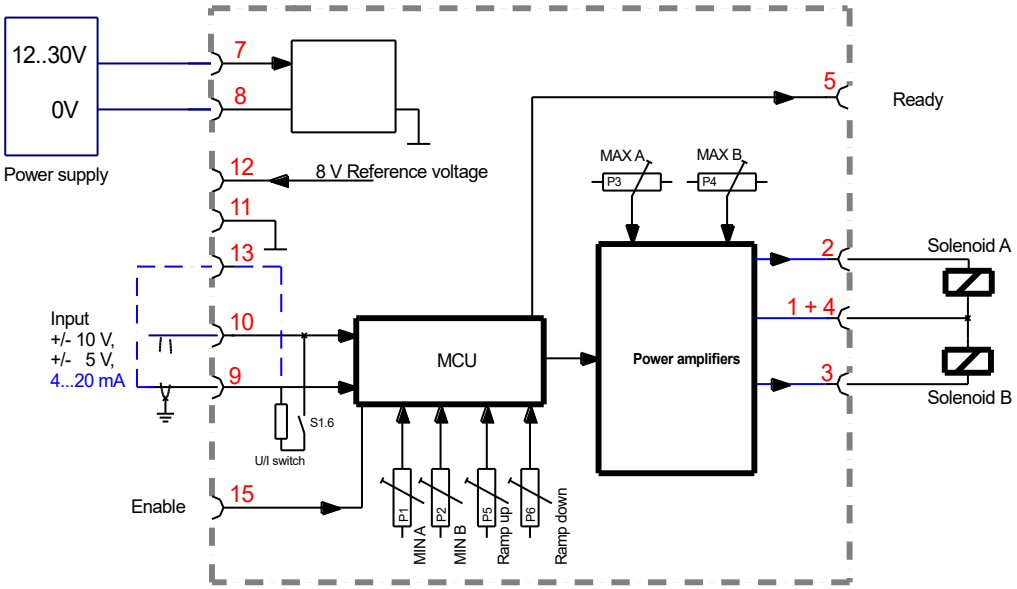
Wiring:

1. PIN 9 and PIN 10 are realized as differential input. For using unipolar voltage signals PIN 9 has to be connected with PIN 11.
2. The input resistor for current signals can't be switched on by DIL-switch anymore, but has to be activated by connecting PIN 9 and PIN 13.

Adjustment:

3. Reference voltage on PIN 12 is 8 V and not changeable anymore. Further function is still possible by different signal ranges adjustable via DIL-switches.
4. There are now only two output current ranges available: 1,2 A and 2,6 A. Default setting remains 1 A. For significant lower currents the L-Version with half output current is available.
5. The function, position and name of the potentiometers and DIL-switches partially have changed, (have a look at 5.1 und 5.2 in this documentation).

## 7.3.2 PAM-192




Changes (PAM-192 / PAM-193)

Wiring:

1. The input resistor for current signals can't be switched on by DIL-switch anymore, but has to be activated by connecting PIN 9 and PIN 13.

2. **CAUTION: Solenoid A and solenoid B have to be swapped.**

Adjustment:

3. There are now only two output current ranges available: 1,2 A and 2,6 A. Default setting remains 1 A. For significant lower currents the L-Version with half output current is available.
4. The function, position and name of the potentiometers and DIL-switches partially have changed, (have a look at 5.1 und 5.2 in this documentation).

## 7.3.3 Special versions

These special versions can be replaced by the PAM-193:

| | |
|---|---|
| PAM-191-*-S1 (PWM = 100Hz) | = PAM-193-P |
| PAM-191-*-S2 (PWM = 100Hz) | = PAM-193-L |
| PAM-192-*-S1 (PWM = 100Hz) | = PAM-193-L |
| PAM-192-*-S2 (PWM = 135Hz) | = PAM-193-L |

PAM-191-P-S3 (MIN directly active) = PAM-193-P-S3

# 8 Notes