1. General
1.1 Brief description and circuitry

Compact amplifier with good price/performance ratio for the actuation of proportional valves using one single acting proportional solenoid only.

Main components:
- Voltage regulator generating a stabilized voltage of 5V DC
- Linear ramp generator (Integrator)
- Current-regulated, pulse width modulated voltage output (PWM), and short-circuit protected final stage

Main features:
- Low hysteresis of the actuated proportional valve
- Adjustable Imin, Imax, frequency and ramp time (up- and downwards together)
- Dither effect due to the low frequency of the final stage
- Reverse voltage protection of the power supply, proper connection indicated by a green LED
- Provision for retrofitting of a filter capacitor (optional)
- Wide power supply voltage range

This module features screw terminals plus 2 x 6.3 mm blade terminals for an external filter capacitor. The performance of this amplifier enables connection of all HAWE proportional valves with one single acting proportional solenoid.

2. Available version, type coding key
2.1 Order coding

Basic type coding for electronic amplifier
For one prop. solenoid only
Design with housing, screw and blade terminals
Construction and development version (internal coding)
Supply voltage 9 to 32 VDC
2.2 Technical data

2.2.1 General parameters

Nomenclature: Electronic amplifier for proportional solenoids
Design: Module with housing, featuring screw and blade terminals
Connection wiring: max. 1.5 mm²
Blade terminals: 6.3 or 2.8 mm (AMP-Faston) for optional, external filter capacitor
Fastening: To be clicked on 35 mm mounting rail (EN 50 022) or 32 mm (EN 50 035) or 15 mm (EN 50 045)
Protection class DIN EN 60529 resp. IEC 60529: IP 20 (intended for installation in a cabinet)
Installed position: Any
Mass (weight): approx. 90 g
Ambient temperature: -20 ... 50°C (up to +70°C, derating to 75% of the max. current output Iₐ)

2.2.2 Electrical parameters

Voltage supply: Uᵦ 9 ... 32V DC
Max. ripple factor: w 10%
Minimum filter capacitor: Cᵦ 2200 µF per 1 A coil current
Voltage output: Uᵦ -1.2V DC (pulse width modulated)
Current output: Iᵦ max. 2.2 A
Adjustable range: Iᵦ: 0.05 ... 0.5 A; Iᵦ: 0.3 ... 2.2 A
Pre-set by HAWE: Iᵦ: 0.05 A; Iᵦ: 1 A
Power consumption: Iᵢₐ approx. 30 mA (internal)
Set-point voltage range: Uᵦ 0 ... 5V DC
Input impedance: Rᵦ > 200 kΩ
Set-point potentiometer: Rᵦ min. 2.2 kΩ; max. 10 kΩ; load capacity min. 0.1W
Reference voltage: Uᵦ + 5V DC ±5%
Max. load capacity: 5 mA (stabilized voltage for the set-point potentiometer)
Ramp time, up and down: tᵦ Set simultaneously 0.3 ... 10 s (linear ramp)
Pre-set by HAWE: 0.3 s
Dither frequency: f Adjustment range 50 ... 200 Hz
Pre-set by HAWE: 80 Hz

2.2.3 Electro-magnetic compatibility (EMC)

The electro-magnetic compatibility has been tested by an accredited approval institute (criteria "B": Interference emission acc. to EN 50 081 and interference immunity acc. to EN 50 082). This EMC test doesn’t relieve the user from the proper execution of a specified EMC check for his complete system (accordingly to regulation 89/336/EWG), since the test assemblies represent only a typical application. The following measures should be checked, if the EMC of the complete system must be strengthened further:
- The required filter capacitor (see sect. 2.2.2) is not only necessary for flawless performance of the device, but also to ensure compliance of the EMC (wire bound interference emission)
- The equipment should be installed in a metal cabinet (shielding)
- All cables, leading in or out of the device should be kept as short as possible. The should be also be shielded and twisted in pairs. (This will reduce the antenna effect and increase the interference immunity).

3. Unit dimensions

All dimensions in mm, subject to change without notice!

[Diagram of unit dimensions and terminal connections]
4. Mounting and adjustment instructions

4.1 Adjustment manual

Attention: The externally supplied voltage must not become negative! Negative voltage can cause malfunctions and ultimately lead to the destruction of the proportional amplifier. If the maximum allowed voltage of 5V DC is exceeded, the set point for current $I_{\text{max}}$ or $I_{\text{max oper}}$ will become ineffective. As a result of this $I_{\text{max}}$ or $I_{\text{max oper}}$ will increase above the set limit.

When the connecting cable is longer than 3 m, a twisted-pair cable should be used to minimise noise and to increase interference protection.

The maximum inductive current $I_{\text{max}}$ is not allowed to exceed the value of $I_{\text{Lim}}$ for the proportional magnet for any length of time, as this could cause a thermal overload and ultimately cause the solenoid to fail.

- **F1** = Fuse 2.5 A (medium time lag)
- **A1** = Amp-meter for measuring the coil current
- **P1** = Set-point potentiometer 2 - 10 kΩ (e.g. wire wound potentiometer 10 kΩ, 2 W)
- **V1** = Voltmeter to the measuring of the set-point voltage

Amplifier Connection:
- Connect an electrolyt condensor, if required, with correct polarity to blade terminals 7 and 8 (see also sect. 4.2).
- Proportional solenoid to screw terminals 1 and 3
- Connect the amp-meter A1 in series (measuring the coil current)
- Connect set-point potentiometer to screw terminals 4, 5, and 6
- Connect power supply to terminals 1 and 2

1. **Adjust the set-point potentiometer to minimum (0 V) for step 6** (GND side: terminal 4)
2. **Adjust the set-point potentiometer to maximum for step 8.** Read the set-point voltage at volt-meter V2. (approx. 5 V)
3. **Switch-on power supply** (green LED emits)
4. **Set ramp times $t_{\text{up}}$ and $t_{\text{down}}$ to minimum** (turn ramp potentiometer anti-clockwise until reaching the end position. Potentiometer 25 turns)
5. **Readjust dither frequency, if necessary**
   - (only if a frequency-meter is available, otherwise do not alter the pre-setting!)
6. **Set $I_{\text{min oper}}$ -potentiometer to the minimum current $I_{\text{min oper}}$ which corresponds to the desired low point according to the Q-I- or $\Delta \text{p-I}$-characteristic line of the proportional valve; for the adjustable $I_{\text{min oper}}$ range refer to section 2.2.2; $I_{\text{min oper}}$ can be read off the amp-meter A1**
7. **Adjust the set-point potentiometer to minimum**
8. **Set $I_{\text{max oper}}$-potentiometer to the maximum current $I_{\text{max oper}}$ which corresponds to the desired high point according to the Q-I- or $\Delta \text{p-I}$-characteristic line of the proportional valve; for the adjustable $I_{\text{max oper}}$ range refer to section 2.2.2.**
9. The dither frequency $f$ is factory-set to 80 Hz. This is sufficient for most cases. It can be readjusted but this should be always monitored frequency meter or an oscilloscope.
   - When this is not available the correct dither amplitude can be determined by turning the dither-potentiometer clockwise until vibrations on the proportional valve can just be felt but without it beginning to cause disturbances (potentiometer 25 turns).
10. **Adjust the ramp time $t_{R}$ to the desired rate.** The ramp times are always valid for the total range of the set-point voltage (5 VDC).
11. **Check the adjusted parameter $I_{\text{min oper}}$ (step 6) is at $U_{\text{Soll}} = 0$V DC; $I_{\text{max oper}}$ (step 8) at $U_{\text{Soll}} = 5$V DC; dither frequency (step 9) and ramp times (step 10) if necessary repeat the calibration.**
12. **Other notes**
   - Always check the power supply first, when any difficulties appear during calibration or initial operation
   - For bridge rectification, check if an electrolytic filter capacitor of at least 2200 µF/A coil current is connected in parallel to the terminals 7 and 8.
   - Check that the supply voltage is high enough for the prop. amplifier. The supply voltage should be about 2V DC higher than would be necessary to generate the set maximum current $I_{\text{max oper}}$ with a warmed up coil without the proportional amplifier.

It is possible to use coils for 12V for proportional amplifiers of 24V DC rated value supply voltage. In this case the supply voltage is transferred automatically to 12V-level with low losses via the PWM output for the valve. It is vital to make sure that the permissible maximum output current $I_{A}$ for the proportional amplifier and the limiting current $I_{\text{Lim}}$ for the field coil are not exceeded!

Advantages: As the proportional valve is operated above its nom. voltage rating (i.e. from 12 to 32V DC), its response time will be reduced and therefore the hydraulic systems can work faster.
4.2 Use of an external filter capacitors

The blade terminals 7 and 8 at the proportional amplifier type EV1G1 12/24 serve to connect an external filter capacitors. In most cases these terminals remain however unused.

In some cases, however, they can be very useful. In case of inadequate smoothing of the supply voltage it can be smoothened sufficiently for use with prop. amplifiers by means of an electrolytic capacitor connected directly at + and - terminals of the power supply. The capacity of the condensor should be 2200 µF per 1 A load. The load on the power supply may be rather high if it covers also other solenoids even if these do not require a smoothened voltage. When using the proportional amplifier type EV1G1-12/24 this capacity of the filters capacitor can be reduced to the actual demand of the prop. solenoids. The circuitry (page 1) illustrates that the capacitor is connected after the reverse polarity protection diode. This way the smoothing for the prop. amplifier is separated from the smoothing for other consumers. Therefore the required capacity can be kept at a minimum.

5. Example circuits

5.1 Control of hydraulic valves with a proportional solenoid

Example a: Operation with external set point potentiometer
F1 = Fuse; 2.5 A (medium time lag, max. 3 x I_n)
P1 = Set-point potentiometer 10 kΩ, min. 0.1 W

Example b: With set point switch for the two adjusted set points I_{min oper} and I_{max oper}
F1 = like example a

Example c: Operation with priority switch for four set-point figures (relais circuit)
Example:
Rapid traverse 1 - K1 → P1
Rapid traverse 2 - K2 → P2
Creeping - K3 → P3
Stop - K1 → K2 → K3 → \perp
F1 = like example a

Example d: Operation via external current output signal e.g. SPS, CNC or PC
Attention: Observe the max. load rating of the current source!
F1 = like example a
Rx = 250 Ω/ 0.5 W

Example e: Operation via external voltage output signal e.g. SPS, CNC or PC
Attention: The set max. output current will rise, if the maximum allowed voltage of 5V DC is exceeded at the terminal of the prop. amplifier. The connected solenoids may be damaged or destroyed due to overheat!
F1 = like example a