Electronic amplifier type EV1D

for controlling proportional valves
Modular design, connection via plug with spring-cage terminal blocks

1. General

The amplifier card EV1D is designed for the control of single hydraulic solenoid valves. It converts the voltage input signal (0-10 V / 0-5 V) in a corresponding control current for the proportional solenoid.

The amplifier is suited for all HAWE proportional solenoids, when using solenoids of alternative makes the peak values for current and voltage specified by the respective manufacturer have to be taken into account.

All internal control processes are performed by a microprocessor. The setting of parameters is via four push buttons and 2-digit LED-display.

1.1 Brief description, circuitry and terminal assignment

Min. and max. current for the valve, ramp time for opening and closing, frequency and amplitude of an overlaid dither (minimizing the valve hysteresis) can be freely adjusted.

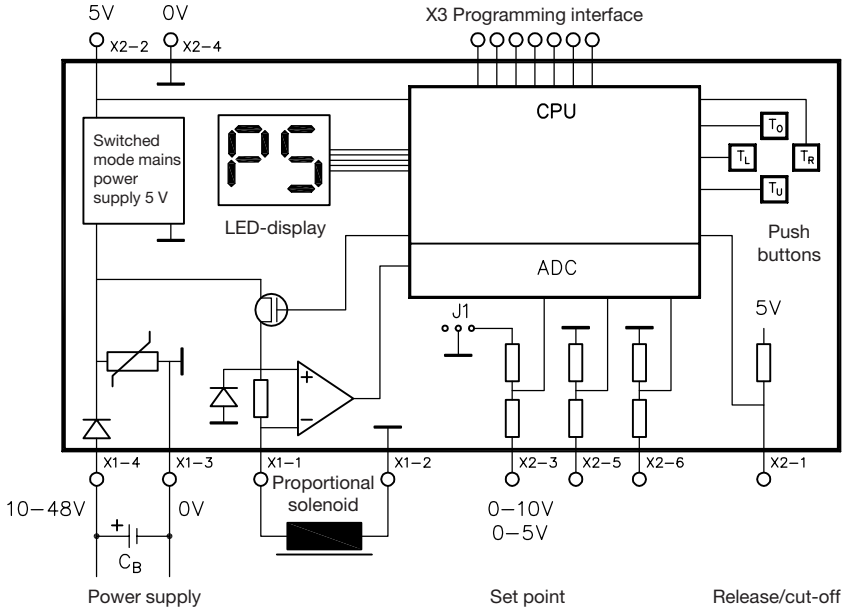
An overview of essential internal components is given in the circuitry diagram.

The amplifier card EV1D is connected via two separate plugs X1 (power), X2 (signal). For more details and terminal assignment, see sect. 3.1.

The external deactivation input X2-1 can be employed to switch-off the output of the amplifier card. When connected to GND the output side will be deactivated otherwise it will remain active.

There are also two additional voltage inputs X2-5, X2-6 (0-10 V) reserved for future special purposes. A reference voltage of 5 V can be picked-up at outputs X2-2 / X2-4 for joy-sticks or external potentiometers.

Block diagram



2. Available versions , type coding

A card holder, as specified in sect. 2.3, must be ordered as an accessory for each module as specified in sect. 2.1, since this is essential to securely fasten the module on the 35 mm or 32 mm support bar. The module board is very compact, there for it does not feature any pre-drilled holes, etc. for any other kind of fastening (for example on bold rods). It is also available as a complete module (module incl. card holder).

2.1 Module

Order coding: **EV 1 D1**

Basic type

Digital version

Single-action proportional solenoid control

2.2 Complete module - module including card holder

Order coding: **EV 1 D1 - KM**

Module, see sect. 2.1

Module card holder, see sect. 2.3

2.3 Accessories for assembly

Order coding: **KM 7831 010**

Module card holder

Internal drawing number

2.4 Specifications

2.4.1 General data

Nomenclature	Electronic amplifier
Design	Module with plugs
Connection leads	max. 1.5 mm²
Fastening	Only via card holder (accessory) on 35 mm standardized support bars to DIN EN 50 022 or 32 mm support bard to DIN EN 50 035
Installation position	Any
Mass (weight)	Module 40 g; card holder 40 g
Protection class conf. IEC 60529	IP 00
Ambient temperature	-20 ... +60°C

2.4.2 Electrical data

Supply voltage	U_B	10 ... 48 V
max. perm. ripple factor	w	10% (ripple)
Required filter capacito	C_B	2200 µF per 1 A induction current
Output voltage	U_A	U_B - 0.7 V DC, pulse-width modulated
Output current	I_A	max. 0 ... 2 A short circuit proof protect.
Setting range	I_{min} I_{max}	0 ... 2 A 0 ... 2 A pre-setting I_{min} = 0 A; I_{max} = 2 A
No-load current	I_L	max. 70 mA (own consumption)
Voltage ranges	$U_{nom.}$	adjustable, select 0 ... 5 V DC or 0 ... 10 V DC Pre-setting: 0 ...10 V DC
Reference voltage	U_{St}	5 V DC ±4% load capacity max. 5 mA (stabilized voltage to supply potentiometer P 1)
Input resistance	R	>50 kΩ
Recommended potentiom.	P	from 2 kΩ up 10 kΩ
Ramp time rise-fall	t_R	0.1 ... 10 s
(Rampe linear)		Ramp, linear rise time and fall time separately adjustable factory pre-setting: 0.1 s for both (minimum)
Enable/disable input		TTL compatible or can be triggered with a contact (if blank release output)
Dither frequency	f	50 ... 100 Hz

2.4.3 Electro-magnetic compatibility (EMV)

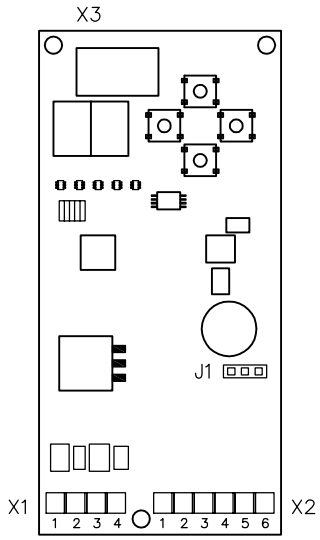
The electro-magnetic compatibility has been tested by an accredited approval institute (criteria „B“: Interference emission acc. to DIN EN 50 081 and interference immunity acc. to DIN EN 50 082). This EMC test doesn‘t relieve the user from the proper execution of a specified EMV check for his complete system (accordingly to regulation 89/336/EWG), since the test assemblies represent only a typical application. The following measures should be checked, if the EMV of the complete system must be strengthened further:

- The required filter capacitor (see sect. 2.4.2) is not only necessary for flawless performance of the device, but also to ensure compliance of the EMV (wire bound interference emission)
- The equipment should be installed in an 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. Dimesions

All dimensions are in mm, subject to change without notice!

3.1 Printed circuit



Plan of terminal connections:

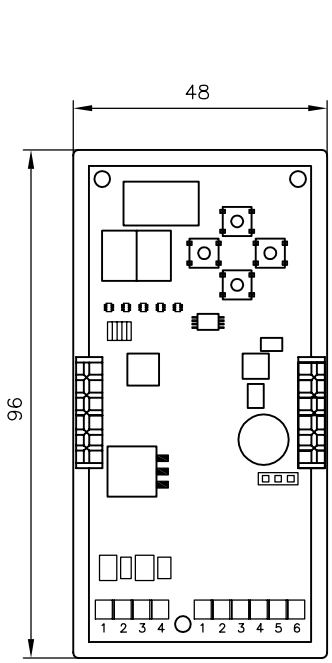
X1-1	+ solenoid
X1-2	- solenoid
X1-3	0 V, power GND
X1-4	10 - 48 V supply voltage
X2-1	enable/disable input
X2-2	Output 5 V
X2-3	reference input 0 - 5 V / 0 - 10 V
X2-4	0 V, analog GND
X2-5, X2-6	Auxiliary inputs
X3	Programming interface

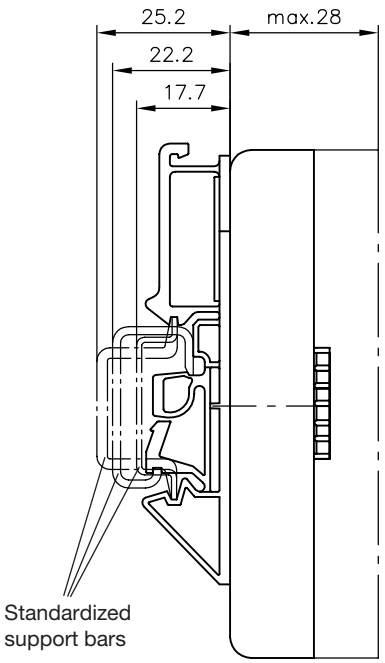
J1 (jumper)

10 V

5 V

3.2 Printed circuit fitted in card holder





See above for description of printed circuit

Assembly of card holder see sect. 6

4. Operation, parameter setting and adjustment

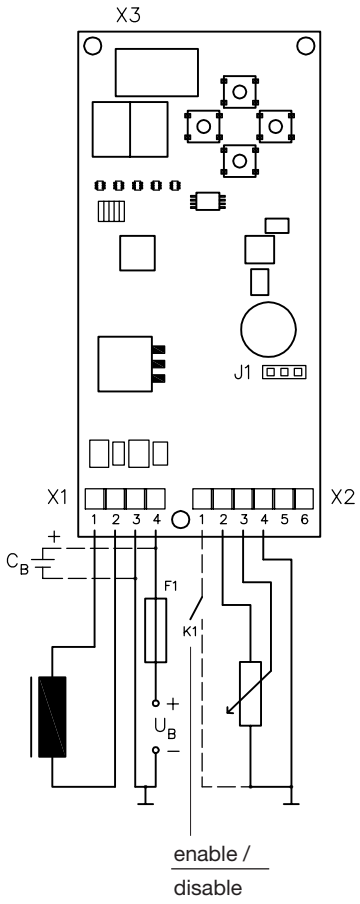
4.1 Display and push buttons

4.1.1 General

All operations can be performed via the push buttons, buttons are named top, bottom, left and right (according to the usual mounting position, terminals bottom side). The user can select the parameter to be adjusted via navigation through the menue. The values (normalized) will show at the display and can be altered via the push buttons. All altered parameters will be active at once, giving immediate feed-back to changes of this newly selected setting.
A confirmation via the push-button is required to save this new setting. Otherwise, the adjustment routine is aborted after 10 sec and all parameter setting will be as before.

For details of the operation and the menue structure are detailed in the following.

Block diagram



F1 - Fusc 2.5 A (medium slow)
C_B - Smoothing capacitor

4.1.2 Display

The 2-digit display is the user interface. It shows:

- Current state in %
- Parameter values
- Parameter No.
- Error codes

The operation state is the standard condition, i.e. the card is fed with a reference control voltage which is converted to a control current for the solenoid coils and the current reference value is displayed. In case an error occurs it will be displayed alternatingly (frequency approx. 1.5 sec) with the current reference value (see also sect. 4.3). Current reference value and error code are not displayed during parameter setting routine as long as the routine is not left.

4.1.3 Jumper

The input voltage range can be set via jumper J1 between 5 and 10 V, default setting is 10 V (see also sect. 3.1).

4.2 Menue architecture

The user parameter settings can be displayed/altered via the menue. All changes are immediately active (like with adjustments via a potentiometer) but all changes need to be confirmed before they are saved in the permanent memory of the card.

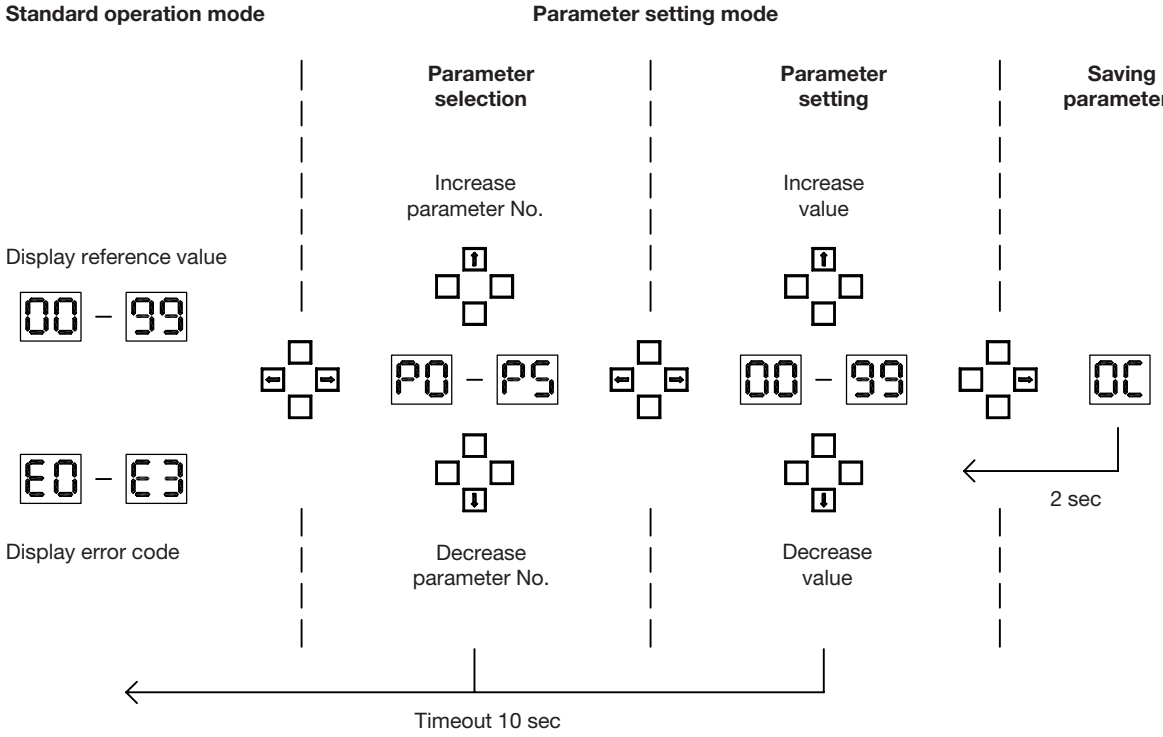
4.2.1 Operation modes

There are two different operation modes: Standard operation and parameter setting mode. Current set-point value and possibly error codes are displayed during standard operation mode. There will be a switch from standard operation to Parameter setting mode when the „right“ button is pressed for more than 2 sec. For more information, see sect. 4.2.2

4.2.2 Navigation

Right and left button serve for navigation within the menue. The right button brings more deep, whereas the left brings you upwards in the menue. The buttons top and bottom serve to increase/decrease values.

Illustr.: Menue architecture



When in „Normal operation mode“ pressing the right button more long will leads to a change into Parameter operation mode“ – display shows P0. Parameter set P0 - P4 can be selected via the buttons top/bottom. For changing the setting of the selected parameter set press the right button – the display shows the standardized value. For more details about the individual parameters, see sect. 4.2.3.

The current parameter value can be altered via buttons top/button. All changes are immediately adopted to the control algorithm i.e. the response accordingly at once.

These changes will saved in the permanent memory of the card, when the right button is pressed more long – the display will show 0C. The previous settings will be valid again, if the parameter setting menue is left by pressing the left button, bringing you back to the normal operation mode.

4.2.3 User parameter

Table 1:

Parameter	Coding		min	max	Default	Standardization
P0	Min. current	I_{min}	0	99	0	20 mA / Incremental
P1	Max. current	I_{max}	0	99	50	20 mA / Incremental
P2	Ramp time up	T_{auf}	1	99	10	100 ms / Incremental
P3	Ramp time down	T_{ab}	1	99	10	100 ms / Incremental
P4	Dither amplitude	A_d	1	99	0	%
P5	Dither frequency (Dither period)	f_d (T_d)	20 (50)	100 (10)	50 (20)	Hz (ms)

Attention: The parameters can be only adjusted in discrete steps via the push buttons. Table 1 additionally lists the conversion factors an increment for the individual parameters.

Minimal and maximum current (P0, P1)

The card is adjusted to the working range of the valve via parameter P0 (I_{min}) and P1 (I_{max}). I_{min} is the current necessary to start opening up the valve (start of flow) whereas I_{max} corresponds to the current when the valve is completely open (max. flow). The equation below shows the ratio between input voltage to output current:

$$I_{out} = I_{min} + (I_{max} - I_{min}) \cdot \frac{U_{in}}{U_{ref}} .$$

U_{in} is the input voltage defined as set point and U_{ref} is the reference voltage (5 V / 10 V) defined via the corresponding jumper. The normalization in 20 mA increments leads to a max. value of 1980 mA.

Ramp time (P2, P3)

The current change per time (up/down) can be limited, if desired, via P2 (T_{up}) and P3 (T_{down}). Parameter P2 (T_{up}) defines the min. transition time from I_{min} to I_{max} whereas P3 (T_{down}) defines the min. transition time from I_{max} to I_{min}. The increment shown in the display is 100 ms i.e. the max. adjustable ramp time is 9.9 sec.

Dither amplitude, dither frequency (P4, P5)

The PWM (pulse width modulation) signal of the valve output features a superimposed dither. Both, frequency and amplitude are adjustable. The dither frequency is set via the parameter P5 (T_d = period duration) and the amplitude via parameter P4.

4.3 Error management

The error codes detected by the card are displayed only when in normal operation mode (not during parameter setting mode). In case an error occurs it will be displayed alternatingly (frequency approx. 1.5 sec) with the current reference value. When several errors are apparent only the highest will be displayed. These error code will be blinking as long as the error is detected.

4.3.1 Classification of out of normal states

An error is everything out of normal detected by the card (see table below). This includes also informative messages. The display can show error code E0 to E3, with E3 being the severest (highest).

Table 2:

Error code	Meaning	Counter measure
E0	External deactivation	Release deactivation input
E1	Idling, coil current too low	Check wiring of connected coil
E2	Excessive current, coil current too high	Check wiring of connected coil Replace amplifier card
E3	EEPROM error	Replace amplifier card

4.3.2 Error codes

Table 2 lists a brief description and cause of the possible error codes.

E0 – **External deactivation**

The card can be deactivated via the external deactivation input. Error code E0 is displayed and the output is cut-off independent of its ramp time setting, when a deactivation signal is received. As soon as the deactivation input is released, both error code message and deactivation are stopped.

E1 – **Idling, coil current too low**

The card can not deliver the desired current to the coil. The PWM output is activated but the measured current is below the set- point. Possible causes are:

- The voltage of the power supply is too low
- The resistance of the connected coil is too high (for the available voltage of the power supply)
- Broken wire to the coil
- Coil defective
- Final stage of the amplifier card is defective

E2 – **Excessive current, coil current too high**

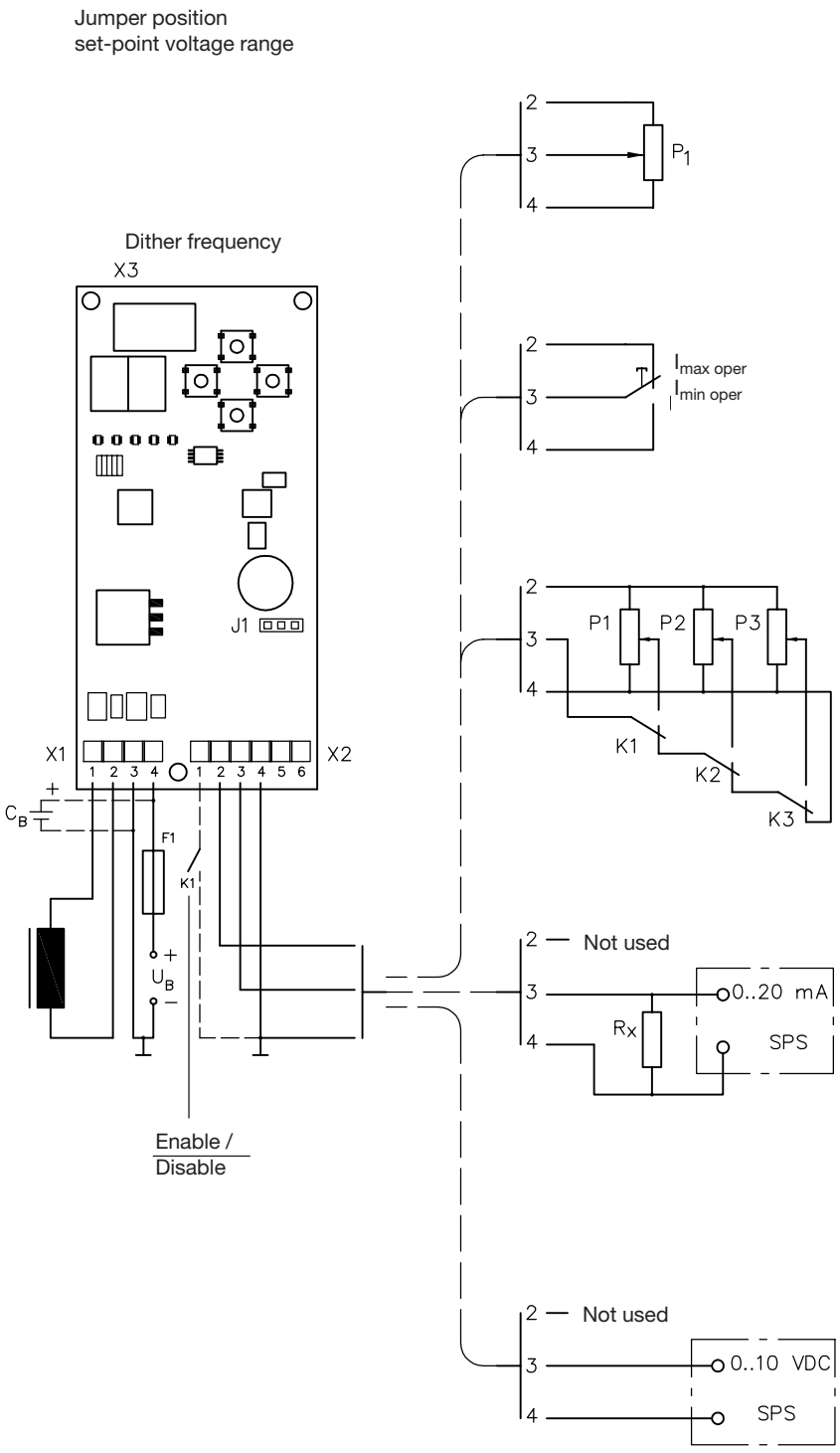
There is a short-cut in the coil circuit. Check weather the coil shows a winding short-cut i.e. resistance too low. Otherwise the final stage of the amplifier card may be defective and the amplifier card has to be replaced.

E3 – **EEPROM error**

Internal failure of the amplifier board, the data are no longer solid in the configuration memory. The card switches itself off automatically and has to be replaced.

5. Typical circuits

5.1 Use of a proportional solenoid to control hydraulic valves



Example a: Operation with an external set-point value potentiometer

F1 = medium-fast fuse; for nominal see sect. 4.1
C_B = smoothing capacitor
P1 = set-point value potentiometer 10 kΩ, min 0.1 W

Jumper J1  5 V DC

Example b: Operation with a set-point value switch for the two set-point values set $I_{min\ oper}$ and $I_{max\ oper}$

F1 = see example a above

Jumper J1  5 V DC

Example c: Operation with a priority-dependant set-point value switch for four set-point values (relay switch)

Typical example of operation:

Fast gear 1 -	K1 → P1
Fast gear 2 -	K2 → P2
Slow gear -	K3 → P3
Stop -	K1 → K2 → K3 → ⊥

F1 = see example a above

Jumper J1  5 V DC

Example d: Operation with external set-point value power source from SPS, CNC or PC

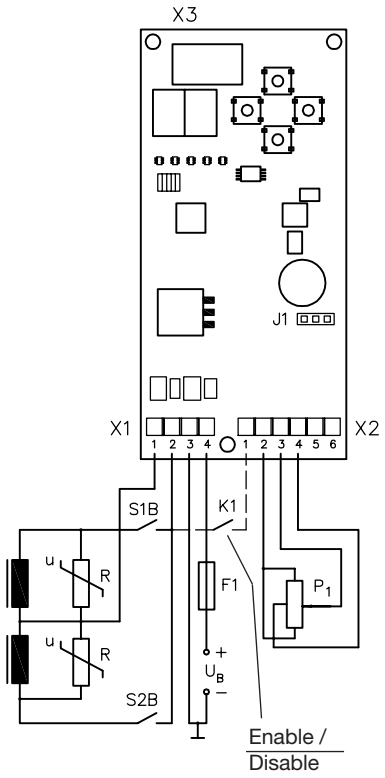
Important: Note the maximum load perm. for the power source

F1 = see example a
Rx = 250 Ω/ 0.5 W

Jumper J1  5 V DC

Jumper J1  10 V DC

5.2 Controlling hydraulic valves using one twin or two individual proportional solenoids for alternating operation



This mode of operation requires a remote-control potentiometer for central tapping and side recognition of two positively connected direct. switches SB 1 and SB 2 for solenoid coils 1 and 2

Example f: Controlling a proportional directional valve type PSL .. or PSV .. as specified in D 7700-..

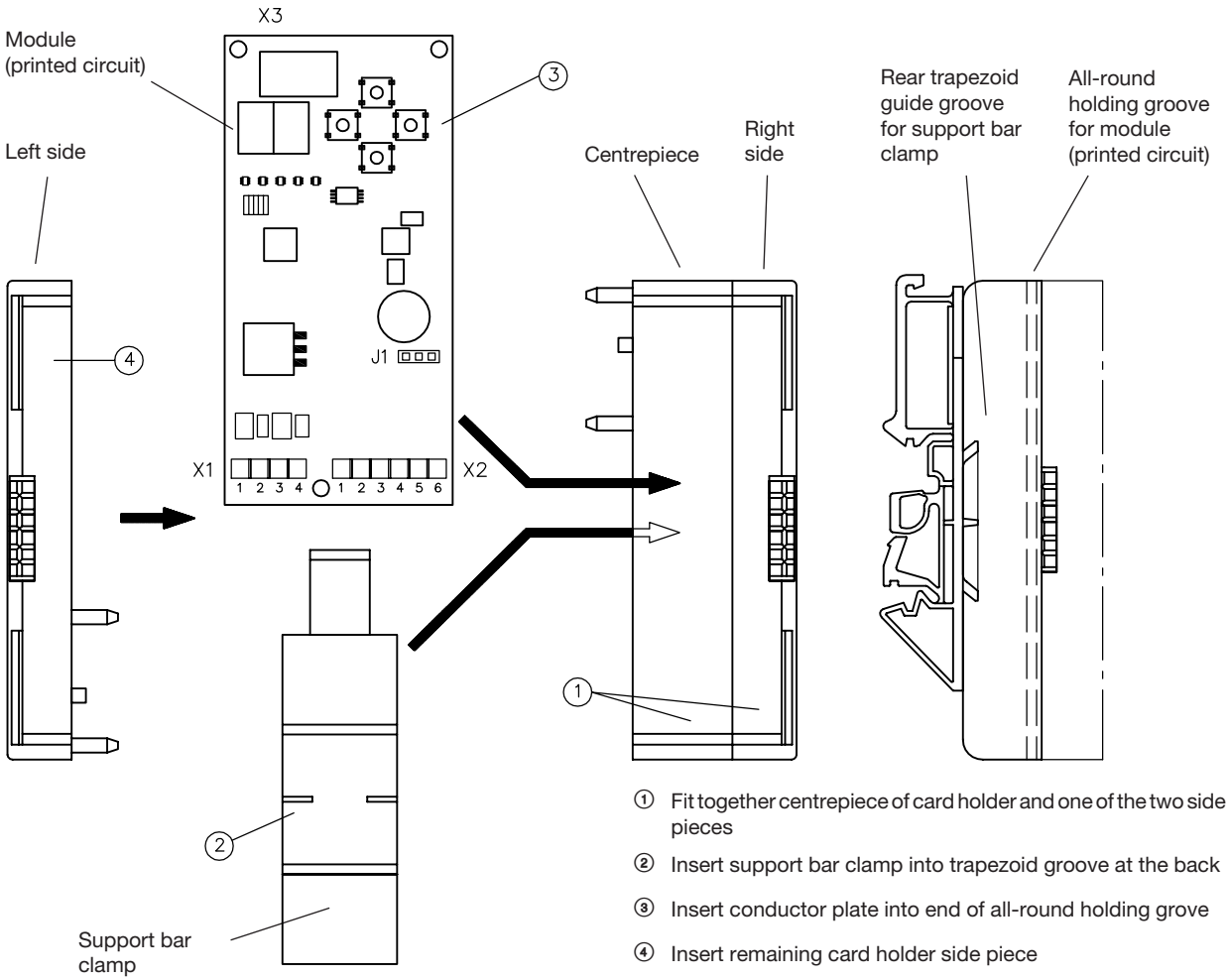
F1 = see example a above
P1 = Potentiometer with fixed central alignment, 2x5 kΩ
R = 31 V varistor, such as a Siemens SIOV-S05K25 or SIOV-S10K25 (against radio interference or excess voltage)
S1 B and S2 B = directional switches are included in the control gear for one axle

Jumper J1 

10 V 5 V

6. Appendix

6.1 Installation of printed circuit module on card holder



① Fit together centrepiece of card holder and one of the two side pieces

② Insert support bar clamp into trapezoid groove at the back

③ Insert conductor plate into end of all-round holding grove

④ Insert remaining card holder side piece