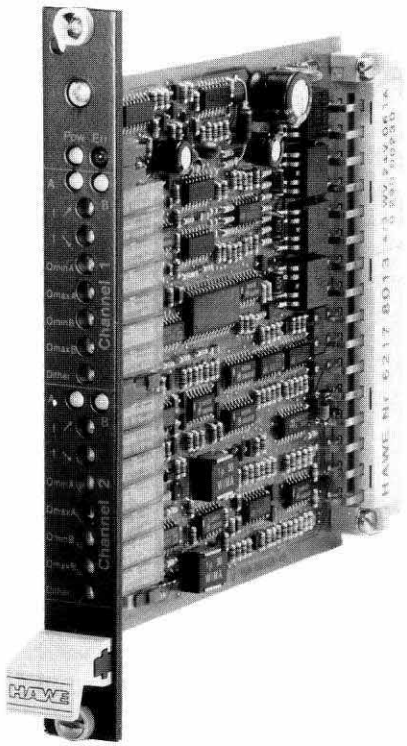
Electronic Amplifier Type EV 22K1-12 and EV 22K1-24

for control of proportional valves
design of board with connector terminal strip to DIN 41 612 D32



1. General

1.1. Brief description

The amplifier board is equipped with two proportional amplifiers operating independently of each other with very good regulating accuracy. It enables 3/3 or 4/3 way proportional valves to be controlled simultaneously, each valve being equipped with a twin-proportional-solenoid or two individual proportional solenoids for alternating drive of the switch position a or b. Thus the amplifier board is primarily intended for electrical control of either two proportional directional control spool valves type PSL(V)... with I or I/0 operation per D 7700-... or type SKS... (D 5700, D 5700 H and D 5700 K) with HEP operation to D 7615.
Control of lifting modules type HMC 2 and HMC 3 to D 7650 is likewise possible. Each of the two individual solenoids of the proportional flow control valves called upon alternately for lifting and lowering is connected to one half of the board, with the second remaining unused.
If there are two individual solenoids in place of a twin solenoid, one connection of each, e.g. No.1, should be jointly connected to a common connection (earth) on the terminal strip of the board casing.
For remote operation, two single axis hand lever potentiometers (joystick) or one double axis hand lever potentiometer (joystick) are suitable as signal emitters for each amplifier board. Specific inputs can also be connected direct to an analoque output of an SPS, CNC or of a PC.

The most important functional components are:

Reverse battery protected current supply unit for individual functional components and short circuit-resistant voltage regulator for production of stabilized voltages ± 5 VDC (EV22K1-12) or ± 10 VDC (EV 11K1-24).
Analogue adder for addition of desired voltages and subtraction of reference voltage.
Ramp generators (integrators), with rise and fall times being set separately.
Dither generators with adjustable dither amplitude, with cutout facility.
Current-regulated, stepped and short-circuit-resistant final stages.
Digital micro-controller for coordination of circuit inputs, operating status, LED and fault monitoring.

The most important properties are:

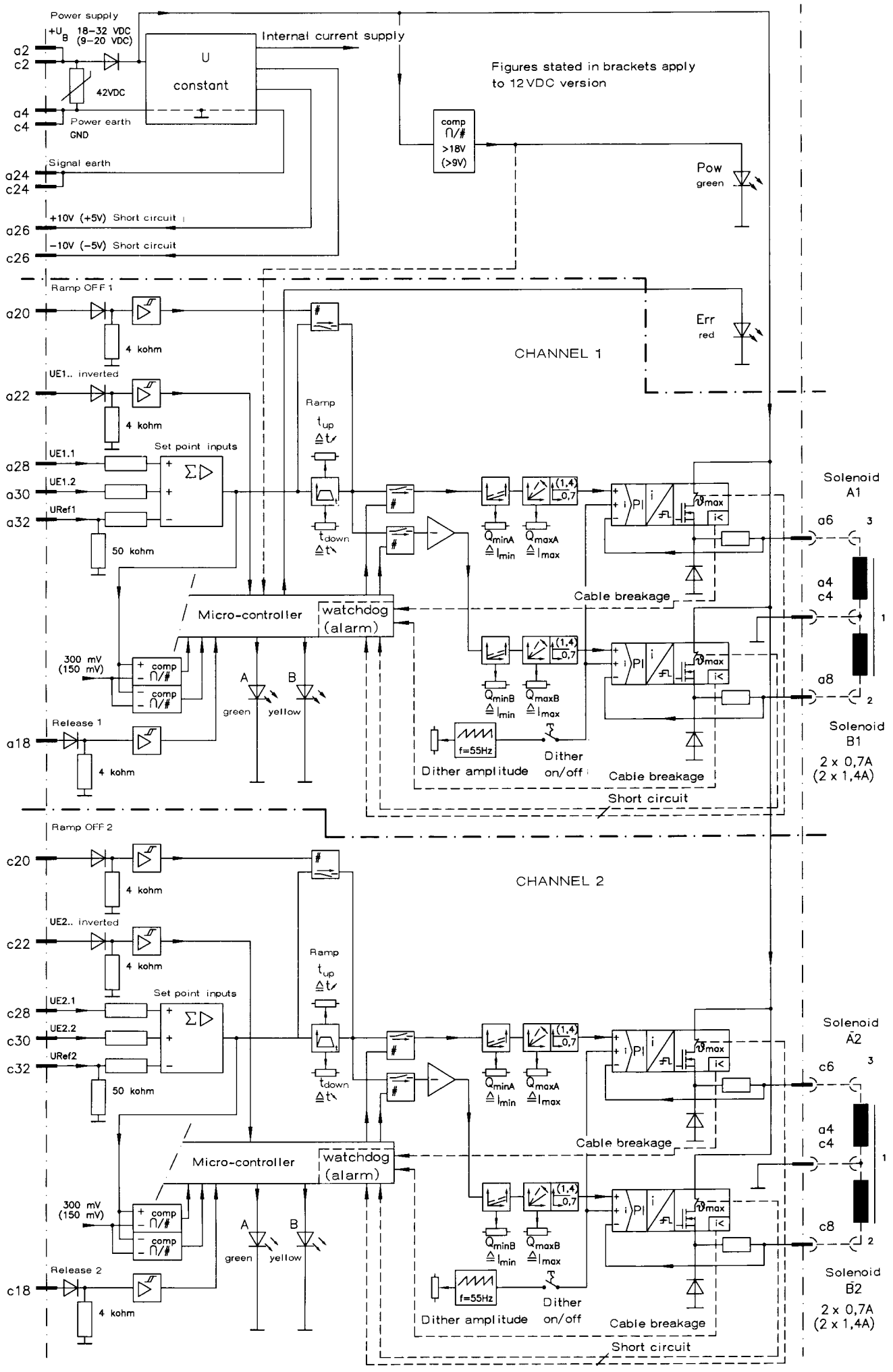
Basic and maximum current I_{min} (Q_{min}) and I_{max} (Q_{max}) precisely adjustable in both directions by means of multiplex potentiometer.
Dither amplitude adjustable, dither frequency approx. 55Hz.
Dither signal is superimposed on output current.
Ramp times upwards and downwards can be adjusted separately by means of multi-way potentiometer.
Reverse battery protection of current supply.
Outputs protected against short circuit and short to earth.
Monitoring of cable breakage and short circuit for outputs, with permanent cut-off in the event of fault.
LED's on front panel clearly signal operating status of individual proportional amplifiers on board.

Analogue inputs:
Set point emitter connection possible for uni-polar potentiometer with direction switch or bi-polar potentiometer.
Real differential inputs, thus making possible safety circuit availability in the event of wire breakage with appropriate set point emitter (see Section 6.1 example 1)
Second set point input allows if necessary for addition of a supplementary signal as regards set point.

Switching inputs (digital inputs):
Ramp cut-out, set point inversion and release.

The front panel of the amplifier board (plate) has the height and width dimensions equivalent to 3 HE x 3 TE (128,4 x 15,4 mm), but the depth is equivalent only to half the European standard board depth (100 mm). Thus, when associated with the board container which has to be ordered as accessory for an installed amplifier board or with a component group carrier for several amplifier boards, it is possible to achieve spacesaving housing in the control cabinet.

1.2. Bloc diagram



2. Versions available, types code

For the amplifier board as in Sect.2.1, one should order as accessory a board container as in Sect.2.2, or if several boards are to be housed together, order at same time a component group carrier.

2.1. Amplifeir board

Order designation:

For supply voltage 12 VDC **EV 22 K1 - 12**
For supply voltage 24 VDC **EV 22 K1 - 24**

Basic type designation

two twin or pair of two individual proportional solenoids, controllable for alternate operation

(Plug-in) board version

Design and development status (internal code)

Supply voltage 12 or 24 VDC (rated)

It is best for an individual board to be installed with a board container KH 7817 900 Sect.2.2.1. As an option a snap on foot S 7817 903 is available, so that the board container can be latched into a switchboard on a 35 mm carrier rail.
With two boards and more the component group carrier BT 7817 910 Section 2.2.2 is recommended (up to 3 boards). If you have more than 3 boards, two BT 7817 910 should be installed and so on. Any sockets unused can be covered over with a dummy plate BT 7817 930.
Screw terminals are provided for connection of feed cables. They can take cables up to 1,5 mm^2.

2.2. Assembly accessory

2.2.1. Board container for one amplifier board and carrier rail snap-on foot

This consists of a frame with guide rails, the 32-pole multiple contact strip to DIN 41 612 Form D 32 and a screw on terminal strip. The board container is intended to receive one amplifier boards. It has single attachment facility using the screw M 4 supplied to an assembly plate, see dimensional illustration in Section 4.2. The snap-on foot for attachment to the base of the board holder makes it possible to clip the board holder in and thus to house the amplifier without problem on 35 mm carrier rails DIN EN 50 022 in control cabinets either longitudinally or transversely.

Order designation: **KH 7817 900**
S 7817 903

KH = board holder
S = carrier rail snap-on foot (not illustrated)

internal drawing number

2.2.2. Component group carrier for two to three amplifier boards

This consists of a screwed aluminium casing with guide rails and 32-pole multiple contact strip to DIN 41 612 D 32 corresponding to a maximum of 3 boards. The relevant terminal strips are positioned at the side and easily accessible. Solenoids must be connected to the upper terminal strip and input to the lower one, so that there is as little influence as possible on input from output current. A separate pair of terminals is provided for connection of supply voltage, with subsequent socket for flat fuse to DIN 72 581 T3 Form C (max. 10 A). If the maximum number of boards is not taken up, slots remaining on the front can be closed off by a black painted dummy plate.

Order designation: **BT 7817 910**
B 7817 930

BT = component carrier for 3 boards [1])
B = dummy panel 3 TE/3 HE black (not illustrated)

internal drawing number

[1]) use appropriate number of BT 7817 910 if more than 3 boards

3. Specifications

3.1. General features

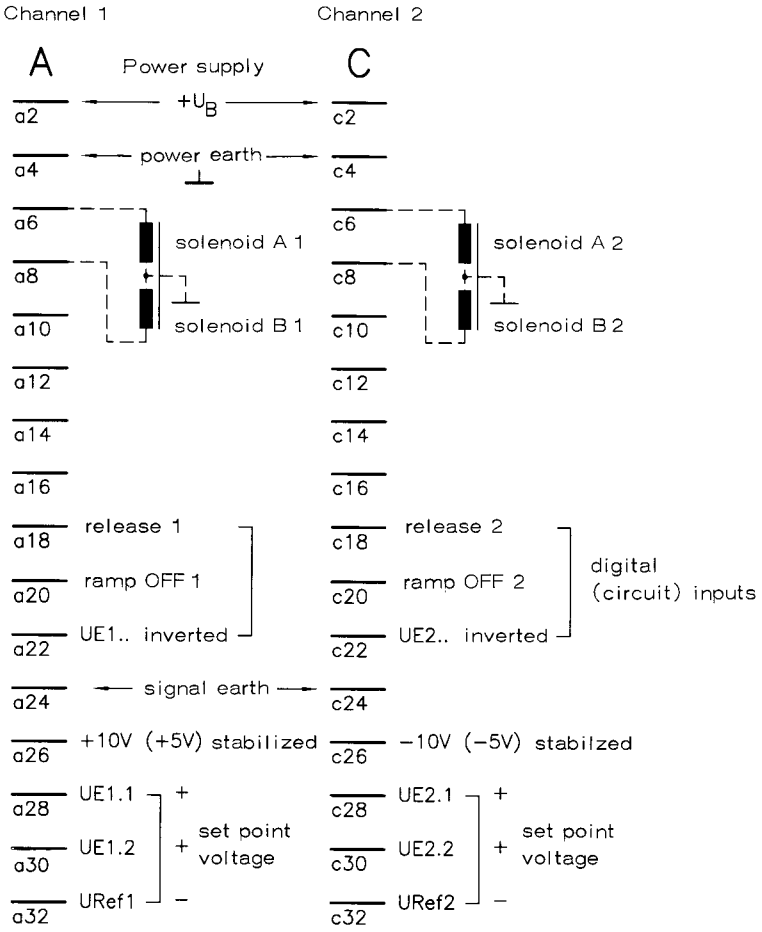
Nomenclature	Electronic amplifier
Design	Plug-in board with 32-pole terminal strip to DIN 41 612 D 32
Mounting	by means of board holder for one board or component group carrier for up to 3 boards
Position when installed	any
Mass (weight)	approx. 100 g
Protection IEC 70 (CO) 13	IP 00
Ambient temperature	0 to + 70°C (restricted use possible down to - 20°C, but reference voltages will only carry 50% load).

3.2. Electrical features

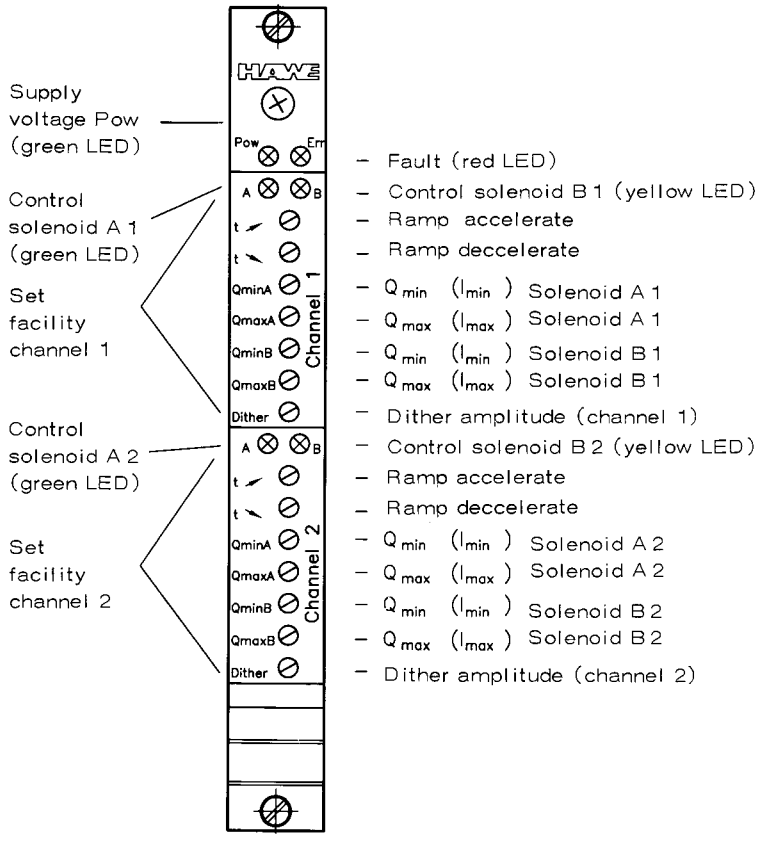
		EV22K1-24	**EV22K1-12**
Power supply	U_B	18...32 VDC	9...20 VDC
Max. permissible ripple factor	w	10 %	
Minimum filter capacitor necessary with supply voltage	C_B	2200 µF per 1 A winding	
Output voltage	U	$\geq U_B$ - 1,2 VDC	
Dead load current (int. consumption)	I_L	max. 80 mA	
Elementary frequency of power in stage	f	≈ 1000 Hz	
Circuit resistant output current	I_A	max. 0,7 A	max. 1,4 A
Setting range	I_{max}	0,4 - 0,7 A	0,8 - 1,4 A
	pre-set	0,6 A	1,2 A
	I_{min}	0 - 0,4 A	0 - 0,8 A
	pre-set	0,2 A	0,4 A
Setting range voltage	U_{tar}	- 10 .. 0 .. + 10 VDC	- 5 .. 0 .. + 5 VDC
Release range for I_{min}	U	± 300 mV	± 150 mV
Input resistance of set point inputs UE.. to signal earth	R	≈ 50 kΩ	
Voltage range at reference input URef related to signal earth	U	-10 .. 0 .. + 10 VDC	- 5 .. 0 .. + 5 VDC
Input resistance of reference inputs URef to signal earth	R	≈ 50 kΩ	
Circuit inputs (digital inputs):			
Release inputs, ramp off inputs, inverting inputs			
Input resistance to power earth	R	≈ 4 kΩ	
Input voltage level (protected against reverse polarity by diode)			
Logic 0	U	0 ≤ U ≤ 8 V	0 ≤ U ≤ 5,5 V
Logic 1	U	9 ≤ U ≤ 32 V	6 ≤ U ≤ 32 V
Stabilized voltage for supply to set point potentiometer	U_{st}	± 10 VDC short circuit resistant	± 5 VDC
Load capacity of stabilized voltage	I_{st}	max. 10 mA	max. 5 mA
Ramp time (set separately) related to full range of output current)	t_R	0,1 - 5 s, pre-set 0,1 s	
Ramp time with RAMP OFF circuit input controlled		< 0,05 s	
Dither frequency (cutout facility)	f	≈ 55 Hz	
Dither amplitude, setting facility	I	100 to 400 mA_{p-p}	200 to 800 mA_{p-p}
(Peak to peak)	Pre-set	≈ 150 mA_{p-p}	≈ 300 mA_{p-p}

3.3. Amplifier front panel and allocation of terminals

Terminal strip
to DIN 41 612 D32



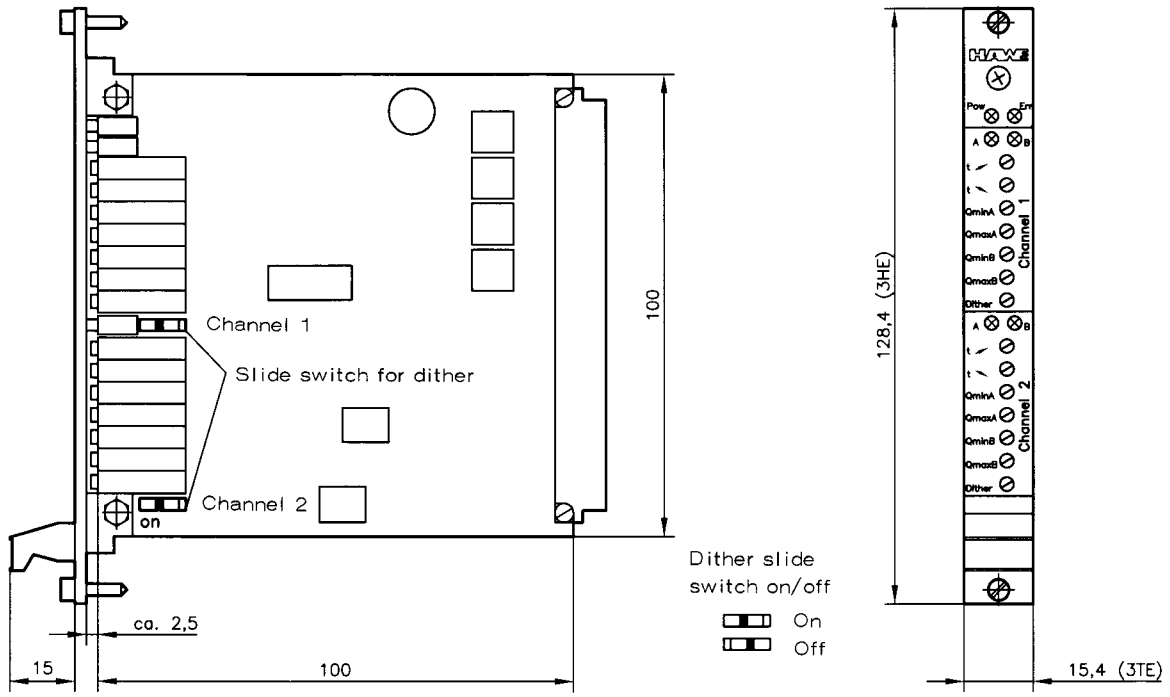
Amplifier front
panel



4. Dimensions

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

4.1. Amplifier board EV22K1-...

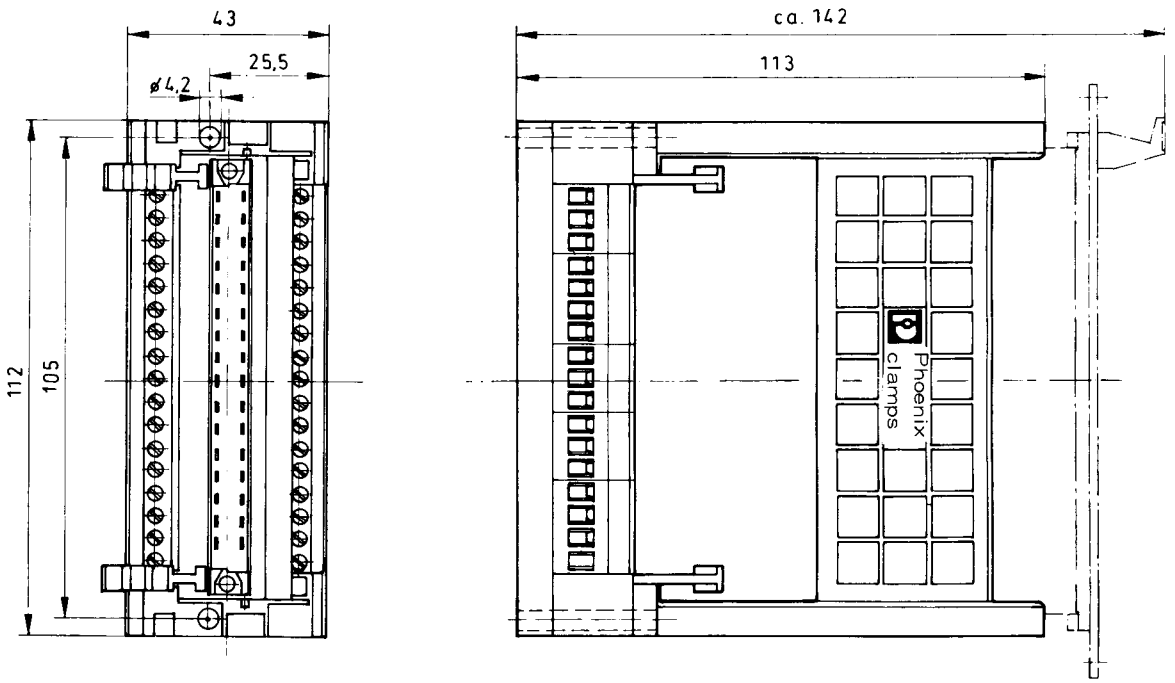


4.2. Assembly accessory

Board holder per Section 2.2.1

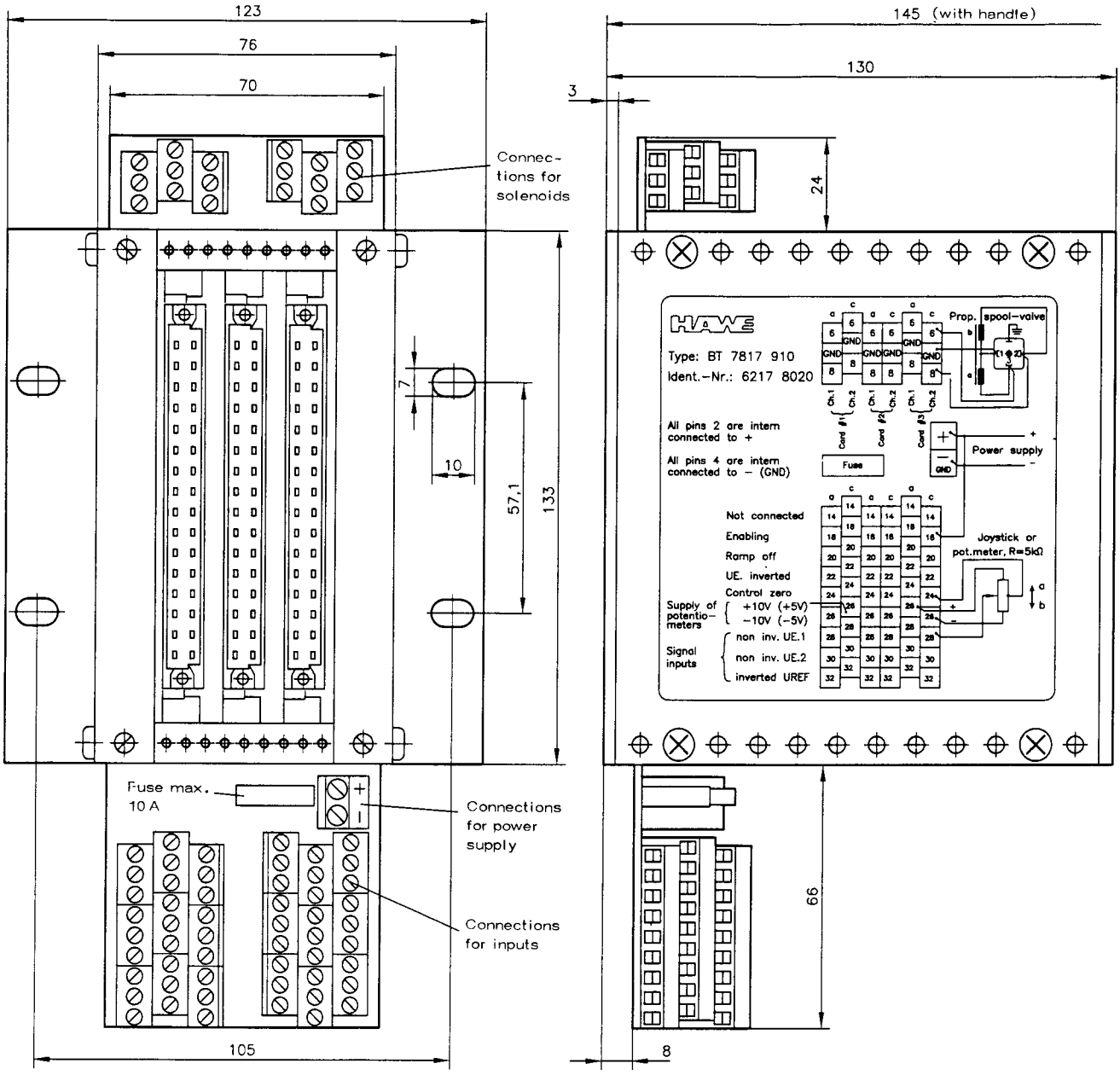
Protection IEC 70 (CO) 13 IP 00
Mass (weight) approx. 150 g

The snap-on foot to be attached to the base of the board holder makes it possible to clip the board holder into control cabinets on 35 mm carrier rails to DIN EN 50 022, either longitudinally or transversely, for housing of the amplifier without problem. The holder must be ordered separately.



Component group carrier per Section 2.2.2

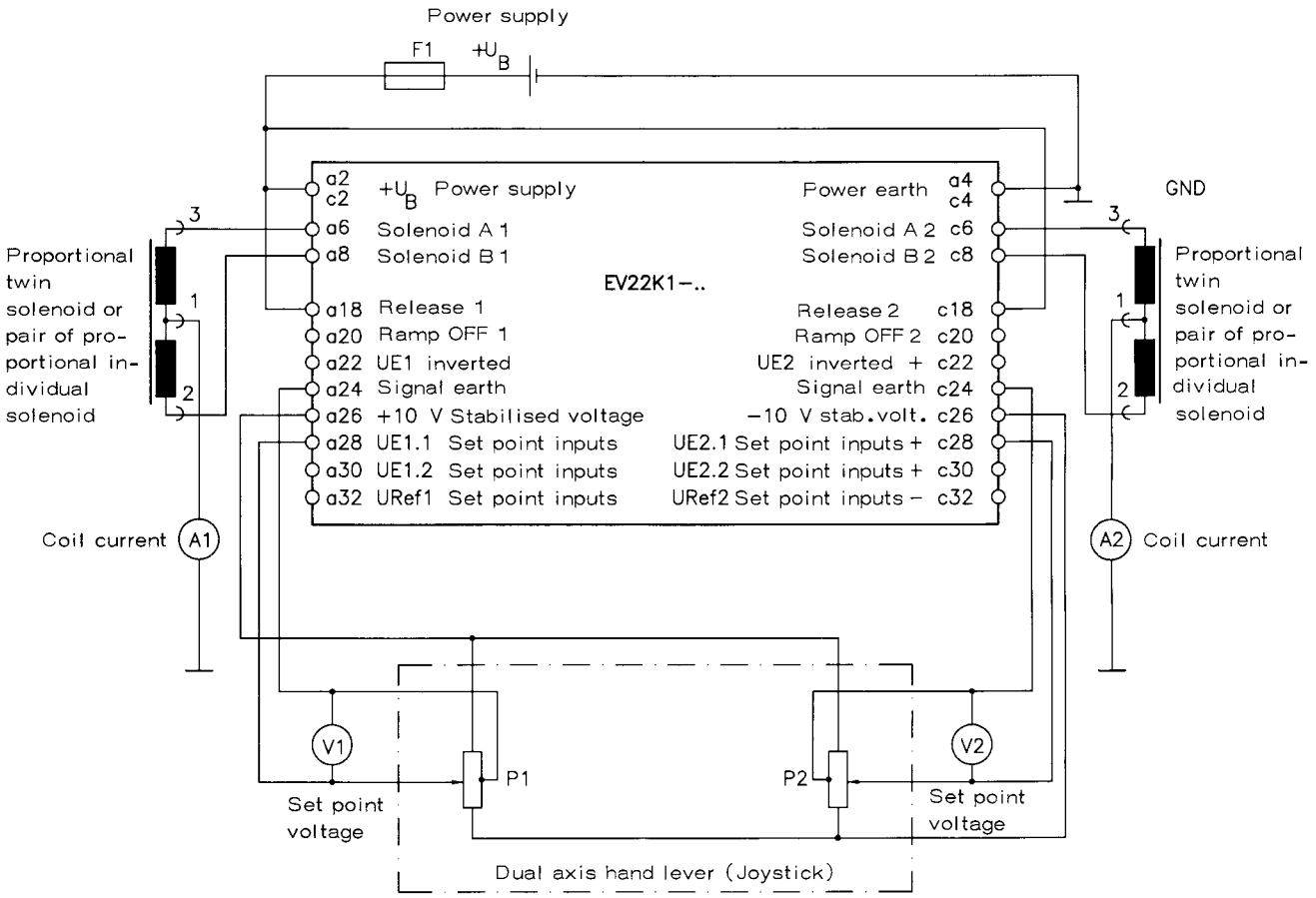
Protection IEC 70 (CO) 13	IP 00
Mass (weight)	approx. 700 g



5. Operating instructions

5.1. Setting instructions

Note: when delivered the amplifier board has been set up in such a way that it can be used, without further setting together with the proportional spool valve PSL or PSV in accordance with pamphlet D 7700.. . One should only undertake more precise matching between the proportional valve and the proportional amplifier is specialist personnel and measurement equipment is available.



The above arrangement applies to the circuitry most used, with a set point potentiometer with central tap (see also example of circuit 1 in Section 6.1).
The board is connected using the board holder or component group carrier (see Sect.2.2). The designation of terminals always corresponds to designation on the terminal strip (see Section 3.3).
Where the length of connectors is over 3 mm, connecting cables with wires twisted in pairs should be used, in order to minimise interference emission or increase interference resistance. I_{max} in the long term may not be above the I_{lim} indicated for proportional solenoids.

F1 = Fuse 1,6 A mT for EV22K1 - 24, 3,15 A mT for EV 2281 - 12 for one board;
a maximum of 3 boards may be protected by one fuse
V 1, V 2 = Check voltmeter for measurement of set point voltage, measurement range 0 to 10 VDC
A 1, A 2 = Check amperementer for measurement of winding current, measurement range 0 to 1 ADC for EV22K1-24, 0 to 2 ADC for EV22K1 - 12.
P 1, P 2 = Joystick e.g. from GESSMANN at 74211-Leingarten specified as follows:
Compound drive V 10 with handle
Switch direction 1 - 2, return spring 1 - 0 - 1
1 potentiometer 2 x 5 Ω T 320
Switch direction 3 - 4, return spring 1 - 0 - 1
1 potentiometer 2 x 5 Ω T 320
wired on terminal strip to EP/57 - 10, open IP 00
Mass per 1/140/141, from V 10, 1 - 00zp

(1) Set ramp times to minimum (turn ramp potentiometer anti-clockwise until slide of potentiometer in transparent case is furthest away from the front panel).

(2) Connect up amplifier and metering appliance in accordance with wiring diagram example

(3) Switch on power. Only the green LED **Pow** should light up on the front panel. If the red LED **Err** lights up, there is a fault. Tables 1 and 2 are used for determining or eliminating the cause of fault (see Section 5.3). This applies for the entire setting procedure.

Setting channel 1 as example

(4) Move joystick P 1 over in one direction and keep it there until the LED **A** lights up (release range of set point voltage for EV22K1-24 approx. ± 300 mV, for EV22K1-12 approx. ± 150 mV, read off on voltmeter V 1) and set the minimum current I_{minA} for direction **A** with the appropriate multiplex potentiometer Q_{minA}. If you turn clockwise, the winding current rises (guide figure for a PSL or PSV proportional spool valve with 24 V solenoids is approx. 220 mA, with 12V solenoids approx. 440 mA). The winding current is read off on the amperemeter A 1.

(5) Move the joystick in the other direction and keep it there until the LED **B** lights up and set the minimum current I_{minB} for direction **B** using the multiplex potentiometer Q_{minB} in accordance with Section 4.

(6) Move the joystick in direction **A** as far as the stop and keep it there (read off the relevant maximum set point voltage on voltmeter V 1) and set the maximum current I_{maxA} for direction **A** with the multiplex potentiometer Q_{maxA}. Moving the multiplex potentiometer clockwise causes the winding current to rise (guide figure for PSL or PSV proportional valves with 24 V solenoids approx. 600 mA, with 12V solenoids approx. 1200 mA). Read off the winding current on amperemeter A1.

(7) Move joystick in direction **B** as far as stop and keep it there and set the maximum current I_{maxB} for direction **B** in accordance with point 6 using the relevant multiplex potentiometer Q_{maxB}.

(8) Switch on slide switch for dither current (to "ON", see dimensional drawing in Sect. 4.1). Set the dither amplitude to the point when with the joystick approximately half over, vibration is clearly felt with the hand on the lever of the proportional valve, but no interference is caused in the hydraulic system (guide figures for proportional solenoid 24 V and with winding current 0,4 A approx. 150 mA p-p or for proportional solenoid 12 V and with winding current 0,8 A approx. 300 mA p-p. These figures can only be measured using an oscilloscope).

(9) Set ramp time for acceleration on multiplex potentiometer t↑ (arrow up). Set ramp time for braking on multiplex potentiometer t↓ (arrow down). Ramp time is increased with clockwise movement.

(10) Check settings Q_{min} (I_{min}), Q_{max} (I_{max}) and dither current and ramp time in both directional and if necessary repeat setting procedure.

Other notes:
External set point voltage should not be outside the reference voltages range upwards and downwards by more than 0,5V. Otherwise there can be incorrect reaction of the proportional amplifier.

If there are faults during the setting procedure or when starting up, check the power supply from mains; with a bridge-connected rectifier: is there an electrolyte filter capacitor of at least 2200 μF/A winding current in circuit parallel with the supply voltage ?
Is the supply voltage high enough for the proportional amplifier? Under load it should be at least approx. 1,5 VDC higher than would be necessary for production of the set maximum current I_{max} with a warm solenoid coil without proportional amplifier.
For using the board as a simple proportional amplifier for control of individual proportional solenoids see Section 6.2.

5.2. Radio interference

On rare occassion it is possible for the proportional amplifier to cut out at the place where it is used through electro-solenoid interference (e.g. where solenoid valves are being used which have no or inadequate interference suppression). In such cases we would recommend subsequent interference suppression of solenoid valves and/or regular incorporation of a radio interference suppression reaction coil in the positive feed or power supply on the component group carrier (in the movement hydraulic system e.g.: interference suppression coil with capacitor, type: FK 107/3, order reference: 0 310 600 028 BERU at 71602 Ludwigsburg).

5.3. Dealing with faults

The amplifier board incorporates two independent proportional amplifiers. Either amplifier is able to control a twin solenoid or two individual solenoids. The LEDs set into the front panel indicate the operating status forms of the amplifier. The green LED (Pow) indicates the power supply to the board, the red LED (Err) indicates a fault status. The red LED (Err) is used for fault reporting for both amplifiers. Otherwise treatment of faults for both amplifiers is entirely separate. This means that if a fault (e.g. serial No. 8, table 1) is indicated by the "Err" LED lighting up, this very probably involves only one amplifier on the board. The faulty channel is the one for which both the other LEDs "A" (green) and "B" (yellow) flash simultaneously. The other channel can continue to work without being affected. In cases serial Nos.6 and 7 of table 1, neither of the two amplifiers is able to work because the supply voltage is too low for both.

Table 1: operating status forms of proportional amplifier EV22K1-..

Serial No.	Light emitting diodes (LED's)				Status	Diagnosis	Effect and remedy
	Power (green)	Err (red)	A (green)	B (yellow)			
1	☼	●	●	●	Normal	Operation, set point voltage $U_S = 0$	Not necessary as normal operation
2	☼	●	●	☼		Operation, solenoid "B" controlled	
3	☼	●	☼	●		Operation, solenoid "A" controlled	
4	☼	●	●	◑		as No.4 or 5, but "release is blocked, PIN 18 is at OV (0 logic level)	
5	☼	●	◑	●			
6	●	●	●	●	Fault	Supply voltage too low U_B<18 V for EV22K1-24 U_B< 9 V for EV22K1-12	see item a in table 2
7	●	☼	●	●			
8	☼	☼	◑	◑	Fault	Cable breakage or short circuit in output (coil side)	see item b in table 2

● LED OFF ☼ LED ON ◑ LED FLASHING

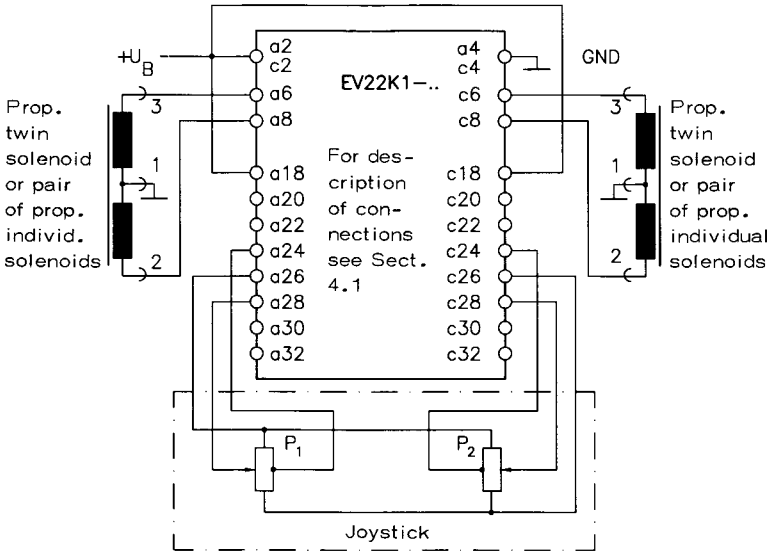
Table 2: effects of fault status and elimination of fault

Item	Effect	Remedy	Reset
a	Both winding currents or outputs A and B amplifier are blocked until reset carried out	Increase supply voltage, if necessary check and improve smoothing	Automatic
b		Check any solenoid coils and feed cables connected for short circuit or interruption and eliminate cause of fault	Only after cause of fault removed: switch on power again or produce positive flank on PIN 18 (RELEASE) of relevant amplifier

Note: A fault status can only be perceived by the electronics if the winding currents on the drive have gone outside the permissible limits. Consequently, one cannot prophesy a short circuit or cable breakage at output if the SET POINT VOLTAGE IS 0 or with the RELEASE BLOCKED (PIN 18). Such faults will only be reported shortly after drive is applied to the relevant side (end stage).

6. Examples of circuit (non-binding suggestions)

6.1. Control of hydraulic valves using either one twin or two individual proport. solenoids

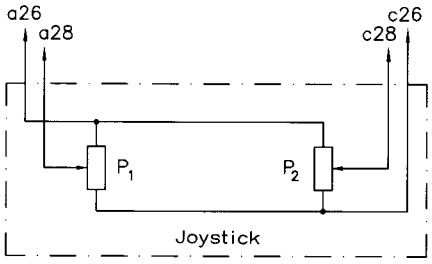


Example 1:

The signal ermitter connected consists of two potentiometers with central tap, e.g. two single axis joysticks or one double axis joystick. Set point voltage is bipolar.

Joystick which can be used (example) type V 10.1-00 zp Fa. GESSMANN at 74211 Leingarten with specification per Section 5.1.

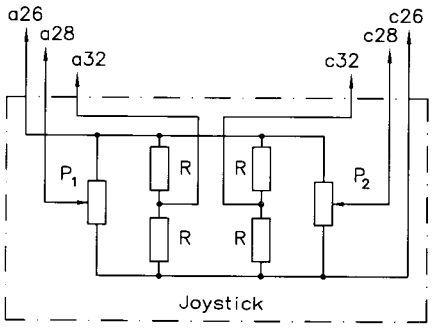
This basic wiring is protected against faulty connection of the un-activated twin prop. solenoid in the event of breakage of a wire at input (set point potentiometer). The un-activated proportional valve remains in the neutral position in the event of such wire breakage, as the set point voltage at input to the prop. amplifier remains zero.



Example 2:

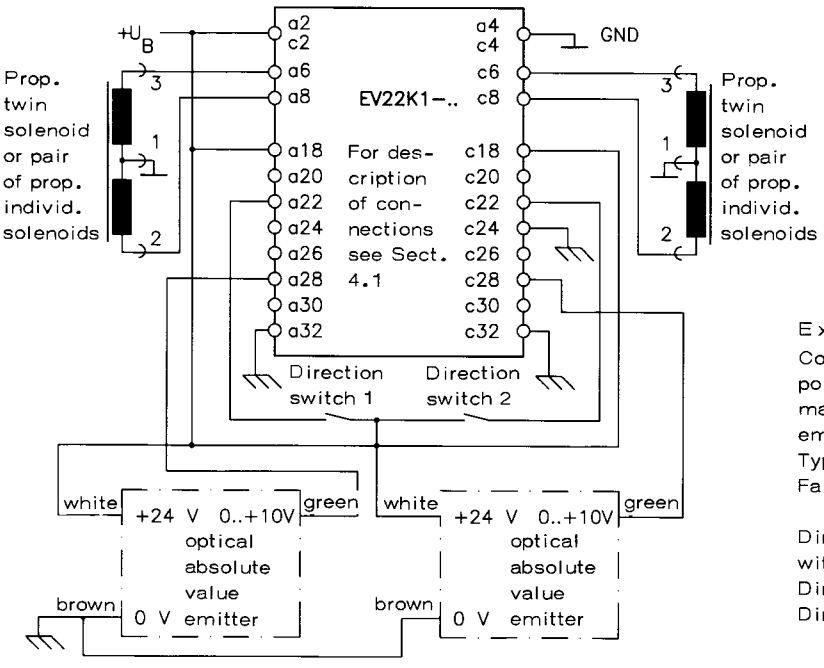
Two single potentiometers with only three connections (without central tap) are used as signal emitters. The set point voltage is bipolar.

This very cheap version from the price aspect does have the disadvantage that, for example, if a supply connection from the set point potentiometer to the reference voltage + 10 V (a 26) breaks, the reference voltage at input to the prop. amplifier immediately jumps to -10 V. This means that the prop. solenoid of the non-activated proportional valve is under drive and consequently the valve moves as far as the stop with unchecked movement and maximum velocity of the consumer item connected to it. Consequentle, it is only reasonable to use such wiring if the signal emitter and the amplifier board are installed so closely togethe that it is unlikely that there will be any damage to the supply cables. Wiring in accordance with example 1 or example 3 is preferable for safety reasons.



Example 3:

As in example 2, two single potentiometers are used as signal emitters. The set point voltage is bipolar. The absent central tap of the set point potentiometer is simulated in each case by two additional resistances approx. 5 .. 10 kohm, 0,25 W. This avoids the safety disadvantages of example 2 and the same applies as in example 1.



Example 4:

Connection of a joystick switch with active set point emitter, set point voltage unipolar, e.g.: master switch with opto-electronic absolute value emitter.

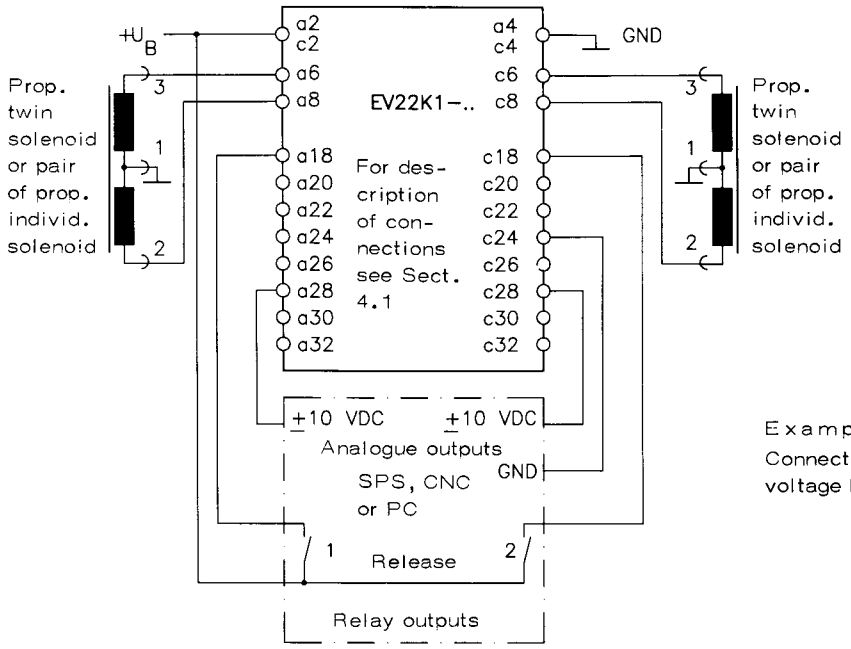
Type: CSOVR 8P1.8P1-2 OEG 010 U

Fa. Spohn and Burkhard at 89143-Blaubeuern

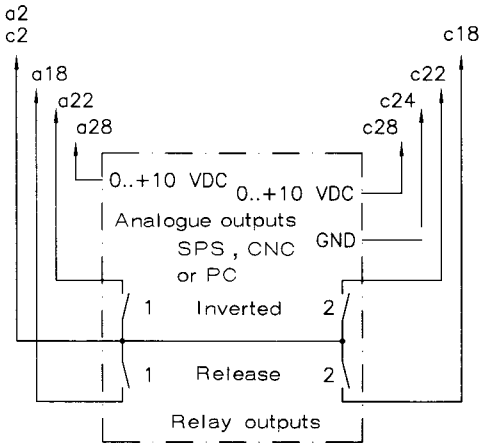
Direction switch coupled internally mechanically with absolute emitter:

Direction switch 1-with opt.abs.value emitter 1

Direction switch 2-with opt.abs.value emitter 2

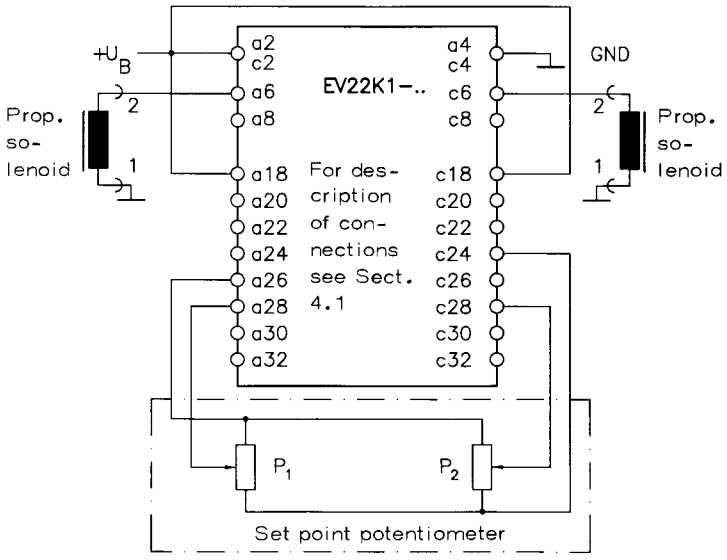


Example 5:
Connection to an SPS, CNC or PC, set point voltage bipolar.



Example 6:
Connection to an SPS, CNC or PC, set point voltage bipolar.

6.2. Control of hydraulic valves with one proportional solenoid



Example 7:
Use as single proportional amplifier.

Both proportional solenoids operating singly should be connected to connections a6 and earth or c6 and earth, with a unipolar set point voltage being selected from 0 to 5V (EV22K1-12) or 0 to 10V (EV22K1-24).

Caution:
In the event of inversion (a22 or b22) or interchange or prefix or the set point voltage applies, the amplifier would go to fault status, because this would be equivalent to drive to the absent second coil and as connections a8 and c8 were unoccpied, it would be interpreted as wire breakage