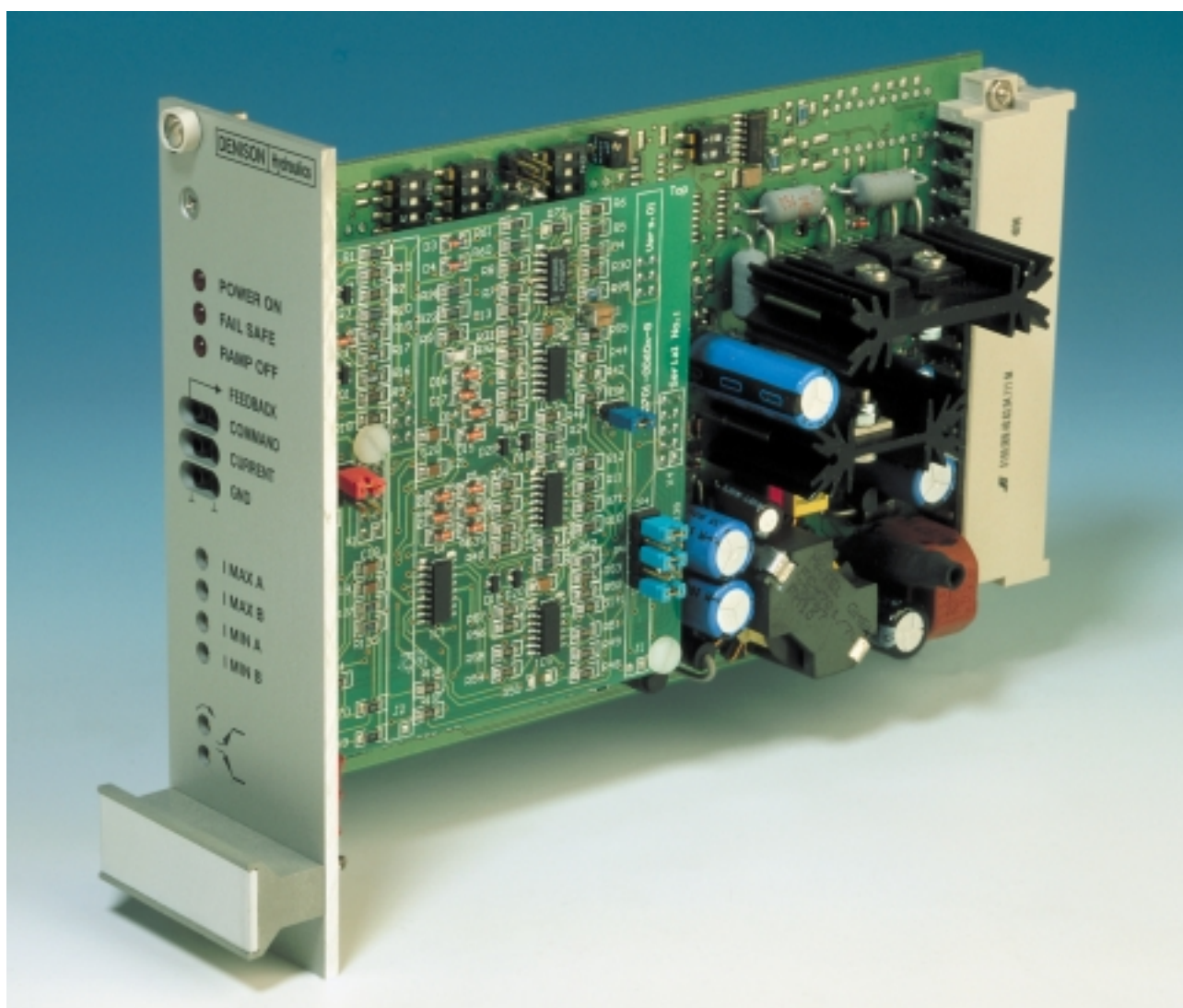


DENISON HYDRAULICS Proportional Amplifier EC01 A2C

Part No. 701-00631-8 and 701-00632-8



Publ. 9-EN 6040-A

DENISON Hydraulics

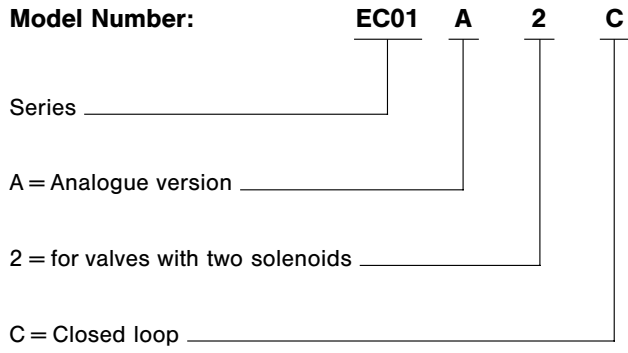
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MODEL CODE, REFERENCE TABLE

MODEL CODE



REFERENCE TABLE

Series	Sol.	Order No.	Factory setting			
			Dither		Current	
			Frequency	Amplitude	I _{nom}	I _{min}
4DP02T	12 V	701-00631-8	150 Hz	300 mA	2800 mA	0 mA
4DP03T 4DP06T	12 V	701-00632-8	250 Hz	150 mA	2200 mA	0 mA

DESCRIPTION, FEATURES, SPECIFICATION

DESCRIPTION

The proportional amplifier EC01 A2C has been developed to control several DENISON hydraulic proportional valves with a transducer, which operate with two (2) solenoids.

The various requirements of the valves, for example nominal current, dither can be selected on the proportional amplifier by DIP switch settings.

The factory settings are shown on page 15.

FEATURES

- 24 VDC supply
- reverse polarity supply voltage protection
- solenoid output short circuit protected
- an external signal can start and stop the proportional amplifier (Stop-function)
- an external signal can switch the ramp function on and off
- linear and, over a wide range, customer adjustable ramp up and ramp down time
- dither amplitude adjustable
- three different dither frequencies selectable by DIP switch settings
- all industry standard command signals can be connected
- DIN 41612 connector type F (48 pin B-D-Z)
- fulfils all the requirements of EMV and is CE certified

SPECIFICATION

- Dimensions Euro card format 160 x 100 mm
- Front plate dimensions 3U / 8HP (128.5 x 40.4 mm)
- Weight approx. 250 g
- Connector DIN 41612, type F, 48 pin
- Supply voltage 24 VDC nominal
- Voltage range 20...32 VDC (battery or AC voltage, rectified and smoothed, ripple < 5%)
- Current approx. 350 mA (+ solenoid current)
- Reference voltages $\pm 15\text{ V } (\pm 5\%) @ 50\text{ mA}$
 $\pm 10\text{ V } (\pm 0.5\%) @ 10\text{ mA}$
- Five Inputs Command signal must be positive!
 1. Voltage $0 \dots \pm 5\text{ V}$
 2. Voltage $0 \dots \pm 10\text{ V}$
 3. Voltage customised selectable, $R_{83} = 20\text{ k}\Omega / \text{V}$ (see layout diagram page 13)
 4. Current $0 \dots \pm 20\text{ mA}$
 5. Current $+ 4 \dots + 20\text{ mA}$
- Output voltage 24 V PWM for the solenoids
- Output current I_{MAX} approx. 2700 mA
- Range of adjustments:
 - $I_{\text{MAX}, \text{A, B}}$ $I_{\text{MIN}} \dots 2700\text{ mA}$
 - $I_{\text{MIN}, \text{A, B}}$ $0 \dots \text{approx. } 50\% \text{ of } I_{\text{MAX}}$
 - Ramp up $1 \dots 50\text{ V/s } (\pm 20\%)$
 - Ramp down $1 \dots 50\text{ V/s } (\pm 20\%)$
- Dither amplitude $0 \dots 300\text{ mA}$
- Dither frequency 100 Hz, 150 Hz, 250 Hz (selectable by DIP switch, see layout diagram page 13)
- Storage temperature $-40^\circ\text{C} \dots +125^\circ\text{C}$
- Operating temperature $0^\circ\text{C} \dots +70^\circ\text{C}$

FUNCTIONAL DESCRIPTION

1. SUPPLY VOLTAGE

The proportional amplifier requires an external DC power supply. A diode on the input protects the board against a power supply connected with the wrong polarity.

Because the amplifier operates as a DC/DC converter the current consumption is less than the solenoid current.

Several amplifiers can be connected to one power supply, which then has to meet the following requirement:

$$P_{MAX} = n \times P_1$$

(P_1 = requirement for one board, n = number of boards connected in parallel).

The DC voltage must be between 20 and 32 VDC.

$$\begin{aligned} B/D28 &= +V_{Supply} \\ B/D30 &= 0V_{Supply} \\ Z2, Z32 &= \text{Earth (necessary for EMV)} \end{aligned}$$

There is a current compensating coil in the supply line, with the result that the 0 V line of the supply voltage is not identical with the ground potential of the amplifier. **For this reason no connection may be made between the 0 V line of the supply voltage and the analogue ground of the amplifier!**

2. REFERENCE VOLTAGES

The reference voltages ± 15 V and ± 10 V (stabilised) are generated by a switched mode DC/DC converter on the board.

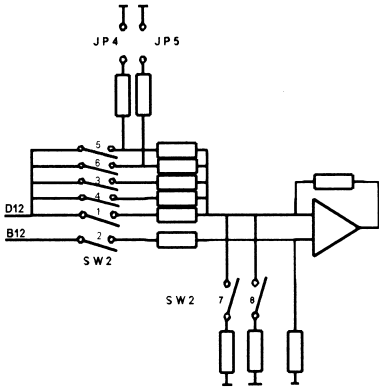
B2	= + 15 V	unstabilised	approx. 50 mA
B4	= - 15 V	unstabilised	approx. 50 mA
D2	= + 10 V	stabilised	approx. 10 mA
D4	= - 10 V	stabilised	approx. 10 mA

The reference voltages are used additionally to power external command potentiometers, transducers or external electronic components for example 5-channel command card.

Furthermore the amplifier has a stabilised 24 VDC supply for transducers, position switches etc.

D6, D32	= + 24 V	stabilised	approx. 80 mA
B6	= GND		

3. COMMAND INPUT



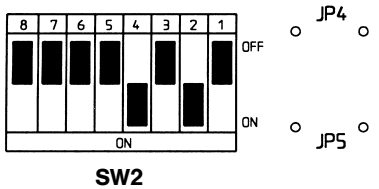
D12 = positive command voltage
B12 = negative command voltage

Five different current and voltage signals can be connected to the proportional amplifier. This accommodates all the industry standard input signals. **The command input is set up as a differential input.** Adaptation for the different input voltages and compensation for the different input currents is made by setting the DIP switches and jumpers (JP4 and JP5) on the **main board** (see page 13) accordingly.

It is essential that the correct jumper and DIP switch settings are made.

If the jumper and/or DIP switch settings are incorrect then the amplifier will not be able to generate the correct output current corresponding to the command signal.

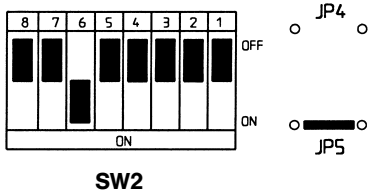
3.1 COMMAND INPUT WITH DIFFERENTIAL INPUT FUNCTION



Because a differential amplifier can only work correctly when, for the input and feedback resistances, particular resistance combinations are selected (SW2/1...8), **this amplifier can only be used as a differential input amplifier when it is set up for a 10 V input signal.** The diagram to the left shows the settings for a 10 V input signal with differential input function.

Jumper "JP4" and "JP5" must be open.
DIP switches SW2/2 & SW2/4 must be closed (ON).

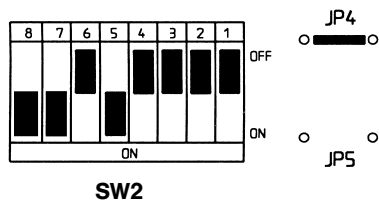
3.2. COMMAND INPUT WITHOUT DIFFERENTIAL INPUT FUNCTION



3.2.1 0...± 20 mA COMMAND SIGNAL

Jumper "JP5" must be closed
DIP switch SW2/6 must be closed (ON)!

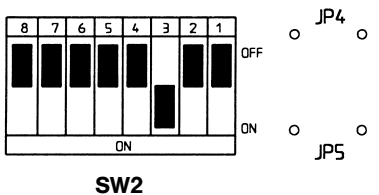
An input signal current of 0... + 20 mA generates an output current of 0... I_{MAXA} respectively 0... - 20 mA generates an output current of 0... I_{MAXB}.
The input impedance is 100 Ω.



3.2.2 + 4... + 20 mA COMMAND SIGNAL

Jumper "JP4" must be closed
DIP switch SW2/5, SW2/7 and SW2/8 must be closed (ON)!

An input signal current of + 4... + 12 mA generates an output current of I_{MAXB}... 0 respectively + 12 mA... + 20 mA generates an output current of 0... I_{MAXA}.
The input impedance is 100 Ω.

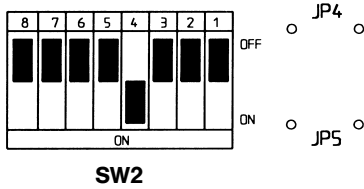


3.2.3 0...± 5 V COMMAND SIGNAL

Jumper "JP4" and Jumper "JP5" must be open
DIP switch SW2/3 must be closed (ON)!

An input signal voltage of 0... + 5 V generates an output current of 0... I_{MAXA} and an input signal voltage of 0... - 5 V generates an output current of 0... I_{MAXB}. This command signal is normally used in conjunction with processor controllers.
The input impedance is 100 kΩ.

COMMAND INPUT WITHOUT DIFFERENTIAL INPUT FUNCTION (continuation)



3.2.4 0...± 10 V COMMAND SIGNAL

**Jumper "JP4" and Jumper "JP5" must be open
DIP switch SW2/4 must be closed (ON)!**

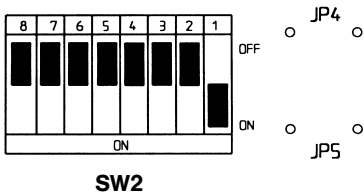
An input signal voltage of 0... + 10 V generates an output current of 0... I_{MAX A} and an input signal voltage of 0... - 10 V generates an output current of 0... I_{MAX B}.

This command signal is normally used when an external command signal potentiometer is used.

See also the description below:

Command from external potentiometer (see 3.2.6) or external signal source (see 3.2.7).

The input impedance is 200 kΩ.



3.2.5 CUSTOMISED COMMAND SIGNAL

**Jumper "JP4" and Jumper "JP5" must be open
DIP switch SW2/1 must be closed (ON)!**

If a command signal voltage is used which does not correspond to any of the above values (for example 0...± 15 V corresponding to 0...± 100 % command signal) the appropriate DIP switch has to be correspondingly set and the resistor R83 (see page 13) has to be calculated according to the maximum voltage level and fitted to the board.

The value of the resistance is calculated as follows:

$$R83 = V_{IN} \times 20 \text{ k}\Omega / V$$

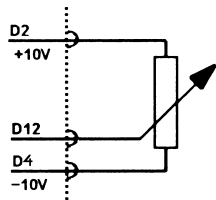
Example:

Command signal 0...± 15 V.

$$R83 = 15 \text{ V} \times 20 \text{ k}\Omega / V = 300 \text{ k}\Omega.$$

The existing resistor must be then replaced with a resistor having the value calculated as above.

The input impedance is equal the new value of R83.



3.2.6 COMMAND VALUE FROM AN EXTERNAL POTENTIOMETER

As standard a 10 kΩ command potentiometer (minimum 4.7 kΩ) should be used. This is then connected to + 10 V amplifier reference voltage (pin D2) and the - 10 V (pin D4). The wiper of the potentiometer is connected to the command signal input (pin D12).

3.2.7 COMMAND VALUE FROM AN EXTERNAL SIGNAL SOURCE

An external signal source can also be used as a command signal (for example a PLC analogue output). In this case the ground of the signal source and the ground of the control board (pin B6) must be connected and also the signal output connected to the command input (pin D12). The DIP switch must be set according to the maximum input command voltage.

When the command signal value is to be used as a differential input then the external signal source must be connected to D12 and B12. The DIP switch settings and the level of the command voltage must be set as described under "Command Input with Differential Input Function" (page 6).

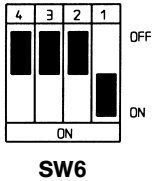
FUNCTIONAL DESCRIPTION

4. DITHER

The proportional amplifier has a square wave generator. This dither signal is superimposed on the command for the output current. Both signals together give the valve current. The superimposed AC-content of the current reduces the hysteresis and friction of the valve. The 4 pole DIP switch SW6 permits 1 from 3 preset frequencies to be selected.

Important! Only one (1) DIP switch must be set in the closed (ON) position!

SW6/1 = closed (ON) 250 Hz
 SW6/2 = closed (ON) 150 Hz
 SW6/3 = closed (ON) 100 Hz

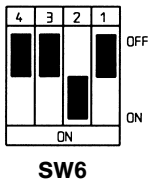


4.1 DITHER FREQUENCY 250 Hz

The dither frequency must be set to 250 Hz for the following valve:
 – 4DP03T / 4DP06T

DIP switch SW6/1 in the closed (ON) position.

For factory setting see page 15.



4.2 DITHER FREQUENCY 150 Hz

The dither frequency must be set to 150 Hz for the following valve:

– 4DP02T

DIP switch SW6/2 in the closed (ON) position.

For factory setting see page 15.

4.3 DITHER AMPLITUDE

The dither amplitude can, if necessary, be accurately set within the range 0...300 mA by adjustment of the "dither" potentiometer RTR5 (see layout diagram page 13).

The factory setting is

150 mA for 4DP03T / 4DP06T
 300 mA for 4DP02T

Adjusting the potentiometer in an anticlockwise direction increases the amplitude and vice versa.

5. MAXIMUM CURRENT RANGE

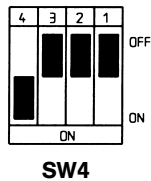
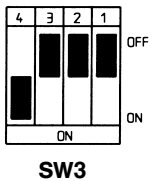
The maximum output current at 100% command signal value can be set by adjusting the SMD multi turn potentiometer RTR3 on the main board. The adjustment using the SMD potentiometer should not normally be made by the customer.

Caution: Wrong adjustments can cause malfunctions or serious damages at the proportional amplifier and the proportional solenoid.

On the main board there are two (2) 4 pole DIP switches (SW3, SW4) with which the maximum current value can be selected (see layout diagram page 13).

Important! Only one switch of SW3 and one switch of SW4 in the closed (ON) position.

SW3/1 and SW4/1 = closed (ON) 400 mA
 SW3/2 and SW4/2 = closed (ON) 800 mA
 SW3/3 and SW4/3 = closed (ON) 1600 mA
 SW3/4 and SW4/4 = closed (ON) 3000 mA

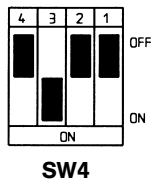
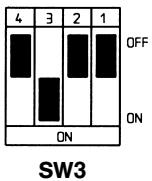


5.1 Maximum Current 3000 mA

The maximum current should be set to 3000 mA for the following valves:

– 4DP02T
 – 4DP03T / 4DP06T

DIP switch SW3/4 and SW4/4 in the closed (ON) position.



5.2 Maximum Current 1600 mA

At the moment there is no valve released for which this current is recommended.

FUNCTIONAL DESCRIPTION

6. CONTROL INPUTS

The amplifier has two digital control inputs. Each input is optically isolated, which permits isolated voltage control of these functions.

When an external voltage supply is used for digital control then it is essential that the 0 V of the voltage source is connected with pin B20 (digital GND).

When voltage isolation is not essential then the 24 VDC supply from the amplifier (pin D6 or D32) can be used for the control. In this case it is essential however, to connect pin B20 (digital GND) to one of the pins Z28, Z30 or B6 (analogue GND).

The permitted voltage level + V_{digital} must be in the range + 4 VDC to 32 VDC.

The current consumption is approx. 5 mA per input at 24 V.

6.1 STOP

The stop input can be used to switch the amplifier on and off. This input is a normally closed contact, in other words when there is no voltage at the input the "Fail Safe" LED is on and the amplifier is in the "Stop" state. The ramp generator is bypassed and the output stages are switched off.

$$\begin{aligned} \text{B16} &= + V_{\text{digital}} \\ \text{B20} &= \text{GND}_{\text{digital}} \end{aligned}$$

6.2 RAMP OFF

With this input the ramp function can be switched on or off. This input is a normally closed contact, in other words when voltage is applied to the input, the LED "Ramp OFF" is on and the output current to the solenoid corresponds to the command signal without delay.

$$\begin{aligned} \text{B18} &= + V_{\text{digital}} \\ \text{B20} &= \text{GND}_{\text{digital}} \end{aligned}$$

7. SENSOR INPUTS

The proportional amplifier has two (2) analogic inputs (sensor 1 and sensor 2). Both sensor inputs are designed to adapt the position transducer signal of the valve to the required values of the PID controller on the proportional amplifier. Herewith the feedback control system of the valve is closed. By setting the associated switch of SW1 an impedance converter can be switched in line or is bypassed.

7.1 SENSOR 1 = VALVE TRANSDUCER FEEDBACK SIGNAL (current)

For 4DP02T / 4DP03T / 4DP06T

The input sensor 1 (pin D8) is designed for the use of LVDT position transducer with a D.C. output current of 4... 20 mA. As a current source must be terminated with a low impedance the associated impedance converter **must** be bypassed.

**DIP switch SW1/1 in the open (OFF) position and
DIP switch SW1/2 in the closed (ON) position**

7.2 SENSOR 2 = VALVE TRANSDUCER FEEDBACK SIGNAL (voltage)

The input sensor 2 (pin B8) is designed for the use of LVDT position transducer with a D.C. output voltage of $7.5\text{V} \pm 4.5\text{V}$. The input can operate with or without an impedance converter. With that an optimal adaptation of the connected external sensor is achieved.

Notice! Only one of switch SW1/3 and SW1/4 must be set into closed (ON) position!

$$\begin{aligned} \text{SW1/3} &= \text{on} && \text{Sensor 2 with impedance converter} \\ \text{SW1/4} &= \text{on} && \text{Sensor 2 without impedance converter} \end{aligned}$$

8. CONTROL OUTPUTS

For the analogic closed loop amplifier there are no control outputs available.

FUNCTIONAL DESCRIPTION ANALOGUE SUB BOARD

The following functions are to be found on the analogue sub board!

9. JUMPER JP1-JP2

The signal at the test socket "COMMAND" can be selected with these jumpers.

Only jumper JP1 or JP2 may be closed!

9.1 COMMAND MEASURING POINT

When jumper JP1 is closed the signal after the ramp generator and the I_{MIN} and I_{MAX} settings can be measured at the test socket "Command".

$$0 \dots \pm 100 \% \text{ command value} = 0 \dots \pm x \text{ V}$$

($x \leq 10$ depending on the I_{MIN} and I_{MAX} settings)

When the jumper JP2 is closed the signal after the first amplifier stage can be measured at the test socket "Command".

$$0 \dots \pm 100 \% \text{ command value} = 0 \dots \pm 10 \text{ V}$$

(independent of whether the command value to the amplifier is a current or voltage signal)

Troubleshooting

In the event of a fault jumpers JP1 and JP2 can be used to identify the source of the problem. If the jumper JP2 is closed and when the command value is changed a corresponding change in the range $0 \dots \pm 10 \text{ V}$ is observed at the test socket "Command" then the main board is operating correctly.

If the jumper JP1 is closed and it is observed that the signal at the test socket "Command" is affected when the I_{MIN} or I_{MAX} potentiometers are adjusted then it can be assumed that the sub board is operating correctly.

The fault can then only be in the final stage of the current control, the dither generator or the PWM generator on the main board.

9.2 JUMPER JP3

This jumper is for special functions of other valves or valve groups. If the amplifier is used with the proportional directional valve 4DP02T / 4DP03T / 4DP06T then the jumper JP3 must be closed.

9.3 JUMPER JP4, JP5, JP6, JP7, JP8

These jumpers are for special functions for different valves or valve groups. If the amplifier is used with the proportional directional valve 4DP02T / 4DP03T / 4DP06T the following jumper configuration applies:

JP4 = closed
JP5 = not closed
JP6 = closed
JP7 = not closed
JP8 = closed

(see also jumper and DIP switch setting pages 15).

9.4 CURRENT MEASURING POINT

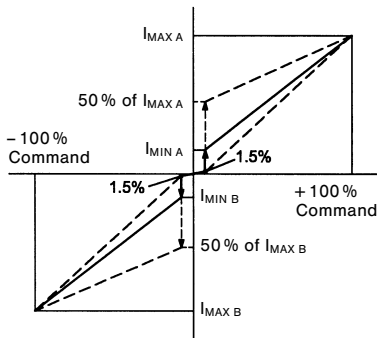
At this measuring point there is a voltage signal proportional to the current.
 $1 \text{ V} \triangleq 1 \text{ A} \pm 10 \%$.

9.5 FEEDBACK MEASURING POINT

At this measuring point there is a voltage signal proportional to the transducer current or voltage.

$4 \text{ mA} \approx -5 \text{ V}$ $12 \text{ mA} \approx 0 \text{ V}$ $20 \text{ mA} \approx +5 \text{ V}$

10. TRIMMING POTENTIOMETERS



10.1 I_{MIN} Setting

The minimum output current and so the initial valve flow can be adjusted with the I_{MIN} potentiometer. The range of adjustment for I_{MIN} is between 0 mA and 50 % of I_{MAX} and is not effective up to 1.5 % of the max. command signal (see 10.2).

Clockwise adjustment of the potentiometer increases the I_{MIN} value and vice versa.

10.2 I_{MIN} Step Function

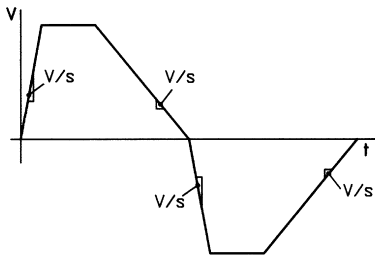
The I_{MIN} step function is necessary when the valve current should be 0 mA with a command of 0 V. At 0 V command there is no current to the valve. When the command is only slightly above 0 V (approx. 1.5 % of the maximum command value) then the current jumps from 0 to I_{MIN} (see 10.1).

10.3 I_{MAX} Setting

The maximum output current can be limited by adjusting the I_{MAX} potentiometer. In this way it is possible to limit the maximum flow of the valve to a lesser value than the rated flow. The value of I_{MAX} can be set in the range I_{MIN} to 2700 mA.

Clockwise adjustment of the potentiometer increases the I_{MAX} value and vice versa.

11. RAMPS



The amplifier has a ramp generator.

Without the ramp function the output current follows the command signal directly.

With two potentiometers the acceleration and deceleration rate can be separately and independently set up in the range 1 ... 50 V/s ($\pm 20\%$).

Clockwise adjustment of the potentiometer reduces the acceleration time (more time for the flow increase) and vice versa.

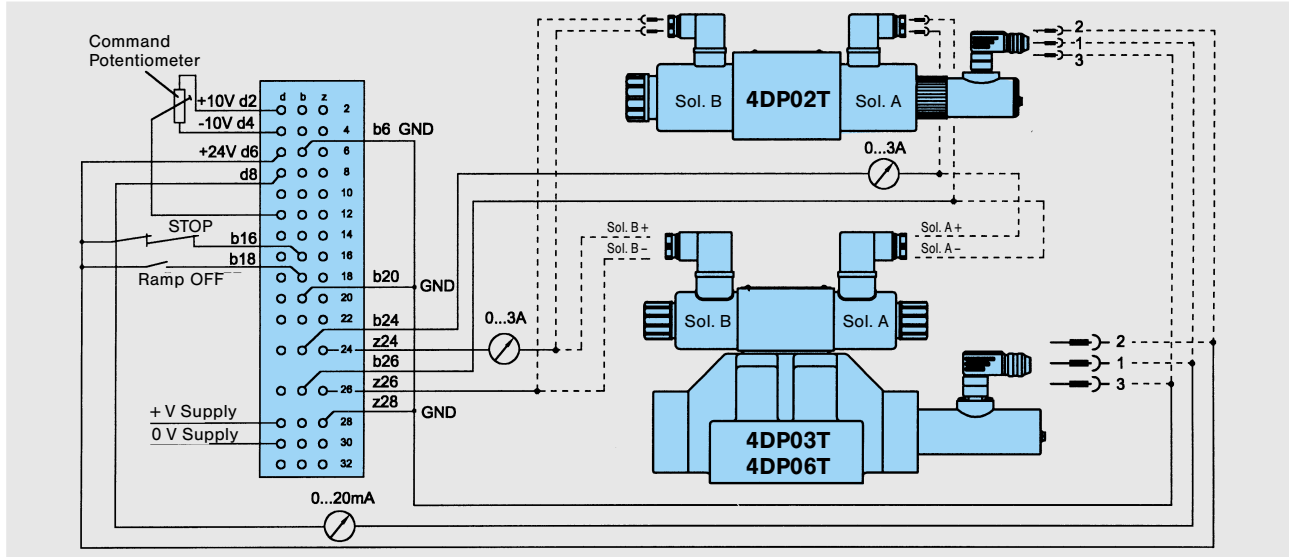
1 V/s corresponds to 10 s ramp time for a command jump from 0 to 10 V.

50 V/s corresponds to 200 ms ramp time for a command jump from 0 to 10 V.

TEST AND SET UP INSTRUCTIONS

12. TEST AND SET UP INSTRUCTIONS

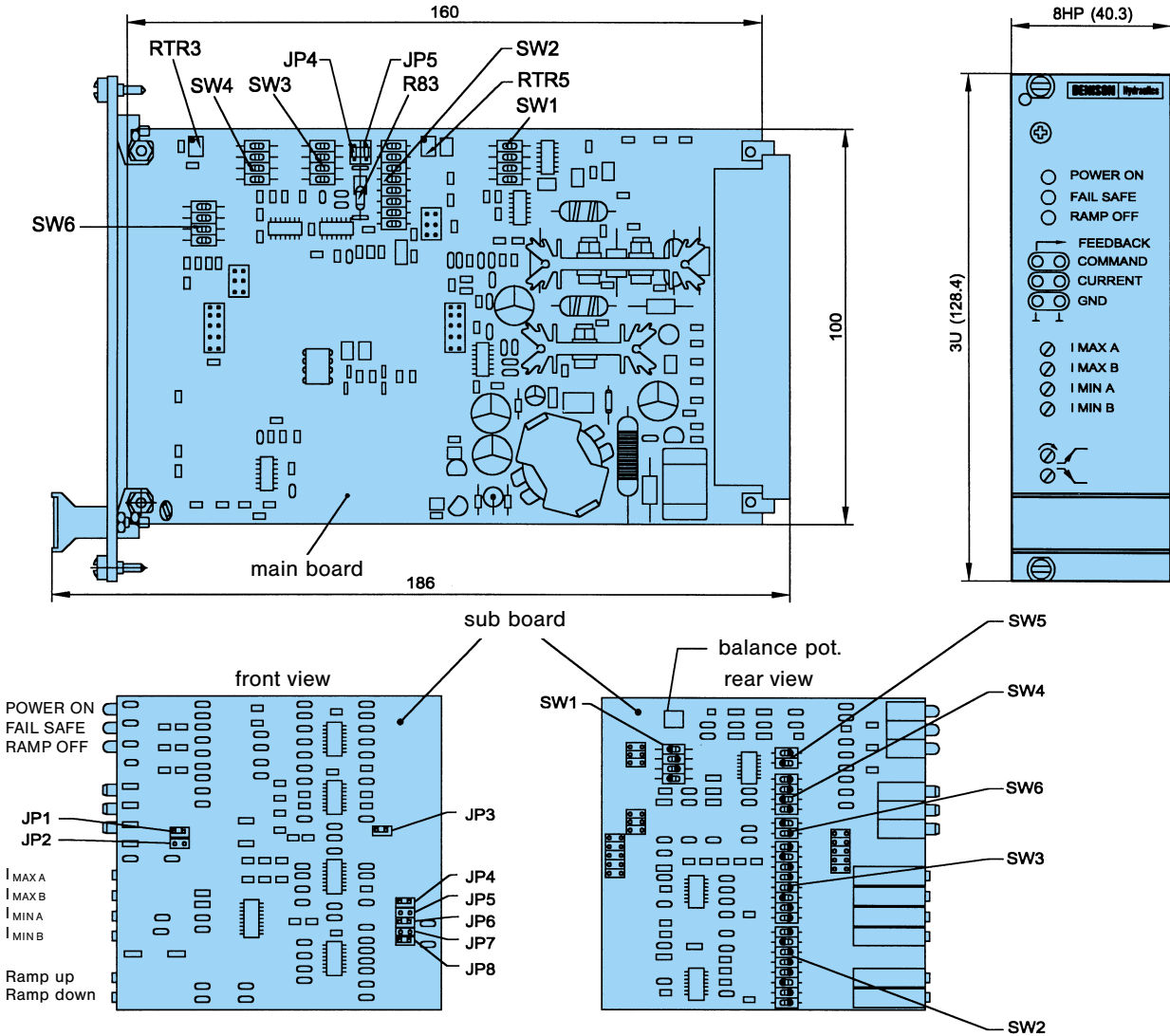
- Connect the amplifier with one of the valves according to the connection diagram shown below.
- Connect a current meter (range 0...3 A) in each solenoid coil circuit or one volt meter (range 0...5 V) in the test sockets on the front panel (1. Current = $\pm V$ and 2. = GND).
The relationship is 1 V/A.
- Connect a current meter (range 0...20 mA) in the feedback circuit or volt meter (range 0...5 V) in the test socket for feedback on the front panel (1. Feedback = +V and 2. = GND).



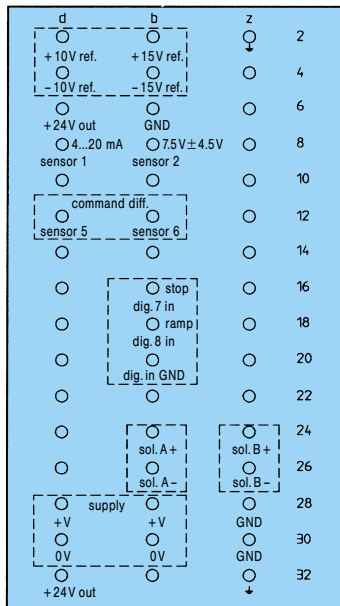
- Set command potentiometer, both ramp potentiometers, " $I_{MIN A, B}$ " and " $I_{MAX A, B}$ " potentiometers to zero.
- Connect the power supply and check if the LED "Power on" is on. The LED "Fail safe" should be off and the ramp function should be switched off (LED "Ramp off" is on) so that the set up is easier.
- With unplugged solenoid connectors measure the transducer current and – if necessary – adjust to 12 mA with the **zero point potentiometer of the transducer**.
- The measurement of the voltage signal at the feedback measuring point should be 0 V. If necessary adjust with the balance potentiometer on the sub board.
- Re-connect the amplifier and valve according to the connection diagram.
- Set the command value to approx. + 10 % of the maximum value (for example 1 V for 10 V maximum value).
- With the potentiometer $I_{MIN A}$ adjust the valve current to compensate for the dead zone.
- Set the command value to approx. – 10 % of the maximum value (for example – 1 V for – 10 V maximum value).
- With the potentiometer $I_{MIN B}$ adjust the valve current to compensate for the dead zone.
- Using the command potentiometer slowly increase the command value to the maximum. Monitor the associated feedback signal. Set the desired flow end value with the potentiometer $I_{MAX A}$.
- Using the command potentiometer slowly decrease the command value to the minimum. Monitor the associated feedback signal. Set the desired flow end value with the potentiometer $I_{MAX B}$.
- Set the ramp times for stepwise changes in the command value from 0 to 100 % (respectively from 0 to – 100 %) and vice versa with the corresponding ramp potentiometers to the desired values (clockwise adjustment of the potentiometer increases the ramp up (and ramp down) time).
- After setting up the proportional amplifier switch on the system and observe the behaviour. Adjust as necessary.
- Because the I_{MAX} and I_{MIN} adjustments are not independent the setting up sequence must be strictly adhered to:
 1. set $I_{MIN A, B}$ and $I_{MAX A, B}$ to zero
 2. adjust $I_{MIN A, B}$ to the required value and
 3. adjust $I_{MAX A, B}$ to the required value

LAYOUT DIAGRAM AND STANDARD PIN ASSIGNMENT

13. LAYOUT DIAGRAM

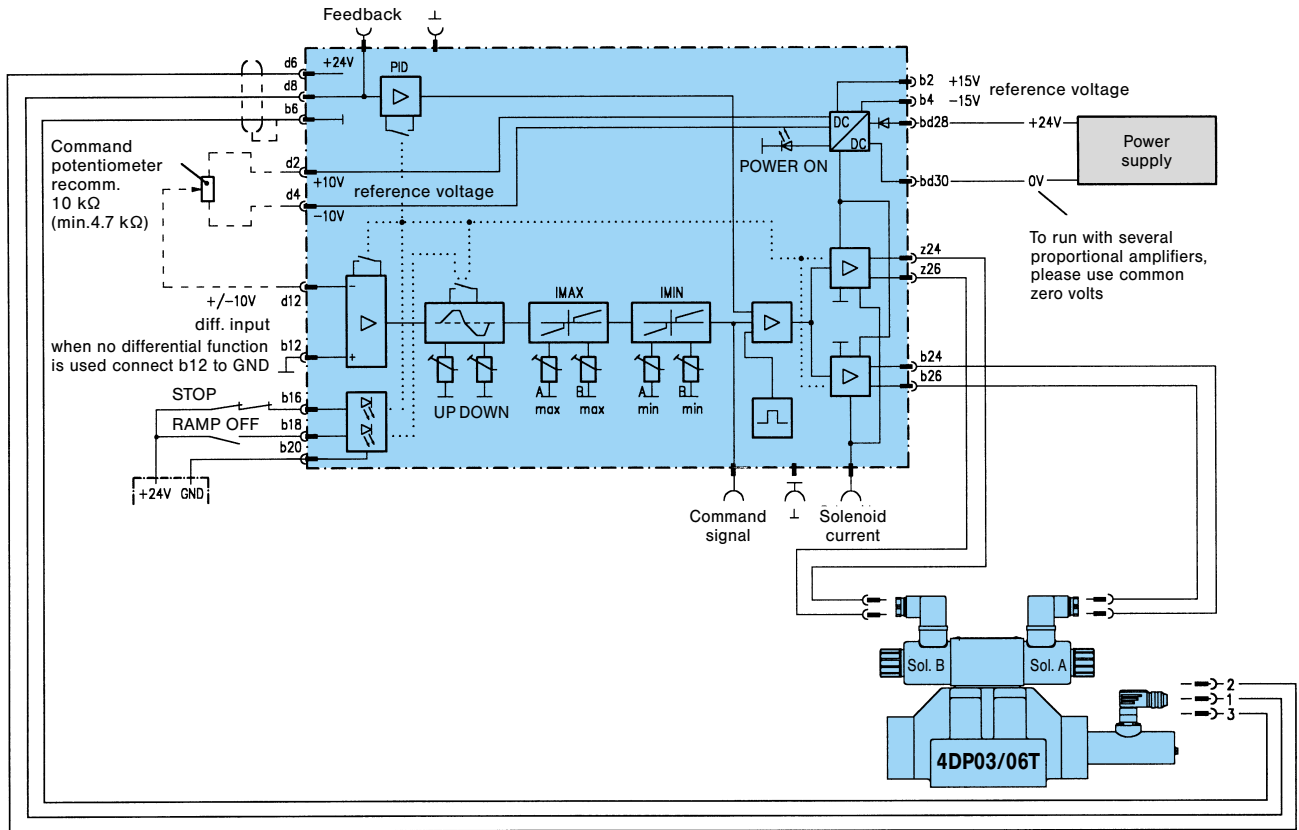


14. STANDARD PIN ASSIGNMENT

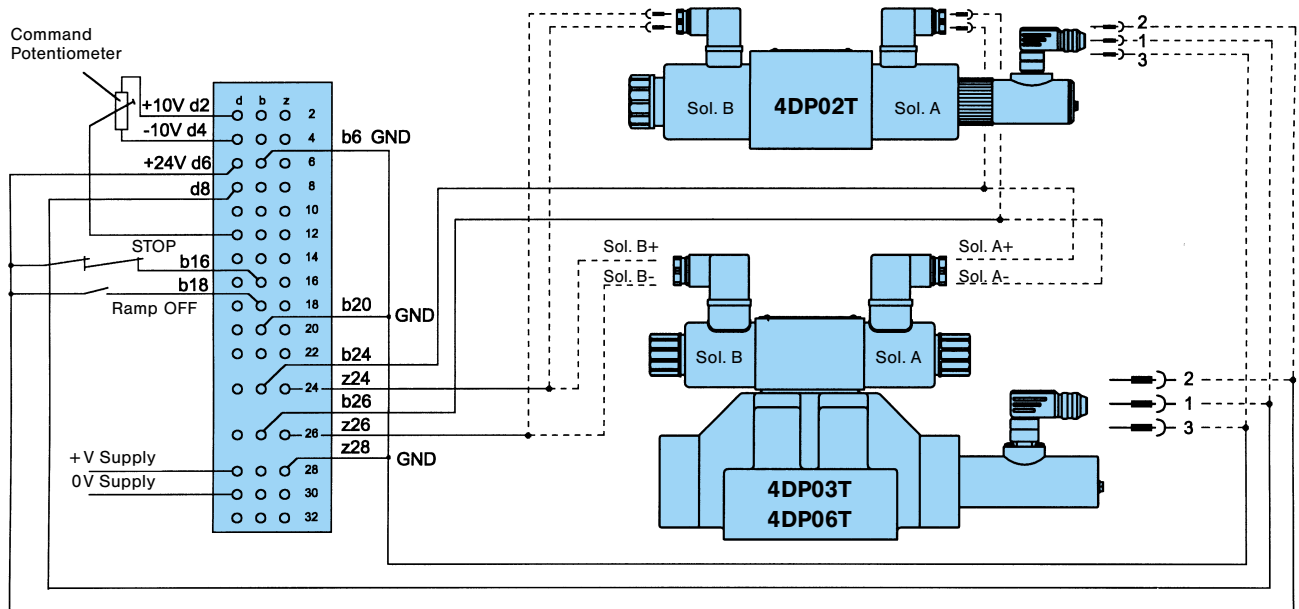


SCHEMATIC & CONNECTION DIAGRAM

15. SCHEMATIC DIAGRAM (Example 4DP03T / 06T, 4DP02T accordingly)



16. CONNECTION DIAGRAM (Example)



Note:

This wiring example shows the command signal generated from a potentiometer and the control inputs using the internal 24 V from the amplifier.

See pages 5, 6 & 8 when other commands and / or control signals are used.

JUMPER AND DIP SWITCH SETTING

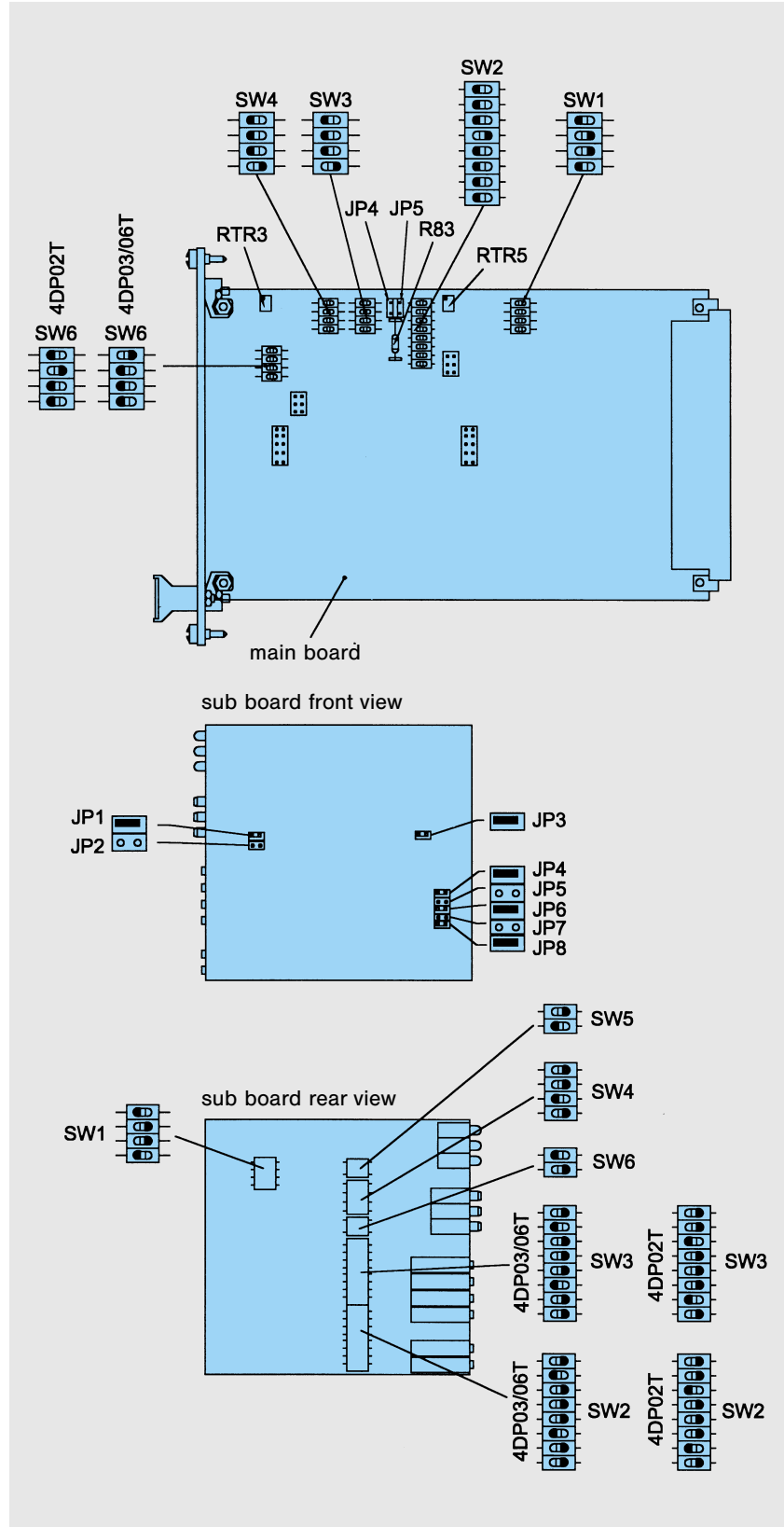
17. JUMPER AND DIP SWITCH SETTING

17.1 For 4DP02T

Order No. 701-00631-8

For 4DP03T / 4DP06T

Order No. 701-00632-8



TROUBLESHOOTING

18. TROUBLESHOOTING

Fault	Possible Cause	Corrective Action
LED "Power ON" is off	<ul style="list-style-type: none"> – no supply voltage – supply voltage not in permitted range – short circuit at the valve connection – short circuit at the reference voltage – amplifier power pack defect 	<ul style="list-style-type: none"> – check supply voltage – check supply voltage – check connection and/or resistance of solenoid coil – check external unit (command value transducer, amplifier, potentiometer) – return amplifier to manufacturer for repair
LED "Fail Safe" is on	<ul style="list-style-type: none"> – stop input incorrectly wired – main board or sub board defect – feedback signal failure – command signal 4...20 mA current selected and broken wire situation 	<ul style="list-style-type: none"> – check wiring – return amplifier to manufacturer for repair – measure feedback current in the range of 4 mA...20 mA when moving the main spool. When there is no current (or less than 3 mA) check wiring and supply voltage of the transducer – check proper fitting and working of the transducer – check wiring and measure command signal in the range of 4 mA...20 mA
No solenoid coil current	<ul style="list-style-type: none"> – wiring between amplifier and valve defect – sub board defect – output stage defect 	<ul style="list-style-type: none"> – check wiring – check operation of the sub board as described on page 9 – return amplifier to manufacturer for repair

The product described is subject to continual development and the manufacturer reserves the right to change the specifications without notice.