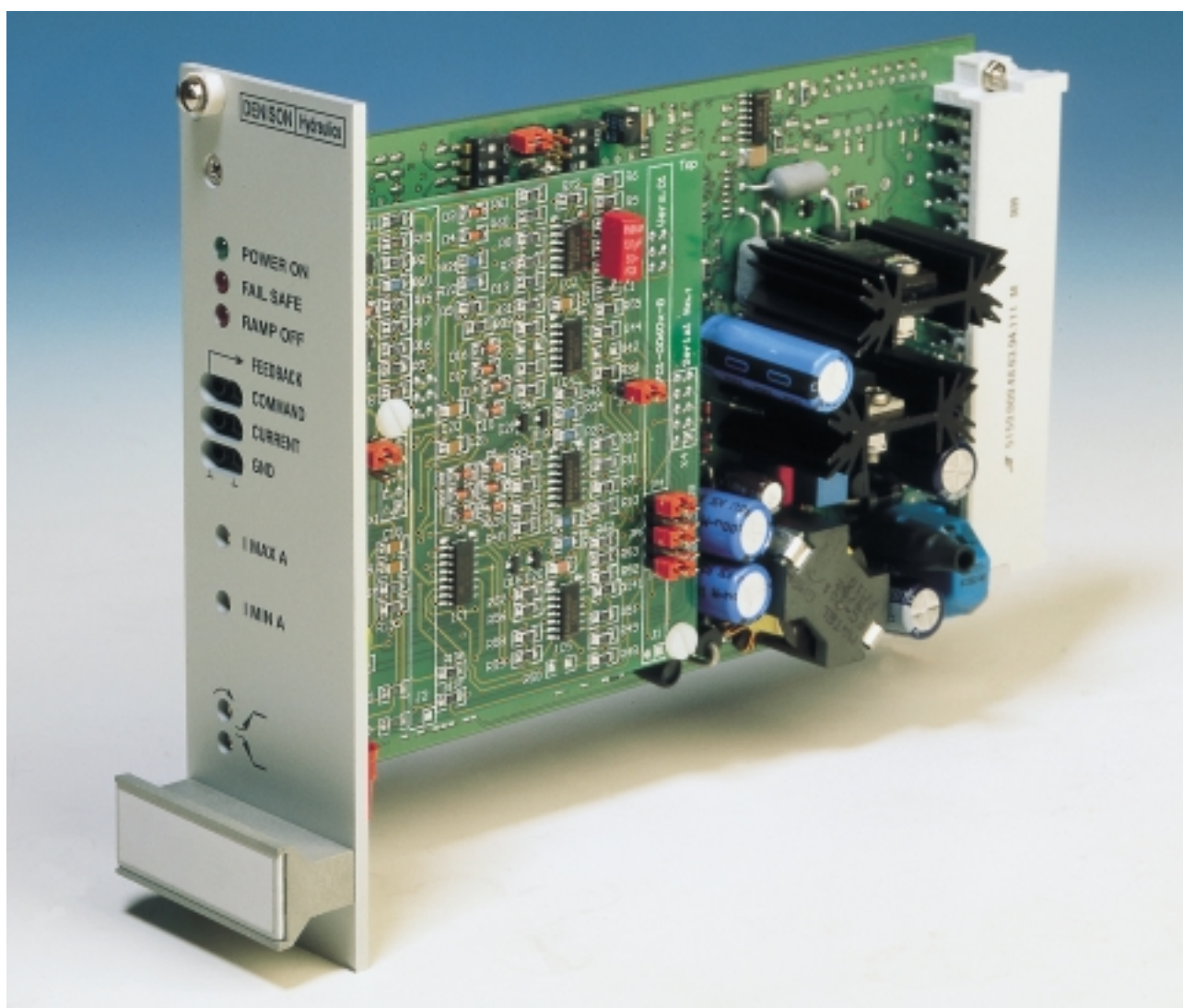


# DENISON HYDRAULICS Proportional Amplifier EC01 A1C

Part No. 701-00621-8



Publ. 9-EN 6030-A

**DENISON** Hydraulics

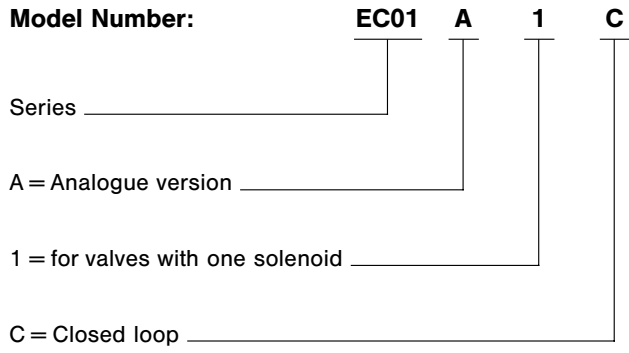
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## MODEL CODE, REFERENCE TABLE

### MODEL CODE



### REFERENCE TABLE

Series	Sol.	Order No.	Factory setting			
			Dither		Current	
			Frequency	Amplitude	I <sub>nom</sub>	I <sub>min</sub>
4DP02T	12 V	701-00621-8	150 Hz	200 mA	2950 mA	0 mA

## DESCRIPTION, FEATURES, SPECIFICATION

### DESCRIPTION

The proportional amplifier EC01 A1C has been developed to control several DENISON hydraulic proportional valves with a transducer, which operate with one (1) solenoid.

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...+ 5 V
  2. Voltage 0...+10 V
  3. Voltage customised selectable,  $R_{83} = 20\text{ k}\Omega / \text{V}$  (see layout diagram page 13)
  4. Current 0...+ 20 mA
  5. Current + 4...+ 20 mA
- Output voltage 24 V PWM for the solenoid
- Output current  $I_{\text{MAX}}$  approx. 3000 mA
- Range of adjustments:
  - $I_{\text{MAXA}}$   $I_{\text{MIN}} \dots 3000\text{ mA}$
  - $I_{\text{MINA}}$  0... approx. 50% of  $I_{\text{MAX}}$
  - Ramp up 1...50 V/s ( $\pm 20\%$ )
  - Ramp down 1...50 V/s ( $\pm 20\%$ )
- Dither amplitude 0...300 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 MAIN BOARD

### 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  $\pm 15$  V and  $\pm 10$  V (stabilised) are generated by a switched mode DC/DC converter on the board.

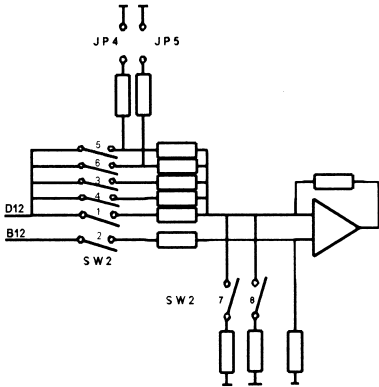
B2	= + 15 V	unstabilised	approx. 50 mA
B4	= - 15 V	unstabilised	approx. 50 mA
D2	= + 10 V	stabilised	approx. 10 mA
D4	= - 10 V	stabilised	approx. 10 mA

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



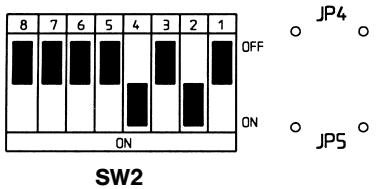
D12 = positive command voltage  
B12 = negative command voltage

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

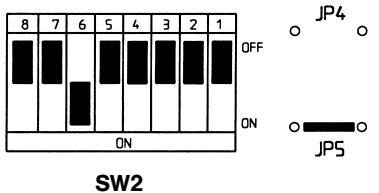


Because a differential amplifier can only work correctly when, for the input and feedback resistances, particular resistance combinations are selected (SW2/1...8), **this amplifier can only be used as a differential input amplifier when it is set up for a 10 V input signal.**

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).**

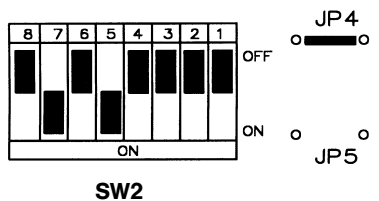
3.2. COMMAND INPUT WITHOUT DIFFERENTIAL INPUT FUNCTION



3.2.1 0...+ 20 mA COMMAND SIGNAL

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

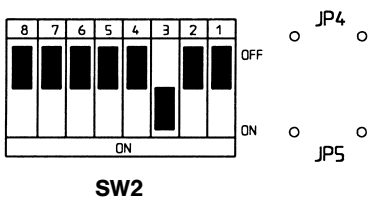
An input signal current of 0...+ 20 mA generates an output current of 0...I<sub>MAX</sub> A.  
The input impedance is 100 Ω.



3.2.2 + 4...+ 20 mA COMMAND SIGNAL

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

An input signal current of + 4...+ 20 mA generates an output current of I<sub>MAX</sub> A.  
The input impedance is 100 Ω.

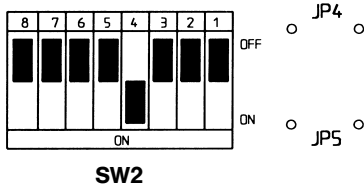


3.2.3 0...+ 5 V COMMAND SIGNAL

**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<sub>MAX</sub> A.  
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)!**

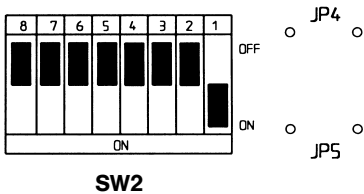
An input signal voltage of 0...+ 10 V generates an output current of 0...I<sub>MAX</sub> A.

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:

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

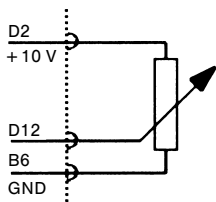
Example:

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 GND (pin B6). 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).

**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 FREQUENCIES 250 Hz and 100 Hz**

Not recommended for available valve ranges.

**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.

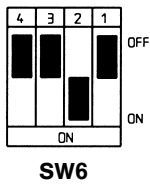
**4.3 DITHER AMPLITUDE**

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

200 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 is a 4 pole DIP switch (SW3) with which the maximum current value can be selected (see layout diagram page 13).

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

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

**5.1 Maximum Current 3000 mA**

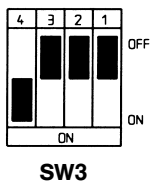
The maximum current should be set to 3000 mA for the following valve:

– 4DP02T

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

**5.2 Maximum Current 1600 mA, 800 mA, 400 mA**

Not recommended for available valve ranges.





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 stage is switched off.

B16 = +  $V_{digital}$   
 B20 = GND  $_{digital}$

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.

B18 = +  $V_{digital}$   
 B20 = GND  $_{digital}$

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

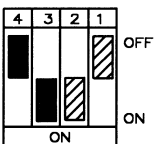


SW1

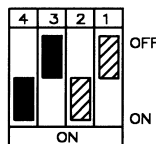
The input sensor 1 (pin D8) is designed for the use of LVDT position transducer with a D.C. output current of 4... 20 mA. As a current source must be terminated with a low impedance the associated impedance converter **must** be bypassed.

**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)



SW1



SW1

The input sensor 2 (pin B8) is designed for the use of LVDT position transducer with a D.C. output voltage of  $7.5V \pm 4.5V$ . 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!**

SW1/3 = on and SW1/4 = off      Sensor 2 with impedance converter  
 SW1/3 = off and SW1/4 = on      Sensor 2 without impedance converter

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".

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

( $x \leq 10$  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".

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

(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  $0 \dots - 10 \text{ V}$  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 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 the following jumper configuration applies:

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

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

### 9.4 CURRENT MEASURING POINT

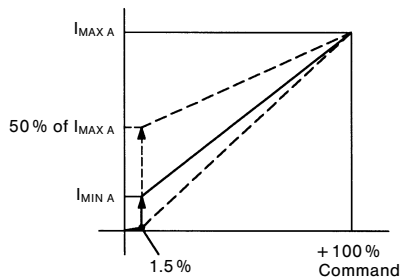
At this measuring point there is a voltage signal proportional to the current.  
 $1 \text{ V} \triangleq 1 \text{ A} \pm 10 \%$ .

### 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<sub>MIN</sub> Setting

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

Clockwise adjustment of the potentiometer increases the I<sub>MIN</sub> value and vice versa.

### 10.2 I<sub>MIN</sub> Step Function

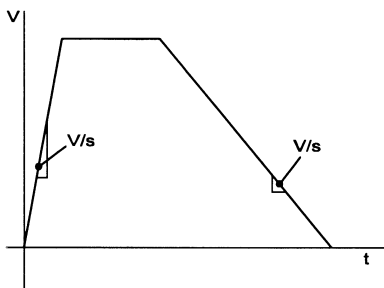
The I<sub>MIN</sub> step function is necessary when the valve current should be 0 mA with a command of 0 V. At 0 V command there is no current to the valve. When the command is only slightly above 0 V (approx. 1.5 % of the maximum command value) then the current jumps from 0 to I<sub>MIN</sub> (see 10.1).

### 10.3 I<sub>MAX</sub> Setting

The maximum output current can be limited by adjusting the I<sub>MAX</sub> 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<sub>MAX</sub> can be set in the range I<sub>MIN</sub> to 2950 mA.

Clockwise adjustment of the potentiometer increases the I<sub>MAX</sub> 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.

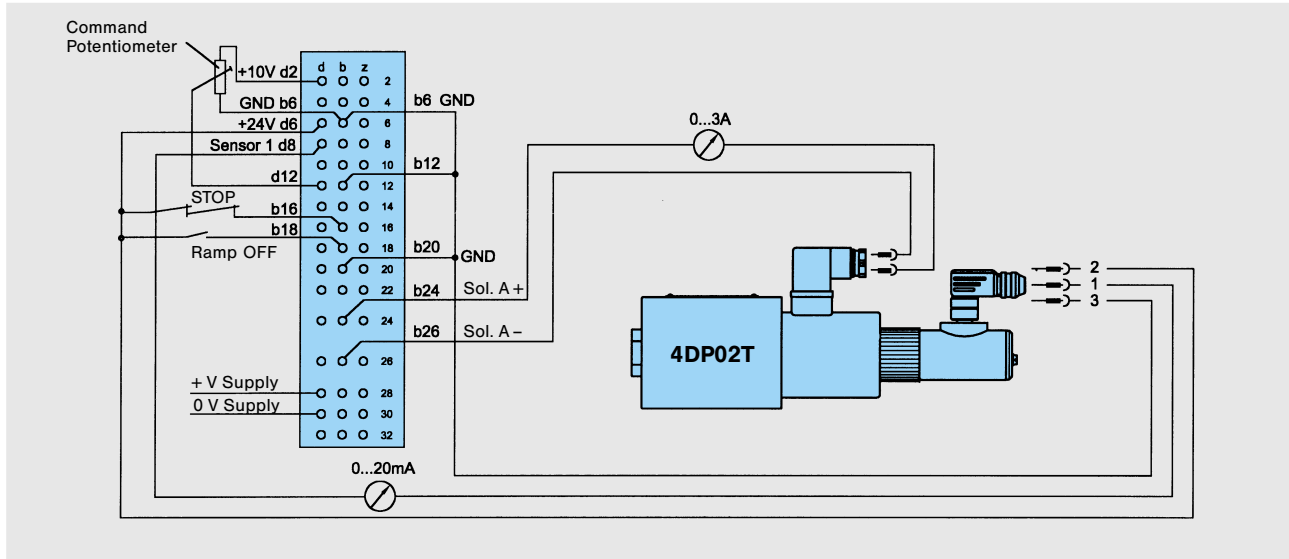
1 V/s corresponds to 10 s ramp time for a command jump from 0 to 10 V.

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

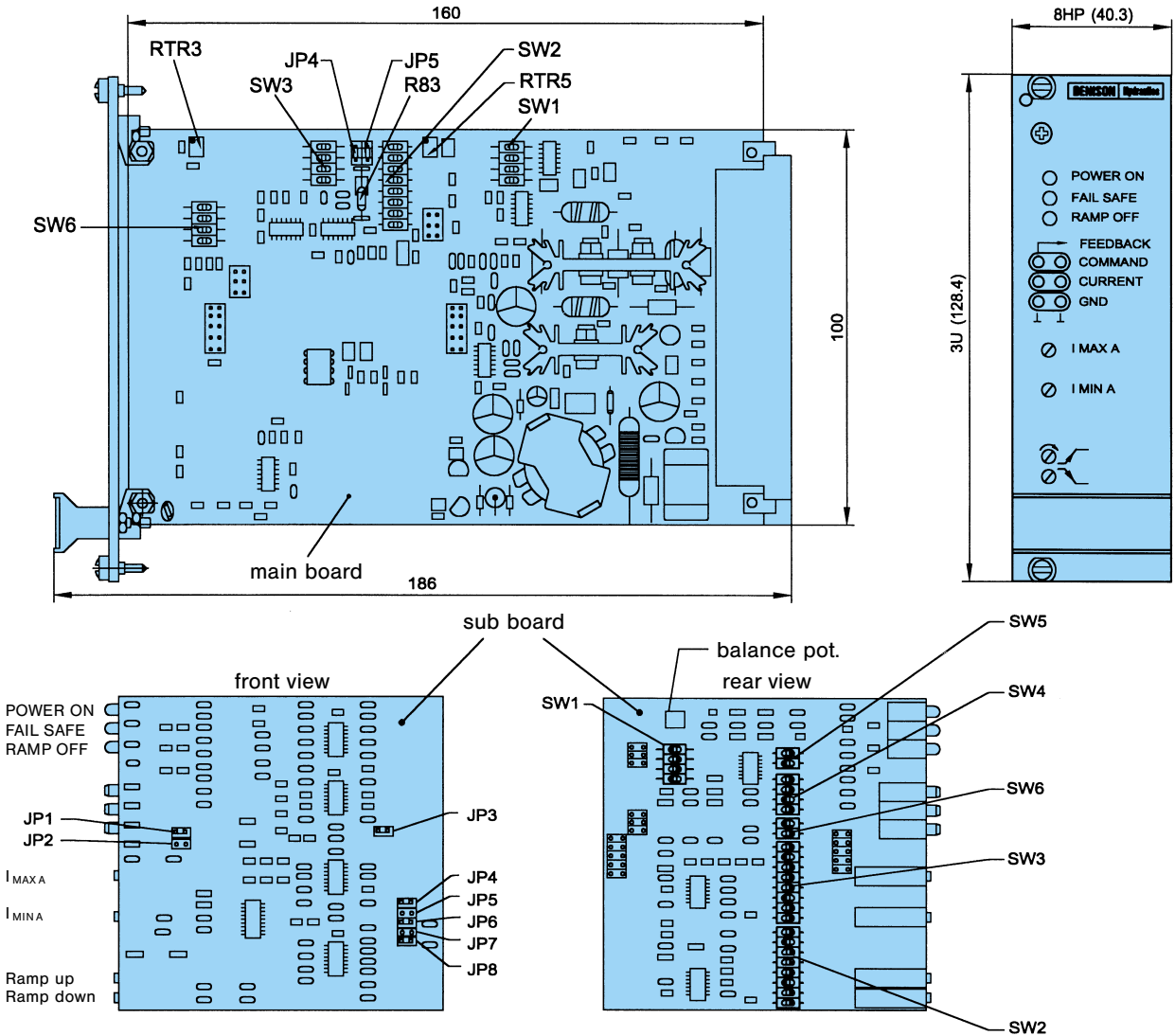
- Connect the amplifier with the valve according to the connection diagram shown below.
- Connect a current meter (range 0...3 A) in the solenoid coil circuit or one volt meter (range 0...5 V) in the test sockets on the front panel (1. Current = +V and 2. = GND). The relationship is 1 V/A.
- Connect 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).



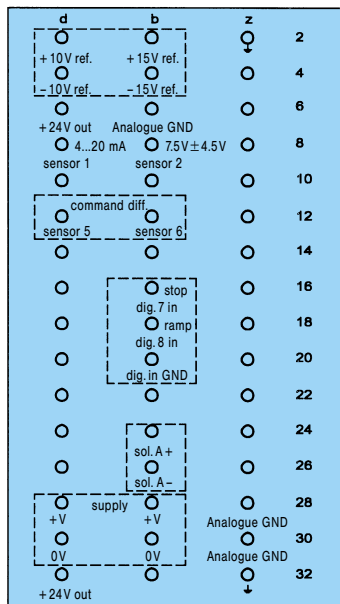
- Set command potentiometer, both ramp potentiometers, “ $I_{MIN A}$ ” and “ $I_{MAX A}$ ” potentiometers to zero.
- Connect the power supply and check if the LED “Power on” is on. The LED “Fail safe” should be off and the ramp function should be switched off (LED “Ramp off” is on) so that the set up is easier.
- With unplugged solenoid connector 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.
- 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  $I_{MAX A}$ .
- Set the ramp times for stepwise changes in the command value 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  $I_{MIN A}$  and  $I_{MAX A}$  to zero
  2. adjust  $I_{MIN A}$  to the required value and
  3. adjust  $I_{MAX A}$  to the required value

# LAYOUT DIAGRAM AND STANDARD PIN ASSIGNMENT

## 13. LAYOUT DIAGRAM

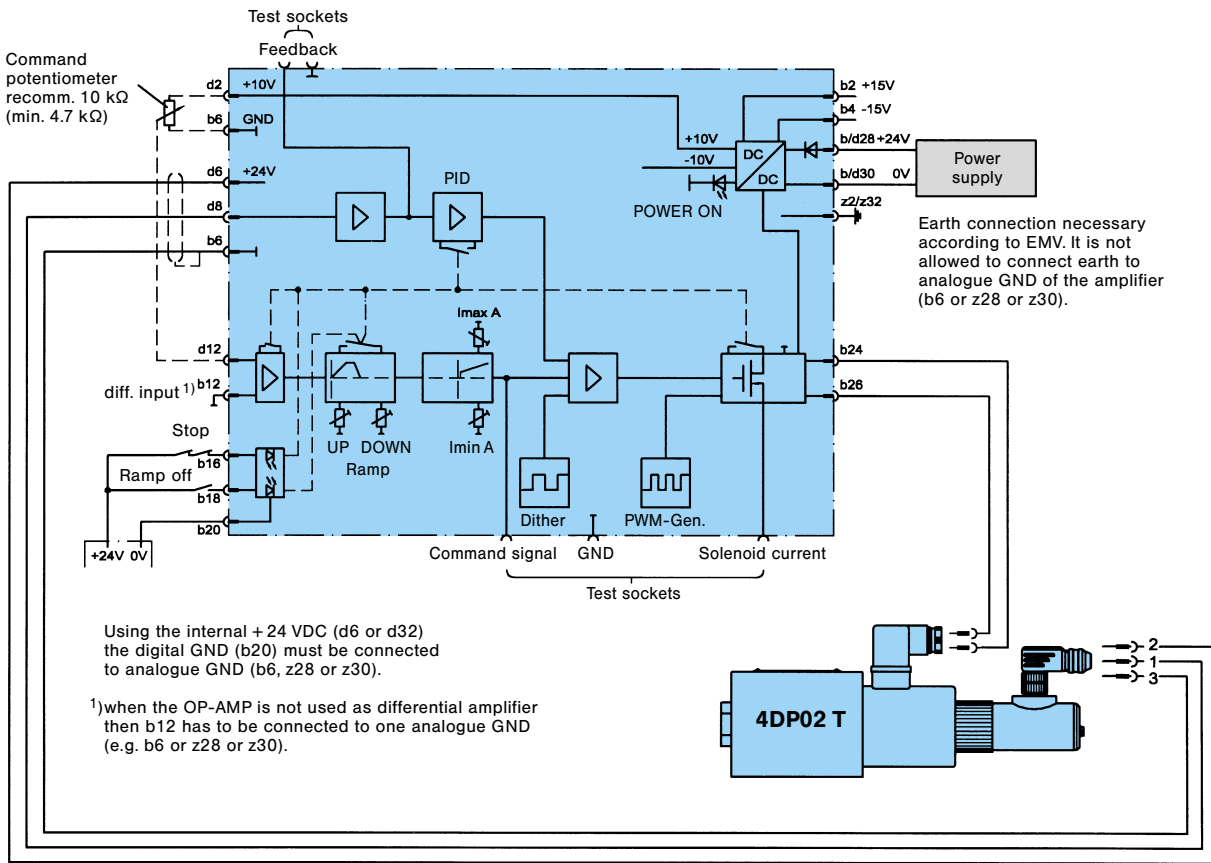


## 14. STANDARD PIN ASSIGNMENT

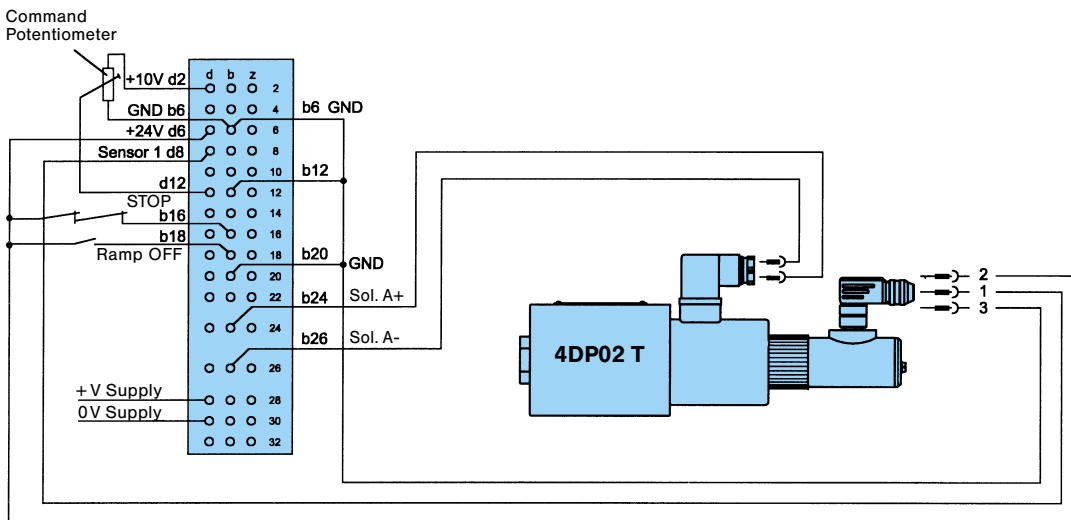


# SCHEMATIC & CONNECTION DIAGRAM

## 15. SCHEMATIC DIAGRAM



## 16. CONNECTION DIAGRAM (Example)



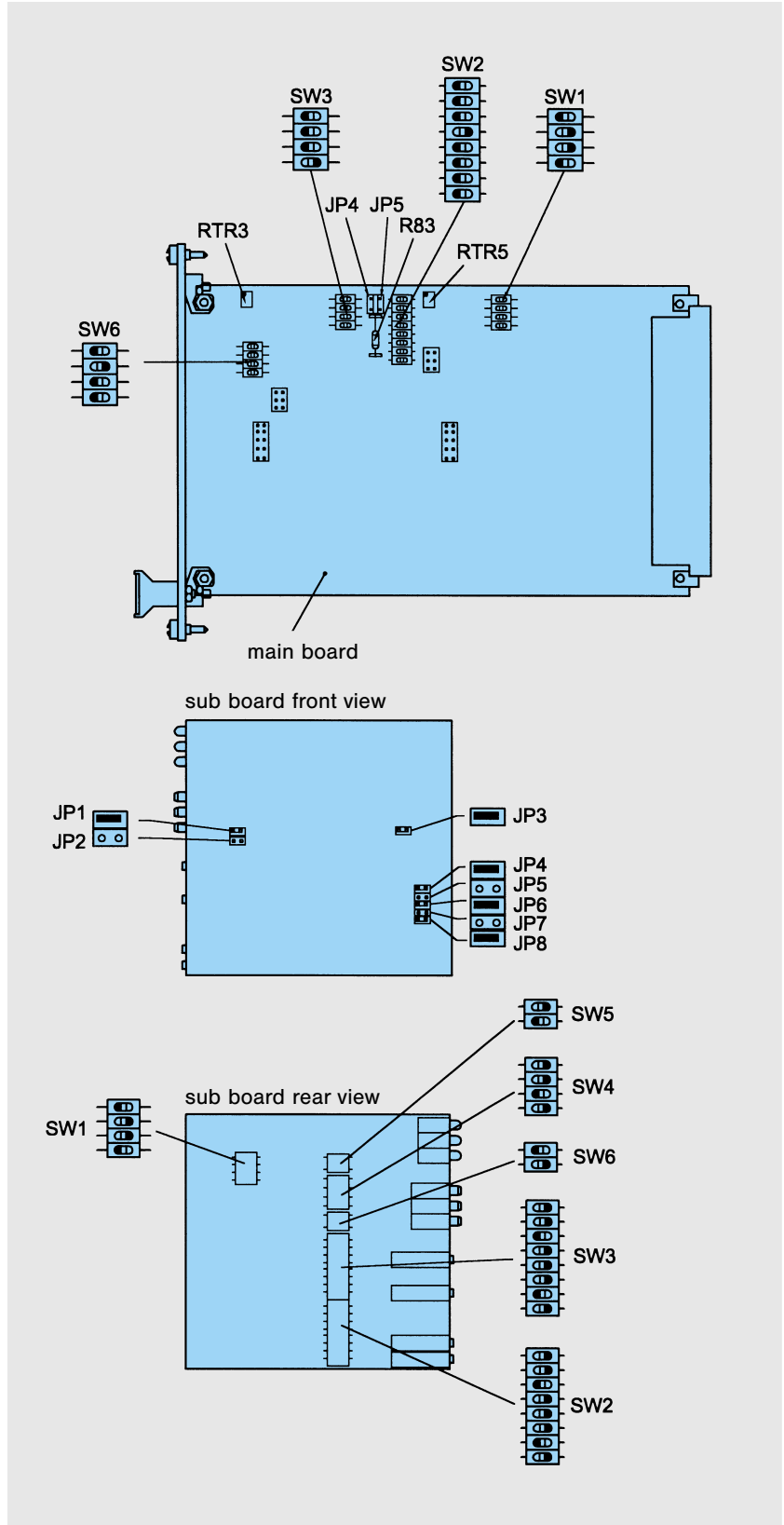
**Note:**

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. 701-00621-8



## TROUBLESHOOTING

### 18. TROUBLESHOOTING

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

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