Instruction Manual

DULCOMETER®
Type D_4a, measured variable pH

Please enter identcode here!

D_4a ___ ___ ___ ___ ___ ___ ___ ___ ___

Please read the Operating Instructions through completely before commissioning this equipment. Do not discard!
Any part which has been subject to misuse is excluded from the warranty!

ProMinent Dosiertechnik GmbH · 69123 Heidelberg · Germany
BA DM 125 08/05 GB
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Operating Instructions
DULCOMETER®, Type D_4a, measured variable pH
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Subject to technical alterations.
Fig. 1: Cross section of metering pump with built-in control system, type D_4a

Fig. 2: Front view showing connectors, displays and controls
Explanation of Symbols

- Set value (display or adjustor)
- Stroke indication
- Manual operation
- Zero calibration, probe
- Slope calibration, probe
- Proportional bandwidth
- Control time (display or adjustor)
- Automatic operation
- Indication of measured value (metering pump off)
- State of relay indication
- Warning display
- Tank empty/Float switch
- Stroke distance adjustment
- Off, control voltage off
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## Ordering System for DULCOMETER® Controller

<table>
<thead>
<tr>
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<th>D Pump Type 4 Version a, measured variable pH</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Measured variable</strong></td>
<td><strong>PH measuring range 0 - 14 pH</strong></td>
</tr>
</tbody>
</table>

### Pump type
- 1601 16 bar; 0.84 l/h (0.54 l/h Version NS)
- 1201 12 bar; 1.45 l/h (0.84 l/h Version NS)
- 0803 8 bar; 2.86 l/h (1.98 l/h Version NS)
- 1022 10 bar; 1.91 l/h (1.50 l/h Version NS)
- 0308 3 bar; 7.00 l/h
- 0215 2 bar; 12.20 l/h

### Liquid end material
- **XX** Without delivery unit
- **NP** Acrylic glass with FPM O-ring
- **NS** Acrylic glass self-bleeding/FPM (not to 0308, 0215)
- **PP** Polypropylene with EPDM O-ring
- **TT** PTFE + 25 % carbon with PTFE seal
- **SS** Stainless steel 1.4571 with PTFE seal

### Electrical connection
- **A** 230 V; 50/60 Hz with Euro plug
- **B** 230 V; 50/60 Hz with Switzerland plug
- **C** 230 V; 50/60 Hz with Australia plug
- **D** 115 V; 50/60 Hz with USA plug

### Connection of measured variable
- 2 SN6 PH
- 7 Plug connector DIN 19262 (without reference electrode connection) PH
- 8 SN6 with reference electrode connection PH
- 9 Plug connector DIN 19262 with reference electrode connection PH

### Correction variable
- 0 None
- 1 Temperature (SN6) PH

### Control direction
- 1 Raise measured value
- 2 Lower measured value
- 3 Control direction selectable (pH)

### Signal current output
- 0 None
- 1 0/4...20 mA ± pH 1...12

### Relay
- 0 None
- A Relay output, level (pick-up action)
- B Relay output, clock generator pump stroke (pick-up action)
- C Relay output, pump stop (pick-up action)
- D Relay output, setpoint reached (pick-up action)
- E Control time monitoring (pick-up action)
- F Safety and power failure signalling relay (drop-out action)
General Instruction for Use

Please read through the following instructions carefully. Knowledge of these instructions will help you use the operating instructions manual more effectively.

Points are highlighted as follows

- Indicates step by step instructions
- Indicates enumerated points

User guidelines

**IMPORTANT**
Guidelines are intended to make your job easier.

and safety guidelines:

**WARNING**
Describes a possibly hazardous situation.
If the situation is not avoided you will be in grave danger and may lead to serious injury.

**NOTICE**
Could result in damage to property if safety guidelines are not observed.
**NOTICE**

- Check by means of the packing list or delivery note whether shipment is complete. Small parts often hide in the packing material.

**NOTICE**

- Read the whole instruction manual carefully before connecting the system to the power supply and putting it into service.

1 **Introduction**

The DULCOMETER® system type D_4a represents a packaged pH measuring, indicating and controlled chemical feed system integrated into a solenoid-operated metering pump.

2 **General Description (Fig. 1)**

For manufacturing and marketing purposes, the pump with built-in control system is separated into two modules which must be ordered separately:

1. Driving unit with built-in control system
2. Liquid end (pump head, diaphragm and intermediate disk)

The housing of the driving unit consists of a chemical-resistant plastic material (glass fibre reinforced Noryl). The short-stroke solenoid directly actuates a diaphragm, which displaces the media in the pump head. The entire actuating and control circuitry is located on the circuit boards and . Two optional circuit boards (standard output signal) and (control time) are available on request and will be charged for extra.

The fuse serves as a short circuit protection. The stroke distance (stroke volume) can be varied by means of knob; the selector switch allows to choose the operating mode. The direction of control (feeding of acid or base) can be selected by means of slide switch inside the housing.
Description of Connectors, Displays and Controls

3 Description of Connectors, Displays and Controls (Fig. 2)

3.1 Connectors

1. Power cord
2. Cable gland PG 7 exists only with relay option (A-F), otherwise a PG 7 blind plug will be there.
   In case with option correction variable temperature a red SN 6 connector will be mounted there.
3. Connector for float switch: If the float switch is connected, the pump will stop and the red LED 12 be lit
   when the minimum level of the chemical feed tank is arrived at.
4. Socket “SN 6 moisture-protected” for connection of a pH probe
5. Pin Socket “Reference Electrode”: only with option: connection of measured variable: SN 6 with
   reference electrode connection pH.
   In case of using a separate probe, the reference electrode must be connected to the pin socket. The
   glass electrode will then be connected to pos. 4.
6. Cable gland PG 9 for standard signal output does only exist, if option: “signal current output 0/4...20 mA”
   was ordered.
   If option “plug connector DIN 19262” was ordered, a connection socket for a DIN 19262 plug for
   connection of a pH combination probe will be there.
   Connection pos. 4 is either not or provided with a cable gland PG 9 for standard signal output.
7. Pin socket, to be connected with the “sample reference potential” stainless steel rod in the sample
   solution. When used, the jumper KB 10 on the circuit board (see 3.4.1) must be removed.

3.2 Displays on the Front Plate

<table>
<thead>
<tr>
<th>Item</th>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
</table>
| 8    | 3-digit liquid crystal display (LCD), displaying the measured value a simulated value or the
       set value, depending on the position of selector switch 21. |
| 9    | Green LED; will be lit when the set value is reached and pump stops. |
| 10   | Yellow LED; flashes with each pump stroke. |
| 11   | Red LED; will be lit in connection with the relay functions ordered as options (A-F). The LED
       shows the pulled-in state of the relay. |
| 12   | Red LED; will be lit continuously when the liquid level in the chemical feed tank drops to a
       minimum, if a float switch is connected to 3. Flashes unless selector switch 21 is switched
       to the AUTOMATIC or AUTOMATIC + CONTROL TIME modes. |
| 13   | Green LED; burns as long as (with relay option E) control time is activated by means of
       selector switch 21, that is, selector switch is set to and the set value is not yet
       achieved. |
### Description of Connectors, Displays and Controls

#### 3.3 Controls

<table>
<thead>
<tr>
<th>Item</th>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td></td>
<td>Potentiometer to adjust set value. If selector switch (21) is in position (1), the set value is displayed on the LCD read-out (8).</td>
</tr>
<tr>
<td>13</td>
<td></td>
<td>Potentiometer for zero calibration (only for pH probes having their zero voltage at pH 7).</td>
</tr>
<tr>
<td>14</td>
<td></td>
<td>Potentiometer for slope calibration of the pH probe, e.g., at pH 4 or pH 10.</td>
</tr>
<tr>
<td>15</td>
<td></td>
<td>Potentiometer to vary the proportional bandwidth, that is, the zone within which the stroking rate decreases from 100 to 15 % as the actual value approaches the set value.</td>
</tr>
<tr>
<td>16</td>
<td></td>
<td>Inoperative unless relay option E was ordered: Potentiometer to set control time that is the time within which the set value can be normally achieved. In case of faults, (e.g., faulty pH probe), the pump stops and the control relay pulls in when the pre-selected control time is exceeded. Simultaneously, the red LED (11) will be illuminated and the control relay will be available for fault annunciation. The pump will not be switched off when jumper KB 11 on the timer circuit board (Fig. 3b) is pulled out. The green LED (18) burns as long as the control time is activated and goes out when the control time has elapsed or the set point has been achieved.</td>
</tr>
<tr>
<td>17</td>
<td></td>
<td>Potentiometer to simulate measured values. Selector switch (21) must be in position (5). Irrespective of the actual measurement, any desired stroking rate can be selected manually by deliberately producing a corresponding error between the simulated measured value and the set value.</td>
</tr>
<tr>
<td>18</td>
<td></td>
<td>Stroke distance control, to select feed volume per stroke.</td>
</tr>
<tr>
<td>19</td>
<td></td>
<td><strong>6-position selector switch</strong>, to select the following modes (from left to right):</td>
</tr>
<tr>
<td></td>
<td></td>
<td>MANUAL: Depending on the set value selected, and the measured value simulated by means of potentiometer (19), the stroking rate may be selected at pleasure. The LCD read-out indicates the simulated measured value.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>OFF: The device is switched off on the control voltage side.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>MEASUREMENT: The measured value is read out. No feeding takes place. This position is used to calibrate the probe.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SET VALUE DISPLAY: The LCD read-out indicates the set value as selected by means of potentiometer (14).</td>
</tr>
<tr>
<td></td>
<td></td>
<td>AUTOMATIC: The control system is in operation and additive feeding takes place relative to the error. The LCD read-out indicates the measured value.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>AUTOMATIC + CONTROL TIME: Automatic operation plus activation of the control time (if relay option E was ordered). The set value must be arrived at within the time set by potentiometer (18), otherwise the pump will stop, LED (13) will go out, LED (11) will be lit and the appropriate relay pulled in.</td>
</tr>
<tr>
<td>20</td>
<td></td>
<td>Change-over switch “Pt 100”/“20 °C” (Option correction variable temperature only)</td>
</tr>
<tr>
<td>21</td>
<td></td>
<td>Control action change-over switch “Acid (Säure)/Caustic (Lauge)” (Options D 13 or D 14 only)</td>
</tr>
</tbody>
</table>
Description of Connectors, Displays and Controls

![Control Circuit Board](image)

**Fig. 3: Control circuit board**

**NOTICE**
The figures (1 to 8) indicated below the jumper strip KB 1 to KB 8 apply. Jumper KB 4 is factory-inserted; relay pulls in.
Description of Connectors, Displays and Controls

Fig. 3a: Control time circuit board

Timer function with pump stop by KB 11

Fig. 3b: Standard output signal circuit board

KB 2 closed = 0...20 mA
KB 2 open = 4...20 mA
Description of Connectors, Displays and Controls

Fig. 4: View of control circuit

Fig. 4a: Direction-of-control swift

Fig. 4b: Jumper strip

Fig. 5: Interior view of pump housing with control-time circuit board
3.4 Internal Terminals and Control Facilities

**WARNING**

Pull mains plug before opening the pump!

To remove the electronic circuit, undo the 6 Philips head screws. Pull the orange colored front panel and the whole control circuitry out. This provides access to the direction-of-control switch (Fig. 1). To separate the circuitry from the pump, disconnect the blue solenoid connector in the upper section of the circuit board, and the protective earth connector (yellow-green cable) at the solenoid. If option D 07 “control time” is available in form of the optional circuit board (Figs. 1, 3a) the 8-pole flat cable connector can be disconnected at the circuit board.

3.4.1 Control Circuit Board (Fig. 3 and 4)

Fig. 3 gives a view of the control circuit board of Fig. 1. The connector of the solenoid is located at the top right. SL 7 at the top left is a connector strip to accommodate the optional circuit board “Standard output signal” (Fig. 3b) if option signal output was ordered. This optional circuit board must be plugged in in a way that the potentiometer screws face the edge of the circuit board. Below, there is an 8-pole socket DIL 8, accepting the flat cable connector of the optional circuit board (Figs. 1, 3a and 5) when relay option E “Control time” is included. Next to the right lower corner of the DIL 8 socket, there are 8 plug-in jumpers KB 1 to KB 8 which have the following functions when open or closed:

- **KB 1**: No connections, no jumper
- **KB 2**: In case of option “Standard output signal”, the signal range is 0...20 mA with the jumper in place, and 4...20 mA without jumper, both ranges corresponding to pH 2...12
- **KB 3**: No connection, no jumper
- **KB 4**: Inversion of relay function. With options having a relay output, the relay function can be changed from normally open to normally closed by removing the factory-made jumper connection
- **KB 5**: With relay option E “Control time”, this position is jumpered in order to actuate the relay
- **KB 6**: With relay option B “Pacing relay”, this position is jumpered. The output relay REL will be actuated synchronously with each pump stroke
- **KB 7**: With relay option C “Pump stop”, this position is jumpered. The output relay REL will pull in whenever the pump is stopped, e.g. when the chemical feed tank is empty or the set value is achieved.
- **KB 8**: With relay option A “Tank level”, this position is jumpered. When a float switch is connected and signals the minimum level, the pump will stop and the output relay REL will pull in
- **KB 9**: With relay option D “Set value achieved”, this position is jumpered. The output relay REL will pull in when the set value is achieved, that is, when the pump is stopped

On the bottom left of the control circuit board, there is the important jumper KB 10: It must be in place when the pH is measured without the “Sample reference potential” being connected to socket . If the sample reference potential (stainless steel bar in sample solution) is connected, as is recommended for an interference-free pH measurement, the jumper KB 10 must be removed.

Relay REL exists in various options.

Fuse protects the electronic circuit and the solenoid against short circuits.
Description of Connectors, Displays and Controls

Fig. 4 shows distinctly some of the components described above: The optional circuit board “Standard output signal” (G), the solenoid connector (MG), the jumpers (KB), the output relay REL, the fuse holder (SI) and the direction-of-control switch (M).

3.4.2 Pump Housing and Solenoid (Fig. 5)

Fig. 5 gives a view of the interior of the black pump housing. The short-stroke solenoid (B) can be seen distinctly. On the bottom of the solenoid, there is the protective earth connector (SI). Below, one can see the optional circuit board (H) with relay option E (“Control time”) with the time selector switch which permits the selection of 8 control time ranges between 1 minute and 6 hours.

Fig. 6 shows the possible settings with relay option E “Control timer”. The slide switch allows 8 time ranges to be set. In the center, potentiometer (18) of the front panel is shown which allows a fine adjustment within the selected time range.

Standard setting: Selector switch: 3
Potentiometer at maximum right: 90 minutes
Open pump housing to obtain access to the selector switch

Fig. 6 Option Control Time
Control time range selector switch Factory setting:
Range 3 (32 min. to 90 min.)
4 Description of the Metering Pump

The DULCOMETER® metering pump type D_4a is an electronically controlled short-stroke solenoid-driven diaphragm-type metering pump.

The pump discharge is discontinuous. Discrete pulses generated by an electronic circuit each energize the solenoid, causing the armature to produce a pump stroke of maximum length of 1.25 mm. The steel-cored diaphragm displaces the media in the liquid end and the valve balls on the suction side are pressed tightly against their seats whilst those on the discharge side open and release the media into the discharge line. Since the duration of the pulse is limited, the solenoid will be de-energized when the stroke has been completed and a spring causes the armature to return to its original position. The discharge valve closes whilst the suction valves open, allowing the media to be drawn into the liquid end.

The stroke volume can be infinitely varied from 100-10 % through knob 20. The adjustment should be made step by step with the pump operating since, while a stroke is being performed, the spindle is relieved for a short moment.

4.1 Installation of the Metering Pump (Fig. 7)

Mount the pump either directly on the top of the chemical feed tank or onto a wall bracket. The valves of the liquid end should always be aligned vertically. The use of a combined footvalve and float switch in the chemical feed tank is recommended. Plug the flat connector into the socket 3. The suction line should slope upward in the direction of flow. The footvalve should hang just clear of the tank bottom. Use an injection valve or an injection lance if the pump is to discharge into a pressurized system.

Further information is contained in the following Section.

Fig. 7: Installation of metering pump
Description of the Metering Pump

4.2 Typical Installation of the Metering Pump

1. Standard arrangement

1 = Metering pump
2 = Chemical feed tank
3 = Foot valve with strainer and non-return valve
4 = Injection valve, spring-loaded
5 = Injection valve with enhanced spring action
6 = Back-pressure valve, adjustable
7 = Accumulator
8 = Solenoid-operated valve

2. Positive suction head for media tending to emit vapor

3. Injection into vacuum systems
How the Pump Should Not Be Installed:

4. Faulty arrangement, suction lift too high

7. Faulty arrangement, accumulator ineffective

5. Faulty arrangement, suction line without air bleeding facilities

8. Correct location of backpressure valve (or spring-loaded injection valve with reinforced spring)

6. Faulty arrangement, positive suction head too high

Formula to calculate the maximum permissible vertical distance \( h_{\text{max}} \) of discharge line above backpressure valve:

\[
 h_{\text{max}} = \frac{P_v \times 14.3}{\rho \times g} \text{ (m)}
\]

- \( \rho \) = Mass density (kg/dm³)
- \( h_{\text{max}} \) = Height of line above backpressure valve (m)
- \( P_v \) = Pressure setting of back pressure valve (bar)
- \( g \) = Gravity constant \( g = 10 \text{ m/s}^2 \)
Description of the Metering Pump

4.3 Suction Lift of the Metering Pump

Depending on the pump type, the maximum suction lift is 2 - 5 mWC. (Table 1). The suction lift with an empty pump head depends on the stroke volume and is lower for low stroke volumes. The pump cannot prime against a head.

If the pump feeds into a pressurized system and has drawn air, the air will be just compressed within the pump head. In this case the discharge line must be disconnected and the air be allowed to escape until the suction line and the pump head are completely filled and free of bubbles.

The type D.4a 1601-0308 NP and PP pumps can be air-bled without disconnection of the discharge line when the air bleeding valve on the liquid end is loosened by a turn.

Table 1: Maximum suction lift of metering pumps

<table>
<thead>
<tr>
<th>Type D.4a</th>
<th>1601</th>
<th>1201</th>
<th>0803</th>
<th>1002</th>
<th>0308</th>
<th>0215</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum suction lift mWC.</td>
<td>6</td>
<td>6</td>
<td>3</td>
<td>6</td>
<td>6</td>
<td>1.5</td>
</tr>
</tbody>
</table>

With media tending to emit vapors, a positive suction head is recommended. This is realized by placing the metering pump on a plinth or bracket at the foot of the chemical feed tank (see Section 4.2, Fig. 2).

Continuously fine bleeding of approx. 20 % of the dosing rate can be adjustet with the needle valve (Fig. 9, Pos. 8).

In order to prevent overfeeding or siphoning when the pump feeds into a vacuum system, e.g, the suction line of a recirculating pump, a backpressure valve should be installed on the liquid end in addition to the injection valve. A maximum of protection will be obtained by the use of a solenoid valve in the discharge line interconnected with the metering pump. This, however, is not necessary except for very high vacuum (Section 4.2, Fig. 3).
5 Commissioning

When the pump has been installed according to the suggestions made in Sections 4.1 to 4.3, place the selector switch on the front plate into the position OFF and make the electrical connections.

5.1 Electrical Connections

With reference to Fig. 2, the electrical connections can be made in the following order:

1. Connect the metering pump to the mains power supply via power plug

2. Option “Relay Output” if available: No-voltage contacts with the following functions:
   - Green = Normally closed contact (NC)
   - Brown = Common contact (C)
   - White = Normally open contact (NO)

3. Connection of the float switch via flat connector, if available

4. Connection of the pH combination probe, or the glass electrode if SN 6 with reference electrode connection pH is available

5. Connection of the reference electrode if (pin socket “Reference electrode”) is available

6. Connection of the recorder via signal cable if Option signal current output is available:
   - Brown: +
   - White: –

7. Connection of the “Sample reference potential”. This is a stainless steel pin immersed in the sample liquid. ProMinent® in-line or immersion probe housings already have this pin fitted.

**NOTICE:**

When use of the sample reference potential is made, remove jumper KB 10 on the control circuit board. Otherwise KB 10 must remain jumpered.

5.2 Installation of pH Probes

pH glass electrodes or combination probes should always be installed protected in a suitable manner, e.g. in an in-line or an immersion type probe housing. The operating conditions for the type of electrode used should be strictly observed. Enclosed, gel-filled pH combination probes (ProMinent®-Type PHE) should not be subject to any liquid pressure, that is, if an in-line probe housing is used, its discharge flow should be “open-ended”.

Irrespective of the working conditions, regular maintenance of the probes is imperative.

The location of the point of measurement and the sampling point of the sample liquid should be selected very carefully with due respect to the requirements of closed-loop control.

For installations in swimming pools detailed information on installation and operation can be obtained from your swimming pool supplier or ProMinent Dosierotechnik GmbH.
5.3 Calibration of Probes

To tune the electrode to the built-in transmitter, place selector switch 21 on the front plate into the position MEASUREMENT. With the switch in this position, no additive feeding takes place. The measured pH value will be displayed on the read-out 8.

Zero calibration is made by means of potentiometer 15. Immerse the glass electrode or the combination probe together with the stainless steel pin (sample reference potential) into a buffer (calibrating) solution pH 7 while the jumper KB 10 (see Section 5.1) is open. If the stainless steel pin is not being used, jumper KB 10 must be closed. Turn potentiometer 15 so as to obtain a stable reading of 7.0 pH on the display.

Rinse the probe with water and carry out the slope calibration by means of the potentiometer 16 and a buffer solution having a pH different from 7, e.g. pH 4 or pH 10. Wait until the reading is stable.

Repeat both zero and slope calibrations to make sure that the values of the buffer solutions are correctly displayed.

Having completed calibration, install the probe in the probe housing ready for measurement and control.

IMPORTANT:
In the case of a probe failure an incorrect measured value can be read. This can lead to uncontrolled feeding. The customer must therefore ensure that as a result of this no consequential damage can occur. Possible safety measures are described below:

pH-measurement
Dirt deposits ageing, contamination of the reference electrode, dampness in the plug connections, cable rupture or mechanical damage (e.g. glass breakage) of pH probes can lead to any signals between pH 10 and 14.

As a safety measure the alarm values as well as the check time can be used.

The highest degree of safety is however only possible with a pH difference measurement (second probe). In general, regular probe maintenance (visual/functional checks, calibration) is necessary.

5.4 Setting the Set Value

To set the set value place selector switch 21 on the front plate into the position SET VALUE DISPLAY.

The LCD read-out will display the set value which can be set to any value between pH 0 and pH 14 by means of potentiometer 14.

NOTICE:
During this procedure the metering pump will start to operate if the measured value differs from the set value.
5.5 Direction of Control Action

Unless ordered otherwise, the factory setting of the control direction is for acid feeding (when the measured value exceeds the set value). The control direction can be changed by means of the slide switch inside the pump (see Figs. 1 and 4):

- Switch position upward = acid feeding
- Switch position downward = alkali feeding

If the pump has been ordered with Option D 13 (Part No. 81.81.18.2), an externally accessible control action change-over switch “Acid (Säure)/Caustic (Lauge)” is provided on the operator panel, see Fig. 2.

5.6 Automatic Operation

To put the system into the automatic mode, place selector switch 21 on the front plate into the positions AUTOMATIC or (if Option is available) AUTOMATIC + CONTROL TIME. In both switch positions the red LED under the switch does not flash. In all other switch positions except OFF the LED flashes to indicate that the system is not in the automatic mode.

In the AUTOMATIC + CONTROL TIME mode, the green LED will be illuminated if a disturbance occurs, and the timer will be started. If the set value is not achieved within the pre-set control time, the green LED will be extinguished, the metering pump will stop, the red LED will be illuminated and the output relay will pull in and actuate an alarm. The alarm can be reset by a short actuation of the selector switch 21 to restart the control system and the timer. The time check will start from the beginning every time a new disturbance occurs after the set value was achieved. That means that the control times are not summated.

The control time should be selected that in normal operation the set value will always be achieved within the control time. Only serious faults like electrode failure or lack of chemicals should cause the control time to be exceeded and alarm to be given.

For setting the control time refer to Figs. 5 and 6 and section 3.4.2.

5.7 Proportional Bandwidth

After the metering pump has been put into the automatic control mode, the controller has to be tuned to the process characteristics by means of potentiometer PROPORTIONAL BANDWIDTH. On the one hand the controller should suppress any disturbance as early as possible, on the other hand there should be no overshooting of the set value. Usually one begins with the maximum setting (turn potentiometer clockwise into its end position) when the controller emits the maximum pulse rate at a disturbance of as little as 1 pH. In this position the set value will be achieved within a minimum of time. However, if the set value is not only restored but overshot, the proportional bandwidth must be reduced (turn potentiometer anticlockwise) until overshooting does not occur any more.

It may also be necessary to adapt the stroke distance of the metering pump to the process. The stroke distance must be substantially reduced if, for instance, a few pump strokes already are capable not only of restoring the set value but of overshooting it.
Fig. 8 shows the characteristics of the stroking rate of a metering pump feeding alkali. The set value be pH 7. At the maximum proportional bandwidth setting the maximum stroking rate will be generated when the error is as low as $\Delta \text{pH} = 1$. At the minimum setting of the proportional bandwidth it takes an error of $\Delta \text{pH} = 3$ to produce the maximum stroking rate.

5.8 Manual Operation

The metering pump with built-in control system can be also controlled manually without reference to the measured pH value. This, for instance, may be useful in case of an electrode failure. In this mode the feeding rate can be controlled by variation of the stroking rate in addition to the variation of the stroke distance. The selector switch is to be placed into the position MANUAL. By turning the potentiometer one can simulate any measured value and thus any error so that the stroking rate can be varied between 15 and a maximum of 100 spm.

Fig. 8: Control characteristics of a type D_4a PH metering pump with built-in control system
6 Technical Data of Control Section

6.1 Controller Stage

Power supply: 230 V ±10 %, 50/60 Hz
or 115 V ±10 %, 50/60 Hz

Read-out: 3-digit liquid crystal display, of measured value, set value or simulated measured value

Display range: 0.0...14.0 pH

Measurement and control range: 0.0...14.0 pH

Direction of control: Internally switch-selectable; factory setting for feeding acid

LED displays: Stroking rate; set value reached (no error); relay output (optional); low level; time check (optional)

Output signal: Option: 0...20 mA (internally changeable to 4...20mA)
closed-loop current signal corresponding to pH 2...pH 12,
maximum burden 750 Ohm

Input amplifier: Differential amplifier with high common mode rejection;
sample reference potential

Input impedance: >5 · 10¹² Ohm

Connector, pH probe: Socket for SN6 plug, moisture-protected, to connect a combination probe; pin socket for sample reference potential

Option: DIN B 19262 socket instead of SN6 socket
Option: Pin socket for reference electrode

Zero shift, zero calibration: ±1.5 pH

Slope calibration range: 47...85 mV/pH

Maximum pulse rate: 6000/h

Average power: 15 W

Peak power while pump is stroking: 200 W

Option „Relay output“: Contact load:
max. 250 V a.c./3 A 1100 VA
min. 24 V d.c./25 mA

Permissible working temperature: -10...+45 °C

Housing: Shock-resistant Noryl, glass fiber reinforced

Dimensions of housing (w/o liquid end): 112 x 173 x 200 mm wide x high x deep

Type of enclosure: IP 65, insulation class F
### Technical Data of Control Section

#### 6.2 Pump Stage

**Technical data**

<table>
<thead>
<tr>
<th>D.4a</th>
<th>Delivery capacity at maximum pressure</th>
<th>Delivery capacity at medium pressure</th>
<th>Connections Ø x i Ø</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ml/stroke</td>
<td>ml/min.</td>
<td>l/h</td>
</tr>
<tr>
<td>1601</td>
<td>0.140</td>
<td>14.0</td>
<td>0.84</td>
</tr>
<tr>
<td>1601 NS</td>
<td>0.09</td>
<td>9.0</td>
<td>0.54</td>
</tr>
<tr>
<td>1201</td>
<td>0.242</td>
<td>24.2</td>
<td>1.45</td>
</tr>
<tr>
<td>1201 NS</td>
<td>0.14</td>
<td>14.0</td>
<td>0.84</td>
</tr>
<tr>
<td>0803</td>
<td>0.477</td>
<td>47.7</td>
<td>2.86</td>
</tr>
<tr>
<td>0803 NS</td>
<td>0.33</td>
<td>33.0</td>
<td>1.98</td>
</tr>
<tr>
<td>1002</td>
<td>0.318</td>
<td>31.8</td>
<td>1.91</td>
</tr>
<tr>
<td>1002 NS</td>
<td>0.25</td>
<td>25.0</td>
<td>1.50</td>
</tr>
<tr>
<td>0308</td>
<td>1.166</td>
<td>116.6</td>
<td>7.00</td>
</tr>
<tr>
<td>0215</td>
<td>2.050</td>
<td>205.0</td>
<td>12.30</td>
</tr>
</tbody>
</table>

(NS: self-bleeding liquid end)

**Type of connections:**
- For PP, NP, NS and TT 6, 8 and 12 mm: Hose sleeve with clamping ring connection
- For stainless steel SS 6, 8 and 12 mm: Swagelok system connection

**Material in contact with medium for version:**

<table>
<thead>
<tr>
<th>Liquid head end</th>
<th>Intake/delivery connection</th>
<th>Seals</th>
<th>Ball (6 - 12 mm connection)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PP Polypropylene</td>
<td>Polypropylene</td>
<td>EDPM</td>
<td>Ceramic</td>
</tr>
<tr>
<td>NP Acrylic glass</td>
<td>PVC</td>
<td>Viton®</td>
<td>Ceramic</td>
</tr>
<tr>
<td>NS Acrylic glass</td>
<td>PVC</td>
<td>Viton®</td>
<td>Ceramic</td>
</tr>
<tr>
<td>TT PTFE with carbon</td>
<td>PTFE with carbon</td>
<td>PTFE</td>
<td>Ceramic</td>
</tr>
<tr>
<td>SS Stainless steel</td>
<td>Stainless steel</td>
<td>PTFE</td>
<td>Ceramic</td>
</tr>
<tr>
<td>Mat. No. 1.4571</td>
<td>Mat. No. 1.4571</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

DEVELOPAN® pump diaphragm with PTFE support.
Viton® is a registered trademark of DuPont Dow Elastomers.

**Metering reproducibility:** ±2 % when used in accordance with operating instructions
### 7 Accessories and Consumables

| Buffer solution pH 7, 50 ml | Order Nr. | 50.62.53 |
| Buffer solution pH 7, 1000 ml | Order Nr. | 50.62.58 |
| Buffer solution pH 4, 50 ml | Order Nr. | 50.62.51 |
| Buffer solution pH 4, 1000 ml | Order Nr. | 50.62.56 |
| Buffer solution pH 5, 50 ml | Order Nr. | 50.62.52 |
| Buffer solution pH 5, 1000 ml | Order Nr. | 50.62.57 |
| Buffer solution pH 9, 50 ml | Order Nr. | 50.62.54 |
| Buffer solution pH 9, 1000 ml | Order Nr. | 50.62.59 |
| Buffer solution pH 10, 50 ml | Order Nr. | 50.62.55 |
| Buffer solution pH 10, 1000 ml | Order Nr. | 50.62.60 |

- **pH combination probe type PHE, pH 1...12, T= 0...60 °C, max. 5 m water column**: 30.50.54
- **pH combination probe type PHEP, pH 1...12, T= 0...80 °C, max. 6 bar**: 15.00.41
- **pH combination probe, refillable, type PHEN, pH 1...12, T= 0...60 °C**: 30.50.90
- **pH combination probe type PHED, pH 1...12, T= 0...80 °C, max. 8 bar**: 74.10.36
- **pH combination probe type PHEX 112 SE, pH 1...12, T= 0 ...100 °C P max. = 16 bar (25 °C), 6 bar (100 °C)**: 30.50.96
- **PHEN 012 SL, refillable laboratory probe electrode, pH 0...12, T= 0...80 °C**: 30.50.78
- **Pt 100 SE resistance thermometer, 0...+100 °C**: 30.50.63

### 8 Spare Parts Kits

Consisting of:
- 1 pump diaphragm
- 1 intake connector, complete for NP, PP, TT version
- 1 delivery connector, complete for NP, PP, TT version
- 2 valve balls
- 4 valve balls for SS version
- 1 set of seals

<table>
<thead>
<tr>
<th>For pump type</th>
<th>Order No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>NP</td>
<td>74.03.58</td>
</tr>
<tr>
<td>NS</td>
<td>79.20.33</td>
</tr>
<tr>
<td>1601 PP</td>
<td>74.03.61</td>
</tr>
<tr>
<td>TT</td>
<td>91.07.78</td>
</tr>
<tr>
<td>SS</td>
<td>91.07.79</td>
</tr>
<tr>
<td>NP</td>
<td>74.03.62</td>
</tr>
<tr>
<td>NS</td>
<td>79.20.34</td>
</tr>
<tr>
<td>1201 PP</td>
<td>74.03.80</td>
</tr>
<tr>
<td>TT</td>
<td>91.07.80</td>
</tr>
<tr>
<td>SS</td>
<td>91.07.81</td>
</tr>
</tbody>
</table>
### Table 3: Spare parts kits

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>NP</td>
<td>74.03.81</td>
<td></td>
</tr>
<tr>
<td>NS</td>
<td>79.20.35</td>
<td></td>
</tr>
<tr>
<td>PP</td>
<td>74.03.84</td>
<td></td>
</tr>
<tr>
<td>TT</td>
<td>91.07.82</td>
<td></td>
</tr>
<tr>
<td>SS</td>
<td>91.07.83</td>
<td></td>
</tr>
<tr>
<td>NP</td>
<td>74.03.85</td>
<td></td>
</tr>
<tr>
<td>NS</td>
<td>79.20.36</td>
<td></td>
</tr>
<tr>
<td>PP</td>
<td>74.03.88</td>
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<td>TT</td>
<td>91.07.84</td>
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<tr>
<td>SS</td>
<td>91.07.85</td>
<td></td>
</tr>
<tr>
<td>NP</td>
<td>74.04.98</td>
<td></td>
</tr>
<tr>
<td>PP</td>
<td>74.04.97</td>
<td></td>
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<tr>
<td>TT</td>
<td>91.07.86</td>
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<td>NP</td>
<td>74.05.00</td>
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<tr>
<td>PP</td>
<td>74.04.99</td>
<td></td>
</tr>
<tr>
<td>TT</td>
<td>91.07.88</td>
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</tr>
<tr>
<td>SS</td>
<td>91.07.89</td>
<td></td>
</tr>
</tbody>
</table>

### 8.1 Spare Parts List
Spare Parts Kits

**D_4a PH**

<table>
<thead>
<tr>
<th>Component Description</th>
<th>Order No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>A PMD housing blue</td>
<td>80.07.41</td>
</tr>
<tr>
<td>B Solenoid E 70 M6 230 V</td>
<td>81.78.08</td>
</tr>
<tr>
<td>Solenoid E 70 M6 115 V</td>
<td>81.78.10</td>
</tr>
<tr>
<td>Solenoid E 70 M3 230 V</td>
<td>81.78.01</td>
</tr>
<tr>
<td>Solenoid E 70 M3 115 V</td>
<td>81.78.03</td>
</tr>
<tr>
<td>C Front section, complete with electronic circuit D_4a 220/240 V</td>
<td>81.91.72</td>
</tr>
<tr>
<td>E Main circuit board</td>
<td>81.90.12</td>
</tr>
<tr>
<td>F Front circuit board</td>
<td>81.90.11</td>
</tr>
<tr>
<td>G Output signal, optional</td>
<td>81.81.06</td>
</tr>
<tr>
<td>H Timer control, optional</td>
<td>81.81.12</td>
</tr>
<tr>
<td>I Fuse 6.3 x 32 mm 0.25 ATT 230 V</td>
<td>71.20.35</td>
</tr>
<tr>
<td>6.3 x 32 mm 0.5 ATT 115 V</td>
<td>71.20.37</td>
</tr>
<tr>
<td>K Control knob</td>
<td>70.35.57</td>
</tr>
<tr>
<td>Arrow disk for control knob</td>
<td>70.35.59</td>
</tr>
<tr>
<td>Cap for control knob</td>
<td>70.35.58</td>
</tr>
<tr>
<td>L Knob of selector switch</td>
<td>70.35.65</td>
</tr>
<tr>
<td>M Knurled screw</td>
<td>46.62.13</td>
</tr>
<tr>
<td>N Perspex cover</td>
<td>81.91.73</td>
</tr>
<tr>
<td>O Control knob</td>
<td>70.35.24</td>
</tr>
<tr>
<td>P Cable gland PG 9</td>
<td>70.38.85</td>
</tr>
<tr>
<td>Q Cable gland PG 7 or</td>
<td>70.38.96</td>
</tr>
<tr>
<td>Plug PG 7 or SN 6 socket red</td>
<td>70.38.70</td>
</tr>
<tr>
<td>R Front plate D_4a</td>
<td>60.61.92</td>
</tr>
<tr>
<td>S SN 6 socket or</td>
<td>81.83.98</td>
</tr>
<tr>
<td>Plug PG 7</td>
<td>70.38.71</td>
</tr>
<tr>
<td>T Relay</td>
<td>71.13.40</td>
</tr>
<tr>
<td>Fastener for relay holder</td>
<td>71.13.42</td>
</tr>
<tr>
<td>U Pin socket, red</td>
<td>70.42.25</td>
</tr>
<tr>
<td>V Pin socket, black</td>
<td>70.42.28</td>
</tr>
<tr>
<td>Coding jumpers</td>
<td>71.39.95</td>
</tr>
<tr>
<td>DIL-jumpers, 7-pole, D_4a, not coded</td>
<td>71.02.38</td>
</tr>
<tr>
<td>DIL-jumpers, 9-pole, D_4a, not coded</td>
<td>71.02.39</td>
</tr>
</tbody>
</table>
9 Faults, Causes and Remedies

9.1 Mechanical Faults

1) Pump does not prime
   a) Bleed air from pump; formaterial version PP/NP loosen air bleeding valve (Fig.9) by giving it a turn, 
      for other types release discharge line at the injection valve and wait until the pump head is filled with 
      media.
   b) Pump valves are dry or stuck; 
      moisten or dismantle and clean valves.
   c) Ruptured diaphragm; 
      replace diaphragm referring to Section 10.2.
   d) Worn valve seats, valves do not close; 
      replace valve seats or O-rings.
   e) Chemical feed tank is empty

2) Leaking liquid end
   a) O-rings are damaged or swollen; replace.
   b) Ruptured diaphragm; replace (Section 10.2.)

3) Pump does not discharge against a head
   a) Ruptured diaphragm; replace (Section 10.2).
   b) Valves do not close; clean, replace if necessary.
9.2 Changing of Diaphragm

A ruptured diaphragm can be recognized by media leaking out of the drain hole 6. To replace the diaphragm proceed as follows:

1. Unscrew the four Philips or hexagon socket head screws, remove pump head, set stroking distance to zero with the pump working and unscrew diaphragm by turning it anticlockwise. If necessary stick the fastening screws through pump head, diaphragm and intermediate disk and turn diaphragm off the armature rod.
2. Place new diaphragm into the intermediate disk and replace pump head so that the suction connector is next to the drain hole in the head plate. Stick fastening screws through and turn the whole assembly clockwise until the diaphragm is securely fixed.
3. Let the pump work, set the stroke distance to 100 % and turn the whole assembly clockwise until the suction connector points right down. Stop pump and tighten screws crosswise.

The arrow marks on the valves indicate the direction of flow.

To enable you to remedy smaller faults at any time we recommend you to have a spare parts kit ready to hand (Section 9).
9.3 Electrical Faults

**NOTICE:**
Ensure that the mains plug is pulled out before opening the pump!

1) Pumpe does not work, none of the LED’s is alight
   - Check mains voltage, then fuse (SI in Fig. 3) inside the housing
2) Pump does not work, LED’s indicate state of operation
   - Check thermal fuse (TH in Fig. 5) for passage
3) Pump does not work, LED’s indicate state of operation,
   - Check d.c. impedance of solenoid bobbin.
     The impedance of the solenoid bobbin should be:
     - 220 V bobbin about 315 Ohm
     - 240 V bobbin about 375 Ohm
     - 115 V bobbin about 105 Ohm
4) Pump does not work, red LED (2) is alight, feed tank is full
   - Check float switch by pulling the float switch plug from its socket (3) and shorting the socket contacts;
     Contacts open: Pump works, yellow LED (10) flashes with each pump stroke
     Contacts jumpered: Pump is idle, yellow LED (10) does not flash, red LED (12) is alight.
     If pump works in this manner, exchange float switch.
5) Read-out (4) displays a value higher than pH 14, liquid reference potential is connected to pin socket (7).
   - Remove jumper KB 10 on the control circuit board (Fig.3).
6) Red LED (12) flashes
   - Selector switch (2) is not in the AUTOMATIC or AUTOMATIC + TIMER CONTROL position

10 Connecting Pt 100 Resistance Thermometer

If the D,4a pump was ordered to include Option D 12, „Automatic temperature correction“ (Part No. 81.81.17.4), item 2 will consist of a red SN 6 connector for connecting a Pt 100 resistance thermometer, instead of a plug or a PG cable gland for the relay output (Option). Then, the relay output will be run out of the pump housing at the liquid end side.

**IMPORTANT:**
There is an additional change-over switch (23) “Pt 100”/“20 °C” on the operator panel. If no Pt 100 is connected, place this switch into position “20 °C”. If a Pt 100 resistance thermometer is used, place this switch into position “20 °C”.

With the Pt 100 connected, the influence of temperature on the pH measurement will be automatically corrected within a temperature range from 0 °C - 100 °C.

As a rule, temperature correction of pH measurements is required only at pH values below 6 and above 8 when frequent temperature changes of the sample liquid occur.
11 Safety Information

NOTICE:

Measuring and control systems and their peripheral equipment may only be connected by trained personnel and qualified electricians.

Contact your customer service responsible!

Disposal of Old Parts

ATTENTION:
Plastic and electronic waste are classified as special waste and must be recycled!

Disposal Law

Waste (old parts) is to be disposed of in an orderly manner for the common good especially the protection of the environment. Therefore old parts have to be disposed of in accordance with the order on the (German) Waste Avoidance and Waste Management Act or recycled in accordance with the (German) Waste and Residual Materials Monitoring Act.

Taking back old parts

The municipal collection points for small quantities of the towns and municipalities accept plastic and electronic waste.

If you should not find any appropriate collection point the ProMinent subsidiary or representative responsible for you will take back your old parts for a small fee!
EC Declaration of Conformity

We, ProMinent Dosierotechnik GmbH
Im Schuhmacherweg 5 - 11
D - 69123 Heidelberg

hereby declare that, on the basis of its functional concept and design and in the version brought into circulation by us, the product specified in the following complies with the relevant, fundamental safety and health stipulations laid down by EC regulations. Any modification to the product not approved by us will invalidate this declaration.

Product description: Metering pump, series "D.4e..."

Product type: D.4e PH.../RH.../CA.../CB...

Serial number: see type identification plate on device

Relevant EC directives:
EC - machine directive 98/37/EC
EC - low voltage directive 73/23/EEC
EC - EMC - directive (89/336/EEC) subsequently 92/31 EEC

Harmonised standards used, in particular:
DIN EN 292-1, DIN EN 292-2, DIN EN 809
DIN EN 60335-1, DIN EN 60335-2-41, DIN EN 50106
DIN EN 61010
DIN EN 50081-1/2, DIN EN 50082-1/2

National standards and other technical specifications used, in particular:
DIN VDE 0700 T1
DIN VDE 0700 T41
DIN VDE 0700 T500

Date/manufacturer’s signature: 24. Nov 99

The undersigned: Dr. Rainer V. Dulger, Executive Vice President R&D and Production

ProMinent®