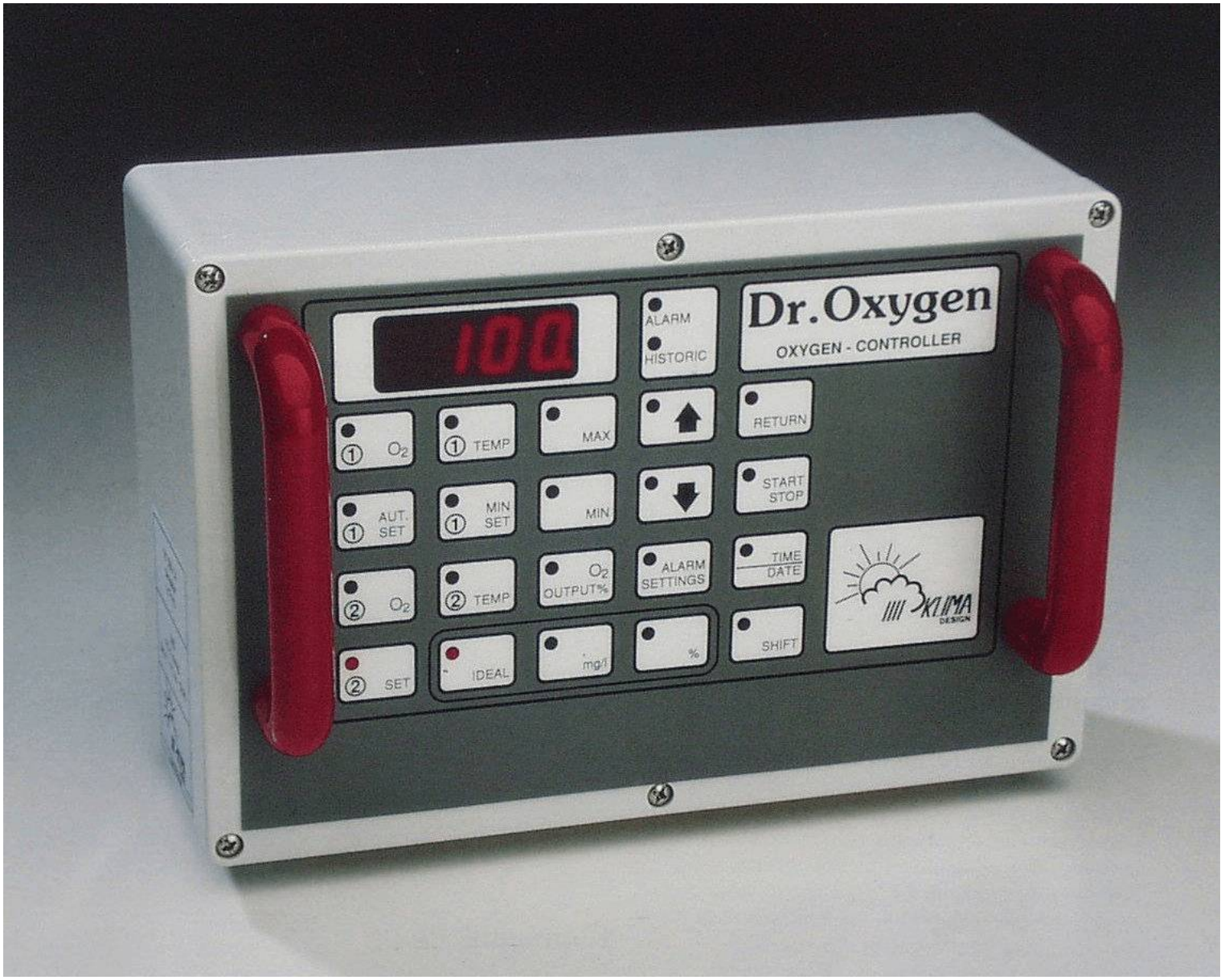
Dr.Oxygen

OXYGEN - CONTROLLER



User Guide

CONTENTS

1.0 Description

1.1 Measuring oxygen and temperature

Dr.Oxygen is a controller designed to maintain ideal oxygen tension on fish farms. The controller carries out continual metering of the oxygen tension and temperature of the water at the intake and outlet.

1.2 Adjustment to oxygen tension ideal for the fish

The ideal oxygen tension for fish at any given time depends on the temperature. Thus, it is not desirable to adjust for a fixed concentration in mg/l but for the ideal tension. What this means in practice is that the controller automatically adjusts the concentration in mg/l to suit the temperature. A figure of 100 is the ideal tension at a given temperature. Figures of 50 and 200 respectively are half and twice the numbers of milligrammes per litre required.

1.3 Indirect controlling of the oxygen tension at the outlet

Dr.Oxygen measures the oxygen tension at the outlet. A special PID regulation routine calculates a new SET point on the basis of the requirement at the outlet, and this controls the oxygen supply. The oxygen tension at the inlet is measured after the water has been aerated. This also means that natural changes in tension in the inlet water are immediately included optimally and utilized, with minimum oxygen consumption and minimum variations from the desired tension.

1.4 Control of an aerator

Dr.Oxygen has a relay terminal for controlling an aerator. The aerator is started when oxygenation is required.

1.5 Operation of pumps and supply of oxygen

Dr.Oxygen has relay terminals for two oxygen valves and two pumps, allowing partial loading and thus reducing energy consumption. Dr.Oxygen supplies oxygen "continuously variably" via time modulation with self-optimizing cycle times. Dr.Oxygen can also supply oxygen continuously variably with the aid of a motor-operated valve.

1.6 Built-in datalogger

Dr.Oxygen has built-in data logging with a facility for displaying "historic" data. It can also be connected to a network - PARTYLINE - for central data collection and control by a PC.

1.7 Alarm functions

Dr.Oxygen can be set to give alarms at too high and too low IDEAL oxygen tensions and temperature levels in the inlet water.

1.8 Data preserved during Power Cuts

There is a built-in clock which keeps going even in the event of power cuts. All data and control parameters are preserved.

1.9 How to place the oxygen probes/temperature sensors

At the intake, the oxygen probe/temperature sensor should be sited after the supply of oxygen - preferably far enough away for the water to be properly mixed.
At the outlet, the oxygen probe/temperature sensor should be sited in a representative/heavily loaded basin. Ensure that the through-flow time is as short as possible, and the controller will react correspondingly quickly. If the probe is sited in a less heavily loaded basin, one can compensate by raising the SET point.

2.1 Controls and display

In this instruction book the buttons are named in **BOLD FACE CAPITALS**.

All day-to-day information is displayed by pressing buttons. When a button is pressed a little light goes on the button concerned, so it is always obvious what is being displayed. The text on the button states its function.

The **ALARM SETTINGS** button is referred to here as **ALARM**.

The **TIME & DATE** button has two words on it separated by a line.
The first time the button is pressed the upper word applies and the second time the lower one. The **ALARM** button has seven different functions. In this book the seventh press on the **ALARM** button is referred to as **ALARM^{7}**.

The **SHIFT** button has a special function. When it is pressed, the buttons "shift" (change) to a new function.
Pressing **RETURN** returns into normal, default mode/function.

Examples.

Press **SHIFT** once followed by ① **AUT SET$_2$** twice, is written as:-

SHIFT^{2}	① **AUT SET^{2}**	

Press **ALARM** seven times is written as:-

ALARM^{7}	

Press the **O$_2$ OUTPUT%** button once, followed by **START STOP**, is written (where it occurs in the ordinary text) as:-

O$_2$ OUTPUT% - START STOP

Buttons

Unit buttons	Info. displayed (only refers to oxygen tension buttons)
IDEAL	The IDEAL value calculated on the basis of mg/l and temp.
mg/l	mg/l, as measured by the oxygen probes.
%	%-age saturation, calculated on the basis of mg/l and temp.

Buttons	Information displayed
① **O_2**	Oxygen tension, inlet.
① **AUT SET**	IDEAL tension which the supply of oxygen is to maintain. = The result of the PID regulator's calculation of the requirement on the basis of ② **SET** and ② **O_2**
② **O_2**	Oxygen tension, outlet.
② **SET**	Desired oxygen tension at outlet. Normally 100 IDEAL.
① **TEMP**	Water temperature at the inlet.
① **MIN SET**	Minimum oxygen tension at the inlet. 100-130 IDEAL.
② **TEMP**	Water temperature at the outlet.
O_2OUTPUT%	Oxygen supply as a %-age of maximum output.
MAX	Retrieval at max. level in memory. Indicator function.
MIN	Retrieval at min. level in memory. Indicator function.
ALARM **ALARM²** **ALARM³** **ALARM⁴** **ALARM⁵** **ALARM⁶** **ALARM⁷**	Code showing controller's alarm status. Minimum oxygen tension at the inlet. Maximum oxygen tension at the inlet. Minimum oxygen tension at the outlet. Maximum oxygen tension at the outlet. Minimum temp. at the inlet. Maximum temp. at the inlet.
RETURN	Returns buttons to normal function
START STOP	Start and stop of alarm or - when **O_2OUTPUT%** button has been pressed - manual supply of oxygen.
DATE	Date
TIME	Time
SHIFT	Change of button function: special values, regulatory parameters and adjustments.

2.2 Setting, altering values, general

If a figure needs changing, this is done by pressing: -

ARROW UP to increase the value, or

ARROW DOWN to decrease it.

The **arrow buttons repeat**, i.e. the value goes on changing as long as the button is kept pressed. After pressing 3 sec. (marked by an audible "beep") the value changes to the second lowest significant figure. This is to allow large-scale changes to be made quickly.

Measured and calculated figures cannot be changed.

For safety purposes, upper and lower limits for the variable values are built in.

2.3 Locking arrow buttons

The arrow buttons have a locking facility so that the figures cannot be changed. This is to prevent unauthorised operation.

The lock self-activates a certain number of minutes after the last time the buttons were pressed. Thus one only needs to unlock the system when necessary.

To unlock the buttons, press SHIFT and then both arrow buttons at once.

SHIFT	**MAX**	No. of minutes until auto-locking activates.

Eg if it is set at 10, it will lock after 10 minutes.
If it is set to 0, it will not lock.

2.4 Display of oxygen tension: IDEAL, mg/l, %-age saturation

Dr.Oxygen is able to display the oxygen tension in three ways: -

IDEAL	The IDEAL tension for the fish according to the present temperature. "100" and more is fine "50" and below is to less and feeding should be suspended
mg/l	Volume of oxygen per litre.
%	Percentage saturation with oxygen.

2.5 Setting minimum oxygen tension at the inlet; aerator

The IDEAL button must be active.

Press ① **MIN SET** and enter the minimum tension desired to be supplied to the basins. This figure will determine when the aerator switches on. The normal tension = 130, but it can be turned down to 100-120 if there is no great need for oxygen.

2.6 Setting desired oxygen tension at the outlet

The IDEAL button must be active.

Press ② **SET** and enter the tension desired at the outlet. The normal tension = 100. Set for values between 80 and 120 as required.

2.7 ① AUT.SET, the calculated set-point

① **AUT.SET** is the present calculated set-point. The controller supplies oxygen so that ① $\mathbf{O_2}$ will move towards this value. The value is minimum = ① **MIN SET**. If more oxygen is required in the outlet - in accordance with ② **SET -**, ① **AUT.SET** is automatically increased as necessary until the desired tension is attained at the outlet.

2.8 O_2 OUTPUT%

O_2OUTPUT%	shows how much the oxygen the system supplies in % of full.

The controller continuously calculates the degree of oxygenation required to maintain the desired tension. It can adopt any value whatever from 0.0 to 100.0, even if the tension is as wished.
It takes a little time for the system to settle down after switching on or after manual intervention.

If two oxygen valves are installed working sequentially, they separate at 50%: valve 1 operates from 0 to 50% and valve 2 from 50 to 100%.

E.g.: **O_2OUTPUT%** shows 75%. Valve 1 is operating on 100% and the other one only operates half the time.

2.9 Hourmeter for 0_2 supply.

O_2 OUTPUT% has a hourmeter allowing oxygen consumption to be compared at various times.

O_2 OUTPUT%	**TIME**	No. of hours, converted to full output.

Remember to switch it off (**O_2 OUTPUT% - START STOP**) when the supply of oxygen is turned off at the valves, otherwise the timer will go on recording (see next section).

The timer is returned to 0 by keeping ARROW DOWN pressed until it returns to 0.

2.10 Manual operation; START/STOP of oxygen supply.

Press **O_2OUTPUT%** button and then press **START STOP**: Oxygen supply will go to 0.

The lamp will begin to flash, and there is manual control over oxygen supply via ARROW UP and ARROW DOWN. Any value can be set and will remain there until **START STOP** is pressed again, even if other buttons are pressed in the meantime.

Aerator: Under *manual* operation the aerator can be turned on and off by setting ① **MIN SET** either over or under ① **AUT SET**.

Next time **RETURN** is pressed, manual operation will be indicated by the **O_2 OUTPUT%** button flashing.

3.0 Alarm start/stop

Alarm monitoring can be toggled on or off with the **START STOP** -button.
*(N.B. NOT when **O_2 OUTPUT%** is activated.)*

ALARM lamp	**STATUS, situation**
On	OKAY; monitoring active
Flashing	Alarm
Off	Alarm monitoring switched off

3.1 Testing the alarm-function

In case of alarm, the alarm relay goes into no-signal mode (no current on the coil).

SHIFT	**ALARM**	Testing the alarm

Press **RETURN** to stop.

3.2 Alarm situations

An alarm is signalled by the ALARM light flashing.

There are various alarm situations, indicated by code numbers.

Press **ALARM** to see the code number displayed.

CODE No.	MEANING
-1	Alarm monitoring off
0	OK
1	Oxygen tension at intake too low
2	Oxygen tension at intake too high
3	Oxygen tension at outlet too low
4	Oxygen tension at outlet too high
5	Temperature at intake too low
6	Temperature at intake too high
7	Short-circuit on temperature sensor at intake
8	Broken wire on temperature sensor at intake
9	Short-circuit on temperature sensor at outlet
10	Broken wire on temperature sensor at outlet

States of alarm - code no.1-6 - are also indicated by flashing on the display when the relevant alarm-level is displayed.

The alarm-code no. is the same as the number of times you will have to press the ALARM-button to get to the corresponding alarm-level, eventually to alter it.

3.3 Setting alarm levels

The alarm levels are also on the **ALARM** button. CODES 1 to 6 represent the number of times the **ALARM** button must be pressed to change the alarm level concerned.

Number of presses after CODE	PRESS	Alarm level	Indicator display
1	**ALARM**[2]	Oxygen tension at intake too low	① **O_2 + MIN**
2	**ALARM**[3]	Oxygen tension at intake too high	① **O_2 + MAX**
3	**ALARM**[4]	Oxygen tension at outlet too low	② **O_2 + MIN**
4	**ALARM**[5]	Oxygen tension at outlet too high	② **O_2 + MAX**
5	**ALARM**[6]	Temperature at intake too low	**TEMP + MIN**
6	**ALARM**[7]	Temperature at intake too high	**TEMP + MAX**

4.0 Log function

Data are stored every 10-minutes, but since only variations are interesting, the data are only stored if the figure differs from what it was 10 minutes before. In the case of an ALARM and on start/stop of alarm monitoring, any changes are logged, whether 10 minutes have passed or not.

4.1 Recall of logged data, entering *historic mode*

Logged data can be displayed by pressing **ARROW DOWN** while

① **O_2** ② **O_2** ① **TEMP** or ② **TEMP**

activated, i.e. the light is on. The system is now in *historic mode* and the lamp will flash by the word "HISTORIC" to indicate that the readings displayed are not current. The display shows the last temperature reading different from the current one. Continuing pressing calls up older figures still.

ARROW UP is used to go forward through time again.

To see the time at which any particular event occurred, press **TIME** (and, where relevant, **DATE**). **TIME** normally displays the time in whole blocks of 10 minutes, except in the event of an ALARM or if **START STOP** has been pressed. Uneven minutes will be displayed in these cases.

When in historic mode, one can press **O_2OUTPUT%** to see what levels applied at the relevant time, and **ALARM**, which will display the code no. for the alarm status.

When in historic mode, one can also go one or more days back in time by pressing **DATE** followed by **ARROW DOWN**. (**N.B.** If not in historic mode, this will alter the date.) On going back one or more days, the time shown will be 0000 hours, i.e. midnight. The historic time can then be changed by pressing **ARROW UP** or **ARROW DOWN**.

MIN or **MAX** can be used to display minimum or maximum values.

The unit buttons **IDEAL, mg/l** and **%** can also be used in historic mode. To return to normal function, press **RETURN**.

5.0 Controlling parameters

P. The **Xp band** ensures that the system reacts immediately to sudden changes;

I. **Integration** maintains correct levels for the time of day or night, the season, the load, the weather, etc.

D. The **Differential function** only operates when changes occur, reducing fluctuations.

Any alteration in these settings should only be done under the supervision of personel skilled in regulation technics.

PRESS		PARAMETER
SHIFT	① **AUT SET**[2]	Xp ban, inlet
	① **AUT SET**[3]	Degree of integration, inlet
	① **AUT SET**[4]	Integration time for reg. routine, inlet
	② **SET**[2]	Xp band, outlet
	② **SET**[3]	Degree of integration, outlet
	② **SET**[4]	Integration time for reg. routine. outlet

Only the Proportional and Integration parameters can be altered.

5.1 Various parameters

PRESS		PARAMETER
SHIFT	**O_2OUTPUT%**	Min. **Impulse Time**, magnetic valves * 100 (500 = 5 seconds)
	MAX	**Locking of the keyboard arrows**. To prevent unauthorised operation. This value states the number of minuttes without pressing any key, after which the arrow keys will be locked. See Chapter 2.3
	DATE	**Year**

5.2 Starting and stopping pumps

Frequent starting and stopping of pumps is not a good thing. Dr.Oxygen therefore ensures that pumps run for at least 10 minutes after each start.
This function is suspended in manual mode.

No. 1 pump starts when **O_2 OUTPUT%** rises above 0. When **OUTPUT%** drops to 0 again, the pump goes on running for at least 10 minutes before switching off.
No. 2 pump starts when **O_2 OUTPUT%** rises above 50. When **OUTPUT%** drops to 50 or less, the pump goes on running for at least 10 minutes before switching off.

5.3 Communication parameters

PRESS		PARAMETER
SHIFT	**MIN**	The Unit's unique station number.
	TIME	Period of time/Number of minutes between one-line-print-outs. Hard copy print-out is switched off when "0". Can be set to 10, 20, 30, 40, 50, 60 . Must be set to "0" when connected to a PC

5.4 Communication with PCs

- Unit's Station Number to be given. **SHIFT - MIN** to be set at "1" for the first unit, "2" for the second unit and so on.
- **SHIFT - TIME** must be "0".
- Dipswitch 4 to be OFF (RS 485) (ON = RS 232).
- Check **TIME**, **DATE** and year **(SHIFT - DATE)**.

5.5 Adjustment of sensors and oxygen probes

Temperature probes are adjusted once and for all on installation.
Oxygen probes to be adjusted every 2 to 4 weeks when provision of oxygen is necessary.

ADJUSTMENT OF	INSTRUCTIONS
Temperature sensor, intake.	The temperature probe is calibrated by the manufacturer and supplied with a calibration figure, which should be keyed in: **SHIFT - ① TEMP** (Offset value for temperature sensor, intake).
Temperature sensor, outlet	The temperature probe is calibrated by the manufacturer and supplied with a calibration figure, which should be keyed in: **SHIFT - ② TEMP** (Offset value for temperature sensor, intake).

Oxygen probe, intake	The oxygen probe and temperature sensor to be removed from the water and hung up out of the sun. After at least ½ an hour's acclimatization time, press **SHIFT - ① O_2**. Then press **both** arrow buttons at the same time. You will hear three rapid "beeps", and the probe is calibrated.
Oxygen probe, outlet	The oxygen probe and temperature sensor to be removed from the water and hung up out of the sun. After at least ½ an hour's acclimatisation time, press **SHIFT - ② O_2**. Then press **both** arrow buttons at the same time. You will hear three rapid "beeps", and the probe is calibrated.

5.6 Oxygen Probe, Repair

Membranes, O-rings, electrolyte and "pot scourer" are provided for repair of the oxygen probe.

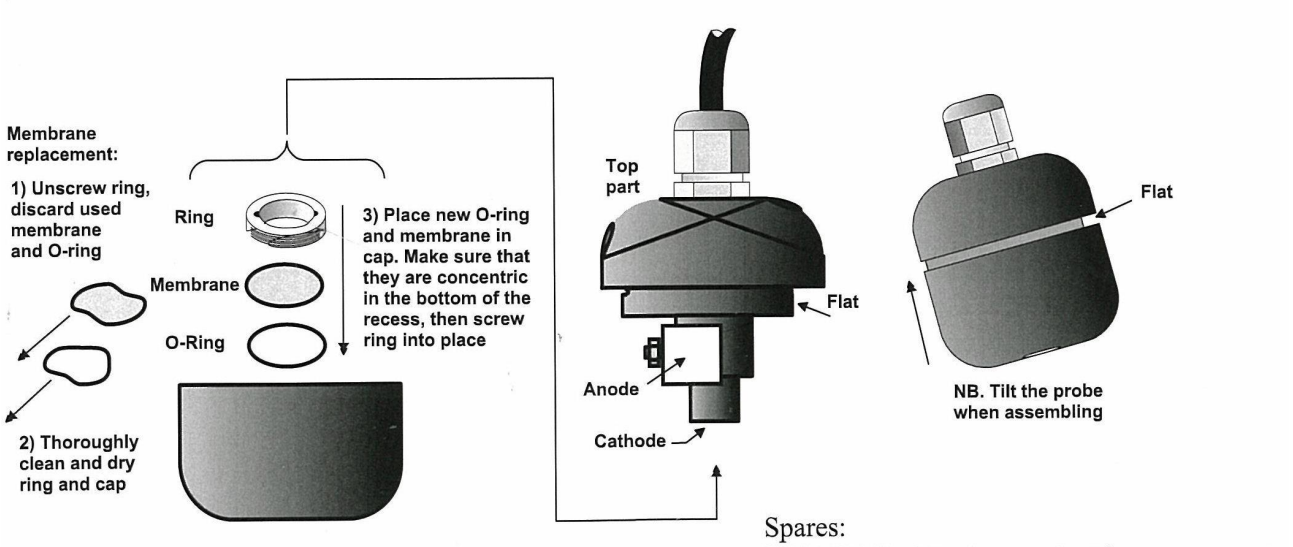
Repair:

1. Unscrew the cap, discard the electrolyte and the membrane from the inside, and clean all parts. The cathode may be cleaned with the "pot scourer" provided..

2. Place a new membrane + O-ring and fill the cap with electrolyte.

3. Put the top and the cap together and engage the thread by half a turn. Locate the flat part of the thread and tilt the probe 15° with the flat part as the uppermost. Turn to screw the cap and the top part together. Excess electrolyte will escape at the flat part.

4. Check that the membrane is flat and correctly positioned. Shake the probe to check that the probe is completely filled (no splashing when shaked !)



Spares:
D10MSAT - Membranes for % measurements.
D10AN3 - Anode for type 3 probes.
D10E3500 - 500 ml type 3 electrolyte.
D10E31L - 1 l type 3 electrolyte.

6.0 TECHNICAL DATA	
Cabinet	Polycarbonate; watertightness IP 65
Dimensions	Width x height x depth = 240 x 200 x 128 mms
Control panel	Film buttons, polycarb.; 20 buttons with indicator lamps
Display	4 figures, 13 mm red LED
Construction	Front lid with display print board and CPU print board. Connection print board with power supply, signal converter and relays. Thermostatically controlled frost protection heating.
Microprocessors	80C31
Inputs	2 analogs for temperature sensors 2 analogs for oxygen probes
Outputs	NO and NC at choice. One 0-10 V DC control signal for motor-operated valve One relay connection, aerator Two relay connections, pumps Two relay connections, magnetic valves One relay-shift function, Alarm. No potential;
Communication	RS232 serial port RS485 "Partyline" for connection to net.
Power supply	220 VAC, 50 Hz, 6W
RAM back-up	The memory is protected by a lithium battery. I.e. the data in the memory are retained even with the power off.
Temperature sensors	The sensor consists of an embedded temperature transducer, AD590 from Analog Device. The transducer comprises a monolithic integrated circuit acting as a high impedance temperature-dependent source of electricity which generates a current proportional to the absolute temperature in degrees Kelvin. The output is 1µA/°K. 0°K = -273.2°C, giving a reading of 0.2932 mA at 20°C. Linearity typically <0.1°C. Offset variation < 1.0°C. The sensor is calibrated by manufacturer , where the offset variation is determined. This is marked on the sensor and should be keyed in, insuring high precision measuring.
Oxygen probes	The oxygen probes generate a voltage proportional to the oxygen tension. The reading is of the order of 6mV per mg oxygen/litre.