Congratulations !

You have purchased the latest in Handheld Dissolved Oxygen-Temperature instrumentation. We trust that your new **MC-82** will give you many years of reliable service.

The **MC-82** is a breeze to operate. This manual has been designed to help you get started, and also contains some handy application tips. If at any stage you require assistance, please contact either your local TPS representative or the TPS factory in Brisbane.

The manual is divided into the following sections:

1. **Table of Contents**
   Each major section of the handbook is clearly listed. Sub-sections have also been included to enable you to find the information you need at a glance.

2. **Introduction**
   The introduction has a diagram, and explanations of the display and controls of the **MC-82.** It also contains a full listing of all of the items that you should have received with your **MC-82**. Please take the time to read this section, as it explains some of items that are mentioned in subsequent sections.

3. **Main Section**
   The main section of the handbook provides complete details of the **MC-82,** including operating modes, calibration, troubleshooting, specifications, and warranty terms.

4. **Appendices**
   Appendices containing background information and application notes are provided at the back of this manual.

TPS Pty Ltd
4 Jamberoo Street
Springwood, Brisbane,
Australia, 4127

Phone	: (07) 32 900 400
International	: 61 7 32 900 400
Fax	: (07) 3808 4871
International	: 61 7 3808 4871
E-mail	: tps@tpssite.com.au
Web Page	: www.tpssite.com.au

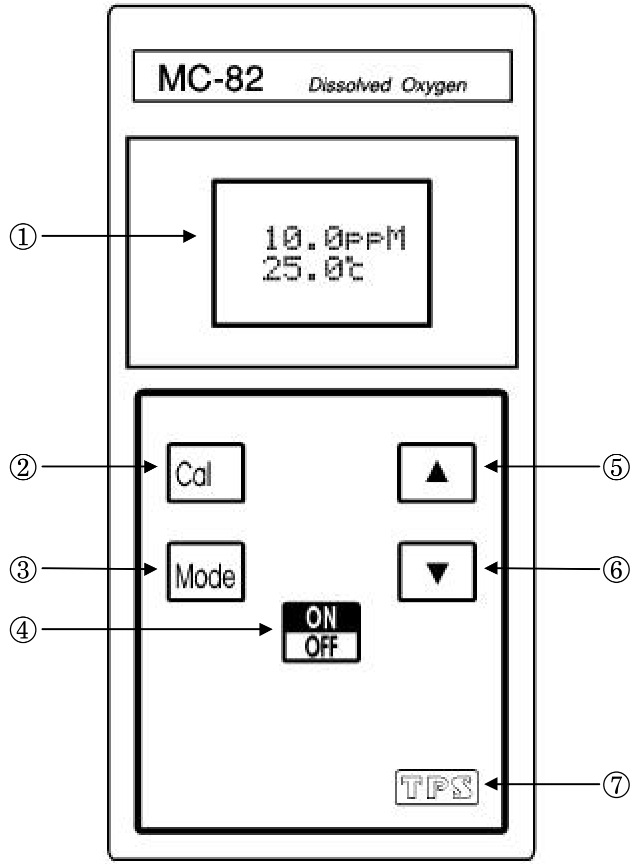
Model MC-82 Dissolved Oxygen Temp. Meter

Handbook Version	: 1.0
Date	: 13Aug96
Author	: MS

Contents

1. Introduction

1.1 MC-82 Display and Controls



① **Display**

16 character alpha-numeric display. “Dual Display” Format shows your choice of % Saturation and Temperature or ppM and Temperature simultaneously. A unique “Large Digit” Format nearly doubles the size of the digits. See section 2.

User-friendly prompts and error messages are also provided.

② **Cal**

Press and hold to calibrate Dissolved Oxygen and Temperature modes. Also used to set salinity correction value for ppM Dissolved Oxygen values. See sections 3.1, 4.1 and 5.

③ **Mode**

Press to change modes between % Saturation, ppM, Salinity Correction, and Temperature.

④ **ON / OFF**

Press to switch the **MC-82** on and off.

Press and hold down this key for 3 seconds to invoke the Battery Saver mode. See section 6.

⑤ ▲ and ⑥ ▼

Press to toggle the **MC-82** between Dual Display Format and Large Display Format. See section 2.1.

The ▲ and ▼ keys are also used to set the salinity correction value for ppM Dissolved Oxygen readout. See section 5.

NOTE: To initialise the unit and reset the memory, press and hold down the ▲ key while switching the **MC-82** on. See section 7.

⑦ TPS

The TPS logo. Your guarantee of **T**echnology, **P**recision and **S**ervice, in electrochemistry.

1.2 Unpacking Information

Before using your new **MC-82**, please check that the following accessories have been included:

	Part No
1. **MC-82** Dissolved Oxygen Temperature Instrument	123146
2. 9V Battery	130026
3. **MC-82** Handbook	130050

Sensor (ordered separately):

1. ED500W Dissolved Oxygen Temperature Sensor (Includes Membrane, Filling Solution & Zero DO_2 kit)	123220

Options that may have been ordered with your **MC-82**:

1. NiCad Rechargeable battery and charger	130007
2. Hard Plastic Carry Case	130057
3. BOD Bottle Adaptor	123201
4. Membrane, Filling Solution & Zero DO_2 kit	123301
5. Zero DO_2 Kit (50g Sodium Sulphite)	123302
6. Filling Solution, 45mL	123303

1.3 Specifications

Ranges	:	0 to 25.0 ppM DO_2 0 to 250.0 % Saturation -10.0 to +120.0 ^{o}C (Sensor limit 50 ^{o}C)
Resolution	:	0.1 ppM 0.1 % Saturation 0.1 ^{o}C
Accuracy	:	±0.1 ppM ±0.3 % Saturation ±0.2 ^{o}C
Salinity Correction	:	0 to 50.0 ppK NaCl (manual entry)
Sensor Zero Range	:	0 to 7.0%
Sensor Span Range	:	70 to 135%
Temperature Compensation	:	Dual automatic system for: 1. Membrane permeability 2. Solubility compensation in ppM mode
Power	:	9V Alkaline Battery for 100+ hours operation. Optional NiCad battery/charger pack available.
Dimensions	:	157 x 78 x 35 mm
Mass	:	Instrument only : Approx 200g Full Kit : Approx 1.5kg
Environment		Temperature : 0 to 45 ^{o}C Humidity : 0 to 90 % R.H.

2. Display Formats and Readout Modes

2.1 Display Formats

The **MC-82** has two display formats:

1. Dual Display format
2. Large Display format

Press the  or  keys to toggle between these two formats.

NOTE: The digits in Large Display format are made by combining the two rows of the display. The result is a small gap approximately half way up the digits.

2.2 Readout Modes for Dual Display format

Press the  key to roll through the readout modes.

In Dual Display format, the readout modes are:

1. **% Saturation**
   Displays % Saturation and Temperature readings simultaneously.
   eg : **100.0%S**
   25.0°c

2. **ppM Dissolved Oxygen**
   Displays ppM Dissolved Oxygen and Temperature readings simultaneously.
   eg : **10.0ppM**
   25.0°c
   If the salinity correction is set to a value other than zero, an "**S**" is added to the display in this mode, to signify that salinity correction is being applied.
   eg : **10.0ppM**
   25.0°c S
   NOTE: If the temperature of the solution exceeds 120.0 °C, or the temperature sensor inside the dissolved oxygen sensor is faulty, the temperature reading on the bottom line is replaced by "**OVR°c**", to signify the over-range condition.

3. **Salinity Correction**
   Displays the salinity correction value for ppM Dissolved Oxygen readout.
   Manually set the salinity value of the sample from 0 to 50.0 ppK (section 5).
   eg : **36.0ppK**

4. **Temperature**
   Displays just the temperature reading.
   eg: **25.0^{o}c**
   NOTE: If the temperature of the solution exceeds 120.0 ^{o}C, or the temperature sensor inside the dissolved oxygen sensor is faulty, the temperature reading on the bottom line is replaced by “**OVR^{o}c**”, to signify the over-range condition.

2.3 Readout Modes for Large Display format

Press the  key to roll through the readout modes.

In Large Display format, the readout modes are:

1. **% Saturation**
   Displays just the % Saturation reading in large digits.

2. **ppM**
   Displays just the ppM Dissolved Oxygen reading in large digits.
   If the salinity correction is set to a value other than zero, an “**S**” is added to the display in this mode, to signify that salinity correction is being applied.

3. **Salinity Correction**
   Displays the salinity correction value for ppM Dissolved Oxygen readout in large digits. Manually set the salinity value of the sample from 0 to 50.0 ppK (section 5).
4. **Temperature**
   Displays just the temperature reading in large digits.
   NOTE: If the temperature of the solution exceeds 120.0 ^{o}C, or the temperature sensor inside the dissolved oxygen sensor is faulty, the temperature reading on the bottom line is replaced by “**OVR^{o}c**”, to signify the over-range condition.

NOTE: The decimal point is replaced by a ∗ if calibration has failed for that parameter. (see sections 3.1 and 4.1), if the unit is initialised (see section 7), or if the unit has lost its factory calibration. (see section 8.1).

3. Dissolved Oxygen Calibration

3.1 Calibration Procedure

1. **NOTE**: A ∗ in place of a decimal point indicates the mode is not calibrated.
2. Press the On/Off key if the meter is not already switched on.
3. Press the Mode key until the meter is in % Saturation or ppM Dissolved Oxygen mode (see sections 2.2 and 2.3). Each mode should be calibrated separately for optimum accuracy.
4. Plug the Dissolved Oxygen sensor into the **Sensor** socket.
5. Ensure that temperature has already been calibrated (see section 4.1).
   NOTE: A ∗ in place of the decimal point in the temperature readout indicates that temperature is not calibrated.
6. Rinse the Dissolved Oxygen sensor in distilled water and blot dry.
7. **Zero Calibration**
   (a) Place the sensor into an oxygen-free solution. This solution may be prepared by dissolving 2g of Sodium Sulphite in 100mL of distilled water.
   A 50g bottle of Sodium Sulphite powder is supplied with a new ED500W sensor for this purpose (part number 123302).
   (b) Allow the reading to stabilise at or near zero. This may take 2-3 minutes.
   (c) Press and hold the Cal key for 2 seconds to calibrate.
   (d) Discard the oxygen-free solution after use.
   (e) A ∗ will not be removed from the display after a Zero Calibration.
8. Rinse the Dissolved Oxygen sensor in distilled water and blot dry.
9. **Air Calibration**
   (a) Hang the Dissolved Oxygen sensor in air. The tip of the sensor should be pointing downwards.
   (b) Allow the reading to stabilise. After a zero calibration, this may take up to 5 minutes.
   (c) Press and hold the Cal key for 2 seconds to calibrate.
   (d) A ∗ in the display will be replaced by a decimal point after a successful air calibration.
10. The **MC-82** is now calibrated and is ready for use.

<u>NOTES:</u>

When taking sample measurements, always ensure that there is adequate flow of solution past the membrane for accurate, stable readings. See section 10.6.

If salinity-corrected ppM Dissolved Oxygen readings are required, set the salinity correction value before taking sample measurements. See section 5.

3.2 Calibration Notes

1. A zero calibration should be performed at least monthly. In applications where there is a low level of dissolved oxygen, a zero calibration may have to be done weekly.
2. An air calibration should be performed at least weekly. Of course, more frequent calibration will result in greater confidence in results.
3. All calibration information is retained in memory when the **MC-82** is switched off, even when the battery is removed.
4. The salinity correction value is ignored during zero and air calibration. There is therefore no need to re-set the salinity correction value when calibrating Dissolved Oxygen.

3.3 Calibration Messages

1. If a zero calibration has been successfully performed, the **MC-82** will display the following message, and then display the zero response of the sensor.

   eg: **Zero** then: **Zero**
   Cal.OK **1.0%**

2. If a zero calibration has failed, the **MC-82** will display the following message, then the failed zero value of the sensor.

   eg: **Zero** then: **Zero**
   Cal.Fail **10.0%**

3. If an air calibration has been successfully performed, the **MC-82** will display the following message, and then the span value of the sensor.

   eg: **Air** then: **Span**
   Cal.OK **100.0%**

4. If an air calibration has failed, the **MC-82** will display the following message, and then the failed span value of the sensor.

   eg: **Air** then: **Span**
   Cal.Fail **70.0%**

4. Temperature Calibration

The temperature readout must be calibrated before attempting Dissolved Oxygen calibration and measurements. The decimal point is replaced by a ∗ if the reading is not calibrated.

4.1 Temperature Calibration

1. Press the [On/Off] key if the meter is not already switched on.
2. Press the [Mode] key until the meter is in Temperature mode.
3. Plug the Dissolved Oxygen sensor into the **Sensor** socket.
4. Place the sensor into a beaker of room temperature water, alongside a good quality mercury thermometer. Stir the sensor and the thermometer gently to ensure an even temperature throughout the beaker.
5. When the reading has stabilised, press and hold the [Cal] key for 2 seconds.
6. The reading from the probe is now displayed on the top line, and the value you are going to set is on the bottom line.

   eg: **25∗0 ^{o}C**
   ↑**26.0**↓
7. Press the [▲] and [▼] keys until the bottom line shows the same temperature as the mercury thermometer.
8. Press the [Cal] key to calibrate the temperature readout.
   Alternatively, press the [Mode] key to abort temperature calibration.

4.2 Calibration Notes

1. Temperature calibration information is stored in memory when the meter is switched off, even if the battery is removed.
2. Temperature does not need to be recalibrated unless the Dissolved Oxygen sensor is replaced or the meter is initialised.

4.3 Calibration Messages

1. If a temperature calibration has been successfully performed, the **MC-82** will display the following message and then the offset value of the probe.

   eg: **Temp** then: **Offset**
   Cal. OK **1.0^{o}C**
2. If a temperature calibration has failed, the **MC-82** will display the following message, and then the failed offset value of the probe.

   eg: **Temp** then: **Offset**
   Cal.Fail **10.5^{o}C**

5. Setting the Salinity Correction Value

The salinity of the sample affects the Dissolved Oxygen reading in ppM mode. As the salinity increases, the solubility of Oxygen decreases. The Dissolved Oxygen sensor is not able to detect the salinity of the sample, so the operator must enter this value manually for salinity-corrected ppM Dissolved Oxygen readings.

To set the salinity correction value:

1. Measure the salinity of the sample solution. For best results, use a good quality salinity meter, such as a TPS model MC-84 or WP-84. Note the reading.
2. Press the ON/OFF key if the meter is not already switched on.
3. Press the Mode key until the meter is in Salinity mode (see sections 2.2 & 2.3). The currently selected salinity correction value is displayed.
4. Press and hold the Cal key for 2 seconds.
5. The display should now look like this:

   Man. Sal
   36.0
6. Press the ▲ and ▼ keys until the bottom line shows the salinity value obtained in step 1.
7. Press the Cal or Mode key to set the salinity correction value.

NOTES:

1. For non salinity-corrected readings in ppM mode, simply set the salinity correction value to 0.0 .
2. If the salinity correction value is set to above zero, an "**S**" is added to the display in ppM mode, to signify that salinity correction is being applied.

   eg : **10.0ppM**
   25.0°c S
3. The salinity correction value is ignored during zero and air calibration. There is therefore no need to re-set the salinity correction value when calibrating Dissolved Oxygen.

6. Battery Saver Function

The **MC-82** is equipped with a battery saver function. If no button has been pressed for five minutes, the unit beeps and flashes the display for 20 seconds, and then shuts off. This function can be disabled for continuous use.

To enable or disable the battery saver function:

1. Press the [ON/OFF] key if the meter is not already switched on.
2. With the meter already switched on, press and HOLD the [ON/OFF] key for 3 seconds. Release the [ON/OFF] key when the message "**Battery Saver**" appears.
3. The display should now look like this:

   Either: **:ON↑↓** / **9.00V** or: **:OFF↑↓** / **9.00V**
4. In this mode, use the [▲] or [▼] keys to toggle the battery saver function on or off.

NOTE: The display also shows the battery volts. This gives the operator an idea of how much battery life is remaining. The symbol flashes when the battery volts drops below 7.50 volts. At 6.00 volts the meter turns itself off.

5. When you have set the battery saver function to the desired position, press the [Mode] key to return to normal measurement mode. The setting is kept in memory when the meter is switched off, even if the battery is removed.

7. Initialising the MC-82

If the calibration settings of the **MC-82** exceed the allowable limits, the unit may need to be initialised to factory default values. This action may be required if the sensor is replaced.

To initialise the **MC-82**:

1. Switch the **MC-82** off, by pressing the [ON/OFF] key.
2. Press and hold the [▲] key while switching the **MC-82** the on with the [ON/OFF] key.
3. The following messages should be displayed:

   Memory Reset ! then: **You MUST Re-Cal.** then: **TPS MC82 Oxygen °c**
4. The meter then displays % Saturation and Temperature. Note that the decimal points have been replaced with a ∗, to indicate that the unit requires recalibration.

8. Troubleshooting

8.1 General Error Messages

Error Message	Possible Causes	Remedy
Factory Cal. Fail **See Handbook**	The EEPROM chip which contains the factory set-up information has failed.	The unit must be returned to TPS for service.
Memory Failed **Calib. Lost** **Memory Reset !** **You MUST Re-Cal.**	User calibration settings have been lost or corrupted.	Re-calibrate the instrument. Both Zero and Air calibration will be required for Dissolved Oxygen (see section 3.1) and a 1 point calibration for temperature (see section 4.1).
Meter displays the word **OFF**, and switches off.	Battery is below 6.00 volts.	Replace the battery.
Meter will not turn on.	Battery is exhausted.	Replace the battery.
Flashing symbol.	Battery is below 7.50 volts.	Replace the battery. Note that the unit will switch itself off when the battery falls below 6.00 volts.

8.2 Dissolved Oxygen Troubleshooting

Symptom	Possible Causes	Remedy
Unit fails to calibrate, even with new probe.	Calibration settings outside of allowable limits due to previous failed calibration.	Initialise the unit. See section 7, Initialising the MC-82.
• Zero calibration fails (Zero is greater than 7.0%) • Air calibration fails (Span is less than 70% or greater than 135%). • Unstable or inaccurate readings.	1. Membrane is leaking or broken. 2. Gap between membrane and gold cathode is dry. 3. Incorrectly fitted membrane. 4. Electrode is empty. 5. Electrode is faulty.	Replace membrane and refill electrode. Undo the barrel 3 turns, then re-tighten to re-flush the filling solution. Membrane should be smooth and convex with no wrinkles. Re-fit membrane if necessary. Replace membrane and re-fill electrode. Return electrode to factory for repair or replacement
Blackened Silver anode wire	Electrode has been exposed to sulphides or other chemical poisoning.	Return to the TPS factory for cleaning and service.
Tarnished or scratched Gold cathode.	Electrode has been chemically poisoned or physically damaged.	Return to the TPS factory for cleaning and service.
Meter reads **OVR ppM** or **OVR%**.	1. Electrode has not yet polarised. 2. Electrode is faulty	Wait for 2-3 minutes for the electrode to polarise after the **MC-82** is switched on. Return electrode to factory for repair or replacement.

8.3 Temperature Troubleshooting

Symptom	Possible Causes	Remedy
Displays **OVR°c** when the electrode is plugged in.	Electrode is faulty.	Return electrode to factory for repair or replacement.
Temperature inaccurate and cannot be calibrated.	1. Faulty connector. 2. Electrode is faulty.	Check the connector and replace if necessary. Return electrode to factory for repair or replacement.

9. Warranty

TPS Pty. Ltd. guarantees all instruments and sensors to be free from defects in material and workmanship when subjected to normal use and service. This guarantee is expressly limited to the servicing and/or adjustment of an instrument returned to the Factory, or Authorised Service Station, freight prepaid, within twelve (12) months from the date of delivery, and to the repairing, replacing, or adjusting of parts which upon inspection are found to be defective. Warranty period on sensors is three (3) months.

There are no express or implied warranties which extend beyond the face hereof, and TPS Pty. Ltd. is not liable for any incidental or consequential damages arising from the use or misuse of this equipment, or from interpretation of information derived from the equipment.

Shipping damage is not covered by this warranty.

PLEASE NOTE:
A guarantee card is packed with the instrument or sensor. This card must be completed at the time of purchase and the registration section returned to TPS Pty. Ltd. within 7 days. No claims will be recognised without the original guarantee card or other proof of purchase. This warranty becomes invalid if modifications or repairs are attempted by unauthorised persons, or the serial number is missing.

PROCEDURE FOR SERVICE
If you feel that this equipment is in need of repair, please re-read the manual. Sometimes, instruments are received for "repair" in perfect working order. This can occur where batteries simply require replacement or re-charging, or where the sensor simply requires cleaning or replacement.

TPS Pty. Ltd. has a fine reputation for prompt and efficient service. In just a few days, our factory service engineers and technicians will examine and repair your equipment to your full satisfaction.

To obtain this service, please follow this procedure:
Return the instrument AND ALL SENSORS to TPS freight pre-paid and insured in its original packing or suitable equivalent. INSIST on a proof of delivery receipt from the carrier for your protection in the case of shipping claims for transit loss or damage. It is your responsibility as the sender to ensure that TPS receives the unit.

Please check that the following is enclosed with your equipment:

- **Your Name and daytime phone number.**
- **Your company name, ORDER number, and return street address.**
- **A description of the fault. (Please be SPECIFIC.)**
  (Note: "Please Repair" does NOT describe a fault.)
- **either $13.50 for return freight for units under warranty,**
  or $24 to cover inspection costs and return freight.

(These amounts are not applicable to full-account customers.)

Your equipment will be repaired and returned to you by air express where possible.

For out-of-warranty units, a repair cost will be calculated from parts and labor costs. If payment is not received for the additional charges within 30 days, or if you decline to have the equipment repaired, the complete unit will be returned to you freight paid, not repaired. For full-account customers, the repair charges will be debited to your account.

- **Always describe the fault in writing.**
- **Always return the sensors with the meter.**

10. Dissolved Oxygen Sensor Fundamentals

The electrode used, is the amperometric type of Clark Electrode and is suitable for the measurement of oxygen pressures in the range 0 to 100 cm of mercury. While the probe actually reads partial pressure of oxygen, the circuit is calibrated to be read in percentage saturation or parts per million (Milligrams/litre). The operation of probes of the Clark type relies on the diffusion of oxygen through a suitable membrane into a constant environment of 0.1 molar potassium chloride. Measurements are best performed with a reasonable flow past the membrane. At sufficiently high flow rates, the oxygen current is totally independent of the flow (few cms./sec.). The cell must not be shaken however or unstable readings will result from electrolyte surge bringing new oxygen from the reservoir to the working cathode surface.

10.1 Operating Principle

The Clark oxygen electrode consists of a gold cathode and a silver/silver chloride anode, placed in an electrolyte solution. This solution is contained behind a plastic membrane. In this case the plastic is 0.025mm intermediate density polyethelene sheet. PTFE (teflon) can be supplied for special applications. It must be realised that using membranes of very different thicknesses will result in an error in the temperature compensation that is applied in the instrument for the membrane permeability. This coefficient (here +4.2%/^{o}C at 25^{o}C) is for this thickness polyethelene. A polarizing voltage of about 800 millivolts is applied between the two electrodes. The gold electrode is placed close to the membrane and because of the polarizing voltage, oxygen diffusing through the membrane will be reduced at the gold electrode.

Equation: $O_2 + 2H^+ + 2\text{ electrons} \rightarrow H_2O_2$

This reduction process will produce a current through the oxygen electrode. A load resistor (actually a thermistor in this case) situated in the electrode itself, converts this current into a voltage proportional to the oxygen partial pressure. The thermistor provided within the body of the electrode can have a temperature coefficient of -4.2%/^{o}C. This gives an accurate temperature compensation for the temperature/permeability effect of the membrane to oxygen, over a range of $\pm$ 20^{o}C about a centre value of 25^{o}C. Note this compensation is not for the solubility effects. A separate sensor also included achieves this.

10.2 Maintenance Of The Membrane

The membrane does not require replacement as long as it remains intact. If punctured or suspected of leaking around the edges, it must be replaced.

To replace the membrane:

1. Unscrew the lower barrel and carefully remove it from the probe. Ensure that the internal lexan barrel is not touched with the fingers, as the metallic surfaces are easily contaminated.
2. Remove the plastic cap and membrane from the end of the barrel.
3. Cut a 30 mm square (approx) piece of membrane material from your probe maintainance kit. Hold this over the end of the barrel, and push the plastic retaining cap back into place evenly. A little moisture on the outside of the membrane will let the cap slip on easily. The excess membrane may be trimmed off with a razor blade.
4. Pour enough 0.1 Molar KCl solution into the barrel to fill only 1/3.
5. Push the barrel carefully onto the lexan internal rod. As this is done, check for leaks on the membrane. The internal rod can be used to gently "pump" the membrane to check for leaks.
6. If no leaks can be seen, screw the outer barrel into place, so that the membrane is evenly and smoothly stretched over the gold internal cathode (gold bead at end). DO NOT OVERTIGHTEN.

   If the probe is washed off and put in fresh water, then, by viewing obliquely in a strong light, it is possible to see electrolyte "streaming" from the tip if it is leaking (even slowly). The effect is one of differential refractive index and is quite sensitive.

   If the response is low, or zero impossible, or reading overranged, fit a new membrane.

10.3 Probe Storage

The Oxygen probe should be kept moist when not in use to prevent the thin film of electrolyte behind the membrane from drying out. To achieve this, the probe can be stored with the tip in water.

For long term storage of several weeks or more, remove and empty the barrel. Replace the barrel with the membrane intact. When the electrode is stored in this way, the membrane sould be replaced and the electrode refilled before use.

10.4 Notes On Units Of Dissolved Oxygen

The terms "Oxygen Concentration" and "Oxygen Partial Pressure" frequently give rise to some confusion.

- Oxygen Concentration is the absolute quantity of oxygen present per unit mass of the liquid.
- Oxygen Partial Pressure is the the oxygen fraction of the total pressure of all of the gases present.

For any one liquid system, Oxygen Concentration and Oxygen Partial Pressure are proportional. However, if the solubility of oxygen in the liquid should change owing to increased quantities of solutes, etc., then the ratio of the Concentration to the Partial Pressure must change. Thus, if one saturates distilled water and a 25% solution of Sodium Chloride with air at atmospheric pressure (25^{o}C) both solutions will have almost exactly the same Oxygen Partial Pressure, namely 15.5 cms of mercury. However, the dissolved Oxygen Concentration parts per million (milligrams per litre) will be 8.2 in the distilled water and 2.01 in the salt solution. This is a rather extreme example, as ocean water is only 3.6% saline. It does however stress the importance of correct interpretation of the salinity, etc.

The Clark Electrode measures the partial pressure of oxygen diffusing through a membrane. The current is a linear measure of this partial pressure, assuming liquid flow conditions are met.

With air, at sea level, the 20.9% oxygen exerts about 15.5 cms (mercury standard) pressure. Water in equilibrium with air and with no C.O.D. or B.O.D., etc., is saturated and has this dissolved oxygen partial pressure. If we define 100% Saturation in Partial Pressure terms, then 15.5 cm. Hg = 100% Saturation. This is a practical unit to use. The probe linear readout is then a linear function of % Saturation. Organic cell walls behave like the probe and pressure units are valuable.

% Saturation is the best unit for industrial control and not ppM, contrary to popular beliefs. The partial pressure (and consequently the pressure defined % Saturation) varies only slightly with temperature. (Recall at this stage that the permeability of the membrane has a temperature coefficient, but the electronics has scaled this out by the operation of the Automatic Membrane Temperature Compensator Thermistor incorporated in the D.O. probe).

If mass units are used for measurement of Dissolved Oxygen, the temperature problem of relating the linear partial pressure reading of the probe, to the mass (ppM or mg/L) at different temperatures becomes more involved. As well, there is the mass variation due to dissolved salts (salinity correction). Therefore, the fully corrected instrument would need 3 correction systems.

(a) Membrane correction for temperature permeability effects.
(b) Solubility correction of Dissolved Oxygen with temperature and
(c) Salinity correction of Dissolved Oxygen by weight (Salinity has no effect on pressure units readout).

In the **MC-82** instrument,
(a) is achieved AUTOMATICALLY.
(b) To provide the mass units (ppM) readout (so popular due to the Winkler process used in the past), the **MC-82** Meter has Solubility Correction via an additional temperature sensor in the electrode.
(c) Salinity correction is provided by manual entry of the salinity of the sample. This must first be measured with a good quality salinity meter, such as a TPS model MC-84 or a WP-84.

10.5 Equilibrium Conditions

Whilst Saline Water has a lower ppM than does Fresh Water, it does not mean it necessarily has less oxygen, biologically available. Both have 100% Saturation (presuming no Chemical Oxygen Demand (C.O.D.), Biological Oxygen Demand (B.O.D.), etc) because both are in partial pressure equilibrium with air. Any usage of oxygen is immediately supplied by the dissolving of more from air, to meet partial pressure equilibrium requirements. This is so for both saline and fresh water. The reporting of oxygen at a lower level (in ppM units) in the Salt Water is therefore QUITE MISLEADING!

In closed systems, such as tanks, pipes and deep waters, equilibrium is not so readily available and the Salinity Effect gains the importance in the reporting of Dissolved Oxygen. It is suggested, unless such closed (or deep, low diffusion) systems are encountered, that Oxygen should be reported in % Saturation or ppM of equivalent Fresh Water.

10.6 Velocity Past The Membrane

Workers have shown that the relationship between the diffusion current (oxygen current) and the external velocity of the liquid is expotential. Some workers using thicker membranes have shown even less dependence of the diffusion current on liquid velocity. Because of the expotential nature of the relationship, very considerable changes in velocity have to be made before noticing any change in the diffusing current once the flow is sufficiently high. Tests with this electrode have shown that flow rates above 0.2 litres/minute past the membrane give results indistinguishable from those with appreciably higher flow rates (5 litres/minute). Fluctuations in readings due to air bubbles passing through the membrane are, however, a different matter. With the type of electrode to be used with this instrument, very little changes in diffusion current are caused by altering the pH of the external environment. Pressure changes over a moderate range exerted on the membrane also cause no change. The probe is sealed by glands for total immersion up to 3 metres.

11. Instrument firmware version number.

If you need to phone or fax TPS for any further technical assistance, the version number of your **MC-82** firmware may be of benefit to us. Please obtain the version number as follows, before phoning or faxing:

1. Switch the **MC-82** on by pressing the ON/OFF key.
2. While the model is being displayed, press the Mode key.
3. The unit will now display the model and version number,
   eg: **TPS MC82**
   Ver 1.0