Palintest®

Leaders in Water Analysis Technology

Macro 900 Water Quality System

Instruction Manual

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Table of Contents

1. Introduction

This manual covers the setup, operation, calibration and maintenance of the Macro 900 Meter, Macro Accessory Probes (all types), Macro 900 Link PC software and associated Macro 900 accessories.

2. What's in the Box?

The Macro 900 Water Quality System is supplied with the following:

- The Macro 900 Meter.
- Quick release lanyard.
- Set of 5 AA Alkaline batteries.
- USB Cable for downloading logged data to a PC.
- Cross-head screwdriver for fitting the batteries and Probe maintenance.
- CD containing Macro 900 Link software, USB drivers and this Instruction Manual.
- Instruction Manual
- Instrument Warranty Registration Card

The accessories included with the Macro Accessory Probe (MAP) you have chosen will vary between models, but in all cases you will receive the following:

- The MAP unit.
- Protective Sleeve End Cap.
- 300mL of Macro Cal Solution.
- Spare 300mL calibration / rinse bottle.
- Spare set of sleeve screws.
- Two mounting nuts (pre-fitted).
- Probe Warranty Registration Card.

In addition, you may receive other solutions and spare parts (see section 18)

2.1. The Macro 900 Meter and the Environment

The Macro 900 Meter is designed to be used outdoors and is rated to IP67, that is to say it is waterproof but it **is not** designed for submersion. In order to prevent accidental dunking or loss, a lanyard is supplied.

Please note that the Macro 900 Meter is only waterproof when the associated Macro Accessory Probe plug is fitted. Without the plug fitted, water can enter the Meter through the socket. Damage caused by water ingress through the socket is not covered by your warranty.

You may notice a small hole on the rear of the unit near the socket. This is a waterproof vent for the internal barometric sensor. **Do not poke anything in this hole!** Doing so will cause major damage to the vent's waterproof membrane and invalidate your warranty.

2.2. The Macro Accessory Probe and the Environment

All Macro Accessory Probes (MAPs) are designed to be fully submerged in water

and rated to IP68, that is to say, it is rated for continual immersion to a depth of 10 meters, and short term immersion to 30 meters.

2.3. About the Probe Sleeve

Each MAP is constructed with a two-part protective aluminium sleeve surrounding the more delicate sensing electrodes.

The lower half of the Probe Sleeve can be easily removed by unscrewing to allow cleaning of the individual electrodes, however, **both halves of the Probe sleeve form an integral, working part of the Probe's measurement system, and MUST be fitted for correct operation.**

2.4. Protective Sleeve End Cap

Whilst the Macro Accessory Probe is fitted with an extremely rugged sleeve, damage may be caused to individual electrodes if sharp objects are allowed to enter the open end of the lower sleeve.

In order to avoid this, a protective Sleeve End Cap is provided and should be used whenever there is a risk that sharp objects may be present in the water being sampled, i.e. down bore holes or in shallow streams littered with rocks or garbage.

When sampling in open water, leave the protective Sleeve End Cap off as the increased flow across the electrodes will give faster readings.

The protective Sleeve End Cap should never be fitted during calibration or when using the MAP with the optional Macro Flow Cell.

If there is any risk of damage to the electrodes, fit the cap. Damage caused to electrodes when the Sleeve or Sleeve End Cap is not fitted, is not covered by your warranty.

2.5. About the Lanyard

The lanyard supplied with the Macro 900 Meter is intentionally long to allow the meter to be worn around the neck or over the shoulder when both hands are needed.

The extra length also allows the meter to be held in a comfortable position in front of you during normal use. The lanyard includes a quick-release clip.

3. Battery Installation and Care

The Macro 900 Meter requires five AA size batteries. To install the batteries, loosen the two screws on the centreline of the rear of the meter and remove the battery compartment lid. Following the battery polarity markings inside the battery compartment, insert five AA cells then replace the compartment lid and tighten the screws.

3.1. Choice of Battery Type

Alkaline or rechargeable batteries may be used, but never mix battery types in the meter. If you choose to use rechargeable batteries, we recommend *Energizer* 2500mAh (or greater) Nickel-Metal Hydride cells, which are widely available.

If the Meter is to be out of use for a long period, remove the batteries to prevent damage due to possible leakage.

3.2. Battery Life

A set of fresh alkaline cells will give over 20 hours use and NiMH up to 40 hours use in the Macro 900 Meter.

3.3. Battery Charging

During the charging process, batteries generate heat and vent gasses, and must never be charged inside a sealed unit. Because the Macro 900 Meter is a sealed unit, we do not allow charging in-situ. Batteries must be removed and charged with a suitable battery charger outside the Meter.

3.4. Battery Condition Icon

On all the main Macro 900 Meter screens, a battery condition icon is displayed in the top left corner. The icon shows full when the batteries are fresh, and gradually empties as the batteries are used. When the batteries need replacing, the empty battery icon will flash on and off. If you ignore this, the Meter will automatically switch itself off when the battery voltage becomes too low for reliable operation.

When using rechargeable batteries, the battery icon will not show completely full, even with freshly charged cells. This is due to the fact that rechargeable batteries are only rated at 1.2V per cell compared to 1.5V per cell for alkaline batteries. This indication does not affect battery life. The icon will simply sit at the ¾ full mark for a longer period of time.

3.5. Battery Saver Functions

The Macro 900 Meter is designed to switch off automatically if you do not touch any of the keys for 30 minutes. The only exception to this is if you have activated the Automatic Data Logging feature. In this case, the Meter will continue to operate until either the memory is full or the batteries go flat.

The display on the Macro 900 Meter incorporates a white backlight to improve visibility in low-light conditions. As on a mobile phone, the backlight switches on each time a key is pressed, and stays on at full brightness for 15 seconds. After 15 seconds, the backlight will fade to half brightness. After a further 15 seconds the backlight will switch off.

During normal operation, if you want to activate the backlight without changing the Meter function, simply press the **ESC** key.

4. Overview of the Operating System

The operating software in the Macro 900 Meter has been designed for simple, intuitive use. Similarly, a great deal of development work has been put into simplifying and automating the calibration procedures in the Macro 900 Meter in order to allow normal field operatives (as opposed to trained lab technicians) to achieve quick and accurate results.

If you are used to operating a mobile phone or programming audio/visual equipment using a remote control, you should feel at home with the familiar up/down left/right arrow shaped navigation keys and central **OK** key.

The tree structure behind the **MENU** key should also be very familiar. Each item on the menu leads to a sub menu and then either onto further menus or final choices. Each branch of the menu system is navigated using the arrow keys. At each point, selections can be made by either pressing the **OK** key or the right arrow key.

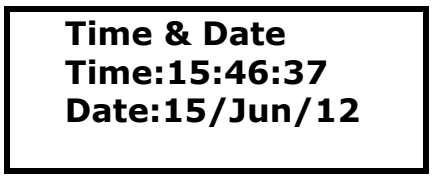
To reverse along a branch of the menu system, use the **ESC** (escape) key or left arrow key. After a short time, you should be able to navigate around the entire menu system at speed using just the four arrow keys. If, at any time, you leave the Meter in one of the sub-menu screens, it will automatically back out to the main operating screen after 15 seconds.

4.1. Initial Switch On, Language and Clock Setup

To switch the meter on or off, briefly press the red key. **Do not hold it down.** The meter contains a clock and is capable of operating in several different languages. When switching on for the first time, you must select an operating language and set the clock. The first screen you will see is the Language Selection Screen.

To select a language, move the cursor down the list using the down arrow key. To enter your selection, press the **OK** key or the right arrow key.

The next screen to be displayed is the Time & Date Setting Screen.



To set the time and date, use the arrow keys to move the cursor around the screen. Use the up and down arrow keys to adjust values. When the time and date are correct, press the **OK** key.

5. Connecting an Macro Accessory Probe (MAP)

The Macro 900 Meter is designed to operate in conjunction with all Macro Accessory Probe models (each variant is considered in later sections).

To connect a MAP, align the key slot of the MAP plug with the Macro 900 Meter socket, then press the plug into the socket and tighten the retaining collar. **Always ensure the Macro 900 Meter is switched off prior to connecting or disconnecting a probe**.

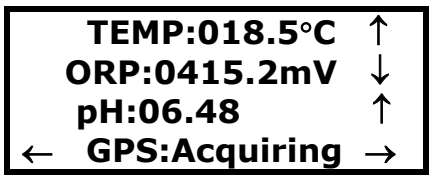
6. Taking Measurements

If the MAP you are using includes a pH/ORP electrode, remove the storage cap by pulling the blue lanyard marked 'Remove Before Use / Replace After Use' straight down. **Do not use a twisting motion to remove or replace the cap as this can unscrew the electrode from the Probe body.** Rinse any salty deposits from the pH/ORP electrode with fresh water.

Fit the protective Sleeve End Cap into the end of the Probe sleeve if required, then switch the Macro 900 Meter on and immerse the MAP in the sample water, making sure that the water level covers the minimum immersion depth groove halfway up the Probe sleeve.

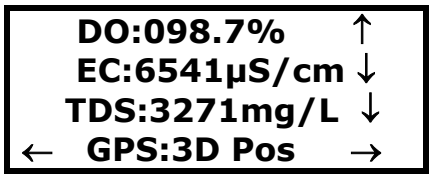
TIP: Occasional application of a smear of silicone grease or similar lubricant to the protective Sleeve End Cap O ring and the inside rim of the Probe sleeve will make fitting and removal of the Cap easier.

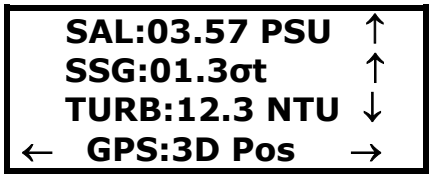
If the MAP is connected correctly, the meter will read the Probe's serial number and model number, then will automatically configure itself to display only those readings the current MAP is capable of taking. Initial Probe readings will be displayed on the Meter's screen along with the current GPS status. The initial data screen for the Macro 900 Meter in conjunction with the MAP 1000 is shown below.

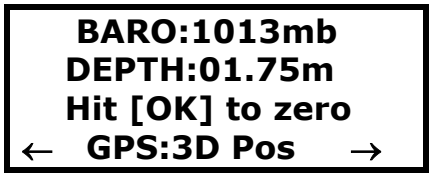


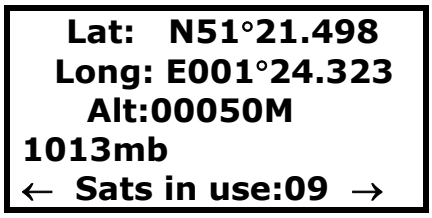
If the current probe / meter combination is capable of reading more than three parameters, left/right arrows will appear at the bottom corners of the screen to indicate further data screens are available (as shown above).

To access these screens, simply press either the left or right arrow keys. Any value that is out of range or unavailable will be displayed as dashes. The other four screens available with the Meter/MAP 1000 combination are shown below.









6.1. What Does It All Mean?

The screens above show the full default range of readings for the Macro 900 Meter/MAP 1000 combination. If you are using a different Probe combination, you may have fewer screens to choose from and the readings may appear in a different order to facilitate logical screen layouts. If an asterisk (*) character is flashing just below the battery symbol, this indicates that Auto Data Logging is switched on. See Automatic Data Logging in section 8.

The table below explains the readings and indicates which to expect with each Meter/Probe combination.

Prefix	Meaning	Units	Available On
TEMP	Probe Temperature	ºC or ºF*	All MAPs
TURB	Turbidity	NTUs	MAP 400, 600, 800, 900, 1000
pH	pH (Acidity/Alkalinity)	pH or pHmV*	MAP 100, 400, 500, 600, 700, 800, 900, 1000
ORP	Oxidation Reduction Potential	mV	MAP 100, 400, 500, 600, 700, 800, 900, 1000
DO	Dissolved Oxygen	%Sat or mg/L*	MAP 300, 500, 600, 700, 800, 900, 1000
EC	Electrical Conductivity	µS/cm or mS/cm†	MAP 300, 500, 600, 700, 800, 900, 1000
TDS	Total Dissolved Solids	mg/L or g/l†	MAP 300, 500, 600, 700, 800, 900, 1000
SAL	Salinity	PSU or ppt*	MAP 300, 500, 600, 700, 800, 900, 1000
SSG	Sea Water Specific Gravity	σt	MAP 300, 500, 600, 700, 800, 900, 1000
BARO	Barometric Pressure	mb or mmHg*	MAP 300, 500, 600, 700, 800, 900, 1000
DEPTH	Depth above / below zero datum	Meters / Feet*	MAP 1000
Lat	Latitude	Degrees & Mins	All Probe Models
Long	Longitude	Degrees & Mins	All Probe Models
Alt	Altitude above Sea Level	Meters or Feet*	All Probe Models
GPS	Position	See Section 6.5	All Probe Models

Note: the BARO prefix is not displayed when either MAP 800 or MAP 900 are in use. In this case, barometric pressure is displayed after the altitude (Alt) at the end of line 3 on the position and altitude screen, with no prefix (as shown [1013mb] on the above screen example).

Items in the Units column marked with an asterisk (*) can be selected as alternative units of measurement in the Settings Menu (see section 9: Setting Units of Measurement). Items in the Units column marked with a dagger (†) are auto-ranging, i.e. when the values become too large to display, the units of measurement automatically re-scale.

On Probe models MAP 100, 400, 500 and 600, the pH field will be replaced by ORP (Oxidation Reduction Potential) if an ORP electrode is fitted in place of the pH electrode. In this case, the reading will be shown in mV. This is again controlled via the Settings Menu.
The EC field can be replaced by its reciprocal value, RES (Resistivity), if selected in the Settings Menu. If selected, readings will be displayed in either Ω▪cm or kΩ▪cm, depending on the value. See section 9: Setting Units of Measurement for more details.

6.2. Trend Indication

To the right of each reading, (except position, BARO and depth), a trend indication is given. This consists of an upwards facing arrow (which indicates the numeric value of the reading is rising), a downwards facing arrow (which indicates the numeric value of the reading is falling) or a two-headed arrow, which indicates a stable reading. Readings are judged to be stable when the variation over a ten second period drops below 1%.

6.3. Global Stability Indication

In addition to the individual trend indications, there is also a global stability indication, which is displayed when **all** readings are stable. This takes the form of a flashing double headed arrow which is displayed at the start of the third line of the display.

When taking a set of readings, gently move the MAP, or raise and lower it in the sample (if there is no natural water flow) until the global stability icon appears. The initial display of the global stability icon will be accompanied by a double beep. When this occurs, all values are stable and ready for reading or adding to the memory (see Section 8 Memory Mode).

Be aware, in order to achieve accurate Dissolved Oxygen (DO) readings when using a Probe fitted with a galvanic DO electrode (MAP 300, 500, 600, 700, 800), the Probe needs to be either placed in flowing water, or needs to be stirred or raised and lowered continuously to ensure a minimum flow rate of 0.3m/s over the DO Electrode. If there is no water flow across the Probe, the oxygen in the immediate area of the DO Electrode will be consumed and the reading will start to fall. **This limitation does not apply to Probes fitted with Optical DO sensors (MAP 900 & MAP 1000).**

6.4. Temperature Compensation

The electrochemical properties of all solutions change with temperature. In addition electrochemical electrode response changes with temperature. It is a fundamental, practical requirement in the field of water quality monitoring that test measurements taken at different temperatures can be compared.

In order to facilitate this, all Macro Accessory Probes measure and automatically correct for temperature.

During calibration of the pH electrode, the variation in the calibration buffer solution and electrode due to temperature is automatically corrected.

During calibration of the EC electrode, the variation in the calibration buffer solution due to temperature is automatically corrected. During measurement of EC, the readings can be displayed without any temperature correction, corrected to 20ºC, or corrected to 25ºC. See section 9: Setting Units of Measurement for more details.

During calibration of the DO electrode, variations due to temperature and air

pressure are automatically compensated. During the measurement of DO, temperature, air pressure and salinity are automatically compensated.

During calibration of the ORP electrode, the variation in the calibration buffer solution due to temperature is automatically corrected. During measurement of ORP however, temperature corrections are not applied as the correction factors are matrix specific.

ORP potential measurements are mostly made to follow reactions rather than for their own sake. The completion of an ORP reaction is normally accompanied by a sharp change in the ORP millivolts reading. This change is usually much larger than the errors induced by temperature effects.

Turbidity calibration and measurement are not susceptible to the effects of temperature therefore compensation is not applied.

6.5. GPS Reception

The Macro 900 Meter contains a built-in GPS receiver and antenna. The antenna is situated at the top of the case, just behind the PALINTEST Logo.

For optimum signal reception, the antenna must be able to 'see' a reasonably large amount of the sky. **The GPS receiver will not work indoors or when shielded from the sky by any solid structure.**

After switch-on, the GPS receiver will automatically start to search for satellites. During this phase, the message **GPS:Acquiring** will be shown on the bottom line of all screens.

As soon as three satellites are acquired, two dimensional position (no altitude) will be calculated and the message **GPS:2D POS** will be shown on the bottom line of the screens.

Once a fourth satellite is acquired, altitude will be calculated and **GPS:3D POS** will be shown on the bottom line of the screens. With a good view of the sky, position should be calculated within ninety seconds of switch-on. To see your geographic position and the number of satellites in use, use the left or right arrow keys to scroll to the Position page.

If you switch the meter on indoors, then carry it outside after several minutes, there may be a considerable delay in acquiring satellites. In this case, switch the meter off, then back on again to reset the acquisition process.

7. Depth Measurement (MAP 1000 only)

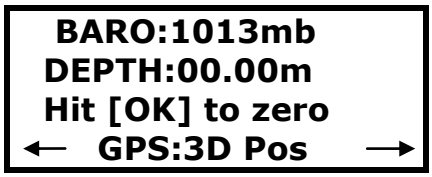
Depth is measured in the MAP 1000 by a pressure sensor mounted inside the body of the probe.

Depth is calculated by subtracting the barometric pressure being measured in the Macro 900 Meter from the water pressure being measured in the MAP 1000. The pressure differential, once corrected for temperature and salinity (water density), is directly proportional to depth.

The depth measurement system uses the EC sensor to detect when the probe has been placed in water. All the time the probe is measuring an EC of zero, the depth will read zero. As soon as an EC value is detected, the meter will start to calculate depth. **For this reason, it is important to ensure the Probe is connected to the Meter and switched on prior to submerging the probe in water.**

7.1. Taking Depth Measurements

Connect the Probe to the Meter and switch on prior to submerging the probe in water. Select the Baro/Depth screen as illustrated below. The depth should be reading zero.



If the depth is not reading zero (this is possible if the probe is wet and a low EC reading is registering), press the OK key. You will be asked to confirm by pressing OK again. Slowly lower the probe into the water. As soon as the depth value starts to register, you can lower the probe more quickly.

7.2. Differential Depth Measurement

To measure changes in depth, it may be more convenient to zero the depth measurement once the probe has been submerged.

To do this, press the OK key whilst displaying depth, then confirm. The unit will now read positive or negative changes in from the current depth (zero datum). Positive values indicate an increase in depth from the zero point, negative values a decrease.
Using the Automatic Data Logging feature detailed in the following section, it is possible to monitor water levels over a period of time for later recall.

8. Memory Mode

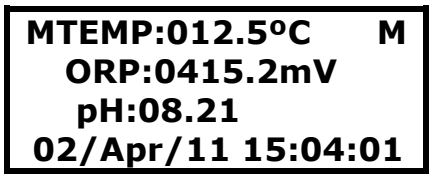
8.1. Manually Saving Readings

When readings are stable (see section 6.3), press the **M+** key to snapshot the readings along with the time, date, GLP (calibration) data and position.

As each reading is saved, a numeric memory location 'Tag' will be briefly displayed which you can note down. This Tag can be used to identify readings at a later date, both on the Macro 900 Meter and when using Macro 900 Link software.

8.2. Recalling and Viewing Saved Readings

To recall your readings, press the **MR** key. On entering Memory Recall mode, the most recent Tag and set of readings are displayed along with the date and time the readings were taken shown on the bottom line of the screen.



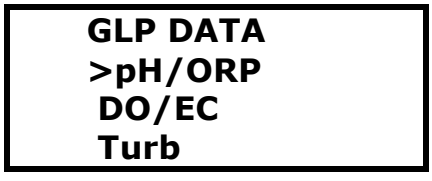
During Memory Recall, an 'M' is flashed in the top left and right corners of the screen alternatively with an up/down arrow and a left/right arrow. This is to indicate that the Meter is in Memory Recall mode and that other screens can be accessed using the arrow keys.

To see earlier readings, press the up arrow key. Just before each set of readings is displayed, the Tag will be briefly displayed. To view all the parameters within one set of readings, use the left/right arrow keys as described earlier. To exit Memory Recall mode, press the **ESC** key. If no key is pressed for 30 seconds, Memory Recall mode will be automatically cancelled.

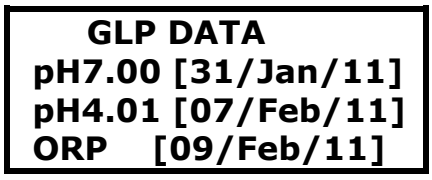
8.3. Recalling GLP Data

Each time a set of readings is added to memory, the date of the last successful calibration of each electrode is also appended to comply with GLP (Good Laboratory Practice) protocol. In addition to the date of the last successful EC calibration, the EC Calibration Standard value is also displayed (see section 14: Calibrating EC for further details).

To view the last successful calibration date for each electrode for any particular stored reading, enter Memory Recall mode, scroll to the parameter of interest by using the up/down keys, and press the **MENU** key. The screen below will be displayed.



Using the up/down keys, select the electrode and press either the OK or the right arrow key. As an example the pH/ORP data will be as shown.



This defines the last successful calibration, **prior to the recorded reading being taken**, was January 31st for the pH 7.00 point, February 7th for the pH 4.01 point and February 9th for ORP. If the date field is dashed (==/===/==), the electrode was either not fitted or has never been calibrated.

To exit this screen press the **ESC** key or the left arrow key.

8.4. Clearing the Memory

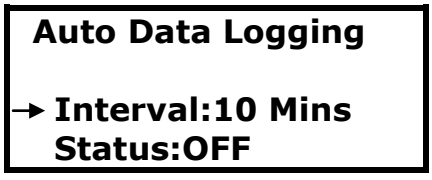
The memory within the Macro 900 Meter is capable of storing up to 1900 full sets of readings.

To clear the entire memory, switch the meter off, hold down the **M+** key, then switch the meter back on. A screen will be displayed asking you to confirm your request. Press OK to clear the memory or ESC to cancel and return to normal operation.

8.5. Automatic Data Logging

To save readings automatically at a defined frequency press the **MENU** key to display the Main Menu screen. (Please note 'Clean Probe' is not currently active as a routine).

Select **Auto Data Logging** by pressing the down arrow key then the right arrow key or the **OK** key. The Auto Data Logging screen will be displayed.



Using the arrow keys to navigate, set the desired logging interval, then set the **Status** to **ON**.

To leave this screen, reverse back to the Main Menu screen then the normal operation screen by pressing the left arrow key. The Meter will now record a full

set of data automatically at the set rate until either the memory is full or the batteries go flat.

When Auto Data Logging is switched on, an asterisk (*) character will flash on and off just below the battery symbol on all main screens.
Cancel Auto Data Logging at any time by setting the **Status** to **OFF**. Auto Data Logging will also be cancelled when the meter is switched off.

8.6. Important Information About Memory Mode

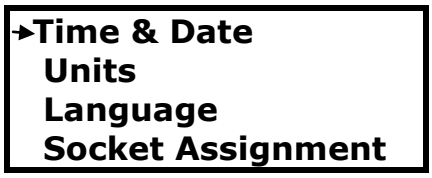
When data is saved in the meter, it is compressed in raw probe format i.e. source data without formatting. When data is recalled in Memory Recall mode, the data is decompressed and processed for display.

The advantage of this is that the readings will always appear in the current Meter configuration. For example, if readings for Dissolved Oxygen are expressed in %Saturation but are later required in mg/L, this can be accomplished by simply changing the meter settings (see section 9: Setting Units of Measurement). The stored data can be displayed any way desired on recall.

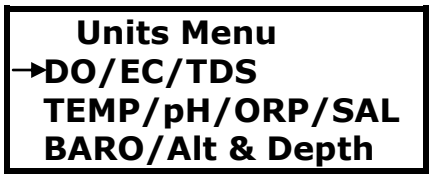
The same rules apply when data is output to a PC running Macro 900 Link software via the USB cable. The data output is always as per the Meter's current configuration. The data can be re-sent as many times as required in various Meter configurations.

9. Setting Units of Measurement

To change the way the Macro 900 Meter displays readings, press the **MENU** key to get to the Main Menu, then choose **Setup & Install.** The Settings Menu will be displayed. Please note, the 'Socket Assignment' option on this screen is only accessible when an MAP 2000 or MAP 7000 Probe is connected.

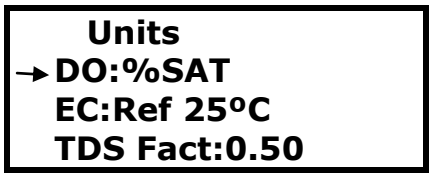


From this screen choose **Units**. The Units Menu will be displayed.



At the Units Menu, you have a choice of which units you want to adjust. Choose the first line to adjust Dissolved Oxygen, Electrical Conductivity or TDS. Choose line 2 to adjust Temperature, pH, ORP or Salinity. Finally, line 3 will give access to Barometric Pressure, Altitude and Depth settings.

Moving the cursor right onto the first line will display the following screen.

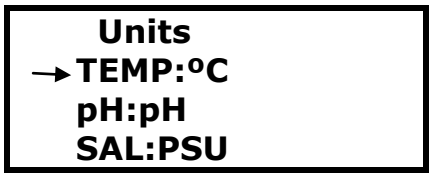


On this screen you can adjust the DO: setting between %Sat and mg/L. This will set the Meter to display Dissolved Oxygen as either % Saturation or in milligrams/Litre (which is the same as parts per million). Both readings are automatically corrected for atmospheric pressure, sample temperature and sample salinity.

The second option on this screen allows you to choose how the Meter displays Electrical Conductivity. There are four options. EC can be displayed as 'Absolute EC' without any temperature correction [ABS EC], as 'Specific EC' referenced to 20ºC [Ref 20ºC], as 'Specific EC' referenced to 25ºC [Ref 25ºC] or as a reciprocal of Absolute EC, which is Absolute Resistivity [ABS RES].

Finally, this screen allows you to set the factor that the Meter uses to calculate Total Dissolved Solids from Specific EC. This is the TDS Fact: (TDS = EC x TDS Fact) and can be set anywhere between 0.00 and 1.00. Default value is 0.65.

Selecting the second line of the Units Menu will display the following screen.



The first option on this screen allows you to change the temperature display between ºC and ºF.

The second option allows you to change the pH display between plain pH and pHmV. Plain pH displays normal, temperature compensated pH values in the range 0 - 14.

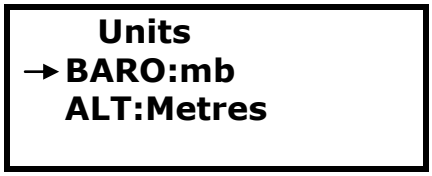
pHmV displays the actual voltage being generated by the pH electrode in +/- millivolts (mV) over a range of +/- 625mV. This is not temperature compensated.

Finally, if you have chosen to replace the pH electrode with an ORP electrode (MAP models MAP 100, MAP 400, MAP 500 & MAP 600 only), this field **must be set to ORP**. The meter will then display ORP in +/- mV over a range of +/- 2000mV.

The ORP option is not available when connected to MAP models MAP 700, MAP 800, MAP 900 and MAP 1000 as they all have combined pH/ORP electrodes and ORP display is automatic.

The last option on this screen allows you to choose between displaying salinity in Practical Salinity Units (PSU), or parts per thousand (ppt), which is the same as grams per litre.

Selecting the third line of the Units Menu will display the following screen.



The first line allows you to choose between displaying Barometric pressure in millibars (mb) or in mm of mercury (mmHg).

The second line allows you to choose between displaying altitude and depth in

metres (M) or feet (F). Whatever units ALT is set to, DEPTH (MAP 1000 only) will follow. Altitude is displayed with respect to mean sea level.

Depth is displayed with respect to the depth zero datum, which can be the water surface or any point at which the depth has been zeroed. See section 7: Differential Depth Measurement for further details.

10. Macro Cal Calibration Method

10.1. About Calibration

Calibration is a very important part of successful water quality measurement and should be carried out regularly as detailed in each separate section of this manual. A great deal of development work has been put into simplifying and automating the calibration procedures in the Macro 900 Water Quality System in order to allow normal field operatives (as opposed to trained lab technicians) to achieve quick and accurate results.

In order to standardise calibration techniques, Palintest provide purpose made, amber plastic, 300mL calibration bottles with non-reflective pads fitted to their bases. All Macro Accessory Probes are designed to be calibrated in these calibration bottles with both halves of the Probe Sleeve fitted but **without the Sleeve End Cap fitted**.

Both halves of the Probe sleeve form an integral, working part of the Probe's measurement system, and MUST be fitted during calibration and measurement for correct operation.

Whilst it is acceptable to use other vessels for calibrating EC, DO pH and ORP, **Turbidity calibration should always be carried out in the purpose made bottles**, otherwise accuracy can be seriously degraded.

10.2. Using MacroCal

MacroCal is an easy way to calibrate any of the MAPs in the field using just one calibration solution. MacroCal calibrates EC at 2570µS/cm, the pH7.00 point and the Zero NTU Turbidity point simultaneously. Ideally, this procedure should be carried out at the beginning of each day the Probe is to be used. To use MacroCal:

1. Remove the lid from a fresh 300mL bottle of MacroCal solution, remove the storage cap from the pH electrode if fitted, wash the Probe in distilled water, then drop the Probe in all the way. Bang the Probe against the pad in the bottom of the bottle several times in order to remove any air bubbles that may be clinging to the Turbidity electrodes.

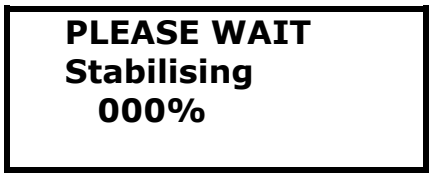
2. When the Probe is inserted, ensure the level of the solution is right up to the threaded part of the bottle. If the level is low the EC electrodes will not be covered and EC will not calibrate properly. If the level is low, top up with fresh MacroCal solution.

3. Switch the meter on and wait until the temperature, EC, pH and Turbidity measurements are all **completely** stable. The longer you can leave the probe to achieve thermal equilibrium before proceeding, the better.

4. Ensure the temperature of the solution is between 5ºC and 40ºC (41ºF - 104ºF).

5. Press the **MENU** key then select **Calibration.** The following screen will be displayed.

6. Select **MacroCal.** The screen will change to:



The Meter will wait until all readings are stable, then it will send the MacroCal command to the Probe, where the calibration takes place. During calibration, the Calibrating screen is displayed and the progress counter counts up. If the calibration is successful, the counter will reach 100% and the following screen will be displayed.

When calibration is complete, press **OK** then **ESC** to return to normal reading mode**.**

Now the DO 100% saturation point should be calibrated in damp air.

To Calibrate the 100% Saturation Point in Damp Air

1. After calibrating with MacroCal, remove the Probe from the bottle, wash in fresh water, then shake off ensuring there are no droplets adhering to the DO membrane.
2. Moisten a clean cloth or piece of tissue paper with fresh water and wrap it around the open end of the probe ensuring all the holes are covered. Place the probe on a flat surface. Do not hold the probe, the heat from your hands will warm the probe up and interfere with calibration.
3. Wait until the temperature measurement is completely stable**. This is very important.**
4. Referring back to the screen shown in item 5 above, select **DO 100%.**
5. Wait while the Meter carries out the calibration procedure.

6. When the ‘Calibrating 100%’ screen (shown above) is displayed, press OK then ESC repeatedly to return to normal reading mode.

Note: If the Probe you are using is fitted with an Optical Dissolved Oxygen electrode, (MAP 900 or MAP 1000), there is no need for daily DO calibration. See section 14: for more details.

10.3. Calibration Error Messages

If the Meter detects a problem with either the MAP or the calibration solution during the calibration procedure, an error will be indicated. The chart below shows the possible errors and how to correct them.

Error Message	Problem	Action
REPLACE DO CAP	Full re-calibration required or Optical DO Cap needs replacing (MAP 900 & MAP 1000 only)	See note below.
BATTERIES TOO LOW	Battery Voltage is too low for reliable calibration	Replace the batteries
NO PROBE RESPONSE	The Probe is not responding	Check connections / cycle power
READINGS UNSTABLE	Readings did not stabilise within the expected period	Top up / replace the MacroCal
OUT OF CAL RANGE	Readings are outside calibration limits Lower Probe Sleeve is not fitted	Top up / replace the MacroCal. Ensure both halves of the Probe Sleeve are fitted and tight.
OUT OF TEMP RANGE	Temperature is outside 5ºC – 40ºC limit	Warm / cool the MacroCal

If the 'REPLACE DO CAP' error occurs during Optical DO Zero calibration, this usually indicates that the DO Cap needs replacing. Perform a full DO calibration first at DO Zero then at 100% DO. If that does not cure the problem, replace the DO Cap (see Replacing the Optical DO Cap (MAP 900 & MAP 1000 only) in section 14).

If the corrective actions shown above for 'READINGS UNSTABLE' or 'OUT OF CAL RANGE' errors do not work, thoroughly clean the Probe and try again. I If the 'OUT OF CAL RANGE' error persists, reset the calibration values to Factory Defaults then try again. If the 'OUT OF CAL RANGE' error persists when calibrating a Galvanic DO sensor, replace the DO Electrode Membrane Cap (see Replacing the Galvanic DO Electrode Membrane Cap in section 14). If the 'OUT OF CAL RANGE' error persists when calibrating EC, check you are using the correct EC Calibration Standard and that both halves of the Probe Sleeve are fitted and tight.

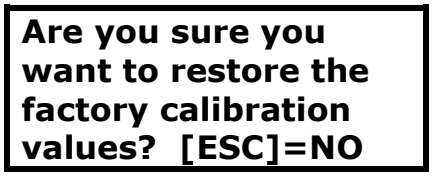
Remember: **Both halves of the Probe sleeve form an integral, working part of the Probe's measurement system, and MUST be fitted during calibration and measurement for correct operation. If you try to calibrate the Probe without the both halves of the sleeve fitted, you will get an error message.**

10.4. Resetting to Factory Calibration Defaults

In some cases, if there has been a serious calibration error, the easiest way to rectify the situation is to reset the Probe to its factory defaults. To do this, first bring up the Calibration screen:

Select Full Cal. This will give you a choice of three electrodes:

Move the cursor arrow to the electrode you want to reset, then press the **MR** key.
A confirmation screen will be displayed.



If you are sure, press the **OK** key. If you want to change your mind, press the **ESC** key. If you press OK, you will see a message that says CAL RESTORED.

Once factory calibration defaults have been restored, you **must** carry out a **full calibration** of the electrode in question.

10.5. Calibration Data Storage

Each MAP contains its own microprocessor and memory. All calibration data, including the GLP data, is stored within the Probe's memory. When a Probe is connected to a Meter, this data is transferred for display and logging.

This is a major advantage and allows you to use a variety of different Probes with a single Meter, without the need for re-calibration.

10.6. Calibration Reports

At the conclusion of each successful individual electrode calibration, a single line Calibration Report is displayed. This report contains the raw output of the electrode under calibration, uncorrected for temperature.

These values can be recorded and used to track the performance and ageing of the individual electrodes. Please note however, in order to maximise the value of this feature, all calibrations must be performed at the same temperature otherwise the recorded values will not be comparable over time.

No calibration report is generated when using MacroCal.

11. After Use

The Sleeve on the MAP is made in two parts, which separate by unscrewing to allow cleaning of the individual electrodes.

After every use, remove the protective Sleeve End Cap (if fitted) then unscrew the lower half of the sleeve as shown.

With the lower Sleeve removed, the individual electrodes are very vulnerable, so please handle the Probe with extreme care. If you drop it, it's going to break!

Rinse the exposed electrodes and the insides of the upper and lower Sleeve under a running cold tap.

Alternatively, agitate the MAP vigorously in a bucket or jug of fresh water using an up and down movement.

Shake the water from inside the top and bottom halves of the Sleeve, then reattach the two halves. Dry the outside of the Probe using a soft cloth.

If the MAP you are using includes a pH/ORP electrode, **remember to replace the storage cap after use**.

Failure to do so will damage the electrode. For more details, see Keeping the Electrodes Moist in section 13.

Never clean the Probe with solvents, alcohol or concentrated acid/alkaline based cleaning products such as Decon 90. These products can strip the anodised finish from the Probe and damage the plastic and rubber components. Damage caused by the use of aggressive cleaning agents or solvents is not covered by your warranty.

Store the Probe without the protective Sleeve End Cap fitted in order to allow free air circulation around the individual electrodes.

TIP: Occasional application of a smear of silicone grease or similar lubricant to the Sleeve thread, the protective Sleeve End Cap O ring and the inside rim of the lower Probe Sleeve will make fitting and removal of the Cap and Sleeve easier.

12. General Probe Maintenance

Each MAP is constructed with a two-part protective aluminium sleeve surrounding the more delicate sensing electrodes. To gain full access to the individual electrodes for periodic maintenance and thorough cleaning, first unscrew the lower half of the sleeve. Next, remove the four small black countersunk screws from around the top of the upper sleeve, then gently slide the upper sleeve off the Probe body being careful not to damage the individual electrodes.

TIP: If you find one of the sleeve screws to be excessively tight, turn the Probe over and undo the screw directly opposite it. This will release the tension on the tight screw and allow its easy removal.

With the sleeve removed, the individual electrodes are very vulnerable, so please handle the Probe with extreme care. If you drop it, it's going to break!

Once any maintenance and cleaning has been carried out, replace the upper Probe sleeve. Before inserting the sleeve screws, apply a little silicone grease or similar lubricant to each screw hole and screw. This will ensure that next time you remove the screws, they will come out easily. If you do not grease the screws, they may corrode into the Probe body and snap off when you try to remove them. **This is not covered by your warranty.**

Finally, tighten the screws and re-attach the lower sleeve. The Probe Sleeve must be absolutely rigid with respect to the Probe Body. If you can move the Probe Sleeve to and fro whilst holding the Probe Body, tighten the four screws further before re-calibration.

The complete Probe sleeve forms an integral part of the Probe and is essential for correct operation. Removing and replacing the upper Probe sleeve will alter the Probe's characteristics, so **full re-calibration is essential** after removal and replacement.

12.1. Identifying Individual Electrodes

The photograph on the right shows an MAP 600. If you have purchased an alternative model, some of the electrodes shown may vary.

1. pH (shown) or ORP or combined pH/ORP Electrode (see note below).
2. Turbidity Receiver Electrode. The polished, 4mm diameter centre section is the lens.
3. Galvanic Dissolved Oxygen (DO) electrode. The clear plastic sheet stretched across the tip is the membrane. DO NOT TOUCH!
4. Turbidity Transmitter electrode. The domed, 4mm diameter section is the lens.
5. Replaceable DO Membrane Cap.
6. Electrical Conductivity (EC) sensing contacts.

MAP Models MAP 100, MAP 400, MAP 500 or MAP 600 may be fitted with either a pH electrode or an ORP electrode. ORP Electrodes can be identified by a single platinum wire in place of the glass bulb on the tip. MAP Models MAP 700 and MAP 800 are fitted with a combined pH/ORP electrode, which has both a glass bulb and a platinum wire sitting side by side. MAP models MAP 900 & MAP 1000 are fitted with optical DO electrodes.

13. pH/ORP Electrode Calibration and Maintenance

13.1. Recognising the pH/ORP Electrode

The pH, ORP and combined pH/ORP electrodes are easy to recognise because they are the only electrodes that are not black. These electrodes have a clear, gel filled body.

13.2. Electrode Removal and Replacement

The pH, ORP and combined pH/ORP electrodes are the only electrodes that are replaceable. To remove an electrode, first remove the Probe sleeve as detailed in section 12: General Probe Maintenance.

The pH/ORP electrode can now be unscrewed from the Probe body by rotating it anti-clockwise. When replacing an electrode, apply a little silicon grease or similar lubricant to the thread and O ring, then screw fully in.

Gripping the black collar at the top of the electrode, tighten until the O ring is fully compressed. **Do not twist the clear section of the electrode whilst tightening.**

Useful Tip: The blue lanyard that is attached to the pH/ORP storage cap makes a very useful belt wrench for tightening and loosening the pH/ORP electrode.

Slide the lanyard over the electrode and use it to grip the knurled body.

Never immerse an MAP with the pH/ORP electrode removed. This will cause serious damage to the electrode socket. **This is not covered by your warranty.**

On MAP Models MAP 100, MAP 400, MAP 500 or MAP 600, if you replace the pH electrode with an optional ORP electrode, you **MUST** set the Meter to display ORP rather than pH or pHmV. See section 9: Setting Units of Measurement.

On MAP Models MAP 700 through MAP 1000, a combined pH/ORP electrode is always fitted and this setting is automatic.

13.3. Keeping the Electrodes Moist

It is very important that the pH/ORP electrode is kept moist when not in use. This is achieved by always fitting the storage cap, which incorporates a sponge that should be soaked in a special storage solution.

The sponge within the storage cap should be moistened with a few drops of pH Electrode Storage Solution each time it is removed and replaced. If a pH/ORP electrode is inadvertently allowed to dry out, it must be re-hydrated by soaking in storage solution for at least one hour prior to use.

13.4. Calibrating pH

pH electrodes should be calibrated fully at least once a week to ensure optimum accuracy. Full calibration involves calibrating at pH 7.00 first, then at pH 4.01. Although the MAP allows only two point pH calibration, the pH electrodes are extremely linear and once calibrated, will read accurately over the full range of 0 – 14.

On MAP Models MAP 100, MAP 400, MAP 500 or MAP 600 you must have a pH electrode fitted and the Meter must be set to read pH or pHmV. If your Meter is set to read ORP, access to pH calibration will be barred.

Due to the way in which pH calibration works, **the Probe must be calibrated at pH7.00 before calibrating at pH 4.01**. Never calibrate at pH 4.01 before first calibrating at pH7.00.

For best results, calibrate as close to 25ºC as possible. The probe will compensate for temperature variation in the calibration buffer and pH electrode during calibration.

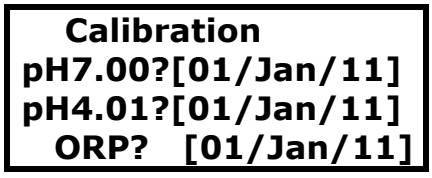
To calibrate the pH electrode follow these steps:

1. Fill a 300mL calibration bottle with fresh pH 7.00 solution or MacroCal, remove the storage cap from the pH electrode, wash the Probe in distilled water, then drop the Probe in all the way. The Sleeve End Cap should not be fitted.

2. Switch the Meter on and wait until the temperature and pH measurements are completely stable.
3. Ensure the temperature of the solution is between 5ºC and 40ºC (41ºF - 104ºF).
4. Press the **MENU** key then select **Calibration.** The following screen will be displayed.

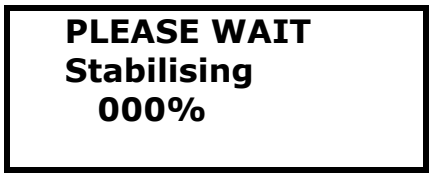
5. Select **Full Cal.** The screen will change to:

6. Select **pH/ORP**. The screen will change to:

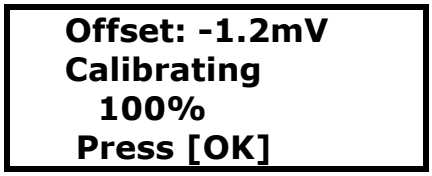


The dates shown to the right of the screen are the dates of the last successful calibration. If no ORP electrode has ever been fitted, the ORP date will be dashed out.

1. Select pH7.00. The screen will change to:



The Meter will wait until the readings are stable, then it will send the calibration command to the Probe, where the calibration takes place. During calibration, the Calibrating screen is displayed and the progress counter counts up. If the calibration is successful, the counter will reach 100% and the following screen will be displayed.



The top line displays the voltage offset from zero for the pH electrode in +/- millivolts (mV). If this offset goes beyond +/-25mV at 25ºC, the pH electrode should be serviced.

This value is not stored in memory so should be noted down in a calibration record book for the Probe. When the offset voltage details have been noted down, press **OK** then **ESC** repeatedly to return to normal reading mode**.**

Remove the Probe from the calibration bottle, rinse thoroughly in de-ionised water, shake off any excess and dry the outer sleeve with a soft cloth.

Now fill a 300mL calibration bottle with fresh pH 4.01 solution and drop the Probe in all the way. Follow the procedure detailed above, but at step 6, select pH4.01. Wait while the Meter stabilises and calibrates. When the 'Calibrating 100%' screen is displayed, the calibration report will display the slope for the pH electrode in millivolts (mV) per pH unit. If this slope goes below 45mV/pH at 25□C, the pH electrode should be serviced. Press **OK** then press the **ESC** key repeatedly to get back to the main display.

Remove the Probe from the calibration bottle, rinse thoroughly in fresh water, shake off any excess and dry the outer sleeve with a soft cloth. Dampen the sponge in the storage cap with storage solution and fit it to the pH/ORP electrode. pH calibration is now complete.

13.5. Errors During Calibration

If a problem occurs during calibration, an error message will be displayed. Refer to section 10 for error message handling.

13.6. pH Electrode Efficiency

If the pH electrode becomes worn or clogged, its efficiency and response time can be reduced. The efficiency of the pH electrode is constantly monitored and in the event of the efficiency dropping below 85%, 'ERROR 01' will be flashed on the bottom line of the display. If this occurs, or if the pH reading response becomes slow, recondition the electrode as described below.

13.7. Servicing the pH Electrode

1. Remove the pH or combined pH/ORP electrode from the Probe body (see Electrode Removal and Replacement).
2. Rinse with methyl alcohol.
3. Replace the electrode.
4. Re-calibrate.

Never place the entire MAP in methyl alcohol, as this will cause irreparable damage to the DO/EC electrode. Damaged caused in this way is not covered by the warranty.

If the methyl alcohol rinse does not restore the electrode, perform the following actions:

1. Remove the electrode from the body again.
2. Soak in 0.1M HCl for 5 minutes.
3. Rinse in de-ionised water.
4. Soak in 0.1M NaOH for 5 minutes.
5. Rinse in de-ionised water.
6. Soak in pH4.01 buffer for 10 minutes.

If the above procedure still does not restore performance, replace the electrode.

13.8. Calibrating ORP

ORP electrodes should be calibrated at least once a month to ensure optimum accuracy. Full calibration involves calibrating at a single point, (250mV at 25ºC) using a 250mV ORP calibration standard such as **Reagecon RS250 Redox Standard,** or similar.

On MAP Models MAP 100, MAP 400, MAP 500 or MAP 600 you must have an ORP electrode fitted and the Meter must be set to read ORP. If your Meter is set to read pH or pHmV, access to ORP calibration will be barred.

On MAP Models MAP 700, MAP 800, MAP 900 and MAP 1000, a dual pH/ORP electrode is always fitted and this setting is automatic.

For best results, calibrate as close to 25□C as possible. The probe will automatically compensate for temperature variation in the calibration solution during calibration.

To calibrate the ORP electrode follow these steps:

1. Fill a 300mL calibration bottle with fresh calibration solution, remove the storage cap from the pH/ORP electrode, wash the Probe in distilled water, then drop the Probe in all the way.

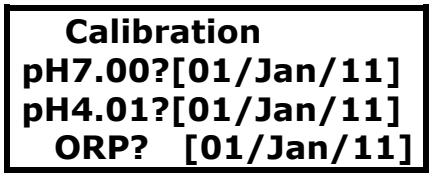
2. Switch the Meter on and wait until the temperature and ORP measurements are completely stable.

3. Ensure the temperature of the solution is between 5ºC and 40ºC (41ºF - 104ºF).

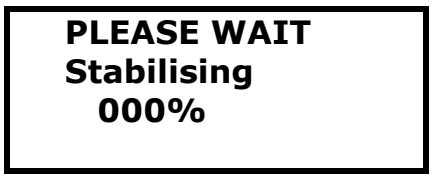
4. Press the **MENU** key then select **Calibration.** The following screen will be displayed.

5. Select **Full Cal.** The screen will change to:

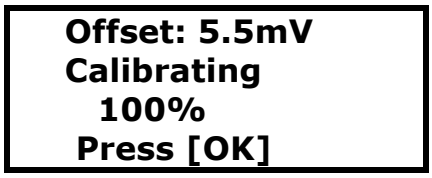
6. Select **pH/ORP**. The screen will change to:



1. Select ORP. The screen will change to:



The Meter will wait until the readings are stable, then it will send the calibration command to the Probe, where the calibration takes place. During calibration, the Calibrating screen is displayed and the progress counter counts up. If the calibration is successful, the counter will reach 100% and the following screen will be displayed.



The Calibration Report on the top line displays the voltage offset between the ORP electrode output and the value of the calibration solution at the calibration temperature in +/-millivolts (mV). During normal operation this offset will be subtracted from the ORP electrode output to give a corrected ORP display.

This value is not stored in memory so should be noted down in a calibration record book for the probe. When calibration is complete, press the **OK** key then the **ESC** key repeatedly to return to normal operating mode.

Remove the Probe from the calibration bottle, rinse thoroughly in fresh water,

shake off any excess and dry the outer sleeve with a soft cloth. Dampen the sponge in the storage cap with storage solution and fit it to the pH/ORP electrode. ORP calibration is now complete.

13.9. Converting ORP Readings to the Hydrogen Scale

Electrochemical measurements are ultimately referred to the so-called hydrogen scale, the convention for which is that the electrochemical potential of a hydrogen electrode in contact with hydrogen gas at one atmosphere partial pressure and a solution containing hydrogen ions at unit activity is zero at all temperatures.

The ORP reference electrode used in Palintest combination electrodes is a 3MPK1 silver chloride type, and exhibits potentials on the hydrogen scale of:

Temperature	Potential
5ºC	221 mV
10ºC	217 mV
15ºC	214 mV
20ºC	210 mV
25ºC	207 mV
30ºC	203 mV
35ºC	200 mV
40ºC	196 mV

Thus, to refer an ORP potential value measured with the MAP to the hydrogen scale, the appropriate value above should be added to the measured value.

14. DO/EC Electrode Calibration and Maintenance

14.1. Recognising the DO/EC Electrode

The DO/EC electrode is easy to recognise because it has a screw-on cap and four stainless-steel EC sensor contacts on the side (see photograph). Dissolved Oxygen (DO) is measured at the end of the electrode by the components behind the removable cap. Electrical Conductivity (EC) is measured on the side of the electrode by the four stainless steel contacts.

14.2. DO Measurement Techniques

MAP models MAP 300, MAP 500, MAP 600, MAP 700 & MAP 800 utilise a Galvanic DO sensor. This consists of an electrolyte filled DO sensor cap with a clear, gas-permeable membrane stretched across a silver electrode.

MAP models MAP 900 & MAP 1000 utilise an optical DO sensor. This sensor does not use a liquid electrolyte and has a black rubber gas-permeable membrane.

See Appendix 1. The Tech Behind Palintest's Optical DO Measurement System for further details.

14.3. Precautions During Use

In order to achieve accurate Dissolved Oxygen readings with the Galvanic DO sensor, the Probe needs to be either placed in flowing water, or needs to be stirred or raised and lowered continuously to ensure a minimum flow rate of 0.3m/s over the DO Electrode. **If there is no water flow across the Probe, the oxygen in the immediate area of the DO Electrode will be consumed and the reading will start to fall.**

MAP models MAP 900 & MAP 1000 featuring the Optical DO sensor do not suffer from this restriction. No water flow is necessary when using these probes.

EC measurement is not possible with the lower Probe sleeve removed as the sleeve forms an integral part of the measurement system.

Never immerse the Probe without the DO Cap fitted or with a damaged membrane. If the components at the end of the DO/EC electrode come into contact with the liquid being tested, serious damage can occur to both the DO/EC electrode circuitry and the pH/ORP electrode.

14.4. Calibrating the DO/EC Electrode

Calibration of the EC section of the electrode is normally carried out during MacroCal (see Macro Cal Calibration Method). EC can be calibrated separately using different EC Calibration Standards, this is covered after the DO calibration section (Calibrating EC).

The DO section of the electrode should be calibrated at the Zero saturation point at least once a month. Before each day's use, the 100% saturation point should be checked in moist air and re-calibrated if necessary. For optimum accuracy, calibrate the DO100% point as near to your sample temperature as possible (within the calibration temperature limits of 5ºC - 40ºC).
If you are going to calibrate both the Zero and 100% points at the same time, **ALWAYS calibrate the Zero point first**, then the 100% point.

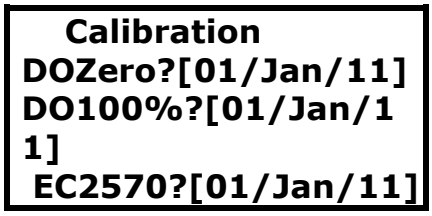
To calibrate the DO/EC electrode follow these steps:

14.5. Calibrating the DO Zero Point

1. Remove the lid from a 150mL bottle of DO Zero calibration solution, remove the storage cap from the pH electrode if fitted, wash the Probe in distilled water, then drop the Probe in all the way. The Sleeve End Cap should not be fitted.
2. Switch the Meter on and wait until the DO reading is completely stable.
3. Ensure the temperature of the solution is between 5ºC and 40ºC (41ºF - 104ºF).
4. Press the **MENU** key then select **Calibration. T**he following screen will be displayed.

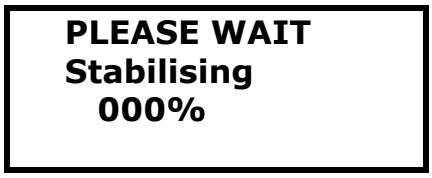
5. Select **Full Cal.** The screen will change to:

6. Select **DO/EC**. The screen will change to:

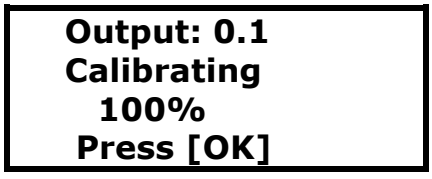


The dates shown to the right of the screen are the dates of the last successful calibration.

7. Select DOZero. The screen will change to:



The Meter will wait until the readings are stable, then it will send the calibration command to the Probe, where the calibration takes place. During calibration, the Calibrating screen is displayed and the progress counter counts up. If the calibration is successful, the counter will reach 100% and the following screen will be displayed.



If the MAP you are calibrating has a Galvanic DO cell, the Calibration Report on the top line will display the voltage output from the DO cell in millivolts (mV). This value should be between 0 and 3 (at 25°C). If the value returned is more than 3.0, the DO Cap should be replaced.

If the MAP you are calibrating has an Optical DO sensor the top line will display a value which represents the health of the luminophore. This value should be between 3.5 and 4.5 (at 25°C). If the value returned is less than 3.5, the Optical DO Cap should be replaced.

This value is not stored in memory so should be noted down in a calibration record book for the probe. When the Cell offset voltage details have been noted down, press **OK** then **ESC** repeatedly to return to normal reading mode**.**

If a problem occurs during calibration, an error message will be displayed. Refer to in section 10 for error message handling. If the 'OUT OF CAL RANGE' error persists when calibrating a Galvanic DO sensor, replace the DO Electrode Membrane Cap.

If the 'REPLACE DO CAP' error persists when calibrating an Optical DO sensor, replace the Optical DO Electrode Cap.

Remove the Probe from the calibration bottle, rinse thoroughly in fresh water, shake off any excess and dry the outer sleeve with a soft cloth.

14.6. Calibrating the DO 100% Saturation Point in Moist Air

1. Wash the probe thoroughly in fresh water, then shake off ensuring there are no droplets adhering to the DO membrane.
2. Moisten a clean cloth or piece of tissue paper with fresh water and wrap it around the open end of the probe ensuring all the holes are covered. Place the probe on a flat surface. Do not hold the probe, the heat from your hands will warm the probe up and interfere with calibration.
3. Switch the Meter on and wait until the temperature measurement is completely stable**. This is very important.**
4. Referring back to the screens shown in items 4 or 6 above (dependent on software version), select **DO100%**
5. Wait while the Meter carries out the calibration procedure.
6. When calibration is complete, the Calibration Report will be displayed.

If the MAP you are calibrating has a Galvanic DO cell, the top line will display the voltage output from the DO cell in millivolts (mV). This value should be between 25.0 and 50.0 (at 25°C). If the value returned is less than 25.0, the DO Cap should be replaced.

If the MAP you are calibrating has an Optical DO sensor, the top line will display a value which represents the health of the luminophore. This value should be between 0.8 and 1.5 (at 25°C). If the value returned is less than 0.8, the Optical DO Cap should be replaced.

These values are not stored in memory so should be noted down in a calibration record book for the probe.

If a problem occurs during calibration, an error message will be displayed. Refer to in section 10 for error message handling. If the 'OUT OF CAL RANGE' error persists when calibrating a Galvanic DO sensor, replace the DO Electrode Membrane Cap.

14.7. Replacing the Galvanic DO Electrode Membrane Cap

The Galvanic DO electrode membrane is a very thin sheet of special plastic, which is permeable to oxygen. Oxygen molecules pass through this membrane into the Oxygen sensor. The membrane is extremely delicate and is factory fitted into the DO Membrane Cap. To ensure optimum performance, the DO Membrane Cap must be replaced every 1-2 months.

Never touch the plastic membrane as the oils in your skin will block the pores in the membrane and stop it from working correctly.

To replace the DO Membrane Cap, follow these simple steps.

1. Remove the lower Probe sleeve.
2. Unscrew the DO Membrane cap from the end of the DO/EC electrode by rotating it anti-clockwise.
3. Gently brush away any scaly grey deposits from the coiled wire section of the electrode with a soft toothbrush, taking care not to damage the coil in the process.
4. After removing the deposits, rinse the electrode with DO Electrode Filling Solution.
5. Rinse a new DO Membrane Cap with DO Electrode Filling Solution then tap it out so that it is completely empty.
6. Using the DO Electrode Filling Solution dropper bottle, half fill the DO Membrane Cap. Gently tap the cap to ensure any trapped air bubbles are released.
7. Holding the Probe so that the DO electrode is facing downwards, **slowly** screw the half-filled DO Membrane Cap back onto the DO electrode then tighten the cap. **Do not over-tighten**. Finger tight is fine. Some solution will overflow. This is normal.
8. Wash the DO/EC electrode with fresh water then replace the lower Probe sleeve.
9. Wait at least six hours (preferably over-night) to allow any oxygen dissolved in the filling solution to be consumed.
10. Carry out both Zero point and 100% point DO calibration as described earlier.

Do not re-install a Galvanic DO Membrane Cap once it has been fully tightened. The membrane will be stretched and will not seal properly over the silver cathode a second time. If the membrane does not create a proper seal over the silver cathode, the DO sensor will not operate correctly and any readings given will be erroneous.

14.8. Replacing the Optical DO Cap (MAP 900 & MAP 1000 only)

The Optical DO Cap contains a lens, which is coated with an oxygen sensitive luminophore, which is in turn coated with a black rubber compound that

provides optical isolation but is permeable to oxygen. Oxygen molecules pass through the rubber into the luminophore.

Never touch the black rubber end of the DO electrode as the oils in your skin can block the pores in the rubber coating and stop it from working correctly.

The luminophore within the DO Cap will need replacing ever 1 – 2 years, as it is a consumable item. Since the luminophore is an integral part of the DO Cap, the entire DO Cap is replaced. An Optical DO Cap can last up to two years dependent upon the amount of use it gets. See Sensor Cap Life in Appendix 1 for further details.

Caution: The inside of the Optical DO Cap is very sensitive to light and can be ruined (bleached) if it is exposed to bright light for any length of time. Never remove the Optical DO Cap from the Probe unless you intend to replace it with a new one. When replacing an Optical DO Cap, do so under subdued light.

To replace the Optical DO Cap, follow these simple steps.
1. Remove the Probe sleeve.
2. Unscrew the Optical DO Cap from the end of the DO/EC electrode by rotating it anti-clockwise. Do not touch the exposed optical components.
3. Apply a light smear of silicone grease to the thread and O ring.
4. Remove the new Optical DO Cap from its light-proof bag and quickly screw it onto the end of the DO/EC electrode. Ensure that the cap is screwed fully onto the electrode and that it is done up tight.
5. Carry out both Zero point and 100% point DO calibration as described earlier.

Please Note: It is essential when replacing the Optical DO Cap to calibrate the Zero point BEFORE calibrating the 100% point.

14.9. Calibrating EC

EC calibration is always carried out at a single point. There is a choice of three single points. These are: 1413µS/cm, 2570µS/cm (using Palintest MacroCal solution) and 12,880µS/cm. These values have been chosen to allow accurate readings to be taken in a variety of water types.

For taking measurements in fresh surface or ground water, use Palintest MacroCal solution. If this is not available, use a third party 1413µS/cm EC Calibration Standard. For taking readings in brackish or salt water, use a third party 12,880µS/cm (12.88mS/cm) EC Calibration Standard.

Both halves of the Probe sleeve form an integral, working part of the Probe's EC measurement system, and MUST be fitted during calibration and measurement for correct operation. If you try to calibrate the Probe without the both halves of the sleeve fitted, you will get the 'OUT OF CAL RANGE' error message.

For best results, calibrate as close to 25ºC as possible. The probe will

compensate for temperature variation in the Calibration Standard during calibration.

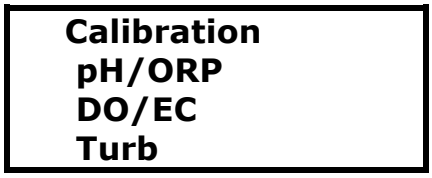
1. Remove the storage cap from the pH electrode if fitted, wash the Probe in distilled water, then drop the Probe into a calibration bottle filled with your chosen EC Calibration Standard. The Sleeve End Cap should not be fitted. **Ensure the liquid level is all the way up to the threaded part of the bottle. Low liquid level will result in erroneous EC calibration**. Refer to the photograph in section 10 Using MacroCal.

2. Switch the Meter on and wait until the temperature and EC measurements are completely stable.

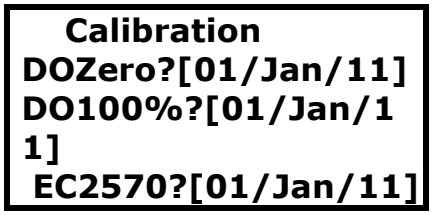
3. Ensure the temperature of the solution is between 5ºC and 40ºC (41ºF - 104ºF).

4. Press the **MENU** key then select **Calibration.** The following screen will be displayed.

5. Select **Full Cal.** The screen will change to:

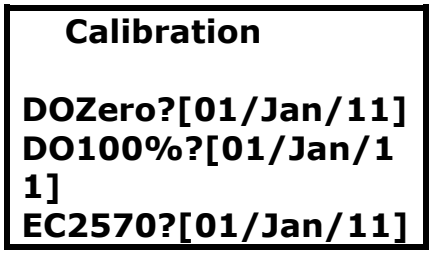


6. Select **DO/EC**. The screen will change to:



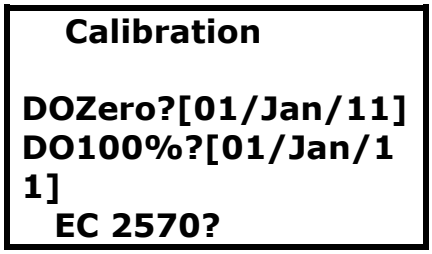
The dates shown to the right of the screen are the dates of the last successful calibration. The value shown on the bottom line next to 'EC' is the value the EC electrode was last calibrated to.

7. Move the pointer down to the bottom line using the down arrow key.



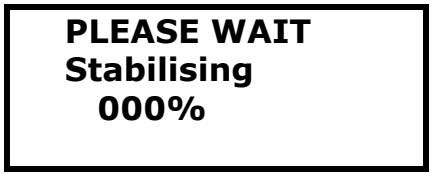
If the Calibration Standard value you are using is already displayed, press the **OK** key to start calibrating. Remember, if you are using MacroCal solution, the EC value on this line should be 2570.

If the value of the EC Calibration Standard you are using is not displayed, press the right arrow key. The bottom line will change to:

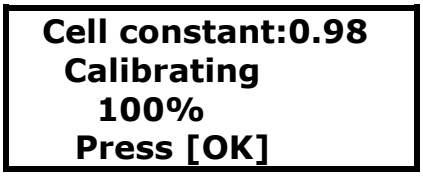


You can now use the up and down arrow keys to select one of three EC Calibration Standard values (1413, 2570 or 12880).

8. Once the correct Calibration Standard value is being displayed, press the **OK** key. The screen will change to:



9. If the calibration is successful, the counter will reach 100% and the following screen will be displayed.



The Calibration Report on the top line displays the EC Cell Constant which should be between 0.75 and 1.25 (at 25°C). If the value reported is outside these limits, clean the EC contacts. This value is not stored in memory so should be noted down in a calibration record book for the probe.

When the cell constant details have been noted down, press **OK** then **ESC** repeatedly to return to normal reading mode**.**

Special Notes:

- If you have selected a Calibration Standard value other than 2570 (MacroCal), then you subsequently use the MacroCal calibration technique described in section 10, the Calibration Standard value will automatically be reset to 2570.
- The Calibration Standard value is stored in the Probe, **not** the Meter. If you use one Meter with several different Probes, you will have to set the Calibration Standard value for each probe individually during calibration.
- If you select a Calibration Standard value but do not press **OK**, the information will not be sent to the Probe and the change will not be registered.

14.10. Verifying EC Calibration

Due to the fact that debris and air bubbles can adversely affect EC calibration, it is advisable to verify calibration has been properly achieved. To do this, follow item nine above with this procedure.

1. Remove the probe from the calibration bottle, shake it off, then reinsert.
2. Press the **ESC** key repeatedly to get back to the Main Menu.
3. Go into settings and make sure EC is set to read with reference to 25ºC. If it's not, set it that way. See section 9: Setting Units of Measurement.
4. Go back to the main screen, wait until the temperature and EC readings are stable, then check that the EC is reading +/- 1% of the Calibration Standard value.
5. If the EC reading is outside the 1% limit, recalibrate, this time leaving more time for stabilisation.

If you can not successfully verify the EC calibration after several attempts, replace the Calibration Standard. If the problem persists, strip the probe down as described below and thoroughly clean the EC contacts.

14.11. Errors During Calibration

At the beginning of the calibration routine, a sanity check is done. If the probe detects that the Calibration Standard value set and the Calibration Standard being used differ, the 'OUT OF CAL RANGE' error will be reported. If any other problems occur during calibration, an error message will be displayed. Refer to in section 10 for error message handling.

14.12. Cleaning the EC Contacts

On a regular basis, remove the lower Probe sleeve and thoroughly clean the four stainless steel EC contacts situated on the side of the DO/EC electrode with a soft cloth or toothbrush and non-abrasive detergent. **Never use solvent or alcohol based products to clean the DO/EC electrode**. After cleaning, replace the lower Probe sleeve and re-calibrate.

15. Turbidity Electrodes Calibration and Maintenance

Turbidity is measured by the MAP using a dual electrode, optical, Nephelometric technique in accordance with ISO 7027, which uses Formazin as a reference standard. The Meter displays turbidity in Nephelometric Turbidity Units (NTU) which are nominally equivalent to Formazin Turbidity Units (FTU).

A Turbidity Transmitter electrode emits a high energy, narrow beam of pulsed infrared light across the centre of the Probe. Light scattered at 90° to the beam axis by suspended solids within the water is collected by a Turbidity Receiver electrode on the opposite side of the Probe.

Turbidity can be calibrated with either Formazin Turbidity Standards or Suspended Polymer Turbidity Standards, depending upon your preferred turbidity reference. Factory calibration is carried out with a 1000 NTU Stabilised Formazin Turbidity Standard in accordance with ISO 7027.

15.1. About Turbidity

Turbidity is a measurement of the light scattering properties of solids suspended within a liquid and is therefore an **indirect** measurement of clarity. Turbidity is not a direct measurement of suspended solids, clarity or colour.

Particle size relative to the wavelength of the transmitted light, particle shape and refractive index modify the distribution of scattered light. Sample colour, (particularly dark colours) can also reduce a certain portion of the scattered light by varying degrees.

Combined, these effects result in wide variability in the distribution and intensity of light scattering from a turbid water sample. As a result, different combinations of particle shape, size, colour and refractive index can produce similar turbidity effects.

By contrast, changing only the incident light wavelength and detector distance can dramatically change the measured turbidity of a given sample. As a result, different model sensors from different manufacturers can measure different turbidity values for the same sample. This highlights the qualitative nature of turbidity measurements.

Integrated monitoring programs, where turbidity measurements from different locations are to be compared, **must** use a single model of sensor and maintain a strict QA and calibration program to accurately characterise, compare, and interpret observed turbidity values.

15.2. Precautions During Use

In common with all other submersion type Turbidity Probes, air bubbles can be a problem when trying to measure turbidity values below 5NTU. In order to avoid air bubbles, keep the Turbidity electrodes clean, and agitate the Probe after submersion in order to dislodge any air bubbles which may be clinging to

the lenses.

When taking Turbidity readings in a flask or beaker, ensure the MAP is at least 25mm (1”) away from the bottom of the vessel in order to avoid reflections which may affect accuracy. This **does not apply** to the purpose-made 300mL Palintest calibration bottles, which have non-reflective pads fitted, the Palintest Flow-Through Cell or when a protective Sleeve End Cap is fitted to the Probe.

The lens system in the Turbidity Electrodes is designed to focus correctly in water. When the Probe is not submerged, the system will be out of focus and random readings will occur. This is normal.

The Probe sleeve forms an integral part of the turbidity measurement system. **Turbidity measurement will not work correctly if the lower Probe sleeve is not fitted**.

15.3. Calibrating the Turbidity Electrodes

Turbidity calibration must be carried out in the purpose made, 300mL, amber calibration bottle with the protective Sleeve End Cap removed.

Both halves of the Probe sleeve form an integral, working part of the Probe’s turbidity measurement system, and MUST be fitted during calibration and measurement for correct operation.

Calibration of the Turbidity electrode Zero NTU point is normally carried out during MacroCal (see Macro Cal Calibration Method).

The Turbidity electrodes should be calibrated at the Zero NTU point before each day’s use, and at least once a month at 1000 NTU to ensure optimum accuracy. To avoid air bubbles in the calibration solutions, **never shake the bottles**.

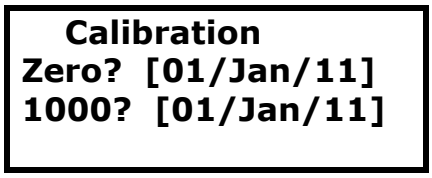
15.4. Turbidity Zero Point Calibration

To calibrate the Turbidity zero point, follow these steps:

1. Fill a 300mL calibration bottle with de-ionised water or fresh MacroCal solution, remove the storage cap from the pH electrode if fitted, wash the Probe in distilled water, then drop the Probe in all the way. The Sleeve End Cap should not be fitted. Bang the Probe against the pad in the bottom of the bottle several times in order to remove any air bubbles that may be clinging to the Turbidity electrodes.
2. Switch the Meter on and wait until the temperature and turbidity readings are stable. If the turbidity reading is very high, there are probably air bubbles adhering to the lenses. Bang the Probe against the pad to remove.
3. Ensure the temperature of the solution is between 5ºC and 40ºC (41ºF - 104ºF).
4. Press the **MENU** key then select **Calibration.** The following screen will be displayed.

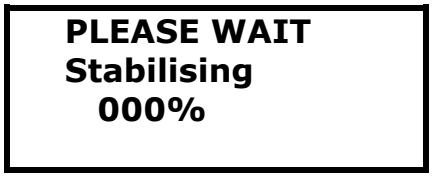
5. Select **Full Cal.** The screen will change to:

6. Select **Turb**. The screen will change to:

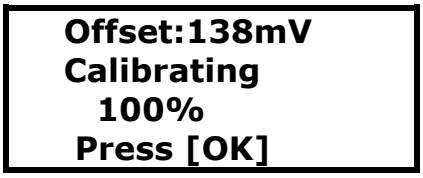


The dates shown to the right of the screen are the dates of the last successful calibration.

7. Select Zero. The screen will change to:



The Meter will wait until the readings are stable, then it will send the calibration command to the Probe, where the calibration takes place. During calibration, the Calibrating screen is displayed and the progress counter counts up. If the calibration is successful, the counter will reach 100% and the following screen will be displayed.



The Calibration Report on the top line displays the voltage offset from zero volts (or bias) for the Turbidity Receiver Electrode in millivolts (mV). This value should be below 1000mV. If the value is higher, thoroughly clean both the Turbidity Electrode Lenses and the inside of the Probe lower sleeve, then re-calibrate both points.

This value is not stored in memory so should be noted down in a calibration record book for the probe.

15.5. Verifying Turbidity Zero Point Calibration

Due to the fact that debris and air bubbles can adversely affect Turbidity calibration, it is essential to verify calibration has been properly achieved. To do this, follow calibration with this procedure.

1. Remove the probe from the calibration bottle, shake it off, then reinsert. Bang the probe to remove any air bubbles.
2. Press the **ESC** key repeatedly to get back to the main screen.
3. Wait until the temperature and TURB readings are stable, then check that the TURB reading is less than 01.0 NTU (this represents 1% of the low scale).
4. If the reading is above this limit, recalibrate, this time leaving more time for stabilisation.

If you can not successfully verify the TURB calibration after several attempts, replace the MacroCal solution / de-ionised water. If the problem persists, strip the probe down as described below under Lens Maintenance and thoroughly clean the Turbidity electrode lenses.

15.6. Calibrating the Turbidity 1000 NTU Point

Remove the Probe from the calibration bottle, rinse thoroughly in fresh water (if using MacroCal solution), shake off any excess and dry the outer sleeve with a soft cloth.

Gently invert, **do not shake,** a bottle of **StablCal® Standard 1000 NTU Stabilised Formazin Turbidity Standard** solution (manufactured by the **HACH Company** and available from most lab supply companies) several times to thoroughly mix.

Formazin Turbidity Standard is hazardous to your health. Be sure to handle with care and to read and comply with all health and safety advice.

Fill a 300mL Turbidity calibration bottle with the solution and drop the Probe in all the way. Again, bang the Probe against the pad in the bottom of the bottle several times in order to remove any air bubbles that may be clinging to the Turbidity electrodes.

Follow the procedure detailed above for Zero point calibration as far as step 6, then select 1000. Wait while the Meter stabilises and calibrates.

After successful calibration, the 'Calibrating 100%' screen will be displayed along with the Calibration Report, which will show the voltage output from the Turbidity Receiver Electrode in millivolts (mV). This value should be between

3000mV and 5000mV. If the value is outside of this range, thoroughly clean both the Turbidity Electrode Lenses and the inside of the Probe lower sleeve, then re-calibrate both points. Press the **OK** key to continue.

15.7. Verifying Turbidity 1000 NTU Point Calibration

Due to the fact that debris and air bubbles can adversely affect Turbidity calibration, it is advisable to verify calibration has been properly achieved. To do this, follow calibration with this procedure.

1. Remove the probe from the calibration bottle, shake it off, then reinsert. Bang the probe against the bottom of the bottle to remove any air bubbles.
2. Press the **ESC** key repeatedly to get back to the main screen.
3. Wait until the temperature and TURB readings are stable, then check that the TURB reading is between 990 NTU and 1010 NTU (this represents 1% of the high scale).
4. If the reading is outside these limits, recalibrate, this time leaving more time for stabilisation.

If you can not successfully verify the TURB calibration after several attempts, replace the 1000 NTU Turbidity Standard. If the problem persists, strip the probe down as described below under Lens Maintenance and thoroughly clean the Turbidity electrode lenses and the inside of the Probe lower sleeve.

Turbidity calibration is now complete.

15.8. Errors During Calibration

If a problem occurs during calibration, an error message will be displayed. Refer to in section 10 for error message handling.

15.9. Recognising the Turbidity Electrodes

The two Turbidity electrodes can be distinguished by their 4mm diameter polished lenses. The Turbidity Receiver electrode is the shortest of the electrodes and its flat lens faces towards the open end of the Probe. The Turbidity Transmitter electrode is directly opposite the Receiver and has a dome shaped, side mounted lens that points towards the centre of the Probe (see Identifying Individual Electrodes in section 12).

15.10. Lens and Sleeve Maintenance

On a monthly basis (or more regularly if heavy fouling occurs), the lenses on the Turbidity Transmitter and Receiver electrodes should be wiped over with a soft damp cloth and **non-abrasive** detergent.

Similarly, the inside of the Probe lower sleeve should be kept clean and free from any deposits that may cause stray light reflections. **Never use an abrasive cleaner on the inside of the Probe sleeve as it has been treated with a non-reflective coating which can be easily damaged.** The inside of the sleeve should be wiped over with a soft damp cloth and **non-abrasive** detergent.

Always re-calibrate after cleaning the sleeve or lenses.

15.11. References

The summary on turbidity at the beginning of this section is based on information from the following sources.

- National Field Manual For the Collection of Water-Quality Data, Turbidity section 6.7, Revised by Chauncey w. Anderson, USGS, 2004.

- Environmental Instrumentation and Analysis Handbook, Randy D. Down and Jay H. Lehr, Chapter 24 Turbidity Monitoring, John Downing, John Wiley & Sons, Inc. 2005

- Turbidity Science, Michael J. Sadar, Hach Company 1998.

- Guidelines and Standard Procedures for continuous Water-Quality Monitors: Site Selection, Field Operation, Calibration, Record Computation and Reporting, Richard J. Wagner et al., USGS Reston VA Meeting, 2000.

16. Macro 900 Link PC Software

Macro 900 Link is a utility program designed to run under Microsoft® Windows® XP®, Vista® or 7 on a stand-alone PC with a minimum screen resolution of 1024 x 768, a CD drive and an available USB 2.0 socket.

16.1. Software Installation

These instructions describe installation on a PC running Windows® Vista®. Other versions of Windows® may vary slightly.

IMPORTANT: Install the software BEFORE plugging your Meter into your PC.

Place the Macro 900 Link CD in your PC's CD drive. Browse your CD drive and click on '**setup.exe**'. You will be given the usual Windows® security warnings. Allow the software to install. Once installed, Macro 900 Link will run automatically. **Leave the CD in your drive.** To communicate with the Meter, two further software 'drivers' need to be installed.

16.2. Driver Installation

Ensure your Meter has batteries installed but is switched off. Connect the Meter to your PC using the USB cable supplied. The Meter will switch itself on automatically and display 'USB CONNECTED' on its screen as you plug into your PC.

The 'Found New Hardware' wizard on your PC will automatically activate. Select the recommended option: '**Locate and install driver software**'. If given the option, **do not** allow Windows® to search the Internet for drivers. The next screen will ask you to '**Insert the disk that came with your Meter**'. The CD should still be in your drive. Click on the '**Next**' button. Wait while the first driver is installed.

The next screen will ask you to '**Insert the disk that came with your USB Serial Port**'. The CD should still be in your drive. Click on the '**Next**' button. Wait while the second driver is installed. When this has completed, Macro 900 Link is ready to use. The CD can now be removed and is not required for subsequent operation.

16.3. Running Macro 900 Link

Select Macro 900 Link from your Programs menu. After an introductory splash-screen has been displayed, the main screen will appear.

Select your preferred operating language by clicking on one of the national flags.

16.4. Uploading Data From Your Meter

Ensure your Meter has batteries installed but is switched off. Connect the Meter to your PC using the USB cable supplied. The Meter should switch itself on automatically and display 'USB CONNECTED' on its screen.

Click the '**Upload Data From Meter'** button. Macro 900 Link will search for the Meter then upload all the available logged data from the Meter to your PC. A progress bar and file counter will be displayed during this process. Once upload is complete, the memory Tag, date and time for all the logged data that has been uploaded will be displayed in the **Uploaded Data** column on the left of the screen.

To view any of the logged data records, simply click on the desired Tag, date and time label as shown above. The data for the highlighted label will be displayed in the individual data boxes, which are grouped by electrode function. Any data that is unavailable or out of range will be displayed as dashes. To move up and down the Tag/date/time column, use either your mouse or the cursor up/down keys.

Remember, the Meter stores all logged data in a raw Probe format, so can be made to output logged data in several different forms, dependent upon the Meter's current settings. See Important Information About Memory Mode in section 8 for more information.

16.5. Displaying GPS Co-ordinates

On the right of the screen, the position at which the data was logged is displayed in the GPS boxes (when logged using an AM-200 GPS Meter only). Latitude and longitude can be displayed as Degrees and decimal Minutes (DD MM.MMMM) or as decimal Degrees (DD.DDDDD). Select one format or the other by clicking one of the two options at the bottom of the GPS box. Positional accuracy of lat/lon co-ordinates is +/- 10 meters with a 3D Position fix.
GPS position is also displayed as an Ordnance Survey Great Britain (OSGB) grid reference, (if the position falls within the United Kingdom) and UTM (Universal Transverse Mercator) co-ordinates. Positional accuracy of OSGB co-ordinates is +/- 1 digit (i.e. +/- 100 metres). Positional accuracy of UTM co-ordinates is +/- 10 metres with a 3D Position fix.

16.6. On Screen Help

Help has been provided in this software in the form of 'Tool Tips'. If you want to know what a control button does or what a data box displays, simply move your mouse pointer over the item in question. A multi-lingual Tool Tip will appear after a few seconds to give you more information.

16.7. Saving Logged Data

Once a set of logged data has been uploaded from the Meter, it can be saved on your PC as a Raw Data file. These files use a proprietary Palintest format and are saved with a .amf (**meter f**ile) extension.

To save the uploaded data, click the '**Save as Raw Data**' button. You will be asked for a file name in the normal Windows® format. The file name you choose will automatically be given the .amf extension.

Useful Tip: Once you have saved the logged data, it is a good idea to clear the Meter's memory so next time you log data, you don't get both your old data and new data uploaded to your PC. See Clearing the Memory in section 8.

16.8. Retrieving Logged Data

Once a Raw Data file has been saved using the above technique, it can be easily retrieved by clicking on the '**Open Raw Data**' button. When a raw data file is opened, it will appear exactly as uploaded data and the file name will be displayed in the box below the Report Header box.

16.9. Exporting Data

Macro 900 Link can export data in three different formats. Before exporting data, the actual data to be exported must be selected.

First, select which data records you want to export by checking the relevant check-boxes in the Uploaded Data column. You can check or un-check all data records simultaneously by checking or un-checking the 'Check / Un-Check All' box above the Uploaded Data column.

Next, select which individual data classes you want to export by checking or un-checking the check-boxes next to each individual data box. You are now ready to export your data.

16.10. Exporting Text Reports

To export a text report, first fill in the boxes in the group marked **Report Header** on the left of the screen. This information will be used at the beginning of your report. Next, click on the '**Export as Text Report**' button. You will be asked to specify a file name. A .txt extension will automatically be added.

A report will be generated that consists of a cover page giving the start and end date, time and position, the total number of readings, an analysis of the highest and lowest readings, the variance between the highest and lowest readings, the average readings and the GLP data. Each block of individual readings, laid out in chronological order, follows this page.

This report can be imported into any text editor or word processor package.

Useful Tip: Of the two text editors supplied with Windows®, Microsoft® WordPad is the preferred text editor for viewing Macro 900 Link Text Reports as this handles text file formatting better than Microsoft® Notepad.

A typical report cover page follows.

16.11. Typical Text Report Cover Page

```
Macro 900 Link REPORT
--------------------------
File name:          C:\Test\3 day test 024690136.txt
Operator name:          G.E.M.
Company name:          Palintest Ltd
Site name:          Test Site 4

Start date and time:     24-Jul-2009  10:09:33
Start position:          Lat:     N     51°21.4989'     Lon:     E
001°24.3232'   OSGB: TR 370 677

End date and time:          27-Jul-2009  13:01:00
End position:          Lat:     N     51°21.4988'     Lon:     E
001°24.3233'   OSGB: TR 370 677

Total number of readings:  877
---------------------------------------
Highest readings
-------------------------------------------------------------------
-----------------------------------------------------
Temp:       19.8C       Tag: 0648   Date: 26-Jul-2009
   Time: 15:51:00
Baro:       1020mb          Tag: 0315   Date:      25-Jul-2009
       Time: 12:19:00
Turb:       05.8 NTU          Tag: 0560   Date:      26-Jul-2009
       Time: 08:46:00
pH:   7.63        Tag: 0565   Date: 26-Jul-2009
   Time: 09:09:00
pHmV:       -36.3mV          Tag: 0009   Date:      24-Jul-2009
       Time: 10:49:01
ORP: 365.7mV          Tag: 0320   Date: 25-Jul-2009
   Time: 12:44:00
DO:   79.4% Sat  Tag: 0742   Date: 27-Jul-2009
   Time: 01:46:00
EC:   810uS/cm  Tag: 0588   Date: 26-Jul-2009
   Time: 10:51:00
RES:  1,445 Ω•cm       Tag: 0285   Date: 25-Jul-2009
   Time: 09:49:00
TDS: 526mg/L          Tag: 0588   Date: 26-Jul-2009
   Time: 10:51:00
SAL:  0.40ppt          Tag: 0001   Date: 24-Jul-2009
   Time: 10:09:33
SSG: 0.0st        Tag: 0001   Date: 24-Jul-2009
   Time: 10:09:33
-------------------------------------------------------------------
-----------------------------------------------------
```

Lowest readings

Temp:	17.9C	Tag: 0254	Date: 25-Jul-2009	Time: 07:14:01	
Baro:	1005mb	Tag: 0838	Date:	27-Jul-2009	Time: 09:46:00
Turb:	04.1 NTU	Tag: 0830	Date:	27-Jul-2009	Time: 09:06:00
pH:	7.55	Tag: 0003	Date: 24-Jul-2009	Time: 10:19:01	
pHmV:	-40.8mV	Tag: 0556	Date:	26-Jul-2009	Time: 08:24:00
ORP:	354.4mV	Tag: 0820	Date: 27-Jul-2009	Time: 08:16:00	
DO:	30.1% Sat	Tag: 0427	Date: 25-Jul-2009	Time: 21:39:00	
EC:	782uS/cm	Tag: 0149	Date: 24-Jul-2009	Time: 22:29:01	
RES:	1,358 Ω•cm	Tag: 0651	Date: 26-Jul-2009	Time: 18:11:13	
TDS:	508mg/L	Tag: 0145	Date: 24-Jul-2009	Time: 22:09:01	
SAL:	0.39ppt	Tag: 0017	Date: 24-Jul-2009	Time: 11:29:01	
SSG:	0.0st	Tag: 0001	Date: 24-Jul-2009	Time: 10:09:33	

	Variance	Average values
Temp:	1.9C	18.81C
Baro:	15mb	1013mb
Turb:	1.7 NTU	4.87 NTU
pH:	0.08	7.60
pHmV:	4.5mV	-39.09mV
ORP:	11.3mV	358.45mV
DO:	49.3% Sat	59.10% Sat
EC:	28uS/cm	792.2uS/cm
Res:	87 Ω•cm	1,415.4 Ω•cm
TDS:	18mg/l	514.4mg/l
SAL:	0.01ppt	0.391ppt
SSG:	0.0st	0.00st

Calibration (GLP) data

Turb Zero:	24-Jul-2009	Turb 1000:	23-Jul-2009

```
pH 7.00:          24-Jul-2009       pH 4.01:          23-Jul-
2009
DO Zero:          23-Jul-2009       DO 100%:  24-Jul-2009
EC:          24-Jul-2009       ORP:        23-Jul-2009
-------------------------------------------------------------------
--------------------------
```

Blocks of individual readings, laid out in chronological order, follow this cover page. The readings picked out on the cover page can be cross-referenced to the blocks of individual readings using the Tag numbers.

16.12. Exporting Excel® Files

To export an Excel® file, click on the '**Export as Excel File**' button. You will be asked to specify a file name. A .xls extension will automatically be added. Excel® files are exported in a Tab delimited text format. This means that each data field is separated by a Tab, and each data record appears on a new line.

Excel® files are saved with a .xls extension and can be opened directly in Microsoft® Excel®. When opening a .xls file created by Macro 900 Link for the first time, Excel® may automatically run a 'Text Import Wizard'. Follow the three simple steps to import the file. Save the file afterwards as a 'Microsoft Excel Workbook'.

16.13. Exporting Google™ Files

To export a Google™ file, click on the '**Export as Google File**' button. You will be asked to specify a file name. A .kml extension will automatically be added. **Please note: only data logged with a valid GPS position can be exported to Google™ files.**

Google™ files are exported in Google's proprietary Keyhole Markup Language with a .kml extension, and can be directly imported into either Google™ Maps or Google™ Earth, where the data is overlaid on maps or satellite images respectively.

Google™ Maps has a maximum import limit of 200 data records per file. If you intend to view your data in Google™ Maps, you must select 200 or less records for export in each file. If you select more than 200 records, Google™ Maps will truncate your file as it is loaded. If you have selected more than 200 data records for export, Macro 900 Link will warn you of this limitation.

Google™ Earth does not suffer from the same limitation, so you can export a full set of records in your file.

16.14. Importing Files into Google™ Maps

To view your files in Google™ Maps, you will need to log on to the Google™ website, select the Maps tag then create a Google™ Account. This is free of charge at present. Once you are signed in, follow these steps:

1. Click on '**My Maps**'.

2. Click on the '**Create New Map**' button.
3. Click on '**Import**'.
4. An Import KML box will appear. Click on '**Browse**'.
5. Browse for the file you exported from Macro 900 Link, and select it.
6. Back in the Import KML box, click the '**Upload from file**' button.
7. Once the file has been imported, click on '**Done**'

You will now be able to view your data overlaid on Google™ Maps. Each data point is represented by a yellow pushpin, and all the data points are listed in a column on the left of the map. To view the data associated with each pin, either click on the pin, or click on the data point in the list.

16.15. Importing Files into Google™ Earth

To view your files in Google™ Earth, you will need to log on to the Google™ website and install the Google™ Earth application on your computer. This is free of charge at present.

Once you have downloaded Google™ Earth and have it running, follow these steps:

1. Click on '**File**'.
2. Select '**Open**' from the list.
3. Browse for the file you exported from Macro 900 Link, and select it.

You will now be able to view your data overlaid on Google™ Earth Satellite images. Each data point is represented by a yellow pushpin, and all the data points are listed in a column on the left of the screen. To view the data associated with each pin, either click on the pin or click on the data point in the list.

Please note: Although you have downloaded the Google™ Earth application and are running it from your PC, you still need to be connected to the Internet in order for the application to access satellite images.

Typical Google™ Maps and Google™ Earth images follow.

16.16. Google™ Examples

The following two images show the same logged data displayed first in Google™ Maps, then in Google™ Earth.

The data displayed on Google™ Maps is useful, but for real detail, Google™ Earth is the answer.

Zooming in on the satellite photos in Google™ Earth is a great way to spot potential sources of pollution. If one of the readings you have taken shows an

abnormality, the chances are that you will be able to spot the possible source of the problem (a riverside factory for example) directly on the satellite photo.

17. Specification

17.1. MACRO 900 METER (V4.XX software)

	MACRO 900 METER
Dimensions (W x H x D)	90mm x 180mm x 39mm (3.5” x 7” x 1.5”)
Weight (including batteries)	450g (15.9oz)
Display	80 character FSTN LCD with backlight
Data Memory	1900 full sets including GLP data
GPS Receiver	12 channel, internal antenna
GPS Accuracy	+/- 10 metres in all 3 dimensions
Atmospheric Pressure	150mb – 1150mb Accuracy +/- 1mb
Languages	English / French / Spanish / German
PC Interface	USB (cable provided)
Power Supply	5 x AA cells. Alkaline or Ni-MH rechargeable
Battery Life	Alkaline > 20 hours. Ni-MH > 40 hours
Operating Temperature	-20˚C to +70˚C
Protection Class	IP67

17.2. PROBES GENERAL

Protection Class	IP68 (permanent immersion)
Immersion Depth	Min 75mm (3”). Max 30m (100’)*
Operating Temperature	-5˚C – +50˚C (23˚F – 122˚F)
Dimensions (L x Dia)	290 mm x 42 mm (11.4” x 1.65”)
Weight (including cable)	725g (25.6oz)

17.3. *Notes Concerning Maximum Probe Immersion Depth

MAPs are supplied as standard with a 3M cable. Extension cables with in-line connectors are available in 5M, 10M and 30M lengths, but are limited to a maximum of 10M immersion depth by the integrity of the connectors.

Custom cable lengths up to 30M can be fitted at the time of ordering to eliminate extension cables and in-line connectors, thereby allowing use of the Probe down to 30m depth.

17.4. PROBES SPECIFIC

			Probe Model									
			MAP 1000	**MAP 900**	**MAP 800**	**MAP 700**	**MAP 600**	**MAP 500**	**MAP 400**	**MAP 300**	**MAP 200**	**MAP 100**
Turbidity	Range	0 – 1000 NTU	●	●	●	—	●	—	●	—	●	—
	Resolution	2 Auto-range scales: 0.0 - 99.9 NTU, 100 - 1000 NTU										
	Repeatability	± 2% of auto selected range										
Galvanic Dissolved Oxygen	Range	0 – 500.0% / 0 – 50.00 mg/L	—	—	●	●	●	●	—	●	—	—
	Resolution	0.1% / 0.01mg/L										
	Accuracy	± 1% of reading or ± 0.1 unit if greater										
Optical Dissolved Oxygen	Range	0 – 500.0% / 0 – 50.00 mg/L	●	●	—	†	†	†	—	†	—	—
	Resolution	0.1% / 0.01mg/L										
	Accuracy	0 - 200%: ± 1% of reading. 200% - 500%: ± 10%										
Conductivity	Range	0 – 200 mS/cm (0 - 200,000 µS/cm)	●	●	●	●	●	●	—	●	—	—
	Resolution	3 Auto-range scales: 0 – 9999 µS/cm, 10.00 – 99.99 mS/cm, 100.0 – 200.0mS/cm										
	Accuracy	± 1% of reading or ± 1µS/cm if greater										
TDS	Range	0 – 100,000 mg/L (ppm)	●	●	●	●	●	●	—	●	—	—
	Resolution	2 Auto-range scales: 0 – 9999mg/L, 10.00 – 100.00g/L										
	Accuracy	± 1% of reading or ± 1mg/L if greater										

Resistivity	Range	5 Ω•cm – 1 MΩ•cm	●	●	●	●	●	●	—	●	—	—
	Resolution	2 Auto-range scales: 5 – 9999 Ω•cm, 10.0 – 1000.0 KΩ•cm										
	Accuracy	± 1% of reading or ± 1 Ω•cm if greater										
Salinity	Range	0 – 70 PSU / 0 – 70.00 ppt (g/Kg)	●	●	●	●	●	●	—	●	—	—
	Resolution	0.01 PSU / 0.01 ppt										
	Accuracy	± 1% of reading or ± 0.1 unit if greater										
Seawater Specific Gravity	Range	0 – 50 σ_t	●	●	●	●	●	●	—	●	—	—
	Resolution	0.1 σ_t										
	Accuracy	± 1.0 σ_t										
pH	Range	0 – 14 pH / ± 625mV	●	●	●	●	●	●	●	—	—	●
	Resolution	0.01 pH / ± 0.1mV										
	Accuracy	± 0.01 pH / ± 0.5mV										
ORP	Range	± 2000mV	●	●	●	●	○	○	○	—	—	○
	Resolution	0.1mV										
	Accuracy	± 0.5mV										
Depth	Range	0 – 30 Meters (0-100 Ft)	●	†	†	†	†	†	†	†	†	†
	Resolution	0.01M (0.4”)										
	Accuracy	+/- 0.1M (4”)										
Temperature	Range	-5°C – +50°C (23°F – 122°F)	●	●	●	●	●	●	●	●	●	●
	Resolution	0.1° C/F										
	Accuracy	± 0.5° C										

Key: ● = Standard Function ○ = Optional, replaces pH electrode — = Not available † = Available to Special Order

The accuracy figures quoted above represent the equipment’s capability at the calibration points at 25□C. These figures do not take into account errors introduced by variations in the accuracy of calibration solutions and errors beyond the control of the manufacturer that may be introduced by environmental conditions in the field.

18. Part Numbers

18.1. Meters & MAPs

Item No.	Name	Description
PT 1401	MACRO 900 METER KIT	GPS Meter shipped complete with 5 AA Alkaline Cells, Lanyard, USB cable, 'Getting Started' cards and CD containing Macro 900 Link software, USB drivers and full Manual. Supplied in a robust carry case with integral foam including screwdriver.
PT 1429	MAP 1000	MAP with Depth, Temperature / pH / ORP / Turbidity / Optical Dissolved Oxygen / Conductivity Electrodes. Shipped with a 3 meter cable, 300mL MacroCal solution, a pH Electrode Storage Cap, a 25mL bottle of Storage Solution, a calibration / rinse bottle.
PT 1428	MAP 900	MAP with Temperature / pH / ORP / Turbidity / Optical Dissolved Oxygen / Conductivity Electrodes. Shipped with a 3 meter cable, 300mL MacroCal solution, a pH Electrode Storage Cap, a 25mL bottle of Storage Solution, a calibration / rinse bottle.
PT 1427	MAP 800	MAP with Temperature / pH / ORP / Turbidity / Dissolved Oxygen / Conductivity Electrodes. Shipped with a 3 meter cable, 300mL MacroCal solution, 1 spare DO Electrode Membrane Cap, a 25mL bottle of DO Electrode Filling Solution, a pH Electrode Storage Cap, a 25mL bottle of Storage Solution, a calibration / rinse bottle.
PT 1426	MAP 700	MAP with Temperature / pH / ORP / Dissolved Oxygen / Conductivity electrodes. Shipped with a 3 meter cable, 300mL MacroCal solution, 1 spare DO Electrode Membrane Cap, a 25mL bottle of DO Electrode Filling Solution, a pH Electrode Storage Cap, a 25mL bottle of Storage Solution, a calibration / rinse bottle.
PT 1425	MAP 600	MAP with Temperature / pH / Turbidity / Dissolved Oxygen / Conductivity Electrodes. Shipped with a 3 meter cable, 300mL MacroCal solution, 1 spare DO Electrode Membrane Cap, a 25mL bottle of DO Electrode Filling Solution, a pH Electrode Storage Cap, a 25mL bottle of Storage Solution, a calibration / rinse bottle.
PT 1424	MAP 500	MAP with Temperature / pH / Dissolved Oxygen / Conductivity electrodes. Shipped with a 3 meter cable, 300mL MacroCal solution, 1 spare DO Electrode Membrane Cap, a 25mL bottle of DO Electrode Filling Solution, a pH Electrode Storage Cap, a 25mL bottle of Storage Solution, a calibration / rinse bottle.
PT 1423	MAP 400	MAP with Temperature / pH / Turbidity electrodes. Shipped with a 3 meter cable, 300mL MacroCal solution, a pH Electrode Storage Cap, a 25mL bottle of

		Storage Solution, a calibration / rinse bottle.
PT 1422	MAP 300	MAP with Temperature / Dissolved Oxygen / Conductivity electrodes. Shipped with a 3 meter cable, 300mL MacroCal solution, 1 spare DO Electrode Membrane Cap, a 25mL bottle of DO Electrode Filling Solution, a calibration / rinse bottle.
PT 1421	MAP 200	MAP with Temperature / Turbidity electrodes. Shipped with a 3 meter cable, 2 calibration / rinse bottles.
PT 1420	MAP 100	MAP with Temperature / pH electrodes. Shipped with a 3 meter cable, 300mL MacroCal solution, a pH Electrode Storage Cap, a 25mL bottle of Storage Solution, a calibration / rinse bottle.

Palintest Ltd reserves the right to change specifications without notice

18.2. Accessories

PT 1441	Flow-through Cell	Heavy duty Flow-Through Cell (can be used with any model MAP)
PT 1430	Extension Cable	5 Meter MAP extension cable (connectors submersible to 10m).
PT 1431	Extension Cable	10 Meter MAP extension cable (connectors submersible to 10m).
PT 1432	Extension Cable	30 Meter MAP extension cable (connectors submersible to 10m).
PT 1460	DO Membrane Kit	5 replacement **Galvanic DO** Electrode Caps complete with pre-fitted membranes. Shipped with a 25mL bottle of filling solution.
PT 1465	Optical DO Cap	Replacement **Optical DO** Sensor Cap (two year shelf life) Fits MAP 900 & MAP 1000 only.
PT 1459	Storage Cap	pH/ORP Electrode Storage Cap complete with warning lanyard & Storage Solution.
PT 1480	Macro 900 Hard Carry Case	Palintest rugged Explorer hard carrying case with foam inserts (includes space for a PT 1441 Flow-through Cell).
PT 1450	pH Electrode	Replacement pH Electrode shipped complete with protective storage cap and a 25mL bottle of Storage Solution (will fit MAP 100, MAP 400, MAP 500 & MAP 600 only).
PT 1451	ORP Electrode	Optional ORP Electrode shipped complete with protective storage cap and a 25mL bottle of Storage Solution (will fit MAP 100, MAP 400, MAP 500 & MAP 600 only).
PT 1452	pH/ORP Electrode	Replacement pH/ORP Electrode shipped complete with protective storage cap and a 25mL bottle of Storage Solution (will fit MAP 700 & MAP 800 only).

18.3. Calibration & Maintenance Solutions

PT 1470	MacroCal Solution	300mL MacroCal solution shipped in a wide neck bottle for direct probe insertion.
PT 1471	MacroCal Solution	600mL bottle of MacroCal solution.
PT 1455	pH7.00 Buffer	300mL pH 7.00 Buffer Solution shipped in a wide neck bottle for direct probe insertion.
PT 1456	pH7.00 Buffer	600mL pH 7.00 Buffer Solution.
PT 1457	pH4.01 Buffer	300mL pH 4.01 Buffer Solution shipped in a wide neck bottle for direct probe insertion.
PT 1458	pH4.01 Buffer	600mL pH 4.01 Buffer Solution.
PT 1468	Zero Oxygen Solution	150mL Zero Oxygen Solution shipped in a wide neck bottle for direct probe insertion.
PT 1469	Zero Oxygen Solution	600mL Zero Oxygen Solution.
PT 1461	DO Filling Solution	25mL Oxygen Electrode filling solution.
PT 1454	Storage Solution	25mL pH / ORP Electrode Storage Solution.
PT 1472	Calibration Bottle	300mL Wide neck calibration / rinse bottle for direct probe insertion.

To order accessories or solutions, contact your local Palintest™ Dealer.

19. Limited Warranty

All Palintest Macro 900 Meters are guaranteed for three years. Probes, Flow-Through Cells and individual electrodes are guaranteed for one year from date of purchase against defects in workmanship and materials when used for their intended purpose and maintained according to instructions. You must return your warranty card within 30 days of purchase to activate your warranty.

This warranty is limited to repair or replacement free of charge. Accidental damage, misuse, tampering, lack of prescribed maintenance, water ingress through unprotected Meter and Probe sockets, and damage caused by leaking batteries are not covered.

If service is required, contact our Service Department directly by email in the first instance (service@palintest.com). Report the model number, date of purchase, serial number and problem. You will be given a Product Return Number by our Service Department. You should then return the equipment, thoroughly cleaned, properly packaged, carriage paid, to the address you are given. If the equipment is within warranty, any necessary repairs will be carried out and your equipment will be returned free of charge.

If the repair is not covered by the warranty, you will be given an estimate for the costs of repair and return carriage.

Please note: The majority of perceived problems can be rectified by careful study of this instruction manual, use of the TROUBLESHOOTING section below, or with a little help from our engineers over the phone**. Always contact our Service Department prior to returning any equipment.**

19.1. Cleaning Prior To Return

In order to protect the health and safety of our employees, any equipment returned for service must be thoroughly cleaned and decontaminated prior to despatch, and must be accompanied by a completed copy of the Decontamination Certificate printed below. Any equipment returned for service without a satisfactory Decontamination Certificate, or any equipment deemed by our engineers to be contaminated, will be quarantined pending receipt of a properly completed Decontamination Certificate.

Never clean the Probe with concentrated acid or alkaline based cleaning products such as Decon 90. These products can strip the anodised finish from the Probe and damage some of the plastic components.

20. TROUBLESHOOTING

This section details some of the common difficulties you may encounter when using the Meter, MAPs and Macro 900 Link software. Try all the suggested remedies. If your problem is still unresolved, contact our Service Department (service@palintest.com).

Problem	Cause / Remedy
The Meter will not turn on when the on/off key is pressed.	✓ Batteries are probably dead or incorrectly fitted. Check you have fresh batteries fitted and that they are inserted the correct way round.
The Meter turns on but turns off again almost immediately.	✓ Batteries are probably nearly dead or incorrectly fitted. Check you have fresh batteries fitted and that they are inserted the correct way round.
The Meter can not find the MAP.	✓ Probably a poor connection. Switch the Meter off, disconnect the MAP plug, ensure there is no debris or moisture in the plug, then re-connect the plug ensuring it is fully inserted and that the screw collar is fully tightened.
The GPS Meter will not show a position fix.	✓ The Meter probably does not have a good enough view of the available satellites. Ensure there are no obstructions between the Meter and the open sky. Remember, GPS **does not** work indoors.
The Macro 900 Link software can not find the Meter.	✓ The USB drivers may not be properly installed. Reinstall the USB drivers carefully following the instructions. ✓ There may be a problem with the USB socket on the PC, try an alternative socket.
The 'USB CONNECTED' message does not appear on the Meter when it is connected to a PC.	✓ The batteries in the Meter may be dead or incorrectly fitted. Check you have fresh batteries fitted and that they are inserted the correct way round. The USB cable **does not** power the Meter. ✓ There may be a problem with the USB socket on the PC, try an alternative socket.
ERROR 01 appears on the Meter screen.	✓ This indicates that the pH electrode has dropped below 85% efficiency. Try cleaning the pH electrode and re-calibrating as described in the relevant section of this manual. If that does not cure the problem, replace the electrode.
ERROR 02 appears on the Meter screen (MAP 900 & MAP 1000 only).	✓ This indicates that the Optical DO electrode needs calibrating or the cap needs replacing. Perform a full DO calibration, first at DO Zero then at 100% DO. If that does not cure the problem, replace the Optical DO Cap
COMMS ERROR appears on the Meter screen.	✓ This indicates that the MAP has stopped responding to requests for data from the Meter. Check the MAP plug is fully inserted. Cycle the power to reset the MAP.

Battery electrolyte leakage detected in the battery compartment.	✓ Remove and discard the batteries immediately. Thoroughly clean the battery compartment and terminals. If the battery terminals are corroded, contact our Service Department for return instructions.
Dissolved Oxygen readings are inaccurate or unstable.	✓ There may be insufficient flow across the Galvanic DO membrane. Ensure a constant water flow whilst taking readings (does not apply to MAP 900 & MAP 1000). ✓ The DO electrode may need calibrating. Recalibrate. ✓ The DO membrane may be dirty. Clean the DO membrane. ✓ The DO membrane may be worn out or damaged. Replace the DO membrane cap. ✓ Calibration may have been carried out at an extreme temperature. Recalibrate at a temperature as close to the sample temperature as possible.

Problem	Cause / Remedy
pH and/or ORP readings are slow, inaccurate or unstable or calibration is impossible.	✓ The electrodes may need re-calibrating. Recalibrate. ✓ The electrodes may need cleaning. Clean as described in the relevant section of this manual. ✓ The electrodes may have been allowed to dry out. Re-hydrate as described in the relevant section of this manual. ✓ The electrodes may be damaged. Replace the electrodes. ✓ The electrode may be loose allowing water to enter the electrode socket. Remove the electrode, blow out the socket with compressed air then leave the probe and electrode in a warm place for at least 48 hours to dry out.
EC readings are inaccurate or unstable. OUT OF CAL RANGE error shows during calibration of EC.	✓ Have you got both halves of the Probe Sleeve fitted? EC will not work without the whole Probe Sleeve fitted. ✓ The MAP may not be inserted deep enough into the sample being measured. Ensure the sample level reaches the minimum depth line on the outside of the MAP. ✓ Trapped air bubbles may be causing problems. Tap and swish the MAP to dislodge them. ✓ The Probe Sleeve may be loose. The Probe Sleeve must be absolutely rigid with respect to the Probe Body for correct EC operation. If you can move the Probe Sleeve to and fro whilst holding the Probe Body, tighten the four screws then recalibrate. ✓ The EC electrode may need recalibrating. Recalibrate. ✓ The EC electrode may be dirty. Clean the EC electrode then recalibrate.
Turbidity readings are inaccurate or unstable.	✓ Have you got both halves of the Probe Sleeve fitted? Turbidity will not work without the whole Probe Sleeve fitted. ✓ Trapped air bubbles may be causing interference. Tap and swish the MAP to dislodge them. ✓ The sample being measured may contain air bubbles. Under these conditions, optical turbidity measurements can not be taken. ✓ The MAP may not be inserted deep enough into the sample being measured. Ensure the sample level reaches the minimum depth line on the outside of the MAP. ✓ The Probe Sleeve may be loose. The Probe Sleeve must be absolutely rigid with respect to the Probe Body

	for correct turbidity operation. If you can move the Probe Sleeve to and fro whilst holding the Probe Body, tighten the four screws then recalibrate. ✓ The Turbidity electrodes may need recalibrating. Recalibrate. ✓ The lenses on the turbidity electrodes may be dirty. Clean the lenses then recalibrate.

21. DECLARATION OF CONFORMITY

Palintest Ltd declares that the equipment described herein is in compliance with the essential requirements and other relevant provisions of Directives 2004/108/EC and 1999/5/EC.

22. Appendix 1. The Tech Behind Palintest's Optical DO Measurement System

22.1. Principle of Operation

The Palintest Optical DO measurement system works on the principle of Dynamic Luminescence Quenching. A gas-permeable chemical known as a luminophore is excited with short bursts of blue light, which causes molecules in the luminophore to emit red photons. The presence of oxygen in contact with the luminophore causes the emission of the red photons to be quenched or delayed. By measuring the delay of the returned red photons with respect to the blue excitation, it is possible to determine the level of dissolved oxygen present.

Whilst this sounds very simple in principle, the optical system and the high-speed electronics required to obtain good accuracy are extremely complex. Housed in a resin filled, marine grade aluminium body that measures just 8mm (0.3") diameter by 13mm (0.5") long, the fully waterproof Sensor Module contains blue excitation and red reference LEDs, optical filters, a photon detector, temperature sensor, driver circuitry and high gain amplification circuitry.

The incredibly small size of the Sensor Module allows it to fit comfortably into the end of a standard 12mm diameter DO electrode in place of a traditional Clark Cell. The addition of a replaceable cap containing a lens coated with the luminophore material completes the DO section of the electrode.

22.2. Sensor Cap Life

All optical dissolved oxygen sensors work on the same principle, and all must have the sensor cap containing the luminophore replaced periodically due to a phenomenon known as photo bleaching.

When a sensor cap is new, the luminophore will return a large number of red photons when excited. As time goes on, a bleaching effect takes place and the number of red photons returned reduces to a point where they are no longer detectable.

The amount of photo bleaching that the luminophore suffers is in direct proportion to the amount of time it is excited by the sensor's blue light source. It therefore follows that the faster a reading can be taken, the less time the luminophore needs to be excited and the longer it will last.

The high-speed circuitry within the sensor module requires just eleven milliseconds to take a reading! This incredibly fast reading time increases the useful life of the luminophore considerably.

Another technique used to prolong the life of the luminophore in the sensor

module is variable excitation brightness. When the luminophore is new, the brightness of the excitation is reduced to a minimum in order to prevent unnecessary photo bleaching. As the output from the luminophore gradually reduces, the brightness of the excitation is increased in order to squeeze the maximum possible life from the sensor cap.

The combination of low duty cycle and variable excitation brightness can stretch the useful life of a sensor cap as far as two years.

23. Appendix 2. Flow Through Cell

23.1. Introduction

The Palintest Flow Through Cell (Flowcell) is designed for use with any model of Palintest MAP and most third party pumping device.

The Flowcell allows sample water to flow up through the MAP, passing over all the individual electrodes simultaneously. This eliminates air contact with pumped samples from groundwater boreholes allowing truly representative measurements to be obtained.

Made from marine grade aluminium and 6mm wall thickness acrylic, the Flowcell is ruggedly constructed for hard use in the field. The base flange includes four holes to allow the unit to be pegged down if necessary.

23.2. Spigot Installation

The Palintest Flowcell is supplied with two pairs of spigots, one pair to fit 6mm (1/4”) ID tube and one pair to fit 10mm (3/8”) ID tube.

The spigots have a tapered thread so should be screwed into the inlet and outlet holes of the Flowcell until they are tight. At this point, they should seal due to the taper. If a spigot will not seal properly, remove it then re-insert with some PTFE plumber’s tape wrapped around the thread.

23.3. MAP Preparation Prior to First Use

If you are using an early MAP with a single part Sleeve, the Sleeve should be removed and a good layer of silicon grease or a few turns of PTFE tape should be applied to the mating surfaces where the Probe Sleeve slides onto the Probe Body. This will prevent sample water being forced up between the Sleeve and body when the Flowcell is under pressure. When the grease or tape has been applied, refit the Sleeve then recalibrate.

If your MAP has a two-part Sleeve, there is no need to apply grease or tape as the upper Sleeve is fitted with an O-ring seal.

23.4. MAP Installation

The lower Sleeve must be fitted to the MAP, but **the protective Sleeve End Cap must not be fitted** as this will reduce flow and cause turbulence.

Loosen the screw collar located at the top of

the Flowcell and slide the MAP in all the way, ensuring it is properly seated in the recess where the clear tube enters the base. Tighten the collar to clamp the MAP in place.

23.5. Operation

Connect the Flowcell to a pumping device so that sample water enters at the bottom and exits at the top. Adjust the flow rate so that there is no visible turbulence or cavitation within the Flowcell. Connect an Meter and monitor the readings. If the readings are jumpy or erratic, reduce the flow rate. The ideal flow rate is around 30 litres/hour (8 US gallons/hour), although the MAP is capable of operating at flow rates as low as 15 litres/hour (4 US gallons/hour). Flow rates above 60 litres/hour (16 US gallons/hour) are not recommended.

23.6. Caution

The maximum operating pressure of the Flowcell is 300mb (4.4 PSI). Select your pumping device accordingly. If necessary, use a three-way bypass valve so that this limit is not exceeded.

23.7. Cleaning

After use, rinse the Flowcell thoroughly with fresh water. To remove stubborn deposits, scrub the inside of the Flowcell with a bottlebrush and non-abrasive detergent, then rinse thoroughly.

Never clean the Flowcell with concentrated acid or alkaline based cleaning products such as Decon 90. These products can strip the anodised finish from the Flowcell and damage the plastic components.

23.8. Flowcell Troubleshooting

Problem	Cause / Remedy
DO readings are abnormally high or are fluctuating wildly.	Aeration of sample water. Check all joints for air leaks. Reduce flow rate to avoid cavitation.
Turbidity readings are abnormally high.	Air bubbles adhering to the Turbidity Electrode lenses. Agitate Flowcell to dislodge. Aeration of sample water. Check all joints for air leaks. Reduce flow rate to avoid cavitation.
Sample water is leaking from around the top of the screw collar.	Screw collar is not tight enough. Tighten up. Grease / PTFE tape has not been applied to the joint between the Probe Sleeve and Probe Body (single part sleeves only). See 'MAP Preparation Prior to First Use' on previous page. Operating pressure is too high. Reduce pressure / flow rate.
Probe is forced up out	Operating pressure is much too high. Reduce

of the Flowcell during use.	pressure / flow rate.

24. Appendix 3. Probe Hanger

MAPs can be used with up to 100m of cable. When using long cable lengths, especially down boreholes, it is advisable to support the Probe on a separate steel cable using a Probe Hanger.

To attach a Probe Hanger to an Palintest Probe, first loosen the top plastic nut that is attached to the top of the Probe and slide it a little way up the cable. Ensure the bottom nut is tight against the top of the probe.

Slide the Probe Hanger over the cable then down onto the threaded part of the Probe.

Bring the top nut down onto the thread, then use the Probe Hanger as a spanner to tighten the nut. The final assembly should be as shown below.

Attach your steel support cable to the Probe Hanger with the snap ring provided.