Instruction Manual

for the

Aquaprobe® AP-700, AP-800 & AP-2000

Multiparameter Water Quality Probe

and associated

Aquameter®, Utilities & Accessories

Aquaprobe® firmware Revision 4.07 and Above
Aquameter® firmware Revision 6.20 and Above

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Note: For return for recycling, please contact Aquaread® Ltd for instructions on how to return end-of-life equipment, accessories, and all auxiliary items for proper disposal.

WARNING

Favourable indications made by this equipment **do not guarantee** water is safe for human or animal consumption. This equipment **can not** detect the presence of harmful bacteria or toxins. If in doubt, **ALWAYS TREAT SUSPECT WATER PRIOR TO CONSUMPTION.**

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TRADEMARKS

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1. Introduction

This manual specifically covers the setup, operation, calibration and maintenance of Aquaprobe® models AP-700, AP-800 & AP-2000 running V4.07+ firmware, Aquameter® models running V6.20+ firmware, AquaLink V5.00+ PC software and associated Aquaprobe® accessories. If your Aquaprobe® or Aquameter® are running earlier firmware, the functionality may differ from that shown in this manual. In this case, contact Aquaread for an earlier version of this manual or return your equipment for firmware upgrade.

2. What's in the Box?

The Aquameter® is supplied with the following:

- The Aquameter® unit.
- 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.
- Getting started card for quick reference.

The Aquaprobe® is supplied with the following:

- Protective Sleeve End Cap.
- Calibration bottle filled with RapidCal Solution.
- Spare calibration / rinse bottle.
- One mounting nut (pre-fitted).
- Getting started card for quick reference.
- 25mL bottle of pH storage solution.
- Pot of silicone grease.
- Spare Galvanic DO Membrane Cap (AP-700 & AP-800 only)
- 25mL bottle of Galvanic DO filling solution (AP-700 & AP-800 only)

If using an AP-2000, you will also need an AP-2000 Extension Cable, which should be purchased separately.

2.1. The Aquameter® and the Environment

The Aquameter® 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 socket on the Aquameter® is only waterproof when the associated plug is fitted. Without the plug fitted, water can enter 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 top. 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 Aquaprobe® and the Environment

The Aquaprobe® AP-700 and AP-800 models are designed to be fully submerged in water and are rated to IP68, that is to say, they are rated for continual immersion to a depth of 10 meters, and short term immersion (less than 12 hours) to a depth of 50 meters.

The Aquaprobe® AP-2000 and AP-2000-D models are designed to be fully submerged in water and are rated to IP68, that is to say, they are rated for continual immersion to a depth of 30 meters, and short term immersion (less than 12 hours) to 100 meters.

2.2.1. Important Notes Regarding Galvanic Corrosion

Galvanic corrosion, sometimes also known as bimetallic corrosion, is an electrochemical process in which one metal corrodes preferentially when it is in contact with a dissimilar metal in the presence of an electrolyte (such as water). A similar galvanic reaction is exploited in batteries to generate an electrical voltage. **When installing an Aquaprobe, it is important to recognise and avoid the possibility of creating a situation where galvanic corrosion can occur.**

All Aquaprobes are made primarily from hard-galvanised marine grade aluminium. All the time that the aluminium body of the Aquaprobe is insulated from any other type of metal, there should be no problem with corrosion (unless the Probe is placed in strong acids or alkalis, for which it is not designed).

Corrosion problems can occur if the Aquaprobe is mounted near to, and connect to a dissimilar metal, such as stainless steel. Typical examples of this are mounting the Probe inside a steel pipe or suspending it from a steel dock on a steel wire. In these situations, a steel-aluminium battery is created that will generate a voltage of around 0.5V and lead to the corrosion of the metal with the lower potential, in this case the aluminium of the Aquaprobe.

It is important to avoid creating a situation where galvanic corrosion can occur in your installation. The easiest way to do this is by electrically insulating the Aquaprobe from the supporting structure. This can be done by suspending the Aquaprobe on a Mylar or Nylon rope rather than a conductive steel wire.

If the Aquaprobe is to be mounted inside a steel pipe, wrap a good thickness of electrical insulation tape around the top and bottom of the Probe to form ‘fenders’ in order to prevent the Probe making physical contact with the inside of the pipe. When doing this, ensure that you do not block any of the holes in the Probe’s sleeve, which are essential for water flow and correct operation of the Probe.

If the above techniques are not possible and a metal-to-metal connection is unavoidable, a sacrificial anode must be attached to the Aquaprobe. Sacrificial anodes are manufactured from zinc and are designed to slide onto the threaded connector section of the Aquaprobe and to be held on by the mounting nut. Zinc is much more active than aluminium and will therefore corrode first leaving the Aquaprobe undamaged.

Sacrificial anodes are, as the name suggest, sacrificial, so will need replacing periodically.

Sacrificial anodes are available for all models of Aquaprobes. Please contact Aquaread Ltd for more details.

2.3. Important Information about the Probe Sleeve & Sleeve End Cap

The Aquaprobe® is constructed with an aluminium sleeve surrounding the delicate sensing electrodes. The Sleeve can be easily removed by unscrewing to allow cleaning of the individual electrodes, however, **the Probe sleeve forms an integral, working part of the Probe’s measurement system, and MUST be fitted for correct operation.**

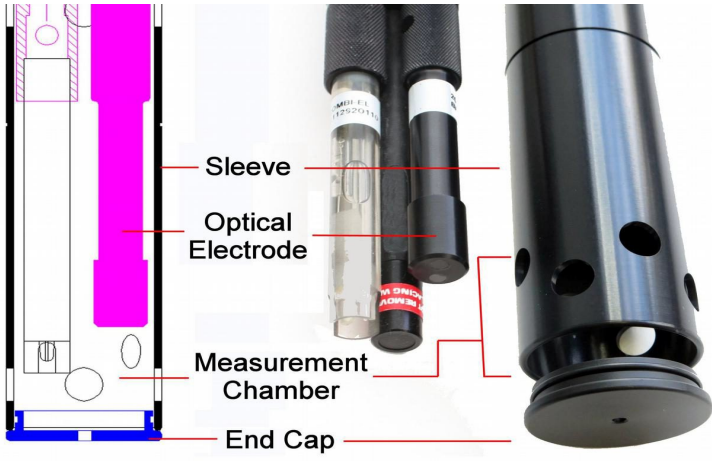
Probe sleeves are also specifically matched to the Probe with which they were supplied. If you have more than one Aquaprobe®, be sure not to mix the sleeves up between the Probes. Doing so may seriously affect the performance of the EC electrode.

All Aquaread® Optical Electrodes are incredibly sensitive. For example, the Turbidity electrode is capable of measuring between 0 and 3000NTU with an internal resolution of greater than 0.1NTU. This means that the electrode is able to detect changes in turbidity that are less than 0.003% of the full range! The other optical electrodes have a similar level of sensitivity. It follows, therefore, that in order to provide stable, repeatable readings, the environment in which the measurements are made must be completely stable and repeatable.

For this reason, the Aquaprobe® is constructed with a matt black aluminium sleeve and end cap that enclose the sensing electrodes and provide a closed, constant condition, non reflective measurement chamber.

This is essential for the correct calibration and operation of all types of optical electrodes.

A diagram of the Aquaprobe's measurement chamber is shown here. Please note, the design of the End Cap may vary depending upon the age and model of your Aquaprobe.



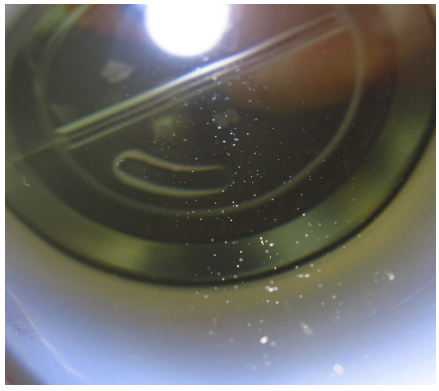
In order to obtain consistent results, the measurement chamber created within the Aquaprobe® must remain physically constant during both calibration and measurement.

If the optical electrode is calibrated under one set of conditions then used to measure under another set of conditions, the readings will naturally be erroneous, especially at low concentrations.

A perfect example of this is calibrating with the end cap removed then measuring with the end cap fitted (or vice-versa). By changing the physical characteristics of the measurement chamber, you also change the calibration and response of the electrode.

Another particular problem when trying to measure very low concentrations is air in the form of both visible and microscopic bubbles. These act like tiny prisms and can refract and reflect both the excitation light and the return signal being measured.

The photograph to the right was taken in a calibration tube after fresh water was poured in. The bubbles are clearly visible in the light beam.



2.4. Top Tips for successful measurements using optical electrodes

- Always keep the measurement chamber and electrode lenses clean.
- Always fit the sleeve and end cap during both calibration and measurement.
- Always allow the readings to settle completely during both calibration and measurement.
- Always try to eliminate air bubbles by agitating the Probe after insertion both during calibration and measurement.
- Always calibrate and zero the electrode as close to your sample temperature as possible. This is especially important with the Ref-Oil electrode.
- Always zero the optical electrodes just prior to use in clean water (bottled still mineral water is ideal) then deploy **without disturbing the measurement chamber**. This is especially important when using the Turbidity and Ref-Oil electrodes.

2.5. About the Lanyard

The lanyard supplied with the Aquameter® may, at first, appear to be a little long. This is intentional. In order to keep the Meter out of the way whilst your hands are full, the lanyard has been made long enough to wear round your neck and over your shoulder so the Meter sits on your hip.

The extra length also allows the meter to be held in a comfortable position in front of you during normal use. In order to prevent you being dragged into the water in the event of the Probe cable becoming snagged, the lanyard includes a quick-release clip.

3. Battery Installation and Care

The Aquameter® 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 in the AM-200 GPS Aquameter®. A fully charged set of 2500mAh NiMH cells will give up to 40 hours use in the AM-200 GPS Aquameter®. Please be aware however that alkaline battery capacities are extremely temperature dependant. The figures quoted throughout this manual for battery life assume a temperature of 21°C. Battery life can be significantly shorter (by up to 50%) at lower temperatures.

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 Aquameter® 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. We recommend the use of one of the *Energizer* range of NiMH chargers.

3.4. Battery Condition Icon

On all the main Aquameter® 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 Aquameter® 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 Aquameter® 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 firmware in the Aquameter® 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 Aquameter® 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.

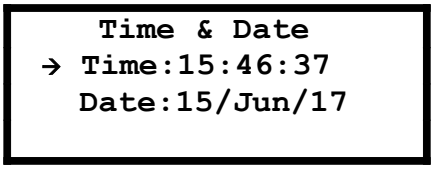
To reverse along a branch of the menu system, use the **ESC** (escape) key or left arrow key. After a short time, you should be able to navigate around the entire menu system at speed using just the four arrow keys. If, at any time, you leave the Meter in one of the sub-menu screens, it will automatically 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 around the list using the arrow keys. 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. Don't worry if you make a mistake first time round. You can easily get back to these screens later through the **MENU** key.

5. Connecting an AP-2000

The AP-2000 is designed to connect to the Aquameter® using an AP-2000 Extension Cable. The cable is built-in on the AP-700 & AP-800 models. The AP-2000 Extension Cable features high-pressure metal connectors, which incorporate several O-ring seals at the Probe end. Prior to first connection, the seals must be lubricated using the silicone grease supplied.
Apply a generous smear of grease to the O-rings where indicated above. Be careful not to get any grease inside the connector near the gold contacts. A small smear of grease should also be applied to the thread on the Probe to allow easy tightening of the collar.

To connect the Extension Cable to the AP-2000, align the coloured dot on the AP-2000 with the ◄**Aquaread®** logo on the plug body, then press the plug into the socket and tighten the retaining collar fully. **DO NOT TWIST THE CONNECTOR BODY WITH RESPECT TO THE PROBE**. Once the AP-2000 has been connected to the Extension Cable, the Aquameter® can be connected.

5.1. Connecting the Aquameter®

Always ensure the Aquameter® is switched off prior to connecting or disconnecting an Aquaprobe®. Align the ◄**Aquaread®** logo on the plug body with the red on/off switch on the Aquameter®, then press the plug into the socket and tighten the retaining collar.

Once the Aquaprobe® is connected to the Aquameter®, switch the Meter on by briefly pressing the red on/off switch. The Aquameter® should detect the Probe and automatically start displaying readings.

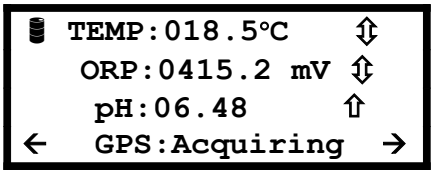
6. Taking Measurements

The Aquaprobe® includes a pH/ORP electrode, which is kept moist by a storage cap. Remove the storage cap by pulling the red 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.

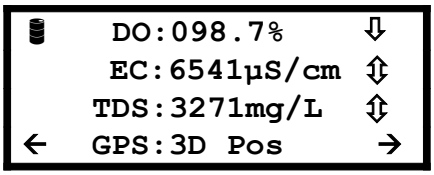
Fit the protective Sleeve End Cap into the end of the Probe sleeve. Switch the Aquameter® on and immerse the Aquaprobe® in the sample water, making sure that the water level covers the minimum immersion depth groove halfway up the Probe sleeve.

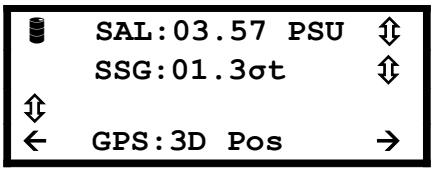
TIP: Occasional application of a smear of silicone grease or similar lubricant to the protective Sleeve End Cap O ring and the inside rim of the Probe sleeve will make fitting and removal of the Cap easier.

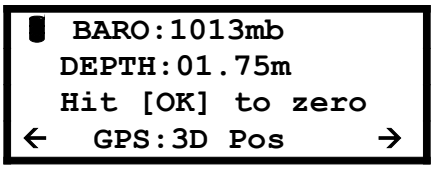
If the Aquaprobe® is connected correctly, the meter will read the Probe’s serial number and model number, then will automatically configure itself to display only those readings the current Aquaprobe® is capable of taking. Initial Probe readings will be displayed on the meter’s screen along with the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

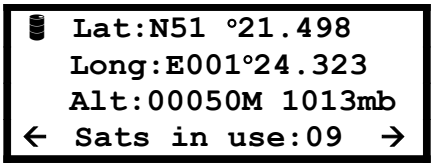


Left/right arrows at the bottom corners of the screen indicate further data screens are available. To access these screens, simply press either the left or right arrow keys. Any value that is out of range or unavailable will be displayed as dashes. The other four screens available with the standard AM-200/AP-2000-D combination are shown below.









6.1. What Does It All Mean?

The screens above show the full default range of readings for the AM-200/AP-2000-D combination. If you are using a different Meter/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	°C or °F*	All Probe Types
pH	pH (Acidity/Alkalinity)	pH or pHmV*	All Probe Types
ORP	Oxidation Reduction Potential	mV	All Probe Types
GPS	GPS Status	See section 6.5	AM-200 + All Probe Types
DO	Dissolved Oxygen	%Sat & mg/L	All Probe Types
EC	Electrical Conductivity	µS/cm or mS/cm†	All Probe Types
TDS	Total Dissolved Solids	mg/L or g/l†	All Probe Types
SAL	Salinity	PSU or ppt*	All Probe Types
SSG	Sea Water Specific Gravity	σt	All Probe Types
BARO	Barometric Pressure	mb or mmHg*	AM-200 + All Probe Types
DEPTH	Depth above / below zero datum	Meters / Feet*	- D models only
Lat	Latitude	Degrees & Mins	AM-200 + All Probe Types
Long	Longitude	Degrees & Mins	AM-200 + All Probe Types
Alt	Altitude above Sea Level	Meters or Feet*	AM-200 + All Probe Types

Note: the Depth page is not displayed with the standard Aquaprobe®. 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.

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 either 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 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 stir the Probe, 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 saving.

6.4. Temperature Compensation

The electrochemical properties of all solutions change with the solution's temperature. In addition, the response of electrochemical measuring electrodes change 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, the Aquaprobe® automatically applies corrections for temperature wherever required.

During three point calibration of the ISE electrodes, the variation in response of the electrodes due to temperature is automatically calculated. During measurement, the variation in response of the electrodes due to temperature is automatically compensated for.

During calibration of the EC electrode, the variation in the calibration buffer solution due to temperature is automatically corrected for. During measurement of EC, the readings can be displayed without any temperature correction, corrected to 20°C, or corrected to 25°C. 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 for. During the measurement of DO, temperature, air pressure and salinity are automatically compensated for.

During calibration of the ORP electrode, the variation in the calibration buffer solution due to temperature is automatically corrected for. During measurement of ORP however, temperature corrections are not applied as the correction factors are system and chemical dependent and are not easily determined.

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 side effects.

During calibration of the optical electrodes, variations in the calibration solutions due to temperature are automatically compensated for. During the measurement, temperature is automatically compensated for.

During calibration of the pH electrode, the small variation in the calibration buffer solutions due to temperature is not compensated for due to the differences in thermal coefficient between various buffer manufacturers. For this reason, the three pH points should be calibrated as close to the buffer manufacturer's specified temperature as possible (usually 20ºC or 25ºC) although a variation of up to +/-10ºC makes very little difference in reality.

During pH measurement, temperature variation is automatically compensated for.

6.5. GPS Reception

The GPS version of the Aquameter® (AM-200) contains a built-in GPS/GLONAS receiver and antenna. The antenna is situated at the top of the case, just behind the Aquaread® 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 the 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 (Aquaprobes with a - D suffix only)

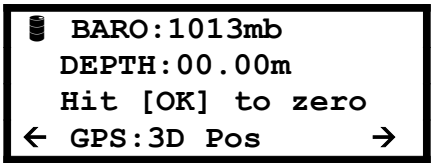
Depth is measured in the Aquaprobe® by a pressure sensor mounted inside the body of the probe.

Depth is calculated by subtracting the barometric pressure being measured in the Aquameter® from the water pressure being measured in the Aquaprobe®. 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

If you want 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 depth from the current depth (zero datum).

If the values are positive, the water level has increased from the zero datum. If the values are negative, the water level has decreased.

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.

7.3. Depth Calibration

The depth sensor is automatically re-zeroed each time the DO 100% point is calibrated in free air. The depth sensor is factory calibrated at two temperatures and two pressures and vary rarely needs to be recalibrated during the lifetime of the Probe. If two point depth calibration is required, it must be done using an AP-PC KIT and associated AquaCal PC Software. Full depth calibration can not be performed using an Aquameter®.

8. Memory Mode

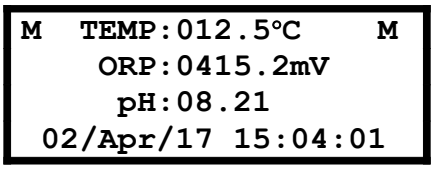
8.1. Manually Saving Readings

When you are happy that the readings are stable (see section 6.3: Global Stability Indication), press the **M+** key to snapshot the readings along with the time, date, GLP (calibration) data and position (GPS models only).

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 Aquameter® and when using AquaLink 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 first along with the date and time the readings were taken shown on the bottom line of the screen.



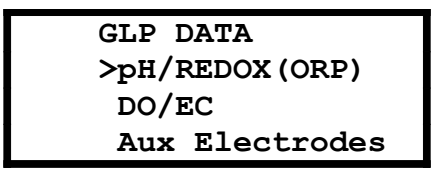
During Memory Recall, an 'M' is flashed in the top left and right corners of the screen alternatively with an up/down arrow and a left/right arrow. This is to indicate that the Meter is in Memory Recall mode and that other screens can be accessed using the arrow keys.

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. This is called GLP (Good Laboratory Practice) Data. In addition to the date of the last successful EC calibration, the Calibration Standard value at which the EC was calibrated is also displayed (see section 15.: EC / Temperature Electrode Calibration and Maintenance 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 reading you are interested in using the up/down keys, then press the **MENU** key. The screen below will be displayed.



Using the up/down keys, select the electrode you are interested in, then press either the OK key or the right arrow key. If, for instance, you selected pH/REDOX(ORP), the screen below would be displayed.

```
 PH 7.00 [31/Jan/17]
 PH 4.01 [07/Feb/17]
 PH 10.0 [07/Feb/17]
 ORP+250 [09/Feb/17]
```

This tells you that 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 & pH 10 points and February 9th for ORP. If the date field is dashed (==/===/==), this means the electrode was either not fitted or had never been calibrated.

Pushing the left or right arrow keys will toggle this screen with the calibration report screen.

```
 PH7 Offset:+01.2mV
 PH4 Slope:56.8mV/pH
PH10 Slope:56.3mV/pH
 ORP Offset:-02.6mV
```

The calibration report screen displays the calibration report values from the last calibration.

To exit this screen press the **ESC** key.

8.4. Clearing the Memory

The memory within the Aquameter® is capable of storing 10,000 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

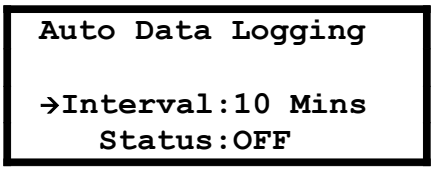
If you want to save readings on a regular basis, in order, say, to check water quality at a certain location over a period of time, you can set the Meter to record readings automatically.

Readings can be logged for short periods with the Meter permanently displaying readings, or for much longer periods in a Low Power Mode, where the Meter switches itself off between readings in order to extent the battery life.

To activate Automatic Logging, press the **MENU** key. The Main Menu screen will be displayed. Please note, the first item on the menu, 'Clean Probe', will only be active if an Aquaprobe® AP-7000 (which has an automatic cleaning system) is connected.

```
→ Clean Probe
  Auto Data Logging
  Calibration
  Setup & Install
```

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 anywhere between 1 and 90 minutes.

To select **Sub-Minute Logging Mode**, move the cursor right again to the word 'Mins', then use the up/down arrow keys to toggle the setting to 'Secs'. Now the logging interval can be set anywhere between 2 and 90 seconds.

To select permanent display logging mode, set the Status to **ON**. To select Low Power logging mode, set the Status to **LOW POWER**. Low Power mode is not available in Sub-Minute Logging Mode.

To activate the selected logging mode, press the **OK** key then revert back to the normal operation screen from the Main Menu by pressing the left arrow key.

To indicate that Auto Data Logging is switched on, an asterisk (*) character will flash on and off just below the battery symbol on all the main reading screens.

If permanent display logging mode was selected (Status set to **ON**), the Meter will record a full set of data automatically at the set rate until either the memory is full or the batteries go flat.

If Low Power Logging Mode was selected (Status set to **LOW POWER**), the Meter will switch itself off 30 seconds after your last key-press. Thereafter it will switch back on at the set rate, stay on for 30 seconds, log the data, then switch back off again. This will be repeated until either the memory is full or the batteries go flat.

If you press any key while the Meter is off between readings in low power mode, the Meter will switch back on. If no further key is pressed, the Meter will switch back off again after 30 seconds and resume Low Power Mode.

You can cancel Auto Data Logging at any time by going back into the screen above and setting the **Status** to **OFF**. Auto Data Logging will also be cancelled if you switch the Meter off manually.

8.6. Battery and Memory Duration in Low Power Logging Mode

Low Power Logging Mode is specifically designed for long term data logging. In order to estimate battery life and memory usage, the following table can be used.

The battery life figures quoted below are based on fresh, good quality alkaline batteries at a Meter temperature of 21°C or over. Colder Meter temperatures will drastically reduce the battery life. For example, at 5°C, the battery life will be approximately half that quoted.

Logging Rate	Battery Life (at 21°C)	Memory Duration*
90 mins	38 Days	625 Days
60 mins	36 Days	416 Days
45 mins	34 Days	312 Days
30 mins	30 Days	208 Days
15 mins	20 Days	104 Days
5 mins	10 Days	34 Days
1 min	2 Days	6.9 Days

So, it can be seen that although the Meter has a maximum data capacity of 625 days, for logging rates above 15 minutes, fresh batteries would need to be fitted every 30 days or so in order to make use of the Meter's full memory capacity.

Conversely, a logging rate of 2 seconds will fill the Meter's memory on a single set of batteries (at 21°C or greater).

Useful Tip: If you want GPS data logged in association with your other data, ensure the Meter is positioned face up with a clear view of the sky.

8.7. Important Information About Memory Mode

When data is saved in the Meter, it is compressed in raw Probe format. In other words, the same way that it came up from the Probe. When you recall the data in Memory Recall mode, the data is decompressed, then processed for display.

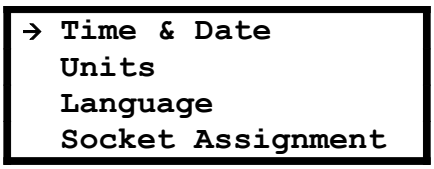
The advantage of this is that the readings will always appear in the current Meter configuration. For example, if you spent a day taking readings with the Meter set to read EC corrected to 25°C, then when you got back you really want to see EC corrected to 20°C or even raw EC, you can do this by simply changing the Meter settings (see section 9 Setting Units of Measurement).

The stored data can be displayed any way you want on recall. You are not limited to viewing the data in the same way it was logged. This is a major advantage and allows you to actually store and recall far more parameters than can be displayed at any one time.

The same rules apply when data is output to a PC running AquaLink Software via the USB cable. The data that is output is always as per the Meter's current configuration. You can output the data as many times as you like in various Meter configurations.

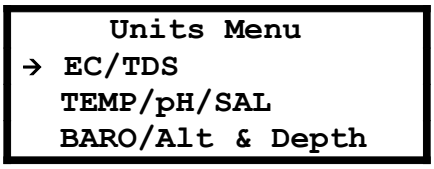
9. Setup & Install

To alter the way the Aquameter® 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 a Probe is connected.



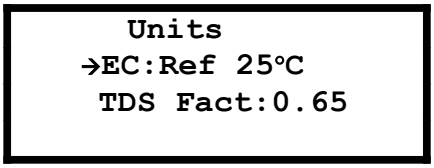
9.1. Setting Units of Measurement

From this screen choose **Units**. The Units Menu will be displayed. Remember, you can use just the arrow keys to navigate through the branches of the menus. You don't need to press **OK** or **ESC** at each level.



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

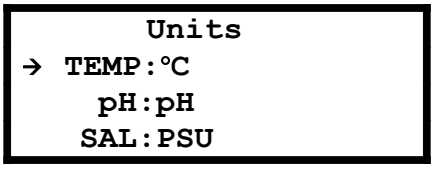
Moving the cursor right onto the first line will display the following screen.



The first 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 20°C [Ref 20°C], as 'Specific EC' referenced to 25°C [Ref 25°C] 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.



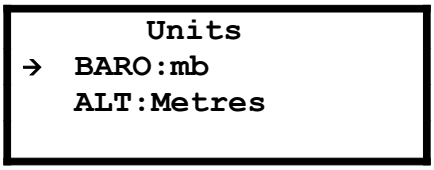
The first option on this screen allows you to change the temperature display between °C and °F.

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.

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 (-D models 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.

9.2. AUX Socket Assignment (not applicable to the AP-700)

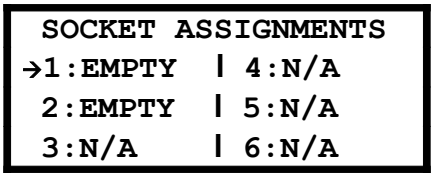
The AP-800 features one, and the AP-2000 features two AUX (axillary) sockets into which additional electrodes may be fitted. AUX socket 1 can be fitted with either AP-2000 Optical electrodes or AP-5000/7000 type ISE (Ion Specific) electrodes. AUX socket 2 can be fitted with AP-2000 type ISE electrodes only.

When an electrode has been fitted to an AUX socket (see appendix 3 for fitting instructions), the socket must be assigned to the specific electrode type.

The Socket Assignment option is only available if the Aquameter® is connected to a Probe. This is because the assignment data is held in the Aquaprobe®, not in the Aquameter®.

When the Socket Assignment option has been selected, the following screen will be displayed.

The numbers 1 – 6 represent the AUX socket numbers. Only socket 1 is available on the AP-800 and sockets 1 and 2 on the AP-2000. Unavailable sockets are shown as N/A. The additional sockets are available on larger Probes.



Using the up and down arrow keys, select the AUX socket you wish to assign then move the cursor to the right by pressing the right arrow key. When the cursor has moved to the right of the AUX socket number, use the up and down arrow keys to select the appropriate electrode type.

The tables below show the available electrode options and the selection that should be made on this screen:

AP-2000/5000 type Optical Electrodes (AUX1 only)

Electrode Part No.	Function	Aquameter® Selection
2000-TURB	Turbidity	TURB
2000-CPHYLL	Chlorophyll	Cphl
2000-BGA-PC	Phycocyanin (Blue-Green Algae PC)	BGA-PC
2000-BGA-PE	Phycoerythrin (Blue-Green Algae PE)	BGA-PE
2000-RHOD	Rhodamine WT Dye	Rhod
2000-FSCEIN	Fluorescein Dye	Fcein
2000-REFOIL	Refined Oil	R-OIL
2000-CDOM	CDOM/FDOM	CDOM

AP-5000/7000 type ISE Electrodes (AUX1 only)

Electrode Part No.	Function	Aquameter® Selection
7000-AMM	Ammonium/Ammonia	NH4
7000-CHL	Chloride	Cl
7000-FLU	Fluoride	F
7000-NIT	Nitrate	NO3
7000-CAL	Calcium	Ca2

AP-2000 type ISE Electrodes (AUX2 only)

Electrode Part No.	Function	Aquameter® Selection
2000-AMM	Ammonium/Ammonia	NH4
2000-CHL	Chloride	Cl
2000-FLU	Fluoride	F
2000-NIT	Nitrate	NO3
2000-CAL	Calcium	Ca2

When the desired electrode type is showing, move the cursor back to the left of the socket number then press OK to send the selection to the Aquaprobe®. The socket assignments are stored in the Aquaprobe®. If you press the ESC key whilst in this screen, any changes you have made will not be transferred to the Aquaprobe®. **Please note: changing an AUX Socket assignment will clear all the calibration data for that socket.**

If you subsequently remove an electrode, be sure to set the socket assignment back to EMPTY.

10. RapidCal 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 Aquameter® in order to allow normal field operatives (as opposed to trained lab technicians) to achieve quick and accurate results.

As a general rule, pH and EC should be calibrated as close to 25ºC as possible. Optical electrodes should be calibrated as close to their deployment temperature as possible.

In order to standardise calibration techniques, Aquaread® provide plastic calibration bottles into which the Aquaprobe® can be directly inserted. The Aquaprobe® is designed to be calibrated in these calibration bottles **with the Probe Sleeve and Sleeve End Cap fitted.**

The Probe Sleeve and Sleeve End Cap form an integral, working part of the Probe's measurement system, and MUST be fitted during calibration and measurement for correct operation. See section 2.3. Important Information about the Probe Sleeve & Sleeve End Cap for further details.

10.2. Special Notes Concerning ISE Electrodes

The high ionic concentration of pH calibration solutions (buffers), including RapidCal, can cause significant offsets in ISE electrodes. ISE calibration solutions other than those for that specific ISE can contain interfering ions, again causing offsets.

These offsets are temporary, but best avoided because they can cause significant errors during both calibration and normal operation.

For this reason all ISE electrodes are supplied with a red rubber sealing cap.

The caps should be fitted to all ISE Electrodes when using pH calibration solutions or other ISE calibration solutions other then that specific for the ISE being calibrated in order to protect the ISE electrodes from the effects of the buffer solution and interfering ions.

10.3. Using RapidCal

RapidCal calibrates EC at 2570µS/cm, the pH7.00 point and the zero point of all optical electrodes (except Turbidity) simultaneously. Ideally, this procedure should be carried out at the beginning of each day the Probe is to be used. In addition, you should check the DO 100% calibration point and zero the Turbidity electrode if fitted. To use RapidCal:

1. Remove the lid from a fresh bottle of RapidCal solution, remove the storage cap from the pH electrode if fitted, wash the Probe in distilled water, ensure the Probe Sleeve and End Cap are fitted, then drop the Probe into the RapidCal solution. Bang the Probe against the bottom of the bottle several times in order to remove any air

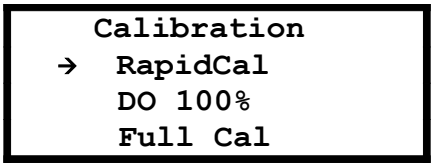
bubbles that may be clinging to the electrodes.

2. When the Probe is inserted, ensure the level of the solution is at least up to the minimum insertion line scribed around the Probe sleeve. 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 RapidCal solution.

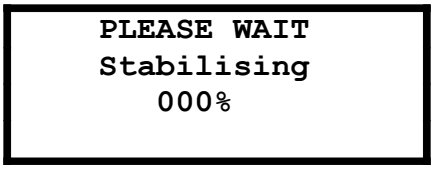
3. Switch the Aquameter® on and wait until all readings are **completely** stable. The longer you can leave the probe to achieve thermal equilibrium before proceeding, the better.

4. Ensure the temperature of the solution is between 5ºC and 40ºC (41ºF – 104ºF). The closer to 25ºC the better.

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



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



The Meter will wait until all readings are stable, then it will send the RapidCal 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 checked and if necessary, calibrated in damp air.

To Check / Calibrate the 100% DO Saturation Point in Damp Air

1. After calibrating with RapidCaL, 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 and DO measurements are completely stable**. This is very important.** If the DO measurement is 100% +/- 1%, there is no need to recalibrate.

4. If recalibration is needed, refer back to the screen shown in item 5 above and select **DO 100%.**

5. Wait while the Aquameter® 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.

Finally, if you have a Turbidity electrode fitted, you should calibrate the zero point now using fresh, still mineral water. Refer to section 16.4.7. Turbidity Zero Point Calibration .

10.4. Calibration Error Messages

If the Aquameter® detects a problem with either the Aquaprobe® 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	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 RapidCal Allow longer for stabilisation.
OUT OF CAL RANGE	Readings are outside calibration limits (can be caused by low level / incorrect calibration solution). Or the Probe Sleeve is not fitted	Top up / check calibration solution is correct type. Ensure the Probe Sleeve is fitted
OUT OF TEMP RANGE	Temperature is outside 5°C – 40°C limit	Warm / cool the RapidCal
CAL ZERO FIRST	You are trying to calibrate an upper calibration point on an optical electrode without first calibrating the zero point in the current calibration session.	Calibrate the zero point first, then without switching the Aquameter off, calibrate the upper point.

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 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. 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 EC, check you are using the correct EC Calibration Standard and that the Probe Sleeve is fitted and tight.

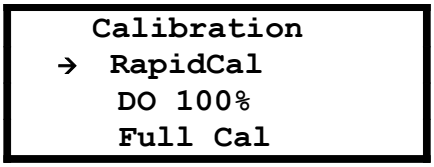
If the 'OUT OF CAL RANGE' error persists when calibrating pH, check you are using the correct pH Calibration Standard for the calibration point selected.

If the 'OUT OF TEMP RANGE' error persists when carrying out a three point ISE calibration, check your solution temperatures are within the specified limits with respect to each other.

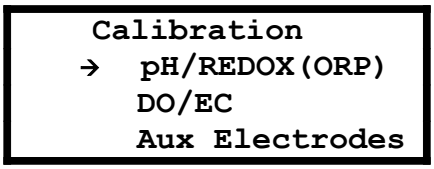
Remember: **The Probe sleeve forms an integral, working part of the Probe's measurement system, and MUST be fitted during calibration and measurement for correct operation. If you try to calibrate the Probe without the sleeve fitted, you may get an error message.**

10.5. 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:

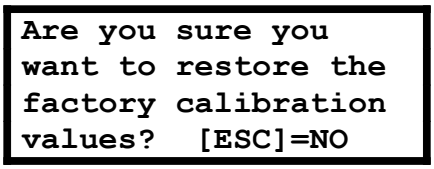


Select Full Cal. This will give you a choice of three electrodes:



Move the cursor arrow to the electrode you want to reset, then press the **MR** key. If you select Aux Electrodes, you must press OK first to enter the Aux Electrode selection screen. Once in that screen, select the Aux electrode you want to reset then press **MR**.

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.

10.6. 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.

10.7. Calibration Data Storage and Retrieval

The Aquaprobe® 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.

In order to recall the calibration data for a certain electrode on the Meter, first select the calibration screen for that electrode. If, for instance, you selected pH/REDOX(ORP), the screen below would be displayed.

```
 PH 7.00 [31/Jan/17]
 PH 4.01 [07/Feb/17]
 PH 10.0 [07/Feb/17]
ORP+250 [09/Feb/17]
```

This tells you that the last successful calibration was January 31st for the pH 7.00 point, February 7th for the pH 4.01 & pH 10 points and February 9th for ORP. If the date field is dashed (==/===/==), this means the electrode is either not fitted or has never been calibrated.

Pushing the left or right arrow keys will toggle this screen with the calibration report screen.

```
 PH7 Offset:+01.2mV
 PH4 Slope:56.8mV/pH
PH10 Slope:56.3mV/pH
 ORP Offset:-02.6mV
```

The calibration report screen displays the calibration report values from the last calibration.

To exit this screen press the **ESC** key.

11. After Use

The Aquaprobe® should always be cleaned after every use.

It is advisable to clean the Probe after use with the cable attached. This will prevent any water entering the Probe's socket and will allow any deposits to be removed from the connector collar and shell.

The Sleeve on the Aquaprobe® can be removed by unscrewing to allow cleaning of the individual electrodes. After every use, remove the protective Sleeve End Cap then unscrew the sleeve. 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!

Rinse the exposed electrodes, the inside of the Sleeve and the Sleeve End Cap with fresh, clean water. Shake the water from inside the Sleeve, then reattach. Dry the outside of the Probe using a soft cloth.

Remember to replace the pH/ORP 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 connector O-rings and thread, Sleeve thread, the protective Sleeve End Cap O-ring and the inside rim of the lower Probe Sleeve will make fitting and removal of these parts easier.

12. General Probe Maintenance

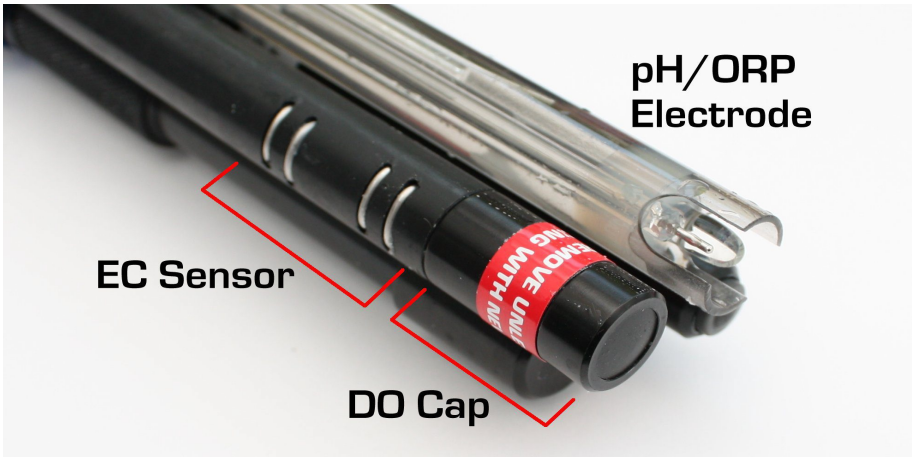
Other than regular cleaning and calibration, very little in the way of maintenance is needed.

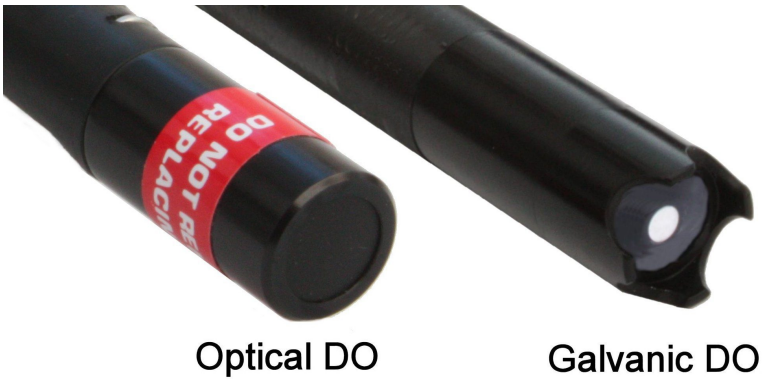
12.1. Identifying The Individual Electrodes

The photograph below shows the standard AP-2000 electrodes. On the AP-2000, the DO and EC sensors are incorporated into one electrode.

On the AP-700 and AP-800, the DO and EC sensors are separate electrodes.

Please note: The photograph shows the AP-2000 with Optical DO. The AP-700 and AP-800 models may have either Optical DO or Galvanic DO sensors.





Galvanic DO caps and later model Optical DO caps do not have the red warning label fitted to the DO cap.

13. pH/ORP Electrode Calibration and Maintenance

13.1. Recognising the pH/ORP Electrode

The combined pH/ORP electrode is easy to recognise because it is the only electrode that is not black. This electrode has a clear, gel filled body.

13.2. Electrode Removal and Replacement

The pH/ORP electrode can be unscrewed from the Probe body by rotating it anti-clockwise. When replacing an electrode, apply a little silicone 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 red lanyard that is attached to the pH/ORP storage cap makes a very useful belt wrench for tightening and loosening the pH/ORP and AUX electrodes.

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

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

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 and/or pH 10.00. The Aquaprobe® allows for both two and three point pH calibration. Should you decide to carry out just a two point calibration, the probe will automatically calculate and save a calibration value for the uncalibrated third point in order to maintain the electrode's linearity over the full range of 0 – 14.

For best results, calibrate all three points as close to 25°C as possible.

13.5. Special Notes Concerning ISE Electrodes

The high ionic concentration of pH calibration solutions (buffers), including RapidCal, can cause significant offsets in ISE electrodes. ISE calibration solutions other than those for that specific ISE can contain interfering ions, again causing offsets.

These offsets are temporary, but best avoided because they can cause significant errors during both calibration and normal operation.

For this reason all ISE electrodes are supplied with a red rubber sealing cap.

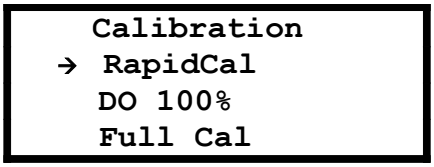
The caps should be fitted to all ISE Electrodes when using pH calibration solutions or other ISE calibration solutions other then that specific for the ISE being calibrated in order to protect the ISE electrodes from the effects of the buffer solution and interfering ions.

13.5.1. Calibrating the First Point (pH 7.00)

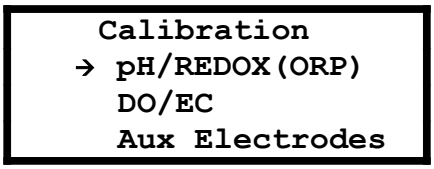
Due to the way in which pH calibration works, **the Probe must be calibrated at pH7.00 before calibrating at pH 4.01 or pH 10.00**. **Never calibrate at pH 4.01 or pH 10.00 before first calibrating at pH7.00.**

To calibrate the pH electrode follow these steps:

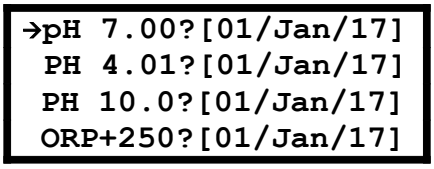
1. Fill a calibration bottle with fresh pH 7.00 solution or RapidCal, remove the storage cap from the pH electrode, wash the Probe in distilled water, then drop the Probe in all the way.
2. Switch the Aquameter® on and wait until the temperature and pH measurements are completely stable.
3. Ensure the 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:

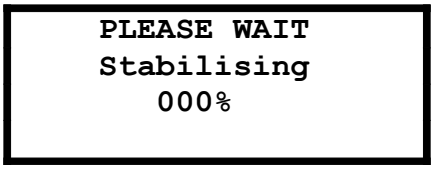


6. Select **pH/REDOX(ORP)**. The screen will change to:

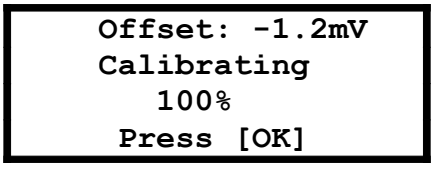


The dates shown to the right of the screen are the dates of the last successful calibration.

7. 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 25°C, the pH electrode should be serviced.

This value is stored in the Probe's memory and can be recalled at any time. See section 10.7. Calibration Data Storage and Retrieval. 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.

13.5.2. Calibrating the Second Point

The pH electrode can now be calibrated at either pH 4.01 or pH 10.00. **If you intend to calibrate at both pH 4.01 and pH 10.00, both points must be calibrated in the same session, i.e. without turning the power off.**

If the power is removed after calibrating just one additional point (pH 4.01 for example), the probe will automatically calculate and save a calibration value for the uncalibrated third point in order to maintain the electrode's linearity.

To calibrate the second point, fill a calibration bottle with fresh pH 4.01 or pH 10.00 solution and drop the Probe in all the way. Follow the procedure detailed above, but at step 6, select either pH4.01 or pH10.0, dependent upon the solution you are using. 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.

13.5.3. Calibrating the Third Point

Without switching the Aquameter® off or disconnecting the Probe, fill a calibration bottle with fresh pH 4.01 or pH 10.00 solution and drop the Probe in all the way. Follow the procedure detailed above, but at step 6, select either pH4.01 or pH10.0 dependent upon the solution you are using. 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.

13.6. Errors During Calibration

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

13.7. 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.

13.8. 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 Aquaprobe® 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.

13.9. Calibrating ORP

ORP electrodes should be calibrated at least once a month to ensure optimum accuracy. Full calibration involves calibrating at a single point, either +250mV (at 25°C) using a +250mV ORP calibration standard such as **Reagecon RS250 Redox Standard,** or +229mV (at 25°C) using a +229mV ORP calibration standard such as Zobell Solution.

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.

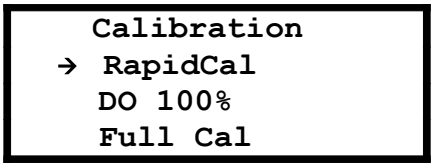
To calibrate the ORP electrode follow these steps:

1. Fill a 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.

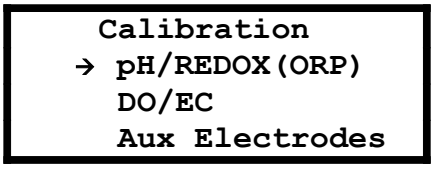
2. Switch the Aquameter® on and wait until the temperature and ORP measurements are completely stable.

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

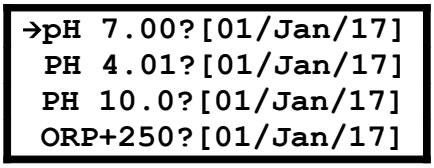
4. Press the **MENU** key then select **Calibration.** The following screen will be displayed.



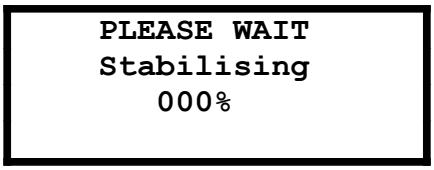
5. Select **Full Cal.** The screen will change to:



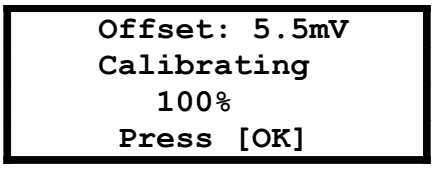
6. Select **pH/REDOX(ORP)**. The screen will change to:



7. Move the arrow to the bottom line. If you are using 250mV calibration solution press the OK key to continue. If you are using 229mV calibration solution, move the cursor to the right, then use the up/down arrow keys to select +229. When the correct solution has been selected, press OK. 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 stored in the Probe's memory and can be recalled at any time. See section 10.7. Calibration Data Storage and Retrieval. Press **OK** then **ESC** repeatedly to return to normal reading 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.

13.10. 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 Aquaread® combination electrodes is a 3MPK1 silver chloride type, and exhibits potentials on the hydrogen scale of:

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

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

14. DO Electrode Calibration and Maintenance

14.1. Recognising the DO Electrode Type

All AP-2000 Aquaprobes are fitted with Optical DO electrodes. The AP-700 and AP-800 may be fitted with either an Optical DO or Galvanic DO electrode. Refer to the photograph on the right to identify your DO electrode type. If your Aquaprobe® features an Optical DO electrode, skip to section 14.6..

14.2. Galvanic DO Electrode

The Galvanic DO electrode consists of an electrolyte filled DO sensor cap with a clear, gas-permeable membrane stretched across a silver electrode.

14.3. Precautions During Use

In order to achieve accurate Dissolved Oxygen readings with the Galvanic DO electrode, 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.**

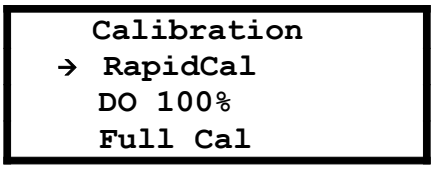
14.4. Calibrating the Galvanic DO Electrode

The DO 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 5°C - 40°C).

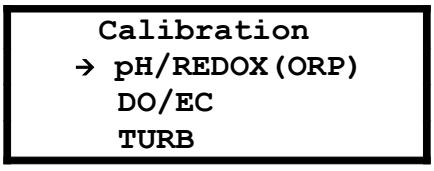
If you are going to calibrate both the Zero and 100% points at the same time, **ALWAYS calibrate the Zero point first**, then the 100% point.

14.4.1. Calibrating the DO Zero Point

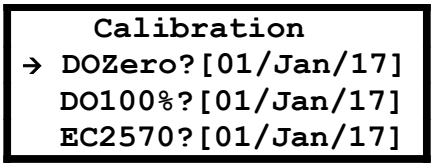
1. Remove the lid from a 150mL bottle of DO Zero calibration solution, remove the storage cap from the pH electrode if fitted, wash the Probe in distilled water, then drop the Probe in all the way.
2. Switch the Aquameter® on and wait until the DO reading is **completely stable**.
3. Ensure the temperature of the solution is between 5°C and 40°C (41°F - 104°F).
4. Press the **MENU** key then select **Calibration. T**he following screen will be displayed.



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

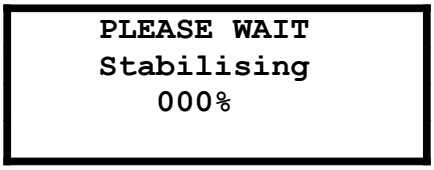


6. Select **DO/EC**. The screen will change to:

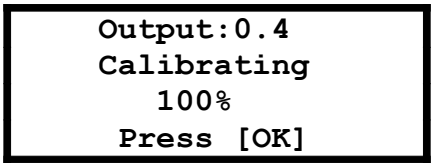


The dates shown to the right of the screen are the dates of the last successful calibration.

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.



The Calibration Report on the top line will display the voltage output from the DO cell in millivolts (mV). Please contact Aquaread for current acceptable calibration values.

This value is stored in the Probe's memory and can be recalled at any time. See section 10.7. Calibration Data Storage and Retrieval. 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 Calibration Error Messages in section 10.4 for error message handling. If If the 'OUT OF CAL RANGE' error persists when calibrating the DO sensor, replace the DO Electrode Membrane 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.

14.4.2. 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 Aquameter® on and wait until the temperature measurement is completely stable. **This is very important.**
4. Referring back to the screens shown in item 6 above, select **DO100%**
5. Wait while the Aquameter® carries out the calibration procedure.
6. When calibration is complete, the Calibration Report will be displayed.

The top line will display the voltage output from the DO cell in millivolts (mV). This value should be over 20.0 (at 25°C). If the value returned is less than 20.0, the 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 Calibration Error Messages in section 10.4 for error message handling.

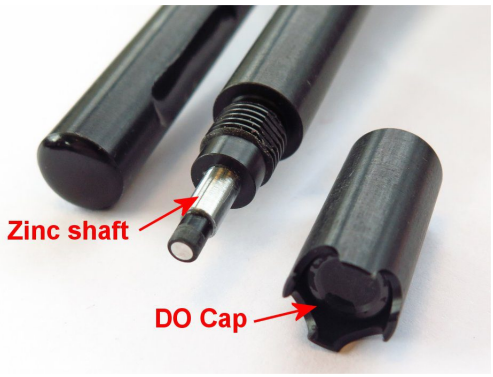
14.5. Replacing a Galvanic DO Electrode Membrane Cap

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 Probe sleeve.
2. Unscrew the DO Cap from the end of the DO electrode by rotating it anti-clockwise.
3. Gently scrape away any soft grey deposits from the zinc shaft of the electrode taking care not to damage the electrode in the process. If the deposits are hard and dry, soak the electrode in DO filling solution until the deposits soften up, then remove them.
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 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.

NEVER 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.

Please note: After a period of use and dependant upon how previous cleaning operations have been performed, the surface of the zinc shaft will become rugged and apparently corroded. This is entirely normal and will not affect the performance of the electrode.

14.6. Optical DO Electrode

If your Aquaprobe® is fitted with an Optical DO electrode, the following sections apply. See Appendix 1. The Tech Behind Aquaread's Optical DO Measurement System for more technical details of the Optical DO measurement system.

Unlike the Galvanic DO electrode, the Optical DO electrode does not consume oxygen during operation so does not require a constant flow of water or stirring.

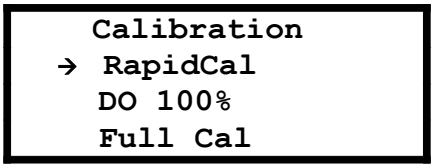
14.7. Calibrating the Optical DO Electrode

The DO 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 5°C - 40°C).

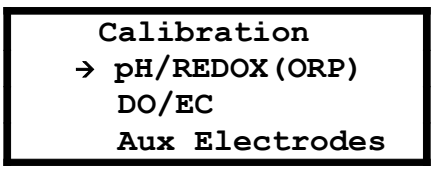
If you are going to calibrate both the Zero and 100% points at the same time, **ALWAYS calibrate the Zero point first**, then the 100% point.

14.8. Calibrating the DO Zero Point

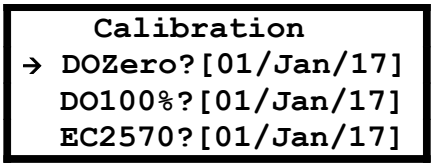
1. Remove the lid from a 150mL bottle of DO Zero calibration solution, remove the storage cap from the pH electrode if fitted, wash the Probe in distilled water, then drop the Probe in all the way.
2. Switch the Aquameter® on and wait until the DO reading is completely stable.
3. Ensure the temperature of the solution is between 5°C and 40°C (41°F - 104°F).
4. Press the **MENU** key then select **Calibration.** The following screen will be displayed.



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

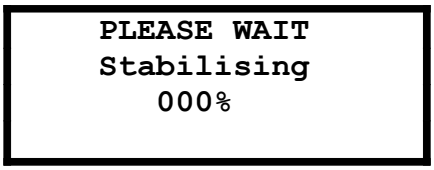


6. Select **DO/EC**. The screen will change to:

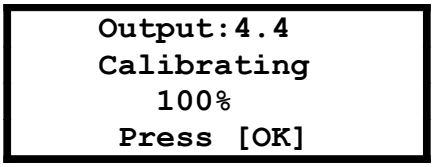


The dates shown to the right of the screen are the dates of the last successful calibration.

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.



The top line will display a value which represents the health of the luminophore. This value should be between 3.5 and 4.7 (at 25°C). If the value returned is less than 3.5, the Optical DO Cap should be replaced.

This value is stored in the Probe's memory and can be recalled at any time. See section 10.7. Calibration Data Storage and Retrieval. 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 Calibration Error Messages in section 10.4 for error message handling.

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.

14.9. 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 Aquameter® on and wait until the temperature measurement is completely stable. **This is very important.**
4. Referring back to the screens shown in item 6 above, select **DO100%**
5. Wait while the Aquameter® carries out the calibration procedure.
6. When calibration is complete, the Calibration Report will be displayed.

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 Calibration Error Messages in section 10.4 for error message handling.

14.10. Replacing the Optical DO Cap

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 every few 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 ten years dependent upon the amount of use it gets.

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.

15. EC / Temperature Electrode Calibration and Maintenance

EC calibration is always carried out at a single point. There is a choice of two pre-set calibration standards or you can enter any calibration standard value between 100µS/cm and 99,999µS/cm manually.

The pre-set standards are: Aquaread® RapidCal (EC value 2570µS/cm) and Aquaread® SC-35 (35ppt sodium chloride solution), which is specifically for use when measuring EC and salinity in sea water.

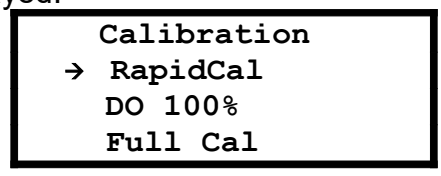
The calibration solution value you use to calibrate EC should always be chosen to be as near to the readings you expect to see in the field as possible. If you are not sure what values to expect, RapidCal is a good choice as this will give reasonably accurate readings across a wide range of EC values.

SC-35 calibration solution is available from Aquaread® dealers or can be made by adding 35 grams of laboratory grade sodium chloride (99.9% pure) to a 1 Litre volumetric flask and topping it up with DEIONISED water (approx 965g of water) to make 1Litre.

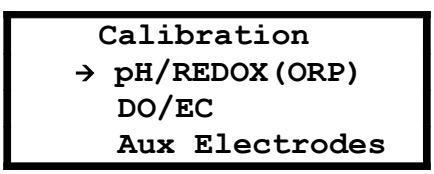
The Probe sleeve forms an integral, working part of the Probe's EC measurement system, and MUST be fitted during calibration and measurement for correct operation.

For best results, calibrate as close to 25ºC as possible. The probe will compensate for temperature variation in the Calibration Standard during calibration.

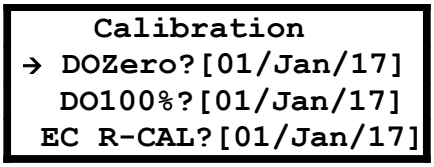
1. Remove the storage cap from the pH electrode if fitted, wash the Probe in distilled water, then drop the Probe into a calibration bottle filled with your chosen EC Calibration Standard.
2. **Ensure the liquid level is all the way up to the neck of the bottle.** **Low liquid level will result in erroneous EC calibration.**
3. Switch the Aquameter® on and wait until the temperature and EC measurements are completely stable.
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 **Full Cal.** The screen will change to:

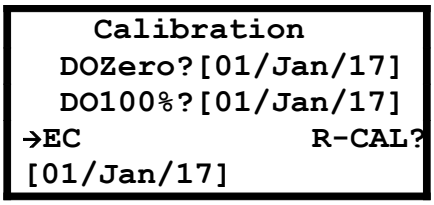


7. Select **DO/EC**. The screen will change to:



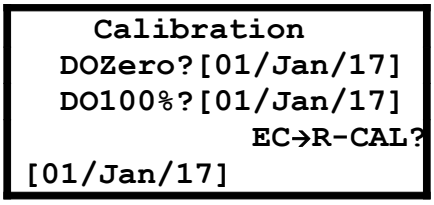
The dates shown to the right of the screen are the dates of the last successful calibration. The value shown on the bottom line next to 'EC' is the value the EC electrode was last calibrated to.

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



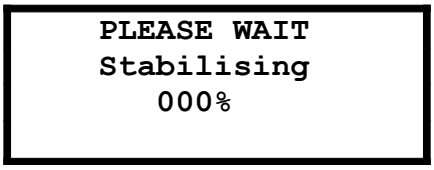
If the Calibration Standard value you are using is already displayed, press the **OK** key to start calibrating. Remember, if you are using RapidCal solution, the EC value on this line should be R-CAL.

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:

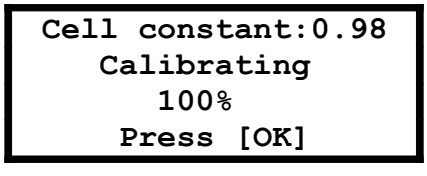


You can now use the up and down arrow keys to select one of two pre-set EC Calibration Standard values (R-CAL or SC-35) or to input any calibration standard value between 100µS/cm and 99,999µS/cm. **The value you input should be the calibration solution's EC value at 25ºC.**

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



10. 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. This value is stored in the Probe's memory and can be recalled at any time. See section 10.7. Calibration Data Storage and Retrieval. Press OK then ESC repeatedly to return to normal reading mode.

Special Notes:

- If you have selected a Calibration Standard value other than R-CAL, then you subsequently use the RapidCal calibration technique described in section 10, the Calibration Standard value will automatically be reset to R-CAL.
- 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.

15.1. 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 ten 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 9.1 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.

15.2. 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 Calibration Error Messages in section 10.4 for error message handling.

15.3. Cleaning the EC Contacts

On a regular basis, 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 Probe sleeve and re-calibrate.

15.4. Calibrating Temperature

The Aquaprobe's temperature sensor is built into the oval resin pocket located on the back

of the EC sensor. The temperature sensor is extremely linear and by default is set up to read within +/- 0.5°C of the true temperature, which is ample for most applications.

If, however, your application requires a better absolute temperature accuracy, you can re-calibrate the temperature sensor to the nearest 0.1°C by applying a temperature offset.

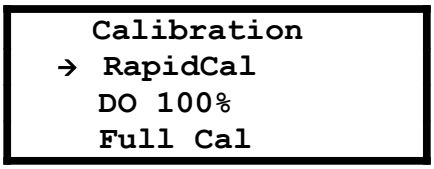
To calibrate the temperature sensor, remove the sleeve from the Aquaprobe® then set the Probe up in a container of water with a known temperature. This would normally be a temperature controlled bath that is fitted with a calibrated thermometer and a circulation device.

The Aquaprobe® can be calibrated at any temperature you choose, and should be calibrated as close as possible to the typical temperatures that will be encountered during normal use.

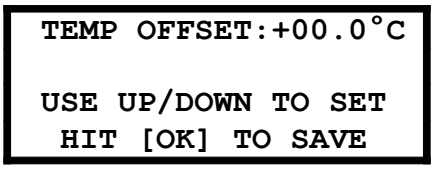
Once the Aquaprobe® is set up in the water bath, switch the Aquameter® on wait until the temperature reading has been **completely stable** for at least five minutes.

Make a note of the temperature displayed on the Aquameter® and compare this to the actual temperature of the water bath as displayed by the calibrated thermometer.

Now select the Calibration screen on the Aquameter®.



When this screen is being displayed, press the 'up arrow' key eight times in quick succession. This will cause the hidden Temperature Offset screen to be displayed.



Now, using the up and down arrow keys, set the temperature offset that is required to correct the temperature reading.

For example, if the water bath is set to 25.0°C and the Aquameter® is displaying 24.80°C, you should input an offset (or correction) of +00.2°C.

Alternatively, if the water bath is set to 25.0°C and the Aquameter® is displaying 25.30°C, you should input an offset (or correction) of -00.3°C.

When you have input the desired offset, hit the OK key. Now return to the temperature measurement screen. If the offset has been correctly input, the Aquameter® will now be reading the corrected temperature.

The temperature correction offset is stored in the Aquaprobe® and applied at all times going forward.

16. Optional Optical Electrodes Calibration and Maintenance

The Aquaprobe® is constructed with an aluminium sleeve surrounding the delicate sensing electrodes. The Sleeve can be easily removed by unscrewing to allow cleaning of the individual electrodes, however, **the Probe sleeve forms an integral, working part of the Probe's measurement system, and MUST be fitted for correct operation.**

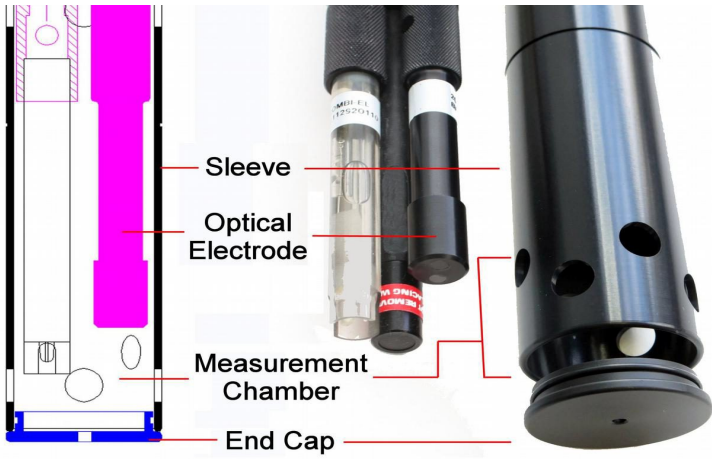
All Aquaread® Optical Electrodes are incredibly sensitive. For example, the Turbidity electrode is capable of measuring between 0 and 3000NTU with an internal resolution of greater than 0.1NTU. This means that the electrode is able to detect changes in turbidity that are less than 0.003% of the full range! The other optical electrodes have a similar level of sensitivity.

It follows, therefore, that in order to provide stable, repeatable readings, the environment in which the measurements are made must be completely stable and repeatable.

For this reason, the Aquaprobe® is constructed with a matt black aluminium sleeve and end cap that enclose the sensing electrodes and provide a closed, constant condition, non reflective measurement chamber.

This is essential for the correct calibration and operation of all types of optical electrodes.

A diagram of the Aquaprobe's measurement chamber is shown here. Please note, the design of the End Cap may vary depending upon the age and model of your Aquaprobe.



In order to obtain consistent results, the measurement chamber created within the Aquaprobe® must remain physically constant during both calibration and measurement.

If the optical electrode is calibrated under one set of conditions then used to measure under another set of conditions, the readings will naturally be erroneous, especially at low concentrations.

A perfect example of this is calibrating with the end cap removed then measuring with the end cap fitted (or vice-versa). By changing the physical characteristics of the measurement chamber, you also change the calibration and response of the electrode.

Always zero the optical electrodes just prior to use in clean water (bottled still mineral water is ideal) then deploy **without disturbing the measurement chamber**. This is especially important when using the Turbidity electrode, which can display negative readings if the zero point is not correctly calibrated.

16.1. Top Tips for successful measurements using optical electrodes

- Always keep the measurement chamber and electrode lenses clean.
- Always fit the sleeve and end cap during both calibration and measurement.
- Always allow the readings to settle completely during both calibration and measurement.
- Always try to eliminate air bubbles by agitating the Probe after insertion both during calibration and measurement.
- Always calibrate and zero the electrode as close to your sample temperature as possible. This is especially important with the Ref-Oil electrode.
- Always zero the optical electrodes just prior to use in clean water (bottled still mineral water is ideal) then deploy **without disturbing the measurement chamber**. This is especially important when using the Turbidity electrode.

16.2. Optical Electrode Calibration Sequence

Optical electrodes feature either two or three point calibration, dependent upon the type. In all cases however, the lower calibration points is ZERO.

When calibrating any optical electrode, **the Zero point must be calibrated first.**

If you are performing a two or three point calibration, all calibration points must be calibrated within the same calibration session (i.e. without turning the Aquameter® off or disconnecting the Aquaprobe®).

If you attempt to calibrate an upper calibration point without first calibrating the ZERO point, a calibration error will occur.

16.3. Fluorescent Electrode Grab Sample Correction Factor

A unique feature of the Aquaread® fluorescent type electrodes is the ability to include a correction factor based upon a grab sample.

If grab sample data is available, a Grab Sample Factor (GS Factor) can be input on the calibration screen of each fluorescent type electrode in order to improve the accuracy of future readings from that electrode.

See the individual fluorescent electrode calibration sections for more details of the unique GS Factor.

16.4. 2000-TURB Turbidity Electrode

Turbidity can be measured by the Aquaprobe® using the optional 2000/5000-TURB optical electrode.

This electrode employs a Nephelometric technique in accordance with ISO 7027, which uses Formazin as a reference standard. The Aquameter® displays turbidity in Nephelometric Turbidity Units (NTU) which are nominally equivalent to Formazin Turbidity Units (FTU).

Turbidity can be calibrated with either Formazin Turbidity Standards or Suspended Polymer Turbidity Standards, depending upon your preferred turbidity reference. Be aware, these two standards will give very different results. **The 20 NTU and 1000 NTU points must both be calibrated in the same type of Standard. If you use Formazine for one point and Polymer for the other, large errors will occur.**

16.4.1. 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.

If you experience any problems using the Turbidity Electrode, refer to Appendix 7. Troubleshooting Turbidity.

16.4.2. Turbidity Electrode Installation

The turbidity electrode should be installed in accordance with the notes in Appendix 3. Fitting AUX Electrodes. The turbidity electrode, when fitted, sits adjacent to the optical DO electrode.

16.4.3. Precautions During Use

In common with all other submersion type Turbidity Probes, air bubbles and stray reflections can be a problem when trying to measure low turbidity values. In order to avoid air bubbles, keep the Turbidity electrode clean, and agitate the Probe after submersion to dislodge any air bubbles which may be clinging to the lenses. In order to maintain a common reflective pattern between calibration and use, **always calibrate and measure turbidity with the protective Sleeve End Cap fitted**.

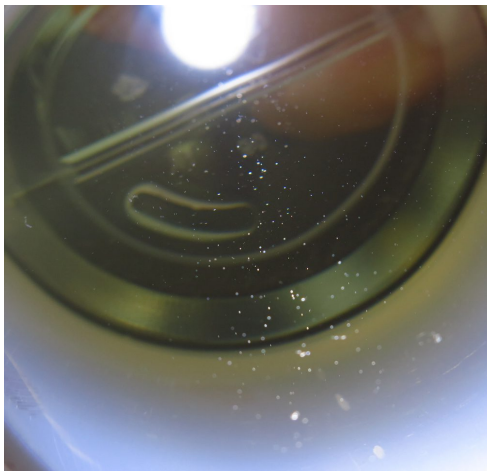
16.4.4. Negative Turbidity Readings

When a Probe is deployed in clean/clear water and negative turbidity readings occur, the cause is usually an erroneous zero point calibration, caused either by contaminated calibration solution, aeration or changes in the measurement chamber between zeroing and deployment.

It follows that if the Probe has been zeroed in a solution that has a turbidity greater than true zero, subsequent measurements taken in a less turbid sample will be displayed as negative. If you experience negative turbidity readings, thoroughly clean the Probe then re-zero in completely clean water. Still, bottled mineral water is recommended for zeroing the electrode as it is cheap and readily available. **Never use sparkling or carbonated water.**

If you still experience negative turbidity readings and you are certain that your zero calibration solution is completely clear water, the problem is almost certainly aeration, i.e. air in the form of both visible and microscopic bubbles. These act like tiny prisms and can refract and reflect both the excitation light and the return signal being measured.

The photograph to the right was taken in a calibration bottle after fresh water was poured in. The bubbles are clearly visible in the light beam. This level of aeration will register the equivalent of around 5NTU as each bubble is seen as a solid particle.



If your zero calibration water is aerated, allow it to stand for a while until the air has all dispersed, then re-insert the Probe and re-calibrate. **Do not leave the Probe sitting in aerated water, the bubbles will simply cling to the inside surface of the Probe and make the problem worse.**

16.4.5. Calibrating the Turbidity Electrode

The Probe Sleeve and Sleeve End Cap form an integral, working part of the Probe's turbidity measurement system, and MUST be fitted during calibration and measurement for correct operation.

16.4.6. Calibration Points

Turbidity electrodes have three calibration points. Careful calibration is essential in order to ensure consistent and reliable results across the full measurement range.

When a turbidity electrode is first installed, **it MUST be calibrated at the Zero NTU and 1000NTU points** in order to establish the individual electrode's slope. **The Zero NTU point must always be calibrated first, followed by the 1000NTU point, both within the same calibration session (i.e. without turning the Aquameter® off).**

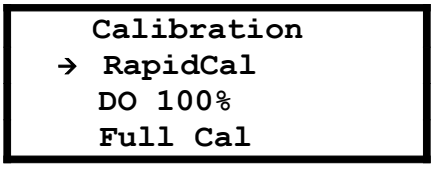
The third calibration point (20NTU) is optional and can be used if enhanced accuracy is required at very low levels.

The Turbidity electrode should subsequently be Zeroed (calibrated at the Zero NTU point) before each day's use. A three point calibration should be carried out once a month to ensure optimum accuracy.

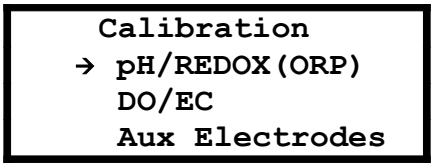
16.4.7. Turbidity Zero Point Calibration

To calibrate the Turbidity zero point (zero the electrode), follow these steps:

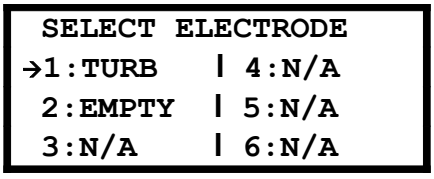
1. Three-quarters fill a calibration bottle with clean water (bottled still mineral water is recommended), remove the storage cap from the pH electrode if fitted, wash the Probe in clean water, then drop the Probe in all the way. **The Sleeve End Cap must be fitted**. Agitate the Probe and swirl the bottle several times in order to remove any air bubbles that may be clinging to the Turbidity electrode.
2. Switch the Aquameter® 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. Agitate the Probe 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.



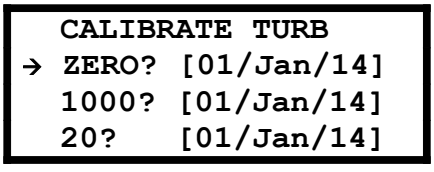
5. Select **Full Cal.** The screen will change to:



6. Select **Aux Electrodes**. The screen will change to:

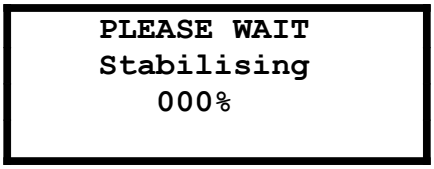


The TURB electrode should have been assigned to AUX socket 1 when it was fitted. Press the OK or right arrow key to select TURB. The screen will change to:



The dates shown to the right of each point 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 output from the Turbidity Receiver Electrode in millivolts (mV). This value is stored in the Probe's memory and can be recalled at any time. See section 10.7. Calibration Data Storage and Retrieval. Press OK then ESC repeatedly to return to normal reading mode.

16.4.8. Verifying the Zero Calibration

An accurate zero point calibration is essential to the correct operation of the turbidity electrode. The zero point calibration can sometimes be erroneous due to small air bubbles or microscopic suspended solids in the calibration solution. For this reason, it is important to verify the zero point calibration before proceeding to calibrate the other points.

After calibrating the zero point, remove the Probe from the calibration bottle then reinsert, agitate and allow the reading to settle. Check the turbidity reading is within +/- 1NTU of zero. If not, re-calibrate the zero point.

16.4.9. Calibrating the Turbidity 20 NTU & 1000 NTU Points

When calibrating the 20 NTU and 1000 NTU points, **the Zero point must be calibrated first within the same calibration session (i.e. without turning the Aquameter® off)**.

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

Gently invert, **do not shake,** a bottle of **20 NTU or 1000 NTU Stabilised Formazin Turbidity Standard** solution (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.

Three-quarters fill a calibration bottle with the solution and drop the Probe in all the way. Again, agitate and swirl the Probe and bottle several times in order to remove any air bubbles that may be clinging to the Turbidity electrode.

Follow the procedure detailed above for Zero point calibration as far as step 6, then select either 20 or 1000, dependant upon the solution the probe is in. 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). Press the **OK** key to continue.

Rinse the probe thoroughly then repeat this procedure for the third point.

16.4.10. Errors During Calibration

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

16.4.11. Lens and Sleeve Maintenance

On a daily basis, the lenses on the electrode should be wiped over with a soft damp cloth.

Similarly, the inside of the Probe Sleeve and Sleeve Cap should be kept clean and free from any deposits that may cause stray reflections.

Never use an abrasive cleaner on the inside of the Probe sleeve or cap as they have 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 the zero point after cleaning the sleeve or lenses.

16.5. 2000/5000-BGA-PC Freshwater Blue-Green Algae (phycocyanin) Electrode

Freshwater Blue-Green Algae (BGA-PC) can be measured by the Aquaprobe® using the optional 2000/5000-BGA-PC optical electrode.

16.5.1. Principle of Operation

The 2000/5000-BGA-PC optical electrode is a submersible, fixed response fluorometer, which provides excitation at 590nm and detects any resultant fluorescence above 655nm.

The electrode induces the phycocyanin to fluoresce, then measures the longer wavelength light which is emitted as a result of the fluorescence process.

16.5.2. Limitations of Use

Determination of BGA-PC in the field using fluorescence measurement techniques will never be as accurate as measurements made in a lab using either cell counting or analysis of molecular phycocyanin after its extraction from cells.

Factors adversely affecting accuracy include:

- Interference from other microbiological species and compounds, which fluoresce at similar wavelengths.
- Differences in the fluorescent response between various species of BGA.
- Differences in the fluorescent response caused by temperature.
- Differences in the fluorescent response caused by ambient light.
- Interference caused by turbidity.

Fluorescence measurement techniques are ideal for researchers who are interested in detecting the presence or absence of a specific substance and measuring relative fluorescence changes that can be used as an indication of increasing or decreasing concentrations.

Fluorescence measurement techniques are not ideal for quantitative measurement. In order to obtain more accurate results, data obtained with the fluorometer in the field should be post-calibrated with data from standard laboratory analysis of grab samples acquired during the study.

If grab sample data is available, a Grab Sample Factor (GS Factor) should be calculated and input on the calibration screen in order to improve the accuracy of future readings.

16.5.3. Calibrating the BGA-PC Electrode

The BGA-PC electrode has two calibration points. Careful calibration is essential in order to ensure consistent and reliable results.

When a BGA-PC electrode is first installed, **it MUST be calibrated at both points** in order to set the electrode's relative sensitivity and establish its slope.

Subsequently, a single point (Zero) calibration should be carried out daily. Full two-point calibration should be carried out every few months.

16.5.4. Calibration Solution Preparation

In order to 'calibrate' (actually, set the relative sensitivity) of the BGA-PC electrode, a 100µg/L calibration solution of fluorescent dye known as Rhodamine WT should be used. This is exactly the same calibration solution that is recommended for calibration of the RHOD electrode.

Please note: there is no direct correlation between Rhodamine concentration and the number of BGA-PC cells/mL. Rhodamine is used as a convenient dye for setting the sensitivity of the sensor. The subsequent display of BGA-PC in terms of cells/mL is a generalisation based on research and experience. The only way to obtain a true value in terms of cells/mL is to correlate the values from the Probe to quantitative data that has been obtained by laboratory analysis of grab samples, then to apply a Grab Sample Factor. See previous 'Limitations of Use' section.

The 100µg/L calibration solution should be freshly prepared by serial dilution from 200g/L standard using deionised water. The following Rhodamine WT standard is recommended:

Part number: 70301027
Description: Rhodamine WT Liquid
Supplier: Keystone Europe Ltd.
Contact: http://www.dyes.com

Be sure to handle chemicals with care and to read and comply with all health and safety advice.

16.5.5. Serial Dilution

The recommended Rhodamine solution is supplied as a 20% or 200g/L solution, dilution of the stock solution should be carried out as follows.

200g/L stock → 100µg/L is recommended to be done as a two step dilution procedure.

Step 1: weigh out 0.5g of 200g/L stock solution in a weigh boat and add this to 1L of deionized water in a volumetric flask, use some of the water from the 1L flask to rinse the weigh boat so no stock Rhodamine remains on the boat. Put a lid on the 1L flask and invert 10 times.

This step results in a 1 in 2000 dilution of the stock. At this point the 1L flask will contain a 100mg/L solution.

Step 2: Transfer 1ml of the 100mg/L solution to a 1L volumetric flask and top up to 1L with deionized water. Put a lid on the 1L flask and invert 10 times.

This step results in a 1 in 1000 dilution of the solution from step 1. The concentration of this solution is 100µg/L. This solution can now be used as Pt-2 calibration of the BGA-PC sensor.

The dilute solution can be stored in a dark bottle in a refrigerator for up to five days. After that time it must be discarded.

16.5.6. Zero Point Calibration

To calibrate the zero point, follow these steps:

1. Fill a calibration bottle with with clean water (bottled still mineral water is recommended), remove the storage cap from the pH electrode if fitted, wash the Probe in clean water, then drop the Probe in all the way. **The Sleeve End Cap must be fitted**. Bang the Probe against the bottom of the bottle several times in order to remove any air bubbles that may be clinging to the electrode.
2. Switch the Aquameter® on and wait until the temperature and BGA-PC readings are stable. If the BGA-PC reading is very high, there are probably air bubbles adhering to the lenses. Bang the Probe against the bottom of the bottle 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.

```
   Calibration
 → RapidCal
   DO 100%
   Full Cal
```

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

```
   Calibration
 → pH/REDOX(ORP)
   DO/EC
   Aux Electrodes
```

6. Select **Aux Electrodes**. The screen will change to:

```
 SELECT ELECTRODE
→1:BGA-PC | 4:N/A
 2:EMPTY  | 5:N/A
 3:N/A    | 6:N/A
```

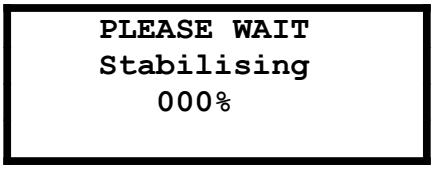
The BGA-PC electrode should have been assigned to AUX socket 1 when it was fitted. Press the OK or right arrow key to select BGA-PC. The screen will change to:

```
  CALIBRATE BGA-PC
→ ZERO? [01/Jan/17]
  Pt-2? [01/Jan/17]
  GS Factor:01.00
```

Calibration point 2 (Pt-2) is the upper calibration point.

The dates shown to the right of each point 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 output from the electrode in millivolts (mV). This value is stored in the Probe's memory and can be recalled at any time. See section 10.7. Calibration Data Storage and Retrieval. Press OK then ESC repeatedly to return to normal reading mode.

16.5.7. Calibrating Point 2

Remove the Probe from the calibration bottle, shake off any excess water then dry the outer sleeve with a soft cloth.

Fill a calibration bottle with freshly mixed Rhodamine calibration solution and drop the Probe in all the way. Again, bang the Probe against the bottom of the bottle several times in order to remove any air bubbles that may be clinging to the electrode.

Follow the procedure detailed above for Zero point calibration as far as step 6, then select Pt-2. 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 electrode in millivolts (mV). Press the **OK** key to continue. The reading on the Aquameter® directly after calibration should be approximately 70,000 cells/mL at 20ºC (this value will vary with temperature).

Calibration is now complete.

16.5.8. Calculating and Applying a Grab Sample Factor

The Grab Sample Factor (GS Factor) is a value that is used as a multiplier to correct the readings made by a fluorescent electrode based on known values derived from grab samples. The default GS factor is 1.00. So when the electrode's output is multiplied by a GS Factor of 1.00, the value is not affected.

If grab sample data is available for the location in which you plan to take measurements, you should calculate a GS Factor for the electrode and input it on the bottom line of the electrode's calibration screen.

To calculate a GS Factor, first take measurements using the fully calibrated electrode.

Next, compare the average of these values with the average values derived by laboratory analysis of grab samples from the same location. To do this, divide the average grab sample value by the average electrode value. This will give you a GS Factor.

For example, your calibrated electrode gives an average output of 100 at a given location. The analysis of grab samples from that location reveal an actual value of 125. So, 125 divided by 100 gives a GS Factor of 1.25.

This value should now be input on the bottom line of the electrode's calibration screen. Once the GS Factor value has been input, the OK key should be hit to send the Factor to the Probe.

Now that this GS Factor has been applied to the electrode, all future measurements will be multiplied by 1.25 prior to being displayed.

In this way, the electrode has been corrected for the local conditions and species of algae.

16.5.9. Errors During Calibration

If a problem occurs during calibration, an error message will be displayed. Refer to Calibration Error Messages in section 10.4 for error message handling.

16.5.10. Lens and Sleeve Maintenance

On a daily basis, the lenses on the electrode should be wiped over with a soft damp cloth.

Similarly, the inside of the Probe Sleeve and Sleeve Cap should be kept clean and free from any deposits that may cause stray fluorescence.

Never use an abrasive cleaner on the inside of the Probe sleeve or cap as they have 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 the zero point after cleaning the sleeve or lenses.

16.6. 2000/5000-BGA-PE Saltwater Blue-Green Algae (phycoerythrin) Electrode

Salt-water Blue-Green Algae (BGA-PE) can be measured by the Aquaprobe® using the optional 2000/5000-BGA-PE optical electrode.

16.6.1. Principle of Operation

The 2000/5000-BGA-PE optical electrode is a submersible, fixed response fluorometer, which provides excitation at 520nm and detects any resultant fluorescence above 575nm.

The electrode induces the phycoerythrin to fluoresce, then measures the longer wavelength light which is emitted as a result of the fluorescence process.

16.6.2. Limitations of Use

Determination of BGA-PE in the field using fluorescence measurement techniques will never be as accurate as measurements made in a lab using either cell counting or analysis of molecular phycoerythrin after its extraction from cells.

Factors adversely affecting accuracy include:

- Interference from other microbiological species and compounds, which fluoresce at similar wavelengths.
- Differences in the fluorescent response between various species of BGA.
- Differences in the fluorescent response caused by temperature.
- Differences in the fluorescent response caused by ambient light.
- Interference caused by turbidity.

Fluorescence measurement techniques are ideal for researchers who are interested in detecting the presence or absence of a specific substance and measuring relative fluorescence changes that can be used as an indication of increasing or decreasing concentrations.

Fluorescence measurement techniques are not ideal for quantitative measurement. In order to obtain more accurate results, data obtained with the fluorometer in the field should be post-calibrated with data from standard laboratory analysis of grab samples acquired during the study.

If grab sample data is available, a Grab Sample Factor (GS Factor) should be calculated and input on the calibration screen in order to improve the accuracy of future readings.

16.6.3. Calibrating the BGA-PE Electrode

The BGA-PE electrode has two calibration points. Careful calibration is essential in order to ensure consistent and reliable results.

When a BGA-PE electrode is first installed, **it MUST be calibrated at both points** in order to set the electrode's relative sensitivity and establish its slope.

Subsequently, a single point (Zero) calibration should be carried out daily. Full two-point calibration should be carried out every few months.

16.6.4. Calibration Solution Preparation

In order to 'calibrate' (actually, set the relative sensitivity) of the BGA-PE electrode, an 8µg/L calibration solution of fluorescent dye known as Rhodamine WT should be used.

Please note: there is no direct correlation between Rhodamine concentration and the number of BGA-PE cells/mL. Rhodamine is used as a convenient dye for setting the sensitivity of the sensor. The subsequent display of BGA-PE in terms of cells/mL is a generalisation based on research and experience. The only way to obtain a true value in terms of cells/mL is to correlate the values from the Probe to quantitative data that has been obtained by laboratory analysis of grab samples, then to apply a Grab Sample Factor. See previous 'Limitations of Use' section.

The 8µg/L calibration solution should be freshly prepared by serial dilution from 200g/L standard using deionised water. The following Rhodamine WT standard is recommended:

Part number: 70301027
Description: Rhodamine WT Liquid
Supplier: Keystone Europe Ltd.
Contact: http://www.dyes.com

Be sure to handle chemicals with care and to read and comply with all health and safety advice.

16.6.5. Serial Dilution

The recommended Rhodamine solution is supplied as a 20% or 200g/L solution, dilution of the stock solution should be carried out as follows.

200g/L stock → 8µg/L is recommended to be done as a two step dilution procedure.

Step 1: weigh out 0.5g of 200g/L stock solution in a weigh boat and add this to 1L of deionized water in a volumetric flask, use some of the water from the 1L flask to rinse the weigh boat so no stock Rhodamine remains on the boat. Put a lid on the 1L flask and invert 10 times.

This step results in a 1 in 2000 dilution of the stock, at this point the 1L flask will contain a 100mg/L solution.

Step 2: Transfer 80µl of the 100mg/L solution to a 1L volumetric flask and top up to 1L with deionized water. Put a lid on the 1L flask and invert 10 times.

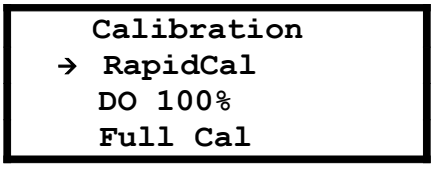
This step results in a 1 in 12500 dilution of the solution from step 1. The concentration of this solution is 8µg/L. This solution can now be used as Pt-2 calibration of the BGA-PE sensor.

The dilute solution can be stored in a dark bottle in a refrigerator for up to five days. After that time it must be discarded.

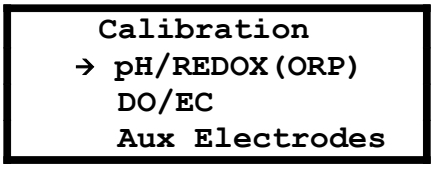
16.6.6. Zero Point Calibration

To calibrate the zero point, follow these steps:

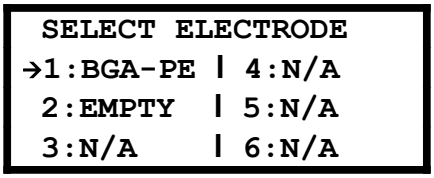
1. Fill a calibration bottle with with clean water (bottled still mineral water is recommended), remove the storage cap from the pH electrode if fitted, wash the Probe in clean water, then drop the Probe in all the way. **The Sleeve End Cap must be fitted**. Bang the Probe against the bottom of the bottle several times in order to remove any air bubbles that may be clinging to the electrode.
2. Switch the Aquameter® on and wait until the temperature and BGA-PE readings are stable. If the BGA-PE reading is very high, there are probably air bubbles adhering to the lenses. Bang the Probe against the bottom of the bottle 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.



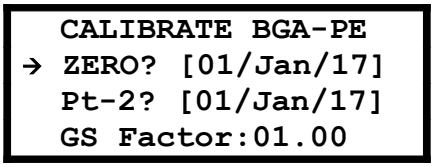
5. Select **Full Cal.** The screen will change to:



6. Select **Aux Electrodes**. The screen will change to:



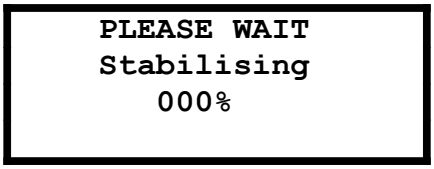
The BGA-PE electrode should have been assigned to AUX socket 1 when it was fitted. Press the OK or right arrow key to select BGA-PE. The screen will change to:



Calibration point 2 (Pt-2) is the upper calibration point.

The dates shown to the right of each point 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 output from the electrode in millivolts (mV). This value is stored in the Probe's memory and can be recalled at any time. See section 10.7. Calibration Data Storage and Retrieval. Press **OK** then **ESC** repeatedly to return to normal reading mode**.**

16.6.7. Calibrating Point 2

Remove the Probe from the calibration bottle, shake off any excess water then dry the outer sleeve with a soft cloth.

Fill a calibration bottle with freshly mixed Rhodamine calibration solution and drop the Probe in all the way. Again, bang the Probe against the bottom of the bottle several times in order to remove any air bubbles that may be clinging to the electrode.

Follow the procedure detailed above for Zero point calibration as far as step 6, then select Pt-2. 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 electrode in millivolts (mV). Press the **OK** key to continue. The reading on the Aquameter® directly after calibration should be approximately 200,000 cells/mL at 20ºC (this value will vary with temperature).

Calibration is now complete.

16.6.8. Calculating and Applying a Grab Sample Factor

The Grab Sample Factor (GS Factor) is a value that is used as a multiplier to correct the readings made by a fluorescent electrode based on known values derived from grab samples. The default GS factor is 1.00. So when the electrode's output is multiplied by a GS Factor of 1.00, the value is not affected.

If grab sample data is available for the location in which you plan to take measurements, you should calculate a GS Factor for the electrode and input it on the bottom line of the electrode's calibration screen.

To calculate a GS Factor, first take measurements using the fully calibrated electrode.

Next, compare the average of these values with the average values derived by laboratory analysis of grab samples from the same location. To do this, divide the average grab sample value by the average electrode value. This will give you a GS Factor.

For example, your calibrated electrode gives an average output of 100 at a given location. The analysis of grab samples from that location reveal an actual value of 125. So, 125 divided by 100 gives a GS Factor of 1.25.

This value should now be input on the bottom line of the electrode's calibration screen. Once the GS Factor value has been input, the OK key should be hit to send the Factor to the Probe.

Now that this GS Factor has been applied to the electrode, all future measurements will be multiplied by 1.25 prior to being displayed.

In this way, the electrode has been corrected for the local conditions and species of algae.

16.6.9. Errors During Calibration

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

16.6.10. Lens and Sleeve Maintenance

On a daily basis, the lenses on the electrode should be wiped over with a soft damp cloth.

Similarly, the inside of the Probe Sleeve and Sleeve Cap should be kept clean and free from any deposits that may cause stray fluorescence.

Never use an abrasive cleaner on the inside of the Probe sleeve or cap as they have 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 the zero point after cleaning the sleeve or lenses.

16.7. 2000/5000-CPHYLL Chlorophyll Electrode

Chlorophyll can be measured by the Aquaprobe® using the optional 2000/5000-CPHYLL optical electrode.

16.7.1. Principle of Operation

The 2000/5000-CPHYLL optical electrode is a submersible, fixed response fluorometer, which provides excitation at 470nm and detects any resultant fluorescence above 630nm.

The electrode induces the chlorophyll to fluoresce, then measures the longer wavelength light which is emitted as a result of the fluorescence process.

16.7.2. Limitations of Use

Determination of chlorophyll in the field using fluorescence measurement techniques will never be as accurate as measurements made in a lab using either cell counting or analysis of molecular chlorophyll after its extraction from cells.

Factors adversely affecting accuracy include:

- Interference from other microbiological species and compounds, which fluoresce at similar wavelengths.
- Differences in the fluorescent response between various species of phytoplankton.
- Differences in the fluorescent response caused by temperature.
- Differences in the fluorescent response caused by ambient light.
- Interference caused by turbidity.

Fluorescence measurement techniques are ideal for researchers who are interested in detecting the presence or absence of a specific substance and measuring relative fluorescence changes that can be used as an indication of increasing or decreasing concentrations.

Fluorescence measurement techniques are not ideal for quantitative measurement. In order to obtain more accurate results, data obtained with the fluorometer in the field should be post-calibrated with data from standard laboratory analysis of grab samples acquired during the study.

If grab sample data is available, a Grab Sample Factor (GS Factor) should be calculated and input on the calibration screen in order to improve the accuracy of future readings.

16.7.3. Calibrating the CPHYLL Electrode

The CPHYLL electrode has two calibration points. Careful calibration is essential in order to ensure consistent and reliable results.

When a CPHYLL electrode is first installed, **it MUST be calibrated at both points** in order to set the electrode's relative sensitivity and establish its slope.

Subsequently, a single point (Zero) calibration should be carried out daily. Full two-point calibration should be carried out every few months.

16.7.4. Calibration Solution Preparation

In order to 'calibrate' (actually, set the relative sensitivity) of the CPHYLL electrode, a 500µg/L calibration solution of fluorescent dye known as Rhodamine WT should be used.

Please note: there is no direct correlation between Rhodamine concentration and the concentration of chlorophyll. Rhodamine is used as a convenient dye for setting the sensitivity of the sensor. The subsequent display of chlorophyll in terms of mg/L is a generalisation based on research and experience. The only way to obtain a true value in terms of cells/mL is to correlate the values from the Probe to quantitative data that has been obtained by laboratory analysis of grab samples, then to apply a Grab Sample Factor. See previous 'Limitations of Use' section.

The 500µg/L calibration solution should be freshly prepared by serial dilution from 200g/L standard using deionised water. The following Rhodamine WT standard is recommended:

Part number: 70301027
Description: Rhodamine WT Liquid
Supplier: Keystone Europe Ltd.
Contact: http://www.dyes.com

Be sure to handle chemicals with care and to read and comply with all health and safety advice.

16.7.5. Serial Dilution

The recommended Rhodamine solution is supplied as a 20% or 200g/L solution, dilution of the stock solution should be carried out as follows.

200g/L stock → 500µg/L is recommended to be done as a two step dilution procedure.

Step 1: weigh out 0.5g of 200g/L stock solution in a weigh boat and add this to 1L of deionized water in a volumetric flask, use some of the water from the 1L flask to rinse the weigh boat so no stock Rhodamine remains on the boat. Put a lid on the 1L flask and invert 10 times.

This step results in a 1 in 2000 dilution of the stock, at this point the 1L flask will contain a 100mg/L solution.

Step 2: Transfer 5ml of the 100mg/L solution to a 1L volumetric flask and top up to 1L with deionized water. Put a lid on the 1L flask and invert 10 times.

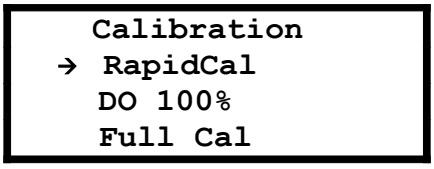
This step results in a 1 in 200 dilution of the solution from step 1. The concentration of this solution is 500µg/L. This solution can now be used as Pt-2 calibration of the CPHYLL sensor.

The dilute solution can be stored in a dark bottle in a refrigerator for up to five days. After that time it must be discarded.

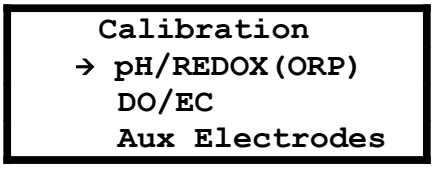
16.7.6. Zero Point Calibration

To calibrate the zero point, follow these steps:

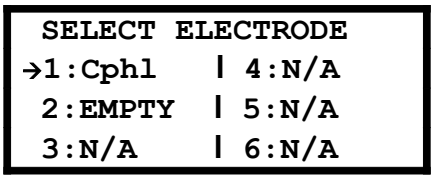
1. Fill a calibration bottle with clean water (bottled still mineral water is recommended), remove the storage cap from the pH electrode if fitted, wash the Probe in clean water, then drop the Probe in all the way. **The Sleeve End Cap must be fitted**. Bang the Probe against the bottom of the bottle several times in order to remove any air bubbles that may be clinging to the electrode.
2. Switch the Aquameter® on and wait until the temperature and Cphll readings are stable. If the Cphll reading is very high, there are probably air bubbles adhering to the lenses. Bang the Probe against the bottom of the bottle 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.



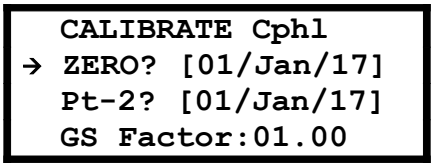
5. Select **Full Cal.** The screen will change to:



6. Select **Aux Electrodes**. The screen will change to:



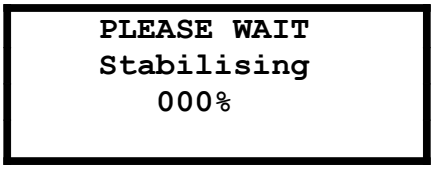
The Cphl electrode should have been assigned to AUX socket 1 when it was fitted. Press the OK or right arrow key to select Cphl. The screen will change to:



Calibration point 2 (Pt-2) is the upper calibration point.

The dates shown to the right of each point 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 output from the electrode in millivolts (mV). This value is stored in the Probe's memory and can be recalled at any time. See section 10.7. Calibration Data Storage and Retrieval. Press **OK** then **ESC** repeatedly to return to normal reading mode**.**

16.7.7. Calibrating Point 2

Remove the Probe from the calibration bottle, shake off any excess water then dry the outer sleeve with a soft cloth.

Fill a calibration bottle with freshly mixed Rhodamine calibration solution and drop the Probe in all the way. Again, bang the Probe against the bottom of the bottle several times in order to remove any air bubbles that may be clinging to the electrode.

Follow the procedure detailed above for Zero point calibration as far as step 6, then select Pt-2. 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 electrode in millivolts (mV). Press the **OK** key to continue. The reading on the Aquameter® directly after calibration should be approximately 118 µg/L at 20ºC (this value will vary with temperature).

Calibration is now complete.

16.7.8. Calculating and Applying a Grab Sample Factor

The Grab Sample Factor (GS Factor) is a value that is used as a multiplier to correct the readings made by a fluorescent electrode based on known values derived from grab samples. The default GS factor is 1.00. So when the electrode's output is multiplied by a GS Factor of 1.00, the value is not affected.

If grab sample data is available for the location in which you plan to take measurements, you should calculate a GS Factor for the electrode and input it on the bottom line of the electrode's calibration screen.

To calculate a GS Factor, first take measurements using the fully calibrated electrode.

Next, compare the average of these values with the average values derived by laboratory analysis of grab samples from the same location. To do this, divide the average grab sample value by the average electrode value. This will give you a GS Factor.

For example, your calibrated electrode gives an average output of 100 at a given location. The analysis of grab samples from that location reveal an actual value of 125. So, 125 divided by 100 gives a GS Factor of 1.25.

This value should now be input on the bottom line of the electrode's calibration screen. Once the GS Factor value has been input, the OK key should be hit to send the Factor to the Probe.

Now that this GS Factor has been applied to the electrode, all future measurements will be multiplied by 1.25 prior to being displayed.

In this way, the electrode has been corrected for the local conditions and species of chlorophyll.

16.7.9. Errors During Calibration

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

16.7.10. Lens and Sleeve Maintenance

On a daily basis, the lenses on the electrode should be wiped over with a soft damp cloth.

Similarly, the inside of the Probe Sleeve and Sleeve Cap should be kept clean and free from any deposits that may cause stray fluorescence.

Never use an abrasive cleaner on the inside of the Probe sleeve or cap as they have 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 the zero point after cleaning the sleeve or lenses.

16.8. 2000/5000-RHOD Rhodamine WT Electrode

Rhodamine WT is a fluorescent red dye that is commonly used in water flow studies and can be measured by the Aquaprobe® using the optional 2000/5000-RHOD optical electrode.

16.8.1. Principle of Operation

The 2000/5000-RHOD optical electrode is a submersible, fixed response fluorometer, which provides excitation at 520nm and detects any resultant fluorescence above 575nm.

The electrode induces the Rhodamine to fluoresce, then measures the longer wavelength light which is emitted as a result of the fluorescence process.

16.8.2. Limitations of Use

Measurement of Rhodamine in the field using fluorescence measurement techniques can be adversely affected by:

- Interference from microbiological species and compounds, which fluoresce at similar wavelengths.
- Differences in the fluorescent response caused by temperature.
- Differences in the fluorescent response caused by ambient light.
- Interference caused by turbidity.

The normal affects of temperature on the fluorescent response of Rhodamine is automatically compensated for by the electrode.

16.8.3. Calibrating the RHOD Electrode

The RHOD electrode has two calibration points. Careful calibration is essential in order to ensure consistent and reliable results.

When a RHOD electrode is first installed, **it MUST be calibrated at both points** in order to set the electrode's relative sensitivity and establish its slope.

Subsequently, a single point (Zero) calibration should be carried out daily. Full two-point calibration should be carried out every few months.

16.8.4. Calibration Solution Preparation

In order to 'calibrate' the RHOD electrode, a 100µg/L calibration solution of Rhodamine WT should be used. This is exactly the same calibration solution that is recommended for calibration of the BGA-PC electrode.

The 100µg/L calibration solution should be freshly prepared by serial dilution from 200g/L standard using deionised water. The following Rhodamine WT standard is recommended:

Part number: 70301027
Description: Rhodamine WT Liquid
Supplier: Keystone Europe Ltd.
Contact: http://www.dyes.com

Be sure to handle chemicals with care and to read and comply with all health and safety advice.

16.8.5. Serial Dilution

The recommended Rhodamine solution is supplied as a 20% or 200g/L solution, dilution of the stock solution should be carried out as follows.

200g/L stock → 100µg/L is recommended to be done as a two step dilution procedure.

Step 1; weigh out 0.5g of 200g/L stock solution in a weigh boat and add this to 1L of deionized water in a volumetric flask, use some of the water from the 1L flask to rinse the weigh boat so no stock Rhodamine remains on the boat. Put a lid on the 1L flask and invert 10 times.

This step results in a 1 in 2000 dilution of the stock, at this point the 1L flask will contain a 100mg/L solution.

Step 2; Transfer 1ml of the 100mg/L solution to a 1L volumetric flask and top up to 1L with deionized water. Put a lid on the 1L flask and invert 10 times.

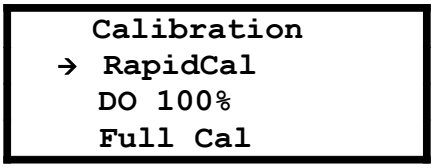
This step results in a 1 in 1000 dilution of the solution from step 1. The concentration of this solution is 100µg/L. This solution can now be used as Pt-2 calibration of the RHOD sensor.

The dilute solution can be stored in a dark bottle in a refrigerator for up to five days. After that time it must be discarded.

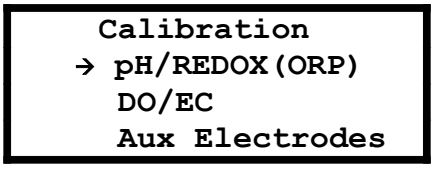
16.8.6. Zero Point Calibration

To calibrate the zero point, follow these steps:

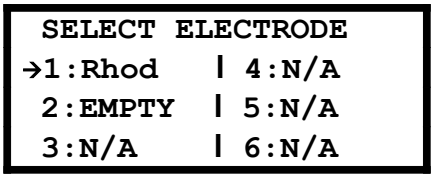
1. Fill a calibration bottle with clean water (bottled still mineral water is recommended), remove the storage cap from the pH electrode if fitted, wash the Probe in clean water, then drop the Probe in all the way. **The Sleeve End Cap must be fitted**. Bang the Probe against the bottom of the bottle several times in order to remove any air bubbles that may be clinging to the electrode.
2. Switch the Aquameter® on and wait until the temperature and Rhod readings are stable. If the Rhod reading is very high, there are probably air bubbles adhering to the lenses. Bang the Probe against the bottom of the bottle 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.



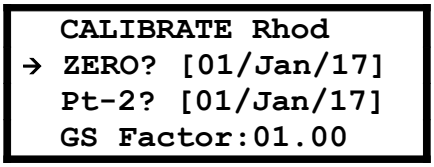
5. Select **Full Cal.** The screen will change to:



6. Select **Aux Electrodes**. The screen will change to:



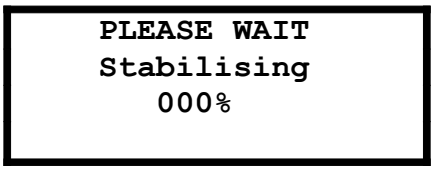
The Rhod electrode should have been assigned to AUX socket 1 when it was fitted. Press the OK or right arrow key to select Rhod. The screen will change to:



Calibration point 2 (Pt-2) is the upper calibration point.

The dates shown to the right of each point 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 output from the electrode in millivolts (mV). This value is not stored in memory so should be noted down in a calibration record book for the probe.

16.8.7. Calibrating Point 2

Remove the Probe from the calibration bottle, shake off any excess water then dry the outer sleeve with a soft cloth.

Fill a calibration bottle with freshly mixed Rhodamine calibration solution and drop the Probe in all the way.
Again, bang the Probe against the bottom of the bottle several times in order to remove any air bubbles that may be clinging to the electrode.

Follow the procedure detailed above for Zero point calibration as far as step 6, then select Pt-2. 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 electrode in millivolts (mV). Press the **OK** key to continue.

Calibration is now complete.

16.8.8. Grab Sample Factor

The Grab Sample Factor (GS Factor) is a value that is used as a multiplier to correct the readings made by a fluorescent electrode based on known values derived from grab samples.

The default GS factor is 1.00. So when the electrode's output is multiplied by a GS Factor of 1.00, the value is not affected.

The GS Factor should be left at 1.00 for the Rhodamine electrode.

16.8.9. Errors During Calibration

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

16.8.10. Lens and Sleeve Maintenance

On a daily basis, the lenses on the electrode should be wiped over with a soft damp cloth.

Similarly, the inside of the Probe Sleeve and Sleeve Cap should be kept clean and free from any deposits that may cause stray fluorescence.

Never use an abrasive cleaner on the inside of the Probe sleeve or cap as they have 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 the zero point after cleaning the sleeve or lenses.

16.9. 2000/5000-FSCEIN Fluorescein WT Electrode

Fluorescein is a fluorescent dye that is commonly used in water flow studies and can be measured by the Aquaprobe® using the optional 2000/5000-FSCEIN optical electrode.

16.9.1. Principle of Operation

The 2000/5000-FSCEIN optical electrode is a submersible, fixed response fluorometer, which provides excitation at 470nm and detects any resultant fluorescence above 550nm.

The electrode induces the Fluorescein to fluoresce, then measures the longer wavelength light which is emitted as a result of the fluorescence process.

16.9.2. Limitations of Use

Measurement of Fluorescein in the field using fluorescence measurement techniques can be adversely affected by:

- Interference from microbiological species and compounds, which fluoresce at similar wavelengths.
- Differences in the fluorescent response caused by temperature.
- Differences in the fluorescent response caused by ambient light.
- Interference caused by turbidity.

The normal affects of temperature on the fluorescent response of Fluorescein is automatically compensated for by the electrode.

16.9.3. Calibrating the FSCEIN Electrode

The FSCEIN electrode has two calibration points. Careful calibration is essential in order to ensure consistent and reliable results.

When a FSCEIN electrode is first installed, **it MUST be calibrated at both points** in order to set the electrode's relative sensitivity and establish its slope.

Subsequently, a single point (Zero) calibration should be carried out daily. Full two-point calibration should be carried out every few months.

16.9.4. Calibration Solution Preparation

In order to 'calibrate' the FSCEIN electrode, a 100µg/L calibration solution of Fluorescein Dye should be used.

The 100µg/L calibration solution should be freshly prepared by serial dilution from 200g/L standard using deionised water. The following Fluorescein Dye is recommended:

Part number: 801 073 81
Description: Keyacid Fluorescein 019187
Supplier: Keystone Europe Ltd.
Contact: http://www.dyes.com

Be sure to handle chemicals with care and to read and comply with all health and safety advice.

16.9.5. Serial Dilution

A three step dilution process should be used as outlined below.

Step 1; Weigh out 0.5g Fluorescein dye powder and add to 1L deionized water in a volumetric flask. Invert 10 times or until all powder is dissolved. This gives a stock solution of 500mg/L.

Step 2; Transfer 10ml of the 500mg/L stock solution into a 1L volumetric flask and top the flask up to 1L with deionized water. Invert to mix.

This step results in a 1 in 100 dilution of the 500mg/L stock resulting in a 5mg/L stock.

Step 3; Transfer 20ml of the 5mg/L stock from step 2 into a 1L volumetric flask. Top up to 1L with deionized water. Invert to mix.

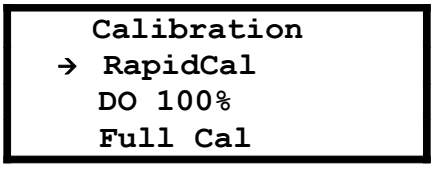
This step results in a 1 in 50 dilution and gives you the 100µg/L FSCEIN calibration standard required for Pt-2.

The dilute solution can be stored in a dark bottle in a refrigerator for up to five days. After that time it must be discarded.

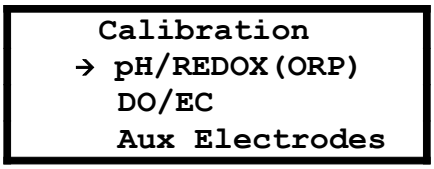
16.9.6. Zero Point Calibration

To calibrate the zero point, follow these steps:

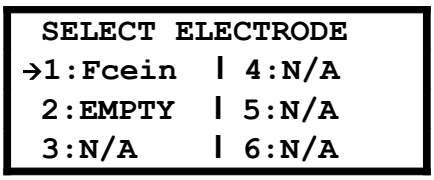
1. Fill a calibration bottle with clean water (bottled still mineral water is recommended), remove the storage cap from the pH electrode if fitted, wash the Probe in clean water, then drop the Probe in all the way. **The Sleeve End Cap must be fitted**. Bang the Probe against the bottom of the bottle several times in order to remove any air bubbles that may be clinging to the electrode.
2. Switch the Aquameter® on and wait until the temperature and Fcein readings are stable. If the Fcein reading is very high, there are probably air bubbles adhering to the lenses. Bang the Probe against the bottom of the bottle 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.



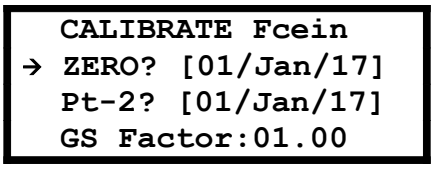
5. Select **Full Cal.** The screen will change to:



6. Select **Aux Electrodes**. The screen will change to:



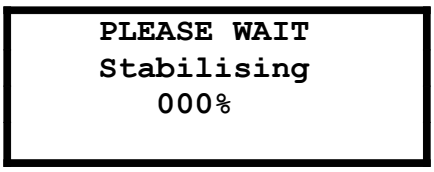
The Fcein electrode should have been assigned to AUX socket 1 when it was fitted. Press the OK or right arrow key to select Fcein. The screen will change to:



Calibration point 2 (Pt-2) is the upper calibration point.

The dates shown to the right of each point 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 output from the electrode in millivolts (mV). This value is stored in the Probe's memory and can be recalled at any time. See section 10.7. Calibration Data Storage and Retrieval. Press **OK** then **ESC** repeatedly to return to normal reading mode.

16.9.7. Calibrating Point 2

Remove the Probe from the calibration bottle, shake off any excess water then dry the outer sleeve with a soft cloth.

Fill a calibration bottle with freshly mixed Fluorescein calibration solution and drop the Probe in all the way.
Again, bang the Probe against the bottom of the bottle several times in order to remove any air bubbles that may be clinging to the electrode.

Follow the procedure detailed above for Zero point calibration as far as step 6, then select Pt-2. 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 electrode in millivolts (mV). Press the **OK** key to continue.

Calibration is now complete.

16.9.8. Grab Sample Factor

The Grab Sample Factor (GS Factor) is a value that is used as a multiplier to correct the readings made by a fluorescent electrode based on known values derived from grab samples.

The default GS factor is 1.00. So when the electrode's output is multiplied by a GS Factor of 1.00, the value is not affected.

The GS Factor should be left at 1.00 for the Fluorescein electrode.

16.9.9. Errors During Calibration

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

16.9.10. Lens and Sleeve Maintenance

On a daily basis, the lenses on the electrode should be wiped over with a soft damp cloth.

Similarly, the inside of the Probe Sleeve and Sleeve Cap should be kept clean and free from any deposits that may cause stray fluorescence.

Never use an abrasive cleaner on the inside of the Probe sleeve or cap as they have 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 the zero point after cleaning the sleeve or lenses.

16.10. 2000/5000-REFOIL Refined Oil Electrode

Refined fuels such as benzene, toluene, ethylbenzene, and xylenes (BTEX) can be measured by the Aquaprobe® using the optional 2000/5000-REFOIL optical electrode.

16.10.1. Principle of Operation

The 2000/5000-REFOIL optical electrode is a submersible, fixed response fluorometer, which provides excitation at 285nm (deep UV) and detects any resultant fluorescence between 330nm and 370nm.

The electrode induces the aromatic hydrocarbons within the refined oil to fluoresce, then measures the longer wavelength light which is emitted as a result of the fluorescence process.

- ➔ **During operation, the Refined Oil Electrode emits high intensity ultraviolet (UV) light, which is harmful to skin and eyes and may cause cancer. Avoid exposure to UV light when the Electrode is in operational.**

- ➔ **Precautions must be taken to avoid looking directly at the Electrode without the use of UV light protective glasses.**

- ➔ **Do not look directly at the lenses on the front face of the Electrode when it is operational.**

- ➔ **Ensure the warning label supplied with the Electrode is attached to the Aquaprobe®.**

16.10.2. Limitations of Use

Determination of refined oil in the field using fluorescence measurement techniques will never be as accurate as measurements made in a lab using either Gas or Liquid Chromatography.

Factors adversely affecting accuracy include:

- Interference from other compounds (such as flour and some bacterial spores which fluoresce at similar wavelengths.
- Differences in the fluorescent response between various types of oil.
- Differences in the fluorescent response caused by temperature.
- Differences in the fluorescent response caused by ambient light.
- Interference caused by turbidity.

Fluorescence measurement techniques are ideal for researchers who are interested in detecting the presence or absence of a specific substance and measuring relative fluorescence changes that can be used as an indication of increasing or decreasing concentrations.

Fluorescence measurement techniques are not ideal for quantitative measurement. In order to obtain more accurate results, data obtained with the fluorometer in the field should be post-calibrated with data from standard laboratory analysis of grab samples acquired during the study.

If grab sample data is available, a Grab Sample Factor (GS Factor) should be calculated and input on the calibration screen in order to improve the accuracy of future readings

16.10.3. Special Precautions When Using the REFOIL Electrode

- Always observe the safety advice printed above.
- Do not deploy the REFOIL electrode in water temperatures above 30ºC.

16.10.4. Calibrating the REFOIL Electrode

The REFOIL electrode has two calibration points. Careful calibration is essential in order to ensure consistent and reliable results. **It is important to calibrate this electrode as close to operational temperature as possible.**

When a REFOIL electrode is first installed, **it MUST be calibrated at both points** in order to set the electrode's relative sensitivity and establish its slope.

Subsequently, zero point calibration should be carried out before each use and full two-point calibration should be carried out every few months.

16.10.5. Calibration Solution Preparation

In order to 'calibrate' the REFOIL electrode, a 10ppm calibration solution of 1-5, naphthalenedisulfonic acid disodium salt should be used. This solution contains naphthalene, an aromatic hydrocarbon, which has **similar** fluorescence characteristics to many Refined Oils.

The 10ppm calibration solution should be freshly prepared by serial dilution from pure 1-5, naphthalenedisulfonic acid disodium salt. The following Naphthalene salt is recommended:

Part number: 250899
Description: 1,5-Naphthalenedisulfonic acid disodium salt hydrate (95% pure)
Supplier: Sigma Aldrich
Contact: www.sigma-aldrich.com

Be sure to handle chemicals with care and to read and comply with all health and safety advice.

16.10.6. Serial Dilution

10ppm Napthalene salt can be prepared either as a one or two step process dependent upon the accuracy of the scales used.

One step process:
Weigh out 10.5mg of the recommended salt and add to 1L of deionized water in a volumetric flask. Invert or mix until all salt has dissolved. This gives the Pt-2 10ppm stock solution required for calibration.

Two step process:
Step 1: Weigh out 1.05g of the recommended salt and add to 1L deionized water in a volumetric flask. Invert or mix until all salt has dissolved. This gives a 1000ppm stock solution.

Step 2: Transfer 10ml of the 1000ppm stock solution to a 1L volumetric flask and top up with 1L of deionized water. Invert 10 times. This step results in a 1 in 100 dilution of the 1000ppm stock giving the 10ppm standard required for Pt-2 calibration.

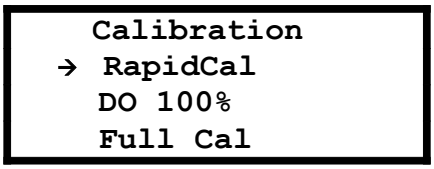
The dilute solution can be stored in a dark bottle in a refrigerator for up to five days. After that time it must be discarded.

Important note: When calibrating the Refined Oil sensor with naphthalenedisulfonic acid disodium salt, the readings given will be in µg/L (ppb) naphthalene. In order to display readings with respect to a specific type of refined oil, it is necessary to prepare a 10ppm solution of the target oil type and use that to calibrate the electrode in place of the naphthalene solution. Alternatively, apply a suitable Grab Sample Factor to correct the naphthalene readings for the target oil type.

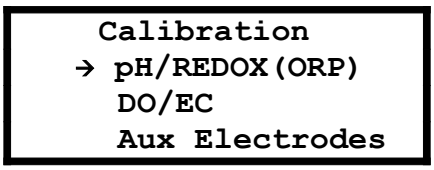
16.10.7. Zero Point Calibration

To calibrate the zero point, follow these steps:

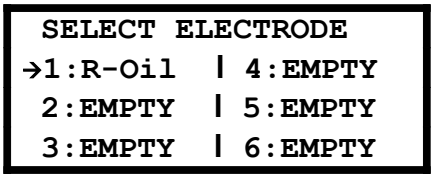
1. Pour 300mL of clean water (bottled still mineral water is recommended) into a clean calibration bottle, remove the storage cap from the pH electrode if fitted, wash the Probe in clean water, then gently lower the Probe in all the way. **The Sleeve End Cap must be fitted**.
2. Switch the Aquameter® on and wait until the temperature and Oil readings are stable. If the Oil reading is very high, there are probably air bubbles adhering to the lenses.
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 **Aux Electrodes**. The screen will change to:



The Oil electrode should have been assigned to an AUX socket when it was fitted. Choose that socket. Press the OK or right arrow key to select Oil. The screen will change to:

```
  CALIBRATE R-Oil
→ ZERO? [01/Jan/17]
  Pt-2? [01/Jan/17]
  GS Factor:01.00
```

Calibration point 2 (Pt-2) is the upper calibration point.

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

7. Select ZERO. The screen will change to:

```
   PLEASE WAIT
   Stabilising
      000%
```

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.

```
   Output:2500mV
   Calibrating
      100%
    Press [OK]
```

The Calibration Report on the top line displays the voltage output from the electrode in millivolts (mV). This value is stored in the Probe's memory and can be recalled at any time. See section 10.7. Calibration Data Storage and Retrieval. Press **OK** then **ESC** repeatedly to return to normal reading mode**.**

16.10.8. Calibrating Point 2

Remove the Probe from the calibration cup, shake off any excess water then dry the outer sleeve with a soft cloth.

Pour 300mL of freshly mixed 1-5, naphthalenedisulfonic acid disodium salt calibration solution into a clean calibration cup then gently lower the Probe in all the way.
Follow the procedure detailed above for Zero point calibration as far as step 6, then select Pt-2. 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 electrode in millivolts (mV). Press the **OK** key to continue. Refined oil calibration is now complete.

16.10.9. Calculating and Applying a Grab Sample Factor

The Grab Sample Factor (GS Factor) is a value that is used as a multiplier to correct the readings made by a fluorescent electrode based on known values derived from grab samples. The default GS factor is 1.00. So when the electrode's output is multiplied by a GS Factor of 1.00, the value is not affected.

If grab sample data is available for the location in which you plan to take measurements, you should calculate a GS Factor for the electrode and input it on the bottom line of the electrode's calibration screen.

To calculate a GS Factor, first take measurements using the fully calibrated electrode.

Next, compare the average of these values with the average values derived by laboratory analysis of grab samples from the same location. To do this, divide the average grab sample value by the average electrode value. This will give you a GS Factor.

For example, your calibrated electrode gives an average output of 100 at a given location. The analysis of grab samples from that location reveal an actual value of 125. So, 125 divided by 100 gives a GS Factor of 1.25.

This value should now be input on the bottom line of the electrode's calibration screen. Once the GS Factor value has been input, the OK key should be hit to send the Factor to the Probe.

Now that this GS Factor has been applied to the electrode, all future measurements will be multiplied by 1.25 prior to being displayed.

In this way, the electrode has been corrected for the local conditions and oil types.

16.10.10. Errors During Calibration

If a problem occurs during calibration, an error message will be displayed. Refer to Calibration Error Messages in section 10.4 for error message handling.

16.10.11. Lens and Sleeve Maintenance

On a daily basis, the lenses on the electrode should be wiped over with a soft damp cloth.

Similarly, the inside of the Probe Sleeve and Sleeve Cap should be kept clean and free from any deposits that may cause stray fluorescence.

Never use an abrasive cleaner on the inside of the Probe sleeve or cap as they have 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 the zero point after cleaning the sleeve or lenses.

16.11. 2000/5000-CDOM/FDOM Chromophoric (Fluorescent) Dissolved Organic Matter

Fluorescent) Dissolved Organic Matter can be measured by the Aquaprobe® using the optional 2000/5000-CDOM optical electrode.

16.11.1. Principle of Operation

The 2000/5000-CDOM optical electrode is a submersible, fixed response fluorometer, which provides excitation at 365nm (UV) and detects any resultant fluorescence between 450nm and 520nm.

The electrode induces the dissolved organic matter to fluoresce, then measures the longer wavelength light which is emitted as a result of the fluorescence process.

➔ **During operation, the CDOM Electrode emits high intensity ultraviolet (UV) light, which is harmful to skin and eyes and may cause cancer. Avoid exposure to UV light when the Electrode is in operational.**

➔ **Precautions must be taken to avoid looking directly at the Electrode without the use of UV light protective glasses.**

➔ **Do not look directly at the lenses on the front face of the Electrode when it is operational.**

➔ **Ensure the warning label supplied with the Electrode is attached to the Aquaprobe®.**

16.11.2. Limitations of Use

Determination of CDOM in the field using fluorescence measurement techniques will never be as accurate as measurements made in a lab using traditional techniques.

Factors adversely affecting accuracy include:

- Interference from compounds which fluoresce at similar wavelengths.
- Differences in the fluorescent response caused by temperature.
- Differences in the fluorescent response caused by ambient light.
- Interference caused by turbidity.

Fluorescence measurement techniques are ideal for researchers who are interested in detecting the presence or absence of a specific substance and measuring relative fluorescence changes that can be used as an indication of increasing or decreasing concentrations.
Fluorescence measurement techniques are not ideal for quantitative measurement. In order to obtain more accurate results, data obtained with the fluorometer in the field should be post-calibrated with data from standard laboratory analysis of grab samples acquired during the study.

If grab sample data is available, a Grab Sample Factor (GS Factor) should be calculated and input on the calibration screen in order to improve the accuracy of future readings

16.11.3. Calibrating the CDOM Electrode

The CDOM electrode has two calibration points, zero and 100ppb (100µg/L). Careful calibration is essential in order to ensure consistent and reliable results. **It is important to calibrate this electrode as close to operational temperature as possible.**

When a CDOM electrode is first installed, **it MUST be calibrated at both points** in order to set the electrode's relative sensitivity and establish its slope.

Subsequently, zero point calibration should be carried out before each use and full two-point calibration should be carried out every few months.

16.11.4. Calibration Solutions

Scientists have not developed a standard way to report CDOM values. Results are therefore expressed in relative units based on calibration to a standard fluorescing compound, usually quinine.

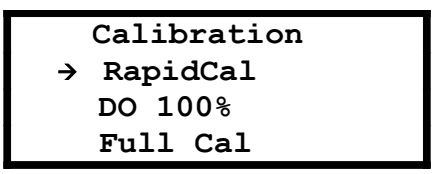
In order to 'calibrate' the CDOM electrode, a 100ppb solution of Quinine Sulphate in sulphuric acid can be used. However, since Quinine Sulphate is extremely expensive and sulphuric acid is dangerous to handle, Aquaread Ltd has formulated an equivalent, non toxic standard for use during CDOM electrode calibration. This is available in 600mL bottles.

Part number: CDOM-CAL-600
Supplier: Aquaread Ltd
Contact: http://www.aquaread.com

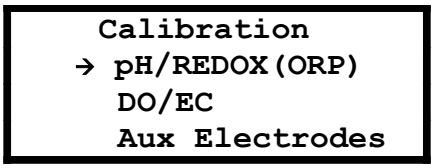
16.11.5. Zero Point Calibration

To calibrate the zero point, follow these steps:

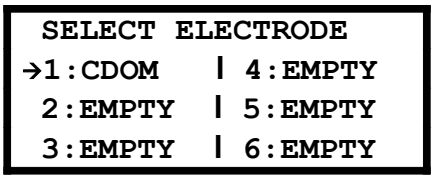
1. Pour 300mL of clean water (bottled still mineral water is recommended) into a clean calibration bottle, remove the storage cap from the pH electrode if fitted, wash the Probe in clean water, then gently lower the Probe in all the way. **The Sleeve End Cap must be fitted**.
2. Switch the Aquameter® on and wait until the temperature and CDOM readings are stable. If the CDOM reading is very high, there are probably air bubbles adhering to the lenses.
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.



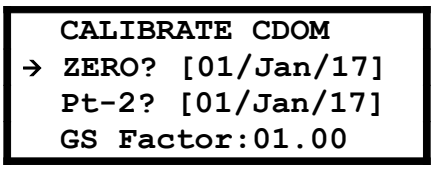
5. Select **Full Cal.** The screen will change to:



6. Select **Aux Electrodes**. The screen will change to:



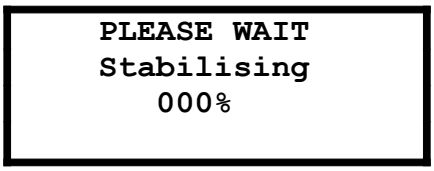
The CDOM electrode should have been assigned to an AUX socket when it was fitted. Choose that socket. Press the OK or right arrow key to select CDOM. The screen will change to:



Calibration point 2 (Pt-2) is the upper calibration point.

The dates shown to the right of each point 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 output from the electrode in millivolts (mV). This value is stored in the Probe's memory and can be recalled at any time. See section 10.7. Calibration Data Storage and Retrieval. Press **OK** then **ESC** repeatedly to return to normal reading mode**.**

16.11.6. Calibrating Point 2

Remove the Probe from the calibration cup, shake off any excess water then dry the outer sleeve with a soft cloth.

Pour 300mL of fresh CDOM-CAL calibration solution into a clean calibration cup then gently lower the Probe in all the way.

Follow the procedure detailed above for Zero point calibration as far as step 6, then select

Pt-2. 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 electrode in millivolts (mV). Press the **OK** key to continue.

CDOM calibration is now complete.

16.11.7. Calculating and Applying a Grab Sample Factor

The Grab Sample Factor (GS Factor) is a value that is used as a multiplier to correct the readings made by a fluorescent electrode based on known values derived from grab samples. The default GS factor is 1.00. So when the electrode's output is multiplied by a GS Factor of 1.00, the value is not affected.

If grab sample data is available for the location in which you plan to take measurements, you should calculate a GS Factor for the electrode and input it on the bottom line of the electrode's calibration screen.

To calculate a GS Factor, first take measurements using the fully calibrated electrode.

Next, compare the average of these values with the average values derived by laboratory analysis of grab samples from the same location. To do this, divide the average grab sample value by the average electrode value. This will give you a GS Factor.

For example, your calibrated electrode gives an average output of 100 at a given location. The analysis of grab samples from that location reveal an actual value of 125. So, 125 divided by 100 gives a GS Factor of 1.25.

This value should now be input on the bottom line of the electrode's calibration screen. Once the GS Factor value has been input, the OK key should be hit to send the Factor to the Probe.

Now that this GS Factor has been applied to the electrode, all future measurements will be multiplied by 1.25 prior to being displayed.

In this way, the electrode has been corrected for the local conditions and species of organic matter.

16.11.8. Errors During Calibration

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

16.11.9. Lens and Sleeve Maintenance

On a daily basis, the lenses on the electrode should be wiped over with a soft damp cloth.

Similarly, the inside of the Probe Sleeve and Sleeve Cap should be kept clean and free from any deposits that may cause stray fluorescence.

Never use an abrasive cleaner on the inside of the Probe sleeve or cap as they have 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 the zero point after cleaning the sleeve or lenses.

16.11.10. Special Note Concerning CDOM Calibration Solutions

All types of CDOM calibration solution are acidic and will therefore, given time, attack the anodised finish on the Aquaprobe.

In order to avoid this, do not leave the Aquaprobe sitting in CDOM solution for more time than it takes to do the actual calibration.

As soon as the Point 2 calibration is complete, remove the Aquaprobe from the CDOM calibration solution and rinse thoroughly.

17. Optional ISE Electrodes Calibration and Maintenance

17.1. ISE Electrode Limitations

All ion selective electrodes suffer from interference from ions which are similar in nature to the target ion. For this reason, ISE Electrodes are not recommended for use in brackish or salt water due to the high level of interfering ions. In order to achieve accurate readings with ISE electrodes, it is recommended the probe is calibrated in a similar condition as is expected in the field measurement. If using in a flowing environment, for the most accurate results the calibration solutions should be stirred at a similar rate as to the expected flow of the environment. If the probe is to be used in a static environment (e.g. a lake or reservoir) then there is no requirement for stirring during calibration.

17.2. Calibration Points

All ISE electrodes have three calibration points. Careful calibration is essential in order to ensure consistent and reliable results. Prior to initial calibration, all ISE Electrodes should be soaked in their relevant Point 1 calibration solution for 20 – 30 minutes.

When an ISE electrode is first installed, **it MUST be calibrated at three points** in order to establish the electrode's slope and thermal characteristics. Two of the calibration points must be at the same temperature whilst the third must be at least 10ºC cooler.

Subsequently, a two-point calibration should be carried out weekly and a single point calibration should be carried out daily. The ISE electrode should be replaced every 6-12 months.

17.3. Special Notes Concerning ISE Electrodes during pH Calibration

The high ionic concentration of pH calibration solutions (buffers), including RapidCal, can cause significant offsets in ISE electrodes. ISE calibration solutions other than those for that specific ISE can contain interfering ions, again causing offsets.

These offsets are temporary, but best avoided because they can cause significant errors during both calibration and normal operation.

For this reason all ISE electrodes are supplied with a red rubber sealing cap.

The caps should be fitted to all ISE Electrodes when using pH calibration solutions or other ISE calibration solutions other then that specific for the ISE being calibrated in order to protect the ISE electrodes from the effects of the buffer solution and interfering ions.

The caps MUST NOT be fitted when calibrating optical electrodes or serious calibration errors will occur due to reflections from the caps.

17.4. 2000-AMM Ammonium/Ammonia Electrode

Ammonium (NH4) and Ammonia (NH3) can be measured by the Aquaprobe® using the optional 2000-AMM ISE electrode within a pH range of 5 – 8.

The Ammonium ISE electrode will suffer interference from Potassium, Sodium and Magnesium ions, which are similar in nature.

17.4.1. Pre-Prepared Calibration Solutions

Pre-prepared calibration solutions are available from your Aquaread dealer. Order codes AMM-CAL-10 and AMM-CAL-100. **These are recommended.** If you wish to formulate your own solutions, please follow the procedure detailed below.

17.4.2. Ammonium Calibration Solution Preparation

When an Ammonium ISE electrode is first installed, it must be calibrated at three points. In order to achieve this, three batches of Ammonium calibration solution must be prepared.

The solutions required are two 200mL batches of Ammonium (as NH4) at a concentration of 10ppm and one 250mL batch of Ammonium (as NH4) at a concentration of 100ppm.

The three calibration solutions should be freshly prepared by serial dilution from 1000ppm calibration standard if Aquaread pre-diluted solutions have not been purchased. The 1000ppm solution is available from Aquaread Dealers (part number AMM-CAL) but it is highly recommended to purchase the pre-diluted solutions if you are not equipped to use high accuracy volumetric liquid handling techniques or have access to high quality grade Deionised water.

Be sure to handle chemicals with care and to read and comply with all health and safety advice.

Preparing the 100ppm solution

250mL of 100ppm solution is required. To prepare this, mix 25mL of 1000ppm calibration standard with 225mL of deionised water.

Dispense 200mL of the 100ppm solution into a calibration bottle and retain 50mL for preparation of the 10ppm solution.

Preparing the 10ppm solution

A total of 400mL of 10ppm solution is required. To prepare this, mix 40mL of the 100ppm solution you have just prepared with 360mL of deionised water. Dispense the 10ppm solution into two calibration bottles (200mL each).

Achieving the correct temperature

During three point calibration, the 100ppm solution and one batch of the 10ppm solution must be at exactly the same temperature. The second batch of 10ppm solution must be at least 10ºC cooler.
In order to achieve this, one batch of the 10ppm solution should be put into a refrigerator and the other two solutions should be put into a water bath at 25ºC.

Once all three solutions are at a stable temperature, calibration can begin.

17.4.3. Three-point Calibration

During three-point calibration, the Aquaprobe® and Aquameter® must remain switched on. If the Aquameter® is switched off between points, the calibration process will be aborted and must be re-started from point 1. The Aquaprobe's sleeve should also be removed in order to reduce the Probe's thermal mass. To calibrate the ISE electrode follow these steps:

Point 1.

1. Remove the Probe Sleeve. Remove the storage cap from the pH electrode, wash the Probe in deionised water, dry the probe thoroughly then gently lower the Probe in to the warm **10ppm** solution.
2. Switch the Aquameter® and leave until the temperature and NH4 readings are completely stable. A minimum of five minutes is recommended.
3. Ensure the temperature of the solution is between 20ºC and 40ºC (68ºF - 104ºF).
4. Press the **MENU** key then select **Calibration.** The following screen will be displayed.

```
   Calibration
 → RapidCal
   DO 100%
   Full Cal
```

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

```
   Calibration
 → pH/REDOX(ORP)
   DO/EC
   Aux Electrodes
```

6. Select **Aux Electrodes**. The screen will change to:

```
 SELECT ELECTRODE
→1:TURB   | 4:EMPTY
 2:NH4    | 5:EMPTY
 3:EMPTY  | 6:EMPTY
```

The Ammonium (NH4) electrode should have been assigned to an AUX socket when it was fitted. Move the pointer to NH4 then press the OK or right arrow key to select.

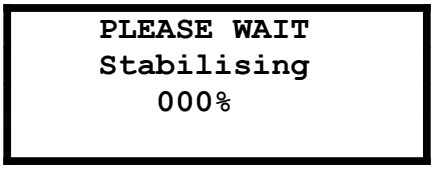
7.The screen will change to:

```
  CALIBRATE NH4
→ Pt-1? [01/Jan/17]
  Pt-2? [01/Jan/17]
  Pt-3? [01/Jan/17]
```

Calibration point 1 (Pt-1) is the warm 10ppm point. Calibration point 2 (Pt-2) is the warm 100ppm point. Calibration point 3 (Pt-3) is the cool 10ppm point.

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

8. 8. Select Pt-1. 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 output from the ISE electrode in millivolts (mV). This value is stored in the Probe's memory and can be recalled at any time. See section Error: Reference source not found Error: Reference source not found. Press OK then ESC repeatedly to return to normal reading mode.

Point 2

1. Remove the probe from the 10ppm solution and wash thoroughly in deionised water. Dry the probe then gently lower it into to the warm **100ppm** solution.
2. Leave until the temperature and NH4 readings are completely stable. A minimum of five minutes is recommended.
3. **Ensure the temperature of the solution is within 1ºC of the previous 10ppm calibration point.** If the solution is warmer or cooler than this, calibration will fail.
4. Referring to steps 4-7 above, select Pt-2 and press OK.

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 as shown above. If the calibration is successful, the counter will reach 100% and the calibration report screen will be displayed.

If the temperature of the 100ppm solution is more than 1ºC different from the Pt-1 calibration temperature, an OUT OF TEMP RANGE calibration error will be reported. If this happens, adjust the temperature and try again.

Point 3

1. Remove the probe from the 100ppm solution and wash thoroughly in deionised water. Dry the probe then gently lower it into to the **cool 10ppm** solution.
2. Leave until the temperature and NH4 readings are completely stable. A minimum of five minutes is recommended.
3. **Ensure the temperature of the solution is at least 10ºCThree-point calibration cooler than the previous 100ppm calibration point.** If the solution is too warm, calibration will fail.
4. Referring to steps 4-7 above, select Pt-3 and press OK.

17.5. 2000-NIT Nitrate Electrode

Nitrate (NO3) can be measured by the AP-2000 using the optional 2000-NIT ISE electrode within a pH range of 3 – 10.

The Nitrate ISE electrode will suffer interference from Chloride, Bromide, Fluoride, Sulphate, Chlorate and Perchlorate ions, which are similar in nature.

17.5.1. Pre-Prepared Calibration Solutions

Pre-prepared calibration solutions are available from your Aquaread dealer. Order codes NIT-CAL-10 and NIT-CAL-100. **These are recommended.** If you wish to formulate your own solutions, please follow the procedure detailed below.

17.5.2. Nitrate Calibration Solution Preparation

When a Nitrate ISE electrode is first installed, it must be calibrated at three points. In order to achieve this, three batches of Nitrate calibration solution must be prepared.

The solutions required are two 200mL batches of Nitrate at a concentration of 10ppm and one 250mL batch of Nitrate at a concentration of 100ppm.

The three calibration solutions should be freshly prepared by serial dilution from 1000ppm calibration standard if Aquaread pre-diluted solutions have not been purchased. The 1000ppm solution is available from Aquaread Dealers (part number NIT-CAL) but it is highly recommended to purchase the pre-diluted solutions if you are not equipped to use high accuracy volumetric liquid handling techniques or have access to high quality grade Deionised water.
Be sure to handle chemicals with care and to read and comply with all health and safety advice.

Preparing the 100ppm solution
250mL of 100ppm solution is required. To prepare this, mix 25mL of 1000ppm calibration standard with 225mL of deionised water.

Dispense 200mL of the 100ppm solution into a calibration bottle and retain 50mL for preparation of the 10ppm solution.

Preparing the 10ppm solution
A total of 400mL of 10ppm solution is required. To prepare this, mix 40mL of the 100ppm solution you have just prepared with 360mL of deionised water. Dispense the 10ppm solution into two calibration bottles (200mL each).

Achieving the correct temperature
During three point calibration, the 100ppm solution and one batch of the 10ppm solution must be at exactly the same temperature. The second batch of 10ppm solution must be at least 10ºC cooler.

In order to achieve this, one batch of the 10ppm solution should be put into a refrigerator and the other two solutions should be put into a water bath at 25ºC.

Once all three solutions are at a stable temperature, calibration can begin.

17.5.3. Three-point Calibration

During three-point calibration, the AP-2000 and Aquameter® must remain switched on. If the Aquameter® is switched off between points, the calibration process will be aborted and must be re-started from point 1. To calibrate the ISE electrode follow these steps:

Point 1.

1. Remove the storage cap from the pH electrode, wash the Probe in deionised water, dry the probe thoroughly then drop the Probe in to the warm **10ppm** solution.
2. Switch the Aquameter® on and leave the probe until the temperature and NO3 readings are completely stable. A minimum of five minutes is recommended.
3. Ensure the temperature of the solution is between 20ºC and 40ºC (68ºF - 104ºF).
4. Press the **MENU** key then select **Calibration.** The following screen will be displayed.

```
   Calibration
 → RapidCal
   DO 100%
   Full Cal
```

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

```
   Calibration
 → pH/REDOX(ORP)
   DO/EC
   Aux Electrodes
```

6. Select **Aux Electrodes**. The screen will change to:

```
 SELECT ELECTRODE
→1:TURB   | 4:N/A
 2:NO3    | 5:N/A
 3:N/A    | 6:N/A
```

The Nitrate (NO3) electrode should have been assigned to AUX socket 2 when it was fitted. Move the pointer down to 2:NO3 then press the OK or right arrow key to select.

7.The screen will change to:

```
  CALIBRATE NO3
→ Pt-1? [01/Jan/17]
  Pt-2? [01/Jan/17]
  Pt-3? [01/Jan/17]
```

Calibration point 1 (Pt-1) is the warm 10ppm point. Calibration point 2 (Pt-2) is the warm 100ppm point. Calibration point 3 (Pt-3) is the cool 10ppm point.

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

8. Select Pt-1. The screen will change to:

```
   PLEASE WAIT
   Stabilising
      000%
```

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 output from the ISE electrode in millivolts (mV). This value is stored in the Probe's memory and can be recalled at any time. See section 10.7. Calibration Data Storage and Retrieval. Press **OK** then **ESC** repeatedly to return to normal reading mode**.**

Point 2

1. Remove the probe from the 10ppm solution and wash thoroughly in deionised water. Dry the probe then drop it into to the warm **100ppm** solution.
2. Leave the probe until the temperature and NO3 readings are completely stable. A minimum of five minutes is recommended.
3. **Ensure the temperature of the solution is within 1ºC of the previous 10ppm calibration point.** If the solution is warmer or cooler than this, calibration will fail.
4. Referring to steps 4-7 above, select Pt-2 and press OK.

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 as shown above. If the calibration is successful, the counter will reach 100% and the calibration report screen will be displayed.

If the temperature of the 100ppm solution is more than 1ºC different from the Pt-1 calibration temperature, an OUT OF TEMP RANGE calibration error will be reported. If this happens, adjust the temperature and try again.

Point 3

1. Remove the probe from the 100ppm solution and wash thoroughly in deionised water. Dry the probe then drop it into to the **cool 10ppm** solution.
2. Leave the probe until the temperature and NO3 readings are completely stable. A minimum of five minutes is recommended.
3. **Ensure the temperature of the solution is at least 10ºC cooler than the previous 100ppm calibration point.** If the solution is too warm, calibration will fail.
4. Referring to steps 4-7 above, select Pt-3 and press OK.

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 as shown above. If the calibration is successful, the counter will reach 100% and the calibration report screen will be displayed.

If the temperature of the cool 10ppm solution is less than 10ºC cooler than the Pt-1 and Pt-2 calibration temperatures, an OUT OF TEMP RANGE calibration error will be reported. If this happens, adjust the temperature and try again.

17.5.4. Two-point Calibration

Two-point calibration should be carried out weekly. For this, 10ppm and 100ppm solutions are required. The two solutions can be at any temperature between 5ºC and 30ºC but they both must be the same temperature (within 1ºC).

If the temperature of the two solutions differ by more than 1ºC, an OUT OF TEMP RANGE calibration error will be reported. If this happens, adjust the temperature and try again.

During two-point calibration, the AP-2000 and Aquameter® must remain switched on. If the Aquameter® is switched off between points, the calibration process will be aborted and must be re-started from point 1.

To calibrate the ISE electrode follow the steps outlined above under three-point calibration for points 1 and 2 only.

17.5.5. Single-point Calibration

Single-point calibration should be carried out daily. For this, just 10ppm solution is required. The solution can be at any temperature between 5ºC and 30ºC .

To calibrate the ISE electrode follow the steps outlined above under three-point calibration for points 1 only.

17.5.6. Errors During Calibration

If a problem occurs during calibration, an error message will be displayed. Refer to Calibration Error Messages for error message handling.

17.6. 2000-CHL Chloride Electrode

Chloride (Cl) can be measured by the AP-2000 using the optional 2000-CHL ISE electrode within a pH range of 2 – 11.

The Chloride ISE electrode will suffer interference from Bromide, Iodide, Cyanide and Sulphide ions, which are similar in nature.

17.6.1. Pre-Prepared Calibration Solutions

Pre-prepared calibration solutions are available from your Aquaread dealer. Order codes CHL-CAL-10 and CHL-CAL-100. **These are recommended.** If you wish to formulate your own solutions, please follow the procedure detailed below.

17.6.2. Chloride Calibration Solution Preparation

When a Chloride ISE electrode is first installed, it must be calibrated at three points. In order to achieve this, three batches of Chloride calibration solution must be prepared.

The solutions required are two 200mL batches of Chloride at a concentration of 10ppm and one 250mL batch of Chloride at a concentration of 100ppm.

The three calibration solutions should be freshly prepared by serial dilution from 1000ppm calibration standard if Aquaread pre-diluted solutions have not been purchased. The 1000ppm solution is available from Aquaread Dealers (part number CHL-CAL) but it is highly recommended to purchase the pre-diluted solutions if you are not equipped to use high accuracy volumetric liquid handling techniques or have access to high quality grade Deionised water.

Be sure to handle chemicals with care and to read and comply with all health and safety advice.

Preparing the 100ppm solution

250mL of 100ppm solution is required. To prepare this, mix 25mL of 1000ppm calibration standard with 225mL of deionised water.

Dispense 200mL of the 100ppm solution into a calibration bottle and retain 50mL for preparation of the 10ppm solution.

Preparing the 10ppm solution

A total of 400mL of 10ppm solution is required. To prepare this, mix 40mL of the 100ppm solution you have just prepared with 360mL of deionised water. Dispense the 10ppm solution into two calibration bottles (200mL each).

Achieving the correct temperature

During three point calibration, the 100ppm solution and one batch of the 10ppm solution must be at exactly the same temperature. The second batch of 10ppm solution must be at least 10ºC cooler.

In order to achieve this, one batch of the 10ppm solution should be put into a refrigerator and the other two solutions should be put into a water bath at 25ºC.

Once all three solutions are at a stable temperature, calibration can begin.

17.6.3. Three-point Calibration

During three-point calibration, the AP-2000 and Aquameter® must remain switched on. If the Aquameter® is switched off between points, the calibration process will be aborted and must be re-started from point 1. To calibrate the ISE electrode follow these steps:

Point 1.

1. Remove the storage cap from the pH electrode, wash the Probe in deionised water, dry the probe thoroughly then drop the Probe in to the warm **10ppm** solution.
2. Switch the Aquameter® on and leave the probe until the temperature and Cl readings are completely stable. A minimum of five minutes is recommended.
3. Ensure the temperature of the solution is between 20ºC and 40ºC (68ºF - 104ºF).
4. Press the **MENU** key then select **Calibration.** The following screen will be displayed.

```
   Calibration
 → RapidCal
   DO 100%
   Full Cal
```

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

```
   Calibration
 → pH/REDOX(ORP)
   DO/EC
   Aux Electrodes
```

6. Select **Aux Electrodes**. The screen will change to:

```
 SELECT ELECTRODE
→1:TURB   | 4:N/A
 2:Cl     | 5:N/A
 3:N/A    | 6:N/A
```

The Chloride (Cl) electrode should have been assigned to AUX socket 2 when it was fitted. Move the pointer down to 2:Cl then press the OK or right arrow key to select.

7.The screen will change to:

```
  CALIBRATE Cl
→ Pt-1? [01/Jan/17]
  Pt-2? [01/Jan/17]
  Pt-3? [01/Jan/17]
```

Calibration point 1 (Pt-1) is the warm 10ppm point. Calibration point 2 (Pt-2) is the warm 100ppm point. Calibration point 3 (Pt-3) is the cool 10ppm point.

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

8. Select Pt-1. The screen will change to:

```
   PLEASE WAIT
   Stabilising
      000%
```

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 output from the ISE electrode in millivolts (mV). This value is stored in the Probe's memory and can be recalled at any time. See section 10.7. Calibration Data Storage and Retrieval. Press **OK** then **ESC** repeatedly to return to normal reading mode**.**

Point 2

1. Remove the probe from the 10ppm solution and wash thoroughly in deionised water. Dry the probe then drop it into to the warm **100ppm** solution.
2. Leave the probe until the temperature and Cl readings are completely stable. A minimum of five minutes is recommended.
3. **Ensure the temperature of the solution is within 1ºC of the previous 10ppm calibration point.** If the solution is warmer or cooler than this, calibration will fail.
4. Referring to steps 4-7 above, select Pt-2 and press OK.

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 as shown above. If the calibration is successful, the counter will reach 100% and the calibration report screen will be displayed.

If the temperature of the 100ppm solution is more than 1ºC different from the Pt-1 calibration temperature, an OUT OF TEMP RANGE calibration error will be reported. If this happens, adjust the temperature and try again.

Point 3

1. Remove the probe from the 100ppm solution and wash thoroughly in deionised water. Dry the probe then drop it into to the **cool 10ppm** solution.
2. Leave the probe until the temperature and Cl readings are completely stable. A minimum of five minutes is recommended.
3. **Ensure the temperature of the solution is at least 10ºC cooler than the previous 100ppm calibration point.** If the solution is too warm, calibration will fail.
4. Referring to steps 4-7 above, select Pt-3 and press OK.

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 as shown above. If the calibration is successful, the counter will reach 100% and the calibration report screen will be displayed.

If the temperature of the cool 10ppm solution is less than 10ºC cooler than the Pt-1 and Pt-2 calibration temperatures, an OUT OF TEMP RANGE calibration error will be reported. If this happens, adjust the temperature and try again.

17.6.4. Two-point Calibration

Two-point calibration should be carried out weekly. For this, 10ppm and 100ppm solutions are required. The two solutions can be at any temperature between 5ºC and 30ºC but they both must be the same temperature (within 1ºC).

If the temperature of the two solutions differ by more than 1ºC, an OUT OF TEMP RANGE calibration error will be reported. If this happens, adjust the temperature and try again.

During two-point calibration, the AP-2000 and Aquameter® must remain switched on. If the Aquameter® is switched off between points, the calibration process will be aborted and must be re-started from point 1.

To calibrate the ISE electrode follow the steps outlined above under three-point calibration for points 1 and 2 only.

17.6.5. Single-point Calibration

Single-point calibration should be carried out daily. For this, just 10ppm solution is required. The solution can be at any temperature between 5ºC and 30ºC .

To calibrate the ISE electrode follow the steps outlined above under three-point calibration for points 1 only.

17.6.6. Errors During Calibration

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

17.7. 2000-CAL Calcium Electrode

Calcium (Ca2) can be measured by the AP-2000 using the optional 2000-CAL ISE electrode within a pH range of 4 – 9.

The Calcium ISE electrode will suffer interference from Magnesium, Barium, Lead, Zinc and Sodium ions, which are similar in nature.

17.7.1. Pre-Prepared Calibration Solutions

Pre-prepared calibration solutions are available from your Aquaread dealer. Order codes CAL-CAL-10 and CAL-CAL-100. **These are recommended.** If you wish to formulate your own solutions, please follow the procedure detailed below.

17.7.2. Calcium Calibration Solution Preparation

When a Calcium ISE electrode is first installed, it must be calibrated at three points. In order to achieve this, three batches of Calcium calibration solution must be prepared.

The solutions required are two 200mL batches of Calcium at a concentration of 10ppm and one 250mL batch of Calcium at a concentration of 100ppm.

The three calibration solutions should be freshly prepared by serial dilution from 1000ppm calibration standard if Aquaread pre-diluted solutions have not been purchased. The 1000ppm solution is available from Aquaread Dealers (part number CAL-CAL) but it is highly recommended to purchase the pre-diluted solutions if you are not equipped to use high accuracy volumetric liquid handling techniques or have access to high quality grade Deionised water.

Be sure to handle chemicals with care and to read and comply with all health and safety advice.

Preparing the 100ppm solution

250mL of 100ppm solution is required. To prepare this, mix 25mL of 1000ppm calibration standard with 225mL of deionised water.

Dispense 200mL of the 100ppm solution into a calibration bottle and retain 50mL for preparation of the 10ppm solution.

Preparing the 10ppm solution

A total of 400mL of 10ppm solution is required. To prepare this, mix 40mL of the 100ppm solution you have just prepared with 360mL of deionised water. Dispense the 10ppm solution into two calibration bottles (200mL each).

Achieving the correct temperature

During three point calibration, the 100ppm solution and one batch of the 10ppm solution must be at exactly the same temperature. The second batch of 10ppm solution must be at least 10ºC cooler.

In order to achieve this, one batch of the 10ppm solution should be put into a refrigerator and the other two solutions should be put into a water bath at 25ºC.

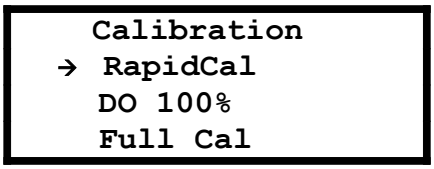
Once all three solutions are at a stable temperature, calibration can begin.

17.7.3. Three-point Calibration

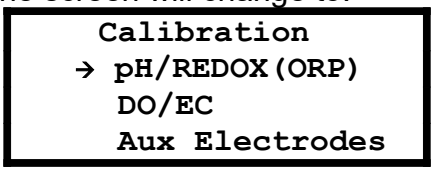
During three-point calibration, the AP-2000 and Aquameter® must remain switched on. If the Aquameter® is switched off between points, the calibration process will be aborted and must be re-started from point 1. To calibrate the ISE electrode follow these steps:

Point 1.

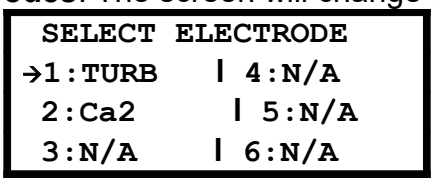
1. Remove the storage cap from the pH electrode, wash the Probe in deionised water, dry the probe thoroughly then drop the Probe in to the warm **10ppm** solution.
2. Switch the Aquameter® on and leave the probe until the temperature and Ca2 readings are completely stable. A minimum of five minutes is recommended.
3. Ensure the temperature of the solution is between 20ºC and 40ºC (68ºF - 104ºF).
4. Press the **MENU** key then select **Calibration.** The following screen will be displayed.



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

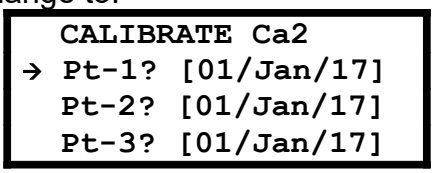


6. Select **Aux Electrodes**. The screen will change to:



The Calcium (Ca2) electrode should have been assigned to AUX socket 2 when it was fitted. Move the pointer down to 2:Ca2 then press the OK or right arrow key to select.

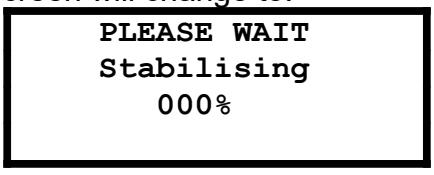
7.The screen will change to:



Calibration point 1 (Pt-1) is the warm 10ppm point. Calibration point 2 (Pt-2) is the warm 100ppm point. Calibration point 3 (Pt-3) is the cool 10ppm point.

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

8. Select Pt-1. 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 output from the ISE electrode in millivolts (mV). This value is stored in the Probe's memory and can be recalled at any time. See section 10.7. Calibration Data Storage and Retrieval. Press **OK** then **ESC** repeatedly to return to normal reading mode**.**

Point 2

1. Remove the probe from the 10ppm solution and wash thoroughly in deionised water. Dry the probe then drop it into to the warm **100ppm** solution.
2. Leave the probe until the temperature and Ca2 readings are completely stable. A minimum of five minutes is recommended.
3. **Ensure the temperature of the solution is within 1ºC of the previous 10ppm calibration point.** If the solution is warmer or cooler than this, calibration will fail.
4. Referring to steps 4-7 above, select Pt-2 and press OK.

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 as shown above. If the calibration is successful, the counter will reach 100% and the calibration report screen will be displayed.

If the temperature of the 100ppm solution is more than 1ºC different from the Pt-1 calibration temperature, an OUT OF TEMP RANGE calibration error will be reported. If this happens, adjust the temperature and try again.

Point 3

1. Remove the probe from the 100ppm solution and wash thoroughly in deionised water. Dry the probe then drop it into to the **cool 10ppm** solution.
2. Leave the probe until the temperature and Ca2 readings are completely stable. A minimum of five minutes is recommended.
3. **Ensure the temperature of the solution is at least 10ºC cooler than the previous 100ppm calibration point.** If the solution is too warm, calibration will fail.
4. Referring to steps 4-7 above, select Pt-3 and press OK.

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 as shown above. If the calibration is successful, the counter will reach 100% and the calibration report screen will be displayed.

If the temperature of the cool 10ppm solution is less than 10ºC cooler than the Pt-1 and Pt-2 calibration temperatures, an OUT OF TEMP RANGE calibration error will be reported. If this happens, adjust the temperature and try again.

17.7.4. Two-point Calibration

Two-point calibration should be carried out weekly. For this, 10ppm and 100ppm solutions are required. The two solutions can be at any temperature between 5ºC and 30ºC but they both must be the same temperature (within 1ºC).

If the temperature of the two solutions differ by more than 1ºC, an OUT OF TEMP RANGE calibration error will be reported. If this happens, adjust the temperature and try again.

During two-point calibration, the AP-2000 and Aquameter® must remain switched on. If the Aquameter® is switched off between points, the calibration process will be aborted and must be re-started from point 1.

To calibrate the ISE electrode follow the steps outlined above under three-point calibration for points 1 and 2 only.

17.7.5. Single-point Calibration

Single-point calibration should be carried out daily. For this, just 10ppm solution is required. The solution can be at any temperature between 5ºC and 30ºC .

To calibrate the ISE electrode follow the steps outlined above under three-point calibration for points 1 only.

17.7.6. Errors During Calibration

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

17.8. 2000-FLU Fluoride Electrode

Fluoride (F) can be measured by the AP-2000 using the optional 2000-FLU ISE electrode within a pH range of 4 – 8.

The Fluoride ISE electrode will suffer interference from hydroxide (OH-) ions, which are similar in nature.

17.8.1. Pre-Prepared Calibration Solutions

Pre-prepared calibration solutions are available from your Aquaread dealer. Order codes FLU-CAL-0.5 and FLU-CAL-5. **These are recommended.** If you wish to formulate your own solutions, please follow the procedure detailed below.

17.8.2. Fluoride Calibration Solution Preparation

When a Fluoride ISE electrode is first installed, it must be calibrated at three points. In order to achieve this, three batches of Fluoride calibration solution must be prepared.

The solutions required are two 200mL batches of Fluoride at a concentration of 0.5ppm and one 250mL batch of Fluoride at a concentration of 5ppm.

The three calibration solutions should be freshly prepared by serial dilution from 1000ppm calibration standard if Aquaread pre-diluted solutions have not been purchased. The 1000ppm solution is available from Aquaread Dealers (part number FLU-CAL) but it is highly recommended to purchase the pre-diluted solutions if you are not equipped to use high accuracy volumetric liquid handling techniques or have access to high quality grade Deionised water.

Be sure to handle chemicals with care and to read and comply with all health and safety advice.

Preparing the 5ppm solution

250mL of 5ppm solution is required.

To prepare this, first make an intermediate dilution of 50ppm. To do this, mix 6mL of 1000ppm calibration standard with 114mL of deionised water. This will produce 120mL of 50ppm solution.

Next mix 25mL of the 50ppm solution with 225mL of deionised water. This will produce 250mL of 5ppm solution.

Dispense 200mL of the 5ppm solution into a calibration bottle and retain the rest for preparation of the 0.5ppm solution.

Preparing the 0.5ppm solution

A total of 400mL of 0.5ppm solution is required. To prepare this, mix 40mL of the 5ppm solution you have just prepared with 360mL of deionised water. Dispense the 0.5ppm solution into two calibration bottles (200mL each).

Achieving the correct temperature

During three point calibration, the 5ppm solution and one batch of the 0.5ppm solution must be at exactly the same temperature. The second batch of 0.5ppm solution must be at least 10ºC cooler.

In order to achieve this, one batch of the 0.5ppm solution should be put into a refrigerator and the other two solutions should be put into a water bath at 25ºC.

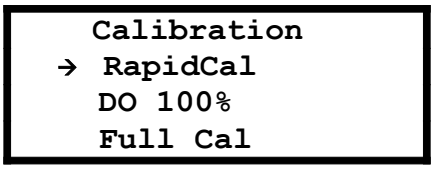
Once all three solutions are at a stable temperature, calibration can begin.

17.8.3. Three-point Calibration

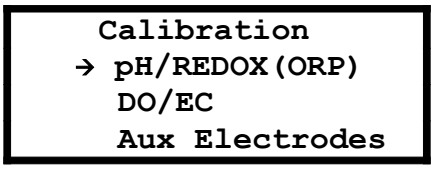
During three-point calibration, the AP-2000 and Aquameter® must remain switched on. If the Aquameter® is switched off between points, the calibration process will be aborted and must be re-started from point 1. To calibrate the ISE electrode follow these steps:

Point 1.

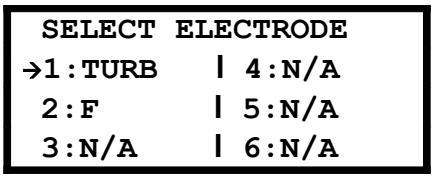
1. Remove the storage cap from the pH electrode, wash the Probe in deionised water, dry the probe thoroughly then drop the Probe in to the warm **0.5ppm** solution.
2. Switch the Aquameter® on and leave the probe until the temperature and F readings are completely stable. A minimum of five minutes is recommended.
3. Ensure the temperature of the solution is between 20ºC and 40ºC (68ºF - 104ºF).
4. Press the **MENU** key then select **Calibration.** The following screen will be displayed.



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

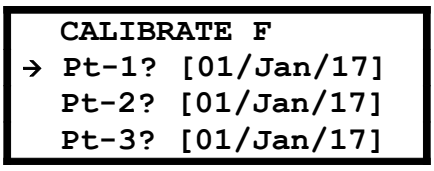


6. Select **Aux Electrodes**. The screen will change to:



The Fluoride (F) electrode should have been assigned to AUX socket 2 when it was fitted. Move the pointer down to 2:F then press the OK or right arrow key to select.

7.The screen will change to:

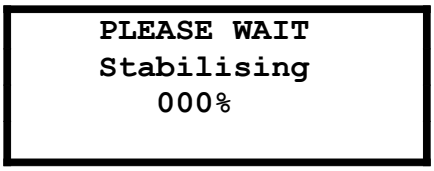


Calibration point 1 (Pt-1) is the warm 0.5ppm point. Calibration point 2 (Pt-2) is the warm

5ppm point. Calibration point 3 (Pt-3) is the cool 0.5ppm point.

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

8. Select Pt-1. 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 output from the ISE electrode in millivolts (mV). This value is stored in the Probe's memory and can be recalled at any time. See section 10.7. Calibration Data Storage and Retrieval. Press **OK** then **ESC** repeatedly to return to normal reading mode**.**

Point 2

1. Remove the probe from the 0.5ppm solution and wash thoroughly in deionised water. Dry the probe then drop it into to the warm **5ppm** solution.
2. Leave the probe until the temperature and F readings are completely stable. A minimum of five minutes is recommended.
3. **Ensure the temperature of the solution is within 1ºC of the previous 0.5ppm calibration point.** If the solution is warmer or cooler than this, calibration will fail.
4. Referring to steps 4-7 above, select Pt-2 and press OK.

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 as shown above. If the calibration is successful, the counter will reach 100% and the calibration report screen will be displayed.

If the temperature of the 5ppm solution is more than 1ºC different from the Pt-1 calibration temperature, an OUT OF TEMP RANGE calibration error will be reported. If this happens, adjust the temperature and try again.

Point 3

1. Remove the probe from the 5ppm solution and wash thoroughly in deionised water. Dry the probe then drop it into to the **cool 0.5ppm** solution.
2. Leave the probe until the temperature and F readings are completely stable. A minimum of five minutes is recommended.
3. **Ensure the temperature of the solution is at least 10ºC cooler than the previous 5ppm calibration point.** If the solution is too warm, calibration will fail.
4. Referring to steps 4-7 above, select Pt-3 and press OK.

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 as shown above.
If the calibration is successful, the counter will reach 100% and the calibration report screen will be displayed.

If the temperature of the cool 0.5ppm solution is less than 10ºC cooler than the Pt-1 and Pt-2 calibration temperatures, an OUT OF TEMP RANGE calibration error will be reported. If this happens, adjust the temperature and try again.

17.8.4. Two-point Calibration

Two-point calibration should be carried out weekly. For this, 0.5ppm and 5ppm solutions are required. The two solutions can be at any temperature between 5ºC and 30ºC but they both must be the same temperature (within 1ºC).

If the temperature of the two solutions differ by more than 1ºC, an OUT OF TEMP RANGE calibration error will be reported. If this happens, adjust the temperature and try again.

During two-point calibration, the AP-2000 and Aquameter® must remain switched on. If the Aquameter® is switched off between points, the calibration process will be aborted and must be re-started from point 1.

To calibrate the ISE electrode follow the steps outlined above under three-point calibration for points 1 and 2 only.

17.8.5. Single-point Calibration

Single-point calibration should be carried out daily. For this, just 0.5ppm solution is required. The solution can be at any temperature between 5ºC and 30ºC .

To calibrate the ISE electrode follow the steps outlined above under three-point calibration for points 1 only.

17.8.6. Errors During Calibration

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

18. AquaLink PC Software

AquaLink is a utility program designed to run under Microsoft® Windows® on a stand-alone PC with a minimum screen resolution of 1024 x 768 and an available USB 2.0 socket.

18.1. Downloading AquaLink™ PC Software from the Aquaread® website

The AquaLink™ PC Software is available for download using the following link: http://www.aquaread.com/downloads.php

From the Aquaread® Downloads page, select 'AquaLink-Aquameter Utility'. The software will be downloaded as a .ZIP file.

18.2. Software Installation

Unzip the downloaded .ZIP file into a temporary directory . Browse the temporary directory and click on '**setup.exe**'. You will be given the usual Windows® security warnings. Allow the software to install. Once installed, AquaLink™ will run automatically.

To communicate with the Aquameter, two further software 'drivers' need to be installed. These are the '**Aquameter**' driver and a '**USB Serial Port**' driver.

18.3. Driver Installation

Connect the Aquameter to your PC using the USB cable provided. The 'Found New Hardware' wizard on your PC should activate automatically.

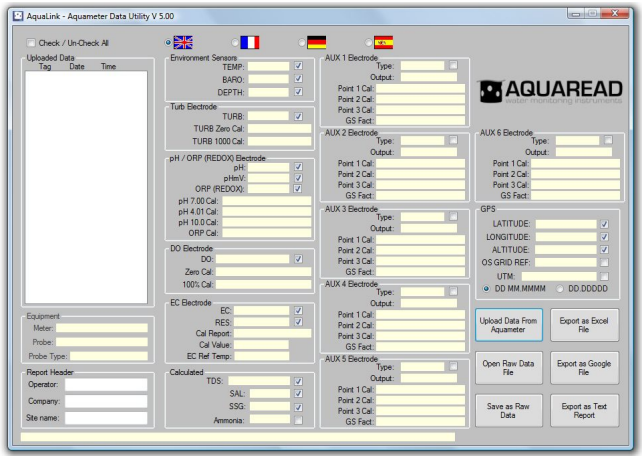
Different versions of Windows® react to plugging USB devices in differently. Earlier versions will give you the option to '**locate and install driver software**'. If this happens, direct Windows® to your temporary directory containing the unzipped download.

If your version of Windows® tries to search the Internet or 'Windows Update' for the drivers, you can allow this to happen or you can stop the search and direct Windows® to your temporary directory.

If Windows® reports a problem installing the drivers, go to your Windows® Device Manager, locate the 'Aquameter' device and update the driver forcing Windows® to search your temporary directory for the driver. Repeat this process for the USB Serial Port.

18.4. Running AquaLink

Select AquaLink from your Programs menu. After an introductory splash-screen has been displayed, the following screen will appear:

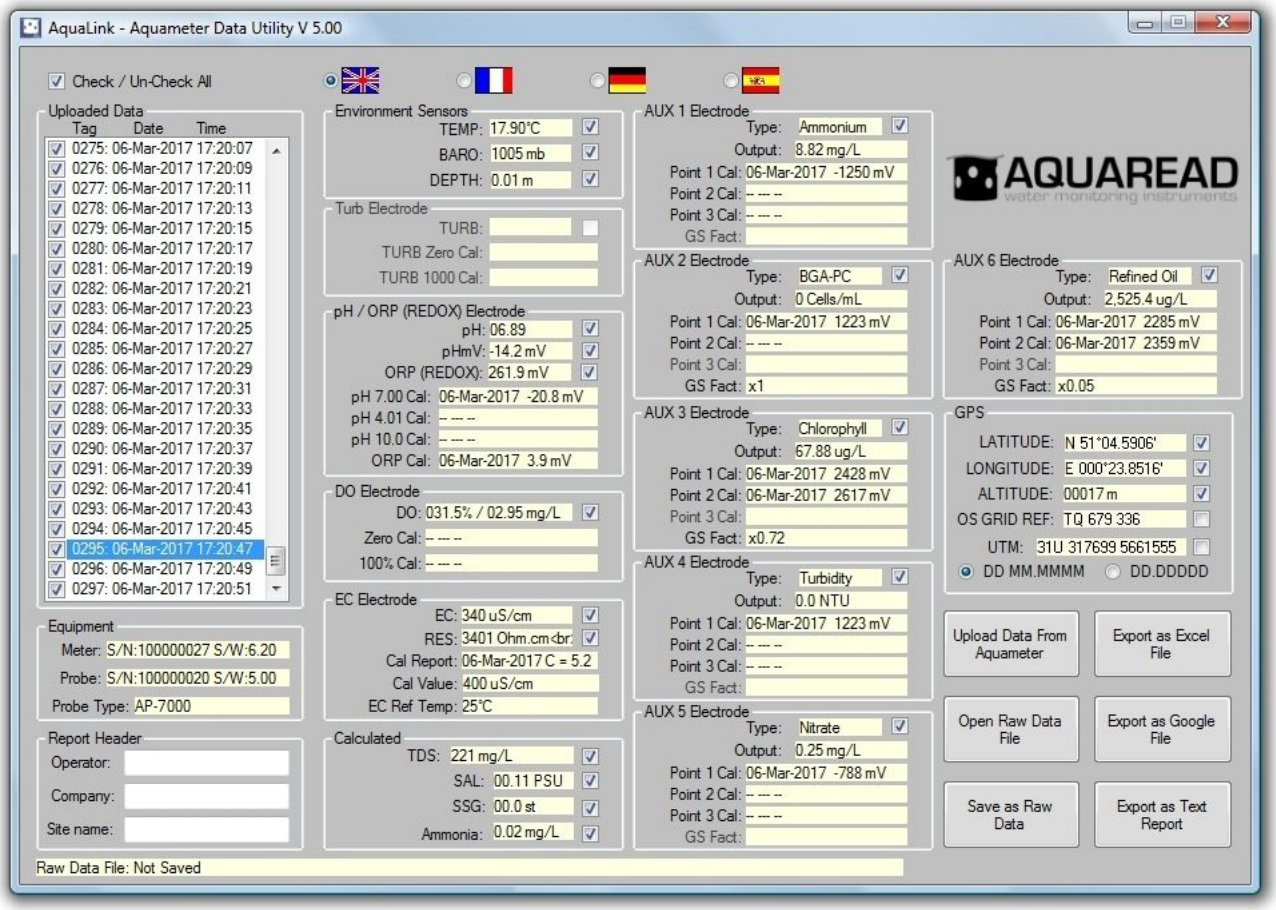


Select your preferred operating language by clicking on one of the national flags.

18.5. Uploading Data From Your Aquameter®

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

Click the '**Upload Data From Aquameter®**' button. AquaLink will search for the Aquameter® 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 Aquameter® 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.

18.6. 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 Aquameter® 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.

18.7. 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.

18.8. Saving Logged Data

Once a set of logged data has been uploaded from the Aquameter®, it can be saved on your PC as a Raw Data file. These files use a proprietary Aquaread® format and are saved with a .amf (**Aquameter® 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 Aquameter®'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.

18.9. 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.

18.10. Exporting Data

AquaLink 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.

18.11. 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 AquaLink Text Reports as this handles text file formatting better than Microsoft® Notepad.

A typical report cover page follows.

18.12. Typical Text Report Cover Page

AquaLink REPORT

File name:	C:\Test\3 day test 024690136.txt
Operator name:	G.E.M.
Company name:	Aquaread® 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.

18.13. 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 AquaLink 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'.

18.14. 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 Google™ Earth, where the data is overlaid on satellite images.

18.15. 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, either double click on your .KML file or follow these steps:

1. Click on '**File**'.
2. Select '**Open**' from the list.
3. Browse for the .KML file you exported from AquaLink, 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.

A typical Google™ Earth image follows.

18.16. Google™ Example

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.

19. Limited Warranty

All Aquaread® Meters are guaranteed for three years, Probes, Flow-Through Cells and individual optical electrodes are guaranteed for two years from date of purchase against defects in workmanship and materials when used for their intended purpose and maintained according to instructions.

Cables and connectors are guaranteed for two years from date of purchase against defects in workmanship and materials. This guarantee does not cover mechanical damage of any kind, including connector damage caused by misalignment or the application of excessive torque.

Consumables, such as pH/ORP electrodes, ISE electrodes, DO caps and all chemicals are covered by an out-of-the-box warranty only. That is to say, if they are faulty when delivered, they will be replaced. Thereafter, there is no 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@aquaread.com). Report the model number, date of purchase, serial number and problem. You will be given a Returns Authorisation 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. Upon receipt of payment, your equipment will be repaired and returned.

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.

19.2. Decontamination Certificate

Please print this certificate, complete all sections, and enclose it with any returned equipment.

Decontamination Certificate

Company Name: _____

Address:

_____

_____

_____

_____

Postal code: _____

Country: _____

Phone: _____

email: _____

Product(s): _____

Serial Number(s): _____

Contaminant (if known):

_____

Decontamination Procedure:

_____

_____

Certified by (print name) : _____

Title: _____

Date: _____

Signature: _____

Please note, returns without an acceptable decontamination procedure being performed prior to sending will be returned to you for decontamination or a cleaning fee will be charged if the contaminant is not hazardous to health.

20. TROUBLESHOOTING

This section details some of the common difficulties you may encounter when using the Aquameter®, Aquaprobe®s and AquaLink software. Try all the suggested remedies. If your problem is still unresolved, contact our Service Department (service@Aquaread.com).

Problem	Cause / Remedy
The Aquameter® 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 Aquameter® 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 Aquameter® can not find the Aquaprobe®.	✓ Probably a poor connection. Switch the Aquameter® off, disconnect the Aquaprobe®, ensure there is no debris or moisture in the plugs and sockets, then re-connect ensuring they are fully inserted and that the screw collars are fully tightened.
The GPS Aquameter® will not show a position fix.	✓ The Aquameter® probably does not have a good enough view of the available satellites. Ensure there are no obstructions between the Aquameter® and the open sky. Remember, GPS **does not** work indoors.
The AquaLink software can not find the Aquameter®.	✓ 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 Aquameter® when it is connected to a PC.	✓ The batteries in the Aquameter® 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 Aquameter®. ✓ There may be a problem with the USB socket on the PC, try an alternative socket.
ERROR 01 appears on the Aquameter® 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 Aquameter® screen.	✓ 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 Aquameter® screen.	✓ This indicates that the Aquaprobe® has stopped responding to requests for data from the Aquameter®. Check the Aquaprobe® plug is fully inserted. Cycle the power to reset the Aquaprobe®.
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.	✓ The DO electrode may need calibrating. Recalibrate. ✓ The DO membrane may be dirty. Clean the DO membrane. ✓ Calibration may have been carried out at an extreme temperature. Recalibrate at a temperature as close to the sample temperature as possible.

Troubleshooting Continued …

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 the Probe Sleeve fitted? EC will not work without the Probe Sleeve fitted. ✓ The Aquaprobe® 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 Aquaprobe®. ✓ Trapped air bubbles may be causing problems. Tap and swish the Aquaprobe® 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 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 the Probe Sleeve and end cap fitted? Turbidity will not work without the Probe Sleeve and end cap fitted. ✓ Trapped air bubbles may be causing interference. Tap and swish the Aquaprobe® to dislodge them. ✓ The sample being measured may contain air bubbles. Under these conditions, optical turbidity measurements can not be taken. ✓ The Aquaprobe® 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 Aquaprobe®. ✓ 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 then recalibrate. ✓ The Turbidity electrodes may need recalibrating. Recalibrate. ✓ The lenses on the turbidity electrodes may be dirty. Clean the lenses then recalibrate. ✓ See Appendix 7. Troubleshooting Turbidity.
Turbidity readings are negative in clear water.	✓ Erroneous zero point calibration caused either by contaminated calibration solution or changes in the measurement chamber between zeroing and deployment. Thoroughly clean the Probe then re-zero in completely clean/clear water. ✓ Ensure probe sleeve end cap is fitted. ✓ See Appendix 7. Troubleshooting Turbidity.

21. DECLARATIONS OF CONFORMITY

21.1. CE Declaration

21.2. UK CA declaration

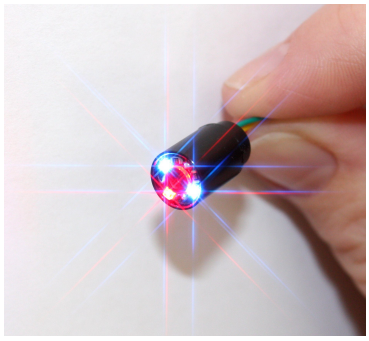
22. Appendix 1. The Tech Behind Aquaread's Optical DO Measurement System

22.1. Principle of Operation

The Aquaread® AquaPlus™ 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. Calling on many years' experience designing military Night Vision Goggle (NVG) compatible optics, Aquaread® engineers have produced an amazingly small and elegant solution.

Housed in a resin filled, marine grade aluminium body that measures just 8mm (0.3") diameter by 13mm (0.5") long, the fully waterproof AquaPlus Sensor Module contains blue excitation and red reference LEDs, optical filters, a photon detector, temperature sensor, driver circuitry and high gain amplification circuitry.



The nano-engineered AquaPlus™ Sensor Module

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 AquaPlus™ 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 AquaPlus™ 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 several years.

23. Appendix 2. Flow Through Cell

23.1. Introduction

The Aquaread® AP-2000 Flow Through Cell (Flowcell) is designed for use with the AP-700, AP-800 and AP-2000 in conjunction with most third party pumping device.

The Flowcell allows sample water to flow up through the Aquaprobe®, 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 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. Aquaprobe® Installation

The Probe sleeve must be fitted to the Aquaprobe®, but the protective **Sleeve End Cap should not be fitted**.

Loosen the screw collar located at the top of the Flowcell and slide the Aquaprobe® 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 Aquaprobe® in place.

23.4. Zeroing Optical Electrodes

If you have any optical electrodes fitted, prior to inserting the Aquaprobe® in the Flowcell, block the inlet spigot and fill the Flowcell with clean, still mineral water. Now insert the Aquaprobe® and zero each optical electrode in turn.

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 Aquameter® 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 Aquaprobe® 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 or other optical electrode readings are abnormally high or are fluctuating wildly.	✔ 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. ✔ Optical electrode not zeroed in Flowcell. Fill the Flowcell with clean water and Zero the optical electrode.
Sample water is leaking from around the top of the screw collar.	✔ Screw collar is not tight enough. Tighten up. ✔ Operating pressure is too high. Reduce pressure / flow rate.
Probe is forced up out of the Flowcell during use.	✔ Operating pressure is much too high. Reduce pressure / flow rate.

24. Appendix 3. Fitting AUX Electrodes

There are two different types of AUX Electrodes designed for use with the Aquaprobe®. These are Optical Electrodes and ISE Electrodes. Optical Electrodes can be identified by the four-section gold connector whilst ISE Electrodes feature a single pin gold connector.

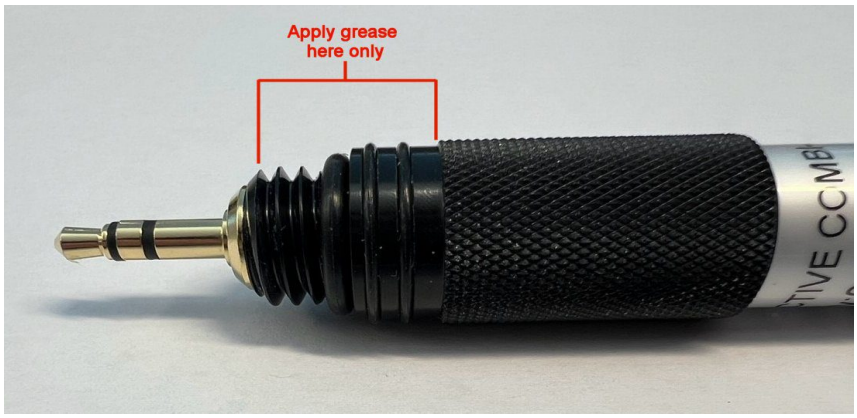
ENSURE NO GREASE IS APPLIED TO THE GOLD CONTACTS

Optical Electrodes are designed to fit into the AP-800 and AP-2000 socket labelled AUX1. ISE Electrodes are designed to fit into the AP-2000 socket labelled AUX2.

24.1. Installing AUX Electrodes

First, identify the type of electrode you are installing, then remove the blanking plug from the relevant AUX socket on the Aquaprobe®. To remove the blanking plug and subsequently tighten the AUX Electrode, use the red lanyard that is attached to the pH/ORP storage cap as a belt wrench as shown below.

Apply a small amount of silicone grease (supplied with the Aquaprobe®) to the threaded section and the O-ring of the AUX Electrode (see photograph). **ENSURE NO GREASE IS APPLIED TO THE GOLD CONTACTS**.



Using a clean cloth or tissue paper, polish the gold contacts ensuring they are completely clean. Carefully insert the electrode into the AUX socket and tighten firmly until the O-ring is completely compressed.

Optical electrodes, when fitted, sit adjacent to the DO electrode. If the DO electrode has a red warning label fitted (see photo below), the label must be removed in order to prevent reflections.

24.2. Socket Assignment and Calibration

After installation, it is essential to connect the Aquaprobe® to an Aquameter® and assign the new electrode type to the relevant AUX Socket. On the Aquameter®, press the MENU key, then select Setup & Install followed by Socket Assignment. When the Socket Assignment option has been selected, the following screen will be displayed.

```
 SOCKET ASSIGNMENTS
→1:EMPTY  | 4:N/A
 2:EMPTY  | 5:N/A
 3:N/A    | 6:N/A
```

Using the up and down arrow keys, select the AUX socket you wish to assign then move the cursor to the right by pressing the right arrow key. When the cursor has moved to the right of the AUX socket number, use the up and down arrow keys to select the appropriate electrode type. The tables below show the available electrode options and the selection that should be made on this screen:

AP-2000/5000 type Optical Electrodes (AUX1 only)

Electrode Part No.	Function	Aquameter® Selection
2000/5000-TURB	Turbidity	TURB
2000/5000-CPHYLL	Chlorophyll	Cphl
2000/5000-BGA-PC	Phycocyanin (Blue-Green Algae PC)	BGA-PC
2000/5000-BGA-PE	Phycoerythrin (Blue-Green Algae PE)	BGA-PE
2000/5000-RHOD	Rhodamine WT Dye	Rhod
2000/5000-FSCEIN	Fluorescein Dye	Fcein
2000/5000-REFOIL	Refined Oil	R-OIL
2000/5000-CDOM	CDOM/FDOM	CDOM

AP-5000/7000 type ISE Electrodes (AUX1 only)

Electrode Part No.	Function	Aquameter® Selection
5000/7000-AMM	Ammonium/Ammonia	NH4
5000/7000-CHL	Chloride	Cl
5000/7000-FLU	Fluoride	F
5000/7000-NIT	Nitrate	NO3
5000/7000-CAL	Calcium	Ca2

AP-2000 type ISE Electrodes (AUX2 only)

Electrode Part No.	Function	Aquameter® Selection
2000-AMM	Ammonium/Ammonia	NH4
2000-CHL	Chloride	Cl
2000-FLU	Fluoride	F
2000-NIT	Nitrate	NO3
2000-CAL	Calcium	Ca2

When the desired electrode type is showing, move the cursor back to the left of the socket number then press OK to send the selection to the Aquaprobe®. The socket assignments are stored in the Aquaprobe®. If you press the ESC key whilst in this screen, any changes you have made will not be transferred to the Aquaprobe®.

Finally, refer to the relevant section of this manual and carry out a full two-point (optical) or three-point (ISE) calibration of the new electrode. **YOUR NEW ELECTRODE WILL NOT GIVE SENSIBLE READINGS UNTIL IT HAS BEEN FULLY CALIBRATED.**

Please note: changing an AUX Socket assignment will clear all the calibration data for that socket.

If you subsequently remove an electrode, be sure to replace the blanking plug and set the socket assignment back to EMPTY.

25. Appendix 4. Standard Electrodes Detailed Specification

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 (EC)	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 **(see note 2)**
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 **(see note 2)**
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 **(see note 2)**
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 **(see note 2)**
Seawater Specific Gravity*	Range	0 – 50 σ_t
	Resolution	0.1 σ_t
	Accuracy	± 1.0 σ_t
pH	Range	0 – 14 pH / ± 625mV **(see note 3)**
	Resolution	0.01 pH / ± 0.1mV
	Accuracy	± 0.1 pH / ± 5mV
ORP	Range	± 2000mV **(see note 3)**
	Resolution	0.1mV
	Accuracy	± 5mV
Depth (-D models only)	Range	± 0 – 60.00 m
	Resolution	1cm
	Accuracy	± 0.2% FS
Temperature	Range	-5˚C – +50˚C (23˚F – 122˚F)
	Resolution	0.01˚C
	Accuracy	± 0.1˚ C

*** Readings calculated from EC and temperature electrode values**

Aquaread® Ltd reserves the right to change specifications without notice. Please refer to Aquaread website for current specifications.

Notes:

1. The accuracy figures quoted throughout this document 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. Accuracy in the field is also dependent upon **full calibration** and minimal time between calibration and use.

2. The EC electrode can be calibrated at any point between 100µS/cm and 99,999µS/cm. The quoted accuracy of the electrode, and therefore all derived readings, relies upon the readings being within a reasonable range of the calibration point.

3. The measurement of pH and ORP relies upon the ability of the electrode to pass a minute electrical current through the water under test. For this reason, when using the standard pH/ORP electrode, the water under test must have a minimum EC (electrical conductivity) of 100µS/cm. Special low EC pH electrodes are available to special order.

26. Appendix 5. Optical Electrodes Detailed Specification and FAQs

26.1. What are the excitation and detection wavelengths?

Each Aquaread® Optical Electrode (with the exception of Turbidity) is effectively a stand-alone, fixed frequency fluorometer, specially tuned to excite and detect fluorescence of selected substances in water.

The Turbidity electrode is not a fluorometer. This electrode employs a Nephelometric measurement technique in accordance with ISO 7027.

The following table shows the excitation peak wavelengths and detection ranges for each electrode.

Electrode	Excitation Peak Wavelength	Detection Range
Chlorophyll	470nm	>630nm
Blue-Green Algae Phycocyanin (BGA-PC)	590nm	>655nm
Blue-Green Algae Phycoerythrin (BGA-PE)	520nm	>575nm
Fluorescein Dye	470nm	>550nm
Rhodamine WT	520nm	>575nm
Refined Oil	285nm	330nm – 370nm
CDOM	365nm	450nm - 520nm
Turbidity	850nm	850nm

Each fluorometer electrode (with the exception of the Refined Oil Electrode) emits short pulses of high energy light at the excitation wavelength and responds to fluorescence in the detection range. The deep UV excitation of the Refined Oil Electrode operates on a 15 second on / 15 second off duty cycle.

26.2. How does the Refined Oil sensor work?

The Refined Oil sensor detects volatile organic compounds (VOCs) that are found in petroleum derivatives. These include benzene, toluene, ethylbenzene, and xylenes (BTEX).

The sensor is a fixed frequency *in situ* fluorometer that uses deep UV wavelengths (285nm) to excite the VOCs. An emission filter is then used to detect any fluorescence generated by the VOCs between 330 and 370nm.

The electrode measures the VOCs immediately in front of the sensor face so will measure at whatever depth the probe is lowered to. Naturally, the probe will only detect compounds that are actually mixed/dissolved in the water, not those floating on the surface.

The Refined Oil electrode is ideal for customers who are interested in detecting the presence or absence of VOC’s and measuring relative fluorescence changes that can be used as an indication of increasing or decreasing concentrations.

The electrode is not intended for absolute, quantitative measurements. This can only really be done using Gas or Liquid Chromatography in a laboratory although if grab sample data is available, a Grab Sample Factor (GS Factor) can be input on the calibration screen in order to improve the accuracy of future readings.

26.3. I can see algae in the water but my sensor is giving low readings. Why?

Aquaread® Chlorophyll and Blue-Green Algae sensors are not designed to measure floating macroscopic (visible to the naked eye) algae or plant material.

The sensors measure the fluorescence from the microscopic phytoplankton suspended within the body of the water below the surface. Carpets of floating algae are often seen on environmental water that has low subsurface phytoplankton concentrations. In these circumstances, the fluorescent algae sensors will return low readings.

26.4. What is the Range and Resolution of the Optical Electrodes?

Turbidity	Range	0 – 3000 NTU
	Resolution	2 Auto-range scales: 0.0 - 99.9 NTU, 100 - 3000 NTU
	Accuracy	± 5% of auto-ranged scale
	MLD(1)	0.0 NTU
	MLR(2)	5.0 NTU
Chlorophyll	Range	0 – 500.0 µg/L (ppb)
	Resolution	2 Auto-range scales: 0.00 - 99.99 µg/L, 100.0 - 500.0 µg/L
	Repeatability	± 5% of reading
	MLD(1)	0.1µg/L
	MLR(2)	5 µg/L
Phycocyanin (BGA-PC) **(Freshwater Blue -Green Algae)**	Range	0 – 300,000 cells/mL
	Resolution	1 cell/mL
	Repeatability	± 10% of reading
	MLD(1)	200 cells/mL
Phycoerythrin (BGA-PE) **(Marine Blue-Green Algae)**	Range	0 – 200,000 cells/mL
	Resolution	1 cell/mL
	Repeatability	± 10% of reading
	MLD(1)	400 cells/mL
Rhodamine WT Dye	Range	0 – 500 µg/L (ppb)
	Resolution	2 Auto-range scales: 0.00 - 99.99 µg/L, 100.0 - 500.0 µg/L
	Repeatability	± 5% of reading
	MLD(1)	0.1 µg/L
	MLR(2)	5 µg/L
Fluorescein Dye	Range	0 – 500 µg/L (ppb)
	Resolution	2 Auto-range scales: 0.00 - 99.99 µg/L, 100.0 - 500.0 µg/L
	Repeatability	± 5% of reading
	MLD(1)	0.1 µg/L
	MLR(2)	5 µg/L
Refined Oil	Range	0 – 10,000 µg/L (ppb) (Napthalene)
	Resolution	0.1 µg/L
	Repeatability	± 10% of reading
	MLD(1)	10 µg/L (Napthalene)
CDOM/FDOM	Range	0 – 20,000 µg/L (ppb) (Quinine Sulphate)
	Resolution	2 Auto-range scales: 0.0 – 9,999.9 µg/L, 10,000 – 20,000 µg/L
	Repeatability	± 10% of reading
	MLD(1)	10 µg/L (Quinine Sulphate)

Aquaread® Ltd reserves the right to change specifications without notice. Please refer to Aquaread website for current specifications.

Notes:

1. MLD (Minimum Level of Detection) is the minimum value the electrode is physically capable of measuring.

2. MLR (Minimum Level of Repeatability) is the value below which optical electrode readings become generally unreliable and unrepeatable (unless taken under ideal conditions) due to interfering factors such as refraction from visible air bubbles and microscopic aeration.

26.5. What is the Accuracy of the Optical Electrodes?

All Optical Electrodes, with the exception of the Turbidity Electrode, employ fluorescent measurement techniques. Interference from microbiological species and compounds which fluoresce at similar wavelengths and differences in fluorescence caused by temperature, ambient light and turbidity can all cause inaccuracies.

Fluorescence measurement is ideal for researchers who are interested in detecting the presence or absence of a specific substance in reasonable concentrations and measuring relative fluorescence changes that can be used as an indication of increasing or decreasing concentrations.

Fluorescence measurement techniques are not ideal for quantitative measurement and it is therefore impossible to specify an absolute accuracy.

In order to obtain accurate results, data obtained with a fluorescent electrode in the field must be post-calibrated with data from standard laboratory analysis of grab samples acquired during the study.

If grab sample data is available, a Grab Sample Factor (GS Factor) can be input on the calibration screen of each fluorescent type electrode in order to improve the accuracy of future readings.

27. Appendix 6. ISE Electrodes Detailed Specification

Ammonium / Ammonia†	Range	0 – 9,000mg/L (ppm)
	Resolution	2 Auto-range scales: 0.00 - 99.99 mg/L, 100.0 – 8,999.9 mg/L
	Accuracy	± 10% of reading or 2ppm (whichever is greater)
	MLD(1)	1.0 ppm
	Interfering Ions(2)	Potassium, Sodium and Magnesium
	pH Range(3)	5 - 8
Chloride	Range	0 – 20,000mg/L (ppm)
	Resolution	2 Auto-range scales: 0.00 - 99.99 mg/L, 100.0 – 19,999.9 mg/L
	Accuracy	± 10% of reading or 2ppm (whichever is greater)
	MLD(1)	2.0 ppm
	Interfering Ions(2)	Bromide, Iodide, Cyanide and Sulphide
	pH Range(3)	2 - 11
Fluoride	Range	0 – 1,000mg/L (ppm)
	Resolution	2 Auto-range scales: 0.00 - 99.99 mg/L, 100.0 – 999.9 mg/L
	Accuracy	± 10% of reading or 2ppm (whichever is greater)
	MLD(1)	0.05 ppm
	Interfering Ions(2)	Hydroxide (OH-)
	pH Range(3)	4 - 8
Nitrate	Range	0 – 30,000mg/L (ppm)
	Resolution	2 Auto-range scales: 0.00 - 99.99 mg/L, 100.0 – 29,999.9 mg/L
	Accuracy	± 10% of reading or 2ppm (whichever is greater)
	MLD(1)	0.5 ppm
	Interfering Ions(2)	Chloride, Bromide, Fluoride, Sulphate, Chlorate and Perchlorate
	pH Range(3)	3 - 10
Calcium	Range	0 – 2,000mg/L (ppm)
	Resolution	2 Auto-range scales: 0.00 - 99.99 mg/L, 100.0 – 1,999.9 mg/L
	Accuracy	± 10% of reading or 2ppm (whichever is greater)
	MLD(1)	0.05 ppm
	Interfering Ions(2)	Magnesium, Barium, Lead, Zinc and Sodium
	pH Range(3)	4 - 9

† Ammonia readings are calculated from Ammonium, pH and temperature electrode values.

Aquaread® Ltd reserves the right to change specifications without notice. Please refer to Aquaread website for current specifications.

Notes:

1. MLD (Minimum Level of Detection) is the minimum value the electrode is physically capable of measuring.

2. Each ion selective electrode is prone to interference from ions that are similar in nature to the target ion. The main interfering ions for each electrode type are listed here. If the water under test contains interfering ions, the electrode will produce erroneous readings. **Ion Selective Electrodes are not recommended for use in brackish or salt water** due to the high level of interfering ions.

3. Each ion selective electrode will only operate within a specific pH and EC range. The pH limits vary and are listed against each electrode. All ion selective electrodes work in conjunction with the pH electrode during measurement. For this reason, the selected Aquaprobe® must have a working pH or pH/ORP electrode fitted and the conductivity (EC) of the water under test must be greater than 50µS/cm.

4. All ion selective electrodes exhibit calibration drift over time. Drift should not be a major problem where the electrodes can be frequently calibrated. However, if the electrodes are to be used in long-term deployment studies, drift is almost certain to occur.

During long term deployment of ion selective electrodes, the user should obtain grab samples during the course of the deployment for analysis in the laboratory by chemical means and use the results to apply post calibration to the recorded results.

5. Accuracy in the field is dependent upon full three-point calibration and minimal time between calibration and use.

6. In order to achieve accurate readings with ISE electrodes, it is recommended the probe is calibrated in a similar condition as is expected in the field measurement. If using in a flowing environment, for the most accurate results the calibration solutions should be stirred at a similar rate as to the expected flow of the environment. If the probe is to be used in a static environment (e.g. a lake or reservoir) then there is no requirement for stirring during calibration.

27.1. Special Notes Concerning ISE Electrodes during pH Calibration

The high ionic concentration of pH calibration solutions (buffers), including RapidCal, can cause significant offsets in ISE electrodes. ISE calibration solutions other than those for that specific ISE can contain interfering ions, again causing offsets.

These offsets are temporary, but best avoided because they can cause significant errors during both calibration and normal operation.

For this reason all ISE electrodes are supplied with a red rubber sealing cap.

The caps should be fitted to all ISE Electrodes when using pH calibration solutions or other ISE calibration solutions other then that specific for the ISE being calibrated in order to protect the ISE electrodes from the effects of the buffer solution and interfering ions.

The caps MUST NOT be fitted when calibrating optical electrodes or serious calibration errors will occur due to reflections from the caps.

28. Appendix 7. Troubleshooting Turbidity

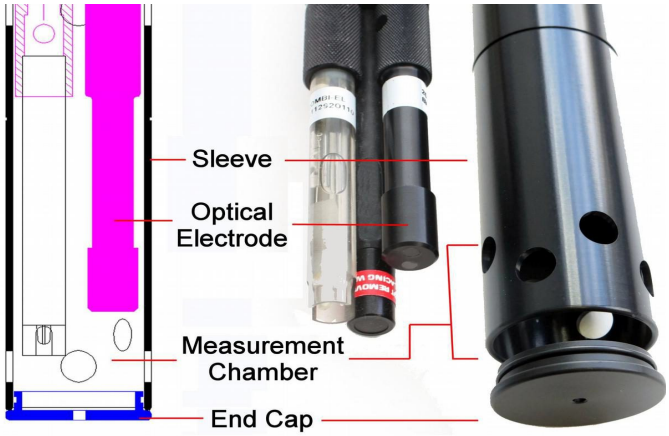
The Aquaread® Turbidity electrode is incredibly sensitive and is capable of measuring between 0 and 3000NTU with an internal resolution of greater than 0.1NTU. This means that the electrode is able to detect changes in turbidity that are less than 0.003% of the full range.

It follows, therefore, that in order to provide stable, repeatable readings, especially at very low levels, the environment in which the measurements are made must be completely stable and repeatable.

For this reason, all Aquaprobes are constructed with a matt black aluminium sleeve and end cap that enclose the sensing electrodes and provide a constant condition, non reflective measurement chamber.

This is essential for the correct calibration and operation of the turbidity electrode.

A diagram of the AP-2000 Aquaprobe's measurement chamber is shown here. Please note, the design of the End Cap may vary depending upon the age and model of your Aquaprobe.



In order to obtain consistent results, the measurement chamber created within the Aquaprobe® must remain physically constant during both calibration and measurement.

If the turbidity electrode is calibrated under one set of conditions, then used to measure under another set of conditions, the readings will naturally be erroneous, especially at low concentrations.

A perfect example of this is calibrating with the end cap removed then measuring with the end cap fitted (or vice-versa). By changing the physical characteristics of the measurement chamber, you also change the calibration and response of the electrode.

28.1. Lens and Sleeve Maintenance

On a daily basis, the lenses on the electrode should be wiped over with a soft damp cloth.

Similarly, the inside of the Probe Sleeve and Sleeve Cap should be kept clean and free from any deposits that may cause stray reflections.

Never use an abrasive cleaner on the inside of the Probe sleeve or cap as they have 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 the zero point after cleaning the sleeve or lenses.

28.2. About Turbidity Measurement

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.

28.3. Precautions During Use

In common with all other submersion type Turbidity Probes, air bubbles and stray reflections can be a problem when trying to measure low turbidity values. In order to avoid air bubbles, keep the Turbidity electrode clean, and agitate the Probe after submersion to dislodge any air bubbles which may be clinging to the lenses. In order to maintain a common reflective pattern between calibration and use, **always calibrate and measure turbidity with the protective Sleeve End Cap fitted**.

28.4. Negative Turbidity Readings

Although the notion of negative turbidity seems strange, it is, in fact, a very useful way to ensure correct zero point calibration.

When an Aquaprobe® is deployed in clean/clear water and negative turbidity readings occur, the cause is usually an erroneous zero point calibration, caused either by contaminated calibration solution, aeration, reflections from the calibration bottle or changes in the measurement chamber between zeroing and deployment.

It follows that if the Probe has been zeroed in a solution that has a turbidity greater than true zero, subsequent measurements taken in a less turbid sample will be displayed as negative.

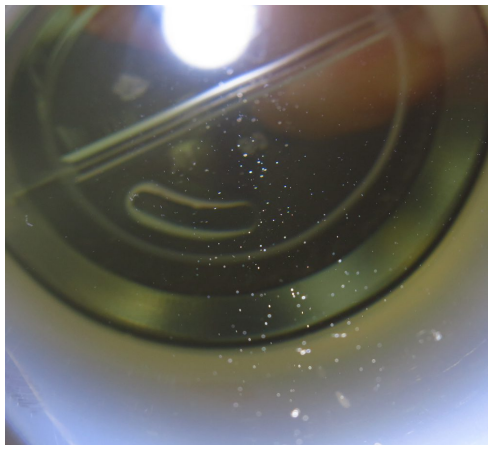
Similarly, if the turbidity electrode was subject to stray reflections from the inside of the calibration bottle during calibration, the absence of those reflections during deployment will result in the sensor seeing less reflected signal and therefore a negative reading will be displayed.

If you experience negative turbidity readings, thoroughly clean the Probe then re-zero in completely clean water. Still, bottled mineral water is recommended for zeroing the electrode as it is cheap and readily available. **Never use sparkling or carbonated water.**

If you still experience negative turbidity readings and you are certain that your zero

calibration solution is completely clear water, the problem is almost certainly either aeration, reflection or sensor saturation.

28.5. Aeration



Aeration is air in the form of both visible and microscopic bubbles. These act like tiny prisms and can refract and reflect both the excitation light and the return signal being measured.

The photograph to the right was taken in a calibration bottle after fresh water was poured in. The bubbles are clearly visible in the light beam. This level of aeration will register the equivalent of around 5 – 10 NTU as each bubble is seen as a solid particle.

If a zero point calibration is conducted under these conditions, when the Probe is subsequently deployed in clear water it will register a negative reading between -5 and -10 NTU.

If your zero calibration water is aerated, allow it to stand for a while until the air has all dispersed, then re-insert the Probe and re-calibrate.

Do not leave the Probe sitting in aerated water, the bubbles will simply cling to the inside surface of the Probe and make the problem worse.

28.6. Reflection

Although all Aquaprobes are provided with a sleeve and End Cap specifically designed to maintain a constant measurement chamber, water must be allowed to flow freely over the sensing electrodes to ensure correct operation. In order for this to occur, a set of holes have been included around the periphery of the sleeve.

Because both the turbidity electrode and the sleeve are threaded parts, the final position of the lenses on the turbidity electrode with respect to the holes in the sleeve is random.

As a result, under certain circumstances, the excitation light emitted by the turbidity electrode can exit the measurement chamber through one of the holes in the sleeve and can then be reflected back in to the measurement chamber causing an artificially high turbidity reading of up to 20NTU.

If a zero point calibration is conducted under these conditions, when the Probe is subsequently deployed in clear water with no reflections, it will register a negative reading of up to -20 NTU.

In order to avoid erroneous zero point calibration due to reflection it is important to zero the turbidity electrode in a non-reflective calibration bottle or in a vessel who's sides come no nearer than 10mm to the probe sleeve.

28.7. Sensor Saturation

Sensor saturation is a very rare problem that can occur in shallow water when combined with very bright sunlight.
The turbidity sensor's transmitter emits very short pulses of light in the infra-red spectrum at a wavelength of 850nm that are invisible to the human eye. The sensor's receiver includes

a visible light filter, which filters out all visible light and allows the infra-red pulses from the transmitter to enter freely.

The sensor's receiver is also AC coupled so it will only react to the very short, intense flashes of light emitted by the transmitter. Under normal circumstances, visible ambient light (from artificial lighting) is filtered out and any background infra-red light (sunlight) is ignored.

However, all things have their limitations, and if very strong sunlight is allowed to enter the measurement chamber from below and shine directly onto the turbidity sensor, the receiver can become maxed-out or saturated.

This situation is rare, but can occur if the sensor is sitting on or near the bottom in shallow water in direct sunlight where the sunlight can be reflected back into the Probe by light coloured sand or pebbles.

Sensor saturation can result in negative turbidity readings as the magnitude of the measurement light pulses are clipped (or reduced) by the upper limit of the sensor.

If this occurs, either lift the Probe up and away from the surface reflecting the sunlight or shade the Probe from direct sunlight.

28.8. Top Tips for successful measurements using optical electrodes

- Always keep the measurement chamber and electrode lenses clean.
- Always fit the sleeve and end cap during both calibration and measurement.
- Always allow the readings to settle completely during both calibration and measurement.
- Always try to eliminate air bubbles by agitating the Probe after insertion both during calibration and measurement.
- Always calibrate and zero the electrode as close to your sample temperature as possible.
- Always zero the optical electrodes just prior to use in clean water (bottled still mineral water is ideal) then deploy **without disturbing the measurement chamber**.

28.9. References

This section is based upon Aquaread's experience in the field and 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.