Instruction Manual

for the

Aquaread AquaSonde®

Range of

Multiparameter Water Quality Sondes

and associated

Utilities & Accessories

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IMPORTANT INFORMATION

Before using this equipment for the first time, it is **ABSOLUTELY ESSENTIAL** that the following steps are followed.

- Read this manual.
- Download and install the SondeLink PC application.
- Fit suitable batteries. These MUST be 3.6V Lithium (Li-SOCl2).
- Fit any optional electrodes required.
- Calibrate all electrodes.
- Setup a suitable logging regime.
- Activate the Sonde by connecting the AquaSonde Deployment Key.

If any of these steps are missed, your AquaSonde will either not log any data or will log erroneous data.

Please read this manual carefully and fully prior to operating this equipment.

1. Introduction

This manual covers the setup, calibration, operation, deployment and maintenance of the Aquaread AqauSonde® range of sondes, which includes the AS-2000, AS-5000 and AS-7000. It also covers the installation and operation of the SondeLink PC software application.

The full functionality of the most complex sonde, the AS-7000, is covered in this manual. Where functionality differs for the smaller AS-5000 and AS-2000 sondes, these differences will be noted. Any references to the 'wiper' or 'self cleaning mechanism' should be ignored if you are using the AS-5000 or AS-2000, which do not have this feature.

2. What's in the Box?

The AquaSonde is supplied with the following:

- 1 x Sleeve End Cap
- 1 x Sonde Hanger Bracket with Nut
- 1 x USB Cable
- 1 x AquaSonde Deployment Key
- 1 x Bottle of RapidCal Solution (size varies with model)
- 1 x Two part calibration / rinse cup

To complete your system, you will need two **3.6 Volt** Primary lithium-thionyl chloride (Li-$SOCl_2$) batteries, which should be purchased separately. The AS-2000 requires C size batteries whereas the AS-5000 and AS-7000 require D size batteries.

Prior to first use, the AquaSonde must be set up. To do this, the AquaSonde must have batteries fitted and must be connected to a PC running SondeLink software.

2.1. Aquaread Aquameter Compatibility

Whilst the AquaSonde range is designed primarily to be calibrated and set up using SondeLink PC software via a USB cable, the sondes can also be calibrated and used for live dip-testing with an Aquaread® Aquameter®.

In order to make connection to an Aquameter®, an Aquaprobe EX-5000 cable is required. The Aquameter® will not communicate with the AquaSonde using the AquaSonde Vent/Data Cable, which is wired solely for USB and Deployment Key communication. Also, when used with an Aquameter®, the AquaSonde must have its own batteries fitted as the Aquameter® will not supply power.

When connected to an Aquameter®, the AS-2000 will operate as an AP-2000-D, the AS-5000 will operate as an AP-5000 and the AS-7000 will operate as an AP-7000. Whilst connected to an Aquameter®, the sondes will not log any data. Setup of the sonde's logging functions and logged data retrieval are not supported by the Aquameter®.

2.2. The AquaSonde and the Environment

The AquaSonde is designed to be fully submerged in water and is rated to IP68, that is to say, it is rated for continual immersion to a depth of 30 meters, and short term immersion (less than 6 hours) to 100 meters.

During deployment, the AquaSonde should be suspended by a suitable suspension wire or a vented cable attached to the Sonde Hanger Bracket. **The sonde should NEVER be**

suspended by the hole in the AquaSonde Deployment Key.

2.3. Vented Cable Option

The AquaSonde contains an internal barometric pressure sensor. This barometric pressure sensor is necessary for correction of both depth and percentage saturation of dissolved oxygen (DO %Sat), which both vary with barometric pressure. DO readings in mg/L are not affected by barometric pressure.

If accurate depth and %DO readings are required during a deployment lasting more than a few hours, during which atmospheric pressure may change, the AquaSonde should be deployed on a vented cable, which will allow the pressure inside the AquaSonde to vary with the ambient air pressure, even when it is submerged.

If accurate depth and %DO readings are not important, the AquaSonde can be fully sealed using the AquaSonde Deployment Key and deployed on a simple suspension wire.

2.4. About the AquaSonde Sleeve and Sleeve End Cap

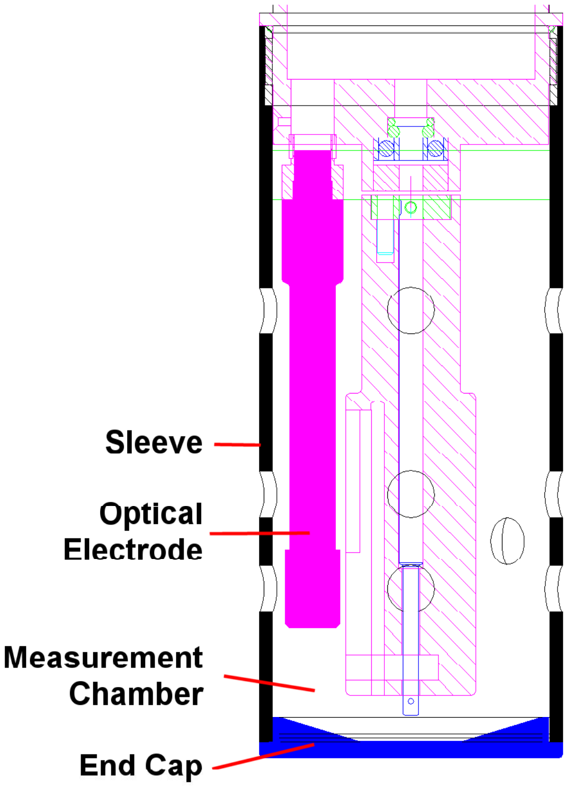
The AquaSonde is constructed with an aluminium sleeve surrounding the delicate sensing electrodes. The Sleeve can be easily removed by unscrewing to allow cleaning of the individual electrodes, however, **The sonde sleeve, end cap and wiper form an integral, working part of the sonde's optical and EC measurement system, and MUST be fitted during calibration and measurement 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.

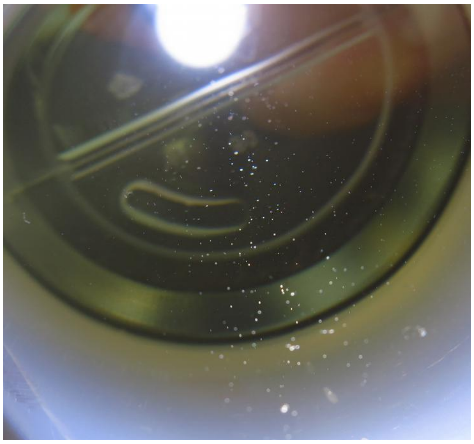
For this reason, the AquaSonde is constructed with a matt black aluminium sleeve and end cap that enclose the sensing electrodes and provide a closed, constant condition, non reflective measurement chamber.

In order to obtain consistent results, the measurement chamber created within the AquaSonde must remain physically constant during both calibration and measurement. It is therefore essential that both the sleeve and sleeve end cap are fitted during calibration and operation of all types of optical electrodes.

If an 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.

2.5. 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 activate the self-cleaning mechanism.
- 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**.
-

2.6. Important Notes Regarding Long-Term Deployment

The AquaSonde should not be deployed and left for extended periods without regular checking, calibration and maintenance. The AS-7000 features an effective electrode cleaning system, but the following advice should still be followed.

The time period between maintenance visits depends heavily upon the deployment conditions. For example, if the sonde is deployed in clean water, the only necessity should be regular single point calibration of the electrodes. This should be done every 4 – 6 weeks.

If the sonde is deployed in water that is polluted, silt-laden or heavily affected by algal growth, maintenance visits should be much more frequent.

With the AS-7000, it is very important to keep the cleaning brushes in good condition. The brushes should be replaced as soon as they show any signs of clogging or deterioration.

Likewise, it is very important to keep the inside of the sonde sleeve and end cap clean and free from any build up of algae or silt.

The sonde sleeve and end cap form an integral part of the optical measurement system. If they are allowed to become excessively dirty, the accuracy of your readings will be affected.

It is strongly recommended that after initial deployment, maintenance visits are made on a weekly basis in order to assess the rate of fouling. After several weeks, it should be possible to establish the optimum time interval for routine maintenance at any given site.

All ion selective electrodes (ISE) 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 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.

2.7. 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 AquaSonde 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.

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.

3. Battery Selection, Installation and Care

3.1. Choice of Battery Type

AquaSonde model AS-2000 units require two 3.6 Volt Primary lithium-thionyl chloride (Li-$SOCl_2$) **C size** batteries.

AquaSonde model AS-5000 and AS-7000 units require two 3.6 Volt Primary lithium-thionyl chloride (Li-$SOCl_2$) **D size** batteries.

Lithium-thionyl chloride (Li-$SOCl_2$) batteries are readily available on-line. **DO NOT USE standard 1.5V batteries.** The AquaSonde will not operate at all on 1.5V batteries.

When purchasing batteries for the AS-7000 model, which has a motorised cleaning system, always ensure the batteries you choose are capable of providing a **maximum continuous current of at least 1000mA**. This information is available as part of the battery specification.

Batteries for the AS-2000 and AS-5000 need to be capable of providing a **maximum continuous current of at least 50mA**. Most commonly available lithium-thionyl chloride cells will provide this current.

3.2. Installing the Batteries

During battery installation the AquaSonde must not be connected to an AquaSonde Deployment Key or a PC.

To install the batteries, grasp the knurled section at the top of the AquaSonde and unscrew the battery cover from the AquaSonde body.

The battery compartment inside the AquaSonde will accept two batteries. Observing the polarity markings in the battery compartment, insert two batteries of the correct type. Apply some silicone grease to the bottom thread and top O rings, then screw the battery cover back on to the AquaSonde body. Be sure to tighten the battery cover properly to prevent water entry.

3.3. Battery Life

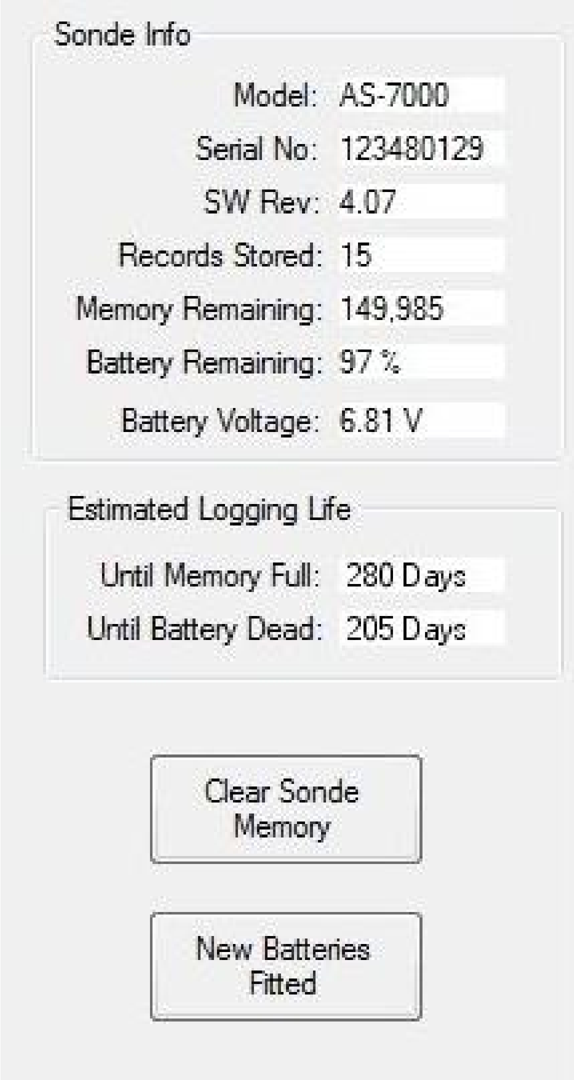
The life of the batteries is dependent upon the logging rate, the event checking rate and the automatic cleaning frequency (AS-7000 only). During setup of the AquaSonde using SondeLink software, the estimated battery life will be displayed and updated as you alter the logging, event and cleaning settings.

3.4. Battery Condition Monitoring

Battery condition is continuously monitored by the AquaSonde. When an AquaSonde Deployment Key is connected, if a low battery condition is detected, the blue LED on the key will give a double flash every two seconds. The batteries should be replaced as soon as possible if this indication is given.

If the batteries become too low to operate the unit reliably, the unit will stop logging data.

Actual battery condition can be viewed any time by connecting the AquaSonde to a PC running SondeLink software and selecting the Data Logging Setup tab.



Sonde Info

Model: AS-7000
Serial No: 123480129
SW Rev: 4.07
Records Stored: 15
Memory Remaining: 149,985
Battery Remaining: 97 %
Battery Voltage: 6.81 V

Estimated Logging Life

Until Memory Full: 280 Days
Until Battery Dead: 205 Days

The Sonde Info panel gives the actual battery capacity remaining and an estimate of the battery life remaining based on the current logging regime. It is advisable not to deploy the sonde with less than 20% battery capacity available.

3.5. Resetting the Battery Condition Monitor

Whenever new batteries are fitted, it is essential to reset the battery condition monitor by clicking the 'New Batteries Fitted' button. This will reset the battery condition monitor to 100% and allow an accurate estimate of battery condition going forward.

DO NOT RESET THE BATTERY MONITOR UNLESS YOU HAVE FITTED NEW BATTERIES. This can lead to loss of data when the batteries unexpectedly run out.

4. Installing Optional Electrodes

Please note: the AquaSonde **should not be connected to any other device** during installation of the optional electrodes.

There are two major types of AUX Electrodes designed for use with the AquaSonde: Optical Electrodes and ISE Electrodes. These and can be fitted to any of the AUX sockets.

The AS-2000 can accept up to two optional electrodes. The AS-5000 can accept up to four optional electrodes and the AS-7000 can accept up to six optional electrodes. The optional electrode sockets are numbered on the AquaSonde starting at AUX1.

All AquaSonde optional electrodes have a similar four contact gold connector with the exception of the AS-2000 AUX2 ISE electrodes, which have a smaller, single pin gold connector.

4.1. Installing Optional Electrodes

First, remove the sleeve from the AquaSonde. Next remove the blanking plug from the AUX socket that you want to use. 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 AquaSonde) to the threaded section and the O-ring of the AUX Electrode (see photograph below).

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.

Each time you install an electrode, make a note of the electrode type and the socket number it has been installed in. This is very important and is required for setting up the socket assignments later.

Repeat this operation until all the optional electrodes have been installed. Keep the blanking plugs in a safe place.

Now, follow the procedure laid out in the next section to install the SondeLInk software and assign the AUX sockets to the electrodes you have just installed.

YOUR NEW ELECTRODE WILL NOT GIVE ANY READINGS UNTIL IT HAS BEEN ASSIGNED TO THE RELEVANT AUX SOCKET IN THE SOFTWARE.

5. Installing SondeLink Utility Software and Assigning AUX Sockets

Prior to first use, the AquaSonde must be set up. To do this, the AquaSonde must have batteries fitted and must be connected to a PC running SondeLink software.

The SondeLink PC Software is available for download using the following link:
http://www.aquaread.com/software-downloads

From the Aquaread® Downloads page, select 'SondeLink - AquaSonde Utility'. The software will be downloaded as a .ZIP file. Unzip the downloaded .ZIP file into a temporary directory.

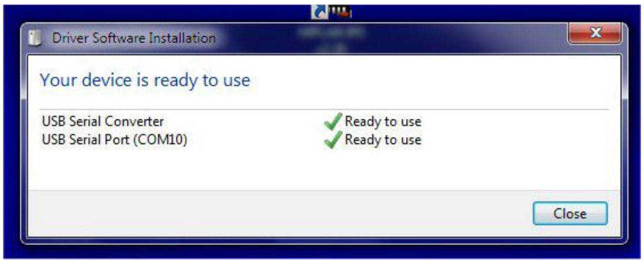
5.1. Driver Installation

To communicate with an AquaSonde, two software ‘drivers’ need to be installed. These are a '**USB Serial Converter**' driver and a '**USB Serial Port**' driver. Connect the AquaSonde USB cable to your PC. You do not need an AquaSonde connected at this point. 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, stop the search and direct Windows® to your temporary directory.

After successful driver installation, the following message should be displayed.



Your device is ready to use

USB Serial Converter	✓ Ready to use
USB Serial Port (COM10)	✓ Ready to use

The USB Serial Port number (COM10 in the above example) may be different, but that is fine provided it shows ‘Ready to use’. If the drivers do not install properly, refer to Section 22 Appendix 7. Troubleshooting SondeLink.

5.2. Software Installation

Now you must install the SondeLink software application. To do this, browse the temporary directory into which you unzipped the download and click on ‘**setup.exe**’.

You will be given the usual Windows® security warnings. Allow the software to install. Once installed, SondeLink will run automatically. Thereafter, it can be found in you Programs List in the Aquaread folder.

5.3. Connecting an AquaSonde

The AquaSonde can be connected to a PC either directly using the USB cable supplied, or via Bluetooth using the optional Aquaread BlueLink accessory.

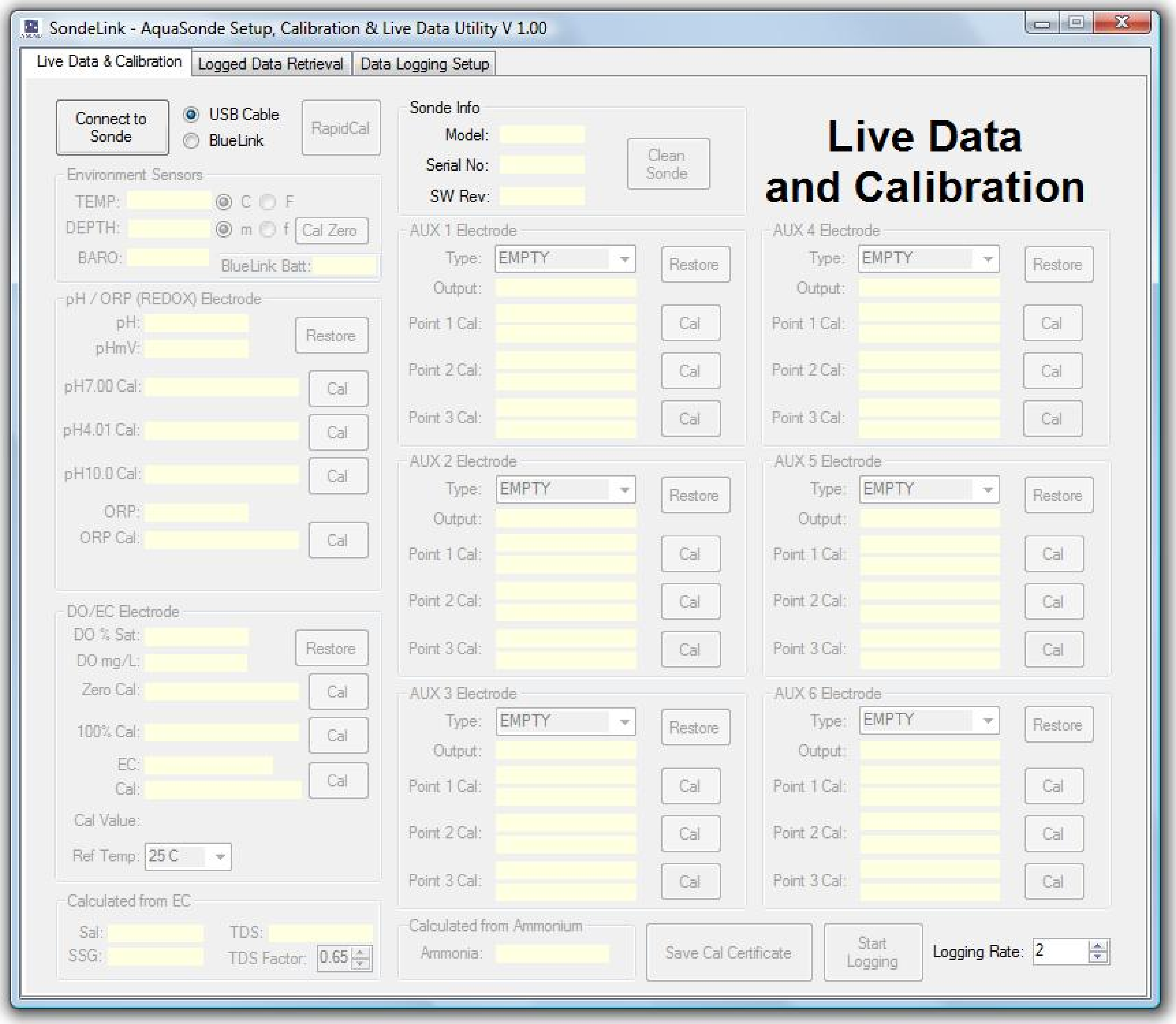
Align the small arrow on the end of the USB cable's round connector with the dot on the AquaSonde connector and plug it in.

Now the AquaSonde can be set up ready for use. This involves three steps: Assigning optional electrodes, calibration and finally Data Logging Setup.

5.4. Assigning Optional Electrodes to AUX Sockets

After installation of any optional electrodes, it is essential to connect the AquaSonde to a PC running SondeLink and assign the new electrode types to the relevant AUX Sockets.

To do this, connect the AquaSonde to the PC as described in section 5.3 Connecting an AquaSonde and start SondeLink. The *Live Data and Calibration* tab will be displayed.



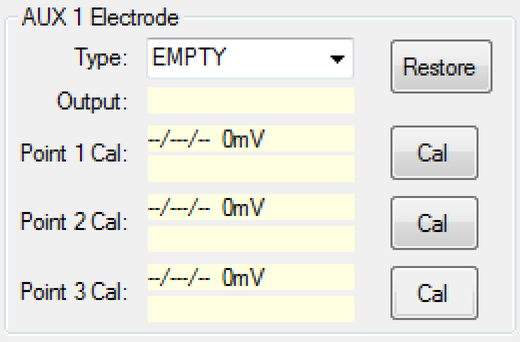
● USB Cable ○ BlueLink

AUX 1 Electrode Type: EMPTY
AUX 2 Electrode Type: EMPTY
AUX 3 Electrode Type: EMPTY
AUX 4 Electrode Type: EMPTY
AUX 5 Electrode Type: EMPTY
AUX 6 Electrode Type: EMPTY

Ref Temp: 25 C
TDS Factor: 0.65
Logging Rate: 2

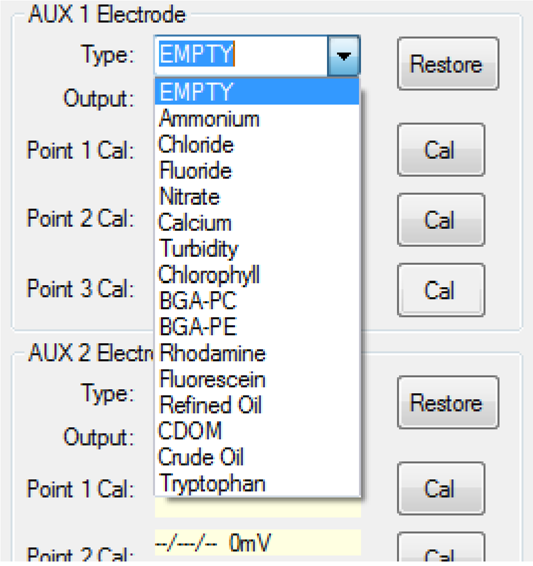
Select either *USB Cable* or *BlueLink* then click on the *Connect to Sonde* button. If the AquaSonde is properly connected and the drivers are installed, SondeLink will start to read live data from the sonde and update every two seconds.

Each AUX socket has its own data section. The data section for the AUX1 socket will look like this:



Type: EMPTY
Output:
Point 1 Cal: --/--/-- 0mV
Point 2 Cal: --/--/-- 0mV
Point 3 Cal: --/--/-- 0mV

From new, the electrode type will be set to EMPTY. To assign a new electrode to the AUX1 socket, use the drop-down box and select the electrode you have just installed from the list.



Type: EMPTY
Point 2 Cal: --/--/-- 0mV

You will be asked to confirm the socket assignment. Repeat this procedure for all populated AUX sockets.

If you subsequently remove or relocate an electrode, be sure to update the socket assignments as detailed above.

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.

6. Taking Live Measurements & Calibrating Electrodes

Now that the sockets have been assigned, the AquaSonde is ready to read live data on the bench. Please remember however, **this data will be largely meaningless until the sonde has been fully calibrated**.

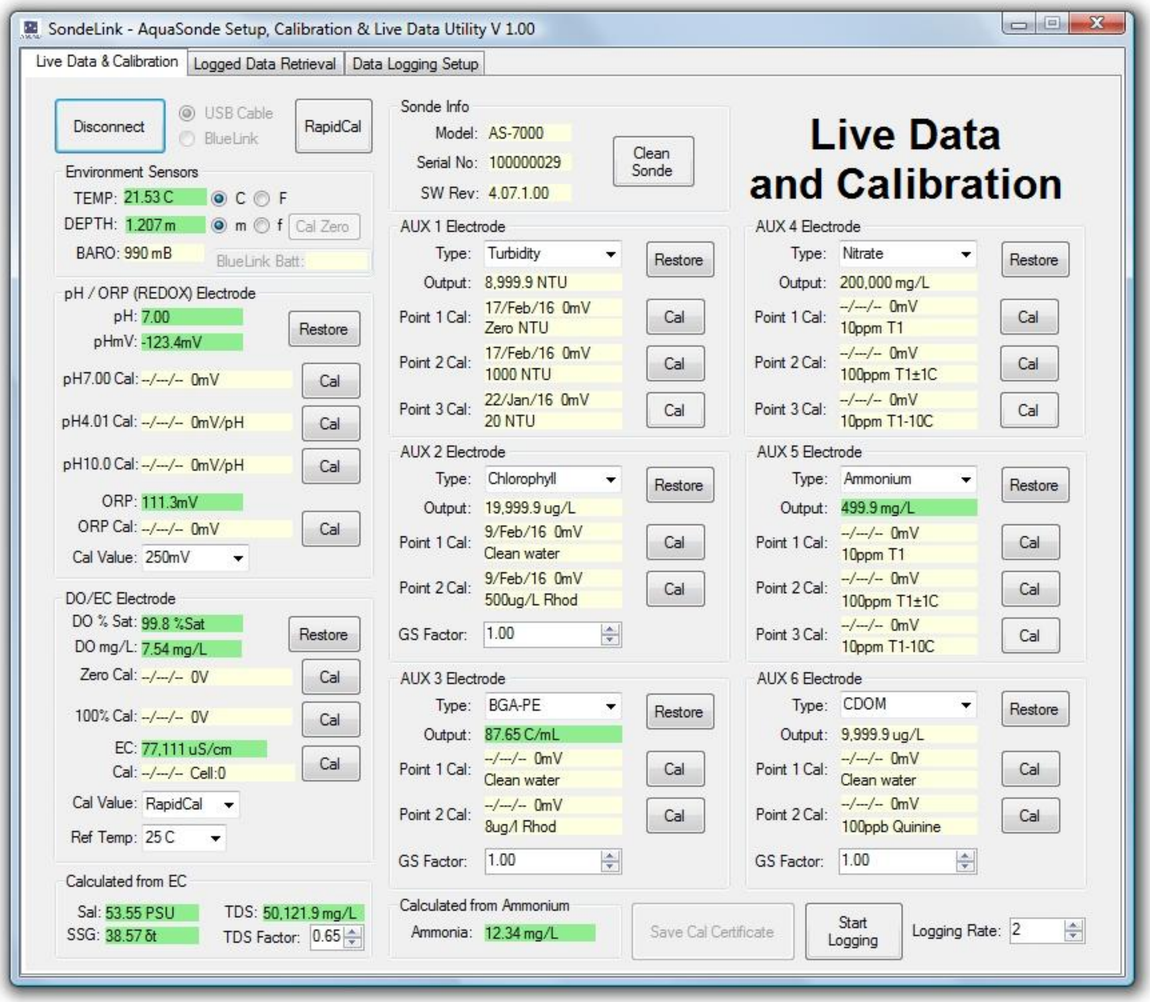
The AquaSonde includes a pH/ORP electrode, which is kept moist by a storage cap. Remove the storage cap by pulling it straight off. **Do not use a twisting motion to remove or replace the cap as this can unscrew the electrode from the sonde body.** Rinse any salty deposits from the pH/ORP electrode with fresh water.

Fit the sleeve then ensure the end cap is fitted to the open end of the sonde sleeve.

TIP: Occasional application of a smear of silicone grease or similar lubricant to the protective Sleeve End Cap threads will make fitting and removal of the Sleeve and Cap easier.

Connect the sonde to a PC running SondeLink and immerse the sonde in the sample water, making sure that the water level covers the minimum immersion depth groove halfway up the sonde sleeve.

On the SondeLink software, select the *Live Data & Calibration* tab then click the *Connect to Sonde* button at the top left of the screen.



● USB Cable ○ BlueLink

Environment Sensors
TEMP: 21.53 C ● C ○ F
DEPTH: 1.207 m ● m ○ f
BARO: 990 mB
BlueLink Batt:

pH / ORP (REDOX) Electrode
pH: 7.00
pHmV: -123.4mV
pH7.00 Cal: --/---/-- 0mV
pH4.01 Cal: --/---/-- 0mV/pH
pH10.0 Cal: --/---/-- 0mV/pH
ORP: 111.3mV
ORP Cal: --/---/-- 0mV
Cal Value: 250mV

DO/EC Electrode
DO % Sat: 99.8 %Sat
DO mg/L: 7.54 mg/L
Zero Cal: --/---/-- 0V
100% Cal: --/---/-- 0V
EC: 77,111 uS/cm
Cal: --/---/-- Cell:0
Cal Value: RapidCal
Ref Temp: 25 C

Calculated from EC
Sal: 53.55 PSU
TDS: 50,121.9 mg/L
SSG: 38.57 δt
TDS Factor: 0.65

Sonde Info
Model: AS-7000
Serial No: 100000029
SW Rev: 4.07.1.00

AUX 1 Electrode
Type: Turbidity
Output: 8,999.9 NTU
Point 1 Cal: 17/Feb/16 0mV Zero NTU
Point 2 Cal: 17/Feb/16 0mV 1000 NTU
Point 3 Cal: 22/Jan/16 0mV 20 NTU

AUX 2 Electrode
Type: Chlorophyll
Output: 19,999.9 ug/L
Point 1 Cal: 9/Feb/16 0mV Clean water
Point 2 Cal: 9/Feb/16 0mV 500ug/L Rhod
GS Factor: 1.00

AUX 3 Electrode
Type: BGA-PE
Output: 87.65 C/mL
Point 1 Cal: --/---/-- 0mV Clean water
Point 2 Cal: --/---/-- 0mV 8ug/l Rhod
GS Factor: 1.00

Calculated from Ammonium
Ammonia: 12.34 mg/L

AUX 4 Electrode
Type: Nitrate
Output: 200,000 mg/L
Point 1 Cal: --/---/-- 0mV 10ppm T1
Point 2 Cal: --/---/-- 0mV 100ppm T1±1C
Point 3 Cal: --/---/-- 0mV 10ppm T1-10C

AUX 5 Electrode
Type: Ammonium
Output: 499.9 mg/L
Point 1 Cal: --/---/-- 0mV 10ppm T1
Point 2 Cal: --/---/-- 0mV 100ppm T1±1C
Point 3 Cal: --/---/-- 0mV 10ppm T1-10C

AUX 6 Electrode
Type: CDOM
Output: 9,999.9 ug/L
Point 1 Cal: --/---/-- 0mV Clean water
Point 2 Cal: --/---/-- 0mV 100ppb Quinine
GS Factor: 1.00

Logging Rate: 2

When a reading box has a green background, this indicates that the reading is stable.

If the AquaSonde is connected correctly, the software will read the sonde's serial number and model number, then will automatically configure itself to display only those readings the current AquaSonde is capable of taking. Live sonde readings will be displayed on the screen.

The screen above shows a full range of readings for the AS-7000. If you are using a different model of sonde, some of the boxes may be unavailable and hence will be greyed-out. The following sections describe each measurement function.

6.1. Logging Live Data

At any time an AquaSonde is connected and running, you can save the readings to a log file on your PC. First select your desired logging interval then click on the 'Start Logging' button at the bottom right of the screen.

You will be asked for a file name, which will default to the AquaSonde's type and serial number. Once started, data will be logged at the selected interval. To stop data logging, click on the 'Stop Logging' button. If you start to calibrate the AquaSonde with the log running, the logging function will be automatically stopped.

The logged data is saved as a TAB delimited file, which can be opened in any spreadsheet application such as Microsoft® Excel®.

6.2. 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 order to allow normal field operatives (as opposed to trained lab technicians) to achieve quick and accurate results.

The AquaSondes are supplied with a two part calibration cup. The sonde is designed to be calibrated in these cups **with the sonde Sleeve, Sleeve End Cap and Wiper fitted.**

The sonde sleeve, end cap and wiper form an integral, working part of the sonde's optical and EC measurement system, and MUST be fitted during calibration and measurement for correct operation.

When calibrating multiple electrodes using a variety of calibration solutions, it is essential that the sonde is thoroughly washed and dried between each step in order to avoid dilution and cross contamination of calibration solutions.

6.2.1. Generating a Calibration Report

At the end of a calibration session you can produce the text for a calibration certificate by clicking on the 'Save Cal Certificate' button. You will be asked for a file name, which will default to the AquaSonde's type and serial number. The file produced will be a TAB delimited text file that can be opened in any word processor package.

6.3. Special Notes Concerning ISE Electrodes

The high ionic concentration of pH calibration solutions (buffers), including RapidCal, can cause significant offsets in ISE electrodes.

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

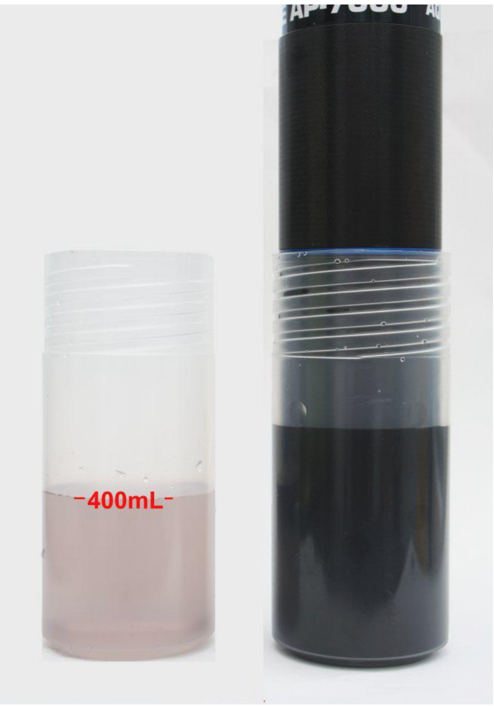
For this reason all ISE electrodes are supplied with a red rubber sealing cap.

The caps should be fitted to all ISE Electrodes during calibration when using pH calibration buffers or RapidCal in order to protect the ISE electrodes from the effects of the buffer solution.

At all other times, the ISE electrodes should be left uncovered.

6.4. Using RapidCal

RapidCal calibrates EC at 2570µS/cm and the pH7.00 point simultaneously. The procedure shown here for calibrating with RapidCal should be followed for calibrating all other electrodes, substituting the RapidCal solution for the solution relevant to the calibration being undertaken. To use RapidCal:



1. Pour 400mL of RapidCal solution into one of the calibration cups provided as shown in the adjacent photograph.

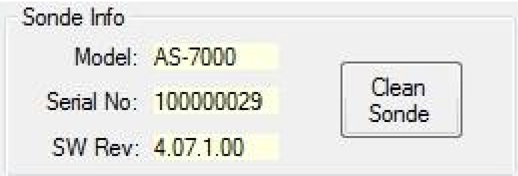
2. Remove the storage cap from the pH electrode if fitted, wash the sonde in de-ionised water, then gently lower the sonde into the calibration cup.

3. If you do not have any ISE caps fitted, activate the sonde cleaning feature in order to remove any air bubbles that may be clinging to the electrodes. To do this, click the Clean Sonde button. **If you have ISE caps fitted, agitate the sonde to eliminate air. Do not activate the cleaning mechanism as the brush will jam against the ISE caps.**

4. Wait until all readings are **completely** stable (temperature, EC and pH reading boxes all shaded green). The longer you can leave the sonde to achieve thermal equilibrium before proceeding, the better. A minimum of two minutes is recommended.

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

6. If calibrating an AS-7000 without any ISE electrodes fitted, click the Clean Sonde button and wait for the cleaning process to complete.


Sonde Info

Model: AS-7000
Serial No: 100000029
SW Rev: 4.07.1.00

7. Now click the RapidCal button.


● USB Cable
○ BlueLink

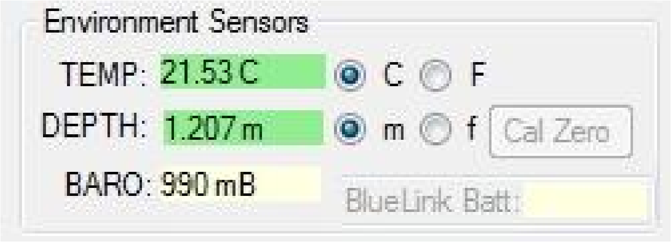
SondeLink will wait until all readings are stable, then it will send the RapidCal command to the sonde, where the calibration takes place.

During stabilisation and calibration, progress is reported on screen with a progress bar. When calibration is complete, a message box will be displayed. Click on the OK button return to normal reading mode. If a problem occurs during calibration, an error message will be displayed with details of the problem.

Important

If you have ISE electrodes fitted to your AquaSonde, you must now remove the rubber sealing caps from all the ISE electrodes.

6.5. Environment Sensors



Environment Sensors

TEMP: 21.53 C ● C ○ F

DEPTH: 1.207 m ● m ○ f

BARO: 990 mB

BlueLink Batt:

This group box displays the following:

Temperature is measured in the AquaSonde by a temperature sensor in the DO/EC electrode. By clicking on the adjacent controls, you can see temperature in Centigrade or Fahrenheit.

Water pressure is measured in the AquaSonde by a pressure sensor mounted inside the body of the sonde that is in contact with the water.

Barometric pressure is measured in the AquaSonde by a pressure sensor mounted inside the body of the sonde that is vented to the atmosphere through the main connector.

Depth is calculated by subtracting the barometric pressure from the water pressure. The pressure differential, once corrected for temperature and salinity (water density), is directly proportional to depth.

The datum on the sonde for depth measurement is the top row of holes on the sonde sleeve. Depth can be displayed in meters or feet.

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

If accurate depth readings are required during a deployment lasting more than a few hours, during which atmospheric pressure may change, the AquaSonde should be deployed on a vented cable, which will allow the pressure inside the AquaSonde to vary with the ambient air pressure, even when it is submerged.

If accurate depth readings are not important, the AquaSonde can be fully sealed using the AquaSonde Deployment Key and deployed on a simple suspension wire. In this case, depth readings will vary with atmospheric pressure changes at a rate of roughly 1cm/mB.

6.5.1. Calibrating the Depth Sensor

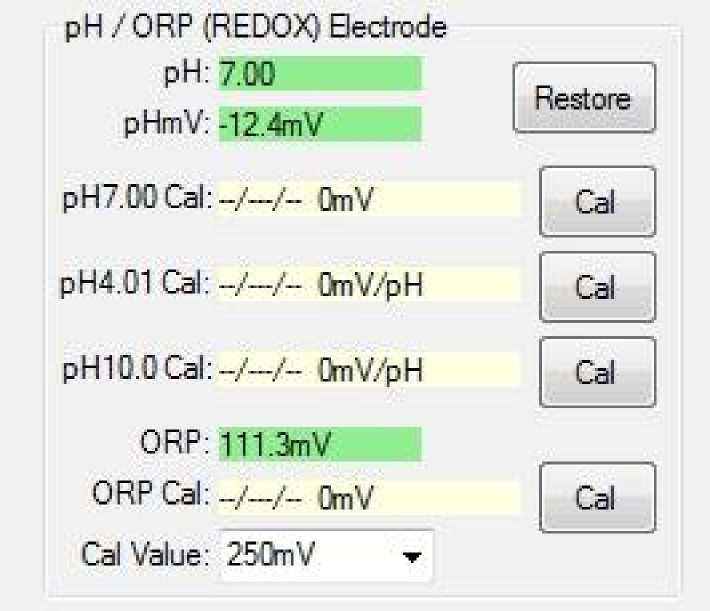
On all AquaSonde models, the depth sensor is fully factory calibrated. Also the depth zero point is always calibrated automatically when a Dissolved Oxygen 100% point calibration is carried out.

The AS-7000 model features a fully pre-calibrated depth sensor that requires only single point referencing to zero, which is carried out automatically whenever the DO 100% point is calibrated. No further depth calibration is required for this model.

In the unlikely event that a full two point depth calibration is required on either an AS-2000 or AS-5000, follow this procedure:

1. With the AquaSonde connected via a vented cable and sitting out of the water, click the '*Cal Zero*' button next to the Depth box.
2. Allow the calibration to complete.
3. **Without disconnecting the AquaSonde**, place the sonde in water so that the top edge of the top ring of holes in the sleeve is EXACTLY 1m under the surface of the water. When this is done, the '*Cal Zero*' button will change to '*Cal 1m*'.
4. Allow the temperature to stabilise completely then click the '*Cal 1m*' button.
5. Allow the calibration to complete.

6.6. PH/ORP (REDOX) Electrode



pH / ORP (REDOX) Electrode

pH: 7.00
pHmV: -12.4mV
pH7.00 Cal: --/---/-- 0mV
pH4.01 Cal: --/---/-- 0mV/pH
pH10.0 Cal: --/---/-- 0mV/pH
ORP: 111.3mV
ORP Cal: --/---/-- 0mV
Cal Value: 250mV

This group box displays the output from the combined pH/ORP (REDOX) electrode. PH is displayed in both pH units and mV. ORP (REDOX) is displayed in mV.

The '*Restore*' button restores the calibration of this electrode to factory defaults.

6.6.1. Keeping the pH Electrode 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.

6.6.2. 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 AquaSonde allows for both two and three point pH calibration. Should you decide to carry out just a two point calibration, the sonde will automatically calculate and save a calibration value for the un-calibrated 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.

6.6.3. Calibrating the First Point (pH 7.00)

Due to the way in which pH calibration works, **the sonde 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. Pour 400mL of fresh pH 7.00 solution or RapidCal into a calibration cup, remove the storage cap from the pH electrode, wash the sonde in de-ionised water, dry thoroughly then gently lower the sonde in all the way.
2. If you do not have any ISE caps fitted, activate the sonde cleaning feature in order to remove any air bubbles that may be clinging to the electrodes. **If you have ISE caps fitted, agitate the sonde to eliminate air. Do not activate the cleaning mechanism as the brush will jam against the ISE caps.**
3. Wait until the temperature and pH measurements are completely stable (boxes are both green).
4. Ensure the temperature of the solution is between 5ºC and 40ºC (41ºF – 104ºF).
5. Click on the '*Cal'* button adjacent to the pH7.00 Cal box.


pH7.00 Cal: -/--/-- 0mV

When calibration is complete, the calibration date and the voltage offset from zero for the pH electrode in +/-millivolts (mV) will be written into the calibration box shown above. If this offset goes beyond +/-30mV at 25°C, the pH electrode should be serviced.

This value is stored in the sonde's memory and will be displayed each time the sonde is connected to SondeLink.

Remove the sonde from the calibration cup, rinse thoroughly in de-ionised water, remove the sleeve and dry all wetted parts thoroughly with clean kitchen paper.

6.6.4. 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 disconnecting the sonde.**
If the sonde is disconnected after calibrating just one additional point (pH 4.00 for example), the sonde will automatically calculate and save a calibration value for the un-calibrated third point in order to maintain the electrode's linearity.

To calibrate the second point, pour 400mL of fresh pH 4.01 or pH 10.00 solution into a clean calibration cup and drop the sonde in all the way. Follow the procedure detailed above, but at step 5, click the *Cal* button for either pH4.01 or pH10.0, dependent upon the solution you are using. Wait while the sonde stabilises and calibrates. When the '*Calibrating Complete*' box 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.

Remove the sonde from the calibration cup, rinse thoroughly in de-ionised water, remove the sleeve and dry all wetted parts thoroughly with clean kitchen paper.

6.6.5. Calibrating the Third Point

Without disconnecting the sonde, pour 400mL of fresh pH 4.01 or pH 10.00 solution into a clean calibration cup drop the sonde in all the way. Follow the procedure detailed above, but at step 5, select either pH4.01 or pH10.0 dependent upon the solution you are using. Wait while the sonde stabilises and calibrates. When the '*Calibrating Complete*' box 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.

Remove the sonde from the calibration cup, rinse thoroughly in fresh water, remove the sleeve and dry all wetted parts thoroughly with clean kitchen paper. Dampen the sponge in the storage cap with storage solution and fit it to the pH/ORP electrode. pH calibration is now complete.

6.6.6. Servicing the pH Electrode

1. Remove the pH or combined pH/ORP electrode from the sonde body.
2. Rinse with methyl alcohol.
3. Replace the electrode.
4. Re-calibrate.

Never place the entire AquaSonde 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.

6.6.7. Calibrating ORP (REDOX)

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.

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 dependant 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.

To calibrate the ORP electrode follow these steps:

1. Pour 400mL of fresh ORP calibration solution into a calibration cup, remove the storage cap from the pH/ORP electrode, wash the sonde in de-ionised water, dry thoroughly then gently lower the sonde in all the way.
2. If you do not have any ISE caps fitted, activate the sonde cleaning feature in order to remove any air bubbles that may be clinging to the electrodes. **If you have ISE caps fitted, agitate the sonde to eliminate air. Do not activate the cleaning mechanism as the brush will jam against the ISE caps.**
3. Wait until the temperature and ORP measurements are completely stable (both boxes green).
4. Ensure the temperature of the solution is between 5ºC and 40ºC (41ºF – 104ºF).
5. Select the correct calibration solution value (either 250mV or 229mV) for the solution you are using in the *Cal Value* drop-down box.

ORP: 111.3mV

ORP Cal: -/--/- 0mV

Cal Value: 250mV

6. Click on the *Cal* button adjacent to the ORP Cal box.

When calibration is complete, the calibration date and the voltage offset for the ORP electrode in +/-millivolts (mV) will be written into the calibration box shown above. This value is stored in the sonde's memory and will be displayed each time the sonde is connected to SondeLink.

Remove the sonde from the calibration cup, rinse thoroughly in fresh water, remove the sleeve and dry all wetted parts thoroughly with clean kitchen paper.

6.6.8. Converting ORP Readings to the Hydrogen Scale

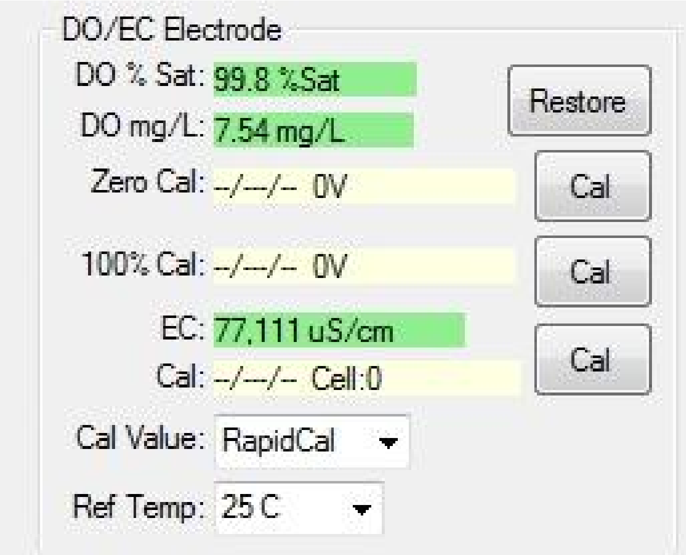
Electrochemical measurements are ultimately referred to the so-called hydrogen scale, the convention for which is that the electrochemical potential of a hydrogen electrode in contact with hydrogen gas at one atmosphere partial pressure and a solution containing hydrogen ions at unit activity is zero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

6.7. DO/EC Electrode



DO/EC Electrode

DO % Sat: 99.8 %Sat

DO mg/L: 7.54 mg/L

Zero Cal: -/--/- 0V

100% Cal: -/--/- 0V

EC: 77,111 uS/cm

Cal: -/--/- Cell:0

Cal Value: RapidCal

Ref Temp: 25 C

This group box displays the outputs from the Dissolved Oxygen (DO) and the Electrical Conductivity (EC) electrode. DO is displayed in both %Saturation and mg/L. If the background of the DO %Saturation box is shaded red, this means the DO electrode requires calibration or service.

The AquaSonde outputs Electrical Conductivity (EC) in an absolute form. The EC value can be corrected to correspond to a reference temperature of either 20°C or 25°C. To choose the way in which EC is reported, simply click one of the three settings within the Ref Temp drop-down box.

The DO %Saturation value calculated by the sonde is dependant upon barometric pressure. Barometric pressure is measured in the AquaSonde by a pressure sensor mounted inside the body of the sonde that is vented to the atmosphere through the main connector.

If accurate DO %Saturation readings are required during a deployment lasting more than a few hours, during which atmospheric pressure may change, the AquaSonde should be deployed on a vented cable, which will allow the pressure inside the AquaSonde to vary with the ambient air pressure, even when it is submerged.

If accurate DO %Saturation readings are not important, the AquaSonde can be fully sealed using the AquaSonde Deployment Key and deployed on a simple suspension wire. In this case, DO %Saturation readings will vary with atmospheric pressure changes at a rate of roughly 0.5%/mB.

Atmospheric pressure does not affect the DO values calculated in mg/L.

6.7.1. DO Electrode Calibration and Maintenance

6.7.2. Recognising the DO/EC Electrode

The DO/EC electrode is easy to recognise because it has a screw-on cap and four stainless-steel EC sensor contacts on the inside facing the wiper. Dissolved Oxygen (DO) is measured at the end of the electrode by the components behind the removable cap. Electrical Conductivity (EC) is measured on the inside edge of the electrode by the four stainless steel contacts. Temperature is also measured in this electrode. The flat on the wiper forms part of the EC cell.

6.7.3. DO Measurement Technique

The AquaSondes feature an optical DO sensor. This sensor does not use a liquid electrolyte and has a black rubber gas-permeable membrane. See Appendix 1. The Tech Behind Aquaread's Optical DO Measurement System for further details.

6.7.4. Precautions During Use

Never immerse the sonde without the DO Cap fitted. If the components at the end of the DO/EC electrode come into contact with the liquid being tested, serious damage can occur to the DO/EC electrode circuitry.

6.7.5. Calibrating the 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.

6.7.6. Calibrating the DO Zero Point

1. Pour 400mL of DO Zero calibration solution into a calibration up, remove the storage cap from the pH electrode if fitted, wash the sonde in de-ionised water, then gently lower the sonde in all the way.

2. Activate the sonde cleaning feature in order to remove any air bubbles that may be clinging to the electrodes. Wait until the temperature and DO measurements are completely stable.
3. Ensure the temperature of the solution is between 5°C and 40°C (41°F - 104°F).
4. Click the *Cal* button next to the DO Zero box.


Zero Cal: --/--/-- 0V

When calibration is complete, the calibration date and a voltage will be written into the calibration box shown above. The voltage value represents the health of the luminophore. This value should be between 3.5 and 4.5 (at 25°C). If the value returned is less than 3.5, the Optical DO Cap should be replaced.

This value is stored in the sonde's memory and will be displayed each time the sonde is connected to SondeLink.

Remove the sonde from the calibration cup, rinse thoroughly in de-ionised water, remove the sleeve and dry all wetted parts thoroughly with clean kitchen paper.

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

1. Moisten a clean cloth or piece of tissue paper with fresh water and wrap it around the end of the sonde ensuring all the holes are covered. Place the sonde on a flat surface. Do not hold the sonde, the heat from your hands will warm the sonde up and interfere with calibration.

2. 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.

3. If recalibration is needed, click the *Cal* button next to the 100% Cal box.

4. Wait while SondeLink carries out the calibration procedure.

5. When the 'Calibrating 100%' screen click the OK button to return to normal reading mode.

6.8. 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. See Sensor Cap Life in Appendix 1 for further details.

Caution: The inside of the Optical DO Cap is very sensitive to light and can be ruined (bleached) if it is exposed to bright light for any length of time. Never remove the Optical DO Cap from the sonde 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 sonde 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.

6.8.1. Calibrating the EC Electrode

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.

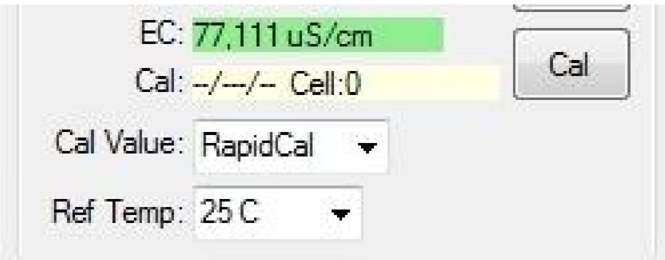
SC-35 calibration solution is available from Aquaread® dealers or can be easily manufactured by adding 33.03 grams of laboratory grade sodium chloride (99.9% pure) to 1 litre of deionised water. RapidCal is available from all Aquaread® dealers.

On the AS-7000 the sonde's central wiper forms an integral, working part of the sonde's EC measurement system, and MUST be fitted during calibration and measurement for correct operation. Likewise, on the AS-2000 and AS-5000 models, the sonde's sleeve forms an integral, working part of the sonde's EC measurement system, and MUST be fitted during calibration and measurement for correct operation. If you try to calibrate the sonde without the wiper (AS-7000) or sleeve (AS-2000/5000) fitted, you will get erroneous results.

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

1. Pour 400mL of calibration solution into one of the calibration cups provided. Remove the storage cap from the pH electrode if fitted, wash the sonde in de-ionised water, then gently lower the sonde into the calibration cup.

2. **Ensure the liquid level is high enough to cover the whole EC electrode. Low liquid level will result in erroneous EC calibration.** Refer to section 6.4 Using RapidCal.
3. Activate the sonde cleaning feature in order to remove any air bubbles that may be clinging to the electrodes. Wait until the temperature and EC measurements are completely stable.
4. Ensure the temperature of the solution is between 5ºC and 40ºC (41ºF - 104ºF).



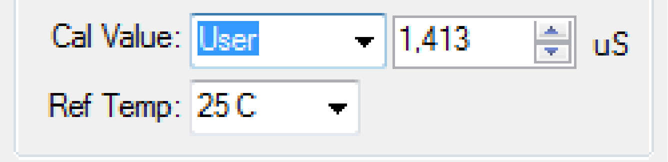
EC: 77,111 uS/cm

Cal: --/--/-- Cell:0

Cal Value: RapidCal

Ref Temp: 25 C

5. In the *Cal Value* drop-down box, select the calibration solution you are using. Your choices are 'RapidCal', 'SC-35' or 'User'. If you select 'User', a new box will appear into which you must enter the EC value of your calibration solution **AT 25ºC**. This information will be printed on the label of the EC calibration standard bottle.



Cal Value: User 1,413 uS

Ref Temp: 25 C

6. Click on the *Cal* button adjacent to the EC Cal box.

When calibration is complete, the calibration date and the EC electrode's cell constant will be written into the calibration box. This value is stored in the sonde's memory and will be displayed each time the sonde is connected to SondeLink.

Remove the sonde from the calibration cup, rinse thoroughly in fresh water, remove the sleeve and dry all wetted parts thoroughly with clean kitchen paper.

Special Notes:
If you have selected a Calibration Standard value other than RapidCal, then you subsequently use the RapidCal calibration technique described in section 6.4, the Cal Value will automatically be reset to RapidCal.

6.8.2. Errors During Calibration

At the beginning of the calibration routine, a sanity check is done. If the sonde detects that the Calibration Standard value set and the Calibration Standard being used differ, an error message will be displayed.

6.8.3. 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 sonde sleeve and re-calibrate.

6.9. Optional Optical Electrodes Calibration and Maintenance

The AS-7000 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 sonde sleeve, end cap and wiper form an integral, working part of the sonde's optical measurement system, and MUST be fitted during calibration and measurement 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.

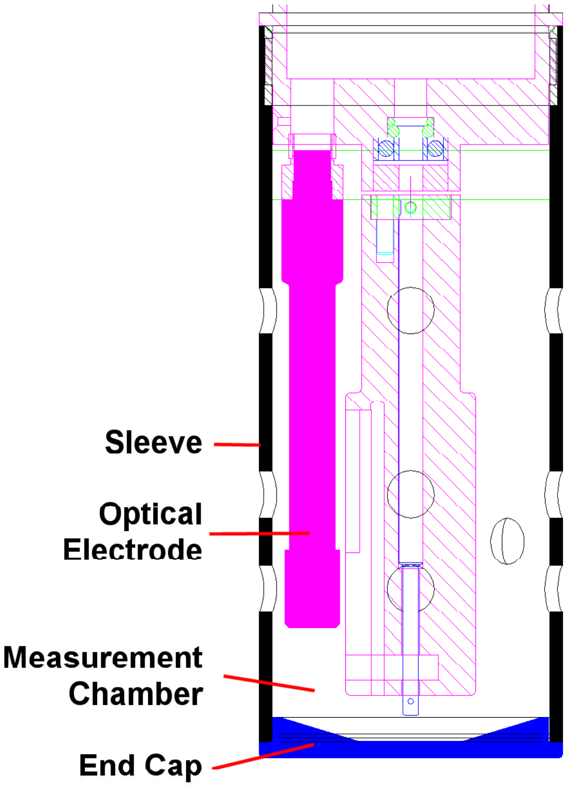
It follows, therefore, that in order to provide stable, repeatable readings, the environment in which the measurements are made must be completely stable and repeatable.

For this reason, the AS-7000 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.

In order to obtain consistent results, the measurement chamber created within the AquaSonde must remain physically constant during both calibration and measurement. It is therefore essential that both the sleeve and sleeve end cap are fitted during calibration and operation of all types of optical electrodes.

If an 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.

6.9.1. 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 activate the self-cleaning mechanism.
- 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.

6.9.2. 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 disconnecting the AquaSonde).

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

6.9.3. 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 accuracy the of future readings from that electrode.

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

6.9.4. Calibrating the Turbidity Electrode

This electrode employs a Nephelometric technique in accordance with ISO 7027, which uses Formazin as a reference standard. The AquaSonde outputs 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**. Factory calibration is carried out with a 1000 NTU Stabilised Formazin Turbidity Standard in accordance with ISO 7027.

6.9.5. 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.

6.9.6. 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 sonde 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**.

If you experience any problems using the Turbidity Electrode, refer to Appendix 5. Troubleshooting Turbidity

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

6.9.7. 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.

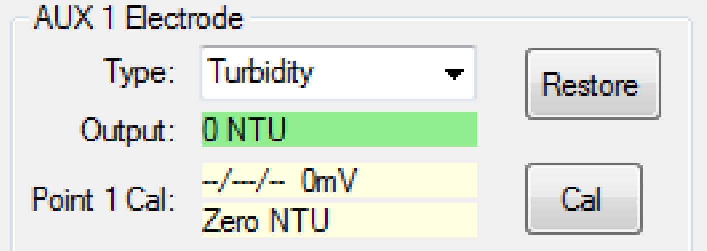
When a turbidity electrode is first installed, **it MUST be calibrated at three points** in order to establish the individual electrode's slope. **The Zero NTU point must always be calibrated first, followed by the other two points, all within the same calibration session (i.e. without disconnecting the AquaSonde).**

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.

6.9.8. Turbidity Zero Point Calibration

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

1. Pour 400mL of clean water (bottled still mineral water is recommended) into a clean calibration tube, remove the storage cap from the pH electrode if fitted, wash the sonde in clean water, then drop the sonde in all the way. **The Sleeve End Cap must be fitted**.
2. Wait until the temperature and turbidity measurements are completely stable (boxes are both green).
3. Ensure the temperature of the solution is between 5ºC and 40ºC (41ºF – 104ºF).
4. Activate the sonde cleaning feature in order to remove any air bubbles that may be clinging to the electrodes.
5. Click on the *Cal* button adjacent to the Point 1 Cal box.



Type: Turbidity
Output: 0 NTU
Point 1 Cal: --/--/-- 0mV
Zero NTU

When calibration is complete, the calibration date and the voltage output from the electrode in millivolts (mV) will be written into the calibration box.

This value is stored in the sonde's memory and will be displayed each time the sonde is connected to SondeLink.

6.9.9. 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 sonde from the calibration bottle then reinsert, activate the sonde cleaning feature then allow the reading to settle.

Check the turbidity reading is within +/- 1NTU of zero. If not, re-calibrate the zero point.

6.9.10. 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 disconnecting the AquaSonde)**.

Remove the sonde from the zero calibration cup, remove the sleeve and dry all wetted parts thoroughly with clean kitchen paper. Re-fit the sleeve and end cap.

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.

Gently pour 400mL of the solution into a clean calibration tube and drop the sonde in all the way. Activate the sonde cleaning feature in order to remove any air bubbles that may be clinging to the electrodes.

Follow the procedure detailed above for Zero point calibration as far as step 4, then select either Point 2 (1000NTU) or Point 3 (20NTU), dependant upon the solution the sonde is in. Wait while the readings stabilise and the Sonde calibrates.

Rinse and dry the sonde thoroughly then repeat this procedure for the third point.

6.9.11. Errors During Calibration

If a problem occurs during calibration, an error message will be displayed.

6.9.12. 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 sonde 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 sonde 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.

6.9.13. Calibrating Fluorescent Types of Optical Electrode

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 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

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.

6.9.14. Limitations of Use

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.

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.
- Differences in the fluorescent response caused by temperature.
- Differences in the fluorescent response caused by ambient light.
- Interference caused by turbidity.

6.9.15. Calibration Points

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

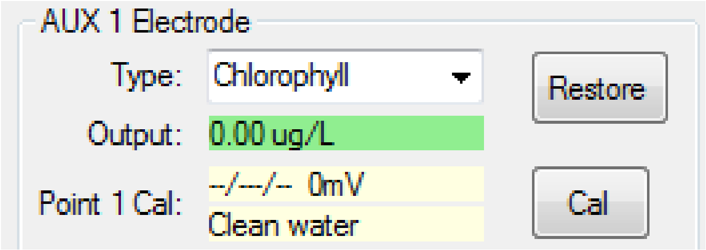
When a fluorescent electrode is first installed, **it MUST be calibrated at both points** in order to establish the individual electrode's slope. **The Zero point must always be calibrated first, followed by the second point, both within the same calibration session (i.e. without disconnecting the AquaSonde).**

The electrode should subsequently be Zeroed (calibrated at Point 1 in clean water) before each day's use. A two point calibration should be carried out once a month to ensure optimum accuracy.

6.9.16. Zero Point Calibration

To calibrate the zero point (Point 1), follow these steps:

1. Pour 400mL of clean water (bottled still mineral water is recommended) into a clean calibration tube, remove the storage cap from the pH electrode if fitted, wash the sonde in clean water, then drop the sonde in all the way. **The Sleeve End Cap must be fitted**.
2. Wait until the temperature and electrode measurements are completely stable (boxes are both green).
3. Ensure the temperature of the solution is between 5ºC and 40ºC (41ºF – 104ºF).
4. Activate the sonde cleaning feature in order to remove any air bubbles that may be clinging to the electrodes.
5. Click on the *Cal* button adjacent to the Point 1 Cal box.



AUX 1 Electrode

Type: Chlorophyll

Output: 0.00 ug/L

Point 1 Cal: --/--/-- 0mV
Clean water

When Point 1 calibration is complete, the calibration date and the voltage output from the electrode in millivolts (mV) will be written into the calibration box.

This value is stored in the sonde's memory and will be displayed each time the sonde is connected to SondeLink.

6.9.17. Verifying the Zero Calibration

An accurate zero point calibration is essential to the correct operation of the fluorescent electrodes. 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 sonde from the calibration bottle then reinsert, activate the sonde cleaning feature then allow the reading to settle. Check the reading is zero. If not, re-calibrate the zero point.

6.9.18. Calibrating the Second Point

When calibrating any fluorescent electrode, **the Zero point must be calibrated first within the same calibration session (i.e. without disconnecting the AquaSonde)**.

A Point 2 calibration standard must be prepared to suite each electrode being calibrated. Each electrode type has a specific requirement, which is detailed in section 7: Calibration Solution Preparation

Once calibrated at Point 1 (the zero point), remove the sonde from the zero calibration cup, remove the sleeve and dry all wetted parts thoroughly with clean kitchen paper. Re-fit the sleeve and end cap.

Gently pour 400mL of the pre-prepared Point 2 solution into a clean calibration tube and drop the sonde in all the way. Activate the sonde cleaning feature in order to remove any air bubbles that may be clinging to the electrodes.

Follow the general procedure detailed above for Zero point calibration as far as step 4, then click on the *Cal* button adjacent to the Point 2 Cal box. Wait while the readings stabilise and the Sonde calibrates.

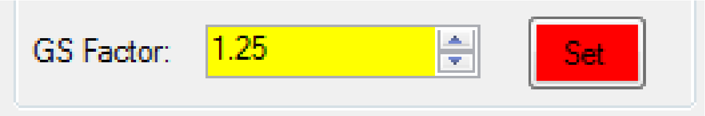
6.9.19. Errors During Calibration

If a problem occurs during calibration, an explanatory error message will be displayed.

6.9.20. 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 in the GS Factor box.



GS Factor: 1.25

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 in the GS Factor box. Once the GS Factor value has been input, click the SET button to send the Factor to the sonde.

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.

6.9.21. 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 sonde 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 sonde 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.

6.10. Calibrating ISE Electrodes

During calibration of the ISE electrodes, very special care must be taken to achieve the specified temperatures. In order to help reduce the sonde's thermal mass and thereby speed up temperature stabilisation, it is advisable to carry out ISE calibration with the sleeve and wiper removed. In this condition, however, the individual electrodes are very vulnerable so care should be taken in order to avoid damage.

6.10.1. 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.

6.10.2. Calibration Points

All ISE electrodes have three calibration points. Three calibration standards must be prepared to suite each electrode being calibrated. Each electrode type has a specific requirement, which is detailed in section 8: ISE Electrode Calibration Solution Preparation.

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.

6.10.3. Special Notes Concerning ISE Electrodes

The high ionic concentration of pH calibration solutions (buffers), including RapidCal, can cause significant offsets in ISE electrodes.

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 during pH calibration or when using RapidCal in order to protect the ISE electrodes from the effects of the buffer solution.

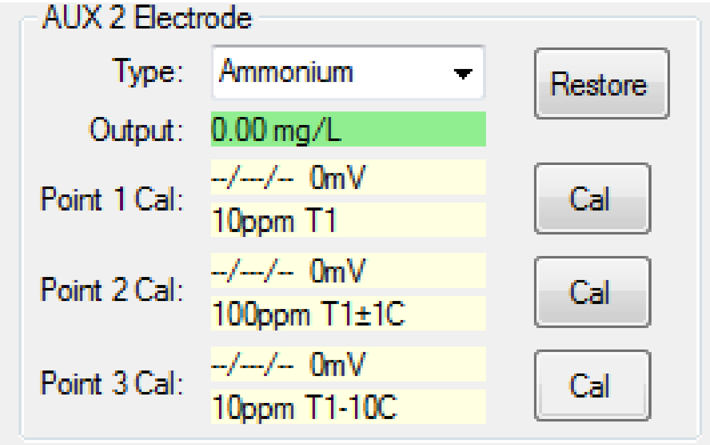
At all other times, the ISE electrodes should be left uncovered.

6.10.4. Three-point Calibration

During three-point calibration, the AquaSonde must remain connected to the PC. If the AquaSonde is disconnected between points, the calibration process will be aborted and must be re-started from point 1. The AquaSonde's sleeve and wiper should also be removed in order to reduce the sonde's thermal mass. To calibrate the ISE electrode follow these steps:

6.10.5. Point 1 Calibration

1. Remove the sonde Sleeve and the Wiper (see section 12.1). Remove the storage cap from the pH electrode, wash the sonde in de-ionised water, dry the sonde thoroughly then gently lower the sonde into warm **Point 1** solution.
2. Connect the AquaSonde and stir the sonde until the temperature and ISE readings are completely stable (shaded green). A minimum of five minutes is recommended.
3. Ensure the temperature of the solution is between 20ºC and 40ºC (68ºF – 104ºF).



Type: Ammonium

Output: 0.00 mg/L

Point 1 Cal: --/--/-- 0mV
10ppm T1

Point 2 Cal: --/--/-- 0mV
100ppm T1±1C

Point 3 Cal: --/--/-- 0mV
10ppm T1-10C

4. Click the '*Cal*' button adjacent to the Point 1 Cal box.

When Point 1 calibration is complete, the calibration date and the voltage output from the electrode in millivolts (mV) will be written into the calibration box.

This value is stored in the sonde's memory and will be displayed each time the sonde is connected to SondeLink.

6.10.6. Point 2 Calibration

1. Remove the sonde from the Point 1 solution and wash thoroughly in deionised water. Dry the sonde then gently lower it into warm **Point 2** solution.
2. Stir the sonde until the temperature and ISE readings are completely stable (shaded green). A minimum of five minutes is recommended.
3. **Ensure the temperature of the solution is within 1ºC of the previous Point 1 calibration point.** If the solution is warmer or cooler than this, calibration will fail.
4. Click the '*Cal*' button adjacent to the Point 2 Cal box.

If the temperature of the Point 2 solution is more than 1ºC different from the Point 1 calibration temperature, an OUT OF TEMP RANGE calibration error will be reported. If this happens, adjust the temperature and try again.

6.10.7. Point 3 Calibration

1. Remove the sonde from the Point 2 solution and wash thoroughly in deionised water. Dry the sonde then gently lower it into **cool Point 3** solution.
2. Stir the sonde until the temperature and ISE readings are completely stable (shaded green). A minimum of fifteen minutes is recommended.
3. **Ensure the temperature of the solution is at least 10ºC cooler than the previous Point 2 calibration point.** If the solution is too warm, calibration will fail.
4. Click the '*Cal*' button adjacent to the Point 3 Cal box.

If the temperature of the cool Point 3 solution is less than 10ºC cooler than the Point 1 and Point 2 calibration temperatures, an OUT OF TEMP RANGE calibration error will be reported. If this happens, adjust the temperature and try again.

At the end of the three-point calibration sequence, replace the wiper (see section 12.1) Sleeve and sleeve cap.

6.10.8. Two-point Calibration

Two-point calibration should be carried out weekly. For this, Point 1 and Point 2 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 AquaSonde must remain connected to the PC. If the AquaSonde is disconnected 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.

6.10.9. Single-point Calibration

Single-point calibration should be carried out daily. For this, just Point 1 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.

6.10.10. Errors During Calibration

If a problem occurs during calibration, an explanatory error message will be displayed.

7. Calibration Solution Preparation

7.1. BGA-PC Electrode 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.

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 sonde 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.

7.1.1. 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 Point 2 calibration of the BGA-PC sensor.

The value output by the AquaSonde directly after calibration should be approximately 70,000 cells/mL at 20°C (this value will vary with temperature).

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.

7.2. BGA-PE Saltwater Blue-Green Algae (phycoerythrin) Electrode 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 sonde 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.

7.2.1. 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 Point 2 calibration of the BGA-PE sensor.

The value output by the AquaSonde directly after calibration should be approximately 200,000 cells/mL at 20ºC (this value will vary with temperature).

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.

7.3. CPHYLL Chlorophyll Electrode 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 sonde 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.

7.3.1. 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 Point 2 calibration of the CPHYLL sensor.

The value output by the AquaSonde directly after calibration should be approximately 118 µg/L at 20ºC (this value will vary with temperature).

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.

7.4. RHOD Rhodamine Electrode Calibration Solution Preparation

Rhodamine WT is a fluorescent red dye that is commonly used in water flow studies.

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.

7.4.1. 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 Point 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.

7.5. FSCEIN Fluorescein Electrode Calibration Solution Preparation

Fluorescein is a fluorescent dye that is commonly used in water flow studies.

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.

7.5.1. 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.

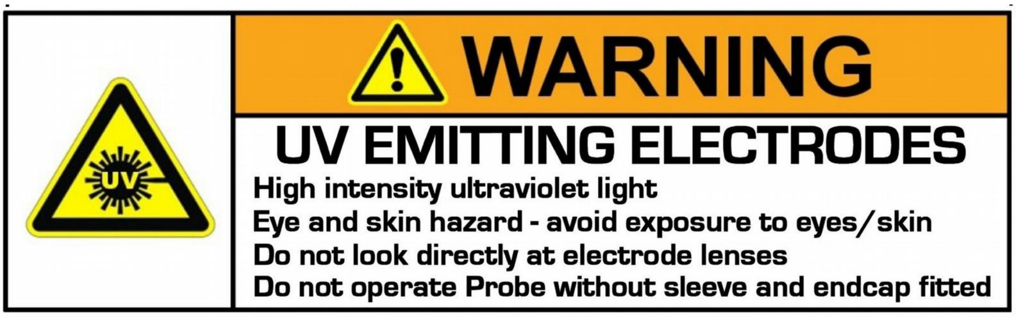
This step results in a 1 in 100 dilution of the 500mg/L stock resulting in a 5mg/L stock.

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 Point 2 calibration.

7.6. REFOIL Refined Oil Electrode

Refined fuels such as benzene, toluene, ethylbenzene, and xylenes (BTEX) can be measured using the optional REFOIL optical electrode.



WARNING

UV EMITTING ELECTRODES

High intensity ultraviolet light
Eye and skin hazard - avoid exposure to eyes/skin
Do not look directly at electrode lenses
Do not operate Probe without sleeve and endcap fitted

- **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 AquaSonde.**

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.

7.6.1. 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.

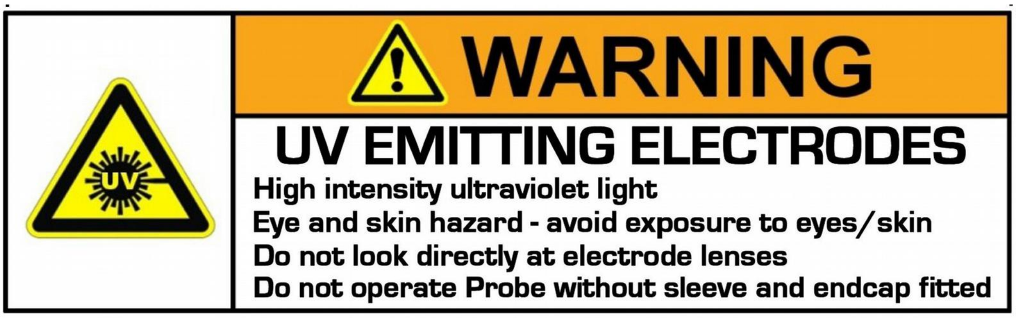
Step 2: Transfer 10ml of the 1000ppm stock solution to a 1L volumetric flask and top up with 1L of deionized water. Invert 10 times. This step results in a 1 in 100 dilution of the 1000ppm stock giving the 10ppm standard required for Pt-2 calibration.

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.

7.7. CDOM/FDOM Chromophoric (Fluorescent) Dissolved Organic Matter Calibration Solution

Fluorescent) Dissolved Organic Matter can be measured using the optional CDOM optical electrode.



WARNING

UV EMITTING ELECTRODES

High intensity ultraviolet light
Eye and skin hazard - avoid exposure to eyes/skin
Do not look directly at electrode lenses
Do not operate Probe without sleeve and endcap fitted

➔ **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 AquaSonde.**

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

7.8. 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.

8. ISE Electrode Calibration Solution Preparation

8.1. AMM Ammonium/Ammonia Electrode

Ammonium (NH4) and Ammonia (NH3) can be measured using the optional 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.

8.1.1. 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 400mL batches of Ammonium (as NH4) at a concentration of 10ppm and one 400mL 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. The following Ammonium standard is recommended:

Part number: SS-702-1610
Description: 500mL Ammonium 1000ppm as NH4 ISE
Supplier: T E Laboratories Ltd, Ireland.
Contact: http://www.tellab.ie

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

Preparing the 100ppm solution

500mL of 100ppm solution is required. To prepare this, mix 50mL of 1000ppm calibration standard with 450mL of deionised water.

Dispense 400mL of the 100ppm solution into a calibration cup and retain 100mL for preparation of the 10ppm solution.

Preparing the 10ppm solution

A total of 800mL of 10ppm solution is required. To prepare this, mix 80mL of the 100ppm solution you have just prepared with 720mL of deionised water. Dispense the 10ppm solution into two calibration cups (400mL 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 25°C. Once all three solutions are at a stable temperature, calibration can begin.

8.2. NIT Nitrate Electrode

Nitrate (NO3) can be measured using the optional CHL 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.

8.2.1. 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 400mL batches of Nitrate at a concentration of 10ppm and one 500mL batch of Nitrate at a concentration of 100ppm.

The three calibration solutions should be freshly prepared by serial dilution from 1000ppm calibration standard. The following Nitrate standard is recommended:

Part number: SS-712-1610
Description: 500mL Nitrate 1000ppm ISE
Supplier: T E Laboratories Ltd, Ireland.
Contact: http://www.tellab.ie

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

Preparing the 100ppm solution

500mL of 100ppm solution is required. To prepare this, mix 50mL of 1000ppm calibration standard with 450mL of deionised water.

Dispense 400mL of the 100ppm solution into a calibration cup and retain 100mL for preparation of the 10ppm solution.

Preparing the 10ppm solution

A total of 800mL of 10ppm solution is required. To prepare this, mix 80mL of the 100ppm solution you have just prepared with 720mL of deionised water. Dispense the 10ppm solution into two calibration cups (400mL 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.

8.3. CHL Chloride Electrode

Chloride (Cl) can be measured using the optional 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.

8.3.1. 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 400mL batches of Chloride at a concentration of 10ppm and one 500mL batch of Chloride at a concentration of 100ppm.

The three calibration solutions should be freshly prepared by serial dilution from 1000ppm calibration standard. The following Chloride standard is recommended:

Part number: SS-706-1610
Description: 500mL Chloride 1000ppm ISE
Supplier: T E Laboratories Ltd, Ireland.
Contact: http://www.tellab.ie

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

Preparing the 100ppm solution

500mL of 100ppm solution is required. To prepare this, mix 50mL of 1000ppm calibration standard with 450mL of deionised water.

Dispense 400mL of the 100ppm solution into a calibration cup and retain 100mL for preparation of the 10ppm solution.

Preparing the 10ppm solution

A total of 800mL of 10ppm solution is required. To prepare this, mix 80mL of the 100ppm solution you have just prepared with 720mL of deionised water. Dispense the 10ppm solution into two calibration cups (400mL 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.

8.4. CAL Calcium Electrode

Calcium (Ca2) can be measured using the optional CHL 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.

8.4.1. 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 400mL batches of Calcium at a concentration of 10ppm and one 500mL batch of Calcium at a concentration of 100ppm.

The three calibration solutions should be freshly prepared by serial dilution from 1000ppm calibration standard. The following Calcium standard is recommended:

Part number: SS-705-1610
Description: 500mL Calcium 1000ppm ISE
Supplier: T E Laboratories Ltd, Ireland.
Contact: http://www.tellab.ie

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

Preparing the 100ppm solution

500mL of 100ppm solution is required. To prepare this, mix 50mL of 1000ppm calibration standard with 450mL of deionised water.

Dispense 400mL of the 100ppm solution into a calibration cup and retain 100mL for preparation of the 10ppm solution.

Preparing the 10ppm solution

A total of 800mL of 10ppm solution is required. To prepare this, mix 80mL of the 100ppm solution you have just prepared with 720mL of deionised water. Dispense the 10ppm solution into two calibration cups (400mL 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.

8.5. FLU Fluoride Electrode

Fluoride (F) can be measured using the optional CHL 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.

8.5.1. 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 400mL batches of Fluoride at a concentration of 0.5ppm and one 500mL batch of Fluoride at a concentration of 5ppm.

The three calibration solutions should be freshly prepared by serial dilution from 1000ppm calibration standard. The following Fluoride standard is recommended:

Part number: SS-709-1610
Description: 500mL Fluoride 1000ppm ISE
Supplier: T E Laboratories Ltd, Ireland.
Contact: http://www.tellab.ie

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

Preparing the 5ppm solution

500mL 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 50mL of the 50ppm solution with 450mL of deionised water. This will produce 500mL of 5ppm solution.

Dispense 400mL of the 5ppm solution into a calibration cup and retain the rest for preparation of the 0.5ppm solution.

Preparing the 0.5ppm solution

A total of 800mL of 0.5ppm solution is required. To prepare this, mix 80mL of the 5ppm solution you have just prepared with 720mL of deionised water. Dispense the 0.5ppm solution into two calibration cups (400mL each).

Achieving the correct temperature

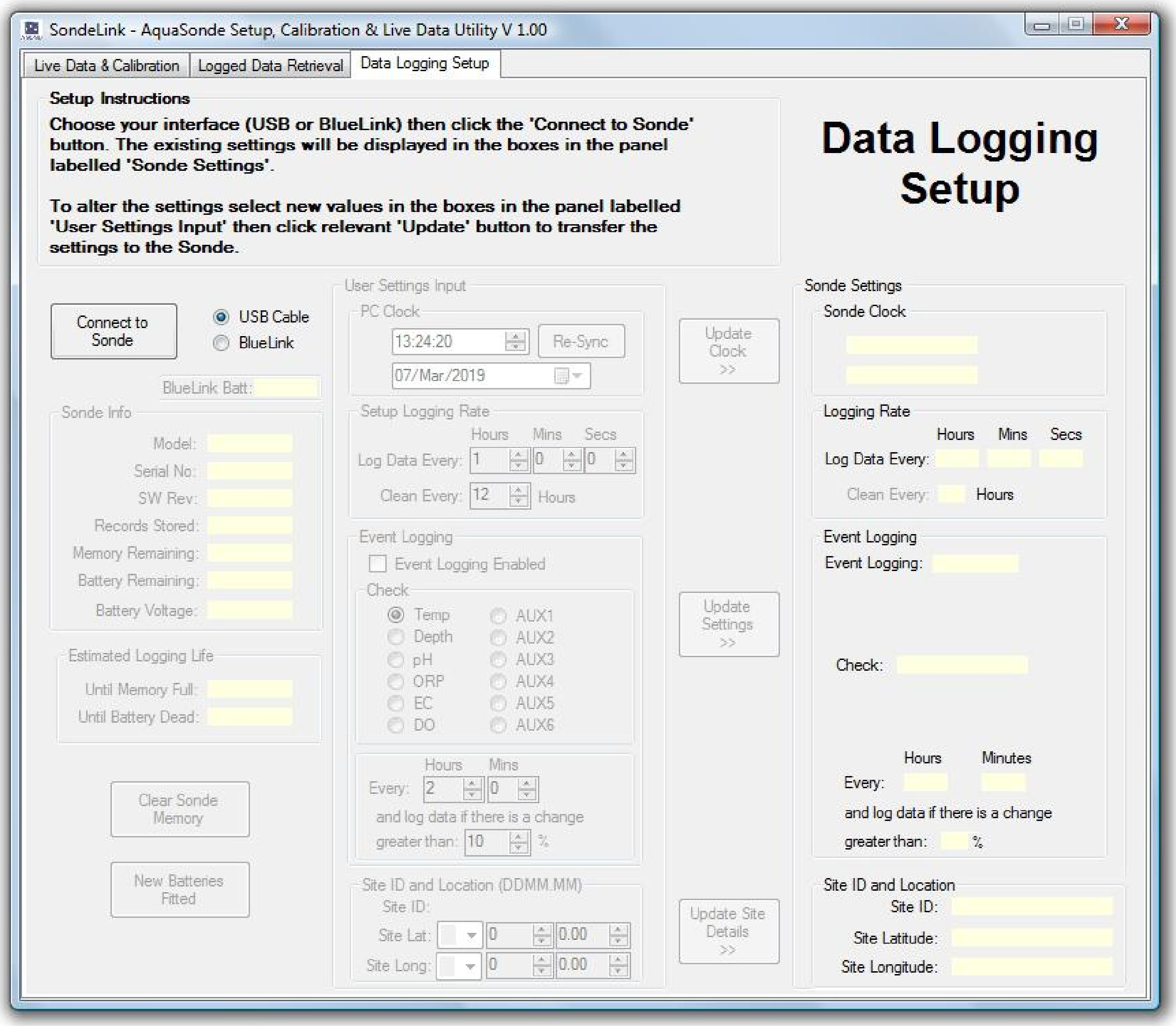
During three point calibration, the 5ppm solution and one batch of the 0.5ppm solution must be at exactly the same temperature. The second batch of 0.5ppm solution must be at least 10ºC cooler.

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.

9. Data Logging Setup

Before the AquaSonde will log any data, a data logging regime must be set up. To do this, connect the AquaSonde to a PC running SondeLink and select the 'Data Logging Setup' tab. The following screen will appear.



Setup Instructions

Choose your interface (USB or BlueLink) then click the 'Connect to Sonde' button. The existing settings will be displayed in the boxes in the panel labelled 'Sonde Settings'.

To alter the settings select new values in the boxes in the panel labelled 'User Settings Input' then click relevant 'Update' button to transfer the settings to the Sonde.

● USB Cable ○ BlueLink

PC Clock: 13:24:20 07/Mar/2019

Log Data Every: 1 Hours 0 Mins 0 Secs

Clean Every: 12 Hours

☐ Event Logging Enabled

Check: ● Temp ○ Depth ○ pH ○ ORP ○ EC ○ DO ○ AUX1 ○ AUX2 ○ AUX3 ○ AUX4 ○ AUX5 ○ AUX6

Every: 2 Hours 0 Mins

and log data if there is a change greater than: 10 %

Site Lat: 0 0.00

Site Long: 0 0.00

Select either *USB Cable* or *BlueLink* then click on the '*Connect to Sonde'* button. If the AquaSonde is properly connected and the drivers are installed, SondeLink will display the sonde's status and current settings.

Sonde information including remaining battery and memory capacity along with an estimated battery and memory life based on the current logging regime will be displayed in the panel labelled 'Sonde Info'. The current settings will be displayed in the boxes in the panel labelled 'Sonde Settings'

To alter the settings, select new values in the panel labelled 'User Settings Input' then click the relevant 'Update' button to transfer the settings to the sonde.

9.1. Sonde Info Panel

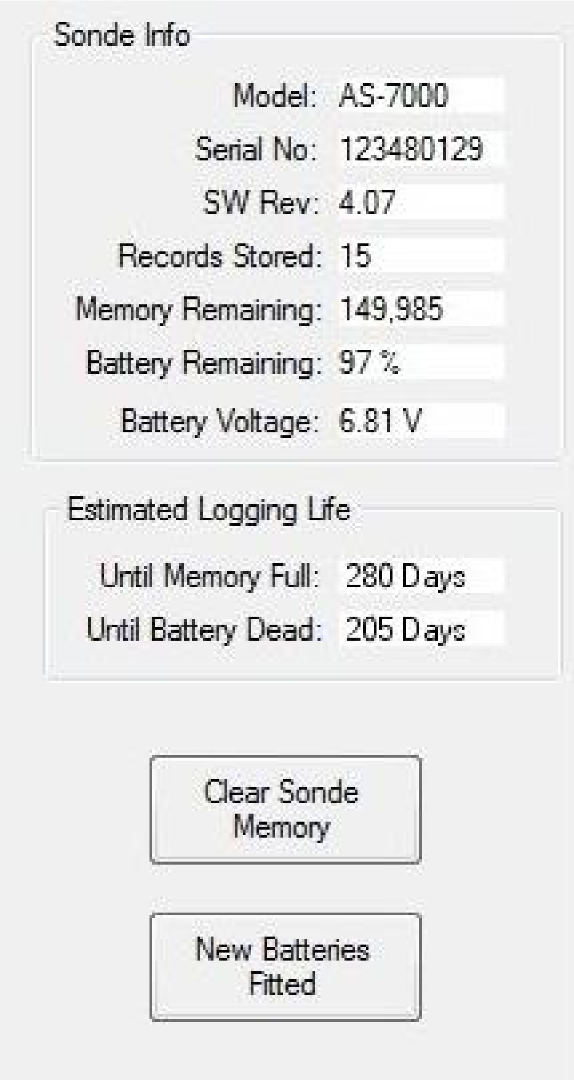
The Sonde Info panel contains data concerning the sonde. This includes model, serial number, software revision, number of records currently stored, number of free records (or memory remaining), battery capacity remaining and the current battery voltage.

In addition, this panel shows the estimated time until the memory is full (in days) and the estimated time until the battery runs flat (in days). Both these values are dynamic and will change as you change the logging settings.

If you want to log data for a specific length of time, adjust the logging, event logging and cleaning rates until the required number of days is shown in the estimated life boxes.

Please be aware that the battery life estimate is just that: an *estimate*. The actual battery life will vary with temperature, quality of the battery and previous usage.

Always be sure to leave a little battery life in hand to ensure that no data is lost.



Sonde Info

Model: AS-7000
Serial No: 123480129
SW Rev: 4.07
Records Stored: 15
Memory Remaining: 149,985
Battery Remaining: 97 %
Battery Voltage: 6.81 V

Estimated Logging Life

Until Memory Full: 280 Days
Until Battery Dead: 205 Days

9.1.1. Clearing the sonde's memory

To clear the sonde's memory, simply click the 'Clear Sonde Memory' button. Please be aware, once the sonde's memory has been cleared, the data can not be recovered. You can save the contents of the sonde's memory to your PC using the 'Save as Raw Data' button on the 'Logged Data Retrieval' tab.

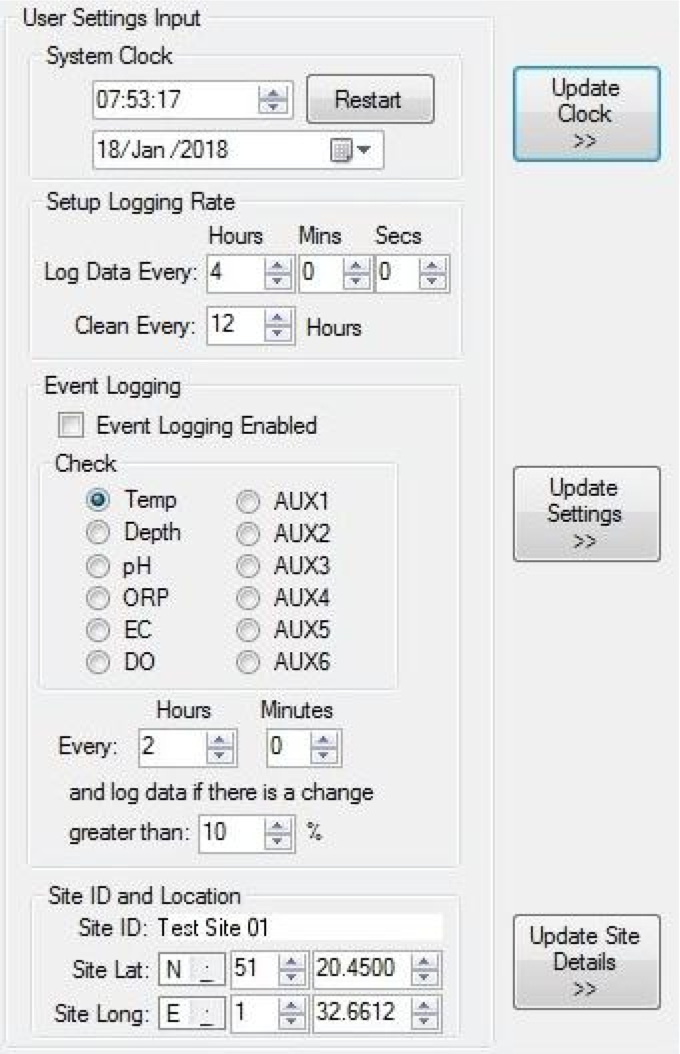
9.2. Resetting the Battery Condition Monitor

Whenever new batteries are fitted, it is essential to reset the battery condition monitor by clicking the 'New Batteries Fitted' button.

This will reset the battery condition monitor to 100% and allow an accurate estimate of battery condition going forward.

DO NOT RESET THE BATTERY MONITOR UNLESS YOU HAVE FITTED NEW BATTERIES! If you do this, the 'Battery Remaining' value will be calculated erroneously. This can lead to loss of data when the batteries unexpectedly run flat.

9.3. User Settings Input Panel



User Settings Input

System Clock

07:53:17

18/Jan /2018

Setup Logging Rate

Log Data Every: 4 Hours 0 Mins 0 Secs

Clean Every: 12 Hours

Event Logging

☐ Event Logging Enabled

Check

● Temp
○ Depth
○ pH
○ ORP
○ EC
○ DO
○ AUX1
○ AUX2
○ AUX3
○ AUX4
○ AUX5
○ AUX6

Every: 2 Hours 0 Minutes

and log data if there is a change greater than: 10 %

Site ID and Location

Site ID: Test Site 01

Site Lat: N 51 20.4500

Site Long: E 1 32.6612

9.3.1. Clock Setup

The first item in this panel is the system clock. This will automatically sync with your PC clock to show current time and date.

If you want to set a different time and date simply type in the new values. At this point, the time and date will stop syncing with the PC clock. If you want to re-sync with the PC clock, click the 'Restart' button.

To transfer the time and date to the sonde, click the 'Update Clock' button.

9.3.2. Logging Rate Setup

The logging rate can be setup to any value between 2 seconds and 120 hours in steps of 2 seconds.

When setting up the logging rate, keep an eye on the estimated battery life figure. Obviously, if you want to log data for a month, there is no point in setting the logging rate to 2 seconds because the batteries are not going to last that long at that rate.

It is always best to log at the slowest permissible rate for your application. This saves the batteries and reduces the amount of data you have to handle at the end of the project.

To transfer the Logging Rate settings to the sonde, click the 'Update Settings' button.

9.3.3. Cleaning Rate Setup

When using an AS-7000, which features self cleaning, the rate at which the self cleaning mechanism runs can be selected in increments of 1 hour.

In clean water, once every 24 hours is generally sufficient. In sea water, a cleaning rate of every six hours is advisable in order to discourage marine growth. In extremely polluted water a faster rate may be required.

Please bear in mind that the cleaning mechanism uses a considerable amount of battery power, so it should be set to the longest period possible for the application. When setting the cleaning rate, keep an eye on the estimated battery life figure.

9.3.4. Event Logging Setup

This panel allows you to choose one parameter to check on a regular basis and forces the sonde to log extra data if a preset change in the chosen parameter is detected.

Using this feature, memory can be saved by using a long logging interval (say several hours or more), but any rapid changes will be logged in full detail.

To activate event logging, first tick the 'Event Logging Enabled' tick box. Next select the parameter that you want to monitor for event logging.

Next, select the time interval at which the event should be checked. **This value must be more regular than the normal logging rate.**

Finally, set the trigger point for the event logging, in other words, the amount each value must change from the previously logged value in order to be logged.

So, for example, you could set the regular logging rate to 4 hours and set the depth to be monitored every 15 minutes, looking for a change of 10% during that 15 minute period.

The sonde will subsequently take a measurement every 15 minutes, but will only log the data if the depth has changed by more than 10% from the previous logged value.

Important note regarding battery life and Event Logging: If you set a long logging interval but a very short event checking interval, the battery life will be estimated on the event checking interval rate. Even though the logger will not log data every time an event is checked, it will take a reading and hence will use the same amount of battery power as a logged data point. Always choose the longest logging / event checking interval that you can for your application in order to prolong the battery life. When setting the event logging rate, keep an eye on the estimated battery life figure.

To transfer the Event Logging settings to the sonde, click the 'Update Settings' button.

9.3.5. Setting Site ID and Location

The Site ID and Location panel allows you to enter a site identifier of up to 16 characters and a latitude and longitude for the site. This data is output at the start of Text (.txt) and Spreadsheet (.csv) files saved from the 'Logged Data Retrieval' tab.

Filling in this panel is optional but can be very useful to help identify the origins of saved data files. To transfer the Site ID and Location settings to the sonde, click the 'Update Site Details' button.

9.4. Checking and Activating the Logging Regime

After setting all the user parameters and transferring them to the sonde, check that the sonde has accepted the settings by comparing the 'Sonde Settings' panel to the 'User Settings Input' panel. They should be the same. Also check that the sonde clock is correct.

The sonde can now be disconnected by clicking the 'Disconnect Sonde' button. When the sonde subsequently has an AquaSonde Deployment Key or a vented cable connected, the logging regime will be automatically activated. See the next section for more details.

10. Deploying the AquaSonde

10.1. Deployment in Open Water

If the sonde is to be deployed in open water (i.e. a river, lake or the sea), a length of **plastic pipe** should first be firmly mounted, then the sonde should be suspended within the pipe so it is always under water, but not on the bottom where it could become buried by silt. This will protect the sonde from currents, wave action, and debris. Mounting the sonde within a **metal pipe is NOT RECOMMENDED**.

10.2. 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 the AquaSonde, it is important to recognise and avoid the possibility of creating a situation where galvanic corrosion can occur.**

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

Corrosion problems can occur if the AquaSonde is mounted near to, and connect to a dissimilar metal, such as stainless steel. Typical examples of this are mounting the Sonde 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 AquaSonde.

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 AquaSonde from the supporting structure. This can be done by suspending the AquaSonde on a Mylar or Nylon rope rather than a conductive steel wire.

If the AquaSonde is to be mounted inside a steel pipe, wrap a good thickness of electrical insulation tape around the top and bottom of the Sonde 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 Sonde’s sleeve, which are essential for water flow and correct operation of the Sonde.

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

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

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

10.3. Vented Cable Option

The AquaSonde contains an internal barometric pressure sensor. This barometric pressure sensor is necessary for correction of both depth and percentage saturation of dissolved oxygen (DO %Sat), which both vary with barometric pressure. DO readings in mg/L are not affected by barometric pressure.

If accurate depth and %DO readings are required during a deployment lasting more than a few hours, during which atmospheric pressure may change, the AquaSonde should be deployed on a vented cable, which will allow the pressure inside the AquaSonde to vary with the ambient air pressure, even when it is submerged.

If accurate depth and %DO readings are not important, the AquaSonde can be fully sealed using the AquaSonde Deployment Key and deployed on a simple suspension wire.

10.4. The AquaSonde Deployment Key

The AquaSonde Deployment Key is an electronic device, which when connected to the sonde either directly or via a vented cable and Vent/Data Hub, will activate the logging regime and continually monitor the battery condition, memory remaining, and the sonde's general health.

The Deployment Key, shown right, features a blue LED, which is used to indicate the sonde's status by a sequence of flashes. The table below describes the various indications.

10.4.1. LED Indications

Sequence	What it means	Action Required
Single flash	Everything is normal. Data is being logged.	None
Double flash	The battery voltage is low or the batteries are dead.	Replace batteries and reset battery condition monitor.
Three flashes	Memory is full. Data is not being logged.	Upload the logged data to a PC and clear the sonde's memory.
Four flashes	This indicates a technical problem with the sonde that needs addressing. This can include the need for calibration or the need to correct the clock among other conditions.	Connect the sonde to a PC and use SondeLink to investigate the issue.

10.5. Suspending the Sonde

During deployment, the AquaSonde should be suspended by a vented cable or a suitable suspension wire attached to the Sonde Hanger Bracket. **The sonde should NEVER be suspended by the hole in the AquaSonde Deployment Key.**

10.6. Suspension Bracket and Nut

The AquaSonde is supplied with a suspension bracket and nut. After installation of the batteries and replacement of the battery compartment cover, the bracket should be slid over the threaded section of the connector and the nut should be run down and hand tightened.

The nut not only secures the bracket, but also locks the battery compartment cover in place to prevent accidental loosening and subsequent leaks.

The bracket includes a hole at the top for suspension on a wire or rope (see photograph) and two holes in the vertical section to allow fixing onto a vertical face or pole.

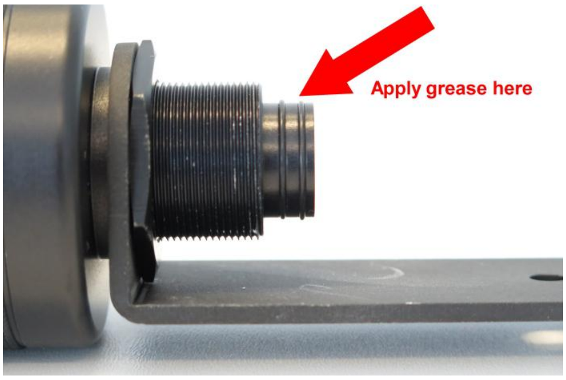
10.7. Deployment on a Suspension Wire

It is important to use a non-stretch cable to suspend the sonde. If the cable stretches after deployment, a corresponding change in depth will be recorded. Braided stainless steel or Kevlar is recommended.

The photograph to the right shows the correct correct method for deploying the AquaSonde on a suspension wire. Prior to deployment, the Deployment Key should be fitted and the blue collar tightened down.

10.8. The AquaSonde Connector

The AquaSonde features a high-pressure metal connector, which incorporates several O ring seals. Prior to first connection of a Deployment Key or vented cable, 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 outer thread of the connector to allow easy tightening of the blue collar.

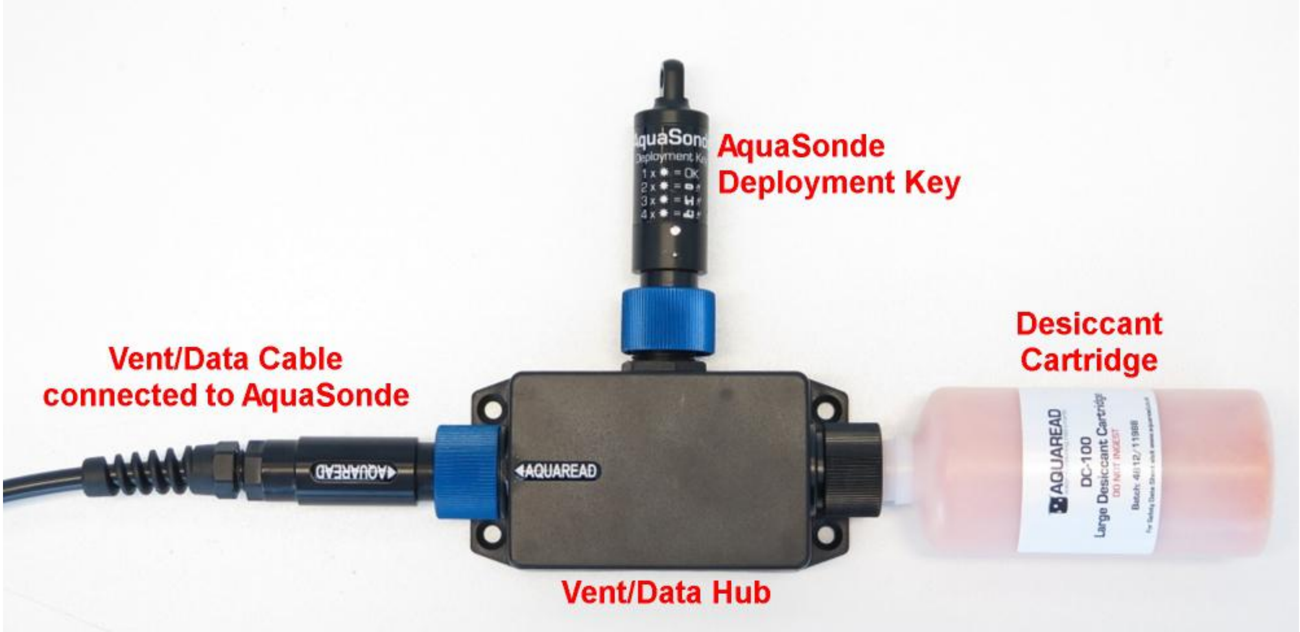
10.9. Deployment with a Vented Cable

To connect a vented cable to the sonde, align the white dot on the AquaSonde's connector with the ◄**AQUAREAD** logo on the plug body, then press the plug into the socket and tighten the retaining collar fully. Remember to grease the O rings prior to inserting the plug.

When deploying the AquaSonde with a vented cable, the sonde can be suspended by the vented cable, but in order to provide strain relief for the plug and socket, **it is essential to Ty-wrap the cable to the bracket just above the plug.** See photograph below for the correct technique.

10.9.1. Vent/Data Hub

When using a vented cable, the free end of the vented cable must be attached to the sonde socket on the Vent/Data Hub and the Deployment Key must be attached to the Key socket. A Desiccant Cartridge should be attached to the desiccant socket to keep the vent line dry. This arrangement is shown below.



The Vent/Data Hub should be mounted in a sheltered location ABOVE THE MAXIMUM WATER LEVEL. The Vent/Data Hub and desiccant bottle MUST NOT be submerged.

If necessary, the AquaSonde can be connected to a PC whilst still submerged for setup or data retrieval by removing the Deployment Key and inserting the AquaSonde USB cable into the Key socket. Please note, the AquaSonde can not be connected to an Aquameter®

or BlueLink Interface via the vented cable or Vent/Data Hub.

10.9.2. Connecting the Deployment Key

Prior to submerging the AquaSonde, be sure to connect the Deployment Key and verify correct operation of the sonde as indicated by the LED. See 10.4.1:LED Indications.

To connect the Deployment Key directly to the sonde, align the white dot on the AquaSonde's connector with the LED on the Deployment Key, then press the key into the socket and tighten the retaining collar fully.

If using a vented cable and a Vent/Data Hub, connect the Deployment Key to the socket on the top of the Hub with the LED facing up as shown in the photograph on the previous page.

When the Deployment Key is connected, the AquaSonde will switch on automatically. The blue LED on the Deployment Key will light up then start flashing at a two second interval if the sonde is functioning. If the LED does not light up or flash, check the batteries are properly installed and that they are in good condition.

10.9.3. Important Information Regarding Depth Measurement

The depth measurement system uses the EC sensor to detect when the sonde has been placed in water. All the time the sonde is measuring an EC of zero, the depth will read zero.

As soon as an EC value is detected, the sonde will start to calculate depth. **For this reason, it is important to ensure the sonde is connected and is active prior to submerging the sonde in water.**

10.10. Normal Operation

Directly after activation with the Deployment Key, the AquaSonde will take readings at two-second intervals for a period of five minutes.

During this period, the LED on the Deployment Key should give a **single flash** every two seconds. If the LED flashes more than once every two seconds, refer to section 10.4.1:LED Indications.

After four minutes have elapsed, the AquaSonde will carry out a clean cycle (AS-7000 only). After a further minute has elapsed, the sonde will log its first lot of data, then enter a dormant state, waiting for the next programmed logging event. During the dormant state, the blue LED will flash every 15 seconds.

It is important that you lower the sonde into the water within four minutes of activating it, otherwise the initial clean, the first set of readings and all subsequent depth readings will be erroneous. It is also important to lower the sonde into the water slowly.
When a logging event is imminent, the sonde will leave its dormant state and take readings every two seconds for a period of forty seconds.

During this time, the blue LED will flash every two seconds. At the end of the forty-second reading period, the readings will be logged and the sonde will re-enter the dormant state.

10.11. Maintenance Once Deployed

The sonde should not be deployed and left for extended periods without regular checking, calibration and maintenance. Naturally, the maintenance period is extended when using the AS-7000, which features an effective electrode cleaning system,

The time period between maintenance visits depends heavily upon the deployment conditions. For example, if the sonde is deployed in clean water, the only necessity should be regular single point calibration of the electrodes. This should be done every 4 – 6 weeks.

If the sonde is deployed in water that is polluted, silt-laden or heavily affected by algal growth, maintenance visits should be much more frequent.

With the AS-7000, it is very important to keep the cleaning brushes in good condition. The brushes should be replaced as soon as they show any signs of clogging or deterioration.

Likewise, it is very important to keep the inside of the sonde sleeve and end cap clean and free from any build up of algae or silt. The sonde sleeve and end cap form an integral part of the optical measurement system. If they are allowed to become excessively dirty, the accuracy of your readings will be affected.

It is strongly recommended that after initial deployment, maintenance visits are made on a weekly basis in order to assess the rate of fouling. After several weeks, it should be possible to establish the optimum time interval for routine maintenance at any given site.

All ion selective electrodes (ISE) 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 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.

10.12. Cleaning

The Sleeve on the AquaSonde 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 sonde 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 sonde 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 pH Electrode Moist.

Never clean the sonde with solvents, alcohol or concentrated acid/alkaline based

cleaning products such as Decon 90. These products can strip the anodised finish from the sonde and damage the plastic and rubber components. Damage caused by the use of aggressive cleaning agents or solvents is not covered by your warranty.

TIP: Occasional application of a smear of silicone grease (provided) to the connector O rings and thread, the battery compartment O rings and thread, Sleeve thread and the protective Sleeve End Cap thread will make fitting and removal of these parts easier.

If you are using an AS-7000, see section 12:The AS-7000 Automatic Cleaning System for full details of the cleaning system.

10.13. Desiccant Cartridges

The desiccant used within the Aquaread® Desiccant Cartridges is a non-toxic, self-indicating synthetic amorphous silica designed to change colour as it absorbs moisture from orange to clear. Desiccant Cartridges are available in two sizes.

The choice of small (DC-50) or large (DC-100) Desiccant Cartridge is dependant upon the humidity at the deployment site and the expected maintenance frequency. If the deployment site is humid or the time between maintenance visits is expected to be long, the large (DC-100) Desiccant Cartridge is recommended.

The time taken for a fresh, dry Desiccant Cartridge to go from orange to clear (i.e. become fully saturated) is dependant upon site conditions. Regular maintenance checks should be made on the installation and the Desiccant Cartridge should be replaced or regenerated **before it is completely saturated (clear).**

10.13.1. Regenerating Desiccant

When the desiccant in a Desiccant Cartridge has absorbed all the moisture it can and has changed from orange to clear, it can be regenerated and reused by a simple drying process.

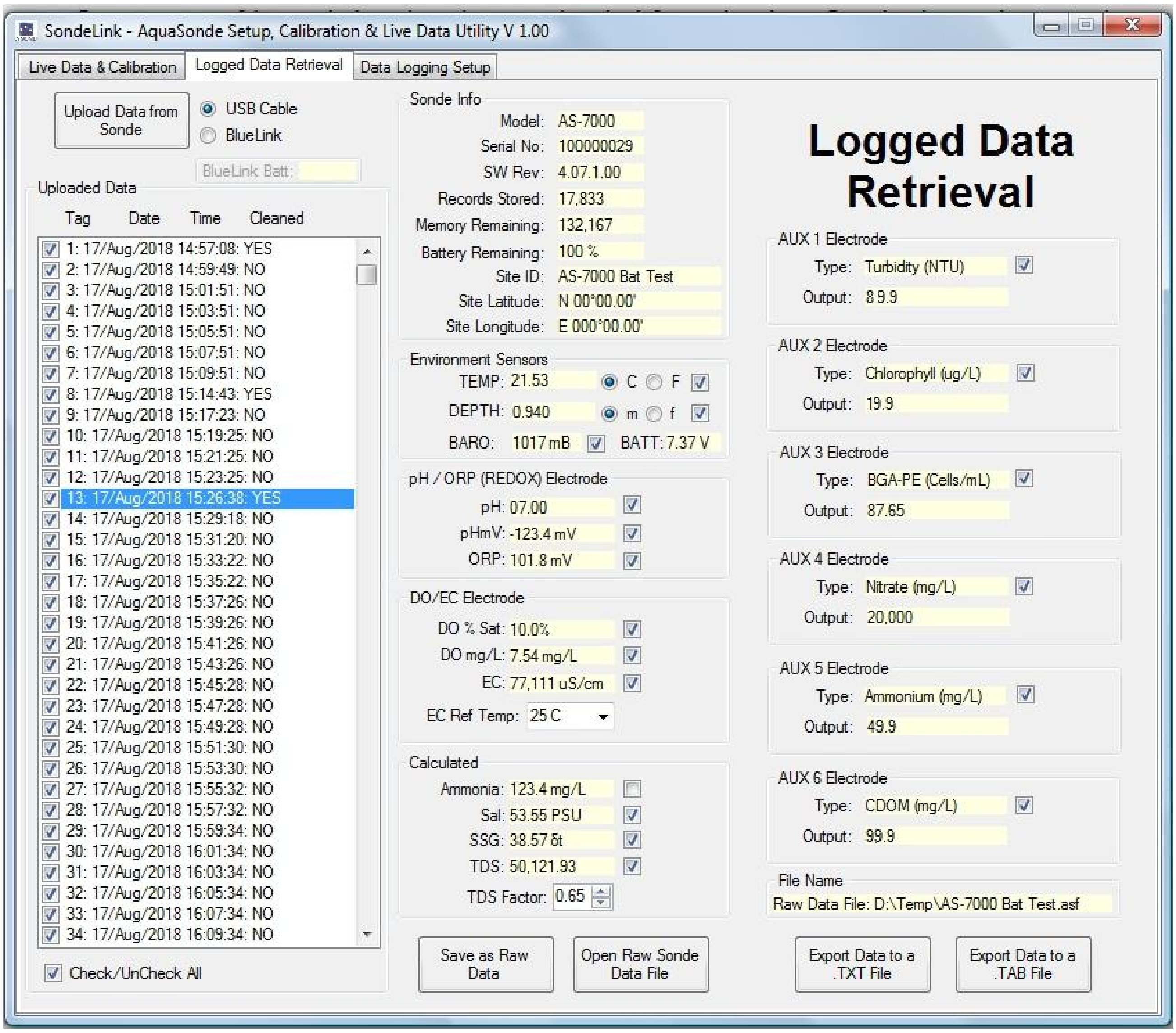
Spread the desiccant crystals evenly on a suitable baking sheet and bake in an oven between 100°C and 200°C for around an hour or until the colour has changed from clear back to deep orange. After being allowed to cool, the crystals can be replaced in the Desiccant Cartridge and reused.

11. Logged Data Retrieval

After the AquaSonde has been deployed for a period and has logged data, the data can be retrieved by re-connecting the sonde to a PC running SondeLink.

11.1. Uploading Logged Data

Select the Logged Data Retrieval tab, select USB or BlueLink connection then click on the '*Upload Data From Sonde*' button.



● USB Cable
○ BlueLink
BlueLink Batt:

Uploaded Data

Tag Date Time Cleaned

☑ 1: 17/Aug/2018 14:57:08: YES
☑ 2: 17/Aug/2018 14:59:49: NO
☑ 3: 17/Aug/2018 15:01:51: NO
☑ 4: 17/Aug/2018 15:03:51: NO
☑ 5: 17/Aug/2018 15:05:51: NO
☑ 6: 17/Aug/2018 15:07:51: NO
☑ 7: 17/Aug/2018 15:09:51: NO
☑ 8: 17/Aug/2018 15:14:43: YES
☑ 9: 17/Aug/2018 15:17:23: NO
☑ 10: 17/Aug/2018 15:19:25: NO
☑ 11: 17/Aug/2018 15:21:25: NO
☑ 12: 17/Aug/2018 15:23:25: NO
☑ 13: 17/Aug/2018 15:26:38: YES
☑ 14: 17/Aug/2018 15:29:18: NO
☑ 15: 17/Aug/2018 15:31:20: NO
☑ 16: 17/Aug/2018 15:33:22: NO
☑ 17: 17/Aug/2018 15:35:22: NO
☑ 18: 17/Aug/2018 15:37:26: NO
☑ 19: 17/Aug/2018 15:39:26: NO
☑ 20: 17/Aug/2018 15:41:26: NO
☑ 21: 17/Aug/2018 15:43:26: NO
☑ 22: 17/Aug/2018 15:45:28: NO
☑ 23: 17/Aug/2018 15:47:28: NO
☑ 24: 17/Aug/2018 15:49:28: NO
☑ 25: 17/Aug/2018 15:51:30: NO
☑ 26: 17/Aug/2018 15:53:30: NO
☑ 27: 17/Aug/2018 15:55:32: NO
☑ 28: 17/Aug/2018 15:57:32: NO
☑ 29: 17/Aug/2018 15:59:34: NO
☑ 30: 17/Aug/2018 16:01:34: NO
☑ 31: 17/Aug/2018 16:03:34: NO
☑ 32: 17/Aug/2018 16:05:34: NO
☑ 33: 17/Aug/2018 16:07:34: NO
☑ 34: 17/Aug/2018 16:09:34: NO

☑ Check/UnCheck All

Sonde Info
Model: AS-7000
Serial No: 100000029
SW Rev: 4.07.1.00
Records Stored: 17,833
Memory Remaining: 132,167
Battery Remaining: 100 %
Site ID: AS-7000 Bat Test
Site Latitude: N 00°00.00'
Site Longitude: E 000°00.00'

Environment Sensors
TEMP: 21.53 ● C ○ F ☑
DEPTH: 0.940 ● m ○ f ☑
BARO: 1017 mB ☑ BATT: 7.37 V

pH / ORP (REDOX) Electrode
pH: 07.00 ☑
pHmV: -123.4 mV ☑
ORP: 101.8 mV ☑

DO/EC Electrode
DO % Sat: 10.0% ☑
DO mg/L: 7.54 mg/L ☑
EC: 77,111 uS/cm ☑
EC Ref Temp: 25 C

Calculated
Ammonia: 123.4 mg/L ☐
Sal: 53.55 PSU ☑
SSG: 38.57 δt ☑
TDS: 50,121.93 ☑
TDS Factor: 0.65

AUX 1 Electrode
Type: Turbidity (NTU) ☑
Output: 8 9.9

AUX 2 Electrode
Type: Chlorophyll (ug/L) ☑
Output: 19.9

AUX 3 Electrode
Type: BGA-PE (Cells/mL) ☑
Output: 87.65

AUX 4 Electrode
Type: Nitrate (mg/L) ☑
Output: 20,000

AUX 5 Electrode
Type: Ammonium (mg/L) ☑
Output: 49.9

AUX 6 Electrode
Type: CDOM (mg/L) ☑
Output: 99.9

File Name
Raw Data File: D:\Temp\AS-7000 Bat Test.asf

Once upload is complete, the record number (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. If you are using an AS-7000 with self cleaning, the '*Cleaned*' column will indicated if a cleaning cycle occurred prior to logging a particular data set.

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 either blanks or dashes. To move up and down the Tag/date/time column, use either your mouse or the cursor up/down keys.

The panel at the top of the screen labelled '*Sonde Info*' gives important information concerning the current status of the AquaSonde.

Included in this is the sonde's model type, serial number and software revision. Below that is a box showing the number of records stored and the memory remaining.

Next there are boxes showing battery capacity remaining and current battery voltage. Finally the sonde's Site ID and position are displayed.

The AquaSonde outputs temperature in °C and depth in metres. To change these units of measurement, click the buttons adjacent to the readings. Adjacent to the barometric pressure reading box, the battery voltage at the time the data was logged is displayed.

The AquaSonde outputs Electrical Conductivity (EC) in an absolute form. The EC value can be displayed as an ABS value or can be corrected to correspond to a reference temperature of either 20°C or 25°C. To choose the way in which EC is reported, simply click one of the three settings within the Ref Temp drop-down box below the EC reading.

Total Dissolved Solids (TDS) is a value calculated by applying a TDS factor to the EC value. This factor is set at 0.65 by default but can be adjusted to suite your application.

11.2. Saving Logged Data

Once a set of logged data has been uploaded from the AquaSonde, it can be saved on your PC as a Raw Data file. These files use a proprietary format and are saved with a .asf (aqua sonde file) extension.

To save the uploaded data, click the ‘Save as Raw Data’ button. The site ID (if set) or sonde serial number will be set as a file name, but you can replace this with a name of your choosing. The file name you choose will automatically be given the .asf extension.

Useful Tip: Once you have saved the logged data, it is a good idea to clear the AquaSonde's memory so next time you log data, you don’t get both your old data and new data uploaded to your PC. See section 9.1.1 Clearing the sonde's memory .

11.3. Retrieving Stored Data Files

Once a Raw Data file has been saved using the above technique, it can be easily retrieved by clicking on the ‘Open Raw Sonde Data File’ button. When a raw data file is opened, it will appear exactly as uploaded data and the file name will be displayed in the 'File Name' box at the bottom right of the screen.

11.4. Exporting Data

SondeLink can export data with two different file extensions. 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 below 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.

11.4.1. Exporting Logged Data for use as a Text File

To export a .txt file, click on the ‘Export Data to a .TXT File’ button. You will be asked to specify a file name. A .txt extension will automatically be added. The file will be output in TAB delimited format. This means that each data field is separated by a Tab, and each data record appears on a new line. These files can be opened with any text editor or word processor application.

11.4.2. Exporting Logged Data for Import into a Spreadsheet

To export a file that can easily be opened in a spreadsheet application such as Microsoft® Excel®, click on the ‘Export Data to a .TAB File’ button. You will be asked to specify a file name. A .tab extension will automatically be added. These 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.

When opening a .tab file created by SondeLink 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’.

11.5. Clearing the Sonde’s Memory

Once the data has been uploaded from the AquaSonde and saved, the sonde’s memory may be cleared by clicking on the '*Clear Sonde Memory*' button, which is located on the '*Data Logging Setup*' tab. See section 9.1.1 Clearing the sonde's memory .

12. The AS-7000 Automatic Cleaning System

The AS-7000 features a motorised cleaning mechanism. This cleaning mechanism is designed for use during long term deployment.

The cleaning cycle can be activated from the SondeLink software in live data mode, which is useful during calibration for removing air bubbles from the electrodes. The cleaning mechanism can also be programmed to activate at a regular interval during long term deployments. See section 9.3.3 Cleaning Rate Setup.

To activate the cleaning mechanism from SondeLink, click the 'Clean Sonde' button.

Sonde Info

Model: AS-7000

Serial No: 100000029

SW Rev: 4.07.1.00

When activated, the centrally mounted wiper will rotate to each occupied electrode position and carry out a brief scrubbing action before returning the its park position.

A 'Wiper Jammed' message will be displayed if the wiper hits an obstacle which prevents it completing it's cleaning cycle. If an obstacle is hit and the wiper jams, it will reverse direction and return to its park position.

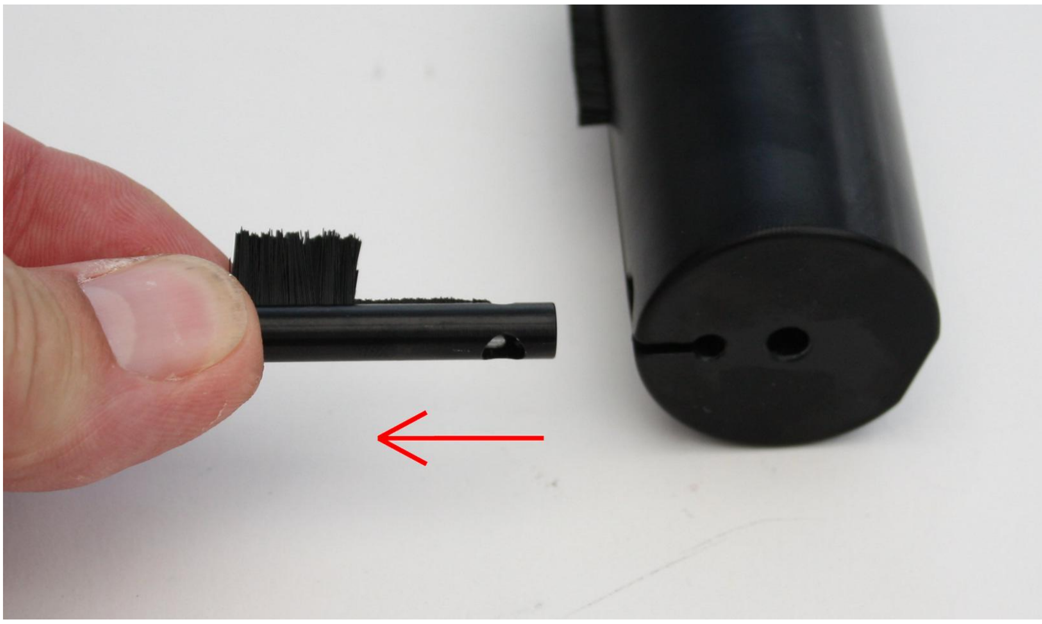
12.1. Wiper Removal and Replacement

Occasional cleaning or replacement of the wiper brushes may be required due to fouling. This is a simple job and requires no tools.

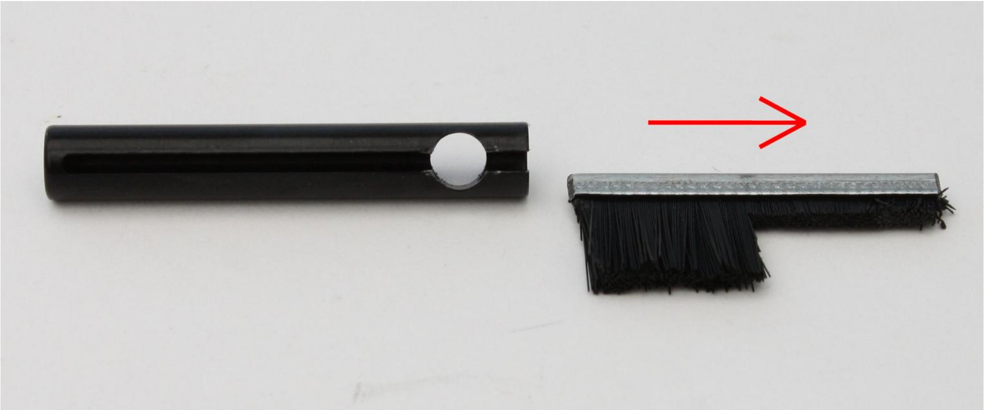
First remove the sleeve then pull the stainless-steel spring pin out of the central shaft.

Next, slide the wiper off the central shaft.

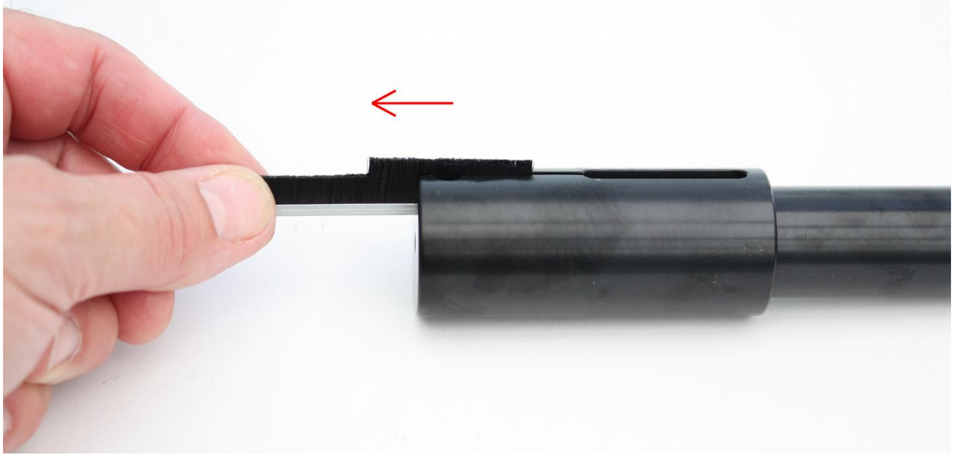
Next, slide the top brush carrier out of the wiper.



Next, slide the top brush out of the top brush carrier.



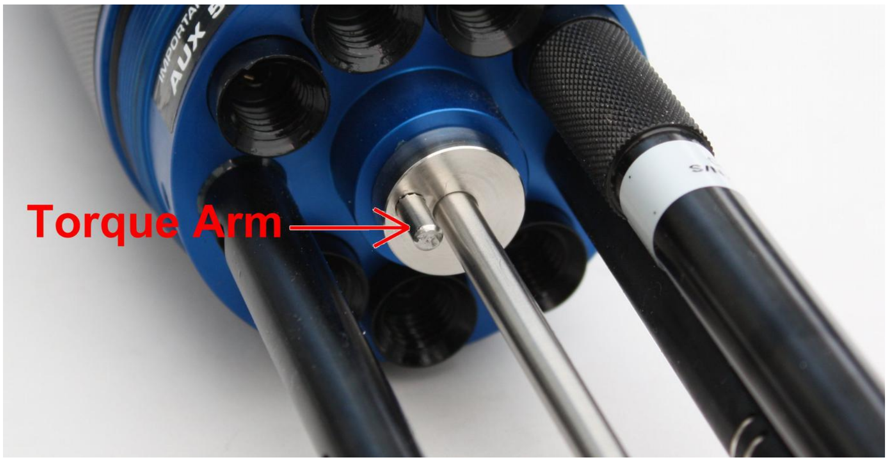
Finally, slide the side brush from the wiper.



Re-assembly is simply the reverse of this process.

Tips:

- Ensure the brushes are re-fitted the right way round. Refer to the photographs above if in doubt.
- Before sliding the wiper back onto the central shaft, rub a small amount of silicone grease onto the shaft.
- When sliding the wiper back onto the shaft, ensure the hole in the top brush carrier is in alignment with the central hole in the wiper.
- Ensure that the torque arm (see below) is aligned with the corresponding receiving hole in the end of the wiper.



Finally, ensure the spring clip is correctly and securely fitted.

13. Limited Warranty

All Aquaread® Meters are guaranteed for three years, Sondes, 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, wiper brushes, 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 sonde 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.**

13.1. 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 sonde with concentrated acid or alkaline based cleaning products such as Decon 90. These products can strip the anodised finish from the sonde and damage some of the plastic components.

13.2. 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: ______________________________ Serial No.: ______________________________

Contaminant (if known): ____

Decontamination Procedure: ____

____

Certified by (print name) : ______________________________ Title: ______________________________

Date: ______________________________

Signature: ______________________________

14. TROUBLESHOOTING

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

Problem	Cause / Remedy
The SondeLink software can not find the AquaSonde.	✓ 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.
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.
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 sonde and electrode in a warm place for at least 48 hours to dry out.
EC readings are inaccurate or unstable. Calibration of EC fails.	✓ Have you got the sonde Sleeve fitted? EC will not work without the sonde Sleeve fitted. ✓ The sonde 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 sonde. ✓ Trapped air bubbles may be causing problems. Tap and swish the sonde to dislodge them. ✓ The sonde sleeve may be loose. The sonde sleeve must be absolutely rigid with respect to the sonde Body for correct EC operation. If you can move the sonde sleeve to and fro whilst holding the sonde body, tighten then recalibrate. ✓ The EC electrode may need recalibrating. Recalibrate. ✓ The EC electrode may be dirty. Clean the EC electrode then recalibrate.
Optical electrode readings are inaccurate or unstable.	✓ Have you got the sonde sleeve and end cap fitted? Optical electrodes will not work without the sonde sleeve and end cap fitted. ✓ Trapped air bubbles may be causing interference. Tap and swish the sonde to dislodge them. ✓ The sample being measured may contain air bubbles. Under these conditions, optical electrode measurements can not be taken. ✓ The sonde 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 sonde. ✓ The electrodes may need recalibrating. Recalibrate. ✓ The lenses on the electrode may be dirty. Clean the lenses then recalibrate.

15. DECLARATION OF CONFORMITY

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

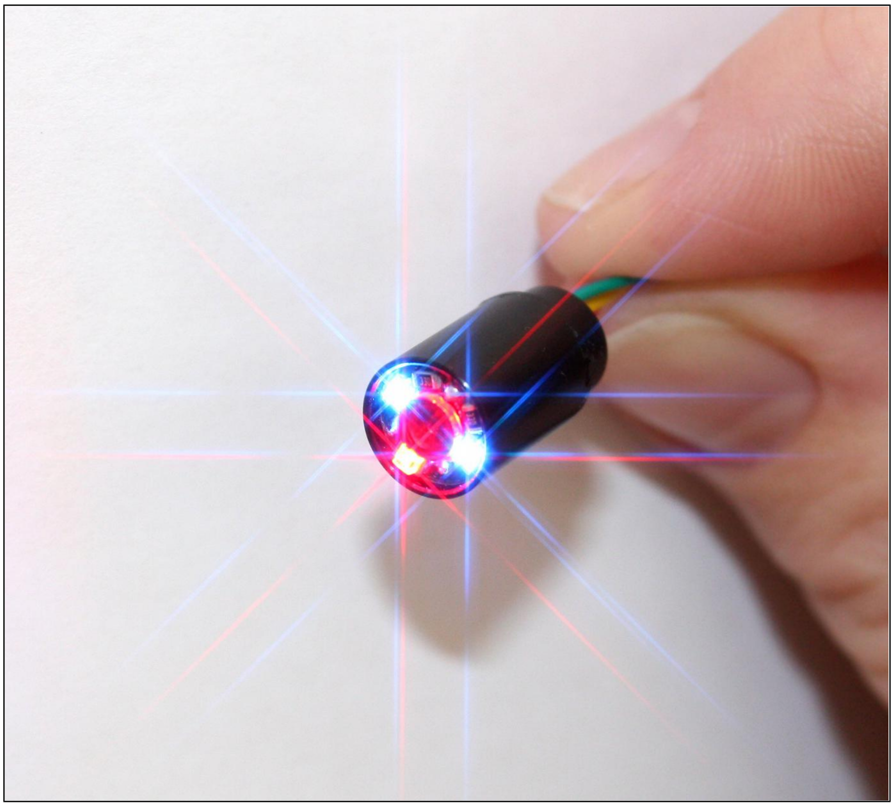
16. Appendix 1. The Tech Behind Aquaread's Optical DO Measurement System

16.1. 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.

16.2. 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.

17. Appendix 2. Standard Sonde Specification

Dimensions (Dia x Length)	AS-2000: 42mm x 515mm AS-5000: 58mm x 570mm AS-7000: 77mm x 635mm
Data Memory	150,000 full sets + GLP (calibration) data
Logging Rate	0.5Hz - 120hours
Atmospheric Pressure	150mb – 1150mb Accuracy +/- 1mb
PC Interface	USB (cable provided), optional BlueLink Bluetooth interface
Power Supply	AS-2000: 2 x 3.6V Lithium C cells. AS-5000/7000: 2 x 3.6V Lithium D cells
Battery Life	Dependent upon logging rate and temperature.
Operating Temperature	-5˚C to +60˚C non freezing
Protection Class	IP68. Rated for continual immersion to a depth of 30 meters

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)**
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	Range	AS-2000/5000: 0 - 60m AS-7000: 0 - 100m
	Resolution	1cm
	Accuracy	± 0.2% FS
Temperature	Range	-5˚C – +50˚C (23˚F – 122˚F)
	Resolution	0.01˚ C/F
	Accuracy	± 0.1˚ C

*** Readings calculated in SondeLink from EC and temperature electrode values**
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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.

18. Appendix 3. Optical Electrodes Detailed Specification and FAQs

18.1. 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.

18.2. 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 sonde is lowered to. Naturally, the sonde 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.

18.2.1. 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.

18.3. 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)

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Notes:

1. MLD (Minimmum 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.

18.4. 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.

19. Appendix 4. 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.
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Notes:

1. MLD (Minimmum 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 AquaSonde 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, the sonde 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 electrode. **If there is no water flow across the ISE electrode, the ions in the immediate area of the electrode will be depleted and the reading will start to fall. This also applies during calibration, where the sonde should be stirred at all times.**

19.1. Special Notes Concerning ISE Electrodes and pH Buffer Solutions

The high ionic concentration of pH calibration solutions (buffers), including RapidCal, can cause significant offsets in ISE electrodes.

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 during pH calibration or when using RapidCal in order to protect the ISE electrodes from the effects of the buffer solution.

At all other times, the ISE electrodes should be left uncovered.

20. Appendix 5. 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.

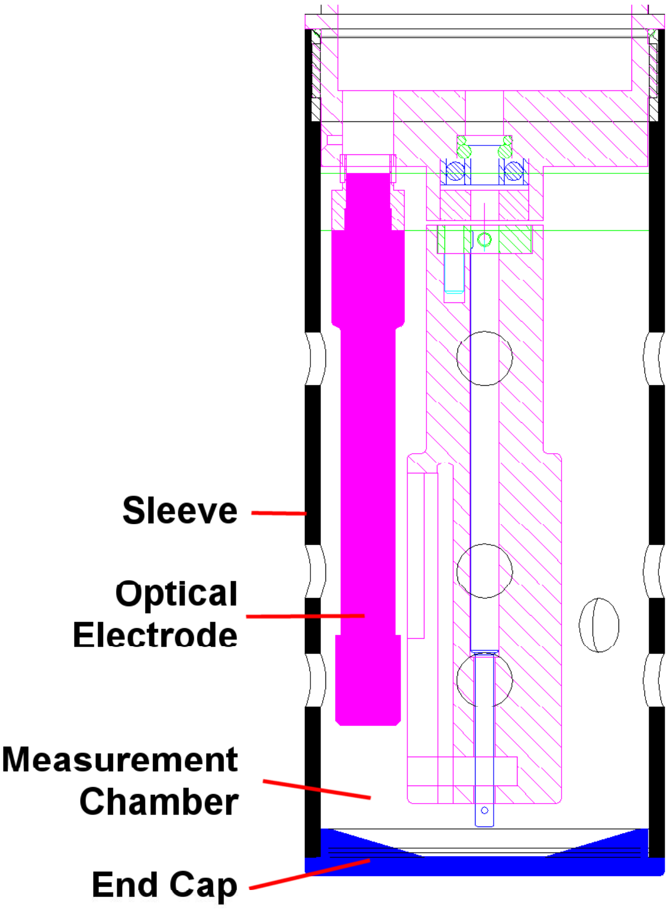
For this reason, all AquaSondes are constructed with a matt black aluminium sleeve and end cap that enclose the sensing electrodes and provide a constant condition, non reflective measurement chamber.

This is essential for the correct calibration and operation of the turbidity electrode.

A diagram of the AS-7000's measurement chamber is shown here.

In order to obtain consistent results, the measurement chamber created within the AquaSonde 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.

20.1. 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 sonde 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 sonde 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.

20.2. 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.

20.3. 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 sonde 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**.

20.4. 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 AquaSonde 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 sonde 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 with a negative symbol.

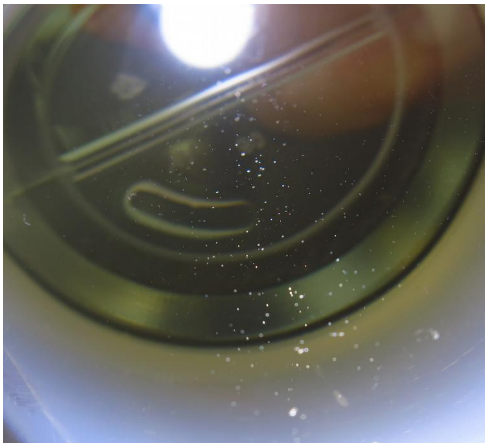
Similarly, if the turbidity electrode was subject to stray reflections from the inside of the calibration bottle during calibration, the absence of those reflections during deployment will result in the sensor seeing less reflected signal and therefore a negative reading will be displayed.

If you experience negative turbidity readings, thoroughly clean the sonde 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.

20.5. 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 sonde is subsequently deployed in clear water it will register a negative reading.

If your zero calibration water is aerated, allow it to stand for a while until the air has all dispersed, then re-insert the sonde and re-calibrate.

Do not leave the sonde sitting in aerated water, the bubbles will simply cling to the inside surface of the sonde and make the problem worse.

20.6. Reflection

Although all AquaSondes 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 sonde is subsequently deployed in clear water with no reflections, it will register a negative reading.

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 sonde sleeve.

20.7. 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 sonde 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 sonde up and away from the surface reflecting the sunlight or shade the sonde from direct sunlight.

20.8. 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 sonde 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**.

20.9. 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.

21. Appendix 6. Calibrating Temperature

The AquaSonde's temperature sensor is built into the oval resin pocket located on the back of the DO/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 using an Aquaread Aquameter®. This process is not possible from SondeLink.

To calibrate the temperature sensor, remove the sleeve from the AquaSonde then set the sonde 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 AquaSonde® 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 AquaSonde is set up in the water bath, connect to the Aquameter® switch it on and 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®.

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

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.

```
TEMP OFFSET:+00.0°C

USE UP/DOWN TO SET
 HIT [OK] TO SAVE
```

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.

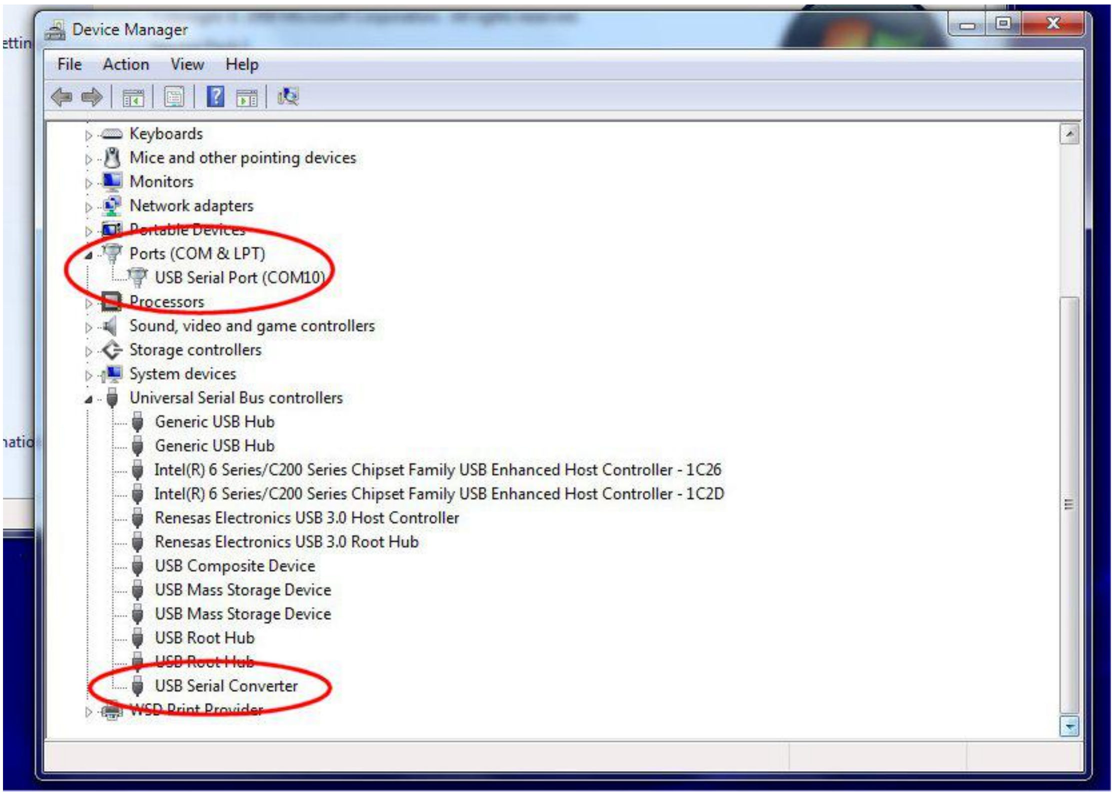
Alternatively, if the water bath is set to 25.0°C and the Aquameter® is displaying 25.30°C, you should input an offset (or correction) of -00.3°C.

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 AquaSonde and applied at all times going forward.

22. Appendix 7. Troubleshooting SondeLink

If the SondeLink software can not find the AquaSonde, or if Windows® reports a problem installing the drivers, go to your Windows® Device Manager. The following two components should be present:



The USB Serial Port number (COM10 in the above example) may be different, but that is fine

If one or other of these components are not installed or are showing an error, re-install the drivers forcing Windows® to search your temporary directory for the drivers you downloaded from the Aquaread® website.

If more than one USB Serial Port is showing, determine which one is associated with the AquaSonde (by unplugging it then re-connecting it), then temporarily disable all other USB serial ports as they may be causing interference with communications to the AquaSonde.