Seametrics

TempHion

pH/ORP (Redox) / ISE Smart Sensor and Data Logger Instructions

PROUDLY MADE IN THE USA

ISO 9001

General Information

Installation

Settings and Calibration

Operation

Direct Read Modbus/SDI-12

Maintenance and Reference

Troubleshooting

IF USING ALKALINE BATTERIES—PREVENT BATTERY LEAKAGE!

TempHion sensors are typically shipped with lithium batteries. If, however, you are using alkaline batteries, be aware that under some circumstances alkaline batteries can leak, causing damage to the sensor. To prevent leakage, the following is recommended. (Does not apply to lithium batteries.)

- **Change the batteries at least every 18 months.**
- **If the sensor will not be deployed for 3 months or more, remove the batteries.**

The **Seametrics TempHion™** Smart Sensor is a microprocessor-based submersible sensor with built-in data logging, storing thousands of records in non-volatile memory. The **pH/ORP** version measures pH, ORP (Redox), and temperature. The **ISE** version measures bromide and temperature.

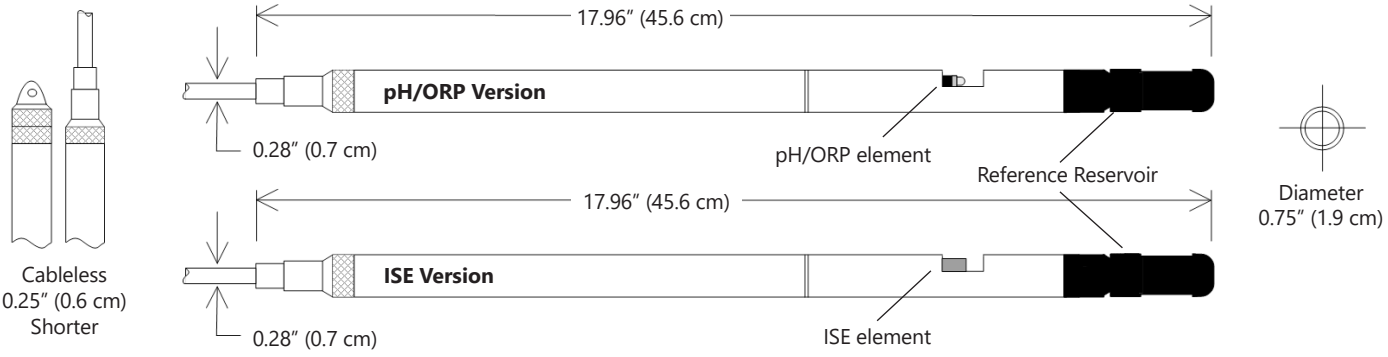
The internal processor in the TempHion allows for easy calibration, using the calibration utilities in Aqua4Plus. Once calibrated, this calibration data is stored in non-volatile memory within the Smart Sensor. When data is collected, this calibration information is applied to the data, resulting in highly accurate readings at a wide range of temperatures.

The TempHion is powered internally with two replaceable AA batteries. Alternately it can be powered with an external auxiliary power supply for data intensive applications. The unit is programmed using Seametrics' easy-to-use Aqua4Plus control software. Once programmed the unit will measure and collect data on a variety of time intervals.

Several TempHions, or a combination of TempHions and other Seametrics Smart Sensors, can be networked together and controlled from one location directly from a single computer.

While most will use the TempHion with our free, easy-to-use Aqua4Plus software, it is by no means limited to that software. You can use your own Modbus® RTU or SDI-12 software or logging equipment to read measurements, thus tying into your existing systems and data bases.

Dimensions



Non-batttery versions are 3.8" (9.65 cm) shorter.

Specifications*

Housing & Cable	**Weight**	0.8 lb. (0.4 kg)			
	Body Material	Acetal & 316 stainless or titanium			
	Wire Seal Material	Fluoropolymer and PTFE			
	Cable	Submersible: polyurethane, polyethylene, or ETFE (4 lb./100 ft., 1.8 kg/30 m)			
	Field Connector	Standard			
Temperature	**Operating Range**	0˚ to 55˚C (32˚ to 131˚F)			
	Storage Range	Without batteries: –20˚ to 80˚C (–4˚ to 176˚F)			
Power	**Internal Battery**	Two replaceable lithium 'AA' batteries - Expected battery life: 18 months at 15 min. polling interval (may vary do to environmental factors)			
	Auxiliary	12 Vdc - Nominal, 9-15 Vdc - range			
Communication	**Modbus®**	RS485 Modbus® RTU, output=32bit IEEE floating point			
	SDI-12	SDI-12 (ver. 1.3) - ASCII			
Logging	**Memory**	4MB - 200,000 records			
	Logging Types	Variable, user-defined, profiled			
	Logging Rates	2x/sec maximum, no minimum			
	Baud Rates	9600, 19200, 38400			
	Software	Complimentary Aqua4Plus			
	Networking	32 available addresses per junction (Address range: 1 to 255)			
	File Formats	.a4d and .csv (also .xls in Windows 8 and earlier)			
Output Channels		**Temperature**	**pH**	**ORP**	**Bromide**
	Element	30K ohm thermistor, Epoxy bead/external housing	Glass combination electrode	Platinum ring	Ag/AgCl solid-state electrode (Ion electrode method)
	Accuracy	±0.2˚C	±0.2 pH units, 0.1% mV value (typical)	0.1 mVH, 0.1% mV value (typical)	±5.0% of measured value (typical)
	Resolution	0.1˚C	0.01 pH units	0.01 mVH units	0.1 ppm
	Units	Celsius, Fahrenheit, Kelvin	pH, mV	Eh, mV	ppm, mV
	Range	0˚ to 55˚C (32˚ to 131˚F)	0-14 pH units / -538 to 260 mV	± 1200 mV	0–10,000 ppm
	Compensated	---	0˚ to 40˚C (32˚ to 104˚F)	0˚ to 40˚C (32˚ to 104˚F)	Isopotential point characterization
	Calibration	---	One or two point calibration w/ pH buffers (4 & 7 or 7 & 10)	EH 1 pt. calibration	One or two point calibration w/ ionic strength adjustment
	Reference Solution		Potassium Nitrate - (KNO_3)	Potassium Nitrate - (KNO_3)	Potassium Nitrate - (KNO_3)
Reference		Ag/AgCl solid state electrode, capillary liquid junction, TempHion™ reference solution			
Maximum Depth		pH/ORP: 700 ft (210 m) / 300 psi, ISE: 230 ft (70 m)/100 psi			
Environmental		IP68, NEMA 6P			

**Specifications subject to change. Please consult out web site for the most current data (seametrics.com). Modbus is a registered trademark of Schneider Electric.*

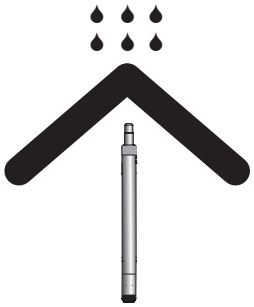
Initial Inspection and Handling

Upon receipt of your smart sensor, inspect the shipping package for damage. If any damage is apparent, note the signs of damage on the appropriate shipping form. After opening the carton, look for concealed damage, such as a cut cable. If concealed damage is found, immediately file a claim with the carrier.

Check the label attached to the cable at the connector end for the proper cable length.

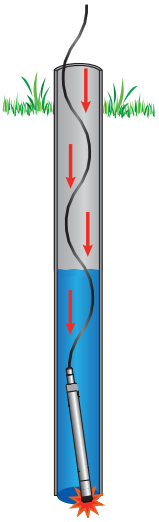
Do's and Don'ts

Do handle sensor with care

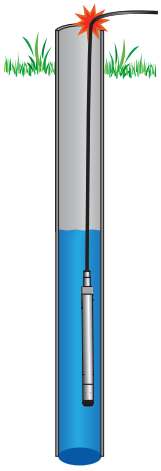


Do store sensor in a dry, inside area when not in use. *(See also "How to Store" in Maintenance section)*

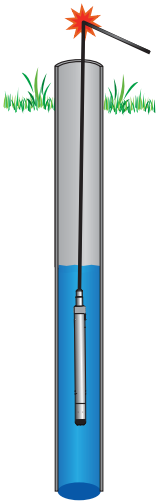
Do install sensor so the connector end is kept dry



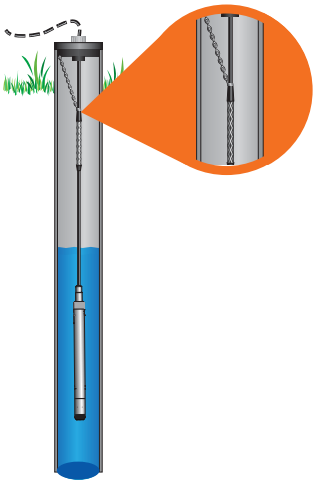
Don't drop into well
Lower gently to prevent damage



Don't scrape cable over edge of well
May nick or fray the cable



Don't bend cable sharply
May weaken internal wires

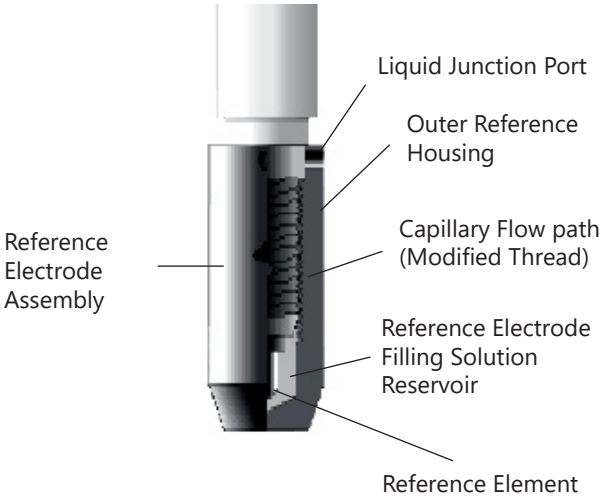


Don't support sensor with the connector
Use a strain relief device

TempHion™ Reference Electrode

TempHion's patented reference electrode is the key to TempHion's superior downhole/high pressure performance. TempHion uses a long capillary pathway, initially filled with reference electrode filling solution, to separate the reference electrode chamber from the solution being analyzed. In addition, TempHion's reference electrode is filled without any air (which is compressible). With this construction, the principle mechanism that will eventually allow test solution to enter the reference chamber and contaminate the reference electrode filling solution is diffusion – an exceedingly slow mechanism. Further, while the capillary pathway is narrow by garden hose standards, its open cross-section is huge compared to the microscopic openings in a conventional porous ceramic fluid/fluid junction. It is therefore much less susceptible to fouling. TempHion's proven stability under actual field conditions is measured in weeks or months, rather than hours or days!

The figure below illustrates the construction of the TempHion reference electrode. Please note that the capillary pathway between the reference and test solutions is established using a modified screw thread. This means that the capillary can be easily opened up for cleaning, refilling, or other maintenance.



Reference Electrode Assembly: The modified thread provides a continuous liquid path between the solution in which the instrument is immersed and the reference element.

TempHions with standard pH elements, ISE elements, and ORP elements come with the TempHion Reference Electrode, as described above.

General Precautions

The rest of this manual includes step-by-step instructions for setting up the TempHion calibrating it, and using it in the field. When reading and following the instructions in these sections, keep these very important considerations in mind:

- Do not handle the surfaces of the sensing electrodes. Oils from fingers can "blind" the reactive surface. Rough handling can scratch the reactive surface.
- Use calibration standards that are accurately prepared. Discard standards after use. Do not return the used standards to the bottles of "fresh" solution.
- When TempHion's reference electrode contains filling solution, the O-ring at the top of the reference assembly must be in the upper position. (See further details under Installation later in this manual.)
- For any step-change in temperature (e.g., where calibration standards are at a different temperature than water to be tested) allow the instrument to come to complete thermal equilibrium before making measurements. Up to 30 minutes may be required.

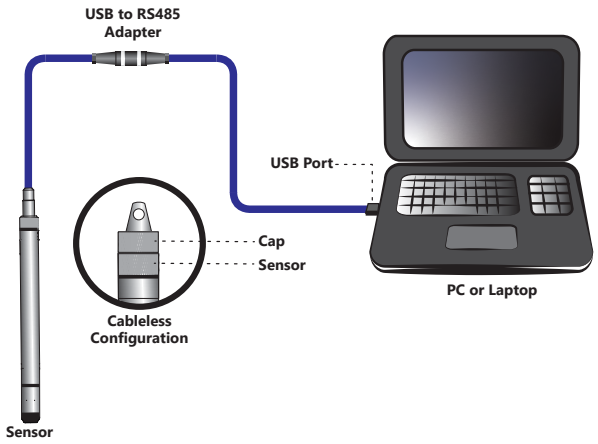
Connecting External Power

The TempHion comes with two replaceable1.5V AA internal batteries.

If auxiliary power is desired, you can use a 9-15 VDC supply that can provide 15 mA. Connect to Vaux++ (pin 1 - white) and Ground (pin 5 - blue) or contact Seametrics for auxiliary power supplies.

Connecting the TempHion to a Computer

Cabled sensors are terminated with a weather-resistant connector. Cableless sensors are terminated with a weather-resistant connector that is inside a screw-cap. Connect the weather-resistant connector to your computer's USB port as shown below.

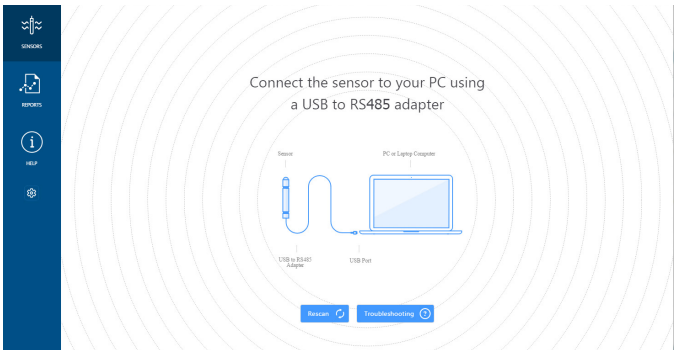


Connecting sensor to your computer using Seametrics' USB to RS485 adapter.

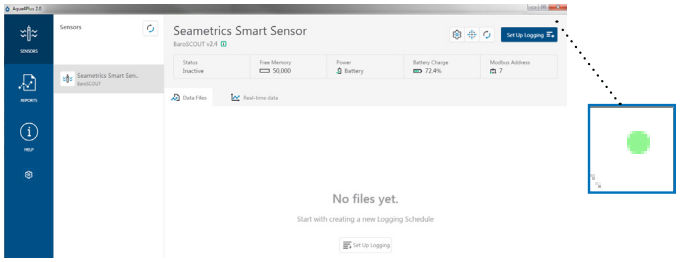
Aqua4Plus communicates with the sensor using the USB to RS485 adapter cable. This cable requires drivers to be installed on your computer. If you are connected to the Internet when you first plug in the cable, it will normally obtain and install the correct drivers automatically. If this does not happen, or if you do not have Internet connection, you can use Aqua4Plus to install the drivers.

Connecting to Sensors

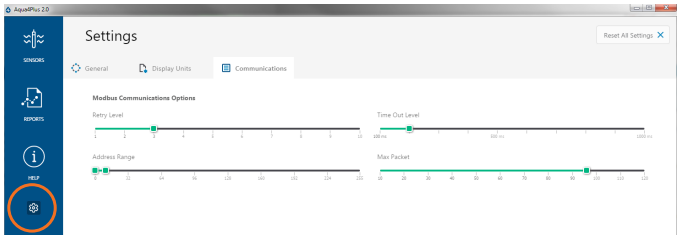
Aqua4Plus 2.0 is designed to automatically detect your communication cable and scan for sensors. It is recommended you connect your USB/RS485 cable to your PC and have the sensor connected before opening Aqua4Plus 2.0.



If your cable and sensor were not connected before opening Aqua4Plus 2.0 simply connect and click Rescan. While scanning is active you'll see a green dot flash in the upper right corner of the program. Scanning is complete when this dot stops flashing.



If your sensor still won't connect you can expand the Modbus address range under program settings here:

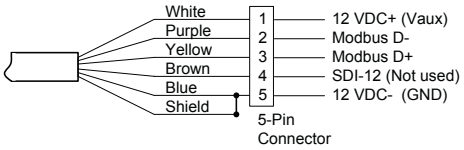


Simply drag the Address Range slider higher up to increase the maximum Modbus address scanned. If you've scanned all the way up through address 255 and still have no connection click Troubleshooting for further troubleshooting or contact Seametrics Tech Support for assistance.

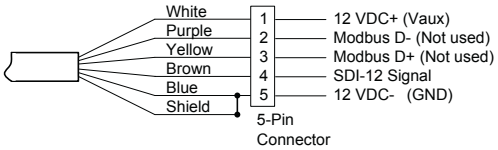
Click  at any time to refresh sensor information.

Cable Wiring

If you buy your cabled sensor with a connector installed (the normal configuration), no further wiring is needed. For reference purposes, the first two diagrams below show the pinout from the connector for various scenarios. The final diagram shows the pinout if you bought your sensor without a connector for use with SDI-12.



For Modbus®—with 5-pin connector



For SDI-12—with 5-pin connector

For SDI-12—without connector

Installing Aqua4Plus Software

The TempHion comes with the Aqua4Plus host software that is installed on your PC or laptop. Use this software to program the datalogger, to retrieve data from the logger, to view collected data, and to export data to external files for use with spreadsheets or databases.

Refer to the software manuals for details on installing and using Aqua4Plus.

Using TempHion Without Aqua4Plus

Most users will use the TempHion with Seametrics' Aqua4Plus software. However, the TempHion is quite versatile, communicating via either Modbus® or SDI-12 interfaces, allowing you to do the following:

- Read a TempHion via Modbus® using your own software.
- Read a TempHion via SDI-12 protocol.
- Display readings from a TempHion on a panel meter.

If you want to use one of these methods, see the chapter *Direct Read Modbus®/SDI-12*.

Grounding Issues

It is commonly known that when using electronic equipment, both personnel and equipment need to be protected from high power spikes that may be caused by lightning, power line surges, or faulty equipment. Without a proper grounding system, a power spike will find the path of least resistance to earth ground—whether that path is through sensitive electronic equipment or the person operating the equipment. In order to ensure safety and prevent equipment damage, a grounding system must be used to provide a low resistance path to ground.

When using several pieces of interconnected equipment, each of which may have its own ground, problems with noise, signal interference, and erroneous readings may be noted. This is caused by a condition known as a Ground Loop. Because of natural resistance in the earth between the grounding points, current can flow between the points, creating an unexpected voltage difference and resulting erroneous readings.

The single most important step in minimizing a ground loop is to tie all equipment (sensors, dataloggers, external power sources, and any other associated equipment) to a single common grounding point. **Seametrics recommends connecting the shield to ground at the connector end.**

Installing the Sensor

The black reference reservoir at the lower end of the TempHion Smart Sensor is shipped filled with Seametrics reference solution. (If your reference reservoir is not filled, see the Maintenance section in this manual.) The black reference assembly has two grooves. The upper groove contains a small hole that forms the liquid junction port. During shipping and storage, an o-ring is located in the upper groove, preventing reference solution leakage and contamination. Be sure to move the o-ring to the lower groove before deploying, thus exposing the liquid junction port. If the o-ring continues to cover the opening, readings will not be representative or accurate.

Be sure to move the o-ring to the lower groove before deploying, thus exposing the liquid junction port.

Lower the sensor to the desired depth. Fasten the cable to the well head using tie wraps or a weather proof strain-relief system. (Note that for shallow installations the liquid in which the sensor is submerged must, at all times, reach high enough to cover the sensing element cutout.)

Be sure the supplied cap is securely placed on the weather-resistant connector at the top of the cable. Do not install such that the connector might become submerged with changing weather conditions. The connector can withstand incidental splashing but is not designed to be submerged.

Note about Calibration

The TempHion must be calibrated before deploying.

The TempHion has one temperature channel and four millivolt channels. The millivolt channels can be configured to measure pH, ORP (Redox), or various selected ions. Before leaving the factory, your sensor has been configured specifically for you. All unneeded channels have been disabled, and the active channels have been pre-configured. Disabled channels will not display in Aqua4Plus.

(Note: Some older TempHions may have more channels. If yours has more channels, refer to the documentation that came with the unit or contact Seametrics for more information.)

All active channels can be calibrated in the field. Temperature channels rarely need calibrating, however the pH, ORP (Redox), and ISE channels should be calibrated before first use and periodically thereafter.

See the next section, "Settings and Calibration" for detailed calibration instructions.

General Calibration Information

The TempHion must be calibrated before first use and periodically thereafter. It should also be calibrated if moving to a different sampling environment where readings will be significantly different than the current environment.

Environmental conditions of turbulence and temperature swings, as well as local likelihood for bio-fouling or mineral deposition, can vary considerably from site to site. Therefore, where the sensor is to be used for long-term monitoring, it is recommended that the calibration be initially checked frequently until a performance history is established.

Aqua4Plus provides an easy-to-use calibration calculator for performing one- or two-point in-field calibrations. Two-point calibrations are more accurate and should be used whenever possible.

Field calibration is performed on each channel separately. To calibrate a specific channel, select Settings and Configuration from the Configure Menu in Aqua4Plus and then click on the channel to be calibrated.

IMPORTANT CALIBRATION NOTES!

Data Files

- Calibration can only be done when there is no data stored on the sensor. Retrieve any data you want and then erase the data before continuing.

Filling Solution Reservoir

- In order for the TempHion Smart Sensor to calibrate and function correctly, the filling solution reservoir must be properly filled with reference solution. For details, see Maintenance section.
- Be sure the o-ring on the black reference housing has been moved to the lower groove, exposing the liquid junction port.

Calibration Buffers and Solutions

- Refer to the following sections for specific solutions and buffers.
- Important! The sensor and all calibration buffers and solutions should be at the same temperature before and during calibration.

Reconditioning

- If your reference electrode has been stored dry or in KCl solution, you should let it sit at least a half hour after filling with reference solution before using or calibrating.
- If your pH sensor has been stored with the bulb dry, you should soak it in your first pH buffer for about four hours to recondition the bulb before calibrating.
- If your ISE sensor has been stored with the element dry, you should soak it in your first calibration solution for at least a half hour before using or calibrating.

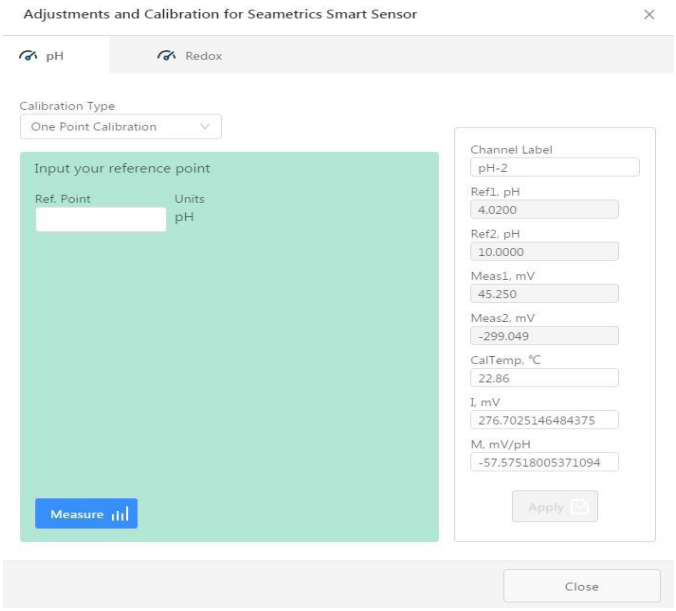
pH Calibration

To perform a pH calibration, first connect to your TempHion and ensure all data has been uploaded and erased from the sensor. Seametrics recommends pH buffers of 4, 7, and 10 for calibration. For a one-point calibration, select the buffer closest to the expected values in your samples. For a two point calibration, select the two buffers that most closely bracket the expected values in your samples. Seametrics recommends a 2 point calibration that brackets the expected pH range of your site.

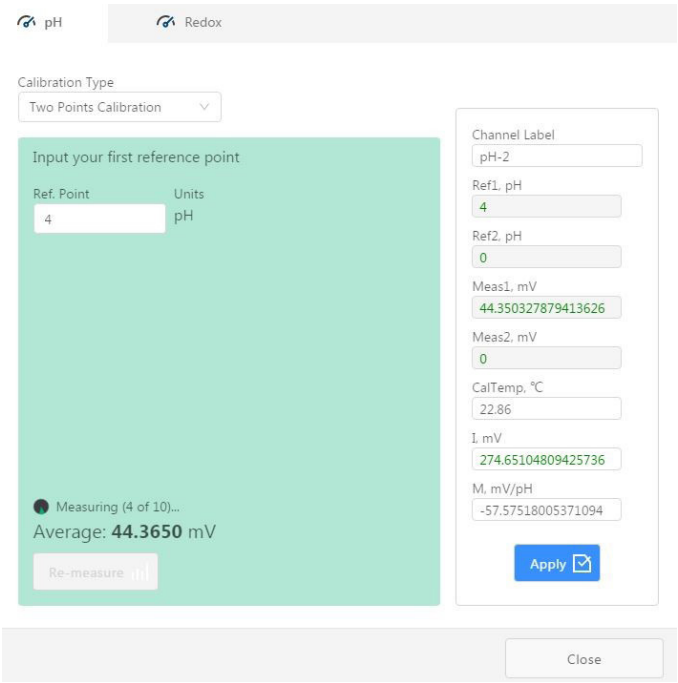
Note: If your TempHion has been stored dry, a 4 hour to overnight soak in pH 4 buffer is needed to recondition the pH bulb.

Prepare your pH buffer(s) and place the sensor in your first point calibration standard, ensure that that the pH bulb is fully submerged, than allow a few minutes for the temperatures to equalize. Check for stable readings under Real-time Data.

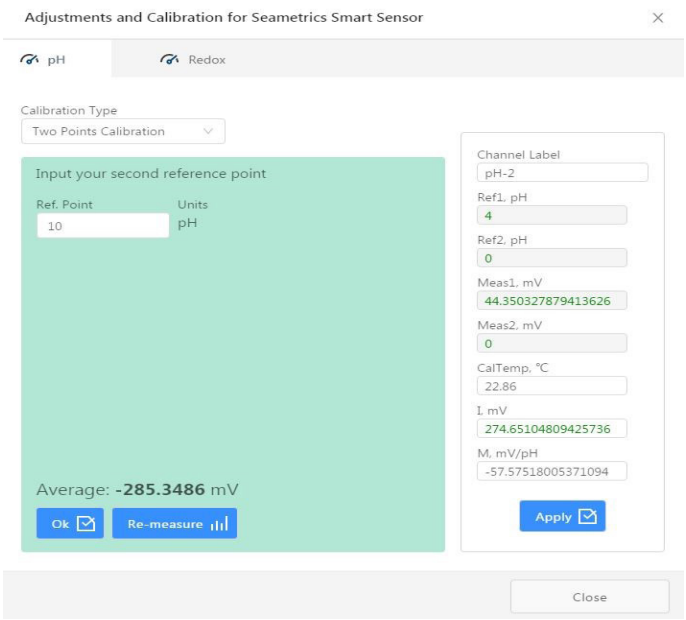
Next select the calibration button.



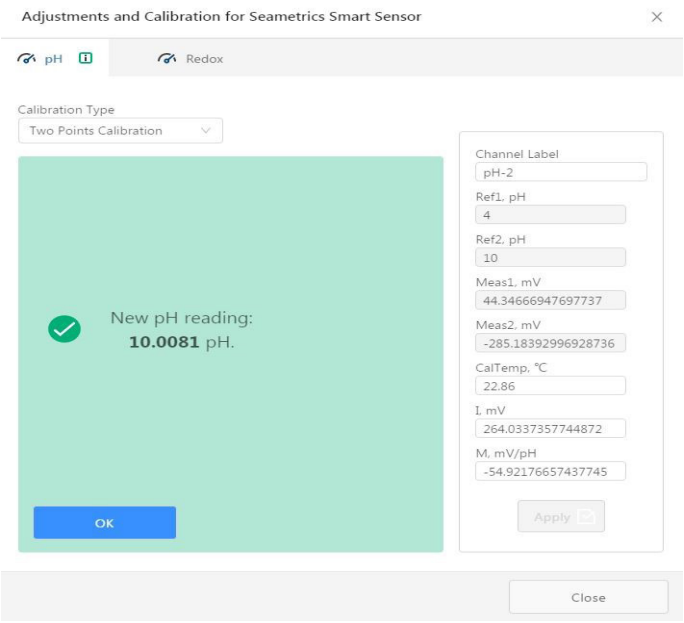
Enter your first point pH value in the Ref. Point box, next click Measure. Aqua4Plus will take 10 readings and display the average. Watch for stability while Aqua4Plus is measuring to ensure an accurate calibration. To accept the first point reading click Ok. If only performing a 1 point calibration click Apply to save new calibration values then close the calibration window, otherwise proceed to the 2nd point by clicking Next.



Place the sensor in your second point buffer and allow a few minutes for it to acclimate. Enter the pH value of the buffer in the Ref. Point box and click Measure.



Aqua4Plus will take 10 readings and display the average. Watch for stability while Aqua4Plus is measuring to ensure an accurate calibration. To accept the second point reading click Ok. Your new offset and slope values will appear to the right, click Apply to confirm your new slope and offset values. Aqua4Plus will provide a real time reading to verify calibration was successful. You may now close the calibration window and proceed with deployment.



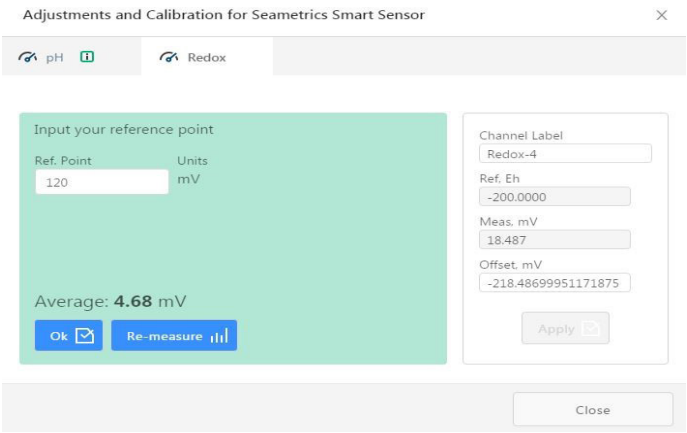
Redox/ORP Calibration

Note on units: The display unit "Eh" refers to readings in millivolts referenced to a hydrogen electrode. In other words, Eh represents millivolt readings that would have been obtained if using a hydrogen electrode and will apply the needed offset to the readings after calibration. The units "mV" are raw millivolt readings from the sensor and will not apply any calibration offsets. From the program settings, set the display units to either mV or Eh, whichever you will be using.

DO NOT USE ZOBELL SOLUTION!

Zobell solution and other Redox standards may foul the TempHion's electrodes. For Redox/ORP calibration a secondary meter should be used to obtain the reference point value. Use a Redox/ORP meter that is calibrated to your desired Redox/ORP scale to obtain this value.

Place both the TempHion and the reference meter into your sample (ideally the waters the TempHion will be installed in). Once readings have stabilized note the value on the reference meter. Open the calibration window and select the ORP tab, then enter reference meter reading in the Ref. Point box. Next click Measure.



Aqua4Plus will take 10 readings and display the average. Watch for stability while Aqua4Plus is measuring to ensure an accurate calibration. To accept the reading click Ok, your new offset value will appear to the right. Click Apply to confirm your new offset value and Aqua4Plus will provide a real time reading to verify calibration was successful. You may now close the calibration window and proceed with deployment.

ISE-Bromide Calibration

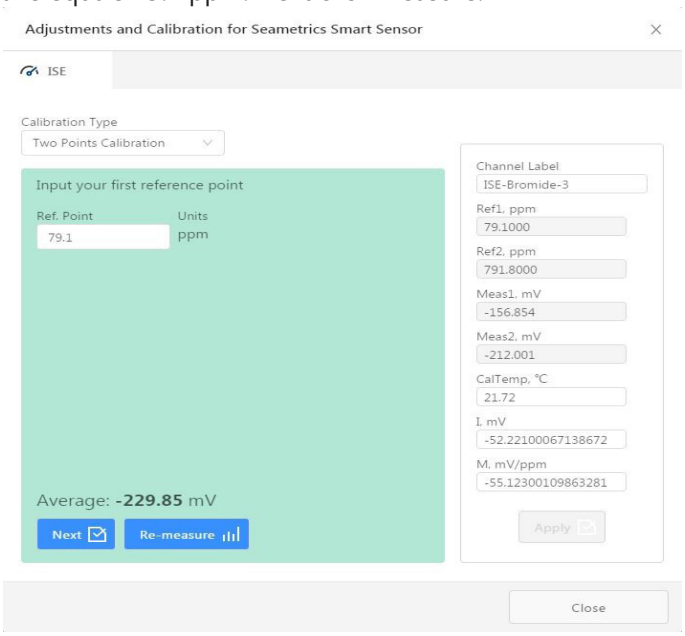
Seametrics recommends using the "known addition method" for preparing calibration solutions. Using this method, the sensor is placed in 100 mL of distilled or deionized water (depending on the container used, more DI water may be needed. Simply scale the following measurements up as needed to fully submerge the electrode). A small amount of standard is added to create a known concentration. The first point is measured. An additional amount of the same standard is added to create a second known concentration. The second point is measured. Seametrics recommends 0.1 Molar NaBr (equates to 7990 ppm). The following instructions are based on using this standard. If you use a different standard, or prefer not to use the known addition method, you must use some other method to determine the concentration used for the first and second point when calibrating. Seametrics recommends performing a 2 point calibration for Bromide.

Prepare your first point standard by adding 1mL of 0.1 Molar NaBr standard per 100 mL of DI water to your container. Accurate measurement of both the DI water and NaBr solution are extremely important for Bromide calibration, Seametrics recommends using a lab grade 100 mL flask for DI water and pipette for the NaBr solution.

Place the TempHion in the standard and use it to stir the solution well. Allow a few minutes for temperature to equalize and readings to stabilize.

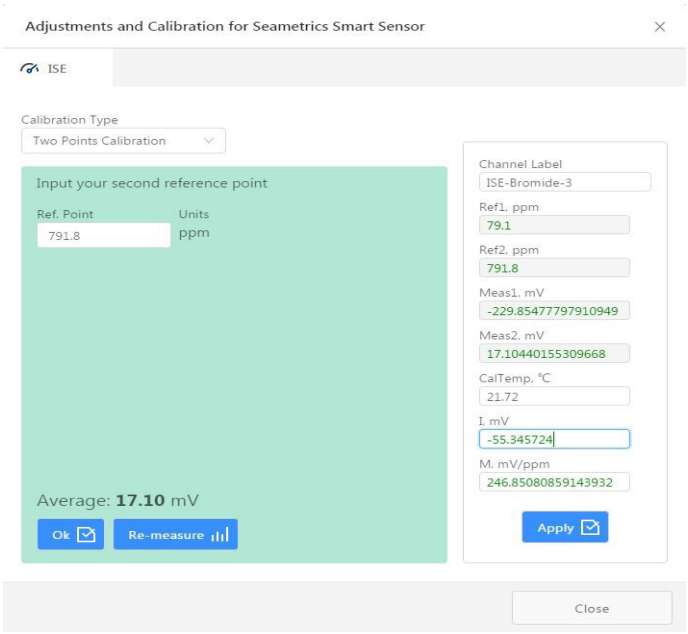
Note: If your TempHion has been stored dry you will want to leave it to soak in the first point for about 30 minutes to recondition the Bromide electrode.

Once temperature and readings appear stable enter your first point value in the Ref. Point box, for 0.1 Molar NaBr this equals 79.1 ppm. Next click Measure.



Aqua4Plus will take 10 readings and display the average. Watch for stability while Aqua4Plus is measuring to ensure an accurate calibration. To accept the reading click Ok, your new offset value will appear to the right. Click Next to continue on to the 2nd point. If only performing a 1 point calibration click Apply to confirm your new offset value and Aqua4Plus will provide a real time reading to verify calibration was successful.

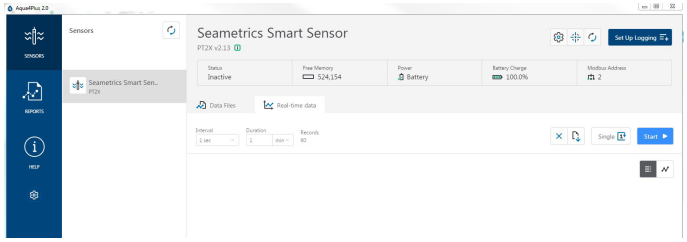
To prepare the second point standard simply add an additional 10 mL of 0.1 Molar NaBr per 100 mL of DI water to your first point solution. Stir well using the TempHion to ensure the solution is fully mixed. Allow a few minutes for the TempHion to acclimate to this solution then enter your reference value in the Ref. Point box, for 0.1 Molar NaBr this equals 791.8 ppm. Next click Measure.



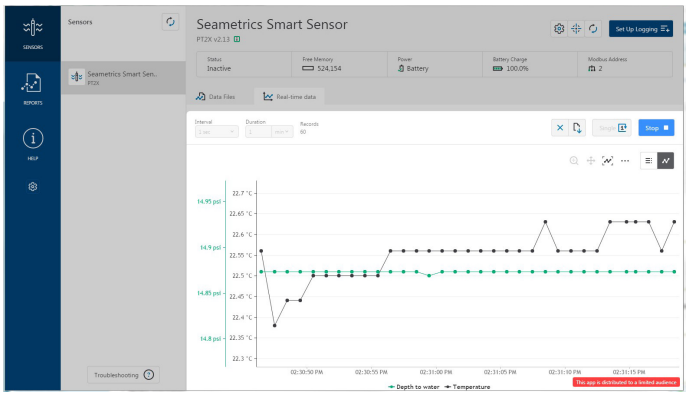
Aqua4Plus will take 10 readings and display the average. Watch for stability while Aqua4Plus is measuring to ensure an accurate calibration. To accept the reading click Ok, your new slope and offset values will appear to the right. Click Apply to confirm your new slope and offset values and Aqua4Plus will provide a real time reading to verify calibration was successful. You may now close the calibration window and proceed with deployment.

Real-time Data

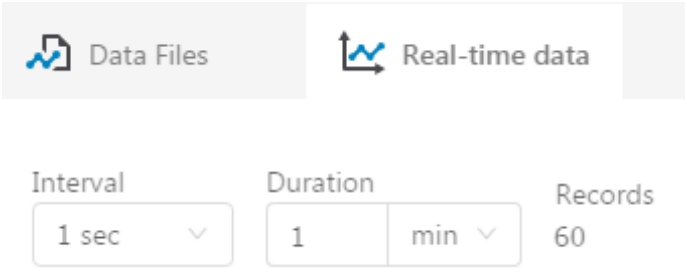
Connect to sensor and select the Real-time data tab



To start real-time readings click Start, readings default to table view. To switch to Real-time graphing view click the graph icon 



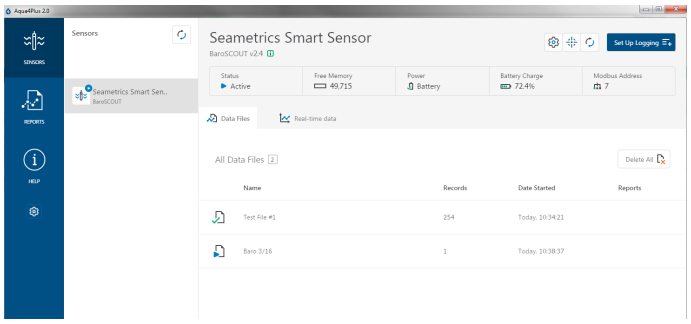
Real-time readings default to a 1 second interval for 1 minute, to adjust enter your desired settings here:



To save this data to the Reports section click the  button located next to the Single button in the Real-Time tab. This will permanently save this real-time data set to your Reports database.

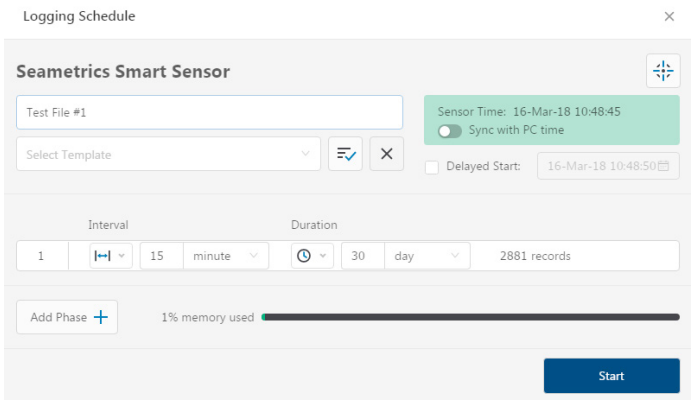
Data Logging

Select Set Up Logging from the sensor screen. If there are no files currently on the sensor you'll see the Set Up Logging button active under the Data Files tab as well as in the upper menu. Once files have been started/logged on the sensor they will be displayed under the Data Files tab.

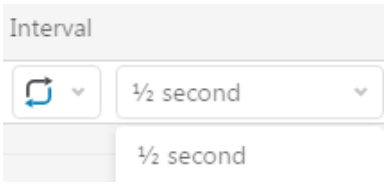


Set Up Logging Window

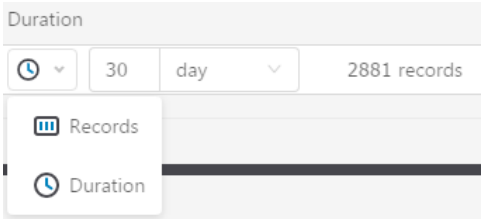
Here you will name your data file and set up the recording interval and duration of each logging phase. Select your desired recording interval and duration for each phase, Aqua4Plus 2.0 will display the available memory at the bottom of the window.



Click to switch between interval and continuous data recording (supported sensors only) Select your continuous rate from the drop down box (on the right).



Duration can be set by either number of records or by setting a duration time, as shown on the right.

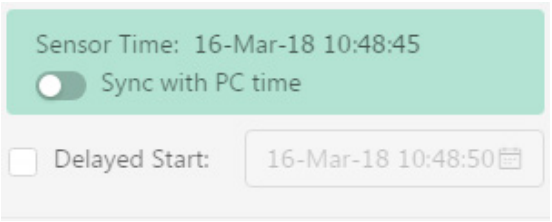


When set by number of records the time of the recording phase will be displayed detailing how long that phase will run. When set by time, the total number of records for that phase will be displayed.

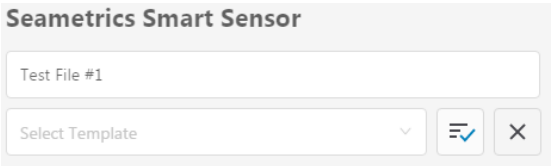
If you need to check settings or perform a calibration click before proceeding with logging setup to switch to the Settings and Calibration screen.

You may sync the sensor clock with the PC clock when starting logging by clicking the slider shown on the right.

Check the Delayed Start box and enter the desired date/time you would like logging to start. This is useful for syncing data when setting up multiple sensors on a site. Data will start logging at the set date/time rather than immediately when Start is pressed.



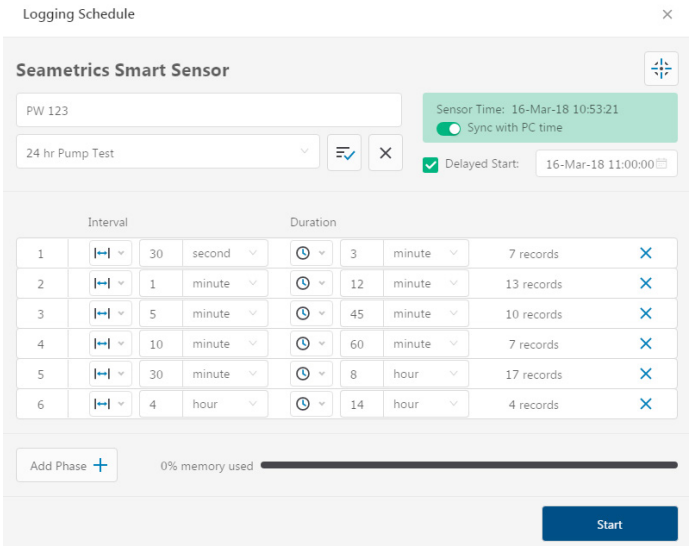
Data file name defaults to Test File # and may be re-named here.



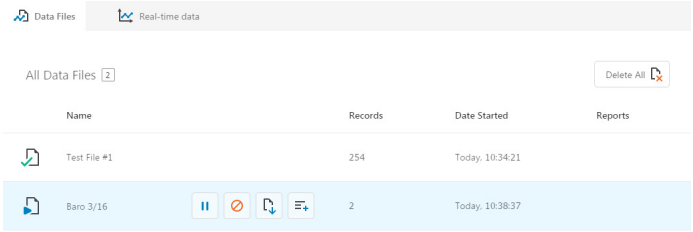
The 3 previous Logging Schedules that were programmed to a sensor will be listed under the Select Template drop down menu. There you will also find pre-programmed logging schedules such as 24 hour pump test, along with any custom logging schedules saved by the user.

To save a logging schedule as a template enter desired settings and click This will add your custom schedule to the Select Template menu.

Once all the desired settings are made simply click Start to begin logging.

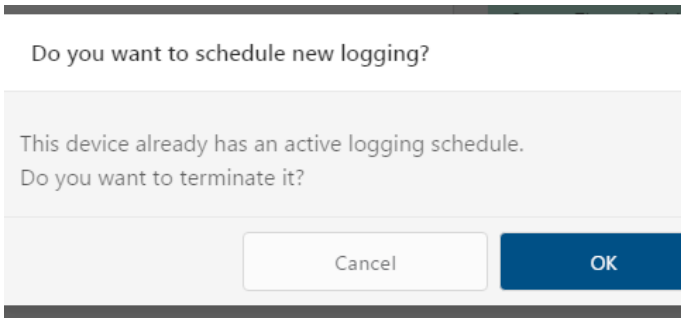


This will return you to the Sensor screen and your status will change to Active with the data file displayed under the Data Files tab. Mouse over an active file to pause, terminate, download, or view logging setup details.

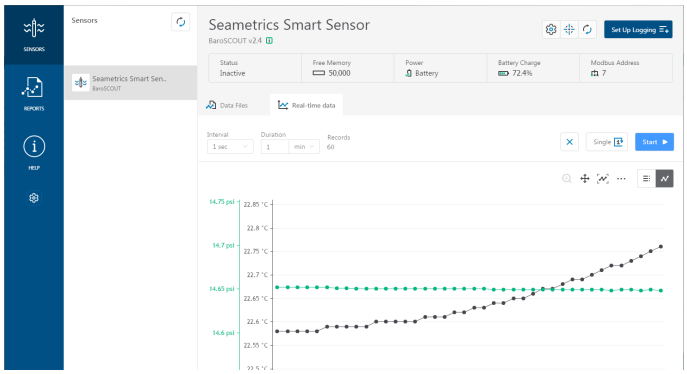


Data files already downloaded will show in the Reports column, clicking here will bring you to the reports screen to view the data. See Reports section for details.

You may only have 1 active data file recording on each sensor, however you can store multiple files in memory if desired.

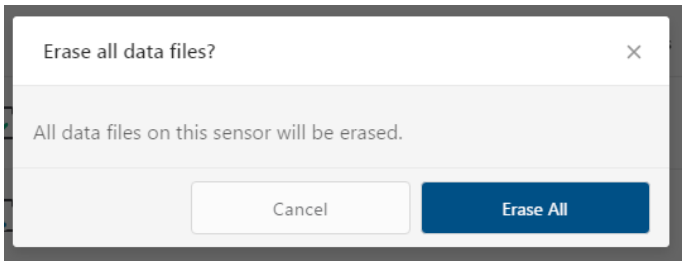


Starting a new file will automatically terminate the active logging and begin the new logging schedule. Real-time data is available during active logging.



To delete files from memory make sure they have all been downloaded to Reports. Files are removed from memory all at once rather than individually.

Once confirmed files are permanently deleted from the sensor memory.



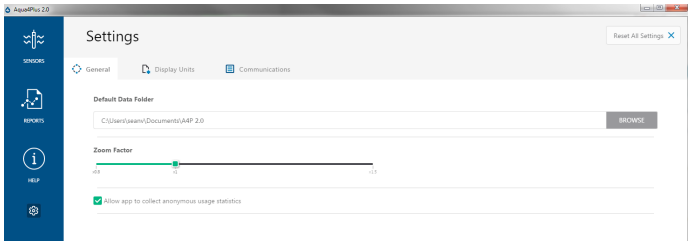
Program Settings

To view/change Aqua4Plus settings click in the blue side-bar menu.

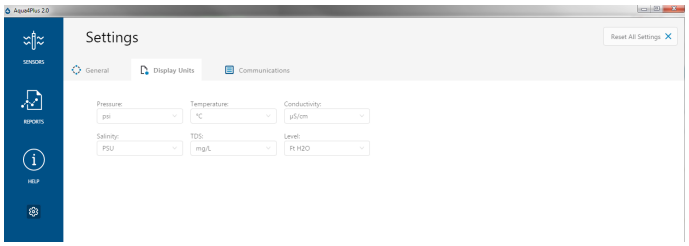
Under the General Settings tab you can change the default data folder location. This is where your Reports are saved to on your PC.

The Zoom Factor slider can be used to adjust the font size within Aqua4Plus.

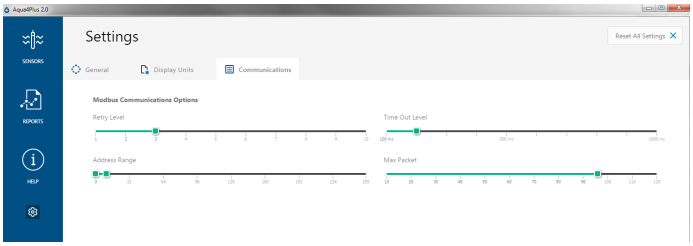
Uncheck the Allow app to collect anonymous usage statistics box if you would like to opt out. This information is used to track Aqua4Plus reliability across different system configurations.



Under the Display Units tab you can select your desired display units for the supported channels. These may be changed at any time and associated Real-Time readings and Reports will rescale to the currently selected display unit. To change Direct Read units scaling see Sensor Settings.



Under the Communications tab you can change your Modbus communication settings. Typically you will only need to change the address range to connect to sensors outside of Modbus address 1-10. In certain cases we may need to change the Retry and Timeout settings to overcome communication issues on very long, or corroded cabling. See Troubleshooting section or contact Seametrics Tech Support for details.



To restore factory default settings click Reset All Settings

Power Consideration

If your sensor does not have internal batteries and is not powered continuously by an auxiliary power supply, then you must turn power on to the sensor at least two seconds before a reading is to be taken to allow the sensor to warm up.

Reading Via Modbus® RTU

Setting Baud Rate

Your TempHion comes configured to communicate at 38,400 baud, with 8 data bits, one stop bit, and no parity. The sensor can also be set to 19,200 or 9600 baud, if needed for your application. You must use Aqua4Plus to make baud rate changes.

If needed, set your TempHion to the desired baud rate in user settings.

Taking Measurements

Reading Registers

Read measurements using Modbus function 03 – Read Holding Registers. Readings are located in two registers each, starting at address 62592. (TempHion register addressing is zero based, i.e., starts at zero. If your equipment uses one based addressing, you will need to add one to the register addresses.)

Register Addresses with Firmware 2.5 or higher

	Zero based	One based
Temperature	62592	62593
pH (in pH units)	62594	62595
ISE (in ppm)	62596	62597
ORP (in Eh)	62598	62599
pH (in mV)	62600	62601
ISE (in mV)	62602	62603
ORP (in mV)	62604	62605

Register Addresses with Firmware prior to 2.5

	Zero based	One based
Temperature	62592	62593
pH (in mV)	62594	62595
ISE (in mV)	62596	62597
ORP (in mV)	62598	62599
pH (in pH units)	62600	62601
ISE (in ppm)	62602	62603
ORP (in Eh)	62604	62605

Measurement Timing

When you request a reading via Modbus, the sensor wakes up, returns the current values in the registers, and then starts taking new readings and updating the registers. After approximately 10 seconds, if no more readings have been requested, the sensor goes back to sleep.

Because of this, the first reading you get will be old. If you are taking readings at intervals of less than 10 seconds, simply ignore the first reading — all remaining readings will be current. On the other hand, if you are taking readings at intervals of greater than 10 seconds, take a reading, ignore it, wait one second, take another reading. Record this second reading.

Data Format

The data is returned as 32-bit IEEE floating-point values, highword first, also referred to as big-endian or float inverse.

For further information and detailed Modbus examples, see Seametrics application note, available on our website at www.seametrics.com.

Reading via SDI-12

SDI-12 commands always return values for all four TempHion channels – temperature, pH, ORP, and ISE channels. Most TempHions are configured either as temperature, pH, and ORP or just temperature and Bromide. You will need to disregard the readings for the channel(s) you do not have configured on your unit.

Note: The default units for temperature is Celsius. To change this, use the Direct Read Units option in the Aqua4Plus Control Software. When using the M!, MC!, C!, or CC! command, all mV channels will report in either pH, ppm, or Eh, depending on the channel type (pH = pH, ORP = Eh, ISE = ppm). When using the M1!, MC1!, C1!, or CC1! command, all mV channels will report in mV.

Addressing

Default SDI-12 Address: 0

SDI-12 Command Nomenclature

<a> = Sensor address

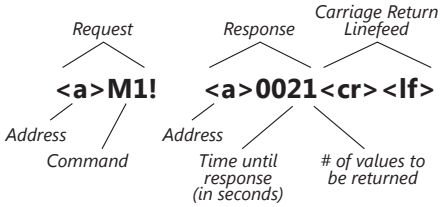
{crc} = SDI-12 compatible 3-character CRC

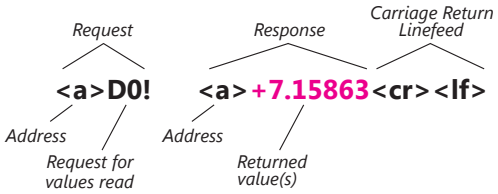
<cr> = ASCII carriage return character

<lf> = ASCII line feed character

highlighted values indicate variable data

All SDI-12 requests consist of a command followed by a request for values. Some software or equipment may combine these, making the second one unnecessary. Refer to your software or equipment documentation for details.





Note: For firmware version 2.0–2.3, the M! and M1! commands are reversed. Likewise for the MC!/MC1!, C!/C1!, and CC!/CC1! commands.

SDI-12 Commands

Sensor Identification

<a>I! <a>13 INWUSA TempHi**206ssssssssss**<cr><lf>

Note: **206** will change to reflect current firmware version.
ssssssssss = device serial number

Acknowledge Active, Address Query

<a>! <a><cr><lf>

?! <a><cr><lf>

Change Address

<a>A<b>! <b><cr><lf>

Change address to <b>

Request Measurement

<a>M! <a>0024<cr><lf>

Request all measurements

<a>D0! <a>**+21.345+7.181+.053+.459**<cr><lf>

Read: temperature, pH (in pH units), (ISE in ppm), ORP (in Eh)

<a>M1! <a>0024<cr><lf>

Request all measurements

<a>D0! <a>**+21.345-134.458+100.48+.84.404**<cr><lf>

Read: temperature, pH (in mV), (ISE in mV), ORP (in mV)

Request Measurement with CRC

<a>MC! <a>0024<cr><lf>	Request all measurements
<a>D0! <a>**+21.345+7.181+.053+.459** {**crc**}<cr><lf>	Read: temperature, pH (in pH units), (ISE in ppm), ORP (in Eh)
<a>MC1! <a>0024<cr><lf>	Request all measurements
<a>D0! <a>**+21.345-134.458+100.48+.84.404** {**crc**} <cr><lf>	Read: temperature, pH (in mV), (ISE in mV), ORP (in mV)

Concurrent Measurement

<a>C! <a>0024<cr><lf>	Request all measurements
<a>D0! <a>**+21.345+7.181+.053+.459**<cr><lf>	Read: temperature, pH (in pH units), (ISE in ppm), ORP (in Eh)
<a>C1! <a>0024<cr><lf>	Request all measurements
<a>D0! <a>**+21.345-134.458+100.48+.84.404**<cr><lf>	Read: temperature, pH (in mV), (ISE in mV), ORP (in mV)

Concurrent Measurement with CRC

<a>CC! <a>0024<cr><lf>	Request all measurements
<a>D0! <a>**+21.345+7.181+.053+.459** {**crc**}<cr><lf>	Read: temperature, pH (in pH units), (ISE in ppm), ORP (in Eh)
<a>CC1! <a>0024<cr><lf>	Request all measurements
<a>D0! <a>**+21.345-134.458+100.48+.84.404** {**crc**} <cr><lf>	Read: temperature, pH (in mV), (ISE in mV), ORP (in mV)

Sensor

There are no user-serviceable parts, other than the batteries and reference solution. If problems develop with sensor stability or accuracy, contact Seametrics. If the sensors have been exposed to hazardous materials, do not return them without notification and authorization.

Cable

Cable can be damaged by abrasion, sharp objects, twisting, crimping, crushing, or pulling. Take care during installation and use to avoid cable damage.

The contact areas (pins & sockets) of the connectors will wear out with extensive use. If your application requires repeated connections other types of connectors can be provided. The connectors used by Seametrics are not submersible, but are designed to be splash-resistant.

Care and Filling of Reference Solution Reservoir

The TempHion's patented reference electrode is key to the TempHion's superior performance. The TempHion uses a long capillary pathway, filled with reference solution, to separate the reference electrode from the solution being analyzed. Proper care and filling of this reference solution reservoir is essential to accurate functioning of the sensor.

All TempHions need to have reference solution in the solution reservoir. The following chart shows the reference solution that should be used with various elements. (*There are also specific settings that are set under Advanced Calibration. These are set at the factory to match your element and need not be changed by the user. They are listed here for reference only.)*

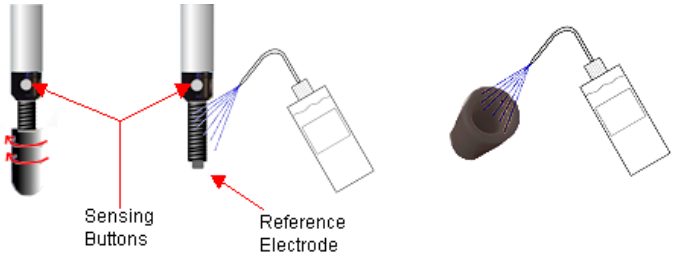
Element	Reference Solution	Isopotential Factor P	Temperature Factor H	Offset
pH	Seametrics	2.97	0.567	--
ORP (Redox)	Seametrics	--	0.54	0
Chloride	ION-Plus B	3.572	0.49	--
Bromide	Seametrics	3.878	0.89	--

CAUTION!
Filling solutions are not considered hazardous, but they can be irritating to the skin. Protective gloves are advised. Rinse hands or gloves with fresh water.

Emptying and Cleaning the Reservoir

Your TempHion is normally shipped from the factory already filled with reference solution. However, from time to time you will need to replace the reference solution. If you notice you are getting erratic readings, this is an indication that the filling solution may need to be replaced. We also recommend replacing the filling solution when doing periodic calibrations.

The TempHion is normally shipped with a bottle of Seametrics Reference Solution. If you will be using a different solution, contact Seametrics for any adjustments that may be needed.



- Unscrew the reservoir cap. **Do not touch or scratch the sensing buttons or the reference electrode!**
- Empty any remaining filling solution from the cap.
- Thoroughly rinse the reference electrode and the inside of the cap with distilled or de-ionized water.
- There may be some crystallized residue inside the cap, on the electrode screw path, or on the electrode itself. If rinsing does not clear this away, then gently use a cotton swab or a soft toothbrush to remove the residue.
- Rinse the electrode assembly and cap thoroughly again after cleaning with the swab or brush.
- Gently, pat dry with a clean paper towel.

Filling the Reservoir

Once the reservoir has been emptied and cleaned, you are ready to fill the reservoir with reference solution.

- Rinse the reference electrode assembly and the inside of the cap with a small amount of the reference solution.
- Empty any remaining solution from the cap.
- Fill cap about half full with reference solution.
- Holding sensor vertically, replace reservoir cap. Some solution should spill from the top as you screw the cap on. This assures that no air bubbles are trapped inside. **If any air bubbles are trapped, a proper electrical connection cannot be made**

and the sensor may read erratically!

Excess filling solution spills over, forcing out any air bubbles

- Once filled, be sure the O-ring is in the upper groove to prevent reference solution leakage and contamination. **Before deploying be sure to move the O-ring to the lower groove to expose the liquid junction port.**

pH Field Calibration Temperature Chart

The pH of any buffer varies slightly with temperature change. For this reason, it is important that you determine the current pH value of the buffer you are using during calibration. From this chart, determine the pH value at your current buffer temperature and use this value as the "Ref pH" value in the Settings and Calibration window. For example, if you are using a pH buffer of 7 and your buffer temperature is 20 degrees C, then you would enter 7.02 in the Ref pH box.

Calibration Temperature				
˚C	˚F	pH 4.00	pH 7.00	pH 10.00
10	50	4.00	7.07	10.19
15	59	4.00	7.05	10.12
20	68	4.00	7.02	10.06
25	77	4.00	7.00	10.00
30	86	4.02	6.99	9.94
35	95	4.02	6.98	9.90
40	104	4.04	6.97	9.85
45	113	4.05	6.97	9.82
50	122	4.06	6.97	9.78

How to Store and Recondition

When storing your TempHion, care must be taken to properly protect the electrodes, including the reference electrode. After storage, before use, the electrodes may need reconditioning, depending on the electrode and the mode of storage. Seametrics' recommendations follow. If you have further questions, please contact your Seametrics technical support representative.

Storage

Reference Electrode

- Best if stored in filling solution.
- Alternately, can be stored in KCl.
- If storing dry, be sure to empty and clean reservoir.

pH bulb / ORP

- Best if stored in pH 4 or KCl.
- Can be stored dry, but may shorten life of bulb. In Seametrics' experience, the bulb should last roughly two years if typically stored dry.

ISE

- Storing dry is best.

Reconditioning

Reference Electrode

- If stored dry or in KCl, refill per maintenance section earlier in this manual. Once refilled, let sit for 30 minutes before using.
- If stored in reference solution, no reconditioning is needed.

pH bulb / ORP

- If stored dry, soak in 1st buffer for 4 hours before calibrating. (Must be calibrated before use.)
- If stored in KCl or pH 4, no reconditioning is needed.

ISE

- If stored dry, soak in 1st calibration solution for 30 minutes before calibrating. (Must be calibrated before use.)

Changing Batteries

Battery Type: Two 1.5V AA batteries—Lithium or Alkaline (lithium recommended). The TempHion sensors are shipped from the factory with fresh batteries. Battery life will depend on battery brand, battery age, temperature of the environment, usage schedule, and other factors.

IMPORTANT!
Because changing the batteries involves opening the water-tight seal, this must be done in a clean, dry environment to avoid contamination or moisture damage to the circuitry.

IF USING ALKALINE BATTERIES —PREVENT BATTERY LEAKAGE!

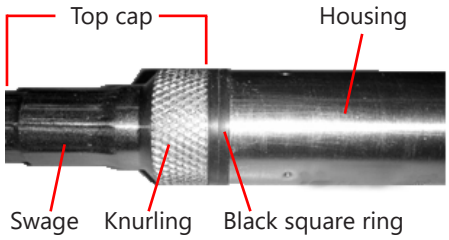
TempHion sensors are typically shipped with lithium batteries. If, however, you are using alkaline batteries, be aware that under some circumstances alkaline batteries can leak, causing damage to the sensor. To prevent leakage, the following is recommended. (Does not apply to lithium batteries.)

- **Change the batteries at least every 18 months.**
- **If the sensor will not be deployed for 3 months or more, remove the batteries.**

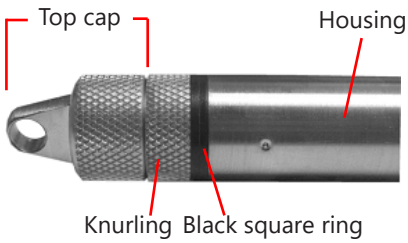
Battery Changing Tips

- Never place a tool on the sensor body, it is very thin and will deform causing leaks at o-ring seals and potentially crushing the circuit board!
- Always twist the sensor body off the top cap assembly rather than twisting the top cap assembly off of the sensor body.
- For cabled sensors, always clamp the sensor on the swaged area when applicable, the shoulder above it will allow you to press down without the worry of the sensor slipping out of the clamping device.
- If the sensor body is slippery or you are unable to grip it hard enough to twist, try a piece of rubber cabinet liner for additional friction.

There is a black, compressible square ring near the top of the sensor. This ring acts as a spring to lock the cable in. This needs to be compressed in order to allow removal of the top cap. Once this ring is compressed, a gentle counterclockwise twist is all that is needed to remove the cable from the sensor body. Compressing the black square ring does take force, **twisting does not.**



Cabled Sensor



Cableless Sensor

Care must be taken to compress the black square ring before attempting to twist the housing. **Forceful twisting of the housing can permanently damage the sensor**.

Securing the Sensor

In order to compress the black square ring, the sensor must be secured so that you can apply downward pressure to compress the ring. This can be done by holding in your hand, using a vise, or using pliers, as follows.

By Hand—cabled version only

1. Tightly grasp the top cap in one hand.
2. Brace your hand against something such as a table or the ground. (Do not allow the cable to be pinched against the brace.)

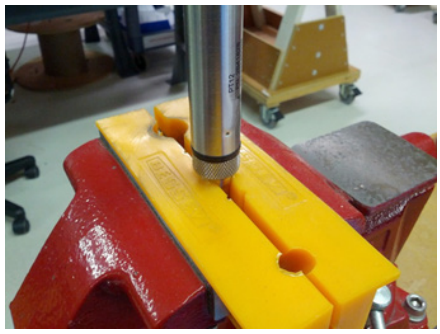
Continue to **Removing the Housing on the next column**.

With Vise—recommended method

Cabled Sensor

1. If possible, use a set of soft jaws as shown to prevent marring the surfaces of the top cap assembly.
2. Place the sensor in a vise clamping gently on the swaged area. You do not need to clamp the vise very hard.

Continue to **Removing the Housing on the next column**.



Cabled Sensor—gripping on swage

Cableless Sensor

1. If possible, use a set of soft jaws as shown to prevent marring the surfaces of the top cap assembly.
2. Remove the cableless top cap.
3. Place the sensor in a vise clamping gently on the knurled area. You do not need to clamp the vise very hard.

Continue to **Removing the Housing on the next column.**

Cableless Sensor—gripping on knurled area

With Pliers or Vise Grips—good for field use

Cabled Sensor

1. Grasp the pliers on the swaged area (do not grab the knurled diameter).
2. Find a hard edge and place the tips or side of the jaws of the pliers onto this edge as shown. This will allow you to press down with your weight to compress the square ring.

Continue to **Removing the Housing in next page**.

Cabled Sensor

Cableless Sensor

1. Leave the cableless cap on in order to protect the pins inside.
2. Grasp the pliers on the knurled area tightly being careful to avoid grabbing the knurled cap.
3. Find a hard surface and place the cableless cap down onto it. This will allow you to press down with your weight to compress the square ring.

Continue to **Removing the Housing in next page**.

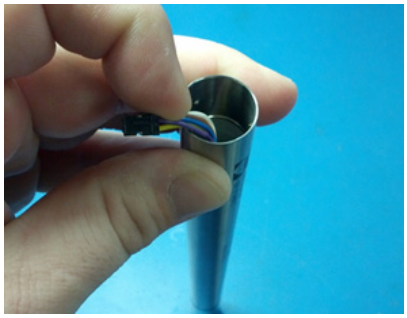
Cableless Sensor

Removing the Housing

1. With your free hand, grasp the sensor body. Press down to compress the square ring. Twist gently. Once the body begins to twist, you can stop the compression action.
2. Finish gently twisting until the sensor body is removed.
3. Carefully disconnect the wiring connector inside from the circuit board in the top cap.

Replacing Batteries and Resealing Sensor

1. Gently pull wiring to one side in order to allow batteries to fall out. Shake gently if needed.
2. Replace batteries with button (+) facing open end.
3. Reinstall wiring connector — it only goes in one way, so make sure not to force it.



Pull wires gently to the side to allow battery removal

Connector connected properly

4. Hold the top cap assembly at 90° to the housing opening as shown. Depress the spring with your fingertip and tuck the wiring into the cutaway on the circuit board with your thumb to protect it while being installed back into the housing.

Wires tucked into slot and spring tucked into housing

5. Rotate the top cap assembly into the opening in the housing being very careful not to nick or pinch any wires.

Push top cap in before twisting and locking

6. Gently press down until the assembly stops and then twist it into place. It will click in and decompress the gasket when it is fully engaged.

Properly completed—black ring uncompressed

Problem	Probable Causes	Things to try...
Software will not communicate with sensor	Loose cable	Make sure all cable connections are secure.
	Contacts in connector loose	Be sure all wires are securely fastened inside the round connector.
	USB driver not installed	See Connecting the TempHion to a Computer in the Installation section or see the USB/RS485 Adapter Installation application note on our web site.
	Incorrect USB or COM port selected (1.9.10 Only)	If using Aqua4Plus, be sure USB is selected in the dropdown box on the tool bar or the correct COM port if using an alternate connection method.
	SEE ALSO ERRATIC READINGS BELOW	
Incorrect readings	O-ring has not been moved to expose the reference reservoir opening	Move the O-ring from the upper groove to the lower groove. See the Installation section.
	Element or reference electrode not reconditioned after storage	See reconditioning information in the How the Store and Recondition section.
	Calibration not performed or incorrectly performed	See Calibration section.
	Incorrect buffers or standards used during calibration	See Calibration section.
Readings drifting over time	Needs recalibration	Recalibrate according to Calibration section.
Erratic readings	Poor connection due to moisture between contacts in connector	Dry thoroughly. Be sure desiccant is fresh (see Maintenance section).
	Loose or broken wires in connector	Repair or return for evaluation and repair.
	Damaged cable, cracked or fraying	Replace cable.
	Moisture in the unit	Return for evaluation and repair.
	Damaged transmitter	Return for evaluation and repair.

LIMITED WARRANTY/DISCLAIMER - Seametrics TempHion SMART SENSOR

A. Seller warrants that products manufactured by Seller when properly installed, shall be free from defects in material and workmanship. Seller's obligation under this warranty shall be limited to replacing or repairing the part or parts or, at Seller's option, the products which prove defective in material or workmanship within TWO (2) years from the date of delivery, provided that Buyer gives Seller prompt notice of any defect or failure and satisfactory proof thereof. Any defective part or parts must be returned to Seller's factory or to an authorized service center for inspection. Buyer will prepay all freight charges to return any products to Seller's factory, or any other repair facility designated by Seller. Seller will deliver replacements for defective products to Buyer (ground freight prepaid) to the destination provided in the original order. Products returned to Seller for which Seller provides replacement under this warranty shall become the property of Seller.

This limited warranty does not apply to lack of performance caused by abrasive materials, corrosion due to aggressive fluids, mishandling or misapplication. Seller's obligations under this warranty shall not apply to any product which (a) is normally consumed in operation, or (b) has a normal life inherently shorter than the warranty period stated herein.

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