

CT2X

Conductivity Smart Sensor and Data Logger Instructions



For PSIG
sensors, refer
to page 25
regarding
desiccant
use!



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IF USING ALKALINE BATTERIES—PREVENT BATTERY LEAKAGE!

CT2X 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 12 months.
- If the sensor will not be deployed for 3 months or more, remove the batteries.

The **Seametrics CT2X** Smart Sensor is a microprocessor-based submersible conductivity/temperature sensor with built-in data logging. This device stores thousands of records of conductivity, temperature, salinity, and total dissolved solids (TDS). The CT2X is also available with a depth/level option giving added functionality in the same sensor housing.

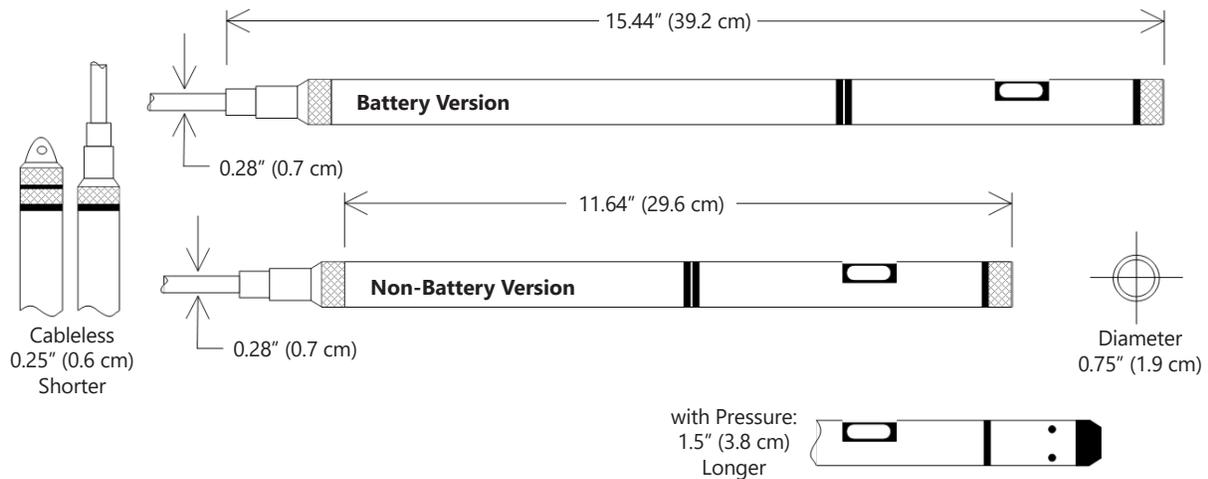
The CT2X incorporates 4-pole electrode cell measurement technology for conductivity, salinity, and TDS. This technology reduces fringe field interference errors, lessens inaccuracy caused by polarization effects, and lowers contact resistance problems. Four-pole electrode technology also allows users to work with one electrode over a wide range of conductivity. The conductivity element is constructed of epoxy/graphite, making it extremely durable for use in rugged field conditions. To clean, simply scrub with a small brush.

Depth and level is measured with an extremely rugged and stable piezo-electric, media isolated pressure element and compensated for temperature using Seametrics's proprietary calibration methodology. Temperature is measured using a borosilicate glass encapsulated thermistor.

The CT2X is powered internally with two replaceable AA batteries. Alternately it can be powered with an external auxiliary power supply for data intensive applications. Several CT2Xs, or a combination of CT2Xs and other Seametrics Smart Sensors, can be networked together and controlled directly from a single computer or via your existing telemetry/control system.

While most will use the CT2X with our free, easy-to-use Aqua4Plus 2.0 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



Specifications*

Housing & Cable	Weight	1.0 lb (0.5 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)		
	Desiccant	1-3 mm indicating silica gel		
	Field Connector	Standard		
Temperature	Operating Range	Recommended: -5° to 40°C (23° to 104°F) Requires freeze protection kit if using pressure option in water below freezing.		
	Storage Range	Without batteries: -40° to 80°C (-40° to 176°F)		
Power	Internal Battery	Two replaceable lithium 'AA' batteries - Expected battery life: 12 months at 15 minute polling interval (may vary due to environmental factors)		
	Auxiliary	Nominal: 12 Vdc, Range: 9–15 Vdc		
Communication	RS485 Modbus® RTU (output = 32-bit IEEE floating point), SDI-12 (ver. 1.3) - ASCII			
Logging	Memory	4MB - 349,000 records		
	Logging Types	Variable, user-defined, profiled		
	Logging Rates	4x/sec maximum, no minimum		
	Baud Rates	9600, 19200, 38400		
	Software	Complimentary Aqua4Plus 2.0		
	Networking	32 available addresses per junction (Address range: 1 to 255)		
	File Formats	.a4d and .csv		
Output Channels	Temperature	Depth/Level	Conductivity	
	Element	Borosilicate glass encapsulated thermistor 30K ohm thermistor	Silicon strain gauge transducer 316 stainless or Hastelloy	Epoxy/Graphite - 4-pole
	Accuracy	±0.25°C	±0.05% FSO (typical, static) ±0.1% FSO (maximum, static) (B.F.S.L. 20°C)	Static: ±0.5% of measured value (0–100,000 µS/cm)
	Resolution	0.1°C	0.0034% FS (typical)	(32 bit internal) 0.1 µS/cm, 0.001 mS/cm, 0.1 mg/L (TDS), 0.001 PSU
	Units	Celsius, Fahrenheit, Kelvin	PSI, FtH ₂ O, inH ₂ O, mmH ₂ O, mH ₂ O, inH ₂ O, cmHg, mmHg, Bars, Bars, kPa	µS/cm, mS/cm, mg/L, PSU
	Range	-5° to 40°C (23° to 104°F)	Gauge: PSI: 1 ² , 5, 7, 15, 30, 50, 100, 300 FtH ₂ O: 2.3 ³ , 12, 35, 69, 115, 231, 692 mH ₂ O: 0.7 ³ , 3.5, 5, 10.5, 21, 35, 70, 210 Absolute ³ : PSI: 30, 50, 100, 300 FtH ₂ O: 35, 81, 196, 658 mH ₂ O: 10, 24, 59, 200	Conductivity ¹ : 0–300,000 µS/cm TDS: 4.9–147,000 mg/L Salinity: 2–42 PSU
	Compensated	---	0° to 40°C (32° to 104°F)	Thermal: None, Linear, or nLFn
	Warmup Time	---	---	200 msec
Max operating pressure	1.1 x full scale			
Over pressure protection	3x full scale up to 100psi—for > 300psi (650 ft or 200 m), contact Seametrics			
Burst pressure	550 psi (approx. 2000 ft or 600 m)			
Environmental	IP68, NEMA 6P			

*Specifications subject to change. Please consult our web site for the most current data (seametrics.com).
 Modbus is a registered trademark of Schneider Electric. Pyrex is a registered trademark of Corning Incorporated.
¹ Accuracy reduced at levels < 10 µS/cm and > 100,000 µS/cm
² ±0.25% accuracy FSO (max) at this range
³ Depth range for absolute sensors has 14.7 PSI subtracted to give actual depth allowed.

Initial Inspection and Handling

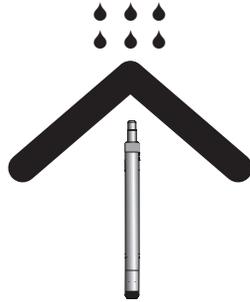
Upon receipt of your smart sensor, inspect the shipping package for damage. If any damage is apparent, note the signs of damage on the appropriate shipping form. After opening the carton, look for concealed damage, such as a cut cable. If concealed damage is found, immediately file a claim with the carrier.

Check the etched label on the sensor to be sure that the proper range and type were provided. Also check the label attached to the cable at the connector end for the proper cable length.

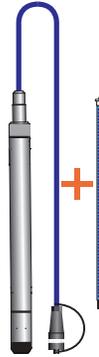
Do's and Don'ts



Do handle sensor with care



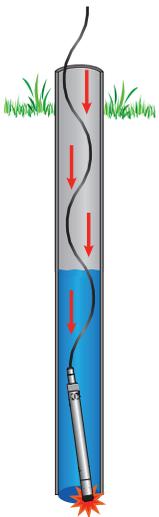
Do store sensor in a dry, inside area when not in use



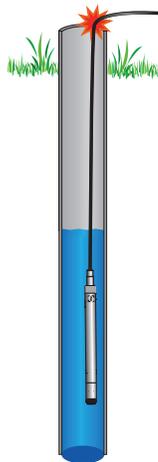
Do install a desiccant tube if using a gauge sensor



Do install sensor so the connector end is kept dry



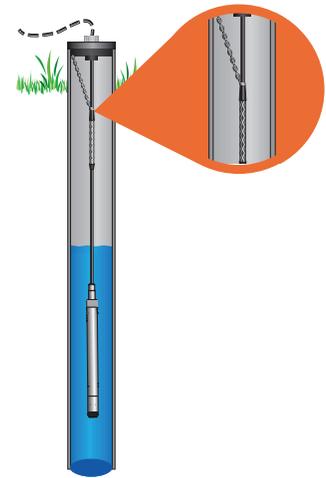
Don't drop into well
Lower gently to prevent damage



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



Don't bend cable sharply
May close off vent tube and/or weaken internal wires



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

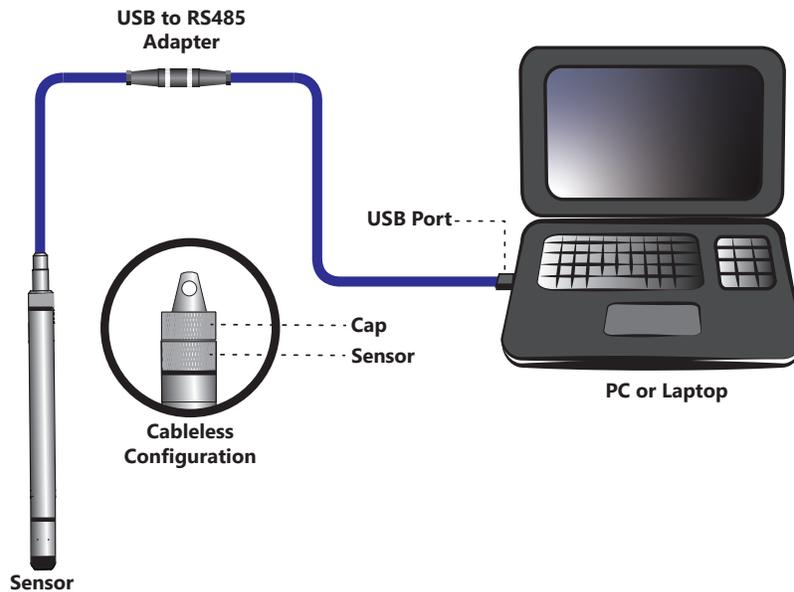
Connecting External Power

The CT2X comes with two replaceable 1.5V 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 CT2X 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.

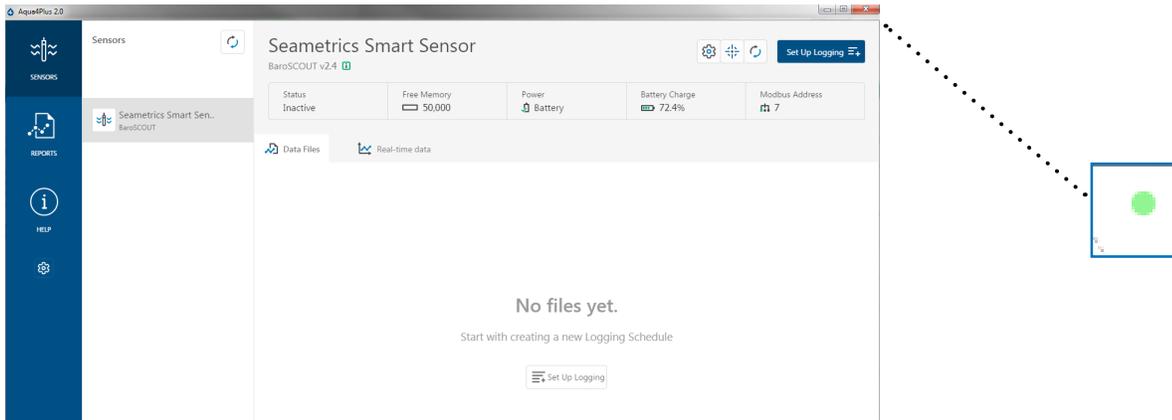
Aqua4Plus 2.0 communicate with the sensor using the USB to RS485 adapter cable. This cable requires drivers to be installed on your computer. If you are connected to the Internet when you first plug in the cable, it will normally obtain and install the correct drivers automatically. If this does not happen, or if you do not have Internet connection, you can use Aqua4Plus 2.0 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:

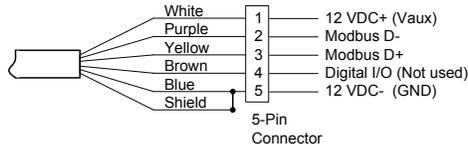


Simply drag the Address Range slider higher up to increase the maximum Modbus address scanned. If you've scanned all the way up through address 255 and still have no connection click Troubleshooting for further troubleshooting or contact Seametrics Tech Support for assistance.

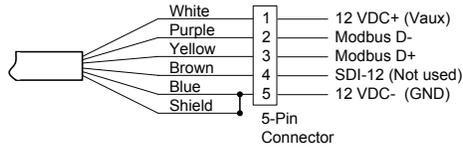
Click  at any time to refresh sensor information.

Cable Wiring

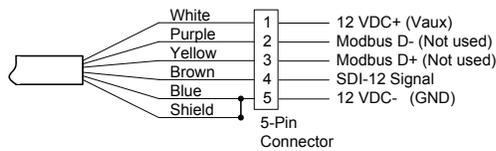
If you buy your cabled sensor with a connector installed (the normal configuration), no further wiring is needed. For reference purposes, the first three diagrams below show the pinout from the connector for various scenarios. The final diagram shows the pinout if you bought your sensor without a connector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



*For Modbus® with firmware lower than 2.0
— with 5-pin connector*



*For Modbus® with firmware 2.0 or higher
— with 5-pin connector*



*For SDI-12 with firmware 2.0 or higher
— with 5-pin connector*



*For SDI-12 with firmware 2.0 or higher
— without connector*

Selecting Linear or Non-Linear Mode

All conductivity measurements are sensitive to temperature change. The CT2X has built-in temperature compensation to correct for changes in temperature. As a user, you can select either a linear temperature compensation method or a non-linear (nLFn) compensation method.

In the linear mode, a constant temperature coefficient is applied to the readings. This defaults to 2.1% per degree C, which works well for a wide range of applications. If you want to use the linear method with a different coefficient, then enter that coefficient in the Temp Coef box on the Settings and Calibration window.

Natural waters, such as ground water, streams, and rivers, often have a very low conductivity and do not respond to temperature in a linear fashion. For this situation, the CT2X provides a non-linear mode, which uses a complex formula to calculate and apply temperature compensation to the readings. This method meets the DIN EN 27888 standards. If you want to use the non-linear method, checkmark the Non-Linear box on the Settings and Calibration window. The temperature coefficient box will disappear.

Using the CT2X Without Aqua4Plus 2.0

Most users will use the CT2X with Seametrics' Aqua4Plus 2.0. However, the CT2X is quite versatile, communicating via either Modbus® or SDI-12 interfaces, allowing you to do the following:

- Read a CT2X via Modbus® using your own software.
- Read a CT2X via SDI-12 protocol.
- Display readings from a CT2X on a panel meter.

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

Installing the Sensor

- Lower the sensor to the desired depth¹.
- Fasten the cable to the well head using a weather proof strain-relief system. When securing a vented cable, make sure not to pinch the cable too tightly or the vent tube inside the cable jacket may be sealed off.
- Take a measurement to insure the sensor is not installed below its maximum range.

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.

If the sensor has the vented pressure option, install the sensor so that the desiccant tube will not flood or lie in water.

The sensor can be installed in any position; however, when it leaves the factory it is tested in the vertical position. Strapping the sensor body with tie wraps or tape will not hurt it. If the sensor is being installed in a fluid environment other than water, be sure to check the compatibility of the fluid with the wetted parts of the sensor.

Desiccant Use

On sensors with a vented pressure option, a desiccant tube prevents moisture in the air from being sucked into the vent tube, which can cause erratic readings and sensor damage.

The desiccant tube is filled with blue silica gel beads. A locking barb and a hydrophobic water filter are attached to the end of the desiccant tube. This filter prolongs the life of the desiccant as much as three times over a desiccant tube without the filter.

Install the sensor so that the desiccant tube and cable connector will not flood or lie in water.

The desiccant is a bright blue color when active and dry. See Maintenance section for care and changing of desiccant.

¹ If your CT2X has the pressure option, then the maximum installation depth depends on the range of the sensor. One (1) PSI is equal to approximately 2.31 feet of water. If you have a 5 PSI sensor, the range is 11.55 feet of water and the sensor should not be installed at a depth below 11.55 feet. If the sensor is installed below its maximum range, damage may result to the sensor and the output reading will not be correct.

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.

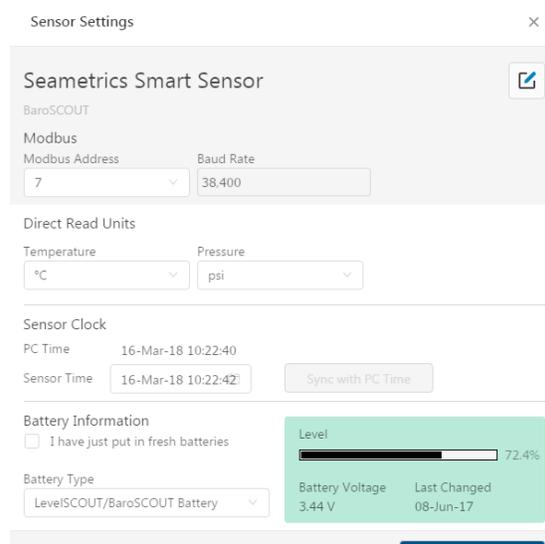
When using several pieces of interconnected equipment, each of which may have its own ground, problems with noise, signal interference, and erroneous readings may be noted. This is caused by a condition known as a Ground Loop. Because of natural resistance in the earth between the grounding points, current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

Sensor Settings

Once connected you'll see the Sensor screen appear and display the connected sensor(s) details. Mousing over  icons will provide tool-tips, mouse over  to view sensor firmware and serial number details.

To change general sensor settings click  in the sensor screen. This allows you to change the following:



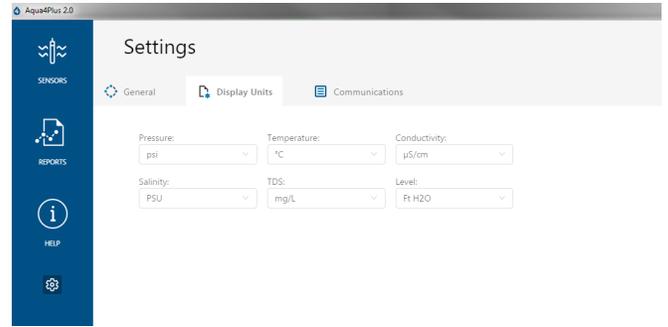
Click  to rename the sensor

To change Modbus address and/or Baud Rate simply select the desired address and/or Baud Rate from the drop down menus. Sensor will automatically reconnect at new address and/or Baud Rate

To change the Direct Read output units (for direct Modbus or SDI12 integration) simply select the desired output units from the drop down menus. To change Aqua4Plus 2.0 display units scaling see Program Settings.

Sensor Clock can be synced with your PC time or set manually if desired. To set manually enter your desired date/time and click Set Time.

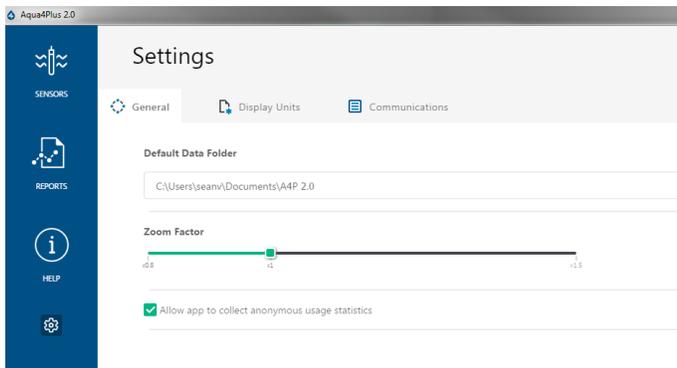
When batteries are changed out make sure to reset the battery information here, simply check the I have just put in new batteries box and select the battery type that was installed from the drop down menu.



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.

Program Settings

To view/change Aqua4Plus 2.0 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 2.0.

Uncheck the Allow app to collect anonymous usage statistics box if you would like to opt out. This information is used to track Aqua4Plus 2.0 reliability across different system configurations.



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



General Calibration Information

Settings and calibration values can only be changed when there is no data on the sensor. Be sure to retrieve any data and then erase the data on the sensor before proceeding.



Important!
When performing calibration, be sure that you use the same units for all measurements that you have selected to view in the program, such as $\mu\text{S/cm}$, mS/cm , psi, feet of water, etc.

Conductivity Calibration

To perform a Conductivity Calibration first connect to your CT2X and ensure all data has been uploaded and erased from the sensor.

Prepare your calibration standard(s) and place the sensor in your first point calibration standard, allow a few minutes for the temperatures to equalize. Check for stable temperature readings under Real-time Data and note the current temperature value. Next select the calibration button 

The calibration screen will default to the conductivity channel, you may also switch to the Pressure channel if you need to perform a pressure calibration setup.

Make sure the Non-linear box is NOT checked during calibration. If you plan to record data after calibration using the Non-linear temperature compensation option come back after calibration is complete and select the Non-linear box.

Select one or two point calibration from the Calibration Type drop down box. Seametrics recommends performing a two point calibration that brackets your expected conductivity range in the field for best accuracy.

Enter the RAW conductivity value of your standard at the temperature noted above (consult conductivity standards temperature reference chart) and enter it in the Ref. Point box. Next click Measure.

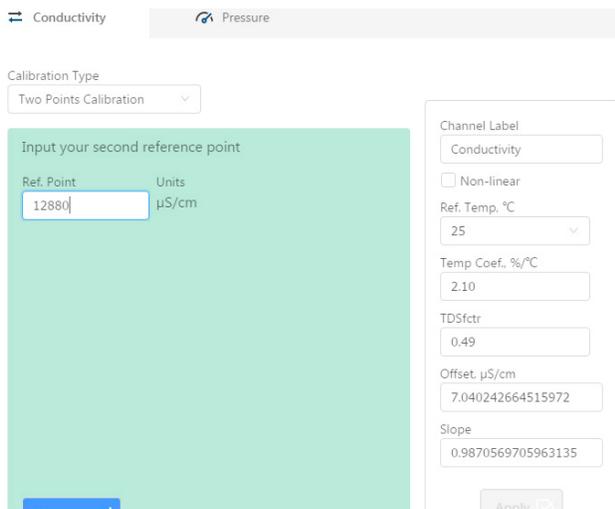
Note: If your conductivity values appear to drift slightly try stirring your standard with the sensor. If the standard has been sitting for a time the solution can begin to settle out affecting the readings.

To calibrate Conductivity select Depth/Submergence, confirm your measurement units, then click Continue.

Aqua4Plus 2.0 will take 10 readings and display the average. Watch for stability while Aqua4Plus 2.0 is measuring to ensure an accurate calibration. To accept the first point reading click Ok.

If you've selected one point calibration next click Apply to apply the new offset value, confirm other settings as needed, then close the calibration window.

If you've selected two point calibration place the sensor in your second point standard and enter the RAW conductivity value of the standard at the temperature noted above (consult conductivity standards temperature reference chart) and enter it in the Ref. Point box. Next click Measure.



Aqua4Plus 2.0 will take 10 readings and display the average. Watch for stability while Aqua4Plus 2.0 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, confirm other settings as needed and click Apply to confirm your new slope and offset values. Aqua4Plus 2.0 will provide a real time reading to verify calibration was successful.

Before closing the calibration screen make sure your settings are correct for temperature compensation as desired. Use the non-linear box for low conductivity natural water applications. This will disable the Ref. Temp and Temp Coef settings and use the nLFn function to temperature compensate the conductivity channel. This method meets the DIN EN 27888 standards.

For linear temperature compensation set the temperature you'd like your conductivity corrected to in the Ref. Temp C box, and the appropriate temperature coefficient you'd like to use in the Temp Coef %/C box. Seametrics defaults the conductivity to a Ref Temp of 25 and 2.1 %/Deg C for the Temp Coef.

TDSfctr is the multiplier applied to the conductivity readings to provide TDS output. Seametrics defaults to 0.49, change as necessary to fit your TDS multiplier.

Confirm any changes by clicking Apply. Once calibration setup is complete click Close.

Pressure Calibration

To perform a calibration setup on the pressure channel first connect to the sensor and ensure all data has been uploaded and erased from the sensor. Next select the calibration button (example images can be found under conductivity calibration page 12).

Next select the calibration setup you'd like to perform:

Comfirm desired measurement units and click Continue.

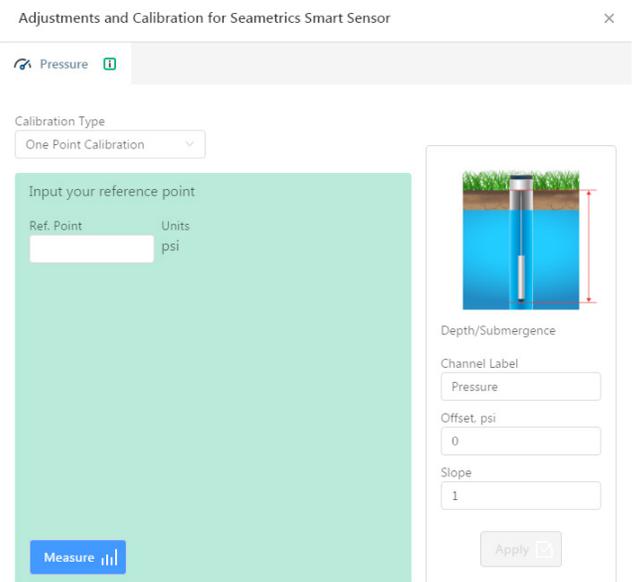
Submergence:

One Point/Zero Point Calibration:

To zero pressure output to atmospheric pressure position the sensor in air in its desired installation position (typically vertical, if sensor will be installed horizontally position as such during 0 point calibration). Select 1 point Calibration under Calibration Type.

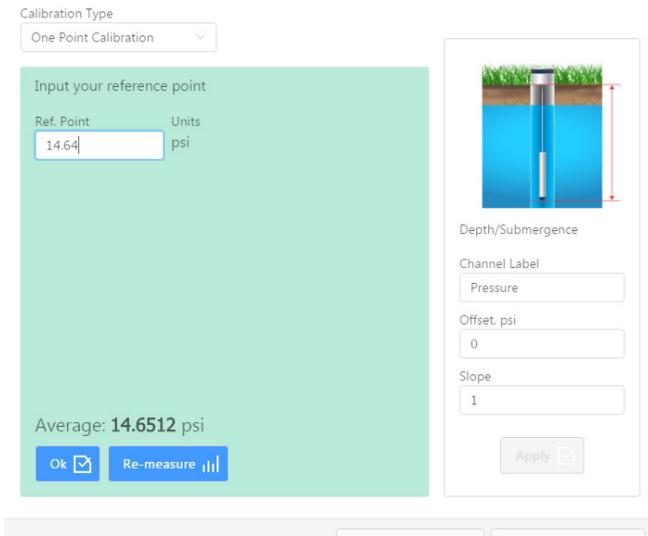
For PSIG sensors use 0 as the reference value and click Measure.

For PSIA sensors enter current barometric pressure from a known accurate barometer set to matching units. Enter your reference value in the Ref. Point box and click Measure.

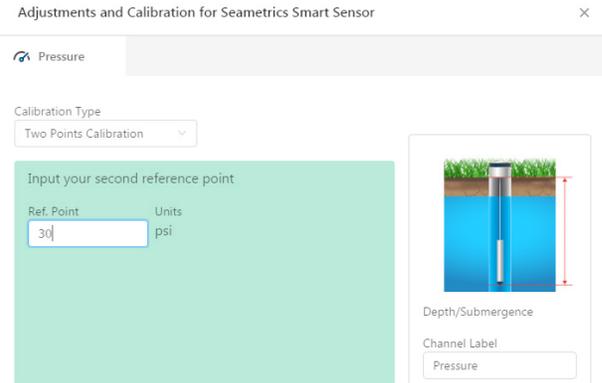


Aqua4Plus 2.0 will take 10 readings and display the average. Watch for stability while Aqua4Plus 2.0 is measuring to ensure an accurate calibration.

Enter known pressure value in matching units in the Ref. Point box for second point measurement



Click Ok to accept the reading and Aqua4Plus 2.0 will calculate a new pressure offset. Click Apply to confirm the new offset value and Aqua4Plus 2.0 will provide a real time reading to verify calibration was successful:



Aqua4Plus 2.0 will take 10 measurements and display the average. Watch for stability while Aqua4Plus 2.0 is measuring to ensure an accurate calibration.

Click Ok and Aqua4Plus 2.0 will calculate the new slope and offset values. Click Apply to confirm the new slope and offset values and Aqua4Plus 2.0 will provide a real time reading to verify calibration was successful.

Depth to water (for PSIG sensors only, see Barometric Compensation Utility for PSIA sensors)

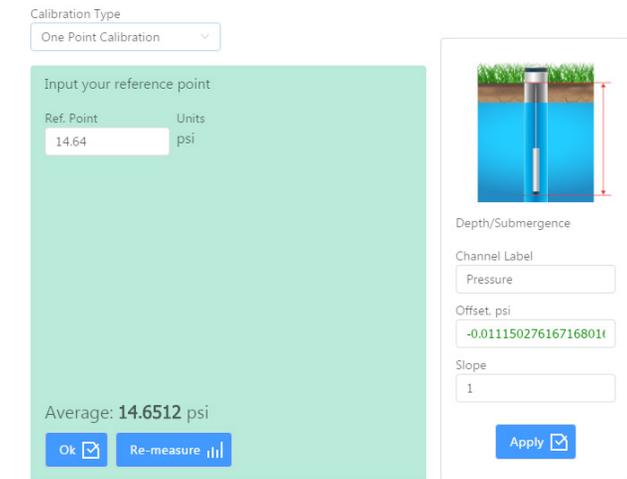
Position the sensor in its desired location and ensure all data has been uploaded and erased from the sensor before proceeding with calibration.

Once positioned connect to sensor and select the calibration button, followed by selecting the Depth to Water option. Double check measurement units selection before proceeding.

Enter your current depth to water (Typically obtained from a water level indicator) value in the Ref. Point box, making sure to match measurement units.

Click Measure and Aqua4Plus 2.0 will take 10 readings and display the average. Watch for stability while Aqua4Plus 2.0 is measuring to ensure an accurate calibration.

Click Accept and Aqua4Plus 2.0 will calculate a new slope and offset, click Apply to accept the new slope and offset and Aqua4Plus 2.0 will provide a real time reading to verify calibration was successful.



2 Point submergence calibration **ONLY RECOMMENDED IF YOU HAVE AN ACCURATE PRESSURE REFERENCE.** Our Smart Sensors rarely change slope during normal use, however if you have an accurate pressure source it is possible to perform a 2 point calibration on the pressure channel.

Select 2 point Calibration under Calibration Type

Perform first point calibration as listed above and click Next

Groundwater Elevation

Position the sensor in its desired location and ensure all data has been uploaded and erased from the sensor before proceeding with calibration.

Once positioned connect to sensor and select the calibration button, followed by selecting the Groundwater Elevation option. Double check measurement units selection before proceeding.

Enter your current Groundwater Elevation reading in the Ref. Point box, making sure to match measurement units.

Click Measure and Aqua4Plus 2.0 will take 10 readings and display the average. Watch for stability while Aqua4Plus 2.0 is measuring to ensure an accurate calibration.

Click Accept and Aqua4Plus 2.0 will calculate a new offset, click Apply to accept the new offset and Aqua4Plus 2.0 will provide a real time reading to verify calibration was successful.

Staff Gauge

Position the sensor in its desired location and ensure all data has been uploaded and erased from the sensor before proceeding with calibration.

Once positioned connect to sensor and select the calibration button, followed by selecting the Staff Gauge option. Double check measurement units selection before proceeding.

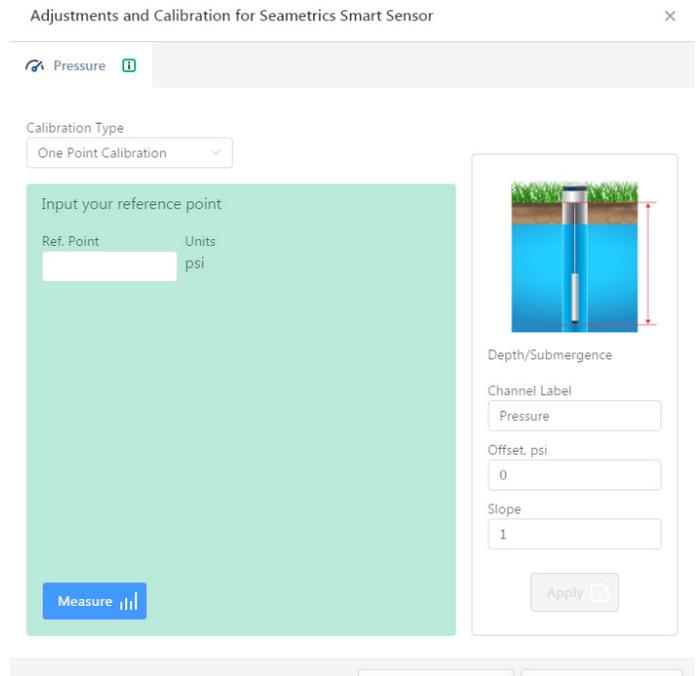
Enter your current Staff Gauge reading in the Ref. Point box, making sure to match measurement units.

Click Measure and Aqua4Plus 2.0 will take 10 readings and display the average. Watch for stability while Aqua4Plus 2.0 is measuring to ensure an accurate calibration.

Click Accept and Aqua4Plus 2.0 will calculate a new offset, click Apply to accept the new offset and Aqua4Plus 2.0 will provide a real time reading to verify calibration was successful.

Removing calibration setup values

To return to factory default simply enter an offset of 0 and slope of 1 in the Offset and Slope boxes:



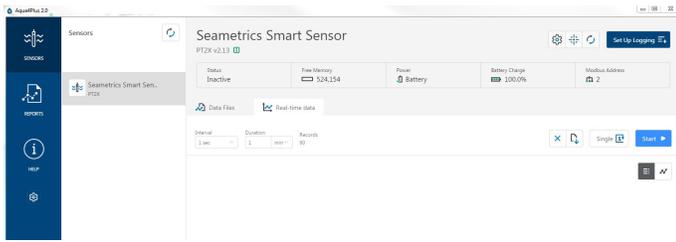
Click Apply to confirm settings and Aqua4Plus 2.0 will provide a real time reading to confirm.

Adjusting for specific gravity

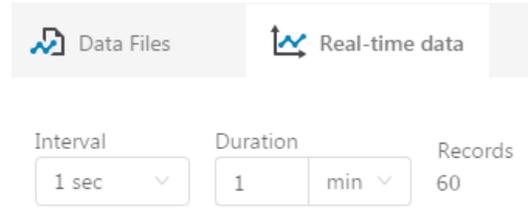
You may enter the specific gravity of your fluid as an inverse multiplier (1/SG) in the Slope field to adjust for specific gravity when needed. Click Apply to confirm settings and Aqua4Plus 2.0 will provide a real time reading to confirm.

Real-time Data

Connect to sensor and select the Real-time data tab



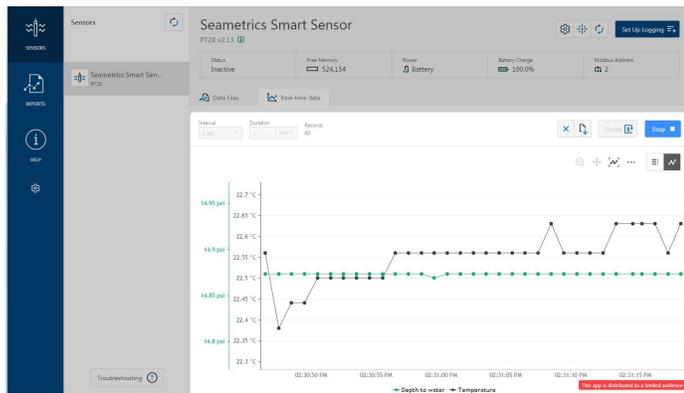
To start real-time readings click Start, readings default to table view



To 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.

Date / Time	Temperature (°C)	Conductivity (µS/cm)	Pressure (psi)	Salinity (PSU)	TDS (mg/L)
20-Mar-18 09:18:21	22.13	350.2	8.997	0.1682	171.6
20-Mar-18 09:18:22	22.13	355.0	8.997	0.1705	173.9
20-Mar-18 09:18:23	22.13	355.3	9.007	0.1706	174.1
20-Mar-18 09:18:24	22.13	356.5	9.007	0.1712	174.7
20-Mar-18 09:18:25	22.13	355.0	9.007	0.1705	174.0

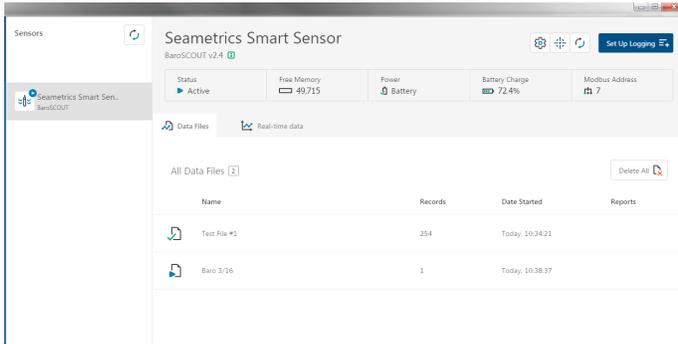
To switch to Real-time graphing view click the  graph icon



Data Logging

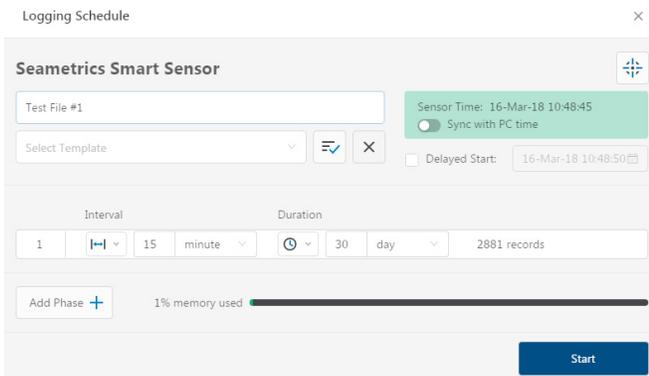
Select Set Up Logging from the sensor screen

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.

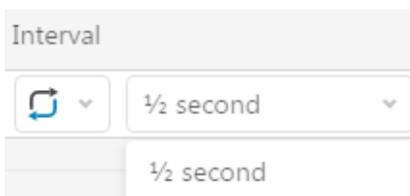


Setting Up Logging Window

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 will display the available memory at the bottom of the window.

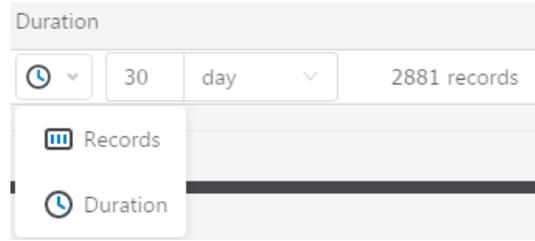


Click to switch between interval and continuous data recording (supported sensors only) Select your continuous rate from the drop down box here.



Duration can be set by either number of records

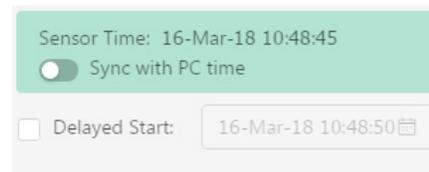
Or by setting a duration time



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.

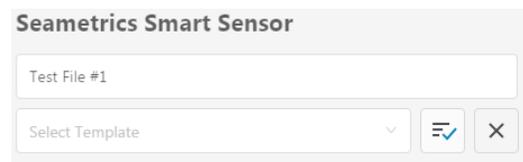
If you need to check settings or perform a calibration click before proceeding with logging setup to switch to the Settings and Calibration screen.

You may sync the sensor clock with the PC clock when starting logging by clicking the slider here.



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.

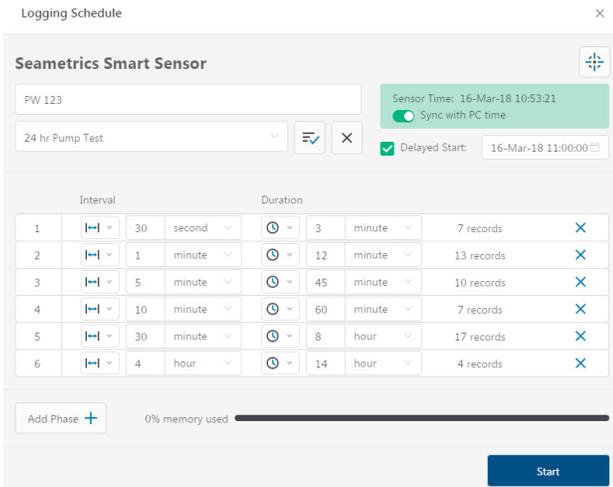
Data file name defaults to Test File # and may be re-named here.



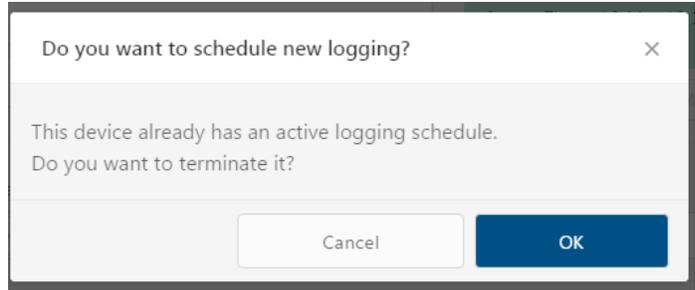
The 3 previous Logging Schedules that were programmed to a sensor will be listed under the Select Template drop down menu. There you will also find pre-programmed logging schedules such as 24 hour pump test, along with any custom logging schedules saved by the user.

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.

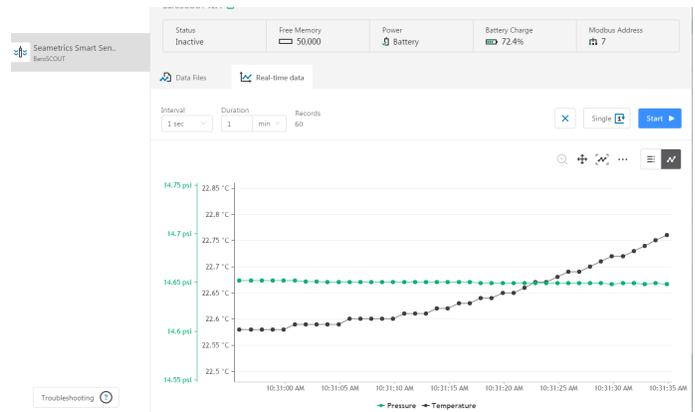
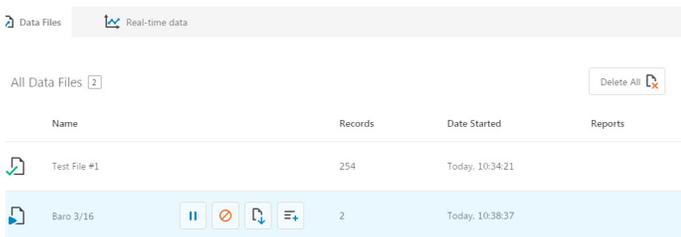


You may only have 1 active data file recording on each sensor, however you can store multiple files in memory if desired.



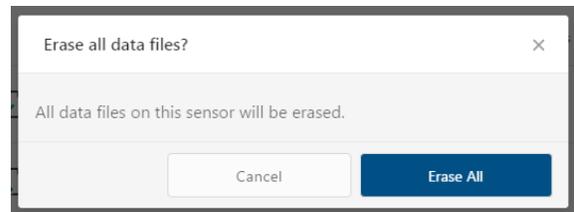
Starting a new file will automatically terminate the active logging and begin the new logging schedule. Real-time data is available during active logging.

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.



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.

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.

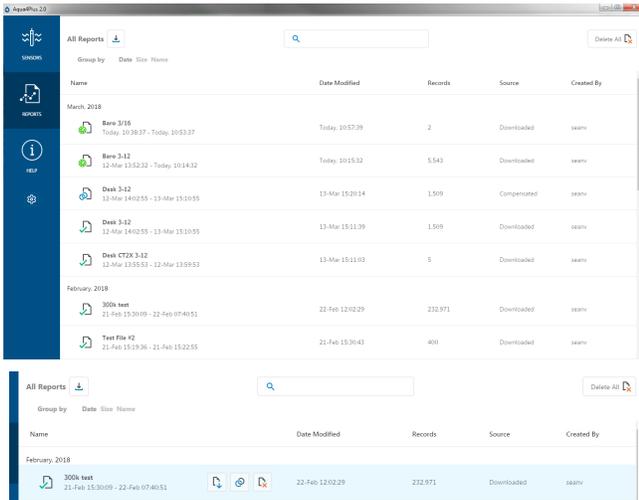


Once confirmed files are permanently deleted from the sensor memory.

Reports

Data downloaded from your sensor is stored in the Reports section of Aqua4Plus 2.0 for viewing and editing. The files will be saved to default data folder on your PC as well. See Program Settings for default data folder location.

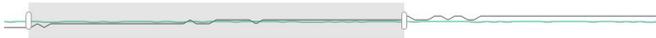
In the main view you'll see a list of reports sorted by date, size, or file name as selected here



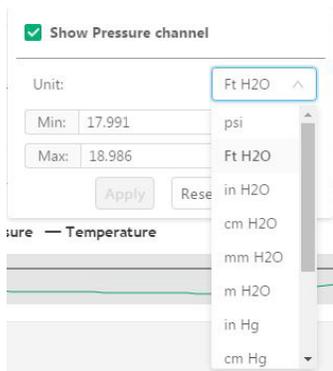
You can also search reports by keyword using the search box

Click on a report to bring up the report details

Reports are displayed in graphing view by default. You can zoom to specific sections by selecting a section with your mouse or by adjusting the slider below the graph, like below.

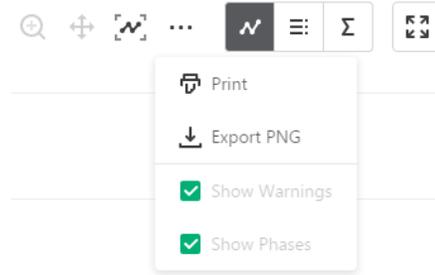


You may change the display units within the graph view by selecting the appropriate channel here:



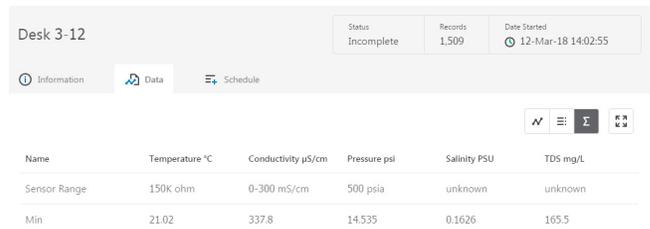
Click  to switch to full screen graphing view

Graph saving and export options are available here:

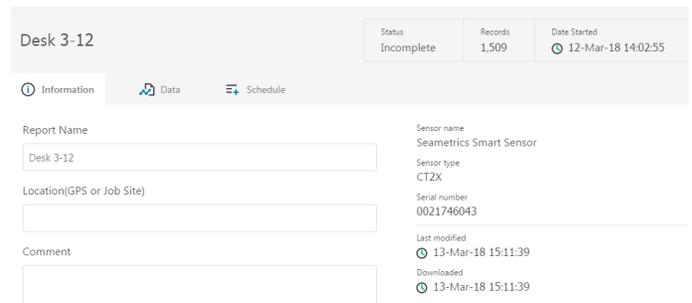


Click  to view data as a table

Click  to view data statistics



The Information tab is a new feature allowing users to add metadata to their reports such as site location, field notes, or comments.



The Schedule tab will display the logging setup details for the report

Click Export to export the report as a .csv file or .a4d file for distribution or use in 3rd party software.

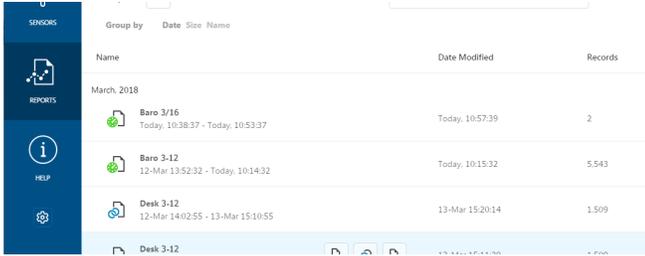
Click Delete to delete the report from Aqua4Plus 2.0

You can also import .a4d files from compatible sensors into Aqua4Plus 2.0 by clicking  at the top of the Reports screen.

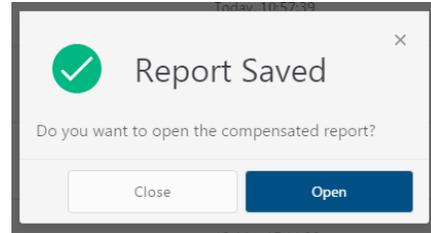
Barometric Compensation

For PSIA sensors we've built a new barometric compensation utility into the Reports section. Click  on a report to compensate the data for barometric pressure.

Aqua4Plus 2.0 will perform the barometric compensation and create a new compensated report. Original reports are retained as uploaded.

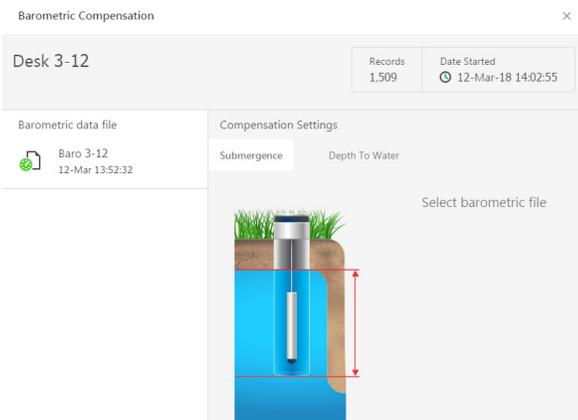


Name	Date Modified	Records
March 2018		
Baro 3-16 Today, 10:38:37 - Today, 10:53:37	Today, 10:57:39	2
Baro 3-12 12-Mar 13:52:32 - Today, 10:14:32	Today, 10:15:32	5,543
Desk 3-12 12-Mar 14:02:55 - 13-Mar 15:10:55	13-Mar 15:20:14	1,509
Desk 3-12		

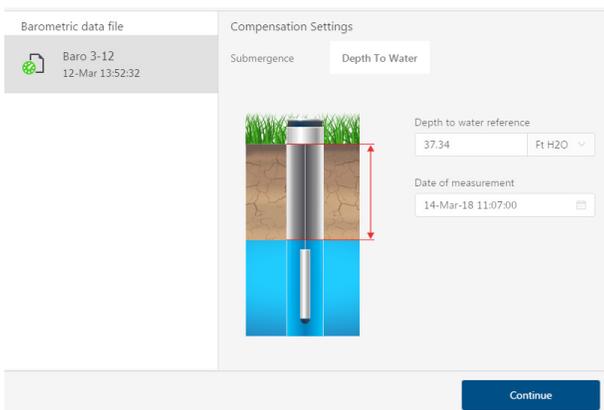


Corresponding barometric files are filtered by date/time and displayed to the left. Select the barometric file you would like to use to compensate the report, select either the Submergence or Depth To Water tab, then click Continue.

Compensated report can then be viewed and exported as needed.



If compensating for Depth to Water enter your depth to water reference measurement and the date/time the measurement was taken (typically taken with a water level indicator before data is uploaded from the sensor) before clicking Continue.



Reading Via Modbus® RTU

Setting Baud Rate

Your CT2X 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 2.0, see Settings, to make baud rate changes.

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' Technical Bulletin available from our web site (www.seametrics.com/downloads).

Taking Measurements

Reading Registers

Read measurements using Modbus function 03 – Read Holding Registers. Readings are located in two registers each, starting at address 62592. (CT2X 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 for the CT2X

	Zero based	One based
Temperature	62592	62593
Conductivity (Linear)	62594	62595
Conductivity (nLFn)	62596	62597
Pressure	62598	62599
Salinity*	62600	62601
TDS*	62602	62603

**Firmware version 2.7 or higher*

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.

Reading via SDI-12

Note: The default units setting for pressure is PSI. The default units setting for temperature is Celsius. To change these, use the Direct Read Units in the Aqua4Plus 2.0 Control Software. Note: Conductivity is always returned in µS/cm, Salinity in PSU, and TDS in mg/L.

Addressing

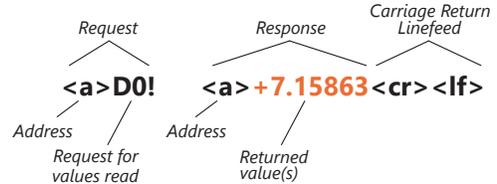
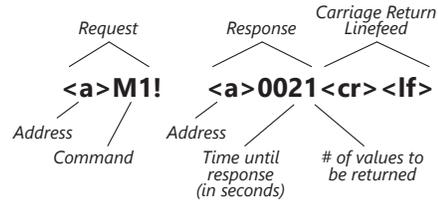
Default SDI-12 Address: 0

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.



SDI-12 Commands

Sensor Identification

<a>! <a>13 INWUSA CT2X 215sssssssss<cr><lf>

Note: 215 will change to reflect current firmware version.
sssssssss = device serial number

Acknowledge Active, Address Query

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

Change Address

<a>A! <cr><lf>

Change address to

Request Measurement

<a>M! <a>0024<cr><lf>
<a>D0! <a>+22.0512+155.0127+155.2155+12.0512<cr><lf>

Request all basic measurements
Read: temperature, conductivity (linear), conductivity (nLFn), pressure

<a>M1! <a>0021<cr><lf>
<a>D0! <a>+22.0512<cr><lf>

Request temperature measurement only
Read temperature

<a>M2! <a>0021<cr><lf>
<a>D0! <a>+155.0127<cr><lf>

Request linear conductivity measurement only
Read linear conductivity

<a>M3! <a>0021<cr><lf>
<a>D0! <a>+155.0127<cr><lf>

Request nLFn conductivity measurement only
Read nLFn conductivity

<a>M4! <a>0021<cr><lf>
<a>D0! <a>12.0512<cr><lf>

Request pressure measurement only
Read pressure

<a>M5! <a>0021<cr><lf>
<a>D0! <a>+20.7862<cr><lf>

Request salinity measurement only
Read salinity

<a>M6! <a>0021<cr><lf>
<a>D0! <a>14700.9<cr><lf>

Request TDS measurement only
Read TDS

Request Measurement with CRC

<a>MC! <a>0024<cr><lf> <a>D0! <a>+22.0512+155.0127+155.2155+12.0512 {crc}<cr><lf>	Request all basic measurements with CRC Read: temperature, conductivity (linear), conductivity (nLFn), pressure
<a>MC1! <a>0021<cr><lf> <a>D0! <a>+22.0512 {crc} <cr><lf>	Request temperature measurement only Read temperature
<a>MC2! <a>0021<cr><lf> <a>D0! <a>+155.0127 {crc} <cr><lf>	Request linear conductivity measurement only Read linear conductivity
<a>MC3! <a>0021<cr><lf> <a>D0! <a>+155.0127 {crc} <cr><lf>	Request nLFn conductivity measurement only Read nLFn conductivity
<a>MC4! <a>0021<cr><lf> <a>D0! <a>12.0512 {crc} <cr><lf>	Request pressure measurement only Read pressure
<a>MC5! <a>0021<cr><lf> <a>D0! <a>+20.7862 {crc} <cr><lf>	Request salinity measurement only Read salinity
<a>MC6! <a>0021<cr><lf> <a>D0! <a>14700.9 {crc} <cr><lf>	Request TDS measurement only Read TDS

Concurrent Measurement

<a>C! <a>0024<cr><lf> <a>D0! <a>+22.0512+155.0127+155.2155+12.0512<cr><lf>	Request all basic measurements Read: temperature, conductivity (linear), conductivity (nLFn), pressure
<a>C1! <a>0021<cr><lf> <a>D0! <a>+22.0512<cr><lf>	Request temperature measurement only Read temperature
<a>C2! <a>0021<cr><lf> <a>D0! <a>+155.0127<cr><lf>	Request linear conductivity measurement only Read linear conductivity
<a>C3! <a>0021<cr><lf> <a>D0! <a>+155.0127<cr><lf>	Request nLFn conductivity measurement only Read nLFn conductivity
<a>C4! <a>0021<cr><lf> <a>D0! <a>12.0512<cr><lf>	Request pressure measurement only Read pressure
<a>C5! <a>0021<cr><lf> <a>D0! <a>+20.7862<cr><lf>	Request salinity measurement only Read salinity
<a>C6! <a>0021<cr><lf> <a>D0! <a>14700.9<cr><lf>	Request TDS measurement only Read TDS

Concurrent Measurement with CRC

<a>CC! <a>0024<cr><lf>

<a>D0! <a> +22.0512+155.0127+155.2155+12.0512 {crc}<cr><lf>

Request all basic measurements with CRC

Read: temperature, conductivity (linear), conductivity (nLFn), pressure

<a>CC1! <a>0021<cr><lf>

<a>D0! <a> +22.0512 {crc} <cr><lf>

Request temperature measurement only

Read temperature

<a>CC2! <a>0021<cr><lf>

<a>D0! <a> +155.0127 {crc} <cr><lf>

Request linear conductivity measurement only

Read linear conductivity

<a>CC3! <a>0021<cr><lf>

<a>D0! <a> +155.0127 {crc} <cr><lf>

Request nLFn conductivity measurement only

Read nLFn conductivity

<a>CC4! <a>0021<cr><lf>

<a>D0! <a> 12.0512 {crc} <cr><lf>

Request pressure measurement only

Read pressure

<a>CC5! <a>0021<cr><lf>

<a>D0! <a> +20.7862 {crc} <cr><lf>

Request salinity measurement only

Read salinity

<a>CC6! <a>0021<cr><lf>

<a>D0! <a> 14700.9 {crc} <cr><lf>

Request TDS measurement only

Read TDS

Desiccant Tubes on Vented Units

On vented sensors, inspect the desiccant tube at least once every two months. The desiccant tube prevents moisture in the air from being sucked into the vent tube, which can cause erratic readings and sensor damage.

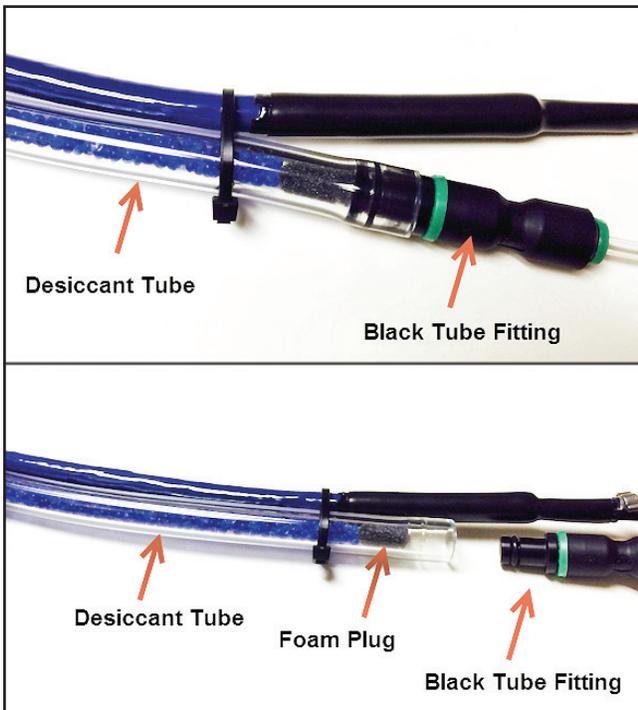
The desiccant tube is filled with blue silica gel beads. A locking barb and a hydrophobic water filter are attached to the end of the desiccant tube. This filter prolongs the life of the desiccant as much as three times over a desiccant tube without the filter.

Install the sensor so that the desiccant tube and cable connector will not flood or lie in water.

The desiccant is a bright blue color when active and dry. As moisture is absorbed the color will begin to fade, becoming a light pink, which indicates full saturation and time to replace. Replacement desiccant and hydrophobic filters can be purchased from Seametrics.

To Change the Desiccant:

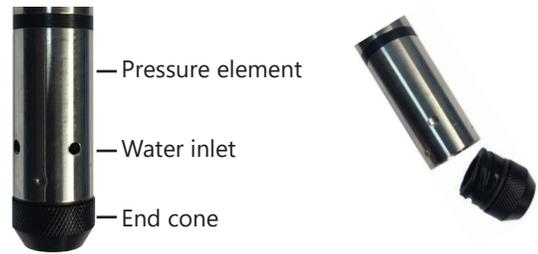
- Pulling gently remove the black tube fitting from the clear desiccant tube.
- Using needle-nose pliers, remove the dark gray foam plug. Do not discard the plug.
- Dump out the old desiccant beads and refill with new desiccant beads – tapping desiccant tube frequently during refilling to ensure that the beads are fully seated in tube.
- Push the foam plug back into the tube.
- Reinsert the black fitting.



Removing Debris from End Cone

At times mud, silt, or other debris may foul the water inlets to the pressure element. The end cone can be removed to clean out the debris.

1. Gently twist off end cone portion only - do not twist off pressure element!
2. Remove debris. **Do not poke anything into the sensor.** This can damage the sensor element and void the warranty.
3. Replace and retighten the end cone.



Gently twist off the end cone and carefully remove debris

Sensor

There are no user-serviceable parts, other than the batteries. If problems develop with sensor stability or accuracy, contact Seametrics. If the transducers 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.

End Connections

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.

Changing Batteries

Battery Type: Two 1.5V AA batteries—Lithium or Alkaline (lithium recommended)



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.



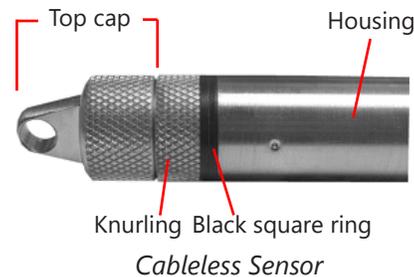
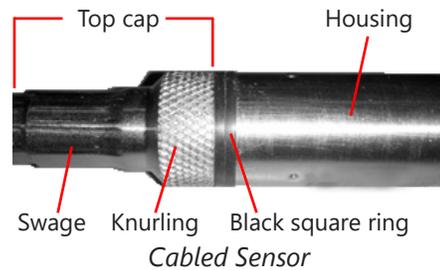
IF USING ALKALINE BATTERIES —PREVENT BATTERY LEAKAGE!
CT2X sensors are typically shipped with lithium batteries. If, however, you are using alkaline batteries, be aware that under some circumstances alkaline batteries can leak, causing damage to the sensor. To prevent leakage, the following is recommended. **(Does not apply to lithium batteries.)**

- Change the batteries at least every 12 months.
- If the sensor will not be deployed for 3 months or more, remove the batteries.

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.**



Battery Life Calculator (Firmware 2.13 or higher)

When changing batteries, it is important to reset the Battery Life Calculator. **If the battery life calculator is not reset, the remaining life information will be incorrect.** Access the Battery Life Calculator from the Configure Menu - Battery Information and Reset. If you have put in new batteries, checkmark the box "I have just put in fresh batteries." Click Save and Close. See sensor settings.

Battery Information

I have just put in fresh batteries

Battery Type

Level 74.0%

Battery Voltage	Last Changed
3.56 V	08-Jun-17

Battery Type: LevelSCOUT/BaroSCOUT Battery

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.**

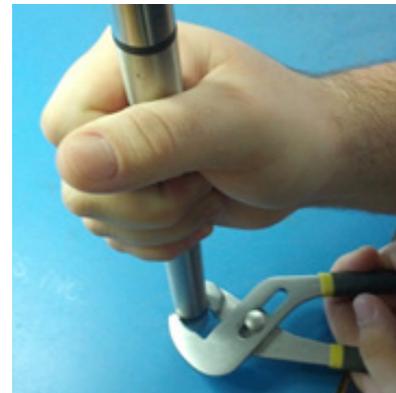


Cabled Sensor

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 Contacts in connector loose SEE ALSO ERRATIC READINGS BELOW	Make sure all cable connections are secure Be sure all wires are securely fastened inside the round connector
Erratic readings	Poor connection due to moisture between contacts in connector Loose or broken wires in connector Damaged cable, cracked or fraying Moisture in the unit Damaged transmitter	Dry thoroughly. Be sure desiccant is fresh (see Maintenance section). Repair or return for evaluation and repair Replace cable Return for evaluation and repair Return for evaluation and repair
Oscillating pressure readings over time (usually 0.5 to 1.5 feet of water)	Plugged vent tube (if using a vented unit) Actual water level changes in the aquifer itself in response to barometric pressure changes. This effect can occur in tight formations where the transmitter will immediately pick up barometric changes but the the aquifer will not.	Be sure desiccant tube is installed. Test by gently applying a small amount of pressure to the end of the desiccant tube and seeing if this affect the transmitter reading. If it does not, then the vent tube is plugged. Return for evaluation and repair. You will need to record barometric pressure as well as the water level pressure and compensate the data
Zero pressure readings when pressurized	Poor connection due to moisture between contacts in connector Loose or broken wires in connector Damaged cable, broken, cracked, or fraying No apparent damage upon visual inspection	Dry thoroughly. Be sure desiccant is fresh (see Maintenance section). Repair or return for evaluation and repair Replace cable Return for evaluation and repair

(Continued on next page)

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Problem	Probable Causes	Things to try...
Conductivity readings erratic or drifting	Poor connection due to moisture between contacts in connector	Dry thoroughly. Be sure desiccant is fresh (see Maintenance section).
	Dirty conductivity element	Clean element
	Out of calibration or improperly calibrated	Recalibrate (see Settings and Calibration section)
	Temperature compensation turned off	In Settings and Calibration section: <ul style="list-style-type: none"> • If using Non-Linear temperature compensation, be sure Non-Linear box is checked • If using normal temperature compensation, be sure that the Temp. Coef. is not set to zero. (2.1 works for a wide variety of fluids). If set to zero, the conductivity readings will vary with temperature.
	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

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**We represent this supplier.
For more information contact
Observator Instruments:**

**T: +31 (0)180 463411
E: info@observator.com**

Rietdekkerstraat 6
2984 BM Ridderkerk
The Netherlands

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