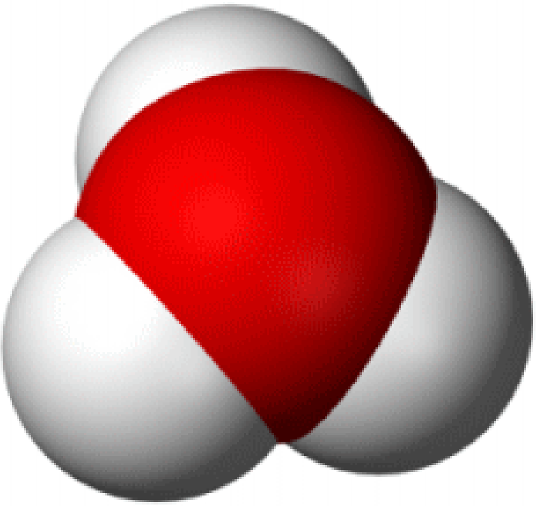
SEA·BIRD SCIENTIFIC

User manual

SeaFET sensor

pH and optional CTD-DO



Document No.	SeaFET170601
Release Date:	2018-03-08
Version:	1
Firmware:	3.6.4
Software:	2.0.0

425-643-9866
seabird.com

Table of Contents

Section 1 Specifications 3
1.1 Mechanical 3
1.1.1 Bulkhead connector 4
1.2 Electrical 4
1.3 Analytical 4
1.4 SBE37 CTD-DO 4

Section 2 Product overview 7
2.1 Sensor components 8
2.1.1 Ion-sensitive field effect transistor (ISFET) 9

Section 3 Set up sensor and verify operation 11
3.1 Install and start software 11
3.2 Verify sensor operation 11
3.2.1 General 12
3.2.2 Display 13
3.2.3 Message logging 14
3.3 Verify sensor collects data 14
3.4 Verify sensor transfers data 15

Section 4 Deployment and recovery 17
4.1 Set clock time 17
4.2 Remove wet cap 17
4.3 Attach anti-fouling guard and deployment cable 18
4.4 Make deployment setup selections 18
4.4.1 General settings 18
4.4.2 Telemetry settings 19
4.4.3 Data processing settings 20
4.4.4 External pump settings 20
4.4.5 Integrate an optional SBE-37 CTD 21
4.5 Make summary report 22
4.6 Real-time data collection 22
4.6.1 Start data collection 22
4.6.2 Look at collected data 22
4.6.3 Save real-time data 23
4.6.4 Configure data file headers 24
4.7 Recover sensor from deployment 24
4.8 Logger-controlled data collection 24

Section 5 Data retrieval and analysis 25
5.1 Process data 25
5.2 Show processed data 27
5.3 Processed data format 28

Section 6 Maintenance 29
6.1 Install wet cap 29
6.2 Clean electrode and sensing element 30
6.3 Remove and replace batteries 30
6.4 Bulkhead connector maintenance 34
6.5 Calibration 35
6.5.1 Manufacturer's calibration 35
6.5.2 Verify calibration 35
6.5.3 SeaFET user calibration 36

Section 7 Troubleshooting 37

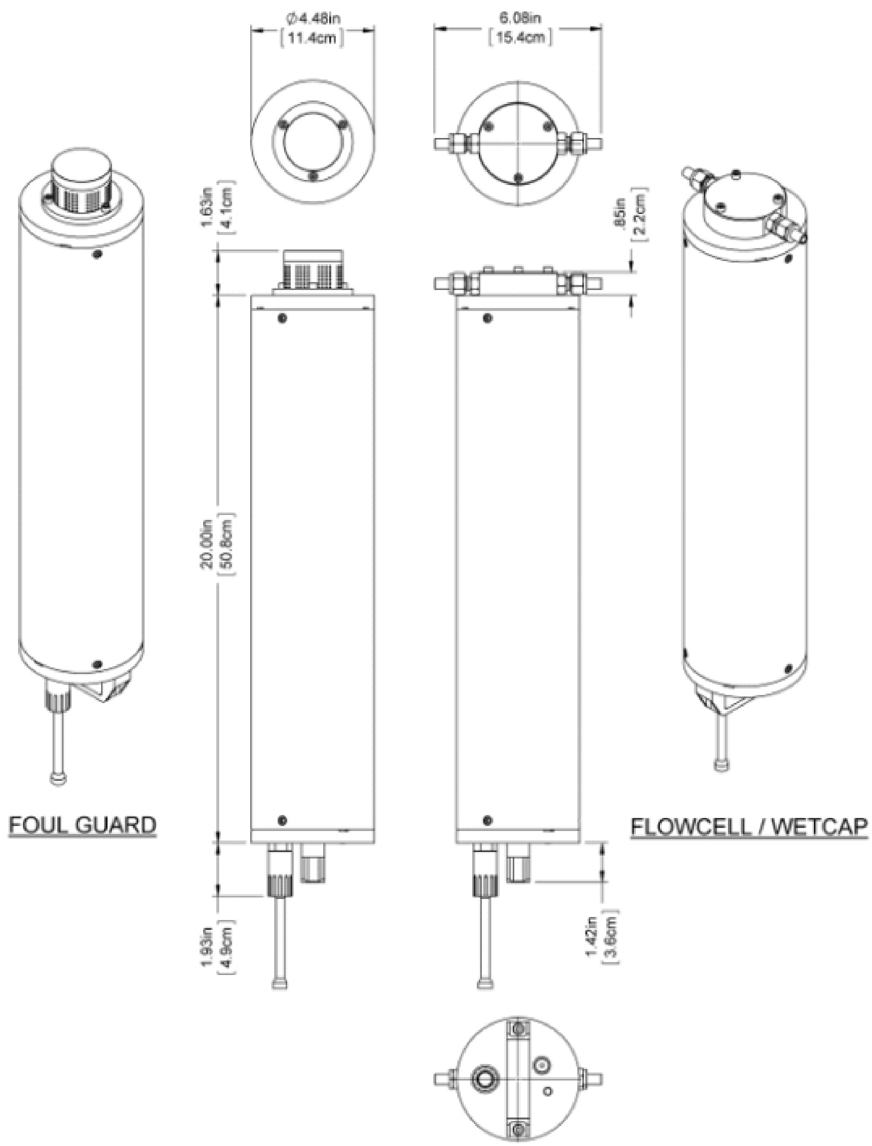
Section 8 Reference 39
8.1 SeaFET data format 39
8.2 CTD data format 40
8.3 Terminal program setup and use 40
8.3.1 Command line operation 41
8.3.1.1 Settings 42
8.3.1.2 Terminal program read-only parameters 43
8.4 Acquisition monitor 43
8.5 Configure data file headers 43
8.6 Deployment considerations 44

Section 1 Specifications

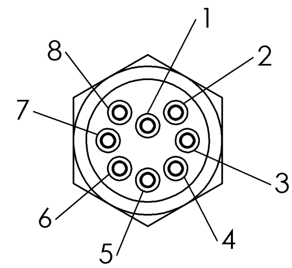
1.1 Mechanical

Rated depth	50 m
Weight in air, water	5.4 kg, 0.1 kg
Length	50.8 cm 4.1 cm (anti-fouling guard) 2.2 cm (flow cell)
Diameter	11.4 cm
Temperature range, operation	0–50 °C
Temperature range, storage	2–55 °C

SeaFET dimensions



1.1.1 Bulkhead connector

Contact	Function	MCBH-8-MP
1	Voltage in	
2	Power supply return-signal ground	
3	USB V in	
4	CTD/pump V in (12 V, 650 mA, optional)	
5	TXD/D+	
6	RXD/D-	
7	CTD TXD (optional)	
8	CTD RXD (optional)	

1.2 Electrical

Input	6–18 VDC
Current draw, operation	main battery: 340–400 mW, isolated battery pack: 10 µA
Current draw, low power	main battery: 70 µA, isolated battery pack: 1.1 mA
Real-time clock drift	2 ppm (0–40 °C)
Communication interface	RS232: 9600–115200 baud, USB: 12 MB/s
Data storage	4 GB (min) (more than 18 million samples)
Data collection rate	to 10 Hz

1.3 Analytical

Measurement range	6.5–9.0 pH
Salinity range	2–40 psu
Accuracy	±0.05 pH
Precision	better than 0.001 pH when averaged
Resolution	0.0001 pH
Stability	0.005 pH/mo

1.4 SBE37 CTD-DO

Optional sensor to integrate with the SeaFET.

	Conductivity	Temperature	Depth	Dissolved Oxygen
Measurement range	0–70 mS/cm	-5–45 °C	20, 100, 350 m	120% surface saturation
Accuracy	0.003 mS/cm/mo	±0.002 °C (-5–35 °C) ±0.01 °C (35–45 °C)	±0.1% full scale range	±0.1 mg/L or ±2%
Resolution	0.0001 mS/cm	0.0001 °C	0.002% full scale range	0.2 µmol/kg
Stability	0.003 mS/cm/mo	0.0002 °C/mo	0.05% full scale range/yr	sample-based drift <1 µmol/kg/100,000 samples @20 °C

Data collection time	2.4–3.2 sec
Current draw	
Input	9–24 VDC
Data storage	xx GB
Weight in air, water	3.4 kg, 1.5 kg

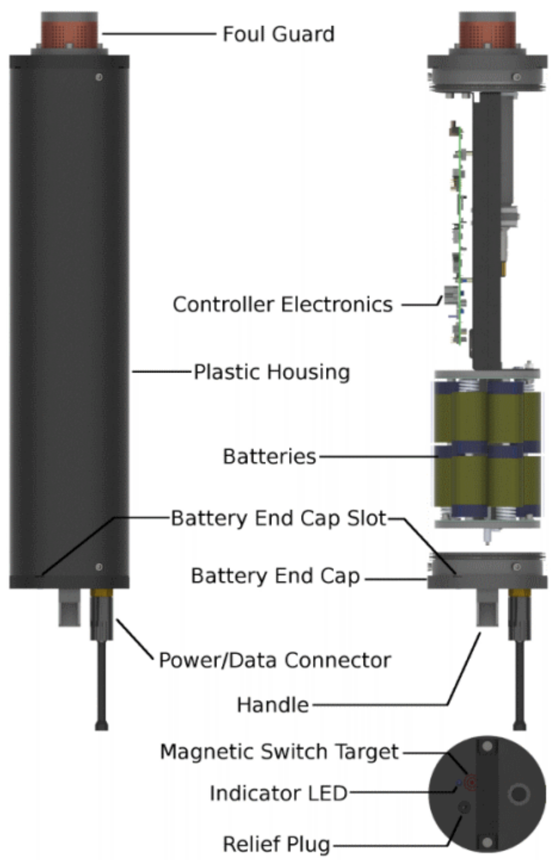
⚠ CAUTION

When sensor is not in use, make sure that the wet cap is in place and is filled with clean seawater. Do not put the sensing elements in fresh water: it may cause data to be unstable and damage to the sensor.

⚠ CAUTION

Do not let the DuraFET KCl gel or the wet cap filling solution freeze. This will damage the DuraFET and void the warranty.

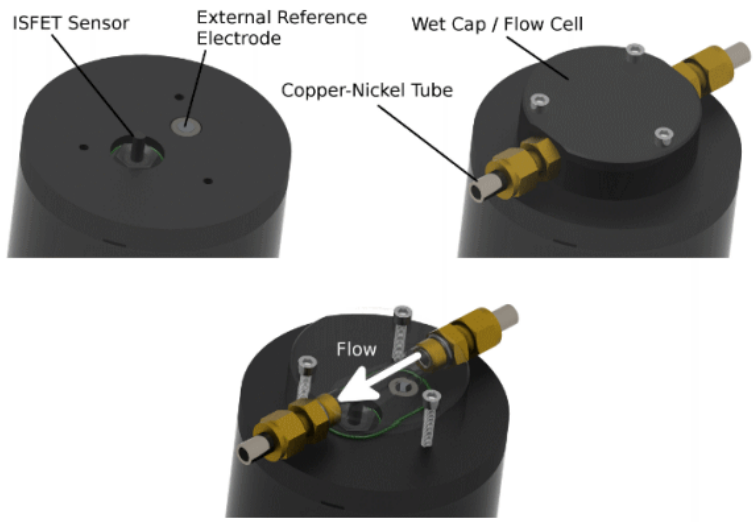
The SeaFET sensor uses ion-sensitive field effect transistor (ISFET) technology to measure pH in marine environments at depths to 50 meters. The sensor stores data and has an internal battery pack so that it can operate autonomously for a long-term deployment.



The SeaFET can attach to an external pump or a Sea-Bird SBE37 CTD. When attached to the CTD, the system operates in SeapHOx mode, which also measures temperature, salinity, oxygen and depth.

The manufacturer-supplied software lets the user set up the sensor, monitor graphical data in real time, and process the collected data.

The end flange with the ISFET sensor and the external reference electrode must be covered with a seawater-filled cap. This cap is also used as a flow cell when the SeaFET is connected to a pump. If the sensor will be completely underwater, attach the copper anti-fouling guard instead.



2.1 Sensor components

⚠ CAUTION

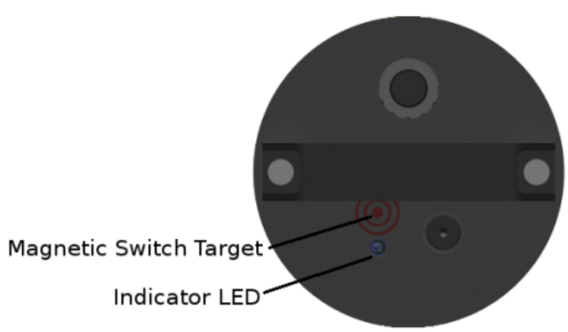
Make sure that the 12 D-cell alkaline batteries are installed and turned on before a deployment, or the collected data will be unusable. Use the software or the magnetic switch to turn on the batteries.

The SeaFET has 12 manufacturer-installed D-cell batteries that are turned on at the magnetic switch or with the software. The LED near the magnetic switch shows the status of various sensor operations.

Table 1 LED status flashes

Green short	- - - - -	Start continuous data collection
Green long	— — — —	Start periodic data collection
Green long, then short	— - — - — -	Start logger-controlled (polled) data collection
Red long	— — — —	Turn off internal batteries

The green short light will flash at regular intervals for the first 24 hours after power is supplied. After that, the light will not flash so that the sensor saves battery power. If the sensor operates in either the periodic or logger-controlled modes, the light will only flash during the data collection event.



To turn on the internal batteries, move the manufacturer-supplied magnet toward the magnetic switch target on the end flange of the sensor.

To turn off the internal batteries, move the magnet to the target, hold for a second, then remove it. The LED flashes red.

The internal batteries are divided into a 12 V main battery pack and a 6 V isolated battery pack. The main battery pack supplies power to the sensor and the isolated battery pack supplies power to the sensing element when the sensor is in a low power "standby" mode.

Power can be supplied to the SeaFET from either the internal batteries or an external power source. The sensor will use an external source when the voltage is at or above 9 volts, but the internal batteries must be installed so that the sensing element has permanent, uninterrupted power. A loss of power to the sensing element requires that it be "re-conditioned," which can take up to 24 hours.

2.1.1 Ion-sensitive field effect transistor (ISFET)

The primary sensor element of the SeaFET is the ISFET, a solid-state sensor with a silver chloride (AgCl) external reference electrode.

External cell

The output from the sensor includes both pHint and pHext values. If the sensor operates correctly, pHint and pHext are similar. If the values are not similar do a calibration verification to determine which is the correct measurement. If the pHint value is out of specification, the potassium chloride (KCl) gel (a consumable component) may be used up and the Durafet® needs to be replaced. If the pHext is out of specification, there may be a problem with the external reference.

Section 3 Set up sensor and verify operation

Make sure that the sensor has new batteries installed or is connected to a power supply (optional) and PC through the RS232 connector on the supplied cable, and is on.

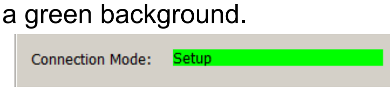
Most PCs no longer have RS232 "COM" ports so an RS232-to-USB converter is necessary. Make sure that the USB driver software is installed on the PC so that there is communication between the sensor and the PC.

3.1 Install and start software

The manufacturer-supplied software communicates with a number of sensors. Refer to the manufacturer's website for the current list of sensors that use this software.

Make sure that the sensor is not connected to the USB port of the PC while the USB-Serial driver is installed. The USB will not function correctly and communication errors will occur.

1. Get the software from manufacturer's website or the manufacturer-supplied CD.
2. Install the appropriate software.
   a. For Windows™: Double-click on the file with ".exe" appended to the name.
   b. For Mac OS X: Double-click on the file with ".pkg" appended to the name. Make sure that the default "Install for all users on this computer" is selected as the destination for the installed software. If "Install for me only" or "Install on a specific disk" is selected, the USB will not connect to the sensor.
3. Push **Run** in the new window.
   The setup wizard starts.
4. Follow the on-screen instructions to install the software.
   - It is only necessary to install the USB-to-Serial driver when the software is first installed.
5. Connect the cable to the bulkhead connector on the sensor and to the PC.
6. If necessary, start the software.
7. Push **Connect** in the Dashboard area.
8. If necessary, change the "Instrument Type" to the connected sensor.
9. Put a check in the "Try All Baud Rates" box.
   The software automatically finds the correct baud rate.
10. If necessary, select the communication port.
11. Push **Connect**.
    The "Connection Mode" shows "Transition" on a yellow background, and then shows "Setup" on a green background.



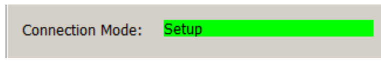
12. Select the **UCI** menu, then *Preferences*.
13. Go to the *General* tab and push **Browse** to find or make the *Default Data Directory* on the PC.
    Data from the sensor is saved here.
14. Push **OK**.

3.2 Verify sensor operation

Do the steps below to make sure that the sensor operates, collects, and transfers data with the settings selected by the user before further setup and deployment.

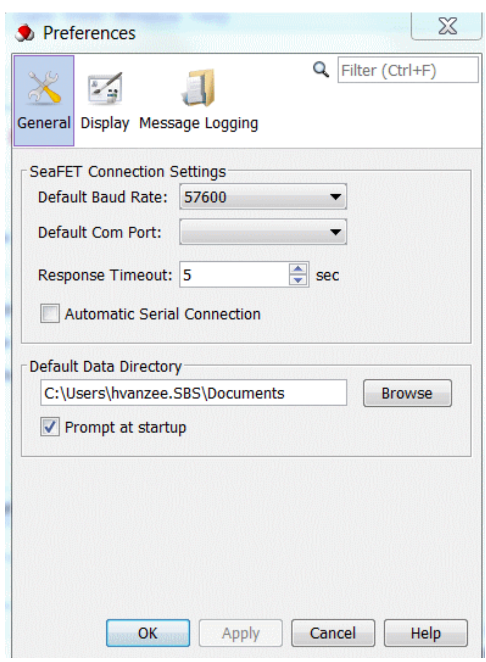
1. Connect the cable to the bulkhead connector on the sensor and to the PC.
2. If necessary, start the software.

3. Push **Connect** in the Dashboard area.
4. If necessary, change the "Instrument Type" to the connected sensor.
5. Put a check in the "Try All Baud Rates" box.
   The software automatically finds the correct baud rate.
6. If necessary, select the communication port.
7. Push **Connect**.
   The "Connection Mode" shows "Transition" on a yellow background, and then shows "Setup" on a green background.



8. For a USB connection: make sure that the internal batteries are sufficient (8 V and 4 V) for deployment and that the batteries are on.
9. Look at the current state of the sensor:
   - if the sensor was not connected to power before the USB cable is connected, it will take 3–5 minutes to start and then connect.
   - if the sensor was connected to power and started, it will take 2–3 seconds to connect.
10. If the internal batteries do not turn on, or the voltage is too low, an "Internal Battery Voltage Too Low" message shows.
    - Connect the USB cable to external power supply and then push Retry.
    - Push Ignore to continue to set up the sensor without the internal battery on.
11. Select the **[Sensor]** menu, then *Preferences*.
12. Go to the *General* tab and push **Browse** to find or make the *Default Data Directory* on the PC.
    Data from the sensor is saved here.
13. Push **OK**.

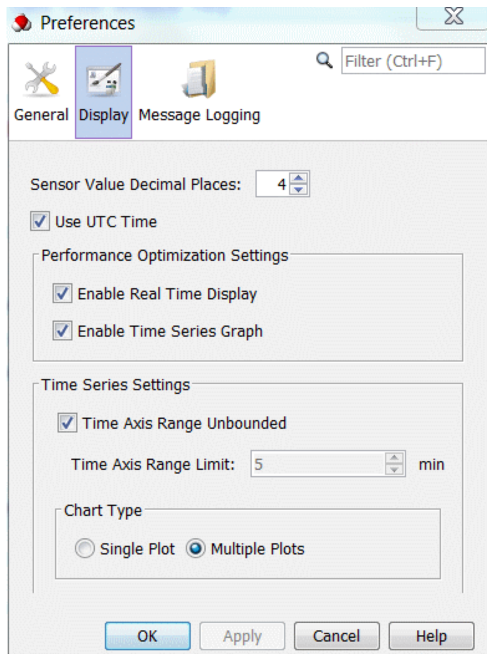
3.2.1 General



1. Select the baud rate for operation. The default is 57600.
2. If necessary, select the Com port. This shows from the PC.

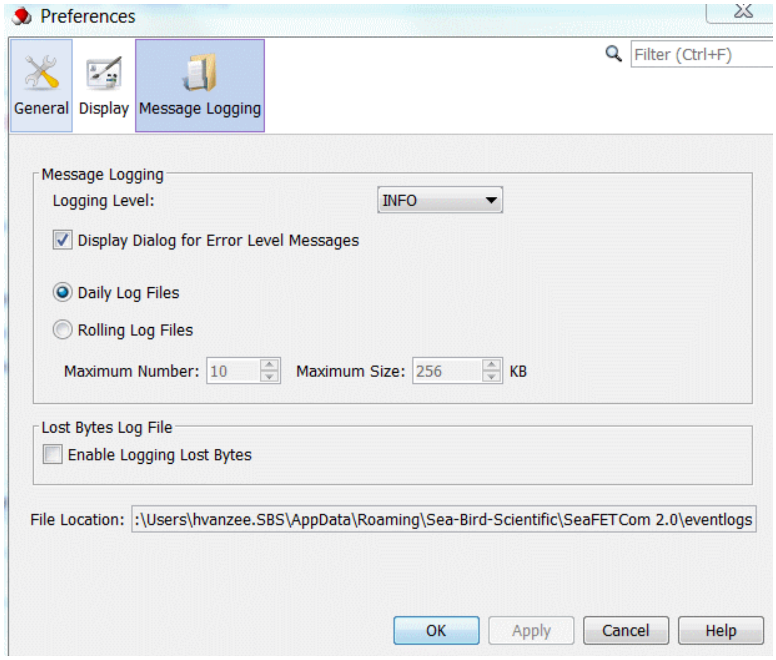
3. Select the number of seconds the software will wait for communication with the sensor. Increase this value if the software and the sensor are not in communication.
4. Put a check in the box at "Automatic Serial Connection" so the software automatically connects to sensor with the default values when the software starts and when the user pushes **Connect**.
5. Push **Browse** to select the directory in which to store the collected data.
6. Put a check in the box at "Prompt at Startup."
   The software lets the user change the directory in which the data is stored every time the software starts.
7. Push **OK** to save the settings.

3.2.2 Display



1. Select the number of decimal places that show in the *Real Time Display* window.
2. Put a check in the box at "Enable Real Time Display" so that the *Real Time Display* window shows the sensor data. Remove the check to increase the speed of a slow PC.
   This does not have an effect on the data that shows in the *Time Series Graph*.
3. Put a check in the box at "Enable Data Acquisition Monitor" so that that window shows. Remove the check to increase the speed of a slow PC.
4. Put a check in the box at "Enable Time Series Graph" so that that window shows. Remove the check to increase the speed of a slow PC.
5. Push **OK** to save the settings.

3.2.3 Message logging

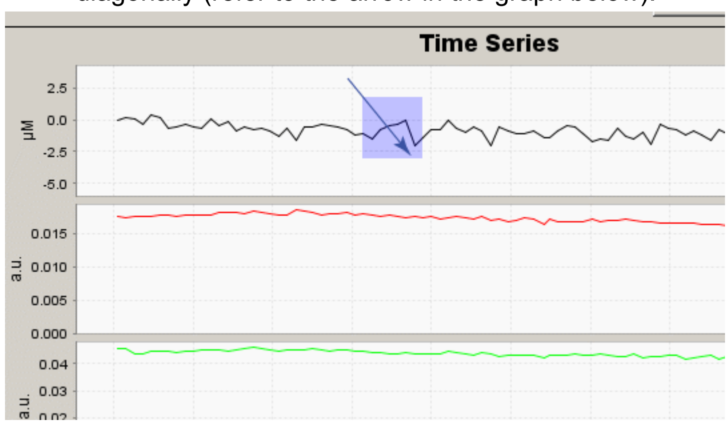


1. Select the level of message to see.
   - TRACE: The most detailed level, used mainly by the manufacturer for troubleshooting.
   - DEBUG: A moderate level of detail, used mainly by support staff at the manufacturer.
   - INFO: Typical level of detail for a deployment. Keeps a log of all high-level operations.
   - WARN: Keeps only warnings within the system. Good for long deployments.
   - ERROR: Keeps only errors that typically need to be examined.
2. Put a check in the box at "Display Dialog for Error Level Messages" to see an alert when an ERROR message is saved.
3. Select "Daily Log Files" to make a new file each day.
4. Select "Rolling Log Files" to store a user-specified "Maximum Number" that is no larger than the "Maximum Size" log files.
5. Put a check in the box at "Enable Logging Lost Bytes" to save extra bytes or incomplete data frames (which are typically discarded) to help with troubleshooting.
6. Push OK to save the settings.

3.3 Verify sensor collects data

1. Push **Start** in the Dashboard area.
   The "Connection Mode" shows "Acquisition."
   - Push **OK** so that the software is "Temporarily enabling Transmit Real Time Setting..." The software shows the data as it is collected in the *Time Series* tab.
   - The **Expected Data Start** window shows "You will see data in approximately *xxx* seconds" and shows an indication of time left. This lets the sensor become stable before it starts to collect data.
2. Push **Select Sensors** in the *Time Series* graph.
3. Put a check in the box next to any additional parameters, so that they will show in the *Time Series* graph.

4. Optional: save data directly to the PC.
   a. Go to the **View** menu and select Data Logging.
   b. Push **Logging Options** to see details in this tab.
   c. Push **Browse** to change the directory to which data is saved on the PC.
   d. Push **Start Logging to File**.
5. Look at the data in the *Time Series* graph. The user can look at data in real-time for each sensor that has power supplied, is connected and is in communication with the software.
   - Put a check in the box next to "Time Axis" to push **Zoom In** and **Zoom Out** to change the scale of time.
   - Put a check in the box next to "Range Axis" to push **Zoom In** and **Zoom Out** to change the scale of the data.
   - To move the data in any direction, push the "Ctrl" key on the PC keyboard and the left button of the mouse pointer at the same time.
   - To select a specific part of the data to zoom in on, pull the mouse pointer diagonally (refer to the arrow in the graph below).



   - Push **Auto Range** to see the data for each selected parameter. The software adjusts the scale so that the data will always show.
   - Push **Default Ranges** to go back to the manufacturer-set default scale for each parameter.
   - Put a check in the box next to "Show Data Points" to see the value of the collected data when the mouse moves over each point.
   - Push **Select Sensors To Display** to change the parameters to look at in the *Time Series* graph.
6. Let the sensor collect data for approximately 5 minutes.
7. Push **Stop** in the Dashboard.
   The "Connection Mode" mode shows "Setup."

3.4 Verify sensor transfers data

⚠ CAUTION

Use only the batteries recommended by the manufacturer as replacements. Do not mix new and used cells or chemistries.

NOTICE

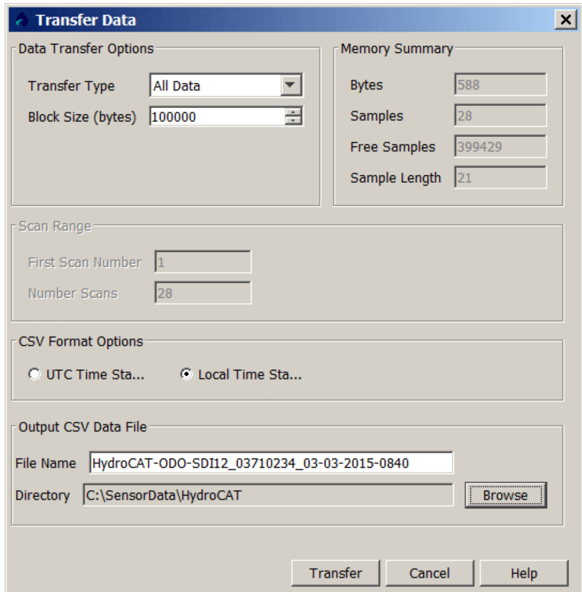
Make sure that the sensor is connected to a power supply or has good batteries installed and is in communication with the software.

1. Push **Transfer Data** in the Dashboard area.

The **Transfer Data** window shows.

- The Memory Summary lets the user estimate the available data storage in the sensor. The "Sample Length" is sensor-specific and shows the length of each data record that the sensor stores. Divide the "Free Samples" by "Sample Length" for an estimate of how many more samples the sensor can store.

2. In the "Transfer Type" drop-down menu in the Data Transfer Options area, select either "All Data" or "Scan Number Range."



- "All Data": all data stored in the sensor is transferred to the PC in both .csv and .xml file types.
- "Scan Number Range": a user-specified range of samples is transferred in both .csv and .xml file types. Select the specific samples in the Scan Range area. Note that the "Number Scans" value is the total number of samples stored in the sensor.

3. In the Output CSV Data File area, type a new filename or use the automatically generated file name.

4. Optional: change the time stamp to UTC.

5. Push **Transfer** to move the data to the PC.

- The default is a check in the box for "Display Data when Transfer Completed." The user can remove the check so that data does not show in the *Time Series* tab after it is saved to the PC.

6. Push **OK** when the **Transfer Progress** window shows 100%.

7. The sensor is ready to set up for a specific deployment.

Section 4 Deployment and recovery

⚠ CAUTION

Make sure that the 12 D-cell alkaline batteries are installed and turned on before a deployment, or the collected data will be unusable. Use the software or the magnetic switch to turn on the batteries.

The manufacturer recommends that the user deploys the sensor horizontally. If the sensor is deployed vertically and the sensing elements face down, bubbles may collect on them. If the sensing elements face up, particles may collect on them. Either condition can compromise the collected data. The sensing elements are sensitive to light, and this exposure will also compromise data.

Make sure to validate the performance of the sensor while it is deployed: stagnant water is a challenge for many potentiometric sensors. Where possible, collect samples of the water near the sensor at the start of a deployment and at the end.

To prepare the sensor for deployment—

1. Make sure that the batteries are installed and turned on.
2. Remove the wet cap that the sensor is shipped or stored with.
3. Install the anti-fouling guard and connect the deployment cable.
4. Make sure that the sensor is connected to the software and PC and has power supplied.
5. Select the **Sensor** menu, then *Settings* and change the settings in each of the *General*, *Telemetry*, *Processing*, and *External Pump* tabs for the applicable deployment.

4.1 Set clock time

The sensor uses an internal clock to apply date- and time-stamps to collected data and to schedule sensor activity. Set the internal clock of the sensor so that it is aligned with the PC. Note that the sensor clock is always set to Coordinated Universal Time (UTC). To change this, go to the **Preferences** menu, then *Display*, and remove the check in the box next to "Use UTC Time."

1. Make sure that the sensor is connected to a PC and has power supplied to it.
2. If necessary, start the software.
3. Select **Sensor**, *Set Clock* from the main menu.
4. Push **Synch Time** to align the sensor clock with the clock of the PC.

4.2 Remove wet cap

1. If necessary, unplug the cable from the sensor.
2. Remove the two stainless steel plugs from the wet cap. Keep them for future use.
3. Put the sensor over a sink or bucket and empty the solution of artificial seawater from the wet cap.
4. Put the sensor upright again.
5. Use a 5/32" hex key to remove the three 10-32 x 5/8" socket head cap screws from the wet cap. Keep the screws to use with the anti-fouling guard.
6. Remove the wet cap. Keep the O-ring for future use.
7. Use a clean dry cloth to clean the sensor and the wet cap of any artificial seawater.
8. Make sure to keep the wet cap, O-rings and stainless steel plugs for future use.

4.3 Attach anti-fouling guard and deployment cable

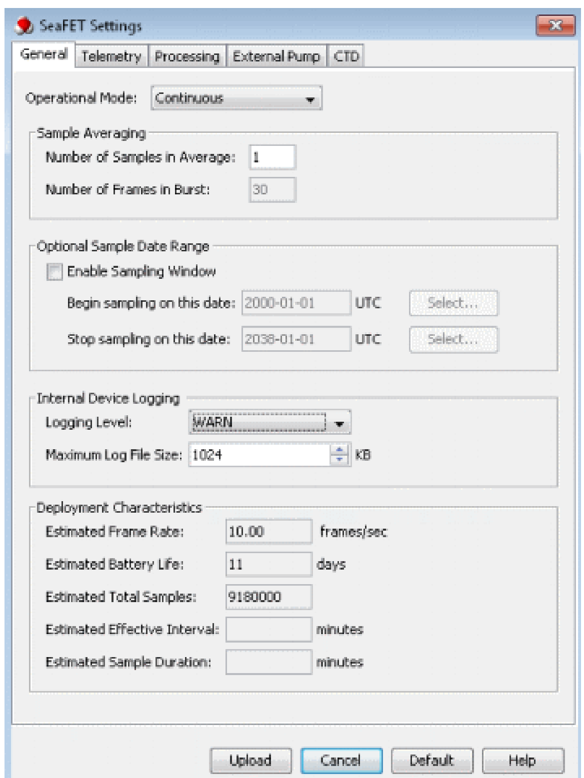
1. Put the sensor on a flat surface with the external reference electrode end flange face up.
2. Put the anti-fouling guard over the ISFET and external reference electrode.
3. Use a 5/32" hex key to install the three 10-32 x 5/8" socket head cap screws that secured the wet cap. Make sure to tighten completely.
4. If necessary, disconnect the test cable from the sensor and connect the deployment cable. If the sensor is to be deployed autonomously, attach the dummy plug and lock collar onto the connector.

4.4 Make deployment setup selections

4.4.1 General settings

The user can operate the sensor in a Continuous, Logger-controlled (polled), or Periodic mode.

- Continuous: The sensor collects data continuously until the power is turned off or the user sends a "$" command and the sensor enters the Setup mode.
- Logger-controlled: The sensor collects data each time a controller such as a buoy, CTD-bearing serial port, STOR-X, etc. sends a character on the telemetry port.
- Periodic: The sensor collects data at a user-specified sample interval, for example, once per hour.



Sample Averaging

"Number of Samples in Average:" Enter the number of pH measurements that are averaged into a data frame.

"Number of Frames in Burst:" Enter the number of data frames in a "burst" of data frames.

Optional Sample Date Range (not available in Logger-controlled mode)

Put a check in the "Enable Sampling Window" box to specify when data collection starts and stops.

Internal Device Logging

The sensor keeps a file of information about its performance and the user can select the level of detail to be saved. Levels are cumulative. For instance, INFO includes WARN and ERROR levels.

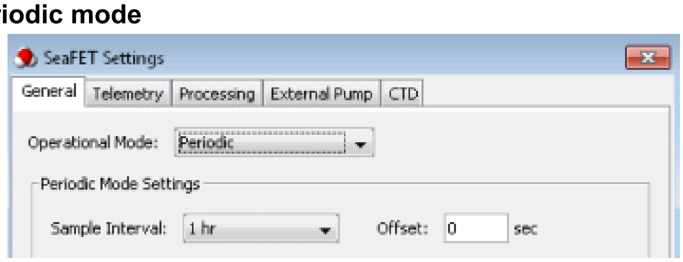
- DEBUG: The most detailed level, used mainly by the manufacturer for troubleshooting.
- INFO: Typical level of detail for a deployment. Keeps a log of all high-level operations.
- WARN: Keeps only warnings within the system. Good for long deployments.
- ERROR: Keeps only errors that typically need to be examined.

These files are saved as MESSAGES.LOG until they are at the maximum size specified in the "Maximum Log File Size" box. The first file is backed up as MSG_OLD.LOG and MESSAGES.LOG is overwritten.

Deployment Characteristics

- "Estimated Frame Rate:" The frame rate, the data that is output from the sensor per second. Frame rate is inversely proportional to the "number of samples in average."
- "Estimated Battery Life:" Related to the nominal battery capacity, the number of data collection events and the duration of each event.
- "Estimated Total Samples:" Related to the frame rate, the number of data collection events, and the duration of each event.
- "Estimated Effective Interval:" Periodic mode only. Related to the "Sample Interval" setting except when the "Estimated Sample Duration" is longer than the specified "Sample Interval."
- "Estimated Sample Duration:" Periodic mode only. Related to the "Number of Samples in Average" and the "Number of Frames in Burst" settings.

Periodic mode



"Sample Interval": Enter the interval between data collection events. For example, 6 hours is four intervals that are each 6 hours long, starting at 00:00, 06:00, 12:00, and 18:00. The user can specify a delay, or offset, to the start time: a delay of 300 sec. (5 min.) changes the start time to 00:05, 06:05, 12:05, 18:05.

4.4.2 Telemetry settings

Data Transmission

"Serial Baud Rate:"Select the baud rate. The default is 57600.

"Transmitted Frame Format:" The format of the data sent from the sensor. Refer to SeaFET data format on page 39 section for details on FULL_ASCII, SHORT_ASCII, and NONE.

"Transmit Diagnostic Messages:" For troubleshooting. This must be turned off during normal operation. A check in this box will cause the sensor to send diagnostic messages. The message level is selected in the *General* tab of the *Settings*.

Data Logging

"Instrument Logging Frame Format:" The format of the data saved in the sensor (FULL_ASCII, SHORT_ASCII, NONE).

"Log File Creation Method:" Select when the sensor starts a new file to save data internally.

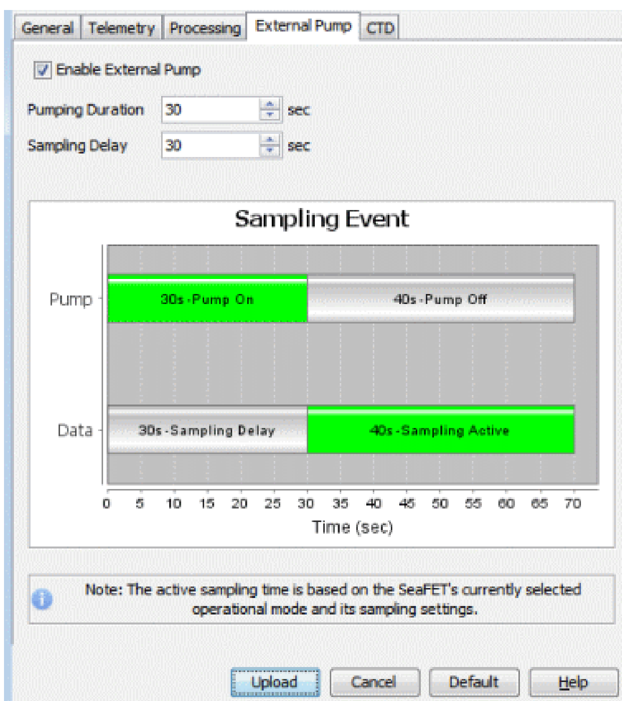
- Daily—a new file starts every day at 00:00:00 UTC.
- By Sample Event—a new file starts for each data collection event.
- By File Size—a new file starts when the current file reaches the user-specified maximum size.

4.4.3 Data processing settings

The sensor calculates pH values for both internal and external sensors for each measurement collected. To calculate pH, the sensor applies the manufacturer's calibration coefficients, temperature values from the on-board thermistor, and a user-specified salinity value that approximates the salinity of the water being measured. To adjust the salinity value, Select the **Sensor** menu, then *Settings*, then the *Processing* tab. Enter the salinity value and push **Upload** to send it to the sensor.

4.4.4 External pump settings

The SeaFET can be integrated with an external pump and is typically set up so that the pump operates before or during data collection. Use the software to set up an external pump for a specific application. Note that operation of the pump increases the current draw of the sensor. The manufacturer recommends the Sea-Bird 5P pump. Make sure that the power to the pump can be supplied from a 12V source, that it will not draw more than 650 mA continuously, and that there is sufficient flow for the sensor.



1. Put a check in the "Enable External Pump" checkbox to enable the sensor to use an external pump.
2. Enter the "Pumping Duration" time. This is the time that the pump operates. Note that when the pump is set up to operate during data collection, it will operate until the data collection is complete.
3. Enter "Sampling Delay" time. This is the time between when a data collection event starts and when the actual data collection starts. If the "Sampling Delay" value is

greater than the value entered in "Pumping Duration," the pump will operate, wait, then collect data with the pump off.

4. Push **Upload** to send these settings to the sensor.

The "Sampling Event" area shows the time that the pump is turned off and on and when data collection starts and stops during a single data collection period.

4.4.5 Integrate an optional SBE-37 CTD

⚠ CAUTION

Set up the CTD to operate with the SeaFET before it is integrated with the SeaFET or the result may be invalid data. Do a pre-deployment test to make sure that the SeaFET communicates with the CTD and the data is processed correctly.

The SeaFET can be integrated with an SBE-37 CTD with dissolved oxygen (DO) measurement capabilities in *SeapHOx* mode to get real-time temperature and salinity corrections and to collect data about oxygen concentration in any mode (logger-controlled, periodic, or continuous). The SeaFET polls the CTD for data at regular intervals to calculate pH. Note that it usually takes approximately 40 seconds for the CTD to collect data that the SeaFET can use because the pump in the CTD must operate. Pump operation will also increase power consumption.

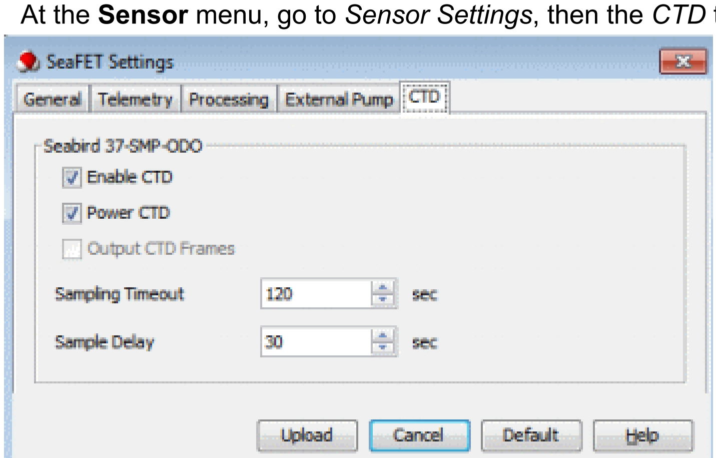
Configure the CTD

Use the commands below in a terminal program such as HyperTerminal® or Tera Term to make sure that the CTD operates with the SeaFET. Refer to Terminal program setup and use on page 40 for details.

- Set the baud rate: BaudRate=9600
- Set the output format: OutputFormat=2
- Turn on temperature output: OutputTemp=Y
- Turn on salinity output: OutputSal=Y
- Turn on oxygen output: OutputOx=Y
- Turn on pressure output: OutputPress=Y
- Set output units: SetCoastal=0
- Set up pump operation: AdaptivePumpControl=N, OxNTau=7

Refer to Bulkhead connector on page 4 for pinout functions to integrate CTDs. If the SeaFET is to supply power to the CTD, the CTD V+ line is connected to the CTD power input line.

1. At the **Sensor** menu, go to *Sensor Settings*, then the *CTD* tab.



2. Put a check in the "Enable CD" box to enable the SeaFET to control the CTD.
3. Put a check in the "Power CTD" box to enable the supply of power to the CTD by the SeaFET.

4. Put a check in the "Output CTD Frames" box to enable the data from the CTD by the SeaFET.
5. Enter a time (in seconds) in the "Sampling Timeout" box for the SeaFET to wait to receive data from the CTD.
6. Enter a time in the "Sample Delay" box for the SeaFET to delay the ISFET parameters (pH, ISFET, temperature, etc.) after a data collection event starts.
   - Use this setting to let the samples become stable after the CTD pump operates and before the SeaFET starts data collection, approximately 40 seconds. This setting is ignored for "Continuous" mode and when an external pump is enabled.

4.5 Make summary report

The user can make a summary report about the status of the sensor at regular intervals or before deployments.

1. If necessary, connect the sensor to the PC and start the software.
2. Select **Sensor** at the main menu, then *Summary Report*.
3. Enter the "Operator Name" and any "Summary Report Comments."
4. Put a check in the "View Report" checkbox to see the report in the default .pdf software on the PC.
5. To change the directory in which the summary is saved, push **Browse**.

4.6 Real-time data collection

Real-time data collection is only possible when the sensor is configured to operate in *Continuous* or *Periodic* mode.

4.6.1 Start data collection

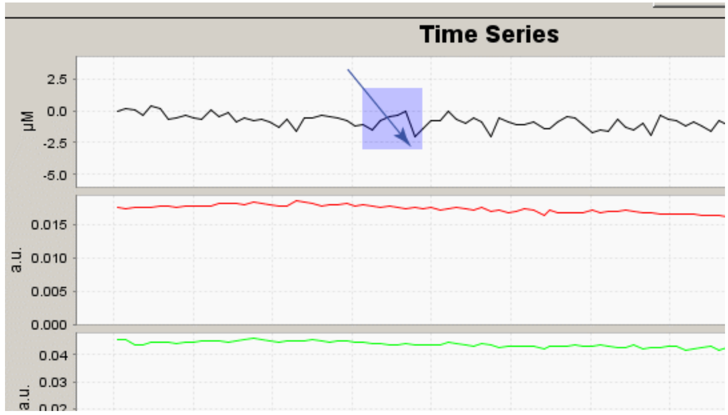
1. Make sure that the sensor has power supplied and is connected to the software.
2. Make sure that the *Operational Mode* from the **Settings** menu is set to *Continuous* (or *Periodic* for pre-deployment tests).
3. Make sure that *Transmitted Frame Format* is set to FULL_ASCII.
4. Push **Start**.
   - *Continuous* mode: The sensor collects data until the user pushes **Stop**.
   - *Periodic* mode: A new window opens that shows the clock time of the sensor and the start time of the next data collection event. Each event is based on the burst setting, the number of frames of collected data that is output by the sensor.

4.6.2 Look at collected data

The user can monitor data in the *Real Time Data* or the *Time Series* graph. Information about the data, such error statistics, shows in the *Acquisition Monitor*, and the collected data is saved to a file on the sensor.

1. The *Real Time* display is continuously updated to show the most recent data collected by the sensor.
2. Look at the data in the *Time Series* graph. The user can look at data in real-time for each sensor that has power supplied, is connected and is in communication with the software.
   - Put a check in the box next to "Time Axis" to push **Zoom In** and **Zoom Out** to change the scale of time.
   - Put a check in the box next to "Range Axis" to push **Zoom In** and **Zoom Out** to change the scale of the data.

- To move the data in any direction, push the "Ctrl" key on the PC keyboard and the left button of the mouse pointer at the same time.
- To select a specific part of the data to zoom in on, pull the mouse pointer diagonally (refer to the arrow in the graph below).



- Push **Auto Range** to see the data for each selected parameter. The software adjusts the scale so that the data will always show.
- Push **Default Ranges** to go back to the manufacturer-set default scale for each parameter.
- Put a check in the box next to "Show Data Points" to see the value of the collected data when the mouse moves over each point.
- Push **Select Sensors To Display** to change the parameters to look at in the *Time Series* graph.

3. Select the **View** menu, then *Acquisition Monitor* (or push **Error Details** on the *Real Time Data* window.
Use this window to see when and why there are errors in the data.

- Frame ID—Unique identifier of the frame in the sensor definition.
- Read—Number of valid frames that were read during data collection for a particular frame.
- Errors—Number of frames that were read that had errors during data collection for a particular frame.
- Checksum errors—Number of frames that had checksum errors. Typically discarded.
- Counter errors—Number of frames that had counter errors. Typically not discarded.
- Status errors—Number of frames that had status errors. Typically discarded.
- Fitting errors—Number of frames that had fitting errors. Typically discarded.

4.6.3 Save real-time data

The sensor has sufficient internal memory to save months or even years of data. For tethered operation such as profiling or a pre-deployment test, the user can set up the software to save data as it is transmitted from the sensor.

1. Make sure that the sensor is connected to the software.
2. In the *Settings* window, set the mode of operation to *Continuous*.
3. Push **Start**.
4. From the main menu, select **View**, then *Data Logging*.
5. Push **Start Log**.
The PC starts to save the data collected by the sensor.

   - To enable "Auto Log Duration," put a check in the box and specify a time to stop the data from being saved.

- To enable "Repeat Auto Log after Interval," put a check in the box and specify a time interval after which the data will be saved.

6. To stop data from being saved to the PC, push **Stop Log**.

4.6.4 Configure data file headers

The user can add custom headers to data files in addition to the default OPERATOR, EXPERIMENT, and COMMENT static headers.

1. Select the **Sensor** menu, then *Advanced*, then *Data Log Header*.
2. Push **Add**
3. Double-click the HEADER_ID row to enter a custom header.
4. Push **OK**.
5. To remove a custom header, select the row to remove and push **Remove**.
6. Put a check in the "Prompt" box so that the software will ask for input of the header record values whenever data collection is started.

4.7 Recover sensor from deployment

⚠ CAUTION
Do not let the sensing elements get dry. If the sensor will not be deployed immediately, put the wet cap in place and fill with artificial seawater.

NOTICE
The sensing element requires continuous current flow for measurement stability. To save battery power, put the sensor into a "Polled" operation mode or turn off the battery pack with the magnetic switch or through the software. Note that it may take up to 24 hours for the sensor to stabilize after power is supplied again.

To put the sensor in a low-power "standby" mode so that warm-up time is not required, connect to the software push **Settings**. Select "Polled" mode, then push **Disconnect**.

Examine the sensor

Make sure that the sensing elements are protected at all times. The anti-fouling guard or the wet cap must be installed on the sensor and filled with artificial seawater.

Look at the sensing elements. Clean them if there are any particulates near them or the ISFET. Look at the ceramic frit at the base of the ISFET: it should be white or off-white. Refer to Clean electrode and sensing element on page 30 for procedures to clean the sensing elements.

4.8 Logger-controlled data collection

In this mode the sensor is controlled by a master system controller such as a buoy controller, CTD with a serial port, or STOR-X.

1. Make sure that the sensor is connected to and in communication with the controller.
2. Make sure that the *Operational Mode* from the **Settings** menu is set to *Polled*.
3. Set the *Transmitted Frame Format* to FULL_ASCII.

The sensor collects data at user-specified intervals and goes into a low power "sleep" mode between events. To operate the sensor manually, send any character on the telemetry line and wait for 3 seconds for the sensor to come into standby mode. The user has 5 seconds to send an "s" character so that the sensor starts a new sample. The sensor will send an "s" character back and then one or more frames of data. When the data collection is complete, or if no "s" command is received, the sensor goes back into a low-power mode.

Section 5 Data retrieval and analysis

The sensor can save and send data at the same time. The user can configure the sensor to send short frames and store long frames, or vice versa.

The fastest way to transfer a large number of files from the sensor is to use the USB mass storage interface. This interface is read-only. To erase files from the sensor, use the file manager in the sensor software.

1. Connect the USB programming cable to the sensor and the PC.
2. Find the sensor's drive on the desktop of the PC or use the file explorer.
3. Select the files to transfer from the sensor's drive.
4. Copy-paste or drag-drop the selected files to a folder on the PC.

The user can also use the File Manager in the software to transfer files. Refer to Verify sensor transfers data on page 15 for details.

Data file structure

There are three types of rules used to create the data files stored in the DATA directory.

- By file size—Data is stored in a single file until the file size is at a user-specified limit ("datasize" setting).
- By data collection event—A new file is made for each event. The files are named incrementally from "A0000000.csv" to "A9999999.csv."
- By day—The sensor makes one file per day, named "yydddnnn.csv" where "yy" is the year, "ddd" is the day of the year, and "nnn" is the sequence number. A file is made on a given day only if a data collection event occurs.

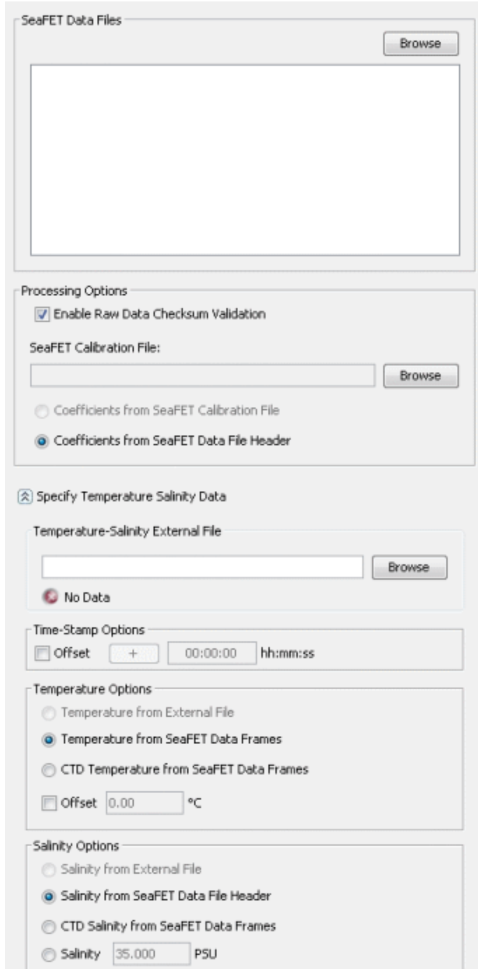
Changes to any settings that have an effect on how data is processed (for example, the number of samples to calculate an average) and will cause the log file name to change in increments of one.

System message files

The system message files contain system log information to diagnose problems if the sensor fails. These files are stored in the LOG directory.

5.1 Process data

Use the *Data Processing Panel* in the software to process data files that have been transferred to the PC. The user can add temperature and salinity measurements to calculate a more accurate pH value than that from the SeaFET sensor, which uses an internal thermistor and a fixed salinity value.



SeaFET Data Files

1. Select **Data**, then *SeaFET Data Processing* from the main menu.
2. Push **Browse** to find and select one or more raw files to put in the SeaFET Data Files list. There are several ways to change which files are selected:
   - Select one file. All others are de-selected.
   - Hold **Ctrl** and select a file to change whether it is selected or de-selected. The other files that are already selected will not change.
   - Hold **Shift** and select a file to select a range of files.
   - Hold **Ctrl** and **Shift** to select a range of files. The other files that are already selected will not change.
   - Use the "up" and "down" arrow keys instead of a mouse.

Processing Options

1. Select "Coefficients from SeaFET Data File Header" to automatically apply calibration coefficients from the data file headers.
2. Push **Browse** to find the file with the coefficients from an external sensor, then select "Coefficients from SeaFET Calibration File."

Specify Temperature Salinity Data

Select "No Data" if there is no external temperature and salinity data.

Push **Browse** to find the file with the temperature and salinity data from an external sensor. The software uses this data in one of two formats:

A generic .CSV format, YYYY-MM-DD hh:mm:ss, <temperature>, <salinity><CR><LF>, where:

- date and time is UTC when the data was collected
- temperature is in C°, floating point format
- <salinity is in PSU, in floating point format
- <CR><LF> is the carriage return and line feed that is the end of the line, or row, of data.

For example—

- 2013-04-25 15:22:48, 10.8326,34.8974

Sea-Bird Electronics .CNV format as made from the *SBE Data Processing* software application. Convert CTD data so that the SeaFET software can read it:

1. Copy the .hex and .xmlcon files from the CTD to the SBE Data Processing directory.
2. Select **Run** from the main menu, then *Data Conversion*.
3. In the *File Setup* tab, select the .hex and .xmlcon files to convert.
4. Go to the *Data Setup* tab. Push **Select Output Variables**.
5. In the Select Output Variables area, add the fields below in order:
   a. Time, sensor (seconds)
   b. Temperature (degrees C)
   c. Salinity, practical (PSU)
6. Push **Start Process**. The software makes a .cnv file.

The data looks similar to the example below:

388682568 10.8326 34.8974 0.000e+00

388682574 10.8547 34.8950 0.000e+00

Time-stamp Options

Put a check in the "Offset" option to specify a positive or negative time offset for the external temperature and salinity data. This will adjust for clock or time zone differences between the two sensors.

Temperature Options

Select one of the options for the source of temperature data for the SeaFET to process:

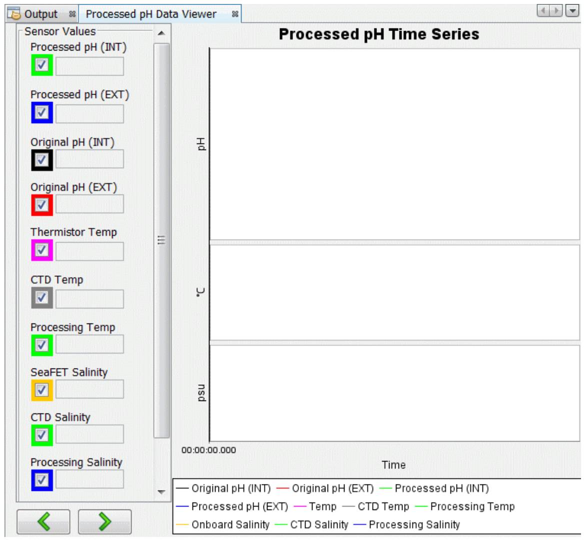
- "Temperature from External File"—values from an external sensor.
- "Temperature from SeaFET Data Frames"—values from the internal thermistor.
- "CTD Temperature form SeaFET Data Frames"—values from the data frames of the SeaFET from an attached CTD.
- Put a check in the "Offset" box and enter a value to apply to the temperature. The value can be from an external file, from the SeaFET, or from a CTD.

Salinity Options

Refer to Temperature Options, above.

5.2 Show processed data

The processed data shows in *Time Series* graph of the software.



Click on the graph to get a marker to see the data from all plots. These show in the "Sensor Values" on the left side of the tab and change as the user moves the marker.

5.3 Processed data format

Data is saved on the PC in time-stamped files that have log file headers with information about the how the files were made and processed.

1. Select **Data** from the main menu, then *SeaFET Data Processing*.
2. In the "Output Data Files" area, push **Browse** to select a directory on the PC in which to save the processed data.
3. Push **Process Selected File(s)**.

The data fields are shown below.

In the "Format" field:

- AI = ASCII Integer. Example: 246.
- AF = ASCII Float. Example: -0.832034.
- AS = ASCII String. Example: SATPHA0001.

Field name	Format	Description
Header	AS 10	Frame header starts with SAT for a Satlantic sensor. The next three characters are the processed "PHP." The last four characters are the serial number of the sensor.
Date	AI	Date from the raw data file: YYYYDDD e.g. 2016046
Time	AF	Time from the raw data file: decimal hours e.g. 16.4261
Internal pH	AF	Original internal pH calculated by the sensor
External pH	AF	Original external pH calculated by the sensor
Temperature	AF	Original temperature calculated by the sensor
Processed internal pH	AF	Internal pH calculated by the software
Processed external pH	AF	External pH calculated by the software
Processing temperature	AF	Temperature (°C) used to process the raw data from the sensor
Processing salinity	AF	Salinity (PSU) used to process the raw data from the sensor
Processing status	AI	Status of the processed values (0 = no error)
Check sum	AI	Accuracy byte frame check sum

Section 6 Maintenance

⚠ CAUTION

When sensor is not in use, make sure that the wet cap is in place and is filled with clean seawater. Do not put the sensing elements in fresh water: it may cause data to be unstable and damage to the sensor.

⚠ CAUTION

Do not use high-purity water such as Milli-Q on the sensor. The manufacturer recommends clean tap water over DI water.

⚠ CAUTION

Do not leave the sensor in direct sun. Heat over 35 °C can cause damage to the sensor.

⚠ CAUTION

Do not touch the sensing elements. They are sensitive to electrostatic discharge (ESD).

⚠ CAUTION

Do not let the sensor come in contact with solutions that do not contain bromide (and NIST-type buffers). This can void the calibration.

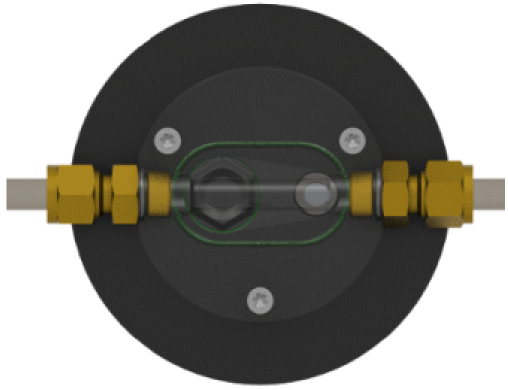
⚠ CAUTION

Use only the batteries recommended by the manufacturer as replacements. Do not mix new and used cells or chemistries.

6.1 Install wet cap

The wet cap is filled with UV-sterilized artificial seawater that has a salinity equivalent to 35 ppt. The sensing element and reference electrodes **must** be kept wet with either the anti-fouling guard or the wet cap, even if the sensor is out of service for a few minutes.

1. Put the sensor on a flat surface.
2. Remove the anti-fouling guard:
   a. Use a 5/32" hex key to remove the three 10-32 x 5/8" socket head cap screws. Keep the screws to use with the wet cap.
   b. Remove the anti-fouling guard from the sensor.
3. Put the wet cap O-ring into the groove at the bottom of the cap. Make sure that the O-ring is not twisted or pinched. Do not use O-ring grease near the sensing element and reference electrode.
4. Put the wet cap over the element and electrode. Make sure that the O-ring touches the face of the end flange.
5. If the wet cap will be used as a flow cell, make sure it is installed in the orientation below so that sufficient water flows through the sensing elements.



6. Use the three 10-32 x 5/8" socket head cap screws to secure the wet cap to the end flange.
7. If necessary, remove the plugs and fill the wet cap with sterilized artificial seawater.
8. Insert the plugs again.
    a. Make sure they are sealed.
    b. If necessary, empty a small amount of water to insert the last plug.
9. Clean the sensor housing and wet cap with a clean lint-free wipe.

6.2 Clean electrode and sensing element

Clean the sensing surfaces after a deployment and before the sensor is put in storage.

1. Remove the wet cap or anti-fouling guard that is attached to the sensor.
2. Flush the electrodes with warm tap water to remove particulates.
3. To remove other types of fouling:
    a. Use a household cleaner such as Joy® or Windex® or a laboratory soap such as Sparkleen® or Detergent 8® to remove oily deposits.
    b. Use diluted hydrochloric acid to remove mineral deposits. Rinse thoroughly with artificial seawater or tap water.
4. Use lint-free wipes or cotton swabs to gently dry the sensing elements.
5. Polish the external reference electrode for approximately 30 seconds at regular intervals with the manufacturer-supplied polishing film.

6.3 Remove and replace batteries

Replace the batteries in the sensor when necessary. Use the sensor *Dashboard* in the software to see what the battery voltage is.

Table 2 Required tools and supplies

8/32" thumb screw	flat head screwdriver
5/32" hex wrench	2 new desiccant packs or sealable plastic bag to store the packs removed from the sensor
1/4" socket driver	12 new alkaline D-cell batteries

1. Make sure that the wet cap or anti-fouling guard is attached to the sensing elements.
2. Remove the vent plug:
    a. Put the sensor on its side on a flat surface.
    b. Put the 8/32" thumb screw into the center thread of the vent plug.
    c. Pull on the thumb screw until it does not come out any further.

3. Use a 5/32" hex wrench to remove the three 10-31 x 3/8" screws from the battery end flange.

4. Insert a flat head screwdriver into the slot between the pressure housing and the end flange.

5. Loosen the end flange with the screwdriver until the end flange can be pulled from the pressure housing with one hand.
   A safety line attaches the end flange to the battery plate to keep the battery connector wires attached.

6. Press the locking tab on the white end flange connector to disconnect and gently pull it out.
7. Remove the desiccant packs and put them in a sealed bag.
8. Remove the two ¼" nuts that hold the battery plate:

- When batteries are installed, the battery plate compresses six springs that hold the batteries. Make sure to loosen the nuts equally—loosen one a few turns, then the other—so that the battery plate does not lock.

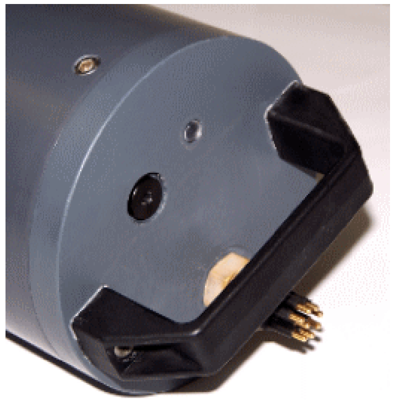
9. Remove the batteries.
10. Follow the polarity labels and put in new batteries.

- Change all of the batteries. Do not mix used and new cells.
- Do not mix battery chemistries. The manufacturer recommends industrial 1.5V alkaline D-cells.

11. Examine, clean, and if necessary, lubricate the O-rings on the end flange.
12. Examine and clean the surface on the inside of the battery compartment where the O-rings sit.
13. Replace the desiccant packs.

The old ones can be used again, but the manufacturer recommends that the user install new packs.

14. Put the battery plate into position and tighten the two nuts equally until the battery plate is flush with the white connector.
15. Connect the battery connector. Make sure that it "locks" in the receptacle.
16. Install the end flange. Make sure that the wiring is not pinched.
17. Use a hex wrench to install the three 10-31 x 3/8" screws.
18. Fully insert the vent plug.



19. Connect the sensor to the software and turn on the internal batteries.
    The voltages in the sensor *Dashboard* are 12V and 6V. If they are not, open the sensor and correct the problem.

6.4 Bulkhead connector maintenance

CAUTION

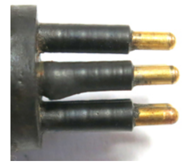
Do not use WD-40® or petroleum-based lubricants on bulkhead connectors. It will cause damage to the rubber.
Damaged connectors can cause a loss of data and additional costs for service.

Damaged connectors can cause damage to the sensor and make it unserviceable.

Examine, clean, and lubricate bulkhead connectors at regular intervals. Connectors that are not lubricated increase the damage to the rubber that seals the connector contacts. The incorrect lubricant will cause the bulkhead connector to fail.

1. Apply isopropyl alcohol (IPA) as a spray or with a nylon brush or lint-free swab or wipes to clean the contacts.
2. Flush with additional IPA.
3. Shake the socket ends and wipe the pins of the connectors to remove the IPA.
4. Blow air into the sockets and on the pins to make sure they are dry.
5. Use a flashlight and a magnifying glass to look for:

Cracks, scratches, or other damage on the rubber pins or in the sockets.		
Any corrosion.		

Separation of the rubber from the pins.	
Swelled or bulging rubber pins.	

6. Apply a small quantity of 3M™ Spray Silicone Lubricant (3M ID# 62-4678-4930-3) to the pin end of the connector. Make sure to let it dry.
7. Connect the connectors.
8. Use a lint-free wipe to clean any unwanted lubricant from the sides of the connectors.

6.5 Calibration

6.5.1 Manufacturer's calibration

NOTICE

The manufacturer recommends that the user return the sensor annually for calibration to make sure it gives the highest level of accuracy for both pH calculation and re-processed data. Note that the DuraFET gel is a consumable component and is usually replaced annually as well. The external reference electrode is replaced as needed.

The manufacturer calibrates the sensor with a single-point calibration at 0.5 m depth in a large tank of temperature-stable, continuous-flow seawater. A pH measurement (the "standard") is collected near the sensor using the spectrophotometric pH determination technique. The sensor records the cell potentials that are collected at the same time as water samples, and these are used together with the standard pH value to calculate a set of coefficients.

Calibration coefficients are stored in the sensor and are used with an on-board temperature measurement and the user-selectable salinity constant to calculate pH from the cell voltage potentials. The calculated pH value shows in each data frame sent from the sensor.

Calibration coefficients are written to the header section of every data file collected by the sensor. The software uses these coefficients when data is to be re-processed.

Because the ISFET sensor is sensitive to pressure, the manufacturer's calibration is only valid for near-surface deployments. To get accurate measurements for deeper deployments, the manufacturer recommends that the user collect independent pH data in situ just before and after a deployment so that an offset correction can be applied.

6.5.2 Verify calibration

⚠ CAUTION

Do not use NIST-type buffers with the sensor to check accuracy. The chemistry of those buffers is not appropriate for marine pH measurements and can damage the external reference electrode.

The manufacturer recommends that the user monitor the accuracy of the calibration at regular intervals. Compare the calculated pH values with independent pH data that is collected just before and after a deployment, either in situ or from direct measurements of a primary standard under temperature-controlled conditions.

One procedure for pre- and post-deployment checks is to start with a sample of known pH and salinity (TRIS or other Certified Reference Material).

1. Fill the wet cap with the sample. Close the opening and update the stored salinity value with the sample salinity value (refer to Data processing settings on page 20 menu for details.
2. Make sure the sensor and a bottle of the additional sample is at a constant temperature in a bath (e.g. overnight).
3. Flush the wet cap with the sample and then fill the wet cap. Return the sensor to the bath. Record data until the values are stable and similar to the expected values. Do not leave the standard TRIS recipe (it has no bromine) in the wet cap for extended periods of time because it will start to change the chemistry of the external reference electrode and void the calibration.

6.5.3 SeaFET user calibration

The user can do a calibration if the necessary equipment is available:

- a large tank or closed-loop pumped system
- temperature-stable natural seawater, as similar to deployment conditions as possible
- continuous flow over the sensor
- electrically grounded water to reduce noise.

Measure the temperature and conductivity of the water when a sample is collected. Use a spectrometer to do an analysis of the sample. Operate the sensor in a frequent periodic mode, with bursts of ten samples per minute for approximately 15 minutes before and after the sample to make sure the conditions are stable.

Use the new calibration coefficients to post-process data or save them in the sensor. The manufacturer recommends that the user make a Summary Report before new coefficients are saved in the sensor. To save new coefficients, go to **Menu**, *Sensor*, *Advanced*, *Upload Coefficients*.

Section 7 Troubleshooting

Possible problem	Possible solution
Data has invalid frames	No user action required. The software ignores the bad data and continues.
Cannot communicate from software to sensor	Use a terminal program such as Tera Term or HyperTerminal® to connect to the sensor. Settings: data bits=8 parity=None stop bits=1 flow control=None baud rate=57600 (manufacturer-set default) If the user still cannot communicate with the sensor, contact support@seabird.com

8.1 SeaFET data format

Data from the sensor is output in ASCII, in "frames." Each frame has "fields" that are comma-delimited. The first field of each frame is a synchronization header. Every frame ends with <CR><LF> (0x0D 0x0A).

In the "Format" field:

- AI = ASCII Integer. Example: 246.
- AF = ASCII Float. Example: -0.832034.
- AS = ASCII String. Example: SATPHA0001.

The sensor can be configured to output long or short ASCII frames.

- Full ASCII example:

```
SATPHA0001,2014083,13.0932646,7.80829,7.78879,20.5221,20.5038,32.6027,4.669,10.523,0.0597991,
-0.85879952,1.13056064,11.326,114,0,5,4.882,9,602,6.106,5.903,100,100,-0.95693927,0x0000,7<CR><LF>
```

- Short ASCII example:

```
SATPHA0001,2014083,13.0932646,7.80829,7.78879,20.5221,20.5038,32.6027,4.669,10.523,0x0000,234<CR><LF>
```

The fields for each frame are given below.

- The integer component of the "Format" column is the fixed size or variable size range of the field.
- The maximum number of characters in a Full ASCII frame is 197.
- The maximum number of characters in a Short ASCII frame is 101.
- Short ASCII frames are listed in **bold**.

Field	Format	Description
HEADER	AS 10	Starts with "SAT", followed by three characters that identify the type of frame. The last four characters are the sensor serial number.
DATE	AI 7	Sample date (UTC), YYYYDDD
TIME	AF 9...10	Sample time (UTC), DECIMALHOUR
PH_INT	AF 7...8	FET|INT calculated pH in total scale
PH_EXT	AF 7...8	FET|EXT calculated pH in total scale
TEMP	AF 6...8	ISFET thermistor temperature, °C
TEMP_CTD	AF 6...8	CTD temperature, °C
S_CTD	AF 6...7	CTD salinity, psu
O_CTD	AF 5...6	CTD oxygen concentration, ml/L
P_CTD	AF 5...6	CTD pressure, dbar
Vrs(FET|INT)	AF 10...11	FET|INT voltage
Vrs(FET|EXT)	AF 10...11	FET|EXT voltage
V_THERM	AF 10	Thermistor voltage
V_SUPPLY	AF 5...6	Supply voltage
I_SUPPLY	AI	Supply current, mA
HUMIDITY	AF 3...4	Electronics compartment relative humidity, %
v_5V	AF 5	Internal 5V supply voltage
V-MBATT	AF 5...6	Main battery pack voltage
V_ISO	AF 5	Internal isolated supply voltage

V_ISOBATT	AF 5	Isolated battery pack voltage
I_B	AI	Substrate leakage current, nA
I_K	AI	Counter electrode leakage current, nA
V_K	AF 10...11	Counter electrode voltage
STATUS	AS 6	16-bit hexidecimal bitmask shows system status.
CHECK SUM	AI 1...3	The sum of all bytes that includes the checksum value should be 0.
TERMINATOR	AS 2	The end of the data frame, <CR><LF> (0x0D and 0x0A).

8.2 CTD data format

The units that are output by the CTD depends on the appropriate configuration of the CTD output format.

The maximum number of characters in a CTD is 91.

Field	Format	Description
HEADER	AS 10	Starts with "SAT", followed by three characters that identify the type of frame. The last four characters are the sensor serial number.
t1	AF 6...8	Temperature, °C
c1	AF 7	Conductivity, S/m
p1	AF 5...8	Pressure, dbar
ox63r	AF 5...6	Oxygen concentration, ml/L
sal	AF 6...8	Salinity, psu
sv	AF 5...8	Sound velocity
sc	AF 7	Specific conductivity
dt	AS 19	Date and Time, YYYY-MM-DDThh:mm:ss e.g. 2014-03-24T13:03:55
TERMINATOR	AS 2	The end of the data frame, <CR><LF> (0x0D and 0x0A).

8.3 Terminal program setup and use

If necessary, use a terminal program to set up and operate the sensor.

1. For USB: Install the USB driver (first use only) that is on the manufacturer-supplied CD.
2. Use the test cable to connect the sensor to the PC and a 12V power supply.
3. Start a terminal emulator program such as HyperTerminal® or Tera Term.
4. Select "Serial" for the type of connection.
5. Set up the connection at 57600, 8 bits, no parity, 1 stop bit, flow control: none.
6. Turn on the power supply.
   The sensor turns on. If connected through a USB, the sensor draws power from the PC USB bus.
7. For USB: enter 5 or more "$" to change into commanded mode.
   The prompt shows **SeaFET>**.
8. Set the system clock: **SeaFET>**set --clock yyyy/mm/dd.hh:mm:ss.
9. Configure the mode of operation:

1. Continuous: **SeaFET>**set --opermode continuous
2. Periodic, with regular intervals of data collection:
   SeaFET>set --opermode periodic

   SeaFET>set --perdival 1h (one event each hour)

   SeaFET>set --brstsize 5 (5 samples per event)

10. Configure how many samples are averaged into the reported measurement: **SeaFET>**set --navg 10 (10 samples per measurement are averaged).
11. Make sure that the internal batteries are on: **SeaFET>**batton.
12. Start data collection: **SeaFET>**exit.

8.3.1 Command line operation

The tables in this section show commands, and settings and parameters for terminal programs.

Command	**Description** **Example**
help	Print a command reference
set --<setting> <value>	Change a setting. Example: SeaFET>set --baudrate 115200
get --<setting>	Look at different settings and parameters. SeaFET>get --clock
list --pkg --data --log	List the contents of a directory. SeaFET>list --data
send --pkg --data --log <file>	Transfer a file from the sensor to the PC via XMODEM. SeaFET>send --data C0000001.csv
recieve --pkg --data --log <file>	Transfer a file from the PC to the sensor via XMODEM. SeaFET>receive --pkg SEAF0009.zip
delete --pkg --data --log <file>	Erase a file. An asterisk erases all files in a directory SeaFET>delete --data C0000001.csv
chksum --pkg --data --log <file>	Get a file checksum. SeaFET>chksum --pkg SEAF0009.zip
chbaud	Change baud rate immediately. Baud rate will change the next time the sensor is turned on.
dmesg <dump_size_in_bytes>	Erase ("dump") the latest system messages.
freset --force --all	Resets the sensor settings to the manufacturer-set defaults. --all also resets the file counters. Make sure there are no data files on the sensor before this command is used.
reboot	"Re-boots" or starts, the sensor again. Resets USB connections.
upgrade	Start the firmware update tool.

ctdterm	Start a terminal window for the CTD. Commands to the slave CTD are routed through the SeaFET.
syncctd	Forces the clocks on the CTD and the SeaFET to adjust to the time from the SeaFET.
battoff	Disconnect the internal batteries. Use before the sensor is put in storage or shipped.
batton	Connect the internal batteries..
exit	Start operation mode again.

8.3.1.1 Settings

Use the settings commands below with the "set" and "get" commands to change the configuration of the sensor.

Setting	Description	Valid values, syntax
baudrate	communication speed	9600, 19200, 38400, 57600, 115200
clock	sensor time	yyyy/mm/dd.hh.mm:ss
opermode	operational mode	continuous, periodic, polled
samplwin	continuous or periodic mode window enable	false (disable), true (enable)
samstart, samstop	continuous or periodic mode data collection start or stop time	yyyy/mm/dd.hh.mm:ss
perdival	periodic data collection interval	1m, 2m, 5m,6m,10m, 20m, 30m, 1h, 2h, 3h, 4h, 6h, 8h, 12h, 24h
perdoffs	periodic data collection offset	0 to "perdival" in seconds
navg	average size of sample	1–100
brstsize	burst size	1–255
samdelay	sample delay(s)	0–255
logfrtyp	logged (saved) frame type	NONE, SHORT_ASCII, FULL_ASCII
outfrtyp	communication frame type	NONE, SHORT_ASCII, FULL_ASCII
logftype	log file generation rule	ACQUISITION, CONTINUOUS, DAILY
datfsize	size limit, MB, for CONTINUOUS files	0–255 (0 = no limit)
msglevel	message log verbosity	ERROR (least) WARN, INFO, DEBUG (most)
msgtotlm	Replicate messages in communication	false (disable), true (enable)
msgfsize	message file size limit, KB	1–65535
thcal	thermistor calibration constants	T0,T1,T2,T3 (no spaces)
inrefcal	internal reference calibration constants	I0,I1 (no spaces)
exrefcal	external reference calibration constants	E0,E1 (no spaces)
intsal	internally stored salinity (psu)	10–50
usepump	enable external pump control	false (disable), true (enable)
pmptime	total time the pump operates	1–255
pmpflush	pump flush time(s). Time from pump start to start of data collection	0–255
usectd	enable slave CTD control and "on-the-fly" TS corrections	false (disable), true (enable)

usectds	use CTD salinity for pH calculations	false, true
usectdt	use CTD temperature for pH calculations	false, true
ctdto	CTD response timeout, seconds	15–600
ctdpower	supply power to CTD during data collection.	false, true
ctdtelem	replicate CTD data frames in SeaFET communications	false, true
syncctd	enable periodic CTD clock adjustment	false, true

8.3.1.2 Terminal program read-only parameters

Setting	Description
serialno	serial number
fwversn	firmware version
disktotal	total disk size, bytes
diskfree	available disk space
mainvolt	main power level voltage
mainbattv	main battery pack voltage
isobattv	isolated battery pack voltage
rtcbattv	RTC backup battery voltage
interhum	electronics compartment relative humidity

8.4 Acquisition monitor

The software has an *Acquisition Monitor* window that shows the results of a data collection event. The user can look at it to see any problems with the data. In most cases, the number of frames with bad data are minimal, but the information in this window can help the user see why and when errors occur.

From the **View** menu, open the *Acquisition Monitor* window, or push **Error Details** in the *Real Time Data* window.

Description of fields

- From the **View** menu, open the *Acquisition Monitor* window, or push **Error Details** in the *Real Time Data* window.

  Frame Id: the unique identifier of the frame in the "instrument package" definition.
- **Read**: the number of valid frames read during the data collection for a frame.
- **Errors**: the number of frames that had errors during data collection for a frame.
- **CheckSum**, **Status**, **Fitting Errors**: the number of frames that had these types of errors. They are usually discarded.
- **Counter Errors**: the number of frames that had counter errors. They are usually not discarded.

8.5 Configure data file headers

The user can edit headers to the collected data files. The default headers are OPERATOR, EXPERIMENT, COMMENT.

To add or remove a custom header:

1. Go to the **Sensor** menu, then *Advanced*, then *Data Log Headers*.
    - Push **Add** to add a custom header

- Push **Remove** to remove the selected custom header

2. Double-click the "Value" cell to edit the value of the associated header.
3. Put a check in the "Prompt" check box so that the software will ask for the header record values when data collection starts.
4. Push **OK** to close the window.

8.6 Deployment considerations

The available bandwidth, power, storage capacity, and length of deployment are variables to think about when the sensor is set up. In general, use the periodic or logger-controlled mode for power-limited deployments. Use the periodic mode for autonomous operation.

The sensor has sufficient memory to save both science and engineering data for all applications, which the manufacturer recommends. This is the FULL_ASCII setting.

Deployments *not* limited by bandwidth, power, data storage capacity

Telemetry settings:

- *Transmitted Frame Format*: FULL_ASCII
- *Instrument Logging Frame Format*: FULL_ASCII

The sensor collects both science data (time, pH, temperature, conductivity, pressure) and engineering data (e.g. battery voltage, internal humidity). To collect data that shows the high-frequency variance in pH:

- *Number of Samples in Average*: 1
- *Number of Samples in Burst*: 30

The sensor collects 30 non-averaged frames per measurement and sends the frames in the burst at approximately 10 Hz. These settings have an effect on the volume of data collected and the amount of power used.

Deployments that *are* limited by bandwidth, power, data storage capacity

Telemetry settings:

- *Transmitted Frame Format*: SHORT_ASCII
- *Instrument Logging Frame Format*: FULL_ASCII

The sensor collects science data (time, pH, temperature, conductivity, pressure) and averages the samples that are collected into one output:

- *Number of Samples in Average*: 30
- *Number of Samples in Burst*: 1

The sensor collects 30 averaged frames per measurement and sends one burst (measurement) at approximately 10 Hz. This measurement takes approximately 3 seconds.

For long-term autonomous deployments with limited power, use the Periodic mode. Example settings:

- Sample Interval: 1 hr
- Number of Samples in Average: 1
- Transmitted Frame Format: FULL_ASCII
- Instrument Logging Frame Format: FULL_ASCI

To see the high frequency component, turn the average setting off and set the *Number of Frames in Burst* as necessary.

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