



SEA-BIRD
SCIENTIFIC

User manual

ECO fluorometers and scattering sensors

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Section 1 Safety information

Please read this entire manual before this equipment is unpacked, set up, or operated. Pay attention to all danger, warning, and caution statements. Failure to do so could result in serious injury to the operator or damage to the equipment.

DANGER

Indicates a potentially or imminently hazardous situation which, if not avoided, will result in death or serious injury.

WARNING

Indicates a potentially or imminently hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION

Indicates a potentially hazardous situation that may result in minor or moderate injury.

NOTICE

Indicates a situation which, if not avoided, may cause damage to equipment. Information that requires special emphasis.

1.1 Hazard information

WARNING



If the user thinks that the lithium batteries have leaks, pressure may have built up inside of the pressure housing. Follow ESD protocols to release internal pressure. Put on safety glasses and protective gloves and make sure that the sensor is pointed away from the body and other people. In a well ventilated area, very SLOWLY loosen the bulkhead connector to release the pressure. Keep away from heat, sparks, flame, and other sources of ignition. Do not smoke.

WARNING

This product can expose the user to chemicals with silica, crystalline (airborne particles of respirable size), which is known to the State of California to cause cancer and birth defects or other reproductive harm. For more information, go to www.P65Warnings.ca.gov.

CAUTION



The pressure housing contains Electrostatic Discharge (ESD) sensitive parts and assemblies that are susceptible to damage from ESD. Follow ESD protocols:

- Put on protective eye wear before you open the pressure housing.
- Any electrostatic charge on the body of the human operator must be released before the pressure housing is opened: put a hand on a grounded surface, or better, wear a grounded antistatic wrist strap.
- At a minimum, wear short-sleeved antistatic clothing, such as cotton, or better, wear an antistatic smock for this service activity. *Do not wear a sweater, fleece or polyester-based clothing.*
- At a minimum, use a workstation with a wood or metal tabletop, or better, a tabletop that dissipates static. *Do not use a workstation with a synthetic or polymeric-based tabletop.*

NOTICE

The manufacturer is not responsible for any damages due to misapplication of misuse of this product including, without limitation, direct, incidental and consequential damages, and disclaims such damages to the full extent permitted under applicable law. The user is solely responsible to identify critical application risks and install appropriate mechanisms to protect process during a possible equipment malfunction.

1.2 Equipment labels

Read all labels and tags attached to the equipment. Personal injury or damage to the equipment could occur if not observed. A symbol on the equipment is referenced in the manual with a precautionary statement.



Electrical equipment marked with this symbol may not be disposed of in European domestic or public disposal systems. Return old or end-of-life equipment to the manufacturer at no charge to the user.



EFUP: Hazardous material exists over the threshold of GB/T 26572.2011. The number in the center of the symbol is the Environmentally Friendly Use Period as specified by SJ/T 11364-2014, China's marking for the Restriction of the Use of Hazardous Substances in Electrical and Electronic Products. This product should be recycled after its environmentally friendly use period.

Section 2 ECO™ quick start guide

⚠ WARNING



fDOM sensors use an ultraviolet LED light source. Do not look directly at a UV LED when it is on. It can cause damage to the eyes. Keep products that have UV LEDs away from children, pets, and other living organisms. Wear polycarbonate UV-resistant safety glasses to protect the eyes when a UV LED is on.

This quick start guide gives the steps necessary to set up and make sure that the ECO sensor operates and collects data before it is deployed.

What's in the box—

- ECO sensor
 - Six 9V AA-size lithium batteries (model-specific, shipped separately)
 - blue-tipped power connector and lock collar for sensors with internal batteries
 - dummy plug and lock collar
 - model-specific spare parts kit
 - model-specific fluorescent stick
 - CD or USB drive with software, user manual, and calibration or characterization information.
1. If the sensor is so-equipped, install the manufacturer-supplied batteries:
 - a. Remove the end flange of the sensor.
 - b. Disconnect the battery pack and remove it from the sensor.
 - c. Install new batteries.
 - d. Connect the battery pack to the sensor again and install the end flange again.
 2. Install the manufacturer-supplied software on a PC.
 3. Verify that the sensor operates and collects data:
 - a. Connect the sensor to the PC and start the software.
 - b. If necessary, supply external power to the sensor (models with no internal batteries).
 - c. Remove and replace the protective cover on the optical face several times, or use the fluorescence stick that shipped with the sensor, to change the value of the collected data.
 - d. Push **Stop Data** to stop data collection.
 4. Verify that the sensor transmits data:
 - Select the *Transfer Data* tab in the software.
 - Push **Receive Data**.
 - Select a location on the PC in which to save the data, and enter a file name.
 - Push **Save**.
 5. If necessary, attach the sensor to the frame on which it will be deployed.
 6. Make sure to do maintenance on the sensor at regular intervals.

Section 3 Specifications

ECO sensors measure different parameters of the Earth's natural waters. The sensors are available in several models and with a variety of optional features.

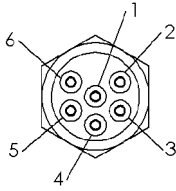
Real-time (RT)	Output is digital or analog. Operates continuously. Does not store data.
Real-time deep (RTD)	6,000 m rated depth. Does not store data.
Standard	Output is digital or analog. Has low power mode. Stores data.
Bio-wiper (S)	Standard, and with Bio-wiper to prevent bio-fouling.
Battery (B)	Standard, and with internal batteries.
Bio-wiper and battery (SB)	Standard, with both a Bio-wiper and internal batteries.

Note: The three-parameter sensor is available in Standard and Battery models only and has no analog output.

3.1 Mechanical

	RT, standard	RTD	S	B, SB
Diameter	6.30 cm			
Length	12.70 cm	17.68 cm	13.3 cm	28.00 cm
Depth rating	600 m	6000 m	300 m	
Temperature range	0–30 °C			
Weight in air, water	0.40 kg, 0.02 kg	1.3 kg, 0.75 kg	0.50 kg, 0.08 kg	0.96 kg, 0.14 kg

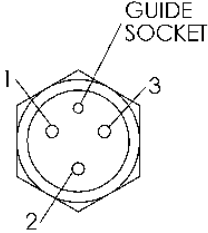
3.1.1 Bulkhead connector

Contact	Function	MCBH6MP connector
1	Ground	
2	RS232 RX	
3	Reserved Analog 2 (FLNTU only)	
4	Voltage in	
5	RS232 TX	
6	Analog 1	

3.1.2 Battery

Additional bulkhead connector on sensors with internal batteries.

Use the three-contact blue-tipped power connector that is supplied with the sensor to supply power to the sensor.

Contact	Function	MCBH-3-FS connector
1	Voltage in	
2	No connect	
3	Battery out	

Specifications

3.2 Electrical

Input	7–15 VDC
Current draw, typical	50 mA; 60 mA (triplet)
Current draw, standby	140 μ A
Current draw, active wiper	140 mA
Linearity	99%

3.3 Communications

	Fluorometer	NTU	Scattering	FLNTU	Triples
Sample rate	to 8 Hz				to 4 Hz
Data storage	108000 samples			90000 samples	77000 samples
RS232 output rate	19200 baud				
Data resolution	14 bit		12 bit		
Digital output maximum	~16380 counts		4130 $\pm$ 30 counts		
Analog output maximum	0–5 V				no analog

3.4 Optical

3.4.1 Single-parameter fluorometer

Parameter	Wavelength EX/EM	Range, Sensitivity
Chlorophyll (Chl)	470/695 nm	0–125, 0.016 μ g/L
Fluorescent Dissolved Organic Matter (fDOM)	370/460 nm	0–500, 0.36 ppb
Uranine (UR)	470/530 nm	0–400, 0.06 ppb/count
Phycocyanin (PC)	630/680 nm	0–230, 0.03 ppb/count
Phycoerythrin (PE), Rhodamine (Rh)	530/595 nm	0–230, 0.03 ppb/count

3.4.2 Single-parameter scattering

Parameter	Wavelength	Range, Sensitivity
Scattering	470 nm, 532 nm, 650 nm	0–5, 0.003 m ⁻¹
	700 nm	0–3, 0.002 m ⁻¹
		0–5, 0.003 m ⁻¹

3.4.3 Two-parameter fluorometer-turbidity

Parameter	Wavelength EX/EM	Range, Sensitivity (chl)	Parameter	Wavelength	Range, Sensitivity (NTU)
Chlorophyll	470/695 nm	0–30, 0.015 μ g/L 0–50, 0.025 μ g/L 0–75, 0.037 μ g/L 0–125, 0.062 μ g/L 0–250, 0.123 μ g/L	Turbidity	700 nm	0–10, 0.005 NTU 0–25, 0.013 NTU 0–200, 0.098 NTU 0–350, 0.172 NTU 0–1000, 0.123 NTU

3.4.4 Three-parameter fluorometer and scattering

Parameter	Wavelength EX/EM	Range, Sensitivity
Chlorophyll (Chl)	470/695 nm	0–30, 0.015 µg/L
		0–50, 0.025 µg/L
Fluorescent Dissolved Organic Matter (fDOM)	370/460 nm	0–375, 0.28 ppb
Uranine (UR)	470/530 nm	0–300, 0.15 ppb
Phycocyanin (PC)	630/680 nm	0–175, 0.086 ppb
Phycoerythrin (PE), Rhodamine (Rh)	530/595 nm	0–175, 0.086 ppb

Parameter	Wavelength	Range, Sensitivity
Scattering	412 nm, 470 nm, 532 nm, 650 nm, 880 nm	0–5, 0.003 m ⁻¹
	700 nm	0–3, 0.002 m ⁻¹
		0–5, 0.003 m ⁻¹

Section 4 Operation and maintenance

4.1 Verify sensor operation

⚠ WARNING



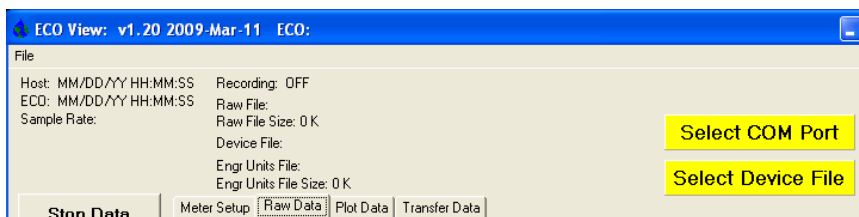
fDOM sensors use an ultraviolet LED light source. Do not look directly at a UV LED when it is on. It can cause damage to the eyes. Keep products that have UV LEDs away from children, pets, and other living organisms. Wear polycarbonate UV-resistant safety glasses to protect the eyes when a UV LED is on.

NOTICE

Do not supply more than 15 VDC to the sensor. More than 15 VDC will cause damage.

Make sure that the sensor operates correctly before further setup and deployment.

1. Connect the 6-contact connector on the optional test cable (refer to the section on the test cable for details) to the sensor.
2. Remove the cap that protects the optical face of the sensor.
3. Connect a serial-to-USB adapter to the test cable to connect the test cable to the PC.
4. Connect the sensor to a power supply:
 - Connect sensors with internal batteries to the manufacturer-supplied, three-contact, blue-tipped power connector. The sensor comes on.
 - Connect sensors without internal batteries to the optional test cable and a regulated power supply set at 12 VDC.
5. Start the software from the manufacturer-supplied CD.
 - a. Select the COM port on the PC.
 - b. Select the device file for the sensor from the CD.
 - c. Select the baud rate if necessary. The default is 19200.



6. Turn on the power supply.
The sensor comes on.
7. Push **Start Data**.
8. Go to the *Raw Data* tab of the software.
The data collected by the sensor shows in the "Signal" column.

Figure 1 Format of data collected by real-time sensors

99/99/99	99:99:99	695	42	700	264	460	51
99/99/99	99:99:99	695	43	700	260	460	55
99/99/99	99:99:99	695	41	700	257	460	64
99/99/99	99:99:99	695	37	700	255	460	62
99/99/99	99:99:99	695	39	700	258	460	50
99/99/99	99:99:99	695	44	700	262	460	53
99/99/99	99:99:99	695	49	700	259	460	58

Wave- length	Signal	Wave- length	Signal	Wave- length	Signal
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Figure 2 Format of data collected by most ECO sensors

Meter Setup	Raw Data	Plot Data	Transfer Data				
06/14/12 06:06:05	532	267	660	3070	695	78	
06/14/12 06:06:06	532	315	660	3406	695	89	
06/14/12 06:06:07	532	437	660	3861	695	127	
06/14/12 06:06:08	532	509	660	4122	695	175	
06/14/12 06:06:09	532	2577	660	4122	695	629	
06/14/12 06:06:10	532	4122	660	4122	695	957	
06/14/12 06:06:11	532	4122	660	4122	695	970	
06/14/12 06:06:12	532	4122	660	4122	695	868	
06/14/12 06:06:14	532	4122	660	4122	695	946	
Date	Time	Wave-length	Signal	Wave-length	Signal	Wave-length	Signal

Note that RT and puck sensors show 9's instead of the Date and the Time.

9. Look at the maximum data value for the sensor. Hold a finger, the protective cap, or fluorescent stick if the sensor is a fluorometer, 1–4 cm away from the optical face of the sensor.

The data value in the "Signal" column in the *Raw Data* tab will increase toward the maximum data value specified for the sensor.

- Scattering and turbidity sensors: use a finger or the protective cap.
- FDOM and phycocyanin sensors: use the blue fluorescent stick.
- Chlorophyll or phycoerythrin sensors: use the orange fluorescent stick.
- Uranine sensors: use the yellow fluorescent stick.
- PAR sensors: point the sensor into the light.

10. Push **Stop Data**.

The Bio-wiper closes on sensors so-equipped. If the power is turned off in mid-cycle, the Bio-wiper starts at the beginning of the cycle when power is supplied again.

4.1.1 Verify analog data output

1. Connect the optional test cable to the sensor. Refer to the section on the [Test cable](#) for details about test cables.
2. Use a regulated power supply to supply 12 VDC to the sensor or connect a 9V battery to the connectors on the test cable.
The sensor comes on.
3. Use the probes on a digital multimeter (DMM) to touch the RCA connector on the auxiliary leg(s) of the test cable.
4. Put the red (signal) probe in the RCA connector and the black (ground) on the outside.
The DMM shows near 0 VDC.
5. Put the fluorescent stick (for fluorometers) or a solid object near the light source of the sensor.
The DMM shows near 5 VDC.

4.2 Monitor data

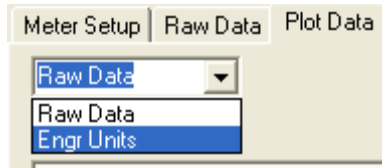
Monitor the data from the sensor in counts. The number of columns of data will vary depending on whether the user has a one-, two-, or three-parameter sensor.

1. Make sure the sensor has power supplied and is on.
2. Push **Start Data**.
3. Go to the *Raw Data* tab to see the data that is collected by the sensor.
Refer to the [Verify sensor operation](#) on page 11 to see the format of the data.

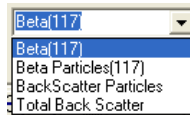
Note: RT and puck sensors usually show 9's as placeholders in the date and time columns.

4.2.1 Monitor data collected in engineering units

1. Go to the *Plot Data* tab.
2. Select "Engr Units" from the drop-down menu near the top of the tab.



3. Select the type of units to see.



The software calculates the engineering units to show in the *Plot Data* tab.

Note: Data is saved in counts, not engineering units.

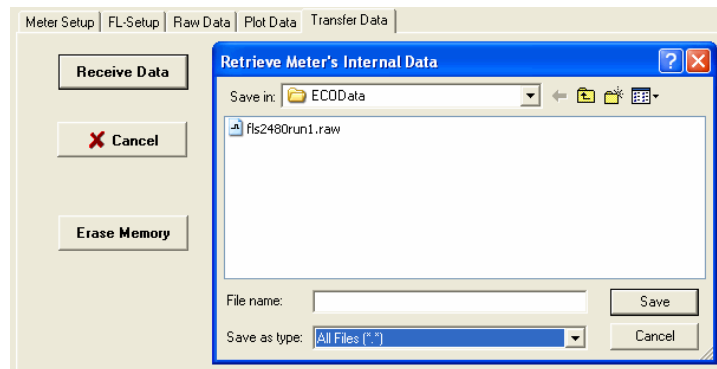
4.3 Get data from sensor

NOTICE

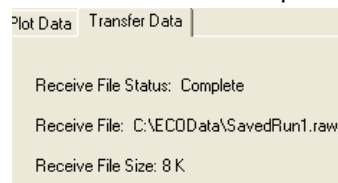
Use only the batteries recommended by the manufacturer as replacements. Do not mix chemistries, V-Ah, or new and used batteries.

Get the data from the sensor and save it to the PC.

1. Make sure that the sensor is not on but has power supplied to it.
2. Select the *Transfer Data* tab in the software.
3. Push **Receive Data**.



4. Select a location on the PC in which to save the data.
5. Type a file name in the **Retrieve Meter's Internal Data** window.
6. Push **Save**.
The software saves the data from the sensor to the PC.
7. Make sure that the data move is complete.



8. Open the data file to make sure that the data is on the PC.
Contact the manufacturer to get a spreadsheet template for an *ECO* sensor.
9. Push **Erase Memory** to erase the data from the memory of the sensor.

4.4 Set up sensor for deployment

1. Refer to the previous section to make sure that the sensor operates correctly.
2. Replace the test cable with a sea cable for deployment.
3. If necessary, remove the protective cap from the sensor.
4. Use either the blue-tipped power connector (sensors with internal batteries only) or an external power supply to supply power to the sensor for deployment. If the power connector and a cable are both attached, the power is supplied by the equipment that supplies the highest voltage.
 - a. Attach the blue-tipped power connector to the three-contact connector. The sensor will begin operation as set up by the user. The manufacturer recommends this mode for moored applications.
 - b. Attach a sea cable to the six-contact connector and turn on the power supply (sensors without internal batteries).
5. Refer to the section on [Additional operations](#) on page 14 for details on how to set up the sensor for a specific application.

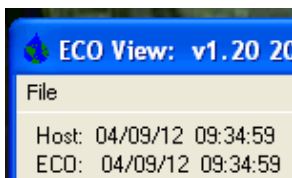
4.5 Additional operations

Note: Real-time (RT and RTD) sensors do not store data. Some of the data collection options in this section do not apply to these sensor models.

4.5.1 Set date and time

Make sure that the sensor is connected to a power supply that is turned on. Make sure that the software is open.

1. If the sensor is in operation, push **Stop Data** to stop the sensor.
2. Select the *Meter Setup* tab.
3. Push **Set Date and Time**.
The software adjusts the time shown by the sensor to agree with the PC.
4. Push **Get Date/Time/Setup** to make sure that the sensor and the PC show the same current time.



4.5.2 Adjust options for data collection

The manufacturer sets ECO sensors to operate at approximately 1 Hz, with the optional internal data storage turned on.

Table 1 Options to collect data

ECOView option	How it works
Set Avg/Data Rate	Adjust from 1 to 65535. Examples:
	1-parameter sensors—approximately 1 Hz = 65; approximately 2 Hz = 30
	2-parameter sensors—approximately 1 Hz = 30; approximately 2 Hz = 15
	3-parameter sensors—approximately 1 Hz = 18; approximately 2 Hz = 6
	PAR sensors—approximately 1 Hz = 310; approximately 2 Hz = 170
Set Number of Samples	Adjust from 0 to 65535. Use 0 to operate continuously.

Table 1 Options to collect data (continued)

The three options below apply only to sensors equipped with internal memory	
Set Number of Cycles	Adjust from 0 to 65535. Select the number of sample groups that the sensor will collect between low-power states.
Set Cycle Interval	Adjust the time interval between sample cycles. Do not type the colons. The minimum is 5 seconds.
Turn Logging ON	Push to turn data storage off or on (sensors with internal data storage only).

Adjust any of the options to collect data in the *Meter Setup* tab.

The screenshot shows the 'Meter Setup' tab with the following settings:

- Set Avg / Data Rate:** 18
- Set Number of Samples:** 10
- Set Number of Cycles:** 3
- Set Cycle Interval:** 000015
- Current Ram Settings:** Average: 18, Sample Rate: 1.12 Hz, Number of Sample: 10, Number of Cycles: 3, Cycle Interval: 00:00:15
- Buttons:** Get Date/Time/Setup, Set Date, Set Time, Store To Flash (highlighted with a red circle and labeled with a red '3')

1 Enter the new value into the variable box.	2 Push the related button that is to the left of the variable box.	3 Push Store to Flash . The new value shows in the column <u>Current Ram Settings</u> .
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In the example above, the 3-parameter sensor will operate at an "Average" of 18 and a "Data Rate" of 1.12 Hz. The sensor will collect data 10 rows of data for 3 cycles, with a low-power interval of 15 seconds after each cycle. The sensor stops after the 10th row of the third cycle of data is collected.

Table 2 Data collection examples

Collect moored data Set Avg/Data Rate = ± 1 Hz Set Number of Samples = 50 Set Number of Cycles = 24 Set Cycle Interval = 006000 Turn Logging ON/OFF = ON The sensor will collect data once per second, 50 times every 60 minutes for 24 hours, and store the collected data.	Collect profiling data Set Avg/Data Rate = ± 1 Hz Set Number of Samples = 0 Set Number of Cycles = N/A Set Cycle Interval = N/A Turn Logging ON/OFF = ON The sensor will collect data once per second and store collected data until the power is turned off.
---	--

If the sensor is set up to collect data intermittently, as for a moored deployment, it may be in a low-power condition. It is not possible to communicate with the sensor in this condition.

1. To start communication again, disconnect the sensor's power supply for one minute.
2. Connect the power again and push **Stop Data** several times.
3. Select the *Meter Setup* tab. Refer to [Adjust options for data collection](#) on page 14.
4. Type **0** into the **Number of Samples** variable box.
5. Push **Set Number of Samples**.
6. Push **Store to Flash**.
The sensor operates continuously.

Make sure that the sensor operates continuously.

1. Select the *Raw Data* tab.
2. Push **Start Data**.

Operation and maintenance

3. Let the sensor operate for 10 samples or more.
4. Push **Stop Data**.

4.5.3 Adjust views in plot data tab

The *Plot Data* tab in the software lets the user see the data that the sensor has collected.



Button	Function	Description
1	Resume	Push to start or stop the data that shows.
2	Pause	The x-axis will stop.
3	Axes scroll	Move either axis up or down, or right or left.
4	Axes zoom	Move either axis up or down, or right or left.
5	Zoom out	Decrease the detail by 2x.
6	Zoom in	Increase the detail by 2x.
7	Zoom box	Draw a box around the data area to zoom all axes.
8	Cursor	Move the cursor bar to a certain data point.
9	Copy	Copy the current data plot to the PC clipboard.
10	Save	Save an image of the current data plot to the PC.
11	Print	Send a snapshot of the current data plot to a printer.

Enter the units of data to view from the drop-down menu above the black view area ($\mu\text{g/L}$, ppb, scattering, etc.)

4.6 General maintenance

⚠ WARNING



Sensors that use ultraviolet light sources (< 400 nm): Do not look directly at a UV light source when it is on. It can cause damage to the eyes. Keep products that have UV light sources away from children, pets, and other living organisms. Wear polycarbonate UV-resistant safety glasses to protect the eyes when a UV light is on.

NOTICE

Do not use abrasive cleaner on the optical face of the sensor. It will cause scratches on the optical epoxy and glass.

NOTICE

Do not use acetone or other solvents to clean any part of the sensor.

1. After each cast or exposure to natural water, flush the sensor with clean fresh water.
2. Use soapy water to clean any grease or oil on the optical face of the sensor. It is made of plastic and can be damaged if an abrasive cleaner is used.
3. Dry the sensor with a clean soft cloth.
4. Install the dummy plug and lock collar to protect the bulkhead connector.
5. Install the protective cap on the optical face.

4.6.1 Clean bulkhead connectors

NOTICE

Do not use WD-40® or petroleum-based lubricant 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.

Use silicone-based lubricants only.

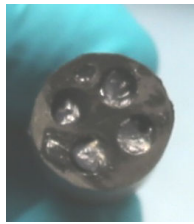
Examine, clean, and lubricate bulkhead connectors at regular intervals. Connectors that are not lubricated increase the damage to the rubber that seals the connector contacts. The incorrect lubricant will cause the failure of the bulkhead connector.

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:

Any corrosion.		
Cracks, scratches, or other damage on the rubber pins or in the sockets.		
Separation of the rubber from the pins.		
Swelled or bulging rubber pins.		

6. Use a silicone-based lubricant on each of the contacts of the bulkhead connector. The manufacturer recommends any of the products listed below.
 - 3M™ Spray Silicone Lubricant (3M ID# 62-4678-4930-3). Make sure to let it dry.
 - Dow Corning Molykote® III Compound (DC III)
 - Dow Corning High Vacuum Grease® (DC 976 V)
 - Dow Corning 4 Electrical Insulating Compound® (DC 4)
 - Dow Corning Molykote 44 High Temperature Grease® (DC 44)

Use a finger to put a small quantity (approximately 1 cm in diameter) of silicone grease on the socket end of the connector and push as much of the lubricant as possible into each socket. Do not use too much lubricant, as that will prevent a good seal.



7. Connect the connectors.
8. Use a lint-free wipe to clean any unwanted lubricant from the sides of the connectors.

4.6.2 Clean Bio-wiper and faceplate

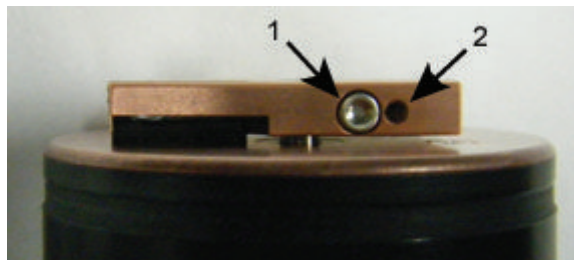
Sensors that have copper faceplates and copper Bio-wipers need to be cleaned at regular intervals to keep the copper effective as an anti-fouling aid. Remove the Bio-wiper and faceplate from the sensor to clean them.

NOTICE

Do not twist the Bio-wiper or the Bio-wiper shaft by hand. Push **Open Shutter** and **Close Shutter** in the software to turn the Bio-wiper. Turning by hand will damage the Bio-wiper motor.

1. Disconnect the sensor from any power source.
2. Use the manufacturer-supplied 3/32" hex key to loosen the screw that holds the Bio-wiper to the sensor.
If necessary, insert the manufacturer-supplied jacking screw into the expander hole to loosen the Bio-wiper. *PAR sensors do not have an expander hole and do not ship with jacking screws.*

Figure 3 Bio-wiper screw holes



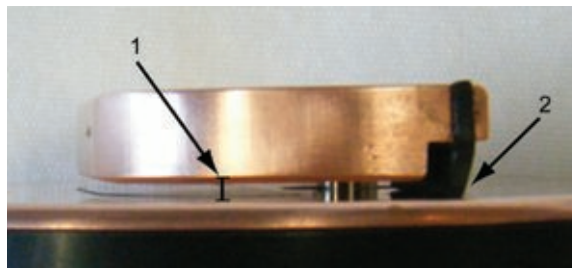
1 the screw in the clamping hole

2 the expander hole

3. Lift the Bio-wiper off of the faceplate.
4. If used, remove the jacking screw.
5. Use a small Phillips screwdriver to remove the screws that attach the faceplate to the optics face.
6. Keep the screws.
7. Clean the Bio-wiper and faceplate with soapy water.
8. Rinse and dry thoroughly.
9. Use a Scotch-Brite® or similar pad to buff the Bio-wiper and faceplate until they are shiny.
10. Use an isopropyl alcohol-saturated cotton swab to clean the Bio-wiper shaft and the shaft hole.
11. Make sure the Bio-wiper and faceplate dry completely.
12. Attach the faceplate again.
13. Make sure the screw used to attach the Bio-wiper is in good condition.
The 3/32" hex key must fit into the screw's socket.

14. If the screw is damaged, use a new screw from the spare parts kit that the manufacturer supplies with the sensor.
These screws are 4-40 x 3/8" 316 stainless steel and are treated with anti-seize.
15. Insert a jacking screw into the expander hole of the Bio-wiper. Turn it slowly until the Bio-wiper goes onto the shaft easily.
16. Put the clean Bio-wiper over the shaft but do not twist the Bio-wiper.
17. Make sure to remove the jacking screw before tightening the 3/32-inch clamping screw.
18. Use the commands in the software to put the Bio-wiper into the closed position.
The Bio-wiper covers the optics.
19. Set the clearance between the Bio-wiper and the faceplate to approximately 0.6 mm.
Note: If the Bio-wiper is has too much bend because it is too close to the faceplate, the motor will use too much current. If it is not close enough to the faceplate, the Bio-wiper will not keep the optics clean.

Figure 4 Bio-wiper clearance



1 Bio-wiper clearance from faceplate

2 Bio-wiper flex

20. Use the 3/32" hex key to tighten the screw. Do not over-tighten the screw.
21. Turn on the sensor to make sure that the Bio-wiper rotates correctly.
The Bio-wiper must rotate 180 degrees and uncover the optics before they come on.
The Bio-wiper will then rotate 180 degrees to cover the optics after they come on.

4.6.3 Internal batteries

⚠ WARNING



Explosion hazard. If the batteries are not installed correctly, explosive gases can be released. Make sure that the batteries are of the same approved chemical type and are inserted in the correct orientation.

⚠ WARNING



If the user thinks that a sensor has water in the pressure housing: Disconnect the sensor from any power supply. Put on safety glasses and make sure that the sensor is pointed away from the body and other people. In a well ventilated area, use the purge port (if the sensor is so equipped), or very SLOWLY loosen the bulkhead connector to let the pressure release.

⚠ WARNING



If the user thinks that the lithium batteries have leaks, pressure may have built up inside of the pressure housing. Follow ESD protocols to release internal pressure. Put on safety glasses and protective gloves and make sure that the sensor is pointed away from the body and other people. In a well ventilated area, very SLOWLY loosen the bulkhead connector to release the pressure. Keep away from heat, sparks, flame, and other sources of ignition. Do not smoke.

⚠ CAUTION	
	The pressure housing contains Electrostatic Discharge (ESD) sensitive parts and assemblies that are susceptible to damage from ESD. Follow ESD protocols: • Put on protective eye wear before you open the pressure housing. • Any electrostatic charge on the body of the human operator must be released before the pressure housing is opened: put a hand on a grounded surface, or better, wear a grounded antistatic wrist strap. • At a minimum, wear short-sleeved antistatic clothing, such as cotton, or better, wear an antistatic smock for this service activity. <i>Do not wear a sweater, fleece or polyester-based clothing.</i> • At a minimum, use a workstation with a wood or metal tabletop, or better, a tabletop that dissipates static. <i>Do not use a workstation with a synthetic or polymeric-based tabletop.</i>

Flooded sensors are usually not serviceable. There is a small chance that the manufacturer can get the data that is stored in the sensor. Contact service@wetlabs.com for more information about flooded sensors.

The manufacturer supplies six Ultralife® 9-volt lithium batteries to supply power to sensors that have internal batteries. The manufacturer recommends these batteries because six batteries supply approximately 6100 mAh, which is the highest capacity currently available.

The use of alkaline or lithium manganese dioxide (LiMnO₂) batteries will not damage the sensor but the capacity is much lower than UltraLife® batteries.

Note: *The nominal water temperature, sequence timing, sample periods, and other variables will change the use-time of the sensor's internal batteries.*

4.6.3.1 Remove batteries

1. Clean any debris from the end flange.
2. Dry the sensor thoroughly.
3. Remove the dummy plugs if necessary.
4. Point the connector end flange down, away from the face.
 - a. Pull the vent plug loose.
 - b. If the sensor has an external thermistor, pull it loose.
5. Dry the vent plug (and the thermistor, if applicable).
6. Use needle-nose pliers to remove the monofilament from the end flange.

Figure 5 Pull monofilament from end flange



7. Remove the end flange from the pressure housing.

The jacking screws supplied as spare parts can be used to push the end flange off of the pressure housing, and then be removed.
8. Carefully disconnect each Molex® connector.
9. Remove the screw that holds the vent plug in the end flange.

10. Dry the end flange and the pressure housing seal areas.
11. Examine the O-rings on the vent plug and thermistor (if applicable).
Remove any O-ring that is damaged.
12. Apply a light coat of vacuum grease on a new 010 O-ring and put it on the vent plug or thermistor.
13. Put the vent plug into the top of the end flange.
14. If applicable, insert the thermistor into the end flange again.
15. Put the screw for the vent plug in the inside of the end flange.
The screw holds the vent plug in the end flange.
16. Carefully pull the white plastic loop to remove the battery pack from the pressure housing.
17. Remove the black plastic protectors from the ends of the long screws that secure the batteries.
18. Loosen, but do **not** remove, the retaining screws using a 1/4" slotted driver.
Do not remove both screws. If both of the retaining screws are removed, the result will be a pile of parts and the replacement process will not be easy.

Figure 6 Both retaining screws removed



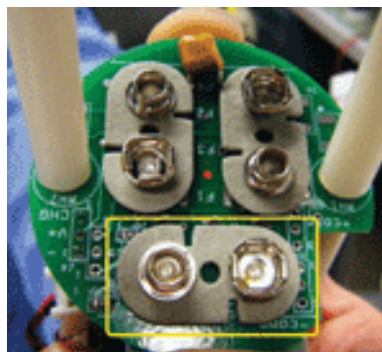
19. Disconnect each of the six batteries.

4.6.3.2 Replace batteries

Install new batteries in the sensor.

1. Tilt the battery board enough to connect the first battery in the contacts that are perpendicular to the other two.

Figure 7 Connect the first battery

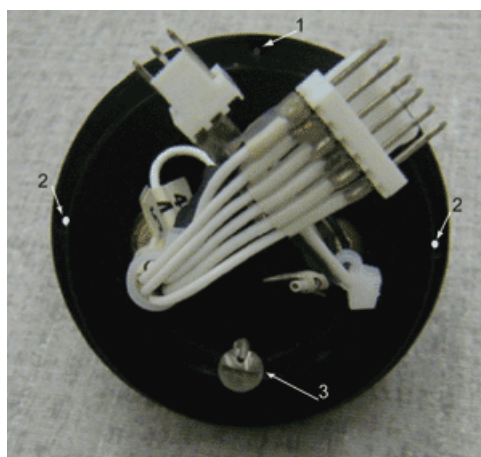


2. Pivot the boards in the opposite direction to connect the other two batteries.

3. Connect the second set of the batteries.
4. Hold the assembly plates on top and bottom and tighten the screws.
The bottoms of the batteries may splay out. Make sure that the batteries do not extend beyond the circuit boards. If they do, the battery pack will scratch the sealing surface when it is put into the pressure housing again.
5. Install the bottom neoprene pad and the black plastic protective covers on the ends of the screws.
6. Remove and examine the 224 O-ring on the pressure housing for damage.
7. Use a new O-ring if necessary.
8. Apply a light layer of grease such as Dow Corning® High Vacuum Grease on the O-ring.
9. Put the battery pack into the pressure housing.
10. Attach the Molex® connectors.

Note that the dowel pin may be in the end flange or in the pressure housing.

Figure 8 Inside of end flange



1 dowel hole	2 through-holes for jacking screws	3 vent plug screw
--------------	------------------------------------	-------------------

11. Put the end flange onto the housing so that the wires are out of the way.
12. Align the dowel pin with the dowel hole in the end flange, not the jack screw holes, which go through the end flange.
13. Make sure that the wires are not pinched between the end flange and the pressure housing.
14. Make sure that the end flange is attached to the pressure housing.
15. Install the monofilament in the end flange.

Section 5 Reference

5.1 Calibration

The manufacturer calibrates all scattering sensors to make sure that the data that is collected meets the specifications for the sensor. This information is on the sensor-specific calibration page that comes with the sensor.

5.2 Characterization

The manufacturer uses a fluorescent material to characterize all fluorescence sensors to make sure that the data that is collected meets the specifications of the sensor. This information is on the sensor-specific characterization page that comes with the sensor.

5.3 Field characterization

The manufacturer recommends that the user perform a field characterization on fluorometers to make sure that the data is as accurate as possible for the user's application. The scale factor and the dark counts values can vary depending on the natural water, temperature, length of the cable, the power supply, and other factors. Do the steps below to field-characterize the sensor.

- **x** = a solution of a known concentration in volts or counts.
 - **output** = the measured sample of interest in volts or counts.
 - **dark counts** = the measured signal output in volts or counts of the sensor in clean water with black tape over the detector.
 - **scale factor** = the multiplier in $\mu\text{g/L/volt}$, ppb/L/volt , OR $\mu\text{g/L/count}$, ppb/L/count .
1. Get a solution of a known concentration, **x**.
 2. Measure and record this solution using the sensor.
This value is the **output** in volts or in counts.
 3. Measure and record the sensor's **dark counts**.
 4. Use this equation to determine the sensor's **scale factor**:
$$\text{Scale factor} = x \div (\text{output} - \text{dark counts})$$
 5. Use the scale factor to determine the concentration of the sample of interest:
$$(\text{output counts} - \text{dark counts}) \times \text{scale factor} = \text{concentration of solution}$$
 6. Store the scale factor and dark counts (offset) in the device file for the sensor, the internal memory of the sensor, or both.

5.3.1 Save field characterization values in device file

The software uses a device file to process data. Refer to the example below.

Note: A colon comes before the comments in the device file. The comments are not used by the software.

```
ECO          FLS-1822
Created on:   04/29/2011

: chl=ug/l.
: iengrunits=ug/l for chl; ppb for PC, PE CDOM and uranine.
: column 4=input the scale factor and offset in this column.
: N/U=not used.

maxvoltage=4.96
asv1=6.2606
asv2=12.5355
asv4=25.2860

COLUMNS=5
N/U=1
N/U=2
N/U=3
Chl=4      0.0052  48
N/U=5
```

1. Replace the values in column 4 of this device file with the scale factor and offset values from the field characterization.
2. Save this device file with a new name.
3. To use this new file in the software, select the *File* menu, then push **Load Device File**.

5.3.2 Save field characterization values in sensor

Make sure that the sensor is connected to a 9V battery or power supply and the PC to do these steps.

1. Start the software if necessary.
2. Push **Select COM Port**. Select the communications port on the PC.
3. Push **Device File**. Select the device file from the field characterization.
4. Make sure the sensor is not in operation.
5. Select the *FL Setup* tab.

	Change Settings To	Current Ram Settings	Device File Settings
Set Engr Scale	0.0001	:	0.0052
Set Engr Offset	1	:	48

Turn Engr Output OFF Engr Output: ON

6. Enter the Scale Factor from the field characterization in the variable box under the Change Settings To column. This is the same value as in the edited device file.
7. Push **Set Engr Scale**.
8. Enter the Offset from the field characterization in the variable box under the Change Settings To column.
9. Push **Set Engr Offset**.
10. Push **Store to Flash**.

The sensor saves the field characterization values in its memory. The values show under the Current Ram Settings column in the software.

5.4 Chlorophyll fluorometer-specific setup

ECO sensors that measure only chlorophyll have two device files. One is a standard device file. The other has an additional column that the software uses to give chlorophyll output in $\mu\text{g/L}$.

1. Edit column 5 of the IENGR device file to show field characterization values.

```
ECO      FL-784
Created on:    07/17/11

:      chl=ug/l
:      iengrunits = ug/l for CHL. ppb for PC, PE, CDOM, uranine.
:      column 5 = input scale factor and offset.

maxvoltage=    4.96
asv1=          6.3834
asv2=          12.7597
asv4=          25.5050

: Has internal CHL in meter output

COLUMNS=6
N/U=1
N/U=2
IENGR=3
N/U=4
Chl=5      0.0077  81
N/U=6
```

2. Save the device file with a new name.
3. Refer to the steps in [Save field characterization values in sensor](#) on page 24 to save these values to the sensor in addition to the device file.
4. Select the *File* menu, then "Load Device File" in the software.
5. Select the new device file.
6. Go to the *FL-Setup* tab.
7. Push **Turn Engr Output ON** to turn the $\mu\text{g/L}$ output on.
Push **Start Data**. An additional column of data in units of $\mu\text{g/L}$ shows in the *Raw Data* tab.

Meter Setup	FL-Setup	Raw Data	Plot Data	Transfer
02/06/12 10:17:40	28.22	695	3693	553
02/06/12 10:17:41	28.20	695	3691	553
02/06/12 10:17:42	28.23	695	3694	553

5.5 Device files

The software uses a sensor-specific device file to show the data in the *Plot Data* tab and to calculate the data output in engineering units. Each device file has three necessary elements. The device file is not necessary to use the software to set up and move data from a sensor.

1. The heading for the *Plot Data* tab.
2. The number of columns in the device file.
3. A description of the contents in each column.

Plot Data tab heading

The first line of the device file shows the model number and the serial number of the sensor. This information appears on the top of the *Plot Data* tab in the software.

Number of columns

The column count shows how many columns of data the software will process. The format is COLUMNS=x.

Description of columns

Each column of data from the sensor comes from a description in the device file.

Number of columns=x

Date=x MM/DD/YY

Reference

Time=x HH:MM:SS
 N/U=x not used
 sc=scale factor
 off=offset
 IENGR=x
 mw=measurement wavelength of the sensor
 dw=display wavelength of the sensor

Example of a fluorometer device file	
chl, phycoerythrin, phycocyanin, uranine, rhodamine, or CDOM=x sc off Column 4 = scale factor (sc) offset (off).	<pre> ECO FLS-1822 Created on: 04/29/2011 : chl=ug/l. : iengr units=ug/l for chl; ppb for PC, PE CDOM and uranine. : column 4=input the scale factor and offset in this column. : N/U=not used. maxvoltage=4.96 asv1=6.2606 asv2=12.5355 asv4=25.2860 COLUMNS=5 N/U=1 N/U=2 N/U=3 Chl=4 0.0052 48 N/U=5 </pre>
Example of a fluorometer device file with µg/L	
chl, phycoerythrin, phycocyanin, uranine, rhodamine, or CDOM=x sc off Column 5 = scale factor (sc) offset (off).	<pre> ECO FL-784 Created on: 07/17/12 : has internal CHL in output. : iengr units = ug/l for CHL, ppb for PC, PE, CDOM, uranine. : column 5 = input the scale factor and offset values. maxvoltage=4.96 asv1= 6.3834 asv2= 12.7597 asv4= 25.5050 COLUMNS=6 N/U=1 N/U=2 IENGR=3 N/U=4 Chl=5 0.0052 48 N/U=6 </pre>
Example of a scattering sensor device file	
lambda (scattering wavelength) = x sc off mw dw Column 4 = scale factor (sc), offset (off), measurement wavelength (mw), and display wavelength (dw).	<pre> ECO BBS-974g Created on: 08/28/12 Columns=5 Date=1 Time=2 N/U=3 Lambda=4 7.916E-06 51 532 532 N/U=5 </pre>
Example of a turbidity sensor device file	
NTU = x sc off Column 4 = scale factor (sc) and offset (off).	<pre> ECO NTUSB-503 Created on: 09/07/2012 COLUMNS=5 N/U=1 N/U=2 N/U=3 NTU=4 0.0153 50 N/U=5 </pre>

5.6 Terminal program operation

Use Windows HyperTerminal®, Tera Term, or other terminal program as an alternative to the manufacturer-supplied software to operate sensors.

baud rate: 19200	stop bits: 1	data bits: 8	flow control: none	parity: none
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5.6.1 Common terminal program commands

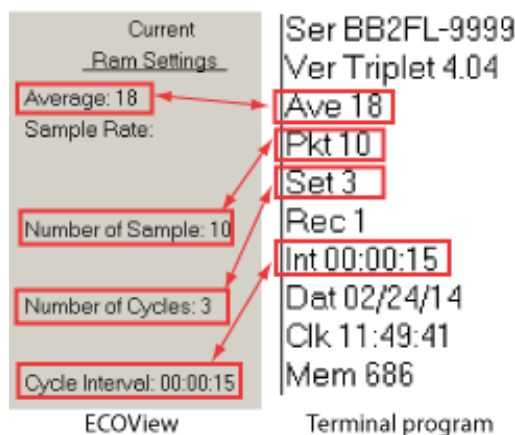
Command	Parameters	Description
!!!!	none	Stops the data collected by the sensor. Lets the user to enter setup values. If the sensor is in a low-power mode, turn the power supply off for one minute, then turn the power on and push the "!" key 5 or more times.
\$ave	1–255	The number of measurements that make up each row of collected data.
\$mnu	—	Prints the menu of setup values to the PC screen.
\$pkt	0–65535	Sets the number of rows of data that are collected between the specified time intervals.
\$rls	none	Gets the settings from the flash memory.
\$run	—	Uses the current setup values to operate.
\$sto	—	Saves the desired setup values to the flash memory.

5.6.2 Terminal program commands for sensors with internal memory

Command	Parameters	Description
\$clk	24-hour time	Sets the time in the internal memory in the format hhmmss.
\$date	date	Sets the date in the internal memory in the format mmddyy.
\$emc	—	Clears the internal memory.
\$get	—	Reads data from the internal memory. Prints etx when it is complete.
\$int	24-hour time	Sets the time interval between sets of measurements the format hhmmss.
\$mvs	1 = ON; 0 = OFF	1 = the Bio-wiper is open. 0 = the Bio-wiper is closed.
\$rec	1 = ON 0 = OFF	1 = Turns on the sensor's internal memory. 0 = Turns off the sensor's internal memory.
\$rls	—	Loads the settings from the flash memory.
\$set	0–65535	Sets the number of rows of data that are output between low-power states.

5.6.3 ECOView and terminal program differences

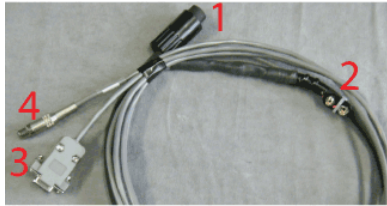
ECOView uses different but equivalent words for data collection options.



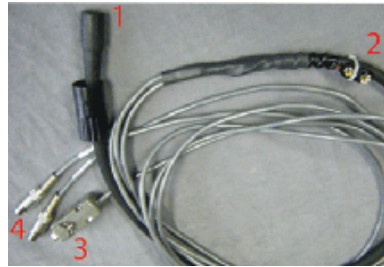
Section 6 Optional equipment

6.1 Test cable

Use a test cable to set up and test the sensor before deployment.



One analog output connector



Two analog output connectors



No analog output

1 six-contact connector	3 db-9 serial port connector
2 9-volt battery connector	4 RCA connector(s)

1. Connect the six-contact connector to the sensor.
2. Connect the 9-volt connector to a 9-volt battery. As an alternative, it can be connected to a regulated power supply.
3. Connect the db-9 connector to the PC. Use a USB-to-RS232 adapter cable if necessary.
4. Use a digital multimeter (DMM) to see analog output (if applicable) from the sensor. The inside of the RCA is signal (red DMM probe) and the outside is ground (black DMM probe).

6.2 Internal batteries

⚠ WARNING



Explosion hazard. If the batteries are not installed correctly, explosive gases can be released. Make sure that the batteries are of the same approved chemical type and are inserted in the correct orientation.

⚠ WARNING



If the user thinks that a sensor has water in the pressure housing: Disconnect the sensor from any power supply. Put on safety glasses and make sure that the sensor is pointed away from the body and other people. In a well ventilated area, use the purge port (if the sensor is so equipped), or very SLOWLY loosen the bulkhead connector to let the pressure release.

⚠ WARNING



If the user thinks that the lithium batteries have leaks, pressure may have built up inside of the pressure housing. Follow ESD protocols to release internal pressure. Put on safety glasses and protective gloves and make sure that the sensor is pointed away from the body and other people. In a well ventilated area, very SLOWLY loosen the bulkhead connector to release the pressure. Keep away from heat, sparks, flame, and other sources of ignition. Do not smoke.

⚠ CAUTION	
 	The pressure housing contains Electrostatic Discharge (ESD) sensitive parts and assemblies that are susceptible to damage from ESD. Follow ESD protocols: • Put on protective eye wear before you open the pressure housing. • Any electrostatic charge on the body of the human operator must be released before the pressure housing is opened: put a hand on a grounded surface, or better, wear a grounded antistatic wrist strap. • At a minimum, wear short-sleeved antistatic clothing, such as cotton, or better, wear an antistatic smock for this service activity. <i>Do not wear a sweater, fleece or polyester-based clothing.</i> • At a minimum, use a workstation with a wood or metal tabletop, or better, a tabletop that dissipates static. <i>Do not use a workstation with a synthetic or polymeric-based tabletop.</i>

Flooded sensors are usually not serviceable. There is a small chance that the manufacturer can get the data that is stored in the sensor. Contact service@wetlabs.com for more information about flooded sensors.

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The use of alkaline or lithium manganese dioxide (LiMnO₂) batteries will not damage the sensor but the capacity is much lower than UltraLife® batteries.

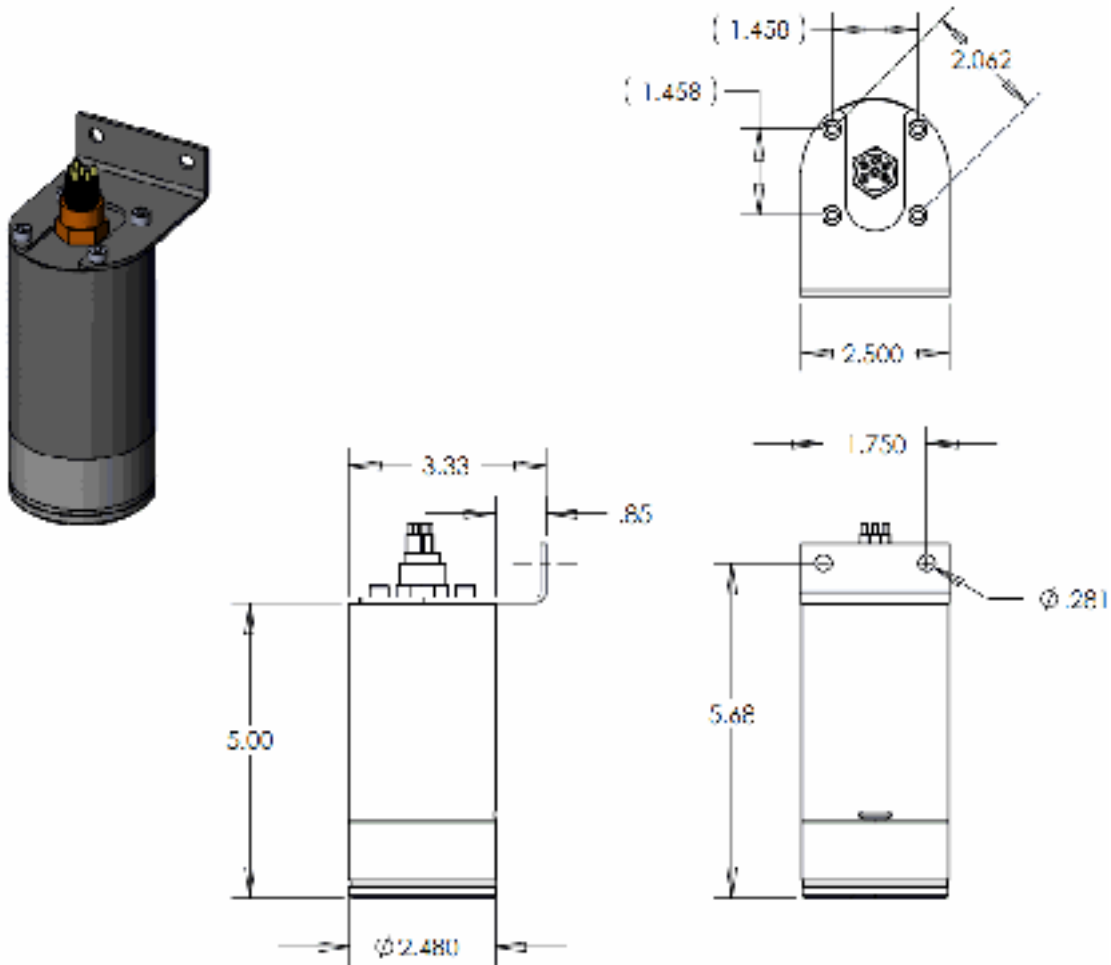
Note: *The nominal water temperature, sequence timing, sample periods, and other variables will change the use-time of the sensor's internal batteries.*

6.3 Bio-wiper and copper faceplate

The Bio-wiper and copper faceplate help decrease bio-fouling during extended deployments. The Bio-wiper is controlled manually using a controller, or it can work autonomously as pre-programmed before a deployment. The temperature and the depth at which the sensor is deployed will change the Bio-wiper cycle time.

6.4 ECO mounting bracket

The details of the mounting bracket for the *ECO* sensors are shown below. The mounting bracket is not installed on sensors with internal batteries or those rated to 6000 m depth.



6.5 Discontinued equipment: external thermistor

This optional equipment is no longer available on new *ECO* sensors as of 15 June 2015.

The calibration coefficient value for the thermistor is on the sensor's characterization page that ships with the sensor. The thermistor gives temperature output in counts. Do one of the methods below to change counts to engineering units.

1. Use the drop-down menu in the *Plot Data* tab of the software to see the thermistor output in °C.
2. Use MATLAB, MS Excel or other software to solve for:
 - Temperature, °C = (Output × Slope) + Intercept

6.6 Discontinued equipment: pressure sensor

This optional equipment is no longer available on new *ECO* sensors as of 15 June 2015.

The calibration coefficient value for the pressure sensor is on the calibration page that ships with the sensor. The pressure sensor gives pressure output in counts. Do one of the methods below to change counts to engineering units.

1. Use the drop-down menu in the *Plot Data* tab of the software to see the pressure sensor output in dbar.
2. Use MATLAB, MS Excel or other software to solve for:
relative pressure, dbar = (output × slope) + intercept
3. Calculate the absolute pressure:
 - absolute pressure, dbar = relative pressure, dbar - relative pressure at atmospheric-water interface, dbar.

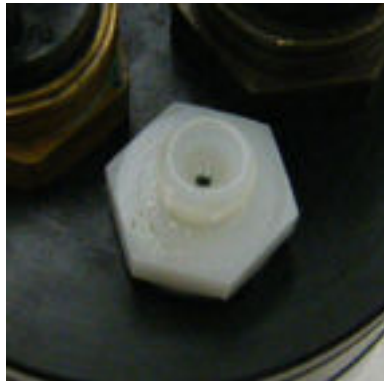
Set the pressure sensor to zero for each deployment. Do not deploy the pressure sensor deeper than the depth rating on the calibration page.

Pressure sensor maintenance

The plastic fitting filled with silicone oil is a buffer between the pressure transducer diaphragm and seawater. Add silicone oil to the reservoir on top of the transducer at regular intervals.

1. Make sure the top of the sensor is clean.
2. Use a 9/16" wrench to hold the white nylon Swagelok® fitting.
3. Use a 7/16" wrench to loosen the cap on top of the fitting.
4. Remove the cap.
5. Use a wire or toothpick to clean the hole in the cap.
 - Do not blow compressed air into the fitting. It will make a mess.
6. Add Dow Corning® 200 Silicone Oil to the reservoir until the oil is in view.

Figure 9 Pressure sensor cap



7. Replace the cap. Make sure not to tighten the cap too much.
8. Clean any excess oil from the end flange of the sensor.

Section 7 General information

Revised editions of this user manual are on the manufacturer's website.

7.1 Warranty

Refer to the manufacturer's website for warranty information (seabird.com/warranty).

7.2 Service and support

The manufacturer recommends that sensors be sent back to the manufacturer annually to be cleaned, calibrated, and for standard maintenance.

Refer to the website for FAQs and technical notes, or contact the manufacturer for support at support@seabird.com. Do the steps below to send a sensor back to the manufacturer.

1. Complete the online Return Merchandise Authorization (RMA) form or contact the manufacturer.
***Note:** The manufacturer is not responsible for damage to the sensor during return shipment.*
2. Remove all batteries from the sensor, if so equipped.
3. Remove all anti-fouling treatments and devices.
***Note:** The manufacturer will not accept sensors that have been treated with anti-fouling compounds for service or repair. This includes AF 24173 devices, tri-butyltin, marine anti-fouling paint, ablative coatings, etc.*
4. Use the sensor's original ruggedized shipping case to send the sensor back to the manufacturer.
5. Write the RMA number on the outside of the shipping case and on the packing list.
6. Use 3rd-day air to ship the sensor back to the manufacturer. Do not use ground shipping.
7. The manufacturer will supply all replacement parts and labor and pay to send the sensor back to the user via 3rd-day air shipping.

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