Water Quality Monitor (WQM)

Hardware User's Guide

This user's guide is an evolving document. If you find sections that are unclear, or missing information, please let us know. Please check our website periodically for updates.

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WET Labs

This unit is guaranteed against defects in materials and workmanship for one year from the original date of purchase. Warranty is void if the factory determines the unit has been abused or neglected beyond the normal wear and tear of field deployment, or if the pressure housing has been opened by the customer.

To return the instrument, contact WET Labs for a Return Merchandise Authorization (RMA) and ship in the original container. WET Labs is not responsible for damage to instruments during the return shipment to the factory. In honoring this warranty, WET Labs will supply all replacement parts and labor, and pay for return via 3rd-day air shipping.

Shipping Requirements

1. Please retain the original shipping material. We design the container to meet stringent shipping and insurance requirements, and to fully protect the WQM.

2. To avoid additional repackaging charges, return the instrument in the original box (or other WET Labs-approved container), using the custom-cut packing foam and anti-static bag.
   - If you use an alternative container, fully surround the instrument with at least 2 inches of foam (NOT bubble wrap or Styrofoam "peanuts").

3. Clearly mark the RMA number on the outside of your shipping container and on all packing lists.

4. Return instruments using 3rd-day air shipping or better: do **not** ship via ground.

Attention!

Return Policy for Instruments with Anti-fouling Treatment

WET Labs cannot accept instruments for servicing or repair that have been treated with anti-fouling compounds, such as marine anti-fouling paint. These products present a handling hazard to our technicians and can damage our laboratory equipment. You must scrape, sand, or otherwise remove all traces of anti-fouling treatment. Also, please note that chemical strippers are likely to damage the WQM housing.

Appendix A suggests alternate methods of biofouling prevention and removal. Please consider using these rather than harsher anti-fouling compounds.

This return policy does not apply to the CTD's in-line anti-fouling cartridge provided with the instrument.

1. Instrument Description

The Water Quality Monitor (WQM) is designed to deliver core biogeochemical water quality parameters in coastal ecosystems from a single integrated package. The WQM combines WET Labs' chlorophyll and fluorometer-turbidity sensors and Sea-Bird's conductivity, temperature, and depth (CTD) and Dissolved Oxygen (DO) sensors.

WET Labs' WQM is designed for long-term deployment on moorings. The WQM has undergone extensive testing in a variety of biofouling regimes.

Please refer to the WQM page on the WET Labs website for the most complete and updated information, including links to live data, our latest test results, papers, FAQ's, and recommended procedures.

1.1 Conductivity, Temperature, Depth Sensor

The CTD components of the WQM are the same accurate and stable thermistor, conductivity cell, and pressure sensors that are used in the SBE MicroCAT and ARGO float products. WET Labs has fortified them for long-term deployment on moorings in high biofouling regimes by incorporating multiple active and passive anti-biofouling technologies. The pump-controlled, TC-ducted system delivers a constant flow rate across the sensors; this maximizes data coherence during sampling, and enhances the protection offered by two anti-biofouling devices located on the inlet and outlet flow ducts. Copper canisters act as additional passive anti-fouling protection for the CTD and the intake and exhaust of the plumbing system.

1.2 Dissolved Oxygen Sensor

The WQM incorporates a Sea-Bird Electronics SBE 43 dissolved oxygen sensor, explicitly engineered for pumped CTD applications to provide stable, rapid-response DO measurements. The SBE 43 is a complete redesign of the Clark electrode sensor, incorporating numerous features that eliminate weaknesses of previous implementations of the Clark method (http://www.seabird.com/technical_references/IOS43Article.pdf). These sensors undergo an 18-point automated calibration procedure at the factory (3 oxygen concentrations at 6 temperatures), and are well characterized with temperature, pressure and salinity in the calibration equations. The SBE 43 is plumbed inline with the CTD and benefits from the same passive biofouling protection provided in the CTD. The sensor is continuously polarized using a 5-year lithium battery, eliminating long polarization wait-times of older designs.

Errors due to improper temperature compensation are avoided by sensor's geometry and by placing a thermistor near the cathode to make the temperature compensation measurement in phase with the oxygen measurement. The pump produces a fixed flow rate across the membrane, ensuring adequate flow past the sensor and eliminating changing response time with variations in flow. The result is sensor with a response time of less than 2 seconds.

Periodic injection of bleach, a rapidly diffusive oxidizer, immediately inhibits biota present within the pumped volume and compliments the slowly diffusing broad spectrum anti-foulant cartridges protecting the conductivity cell. The bleach is especially helpful when the sampling interval is less than 30 minutes. Sampling more often may not allow the slowly diffusing anti-foulant to build to its most effective concentration. The multi-tiered anti-foulant approach allows users to make a knowing choice between short sample intervals and fouling resistance to suit their science and operational goals.

1.3 Chlorophyll Fluorometer and Turbidity Sensor (FLNTU)

The combination fluorometer and turbidity sensor uses a dual-LED/single-detector system that measures both chlorophyll fluorescence and turbidity within the same volume of water. Chlorophyll fluorescence is excited with a 470 nm LED, while the turbidity measurement employs a 700 nm LED. The detector measures the returned light using a filter set to limit the response to the near infrared region corresponding to the peak of chlorophyll emission (695 nm) and the particulate backscattering at 700 nm. The detector angle, with respect to the excitation optics, is 140 degrees.

1.4 BLeach Injection System (BLIS)

Each WQM is equipped with a bleach injection system. The system periodically injects user-determined measured amounts of a household-grade bleach solution into the plenum of the DO sensor. Field trials show that periodic bleach injection prolongs the WQM deployment by at least a month or more.

1.5 Control Electronics

The control electronics and associated firmware and software allow the user to program the WQM sampling scheme, output, and bleach injection routine. For specific information about software controls, please see the WQM software user's guide.

1.6 Delivered Equipment

Installed Parts

Qty	Item	P/N
1 1	6-socket dummy plug Lock collar	EXA-KX0038 EXA-KX0025
1 1	4-pin dummy plug Lock collar	EXA-KX0004 EXA-KX0025

Spare Parts Kit

Qty	Item	P/N
1	Playtex® Premium Nurser kit (silicone nipple); includes drop-in liners	XXX-000086 XXX-000087
1	Test cable	CXA-KX0115
1 1	Pigtail, six-socket Lock collar	EXA-KX0018 EXA-KX0025
1	3/32-in. hex key for Bio-wiper™	GXA-SX0050
1	5/32-in. hex key for CT–BLIS clamp	GXA-SX0109
1	7/64-in. hex key for BLIS	GXA-SX0093
3	4-40 x 3/8-in. 316 stainless steel socket-head cap screws for Bio-wiper™	GXA-SX0099
8	4-40 x ¼-in. pan head acetal flathead screws	GXA-SX0146
3	4-40 x ¼-in. flat head Phillips screws	GXA-SX0155
4	6-32 x 3/8-in. nylon socket-head cap screws for BLIS	GXA-SX0067
1	Fluorescent stick for bench testing FLNTU	MAA-220050
1	Scotch-Brite™ pad for cleaning copper	XXX-000229
1	CT-DO cleaning device	50431
1	50 ml plastic bottle, Triton®X-100	50091
1	Ecominder anti-fouling paint kit	BAA-003000
1	3/8-in. right-angle hose barb	RXA-031630

1.7 Specifications

Conductivity

Range	0–9 S/m
Accuracy	0.003 mS/cm
Resolution	0.0005 S/m

Depth

Range	0–100 or –200 m
Accuracy	0.1% FS
Resolution	0.01% FS

Fluorescence

Range[c]	0–50 µg/l
Accuracy[d]	0.2% FS µg/l
Precision	0.04% FS µg/l
Wavelength	EX/EM 470/695 nm

Electrical

Connector	MCBH-6-MP, MCBH-4-FS
Output	RS-232
Input	12–18 VDC
Current draw	275 mA (typical)
Current draw	< 100 µA (sleep)
Sample rate	1 Hz

Temperature

Range	-5–35 deg C
Accuracy	0.002 deg C
Resolution	0.001 deg C

Dissolved Oxygen

Range[a]	120%
Accuracy[b]	0.1 mg/l
Resolution	0.01 mg/l

Turbidity

Range[c]	0–25 NTU
Accuracy	0.1 FS NTU
Precision	0.04% FS NTU
Wavelength	700 nm

Mechanical

Depth[e]	200 m
Pressure housing	Acetal copolymer, ABS, PVC, titanium, copper
Dimensions	65.4 cm long x 18.5 cm max OD
Weight in air	5.4 kg
Weight in water	1.8 kg

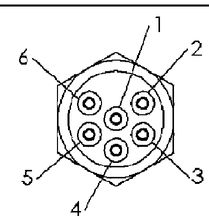
a. Oxygen range is relative to surface saturation.
b. +/- 0.2 mg/l or 2% of reading, whichever is greater.
c. Available measurement ranges:

- 0–30 µg Chl/l, 0–10 NTU
- 0–50 µg Chl/l, 0–25 NTU
- 0–125 µg Chl/l, 0–1000 NTU

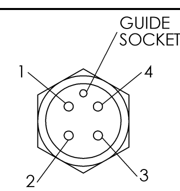
d. Chlorophyll fluorescence is created by living organisms and is subject to taxonomical and physiological changes. Field calibration is highly recommended. See user's guide for standard protocols.
e. Depth rating is the lesser of 200 m or the pressure sensor rating.

1.7.1 Connector Pinout Summary for WQM

Pin	Function
1	Ground
2	RS-232 (RX from host)
3	NC
4	V +
5	RS-232 (TX to host)
6	NC

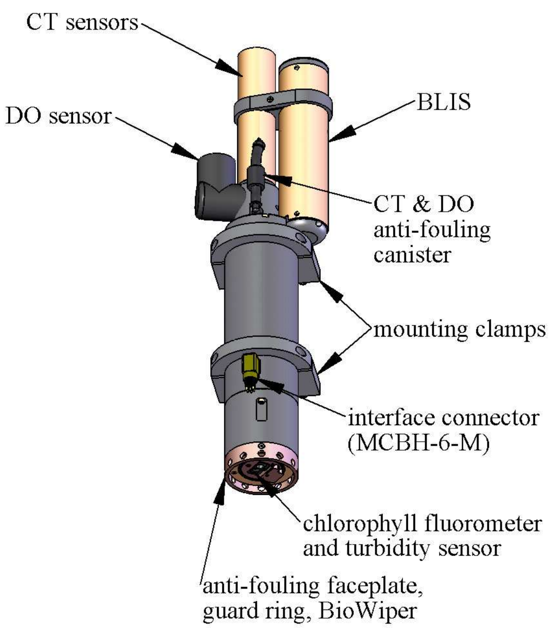


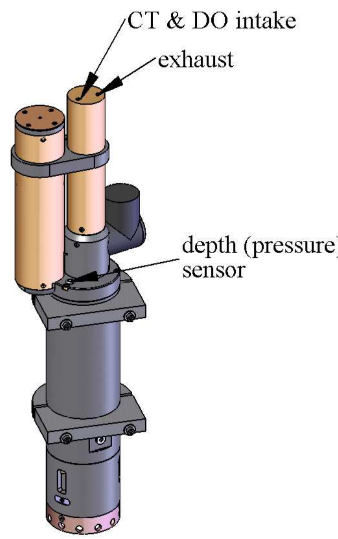
Socket	Function
--	NC
--	NC
--	NC
--	NC



2. Setup and Operation

The illustrations below show the main exterior features and sensor locations of the WQM, in its vertical orientation: the CTD is at the top and the fluorometer and turbidity optical sensors are at the bottom, facing down. This allows bubbles to float free of the CT- and DO-sensors' plumbing system, and it shields the optical sensors from direct sunlight. Under normal conditions, the optical sensors are not sensitive to external light sources; however, the detector may saturate if pointed directly at the sun.

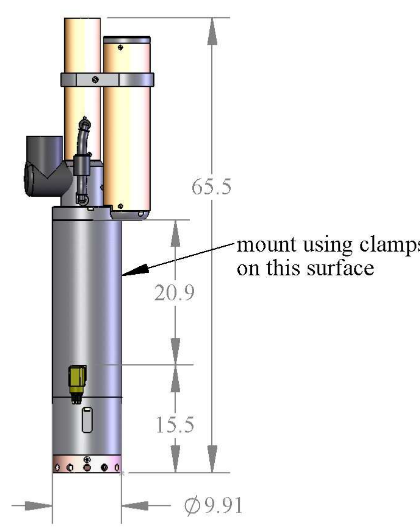




2.1 Mounting WQM for Deployment

WET Labs recommends an vertical, or upright, mounting orientation.

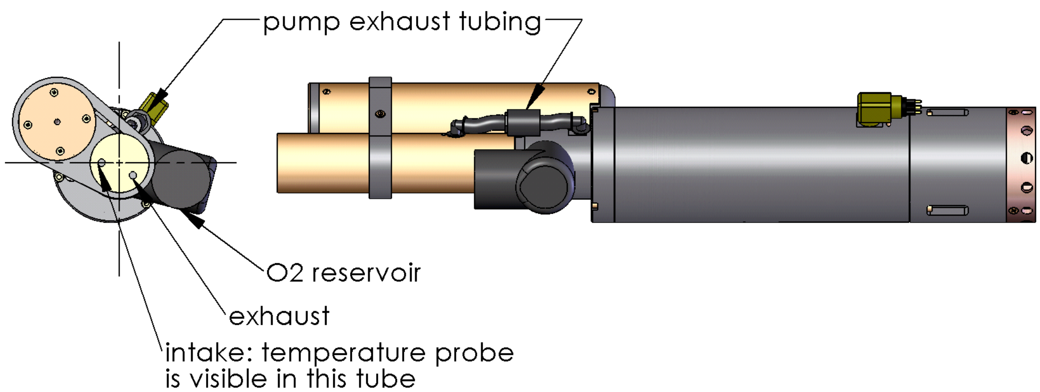
The best location for mounting clamps (available separately from WET Labs) is along the 20.9-cm long surface of the body. See illustration at right. Do not attach clamps below the connector, or to the copper parts on top. The cable will loop down below the connector. To keep it from interfering with the optical instruments, attach it to the guard ring with a cable tie.



Side View

2.1.1 Mounting WQM for Horizontal Deployment

When it is not possible to orient the WQM vertically, it may be mounted horizontally, as shown below. Note that the intake duct is in the 9:00 position when viewed from the end of the CTD (see left image below). Horizontal mounting creates a challenge for the pump and plumbing to purge air from the system. The orientation shown helps the pump fill with water, enabling it to operate properly. Several sample cycles may pass before all bubbles are purged from the system. If noisy conductivity data persists when operating the instrument horizontally, a special plumbing fitting is available to improve air purging. Contact WET Labs. Place mounting clamps (optional equipment) on the main body of the WQM, as for vertical mounting. (See illustration on page 5.)



2.2 Preparing the BLIS for Deployment

During normal operations, to prevent bleach from being pumped into a dry CT-DO sensor manifold, the BLIS operates only when the WQM is immersed in water.

WARNING!

Bleach is very corrosive and harmful to almost every part of the WQM. Great care should be taken to ensure that bleach is not inadvertently pumped by the BLIS into the WQM. When testing the BLIS system, the WQM should always be immersed in water and the plumbing filled with water.

Before a WQM is deployed, the BLIS must be filled with bleach and the BLIS pump primed. BLIS uses a 125 ml Playtex® Premium Nurser baby bottle as a bleach reservoir. This product has a disposable drop-in liner of HDPE plastic, and a silicone nipple, which allow long-term exposure to bleach. DO NOT substitute other bottles.

The host software calculates the maximum deployment time based on each pump's calibration information. The software also allows you to adjust the injection quantity and frequency. The rate of marine growth in your area may be an overriding factor in setting your bleach injection schedule. Other factors to consider are bleach quality, age, and concentration.

The BLIS pump's injection rate may vary as it ages. WET Labs will test the pump and adjust the calibration during annual servicing.

2.2.1 Check BLIS Operation

1. Remove the BLIS end cap: Use a 7/64-in. hex key to remove the two screws.

2. Twist and pull to remove the cap and expose the bleach reservoir.

3. Grasp the bleach reservoir by the rim of the bottle and pull gently. You may feel the resistance of a slight suction as the nipple pulls free of the intake.

4. Remove the BLIS–CTD clamp. Use a 5/32-in. hex key to loosen the clamp. Slide it up and off the BLIS and CTD.

5. Use a 7/64-in. hex key to remove the two screws at the base of the outer BLIS sleeve (copper tube).

WARNING!
The BLIS will clog and malfunction if it intakes sediment or other solids.

6. Remove the outer BLIS sleeve by pulling straight up with a minimum of twisting.

WARNING!
Do not scrape the sides of intake. Scratches on this surface will prevent the nipple of the bleach reservoir from sealing properly.

7. Clean the BLIS module (black plastic housing attached to WQM) with fresh water and a rag to remove all sediment and loose material. Inspect the intake and rinse it gently with fresh water if you see debris in the intake.

8. Clean the BLIS cap and outer sleeve with fresh water and a rag to remove all sediment and loose material. These parts must be clean to protect the BLIS intake during reassembly. Firmly attached corrosion (i.e. patina) is ok. Flaking corrosion must be removed with Scotch-Brite.

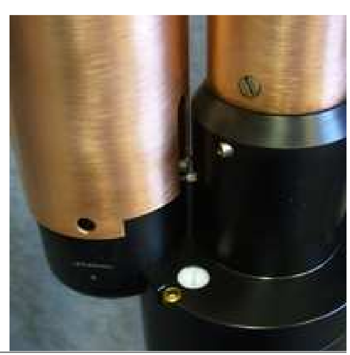
9. Connect the WQM to the host PC and establish communication with the host software. Supply power to the WQM: it will automatically begin collecting data. Select Stop WQM Sample.

Fill the bleach intake port with water. Command the pump to inject 300 squirts (150 seconds at 2 Hz). The intake should be emptied before the pump stops.

Troubleshooting water in the intake—if the water level does not recede:

- Make sure you're giving it enough time. The flow rate is ~1ml/min.
- Can you hear the pump clicking? It makes a "squishy" clicking sound that is distinct from the sharper clicking that occurs simultaneously inside the WQM closer to the ECO.
- If the pump is not clicking, make sure the unit is plugged in and powered up. Check communications via the host.
- Check again for intake blockage.
- Call WET Labs Technical Support for further instructions or to obtain an RMA for return.

10. Reassemble the outer sleeve to the base of the BLIS. The slot in the sleeve must line up with the little tube between the BLIS and the CT-DO sensor head.



11. Secure the outer sleeve to the BLIS base. Install the two 6-32 x 3/8-in. screws using the 7/64-in. hex key.

12. Slide the clamp over the CT guard and the BLIS sleeve into position, approximately as shown. Use the 5/32″ hex key to snug up the screw. Do not overtighten.

13. Install the BLIS end cap:

    Unless you are returning the WQM to service immediately, install the BLIS end cap to keep the parts together and to keep the BLIS intake clean.

2.2.1 Fill the BLIS Reservoir with Bleach

1. BLIS reservoir parts (L-R): bottle body, drop-in liner, silicone nipple with threaded cap.

2. Install the drop-in liner in the bottle body. Push the liner's bottom with your fingers to give it some shape.

3. Use a graduated cylinder to measure bleach; record the amount used. The reservoir holds 125 ml nominal, or 150 ml to the brim.

4. Pour the bleach into the liner. Note that dye was added for these photos.

5. Screw on the cap and silicone nipple. Make it snug, but do not overtighten. The nipple will fill with solution when mounted in the vertical (recommended) orientation.

6. If you intend to mount the WQM horizontally, or if the air in the reservoir is otherwise of concern, purge the air by pushing up on bottom of the drop-in liner with your fingers until bleach flows from the nipple.

2.2.2 Install BLIS Reservoir

1. Wet reservoir's nipple with clean water, then set it into the BLIS as shown.

2. Seat the nipple in the intake. Grasp the rim of the reservoir and rotate the reservoir back and forth about 15 degrees (about 1 cm at the rim.)

Gently push down on the rim as you rotate it and the nipple will seat properly in the intake.

If you have any question about performing this procedure, practice while the BLIS outer sleeve is removed. Use water, not bleach when practicing.

3. Set the BLIS end cap into the BLIS outer sleeve. It will compress the reservoir and ensure that the nipple remains sealed in the intake.

WARNING!
Bleach is corrosive to many of the WQM's outer components. Avoid spilling bleach onto the instrument.

4. Gently press down on the cap and align the threaded holes in the cap with the holes in the outer sleeve.

5. Install the two 6-32 x 3/8-in. nylon screws, one on each side.

   DO NOT re-use old screws. Replacement screws are in the spare parts kit that shipped with the WQM and are available from WET Labs.

6. Draw bleach into the pump. Run the BLIS pump for 10 seconds at 2 Hz. This will draw bleach from the bottle into the BLIS plumbing, but will not pump bleach as far as the CT/DO chamber.

7. Flush the CT-DO flow path with fresh water for several minutes and rinse the housing thoroughly to remove any bleach that may have spilled or entered the flow chamber.

⇨ *Tool Tip*—A lab sink or laundry tub with a water supply via 3/8-in. ID Tygon tubing will make flushing the flow path easier. A garden hose will work as well; just keep the flow below 2 liters/min when flushing the CT-DO passages.

3. WQM Maintenance and Cleaning

The WQM should be serviced after each deployment, but in highly productive regions, it may need more frequent servicing. In addition, WET Labs recommends you return your WQM to us annually for a thorough cleaning and servicing by our trained technicians.

The procedures in the following sections are for cleaning the conductivity cell and dissolved oxygen sensor. These components are in the CT-DO pumped flow path.

3.1 Cleaning Supplies and Solutions

3.1.1 Supplies

- Deionized (or distilled) water. If not available, fresh tap water; warm (wrist temperature)
- Dilution of Triton® 100-X —1000:1
- Dilution of bleach—50:1
- CT-DO cleaning device
- 2 beakers
- Scotch-Brite™ pad
- 500 ml graduated cylinder
- 100 ml graduated cylinder
- Small Phillips screwdriver

3.1.2 Preparation of Cleaning Solutions

- **Bleach**—dilute household bleach to 50:1 (1 liter of water to 20 ml of bleach) to produce the proper concentration to clean the oxygen sensor.
- **Triton® 100-X**—dilute the concentrated Triton® 100-X to 1000:1 (1 liter of warm water to 1 ml of Triton® 100-X). Allow solution to come to room temperature (approx. 20 deg C) prior to use.

Cautions

- Stronger solutions do not improve efficacy of cleaning.
- Do not use stronger solutions or longer wash times than recommended above.

WARNINGS

- **Do not use Triton® 100-X for long washes. Prolonged exposure of Triton® 100-X is harmful to the DO sensor membrane and causes the sensor's calibration to drift.**
- **Never put full strength Triton® 100-X or bleach into the instrument.**

Notes on materials and substitutions:

- Triton® 100-X—Triton® 100-X is included with every WQM shipment and may be ordered from WET Labs. Dilute as directed above. Triton® 100-X is Octyl Phenol Ethoxylate, a mild, non-ionic surfactant (detergent), and is manufactured by Mallinckrodt Baker (see http://www.mallbaker.com/changecountry.asp?back=/Default.asp for local distributors). Other liquid detergents can probably be used, but scientific grades (with no colors, perfumes, glycerins, lotions, etc.) are required.

- **Bleach**—Bleach is a common household product used to whiten and disinfect laundry. Bleach is typically 4–7 percent (40,000–70,000 ppm) sodium hypochlorite (Na-O-Cl) solution that includes stabilizers. Some common commercial product names are Clorox (U.S.) and eau de Javel (French).

- **Water**—De-ionized (DI) water is reliably pure, but commercially distilled water or fresh clean tap water is also sufficient for all uses above. On ships, fresh water can occasionally contain traces of oil and should not be used for rinsing, cleaning, or storing sensors, unless there is no alternative. Bottled drinking water or filtered water is the best alternative in this situation.

3.2 Cleaning Conductivity and Dissolved Oxygen Sensors

Follow the steps below for a routine cleaning, sufficient when the WQM has no visible deposits or marine growth post-deployment. Sensors with visible deposits and marine growths are considered severely fouled. For such sensors, repeat the steps for a routine cleaning (below) up to five times.

Soak the CT-DO chambers with DI water (or alternative) at room temperature (~ 20 deg C). This will kill any salt water organisms and will help loosen unwanted material. You may wish to submerge the entire instrument. Soak for at least 30 minutes, then flush.

1. Cut the cable tie on the exhaust tubing, if present.

2. Slip the exhaust tubing from the elbow by flexing the assembly. Do not remove the screws holding the elbows.

3. Slip the 3/8-in. ID tubing of the CT-DO Cleaning Device onto the exhaust elbow.

4. Remove the syringe plunger. Hold the syringe up and slowly pour about 1 liter of DI water into the syringe to clean any loose debris from the pumped system. If you have access to a water system, you may connect directly to this port as shown below.

5. Still holding the syringe up, pour it full of the diluted Triton cleaning solution.

6. Replace the syringe plunger. Inject the solution into the CT-DO chamber.

7. Agitate the solution by rapidly pushing and pulling on the syringe plunger. Suds will eject from the intake port.

8. Repeat steps 4–6 several more times.

9. Remove the syringe plunger. Hold the syringe up and pour it full of the diluted bleach solution.

10. Replace the syringe plunger. Inject the solution into the CT-DO chamber.

11. Agitate the solution by rapidly pushing and pulling on the syringe plunger.

12. Repeat steps 9 and 10 several more times.

13. Flush with DI water as you did at the beginning (Step 4) to clear all traces of bleach and detergent.

- Flushing is simplified with a DI water system, shown here. Flush by directing a stream into the intake port at the top of the instrument, or by connecting to the exhaust elbow. Use only gentle pressure—2 liters/min is sufficient.
- After cleaning, reassemble the exhaust tubing and secure with cable ties, if desired.
- Cover the inlet and exhaust ports with tape to keep the oxygen sensor moist during short-term storage. Remove tape prior to deployment.

3.2.1 Replacing CT-DO Intake Anti-fouling Device

The WQM is equipped with two anti-fouling devices in the CT-DO flow path. One is in the intake and the other is in the exhaust. They are effective for approximately a year. WET Labs strongly recommends you return your WQM annually for service, which includes factory replacement of the anti-fouling devices.

WARNING!

Anti-fouling devices contain tributyltin oxide. Wear rubber or latex gloves and eye protection when handling. Wash hands thoroughly after handling.

Contact Sea-Bird Electronics to obtain replacement cartridges (P/N AF24173).

1. Use a #2 Phillips screwdriver to remove the two screws on opposite sides of the copper sleeve.

   Do not remove the three screws on top.

2. Pull the cap up and off to expose the T-C duct top. **Do not twist.** If it is difficult to remove, pry gently and evenly with a screwdriver.

3. Use a #0 Phillips screwdriver to loosen the four screws securing the T-C duct top.

   Note that the screws have tiny O-rings under their heads.

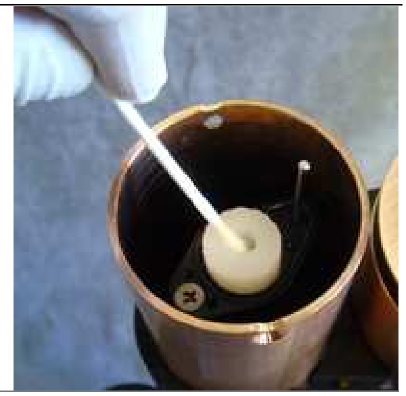
4. Lift the T-C duct top straight up and off.

5. The anti-foulant cartridge in the T-C duct base is now visible.

   The O-ring may pop out of its groove. Gently push it back into place if necessary.

6. Use a cotton swab to carefully remove the anti-foulant cartridge from the T-C duct base without pushing the swab all the way through, as the conductivity cell may be damaged.

   If the anti-foulant cartridge is difficult to remove, use needle-nose pliers and carefully break up the material.



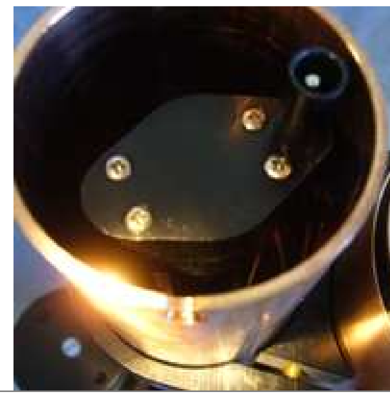
7. While the anti-foulant cartridge is removed, wipe out its recess in the T-C duct base.

8. Place the used anti-foulant cartridge and swab into a bag for disposal.

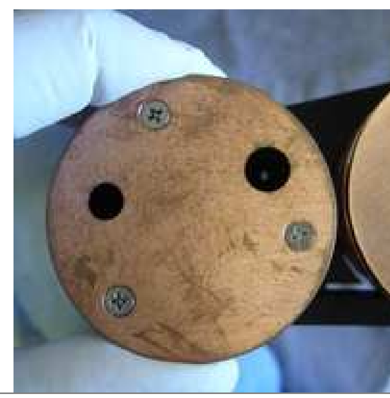
9. Thread a new anti-foulant cartridge onto a swab and slide it into the recess.

10. Use the end of the swab to seat the anti-foulant cartridge. Check the O-ring to make sure it's free of contamination such as lint from the swab.

11. Replace the T-C duct top. The four screws should be just snug. There should be no gap between the T-C duct top and the T-C duct base.



12. Align the cap as shown and slide it into place. You can see the tip of the temperature probe in the hole on the right.



13. Install the two large Phillips head screws on either side of the cap.

3.2.2 Replacing CT-DO Exhaust Anti-fouling Device

1. The second anti-foulant cartridge is in the canister in the exhaust tubing.

2. Carefully rotate the plumbing elbows and flex the tubing to disconnect the canister. Note that one end has wrench flats.

3. Unscrew the end of the canister.

4. Replace the anti-foulant cartridge as you did on the intake.

Re-assembly is the reverse of the removal.

3.3 Cleaning the FLNTU

After each deployment, flush with clean fresh water.

WARNING!
Do not use acetone or other solvents to clean the sensor.

Remove the Bio-wiper™ and copper faceplate to access the sensor face (see procedure below). The sensor face is composed of ABS plastic and optical epoxy, and can easily be damaged or scratched. Use soapy water to remove any grease or oil accumulation. Rinse well and gently wipe dry with a soft cloth. Then follow the instructions below.

3.3.1 Cleaning and Maintaining Copper Components

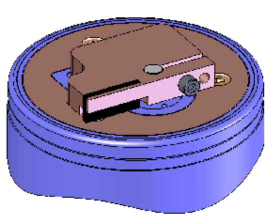
To maximize anti-fouling capability, the Bio-wiper™ and faceplate must be removed from the meter for thorough cleaning. Depending on the degree of accumulated biofouling, it may also be necessary to remove the outer faceplate and the WQM guard ring for cleaning:

1. Be sure the WQM is **NOT** powered or connected to a power source prior to uninstalling the Bio-wiper™ and faceplate.

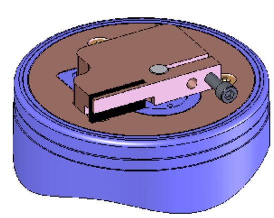
WARNING!
Manually turning the motor shaft can damage the wiper motor and will void the warranty.

Make sure the Bio-wiper™ is loosened from the shaft before attempting to rotate the Bio-wiper™.

2. To remove the Bio-wiper™, use the factory-supplied 3/32-in. hex key to loosen the screw that secures the wiper to the shaft of the instrument. It may be necessary to remove the screw from the clamping hole and screw it into the releasing hole, tightening it just enough to free the Bio-wiper™ from the shaft.



clamping screw hole
(left side of wiper edge)



releasing screw hole
(right side of wiper edge)

3. Remove the faceplate, using a small screwdriver to remove the screws that attach the plate to the optics head.

4. Wash the Bio-wiper™ and copper faceplate with soapy water. Rinse and dry thoroughly. Note the condition of the copper on the instrument side of the wiper. It is normal for copper to corrode and turn green, especially after the instrument has been removed from the water.

5. Buff the faceplate, Bio-wiper™, and copper face ring with a pad of green Scotch-Brite® (or similar product) until shiny.

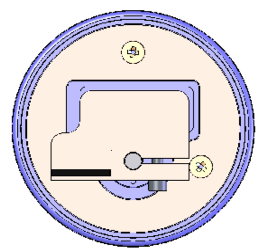
6. Clean the Bio-wiper™ shaft and the shaft hole using an isopropyl alcohol-saturated cotton swab. Allow to dry.

7. Re-install the faceplate.

8. Check the screw used to secure the Bio-wiper™ to the shaft: a hex key must fit snugly into the screw socket. If the socket is in any way compromised, use a new screw (4-40 x 3/8 in. 316 stainless steel socket-head cap screw, treated with anti-seize. These are shipped as part of the meter's spare parts kit.)

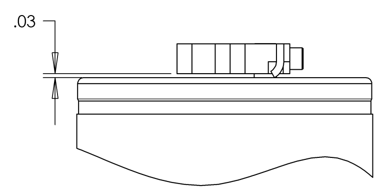
9. Slide the Bio-wiper™ over the shaft. Be careful not to twist it on, thus rotating the shaft. If the wiper does not slide on easily, insert the screw into the expander hole, turning slowly until the Bio-wiper™ slides easily onto the shaft.

10. Rotate the Bio-wiper™ into the closed position.



11. Set the gap between the Bio-wiper™ and the instrument face to 0.03 in. (0.8 mm). An improperly set gap either will fail to clean the face, or will cause the motor to draw excessive current.

    Three business cards are approximately 0.03 in. thick and can be used as a spacer.



12. Use the 3/32-in. hex key to tighten the screw to "finger-tight," then snug an additional quarter-turn.

13. Run the instrument to verify operation. The Bio-wiper™ must rotate 180 degrees to clear the optics before sampling, and 180 degrees to cover the optics after sampling.

14. If the wiper requires adjustment, loosen the screw, make the necessary adjustments, and repeat steps 9 through 13 to ensure that the wiper is performing properly.

3.4 Inspecting the Pressure Sensor

Approximately once a year, inspect the pressure port to remove any particles, debris, etc.

WARNING!
Do not put a brush or any object in the pressure port. Doing so may damage or break the pressure sensor.

3.5 Purging the BLIS

Prior to long-term storage, the BLIS reservoir, pump, and tubing should be purged to prevent the inadvertent discharge of bleach into the WQM pump manifold and onto the DO sensor. Follow the procedures in section 2.2.1 to purge the BLIS.

3.6 Long-Term Storage

Clean the CT-DO sensors per section 3.2.

Note
During service and storage, maintain temperature at or below 25 deg C. If temperatures are raised above 40 deg C, sensors exhibit a temporary increase in sensitivity of a few percent. This relaxes back to historical sensitivity after a few days when temperatures return below 30 deg C.

WARNING!
Do not fill the tubing with water, Triton® 100-X solution, or bleach solution.

During storage, oxygen in the plenum and tubing will continue to be consumed because the sensor is continuously polarized by an internal battery. However, the sensor will drive the plenum volume to zero oxygen if air is blocked from entering the tubing, and calibration drift between uses will be stopped. To minimize drift during storage, we strongly recommend covering the intake and exhaust ports on the CT-DO guard. DO NOT store in Triton-X or bleach solution.

- **If there is no danger of freezing:** After flushing and cleaning, place tape over the intake and exhaust ports.
- **If there is danger of freezing, such as on deployment after maintenance:** Shake all excess water out of the plenum and then tape the intake and exhaust ports, leaving the sensor membrane dry. Store where temperatures are above freezing (in the shipboard cabin), and keep instrument warm prior to deployment (i.e. in a warmed case on deck).

4. Calibration and Characterization

4.1 Conductivity Sensor Calibration

The conductivity sensor incorporates a fixed precision resistor in parallel with the cell. When the cell is dry and in air, the sensor's electrical circuitry puts out a frequency representative of the fixed resistor. This frequency is recorded on the Calibration Certificate and should remain stable (within 1 Hz) over time.

The primary cause of calibration drift in conductivity sensors is the fouling of the cell by chemical or biological deposits. Fouling alters cell geometry, resulting in a shift in cell constant. Accordingly, the most important determinant of long-term sensor accuracy is the cleanliness of the cell. We recommend annual factory calibrations for routinely deployed instruments. If instrument suffers severe fouling, more frequent servicing may be required.

4.2 Temperature Sensor Calibration

The primary source of temperature sensor calibration drift is the aging of the thermistor element, which is ordinarily a few thousandths of a degree per decade. Sensor drift is not substantially dependent upon the environmental conditions of use.

4.3 Pressure Sensor Calibration

The strain-gauge pressure sensor is capable of meeting the error specification with some allowance for aging and ambient temperature induced drift. Pressure sensors show most of their error as a linear offset from zero. The WQM host software allows you to reset the offset to adjust for changes as necessary.

Allow the WQM to equilibrate (with power on) in a reasonably constant temperature environment for at least 5 hours before starting. Pressure sensors exhibit a transient change in their output in response to changes in their environmental temperature. This effect is minimized by thermally decoupling the sensor from the body of the instrument. However, there is still some residual effect; allowing the instrument to equilibrate before starting will provide the most accurate calibration correction.

4.4 Dissolved Oxygen Sensor Calibration

The DO sensor measures the flux of oxygen across a Teflon membrane. The primary mechanism for calibration drift in the SBE43 DO sensor is the fouling of the membrane (reducing permeability), resulting in a well characterized linear calibration shift. The offset at zero oxygen remains stable unless the sensor is damaged. Accordingly, the most important determinant of long-term sensor accuracy is the cleanliness of the membrane. We recommend the DO sensor be validated against a reference measurement (e.g., Winkler water sample) before and after each deployment, but particularly when the sensor has been exposed to contamination by oil slicks or biological materials. Validation samples can be used to correct data during post processing if fouling drift is suspected Furthermore, validation references can help the user determine if the sensor needs to be serviced. Annual factory calibrations and service are highly recommended.

4.5 Fluorometer and Turbidity Sensor

The FLNTU is configured for a chlorophyll measurement range of 0.02–50 µg/l, and the turbidity sensor's measurement range is 0–25 NTU. Gain selection is done at WET Labs by adjusting several gain settings inside the instrument, and running a dilution series to determine the zero voltage offset and to ensure that the dynamic range covers the measurement range of interest. The dilution series also establishes the linearity of the instrument's response. As is the case with other fluorometers, users must perform a detailed characterization to determine the actual zero point and scale factor for each particular use.

Appendix A: Anti-fouling Technical Reference

While the copper-clad surfaces of WQM are unlikely to foul, the external plastic surfaces remain vulnerable. The following are suggestions, tips, and techniques that have worked for others in the oceanography community.

WET Labs Anti-fouling Paint Kit. WET Labs recommends this kit for optimum bio-fouling protection. The kit includes Ecominder® anti-fouling paint, tape, brush, and detailed instructions. Ecominder® is specially formulated as a safe, effective alternative to traditional copper-based anti-fouling paints. Simply wrap your instrument package with the supplied tape, then paint the tape with Ecominder®. After deployment, remove the anti-fouling paint by simply peeling off the tape. Each kit contains more than enough material for two deployments.

Adhesive-backed copper foil tape. This tape is very thin and pliable, and it's easy to apply, especially in the narrower widths. Because the acrylic adhesive backing becomes gooey after long exposure to seawater, we first apply a layer of electrical tape to the plastic, then apply the copper foil over the electrical tape. To remove build-up, simply unwrap the electrical tape and you're left with a fairly clean housing. The copper corrodes over time. Start with one layer of tape for every six weeks of deployment Source: www.mcmaster.com, P/N 76555A725.

Electrical tape. High quality electrical tape (i.e. 3M Scotch Super 33+) will withstand extended service in seawater, and can be removable with little or no adhesive residue. Softer types of biofoulants will peel off with the tape. Tape can be applied over irregular surfaces. It also blocks light, inhibiting growth in cavities.

Pressure washing. WET Labs does not recommend this for the sensor, as intense spray can compromise seals and damage probes.

Appendix B: Internal Uninterruptible Power Supply

The WQM is equipped with an internal Uninterruptible Power Supply (UPS), used to power the WQM CPU should power be interrupted while the WQM is collecting data. Any interruption activates the UPS, which will power the CPU long enough to save any recent data, close any open files, and store required operating parameters.

If power is restored to the WQM within 1 second of power removal, the WQM will restart data collection, processing, and storage.

The UPS is not used to power the FLNTU, which means the shutter will be left in an open position, leaving the optics subject to bio-fouling.

The UPS contains a 9-volt Lithium battery. While these batteries have sufficient capacity to support thousands of UPS shutdown cycles, they do have a limited shelf life. To insure reliable UPS operation, we recommend returning the WQM for UPS servicing every 3 years. Please note: the UPS will be serviced every time the WQM is returned for CTDO or FLNTU calibration or servicing.

Appendix C: Ecominder® Application

Purpose

Applying electrical tape and anti-fouling paint to your instrument package will help reduce biological growth and make it easier to clean after a deployment.

Procedure

Please note this is a general procedure. Variables such as temperature, salinity, available light, dissolved oxygen—the parameters you are probably monitoring—will affect the productivity of the water and the performance of anti-fouling measures. Your situation is unique, and so will be your results. Adapt this procedure to meet your specific needs.

Cautions

Read, understand, and follow the paint manufacturer's instructions and Material Safety Data Sheet (MSDS). Instructions are on the label on the paint can. The MSDS is attached to these instructions.

If there are discrepancies between these guidelines and the paint manufacturer's instructions, the manufacturer's instructions take precedence.

You are responsible for providing your own personal protective equipment, such as gloves, safety glasses, etc.

Supplied Parts

- 1 pint Ecominder Waterborne Antifouling Coating "ᵉPaint"
- 2″ foam brush in re-sealable plastic bag
- Scotch™ Super 88 electrical tape (1.5″ wide; 44′ long)

1. Mount all instruments, connect cables and make sure everything's working properly. If there's a problem, fix it before you start taping.

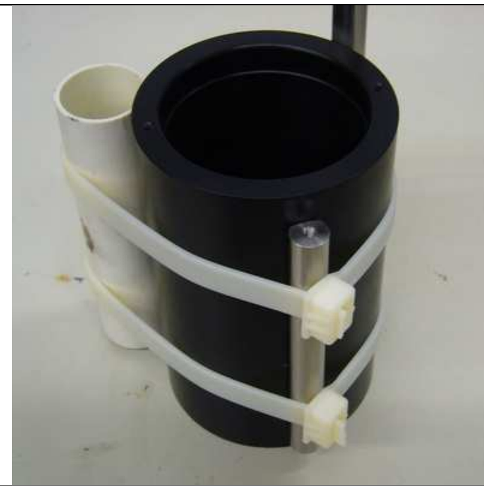
2. Determine a strategy for taping and painting. Some things can't be taped, like optics and moving parts. Other things are less obvious: zinc anodes won't work if they're painted. Stainless steel may be fine if it's wrapped tightly with tape, but it might pit and rust if it's wrapped loosely. Copper surfaces are usually best left alone.

   ᵉPaint will inhibit growth for some period of time, depending on the conditions. The Super 88 electrical tape has a low-residue adhesive that allows easy removal of the ᵉPaint and anything that has grown on the tape, such as barnacles.

3. You don't have to tape every surface you're going to paint, and you don't have to paint every surface you tape. **We ask that you not return instruments with anti-fouling paint on them**, so please tape what you intend to paint on your instrument. Beyond that, if you want to paint your cage, clamps and cables…do so. No tape necessary.

4. The tape is handy when there are irregular objects with lots of surface area. You can wrap the mess like a mummy and just paint the smooth outer surface created by the tape.

   As an example (right) we started with an arbitrary collection of parts that would look like condos for crabs.



5. Little pieces of tape were used to close off the ends of the white tube, then the whole thing was wrapped. You can stretch the tape quite a lot to make it conform to irregular surfaces. The smoother the finished surface, the less paint you'll use, and the fewer drips you'll see. Make sure you don't leave any gaps or paint will enter the void and make a mess.

6. Apply paint. The first coat may bead up a bit and be ugly. Wait about 8 hours between applying paint coats. Coverage improves with the second and third coats. Wait 24 hours after applying the last coat to deploy the package. Note that this is a thin white paint being applied over black plastic, so it's not going to end up looking like gel coat on a yacht. It will work just fine.

   Finished! Our test piece went in the bay looking just like this. The paint remains flexible on the open spans of tape.

WET Labs

Revision History

Revision	Date	Revision Description	Originator
A	10/2/07	New document (DCR 535)	A. Derr, D. Romanko, C. Orrico, H. Van Zee
B	10/17/07	Change screws on BLIS outer assembly (ECN 271, DCR 541)	A. Derr
C	1/21/08	Finalize revision B edits from C. Janzen (DCR 559)	A. Derr, H. Van Zee
D	2/7/08	Update specs; add Appendix C for ePaint (DCR 560)	I. Walsh
E	2/13/08	Change supplied test cable (ECN 283; DCR 563)	C. Wetzel
F	3/11/08	Add procedure for AF replacement (DCR 568)	A. Derr
G	3/13/08	Include P/N for ePaint (ENC 291, DCR 572)	H. Van Zee
H	5/19/08	Revise Section 1.6, Delivered Equipment (DCR 594)	H. Van Zee
I	10/8/08	Delete horseshoe mounting clamps from spare parts list (ECN 327, DCR 625)	A. Derr
J	5/7/09	Add hose barb to spare parts kit (DCR 668)	A. Derr