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Tech Note 130312-2: Functional Checks and Cleaning Methodology for Transmissometers

Introduction

Transmissometers measure the light lost across a known distance. The maximum signal for a transmissometer occurs when there is no target between the light source and the receptor. The term "top down" describes the type of sensor where the "blank" value is the highest signal output and a given target population causes the signal to decrease.

In contrast, the *ECO* line of fluorometers and backscattering sensors are "bottom up" sensors: the signal increases with the concentration of the particular target. The manufacturer calibrates transmissometers using the cleanest water we can obtain and by convention, subtracts the absorption due to water during the calibration process. Hence, the transmissometer signal encompasses the signal due to particles and dissolved materials in the target volume.

For "top down" sensors, the single most important variable in obtaining good data is the cleanliness of the sensor's optical surfaces.
This document details the best practices tracking transmissometer performance including:

- check out procedure upon receipt of sensor
- pre-deployment check
- post-deployment check
- cleaning method to obtain clean optical surfaces.

Following these steps will assure the best possible data from these sensors.

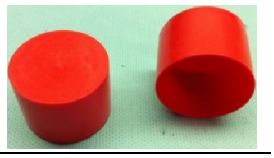
Functional Check #1—Incoming

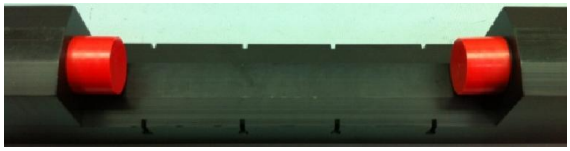
Important: Do not touch the optical surfaces of the sensor.

1. Remove the sensor from the shipping container and any associated packaging.
2. Supply power to the sensor following the instructions in the User's Guide. The sensor should be checked in air only.

Remove the Protective Caps

Two red plastic caps are attached to the C-Star, C-Rover, Biofloat, and ac-s sensors to protect the exposed optical windows from scratches, dirt, and dust. The caps are made from a flexible plastic that seals around the optics.

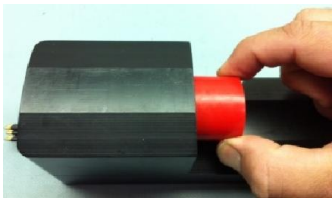




Caps attched to C-Star optics | Caps attched to C-Rover or ac-s optics

Note: Remove the caps before the sensor is deployed.

1. To remove the caps, lightly squeeze the top of the cap with the thumb and forefinger.



Squeeze to remove C-Star caps

Squeeze to remove ac-s and C-Rover caps

2. Pull the cap straight away from the optics.
   The O-ring on the optics prevents the caps from falling off and will give some resistance during removal.

3. Store the caps in a known location for reuse.

Note: Remove the caps before the sensor is deployed.

To reinstall the caps:

1. Clean and rinse the optical windows with fresh water. Refer to the sensor's User's Guide for instructions on cleaning transmissometer windows.
2. Dry the windows with pressurized air ("canned air"), and/or lint-free cloth (e.g. optical-grade Kimwipes).

Push the cap over the window until the base of the cap bottoms out on the optical housing.

- There will be some resistance due to the O-ring sealing against the inner surface of the cap.

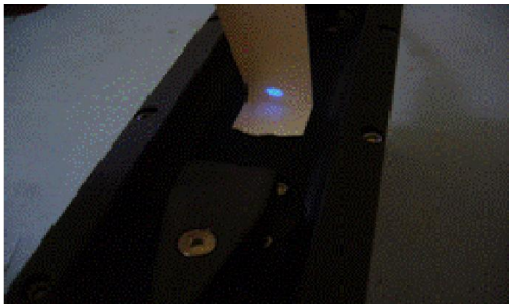
3. Repeat for the second optical window.

Basic Functional Check

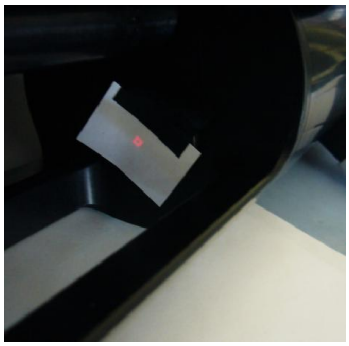
Warning!

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

1. Check the light source with a piece of white paper in the light path. You should see a circle of light of the color specified for the sensor, e.g. red, green or blue. A UV transmissometer will generally cause white paper to fluoresce blue. If you do not see a light, check the power supply. If you still do not see a light, contact WET Labs support.



White tape blocking the light beam (BAM)



White paper blocking the light beam (C-Rover and ac-s)

Data is output from the transmissometer in the order shown below:

Column	Value	Example
1	Instrument serial number	CSTR-0000 11829 13838 13695 0.003 527
2	Reference counts	CSTR-0000 11829 13838 13695 0.003 527
3	Signal counts	CSTR-0000 11829 13838 13695 0.003 527
4	Corrected signal raw counts	CSTR-0000 11829 13838 13695 0.003 527
5	Calculated beam c, inverse meters	CSTR-0000 11829 13838 13695 0.003 527
6	Internal thermistor, counts	CSTR-0000 11829 13838 13695 0.003 527

2. With the light source blocked (do NOT touch the window), make sure that the signal raw count and the corrected signal raw count and are zero.

```
CSTR-0000 12683 00000 00000 99.999  527
```


Finger blocking the light beam (BAM)


Finger blocking the light beam (C-Rover and ac-s)

! Blocked values greater than 50 counts are cause for concern and may indicate an sensor that needs to be serviced.

3. Turn the power supply off and then back on. If a high blocked value (> 50 counts) persists, contact WET Labs Support.

➡ Note that the calculated beam c value is not meaningful when the light is blocked. The sensor outputs 99.999 for the calculated beam c with the signal blocked.

4. With an unobstructed light path check that the corrected signal counts approaches the clean air value (CSC_{air}) on the sensor's calibration sheet or the last clean air value on the sensor's calibration log.

```
CSTR-0000 12683 12977 12966 0.551 527
```

In general, clean air values will only approach or equal the manufacturer's air values in a clean, controlled environment.

Clean Air Check Criteria

If the sensor is reading within 100 corrected counts compared to CSC_{air}:

1. The sensor is working properly and the optical surfaces are clean.
2. Cleaning the optical surfaces is optional.
3. Record the sensor output on the Transmissometer Air Calibration log or a similar document.

If the sensor is reading more than 100 but less than 500 corrected counts greater than CSC_{air}:

1. Clean the optical surfaces following the cleaning procedure listed in this document.
2. Repeat the cleaning steps (if necessary) until:
   - 100 corrected counts or less is achieved
   - Air-corrected counts are stable between cleanings but are still between 100 to 500 corrected counts from CSC_{air}
3. Record the sensor output on the Transmissometer Air Calibration log or a similar document.

If the sensor is reading more than 500 corrected counts greater than CSC_{air}:

1. Clean the optical surfaces following the cleaning procedure listed in this document.
2. Repeat the cleaning steps (if necessary) until:
   - 100 corrected counts or less is achieved
   - Air-corrected counts are stable between cleanings but are still between 100 to 500 corrected counts from CSC_{air}
3. Record the sensor output on the Transmissometer Air Calibration log or a similar document.
4. If the instrument fails to output a corrected air calibration value within 500 counts of the manufacturer's last calibration, contact WET Labs Support. The sensor may have to be returned for re-calibration or repaired.

Functional Check #2—Post Installation

Note: The sensor should be in air only. Do not touch the optical surfaces.

Once the sensor has been mounted onto a cage or other method of deployment, the air value should be checked using the power system that is going to be used for deployment.

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3. Record the sensor output on the Transmissometer Air Calibration log or a similar document.
4. If the instrument fails to output a corrected air calibration value within 500 counts of the manufacturer's last calibration, contact WET Labs Support. The sensor may have to be returned for re-calibration or repaired.

Functional Check #3—Pre-Deployment

Note: The sensor should be in air only. Do not touch the optical surfaces.

This check may be skipped if the installation and deployment are the same. Many times cages are put together long before deployment and the sensor will need to be checked for proper measurement.

Clean Air Check Criteria

If the sensor is reading within 100 corrected counts compared to CSC_{air}:

1. The sensor is working properly and the optical surfaces are clean.
2. Cleaning the optical surfaces is optional.
3. Record the sensor output on the Transmissometer Air Calibration log or a similar document.

If the sensor is reading more than 100 but less than 500 corrected counts greater than CSC_{air}:

1. Clean the optical surfaces following the cleaning procedure listed in this document.
2. Repeat the cleaning steps (if necessary) until:
   - 100 corrected counts or less is achieved
   - Air-corrected counts are stable between cleanings but are still between 100 to 500 corrected counts from CSC_{air}
3. Record the sensor output on the Transmissometer Air Calibration log or a similar document.

If the sensor is reading more than 500 corrected counts greater than CSC_{air}:

1. Clean the optical surfaces following the cleaning procedure listed in this document.
2. Repeat the cleaning steps (if necessary) until:
   - 100 corrected counts or less is achieved
   - Air-corrected counts are stable between cleanings but are still between 100 to 500 corrected counts from CSC_{air}
3. Record the sensor output on the Transmissometer Air Calibration log or a similar document.
4. If the instrument fails to output a corrected air calibration value within 500 counts of the manufacturer's last calibration, contact WET Labs Support. The sensor may have to be returned for re-calibration or repaired.

Post-Deployment Rinse

When the sensor is removed from the water, the optical surfaces should be rinsed with clean water. Any clean water source is adequate to remove salt water from the sensor. This will prevent salts from drying onto the window and remove any loose material. The windows can then be dried with clean air. However, it is more important to record the start value prior to the next deployment than performing an air calibration after every use of the instrument. Rather, the operational data should be used to judge if further cleaning is needed. The primary question should be "is the data reasonable?"

Functional Check #4—Post Deployment Output

After all the optical surfaces have been cleaned and dried using the Cleaning Procedure in this document, record the sensor output. Note that the sensor optics may need to be cleaned multiple times, depending on the level of cleanliness. This air value is used for tracking the sensor's output to determine if there is any long term drift, and in particular, when to return the sensor for service.

Note that a post-deployment air calibration does not determine the validity of the data obtained during deployment due to possible changes to the optical surfaces. In general, it is difficult to estimate any drift of the instrument due to fouling after the instrument is removed from the water.

Clean Air Check Criteria

If the sensor is reading greater than 500 corrected counts compared to CSC_{air}, contact WET Labs Support. The sensor may have to be returned for re-calibration or repaired.

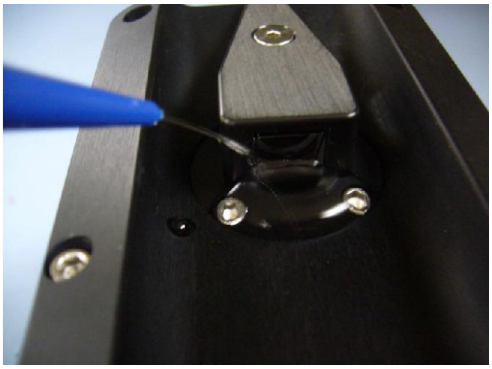
Maintenance Supplies

The manufacturer recommends that the user put together a maintenance kit that contains:

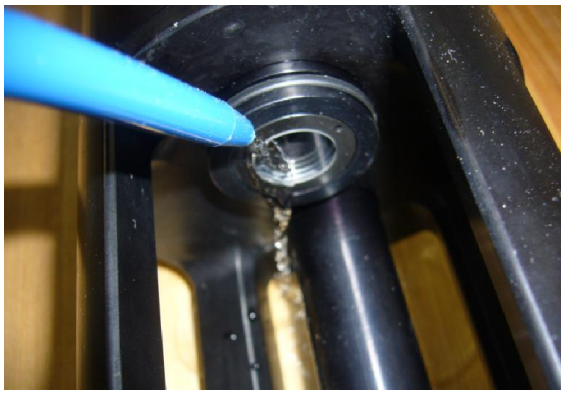
1. Two 500 ml squirt bottles.
   - One for a dilute detergent solution
   - One for clean water
2. A commercial detergent such as Microclean or Dawn.
   - Two drops of detergent in a 500 ml squirt bottle filled with 0.2 or 0.4 µm filtered distilled and deionized water is sufficient.
3. De-ionized (DI) or Reverse Osmosis (RO) water.
4. Lint-free laboratory wipes (i.e. Kimwipes) and/or lens paper
5. Polyurethane-tipped, lint-resistant swab
6. Compressed clean air source. Pressurized sources in order of most to least effective:
   a. Clean dry nitrogen
   b. Clean dry air
   c. Canned air
7. A notebook for recording maintenance dates and tracking output.

Optics Cleaning Procedure

1. Squirt a small amount of a dilute solution of detergent onto the optical face of the exposed glass.
   - Two drops of detergent in a 500 ml squirt bottle filled with 0.2 um filtered distilled and de-ionized water is sufficient to break surface tension on the optical face and dislodge particles and minor surface oils.
   - Unfiltered DI water will also work, but may leave some particles on the optical surface.
   - If the sensor is more severely fouled, use detergent first and then follow with the dilute solution.

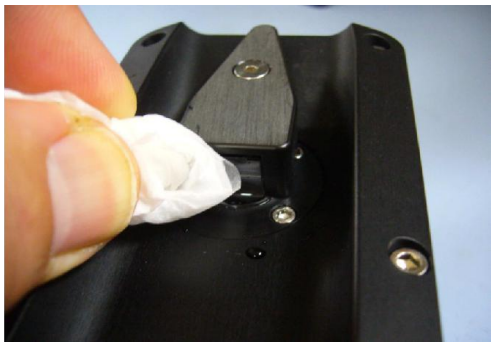


Squirting DI water onto optical window (BAM)

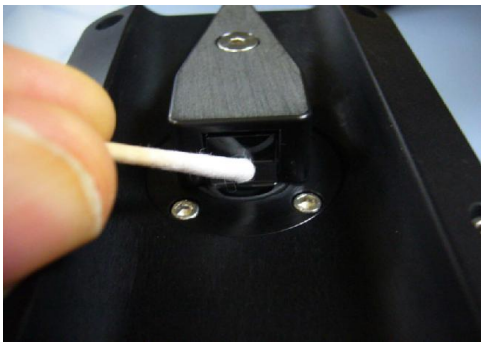


Squirting DI water onto optical window (C-Rover/ac-s)

2. Use a lint-free cleaning wipe or swab to gently dab/tap the optical surface to remove particles and fouling films while the optical face is wet. Make sure that fibers do not remain on the optical surface.



Wipe used (BAM)



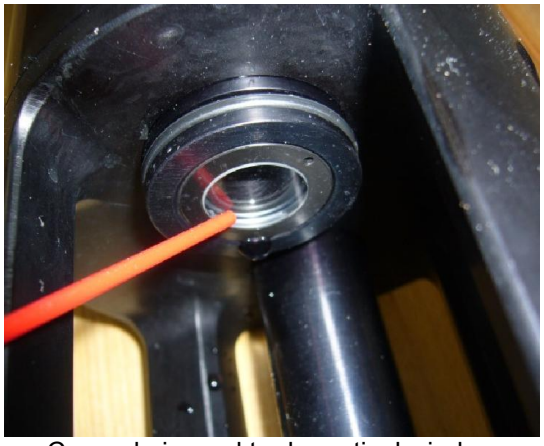
Cotton swab used (BAM)

Wipe used (C-Rover/ACS)

Cotton swab used (C- Rover/ac-s)

Important: If using canned air be careful not to spray propellant on the optics. Spray should be started away from transmissometer to clear any liquid from the spray nozzle. Use dry nitrogen (best) or clean/dry compressed air to dislodge any particulates and dry the optical surface. In general, the optics will need to be cleaned several times before a stable clean air value is recorded.

Canned air used to dry optical window (BAM)



Canned air used to dry optical window (C-Rover/ac-s)

Tracking Worksheet Examples

Functional Air Checks					
	Test 1	Test 2	Test 3	Test 4	Test 5
Serial Number:					
Corrected Signal Clean (CSCair) Calibration:					
Cal Date:					
CSCair Incoming:					
Offset:					
Test and Data Log Recorded By:					
Date:					
CSCair Post installation:					
Offset:					
Test and Data Log Recorded By:					
Date:					
CSCair Pre-Deployment Test:					
Offset:					
Test and Data Log Recorded By:					
Date:					
CSair Post-Deployment Rinsed Test:					
Offset:					
Test and Data Log Recorded By:					
Date:					
CSCair Post-Deployment Cleaned Test:					
Offset:					
Test and Data Log Recorded By:					
Date:					

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Transmissometer Air Calibration Log

Serial Number: _____

Date Purchased: _____

Date	Reference Counts	Raw Signal Counts	Corrected Signal Counts	beam c m-1	Internal Temp Counts	Operator	Notes