

Turbidity Sensor

ECO NTU

User's Guide

The 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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ECO Sensor Warranty

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 was subjected to abuse or neglect beyond the normal wear and tear of field deployment, or in the event 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. WET Labs will supply all replacement parts and labor and pay for return via 3rd day air shipping in honoring this warranty.

Shipping Requirements

1. Please retain the original ruggedized shipping case. It meets stringent shipping and insurance requirements, and protects your meter.
 2. Service and repair work cannot be guaranteed unless the meter is shipped in its original case.
 3. Clearly mark the RMA number on the outside of your case and on all packing lists.
 4. Return instruments using 3rd day air shipping or better: do **not** ship via ground.
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Return Policy for Instruments with Anti-fouling Treatment

WET Labs cannot accept instruments for servicing or repair that are treated with anti-fouling compound(s). This includes but is not limited to tri-butyl tin (TBT), marine anti-fouling paint, ablative coatings, etc.

Please ensure any anti-fouling treatment has been removed prior to returning instruments to WET Labs for service or repair.



Electrical equipment marked with this symbol may not be disposed of in European public disposal systems. In conformity with EU Directive 2002/96/EC (as amended by 2003/108/EC), European users of electrical equipment must return old or end-of-life equipment to the manufacturer for disposal at no charge to the user.

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1. Specifications

Model	NTU(RT)/D	NTU	NTUB	NTUS	NTUSB
Mechanical					
<i>Diameter</i>	6.3 cm				
<i>Length</i>	12.7 cm		27.4 cm	13.3 cm	27.99 cm
6000 m	17.68cm		--		
<i>Weight in air</i>	0.4 kg		0.96 kg	0.5 kg	0.96 kg
6000 m	1.3 kg		--	--	--
<i>Weight in water</i>	0.02 kg		0.14 kg	0.08 kg	0.14 kg
6000 m	0.75 kg		--		
<i>Material, std depth</i>	Acetal copolymer				
6000 m	Titanium		--		
Environmental					
<i>Temperature range</i>	0–30 deg C				
<i>Depth rating</i>	600 m		300 m		
“deep” unit	6000 m		--		
<i>Optional pressure sensor</i>	N	Y	Yes		
<i>Optional thermistor</i>	N	Y	Yes		
Electrical					
<i>Digital output resolution</i>	14 bit				
<i>Analog output signals</i>	0–5 V				
<i>Connector</i>	MCBH-6-MP				
<i>Input</i>	7–15 VDC				
<i>Current, typical</i>	50 mA				
<i>Internal data logging</i>	N	Y	Y		
<i>Current, sleep</i>	--	140 µA			
<i>Data memory</i>	--	108,000 samples			
<i>Internal batteries</i>	N		Y	N	Y
<i>Sample rate</i>	to 8 Hz				
<i>RS-232 output</i>	19200 baud				
<i>Optional anti-fouling bio-wiper™</i>	N		Y		
<i>Bio-wiper™ cycle</i>	--		140 mA		
Optical					
<i>Wavelength</i>	700 nm				
<i>Ranges</i>	0–125, 0–1000 NTU				
<i>Sensitivity</i>	0–125: 0.02 0–1000: 0.12				



NTU(RT)/D—Provides analog or RS-232 serial output with 16,330-count range. This unit operates continuously when powered. Available with a 6,000 m depth rating.

NTU—Provides the capabilities of the NTU(RT) with periodic sampling.

NTUB—Provides the capabilities of the NTU with internal batteries for autonomous operation.

NTUS—Provides the capabilities of the NTU with an integrated anti-fouling *Bio-wiper*[™] and copper faceplate.

NTUSB—Provides the capabilities of the NTUS with internal batteries for autonomous operation.

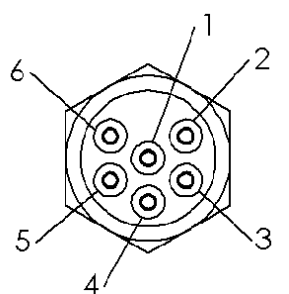
2. ECO Meter Components

The following subsections describe the bulkhead connectors, items delivered with the ECO sensor, and optionally available equipment.

2.1 Connectors

ECO-Series meters use a six-pin bulkhead connector. The pin functions for this connector are summarized below.

Pin	Function
1	Ground
2	RS-232 (RX)
3	Reserved
4	V in
5	RS-232 (TX)
6	Analog out

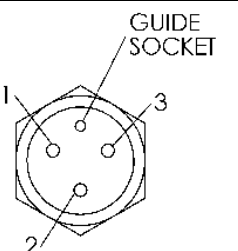


Input power of 7–15 VDC is applied to V in (pin 4). The power supply current returns through the common ground pin (pin 1). The input power signal has a bi-directional filter. This prevents external power supply noise from entering the meter, and also prevents internally generated noise from coupling out on to the external power supply wire. Data is sent out the serial output pin.

2.1.1 *ECO* NTUB, NTUSB Connectors

Units with internal batteries have a second bulkhead connector that comes with a jumper plug to supply power to the unit. The pin functions for this connector are summarized below.

Socket	Function
1	V in
2	N/C
3	Battery out



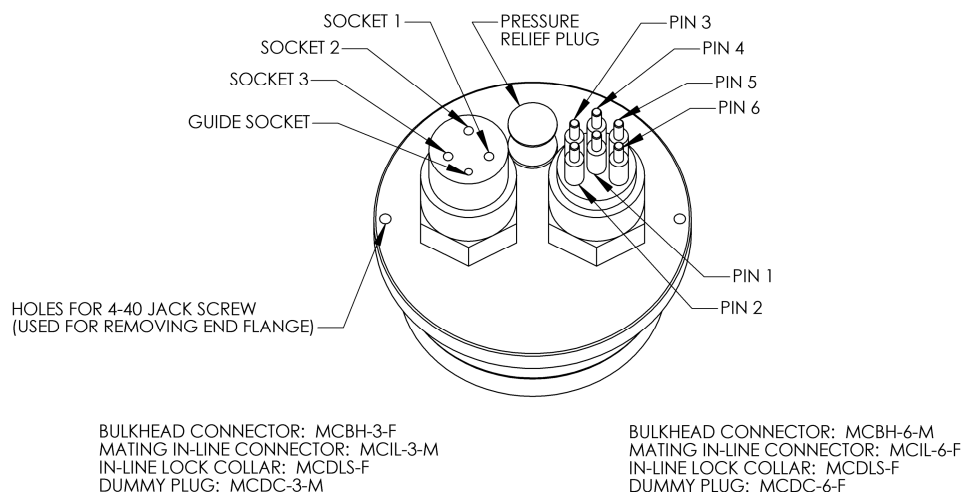


Figure 1. *ECO* NTUB and NTUSB connector schematic

NTUB and NTUSB (internal battery units) are supplied with a jumper plug that provides power from the internal batteries for autonomous operation. (Power is supplied from pin 1 to pin 3.)

2.2 Delivered Items

The standard *ECO* delivery consists of the following:

- the instrument itself
- dummy plug with lock collar
- protective cover for optics
- this user's guide
- *ECOView* user's guide
- *ECOView* host program and device files (on CD)
- instrument-specific calibration sheet
- Non-battery units only: stainless steel mounting bracket and hardware (See Appendix A for details)
- Internal battery units: six 9-V Lithium batteries (installed)

Spare Parts (equipment-dependent)

- *Bio-wiper*[™] units: one 3/32-in. hex key for *bio-wiper*[™] removal
- *Bio-wiper*[™] units: three 4-40 x 3/8 in. 316 stainless steel screws for securing *Bio-wiper*[™]

- Internal battery units: Additional spare parts
 - Two end flange O-rings (size 224) and two vent plug O-rings (size 010)
 - Two jacking screws for connector flange removal
 - One 3/32-in. hex key for jacking screws
 - Power plug for autonomous operation
 - Three pre-cut segments (7 inches) of 0.036-inch diameter monofilament for end flange
 - Three pre-cut segments (0.25 inches) of 0.094-inch diameter white nylon bar stock for replacing the white plastic dowel pin.

2.3 Optional Equipment

2.3.1 Test Cable

A test cable is optionally available with each unit. This cable includes:

1. An inline connector for providing power to the instrument from a user-supplied 9V battery or regulated power supply.
2. An auxiliary analog out connector.
3. A DB-9 serial interface connector.
4. A six-socket connector for providing power and signal to the instrument.

2.3.2 *Bio-wiper*[™] and Copper Faceplate

The NTUS and NTUSB are equipped with an integrated non-contact anti-fouling *Bio-wiper*[™] and copper faceplate for use in extended deployments. This wiper can be manually controlled by a host controller package, or can perform autonomously as part of a pre-programmed sampling sequence upon instrument power-up. The rate of closure and opening is dependent upon both temperature and depth.

Refer to Section 4.5.1 for important details on the maintenance and cleaning of the *Bio-wiper*[™] and copper faceplate.

WARNING!

Do **NOT** rotate the *Bio-wiper*[™] manually. This can damage the wiper motor and will void the warranty.

2.3.3 Batteries

ECO units with internal batteries are supplied with six 9-volt Lithium batteries as their power source. They can use either standard alkaline cells for a total capacity of approximately 1000 mA-hrs, or for longer deployments, LiMnO₂ cells to achieve more than 2000 mA-hrs of operational capacity. Actual total usage time of the internal batteries is a function of several parameters. These include nominal water temperature, sequence timing, sample periods, and total deployment duration.

For even greater deployment capability contact WET Labs for information on external battery packs.

2.3.4 External Thermistor

ECO meters are optionally equipped with an external thermistor. The thermistor is calibrated at WET Labs and the calibration coefficients are supplied on the instrument's calibration sheets. Thermistor output is in counts and can be converted into engineering units using the instrument's device file and ECOView software or the raw data can be converted in the user's software (e.g. MATLAB or Excel) using the calibration equation:

$$\text{Temperature (deg C)} = (\text{Output} * \text{Slope}) + \text{Intercept}$$

2.3.5 Pressure Sensor

ECO meters are optionally equipped with a strain gauge pressure sensor. The pressure sensor is calibrated at WET Labs and the calibration coefficients are supplied on the instrument's calibration sheets. Pressure sensor output is in counts and can be converted into engineering units using the instruments device file and ECOView software or the raw data can be converted in the user's software (e.g. MATLAB or Excel) using the calibration equation:

$$\text{Relative Pressure (dbar)} = (\text{Output} * \text{Slope}) + \text{Intercept}$$

Please note that strain gauge pressure sensors are susceptible to atmospheric pressure changes and should be "zeroed" on each deployment or profile. The calibration equation for pressure above should be used first to get the relative pressure and the cast offset should then be subtracted to get the absolute pressure:

$$\text{Absolute Pressure (dbar)} = \text{Relative Pressure (dbar)} - \text{Relative Pressure at Atmospheric/Water interface (dbar)}$$

WARNING!

Do not exceed the pressure sensor's depth rating (see calibration sheet).

Pressure Sensor Maintenance

A plastic fitting filled with silicone oil provides a buffer between the pressure transducer and seawater. The transducer is both sensitive and delicate. Following the procedures below will ensure the best results and longest life from your pressure sensor.

Pressure is transmitted from the water to the stainless steel transducer diaphragm via a plastic fitting filled with silicone oil. The inert silicone oil protects the pressure sensor from corrosion, which would occur after long exposure to salt water. The fitting will generally prevent the oil from escaping from the reservoir into the water. However, you may occasionally wish to ensure that oil remains in the reservoir on top of the transducer.



WARNING

Never touch or push on the transducer.

1. Thoroughly clean the top of the instrument.
2. Completely remove the white nylon Swagelock fitting using a 9/16-in. wrench.
3. Check for obstructions in the tiny hole. Blow clear with compressed air or use a small piece of wire.
4. Wipe clean the O-ring at the base of the Swagelock fitting.
5. Screw the Swagelock fitting into the end flange until finger tight.
6. Tighten it an additional 1/8 turn using a wrench only if necessary.
7. Wipe up any excess oil.

3. Instrument Operation

Operating environment notice

ECO sensors are precision instruments. Data transfers should be performed away from harsh environments such as strong electric fields or electrostatic discharge sources. If used in a such an environment, there is a chance that the sensor may experience disturbances that will temporarily stop data transfers. In that event, move the sensor to a location further from the electric field or ESD source. Reset the sensor by momentarily turning its power supply off, then on.

Please note that certain aspects of instrument operation are configuration-dependent. These are noted where applicable within the manual.

3.1 Initial Checkout

Supplied from the factory, *ECOs* are configured to begin continuously sampling upon power-on. Electrical checkout of *ECO* is straightforward using the optional test cable.

Connect the 6-socket connector on the test cable to the instrument to provide power to the meter. Connect the battery leads on the test cable to a 9V battery (or regulated power supply). Light should emanate from the meter.

3.1.1 Analog Option

Connect a digital multimeter (DMM) to the auxiliary leg of the test cable: the center of the RCA connector provides analog out signal and the outside provides ground. With the sensor face clean and dry the instrument should read approximately 0.050–0.095 VDC. The analog signal will saturate at approximately 5 volts.

3.2 Operating the Sensor for Data Output

1. Connect the 6-socket connector to the instrument to provide power. Connect the DB-9 connector to a computer with the ECOView host program installed on it.

WARNING!

Always use a regulated power supply to provide power to ECO sensors if not using the 9V battery provided with the test cable: power spikes may damage the meter.

2. Start ECOView. Select the appropriate COM Port and Device File. Supply power to the meter, then select the **Start Data** button. Output will scroll in the Raw Data window. Test the instrument's signal using the protective cap. The signal will saturate with the cap on (maximum value on characterization sheet). When applying power to sensors with a Bio-wiper[™], it will open and, depending on the settings, operate until you select **Stop Data** in ECOView. The Bio-wiper[™] will close and the instrument will await the next command.
3. If the sensor completes the requested samples (this is common for meters set up in moored applications), it will go into sleep mode, and the meter will not light when power is cycled. To “wake” the meter, allow it to sit unpowered for about 2 minutes, then click **Stop Data** five times at the rate of two times per second immediately upon applying power. This interrupts the sensor, returning it to a “ready” state, awaiting commands.

4. Check the settings for the ECO and change if necessary. ECOView factory settings for continuous operation:
 - Set Number of Samples = 0
 - Set Number of Cycles = 0
 - Internal Memory=On
5. If the meter does not light after performing step 3, check the battery. Replace if necessary, perform steps 2 and 3 to verify communication. If it still does not light, contact WET Labs.

Refer to the ECOView User's Guide for details about using the software.

3.3 Bio-wiper™ Operation

The *ECO*-NTUS and -NTUSB are provided with an anti-fouling Bio-wiper™ and faceplate that extend the possible deployment duration by retarding biological growth on the instrument's optical surface. The Bio-wiper™ covers the optical surface: 1) while the instrument is in "sleep" mode; 2) when it has completed the number of samples requested; and 3) when the user selects **Stop Data** in ECOView or types "!!!!" in a terminal program. When the meter wakes up, the optical surface is exposed by the Bio-wiper's™ counter-clockwise rotation.

If power is shut off in mid cycle, the Bio-wiper™ will reinitialize to the beginning of the user-selected settings when power is applied again.

3.4 Deployment

WARNING!

NTUS and NTUSB:

Always check vent seal plug for full insertion immediately prior to deployment.

Caution

The NTU should be mounted so that the LED source will not "see" any part of a cage or deployment hardware. This will compromise the sensor's output.

Once power is supplied to the *ECO* meter, the unit is ready for submersion and subsequent measurements. Some consideration should be given to the package orientation. Do not face the sensor directly into the sun or other bright lights. For best output signal integrity, locate the instrument away from significant EMI sources.

Other than these basic considerations, one only needs to make sure that the unit is securely mounted to whatever lowering frame is used and that the mounting brackets are not damaging the unit casing.

3.5 Upkeep and Maintenance

After each cast or exposure of the instrument to natural water, flush with clean fresh water, paying careful attention to the sensor face. Use soapy water to cut any grease

or oil accumulation. Gently wipe clean with a soft cloth. The sensor face is composed of ABS plastic and optical epoxy and can easily be damaged or scratched.

WARNING!

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

3.5.1 Bio-wiper[™] and Faceplate Cleaning and Maintenance

The Bio-wiper[™] and the copper faceplate need to be removed from the meter for thorough cleaning to maximize anti-fouling capability.

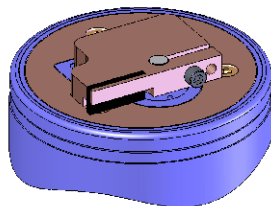
1. Be sure the meter is **NOT** powered or connected to a power source prior to uninstalling the Bio-wiper[™] and faceplate.

WARNING!

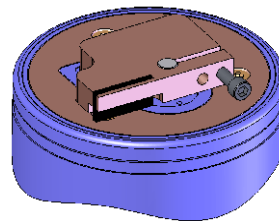
Manually turning the motor shaft can damage the wiper motor and will void the warranty.

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

2. Remove Bio-wiper[™]: Use the factory-supplied 3/32-in. hex key to loosen the screw that secures the wiper to the shaft on 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



releasing screw hole

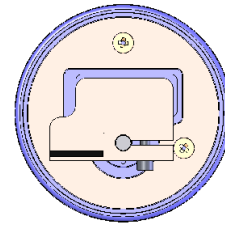
3. Remove faceplate: Use a small Phillips screwdriver to remove the screws that attach the plate to the optics head.

WARNING!

Be sure to retain and re-use the factory-installed acetal screws.

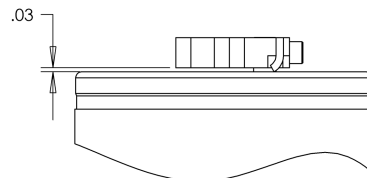
4. Wash *Bio-wiper[™]* and/or copper faceplate with soapy water. Rinse and dry thoroughly. Note the condition of the copper on the instrument side of the wiper. It is normal for copper to corrode and turn green, especially after the instrument has been removed from the water. This corrosion will slightly reduce the shutter's anti-fouling ability the next time it is deployed.
5. Buff each with a pad of green Scotch Brite[®] (or similar) until shiny.

6. Clean the *Bio-wiper*TM shaft and the shaft hole using an isopropyl alcohol-saturated cotton swab. Allow to dry.
7. Re-install 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 treated with anti-seize. These are shipped as part of the meter's spare parts kit.)
9. Slide the *Bio-wiper*TM 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*TM slides easily onto the shaft.
10. Rotate the *Bio-wiper*TM into the closed position.



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

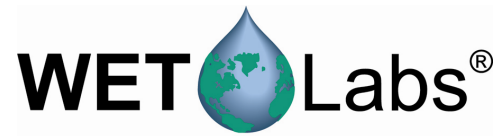
To gauge 0.03 in., fold a piece of paper in half, then in half again, then fold a third time, creasing the edges. It's now 8 sheets and about 0.03 in. thick.



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*TM must rotate 180 degrees to clear the optics before sampling, and 180 degrees to cover the optics after sampling.
14. If the wiper needs adjusting, loosen the screw, make any necessary adjustments, and repeat steps 9 through 13 to ensure the wiper is performing properly.

4. Internal Batteries

ECO sensors powered with internal batteries can either run directly from the internal batteries or can operate from power supplied by an external DC power supply (7–15



volts). Internal-to-external source conversion is facilitated by a jumper plug that plugs into the unit's bulkhead connector. When inserted, the plug forms a connection from the battery to the electronics power supply. By removing the plug, the instrument can be powered and communicate via a test or deployment cable.

4.1 Removing End Flange and Batteries

WARNING!

Changing the batteries will require opening the pressure housing of the ECO sensor. Only people qualified to service underwater oceanographic instrumentation should perform this procedure. If this procedure is performed improperly, it could result in catastrophic instrument failure due to flooding or in personal injury or death due to abnormal internal pressure as a result of flooding.

WET Labs Inc. disclaims all product liability from the use or servicing of this equipment. WET Labs Inc. has no way of controlling the use of this equipment or of choosing qualified personnel to operate it, and therefore cannot take steps to comply with laws pertaining to product liability, including laws that impose a duty to warn the user of any dangers involved with the operation and maintenance of this equipment. Therefore, acceptance of this equipment by the customer shall be conclusively deemed to include a covenant by the customer to defend and hold WET Labs Inc. harmless from all product liability claims arising from the use and servicing of this equipment. Flooded instruments will be covered by WET Labs Inc. warranties at the discretion of WET Labs, Inc.

1. Make sure the instrument is thoroughly dry.
2. Remove the dummy plugs.
3. With connector end flange pointed downwards away from face, release seal from vent plug.
4. Remove moisture from vent plug area.
5. Using needle nose pliers, remove filament from end flange.
6. Lift flange from pressure housing until seal is broken. The jacking screws can be used to “push” the flange from the pressure housing and then can be removed or left in the end flange.
7. Remove any excess moisture from flange–can seal area.
8. Work end flange out of pressure housing and remove any residual moisture. Remove the gray foam spacer and the neoprene insulator.
9. The battery pack is connected to the processor boards by a six-pin Molex connector: do NOT pull too hard or far on the battery pack or it will come unplugged and the unit returned to WET Labs.
10. Gently pull the white cord at the loop to remove the battery pack from the pressure housing.

11. Remove the black plastic protectors from the ends of the long screws securing the batteries.
12. Loosen and remove the screws (3/16-in slotted driver).

4.2 Replacing End Flange and Batteries

1. Replace the batteries.
2. Re-install the screws:
 - Align the groove in each of the plates so the six-wire extension bundle will fit in it along its length.
 - Be careful not to cross-thread into the bottom end plate nor to over-tighten the screws.
 - If they are too tight, the fiber washers that act as separators between the batteries will flex.
 - Make sure there are equal amounts of screw threads protruding from the bottom end plate when they are secure. This will ensure the pack is straight and will fit into the pressure housing with no difficulty.
3. Re-install the black plastic protective covers on the ends of the screws.
4. Remove and check the pressure housing O-ring for nicks or tears. Replace if necessary. Before re-installing, apply a light coat of vacuum grease on the O-ring.
5. Carefully replace the battery pack in the pressure housing. Place the neoprene insulator on the battery assembly and lay the white cord on the top.
6. Plug in the two-pin, then the six-pin Molex connectors. Sensor operation can now be tested if desired.
7. Align the hole in the end flange (NOT the jack screw holes) with the white dowel pin. While coiling the six wire bundle and making sure none are pinched between the end flange and the pressure housing, position the flange on the housing. Leave space to re-insert the gray foam spacer, making sure the cut-out accommodates the vent plug screw.
8. Push the end flange all the way on to the pressure housing, making sure no wires are pinched. Be sure the vent plug does not pop up. If it does, you'll need to re-position the foam spacer.
9. Re-insert the monofilament.

4.3 Checking Vent Plug

If there is fouling on the vent plug, it should be cleaned and the two 010 O-rings replaced. Otherwise, this mechanism should be maintenance-free.

WARNING!

The pressure housing is made of plastic material that scratches easily. Do not let the screwdriver slip and scratch the can when removing or replacing the vent plug. Use a toothpick (something softer than the plastic) to remove the O-rings from the vent plug.

1. Pull vent plug out about half way; hold plug while unscrewing the truss screw. When screw is removed, pull vent plug from end flange.
2. “Pinch” bottom O-ring around vent plug to form a small gap you can work a toothpick into. Use the toothpick to help roll the bottom O-ring off the plug.
3. Perform the same procedure with the top O-ring.
4. Clean the vent plug and vent plug hole using a dry lint-free tissue or cotton swab.
5. Lightly coat two undamaged or new O-rings with silicon grease. Install the top O-ring (nearest to large end of plug) first, then the bottom one.
6. Insert vent plug into its hole in the end flange and hold it while inserting the truss screw. Rotate the vent plug to begin tightening the screw. Finish tightening using a screwdriver, being careful not to over-tighten truss screw.

Note

A portion of the truss screw head has been removed to allow for venting in case of pressure buildup.

5. Data Analysis

Data from the *ECO* turbidity sensor, whether digital or analog, represents raw output from the sensor. Applying linear scaling constants, this data can be expressed in NTUs.

5.1 Scale Factor

The scale factor is factory-calculated by obtaining a consistent output of a solution with a known concentration, then subtracting the meter's dark counts. The scale factor, dark counts, and other characterization values are given on the instrument's characterization sheet.

Scale Factor = $xx \div (\text{meter output} - \text{dark counts})$, where xx is the value of a Formazin concentration.

For example: $12.2 \div (2011 - 50) = 0.0062$.

The scale factor is then applied to the output signal to provide the direct conversion of the output signal to NTUs. WET Labs supplies a scale factor on the instrument-specific calibration sheet that ships with each meter. While this constant can be used to obtain approximate values, field calibration is highly recommended.

5.2 Analog Response

The NTU response is linear over the measurement range provided. Because of the varied environments in which each user will work, it is important to do calibrations using similar seawater as you expect to encounter *in situ*. Refer to the characterization section for further details. This will provide an accurate blank for calculating the scale factor, thereby providing an accurate and meaningful calibration. Once a zero point has been determined and a scale factor established, the conversion of DC volts to NTUs is straightforward:

$$[\text{NTU}]_{\text{sample}} = (V_{\text{output}} - V_{\text{dc}}) * \text{Scale Factor}$$

where

$[\text{NTU}]_{\text{sample}}$ = level of turbidity (NTU)

V_{output} = output when measuring a sample of interest (VDC)

V_{dc} = dark counts, the measured signal output (in VDC) of meter in clean water with black tape over the detector

Scale factor = multiplier in NTU/volts

5.3 Digital Response

Digital data is processed in a similar fashion to analog data. Scaling is linear, and obtaining a "calibrated" output simply involves subtracting a digital offset value from output when measuring a sample of interest and multiplying the difference by the instrument scaling factor.

$$[\text{NTU}]_{\text{sample}} = (\text{NTU}_{\text{output}} - C_{\text{dc}}) * \text{Scale Factor}$$

where

$[\text{NTU}]_{\text{sample}}$ = concentration of NTU solution

NTU_{output} = output when measuring a sample of interest (counts)

C_{dc} = dark counts, the measured signal output of meter in clean water with black tape over the detector

Scale factor = multiplier in NTU/counts.

6. Characterization and Testing

ECO NTU meter's measurement range is 0–250 NTU. Gain selection is done at WET Labs by setting 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.

The tests below ensure the meter's performance

1. **Dark counts:** The meter's baseline reading in the absence of source light is the dark count value. This is determined by measuring the signal output of the meter in clean, de-ionized water with black tape over the detector.
2. **Pressure:** To ensure the integrity of the housing and seals, *ECOs* are subjected to a wet hyperbaric test before final testing. The testing chamber applies a water pressure of at least 50 PSI.
3. **Mechanical Stability:** Before final testing, the *ECO* meters are subjected to a mechanical stability test. This involves subjecting the unit to mild vibration and shock. Proper instrument functionality is verified afterwards.
4. **Electronic Stability:** This value is computed by collecting a sample once per second for twelve hours or more. After the data is collected, the standard deviation of this set is calculated and divided by the number of hours the test ran. The stability value must be less than 2.0 counts/hour.
5. **Noise:** Noise is computed from a standard deviation over 60 samples. These samples are collected at one-second intervals for one minute. A standard deviation is then performed on the 60 samples, and the result is the published noise on the calibration form. The calculated noise must be below 2 counts.
6. **Voltage and Current Range Verification:** To verify the *ECO* operates over the entire specified voltage range (7–15 V), a voltage test is performed at 7 and 15V, and the current draw and operation is observed. The current must remain constant at both 7 and 15V.

7. Terminal Communications

As an alternative to the ECOView host software, *ECO* sensors can be controlled from a terminal emulator or customer-supplied interface software. This section outlines hardware requirements and low-level interface commands for this type of operation.

7.1 Interface Specifications

- baud rate: 19200
- data bits: 8
- parity: none
- stop bits: 1
- flow control: none

7.2 Command List

Command	Parameters passed	Description
!!!!	none	Stops data collection; allows user to input setup parameters. Note that if the meter is in a sleep state, the power must be turned off for a minute, then powered on while the “!” key is held down for several seconds. If this does not “wake” the meter, refer to the ECOView user’s guide Operation Tip to “wake” a meter in a low power sleep state to enable inputting setup parameters.
\$ave	single number, 1 to 65535	Number of measurements for each reported value
\$clk	24hr format time, hhmmss	Sets the time in the Real Time Clock
\$dat	date, format mmddyy	Sets the date in the Real Time Clock
\$emc	none	Erases the Atmel memory chip, displays menu when done
\$get	none	Reads data out of Atmel memory chip. Prints "etx" when completed.
\$int	24hr format time, hhmmss	Time interval between packets in a set
\$mnu	none	Prints the menu, including time and date
\$pkt	single number, 0 to 65535	Number of individual measurements in each packet
\$rec	1 (on) or 0 (off)	Enables or disables recording data to Atmel memory chip
\$rls	none	Reloads settings from flash
\$run	none	Executes the current settings
\$set	single number, 0 to 65535	Number of packets in a set
\$sto	none	Stores current settings to internal flash

8. Device and Output Files

Each meter is shipped with a CD containing the meter-specific device file, a sample output file, characterization information, and the applicable user's guides.

The ECOView host program requires a device file to provide engineering unit outputs for any of its measurements. Except for the first line in the device file, all lines of information in the device file that do not conform to one of the descriptor headers will be ignored. Every ECOView device file has three required elements: Plot Header, Column Count Specification, and Column Description.

8.1 Plot Header

The first line in the device file is used as the plot header for the ECOView Plots.

8.2 Column Count Specification

The Column Count Specification identifies how many columns of data to expect. It follows the format "Column=n." The Column Count Specification must be present before any of the Column Descriptions are listed.

8.3 Column Description

Every column in the ECO meter's output must have a corresponding Column Description in the device file. The following notation is used in identifying the elements of each Column Description.

x = the column number, starting with 1 as the 1st column

sc = scale

dc = dark counts: meter output in clean water with optics head taped

mw = wavelength measured by the sensor

dw = display wavelength: color to plot scattering data in

v = measured volts dc

Valid Column Descriptions are listed in the subsections below.

8.3.1 Turbidity Measurements

NTU= x sc dc

9.3.2 Miscellaneous

Date= x MMDD/YY

Time= x HH:MM:SS

N/U= x Not Used

Scale, offset, and output are factory-set engineering unit calculations the user can manually adjust. Engineering units are displayed through ECOView in the Plot Data tab. Parameters for changing the internally calculated engineering units:

iengrscale=sc

iengroffset=off

iengrunits=label where label is any continuous character string.

8.4 Sample Device Files

Below is a sample device file for NTU meters.

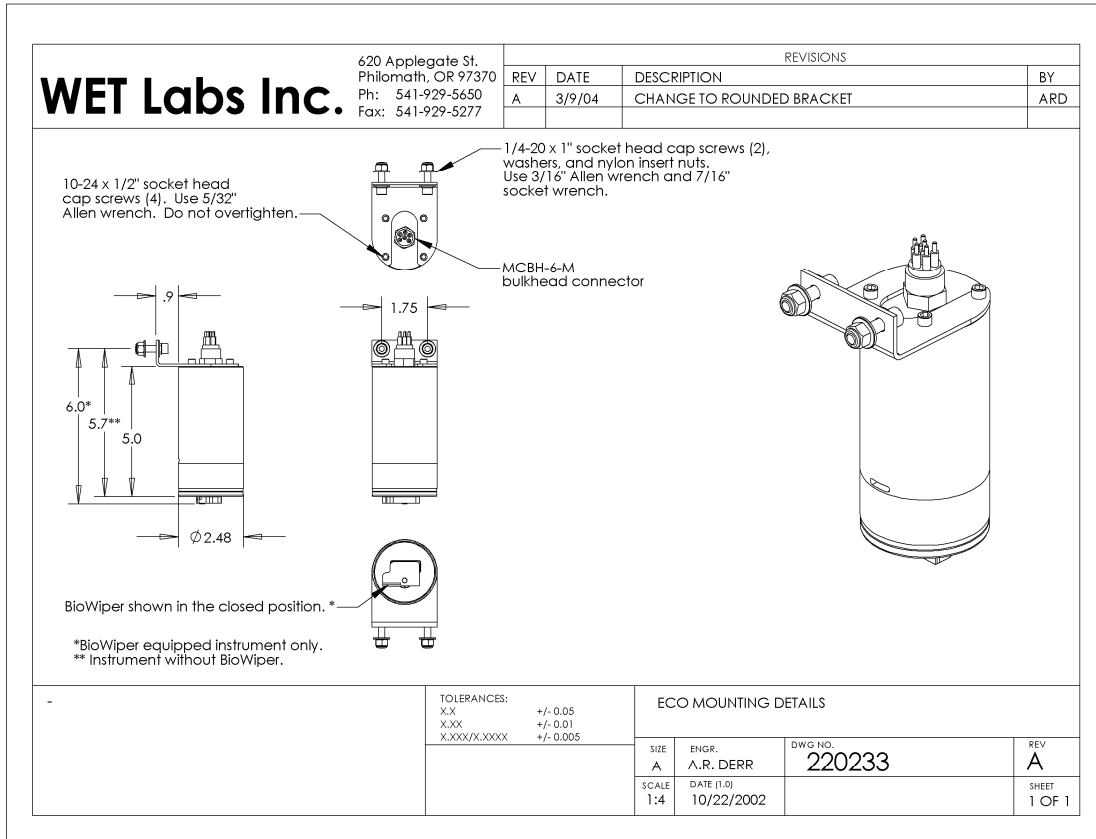
```
ECO NTUS-785
Created on: 08/03/07
Columns=5
Date=1
Time=2
N/U=3
NTU=4      0.0063      85.0
N/U=5
```

8.5 Sample Output Files

The reference column is unused by ECO firmware versions, but in 3.01 the scattering wavelength of the NTU displayed.

Date (MM/DD/YY)	Time (HH:MM:SS)	λ	NTU Signal	Thermistor
08/03/07	11:22:51	700	69	536
08/03/07	11:22:53	700	68	536
08/03/07	11:22:54	700	68	536
08/03/07	11:22:56	700	67	536
08/03/07	11:22:57	700	69	536
08/03/07	11:23:00	700	68	536

Appendix A: Mounting Bracket Drawing





WET Labs WEEE Policy

In accordance with Directive 2002/96/EC and the Council of 27 January 2003, WET Labs policy regarding the collection and management of Waste Electrical and Electronic Equipment (WEEE) is published here and is available at www.wetlabs.com.

A core component of our corporate vision is to accept responsibility for preserving our environment and we embrace the opportunity to work with our customers and the EU to reduce the environmental impact resulting from the continuous improvement of our products.

WEEE Return Process

To meet the requirements of the WEEE Directive, WET Labs has instituted a product end-of-life take back program. To arrange return for an end-of-life WEEE product:

1. Contact WET Labs Customer Service
 - By phone: 1-541-929-5650
 - By email: support@wetlabs.com

WET Labs will provide:

WEEE RMA number

Shipping account number, method, and address

2. Package and ship the WEEE back to WET Labs

WEEE will be processed in accordance with WET Labs' equipment end-of-life recycling plan.

Revision History

Revision	Date	Revision Description	Originator
A	9/19/07	New document (DCR 532)	M. Johnson, H. Van Zee
B	4/3/08	Change LED to 700 nm (ECN 293, DCR 580)	M. Johnson
C	7/10/08	Change dark counts derivation to reflect current production methodology (DCR 600)	A. Barnard, M. Johnson, H. Van Zee
D	2/9/09	Update to G4 current draw specs (DCR 653)	M. Johnson
E	9/21/10	Updates to sensitivity, range, current draw, and memory (DCR 695)	I. Walsh
F	9/14/11	Add WEEE Statements (DCN 775)	H. Van Zee
G	6/4/12	Add ESD operating notice (DCN 798)	J. Pearson, H. Van Zee