

ECO Sensors Calibration Coefficients

The procedures below are valid for Seasave V7 and SBE Data Processing software, v. 7.21 and later. This Application Note applies to the following *ECO* sensors:

- ECO-FL fluorometer - FL, FLD, FL(RT), FL(RT)D, FLS, FLB, or FLSB
- ECO-NTU turbidity meter – NTU(RT), NTU(RT)D, or NTUS, NTUB, NTUSB
- ECO-FLNTU – combines a fluorometer and turbidity meter, and requires two channels in your CTD
- ECO-bb – scattering meter, with output in $\text{m}^{-1} \text{sr}^{-1}$.

Note:

- The ECO-bb comes with a calibration sheet that lists values for Dark Outputs and Scale Factor. Each of these values is supplied in terms of both voltage and counts.
 - Use the **voltage values** in the Sea-Bird software if using an ECO-bb set to analog output.
 - Use the **counts values** in the Sea-Bird software if using an RS232 output ECO-bb (compatible only with SBE 16plus V2, 16plus-IM V2, or 19plus V2 CTDs).

Fluorometer Calibration Coefficients

The fluorometer has a response that is linear over the measurement range provided.

ECO-FL

The measurement range for the analog output version of this sensor can be adjusted with the analog scaling value. To change the range, connect the ECO-FL directly to the computer and use the ECOView software to enter a new analog scaling value.

Analog Scaling Value/Range	1	2	4 (default)
Chlorophyll α: Nominal range, $\mu\text{g/l}$	0–30	0–50	0–125
Rhodamine: Nominal range, ppb	0–55	0–110	0–230
Phycocyanin: Nominal range, ppb	0–55	0–110	0–230
Phycoerythrin: Nominal range, ppb	0–55	0–110	0–230
CDOM: Nominal range, ppb	0–125	0–250	0–500
Uranine: Nominal range, ppb	0–100	0–200	0–400

ECO-FLNTU

The measurement range for this combination fluorometer and turbidity meter is factory-configured, and cannot be adjusted in the field. For the fluorometer channel, the range is approximately 0–30, 0–50, 0–75, or 0–125 $\mu\text{g/l}$ (see *Turbidity Meter Calibration Coefficients* below for the turbidity meter channel).

ECO-FL as part of the Triplet

When the ECO-FL is part of the Triplet, the measurement range is factory-configured and cannot be adjusted in the field.

Chlorophyll α: Nominal range, $\mu\text{g/l}$	0–50
Rhodamine: Nominal range, ppb	0–175
Phycocyanin: Nominal range, ppb	0–175
Phycoerythrin: Nominal range, ppb	0–175
CDOM: Nominal range, ppb	0–375
Uranine: Nominal range, ppb	0–300

Setting Up Configuration (.xmlcon) File for Fluorometer

1. Use the Configure Inputs menu in Seasave V7 (real-time data acquisition software), or the Configure menu in SBE Data Processing (post-processing software), to create or modify the .xmlcon file:
 - For the voltage (analog) output ECO FL: Select *Fluorometer – WET Labs CDOM* for the CDOM fluorometer or *Fluorometer – WET Labs ECO-AFL/FL* for all other ECO fluorometers for one of the **external voltage channels** on the CTD.
 - For the RS232 (digital) output ECO FL (SBE 16*plus* V2, 16*plus*-IM V2, or 19*plus* V2 CTDs only): Select *Fluorometer – WET Labs CDOM* for the CDOM fluorometer or *Fluorometer – WET Labs ECO-AFL/FL* for all other ECO fluorometers for one of the RS232 channels on the CTD.
2. The software prompts for Dark Output and Scale Factor and calculates concentration as:
Concentration ($\mu\text{g/l}$ or ppb, as applicable) = (Output – Dark Output) * Scale Factor (see Note)
where:
 - Output (volts for analog output sensor; counts for digital output sensor) = *in-situ* output of the fluorometer
 - Dark Output (volts for analog output sensor; counts for digital output sensor) = measured output for a seawater blank (pure, de-ionized water) with black tape over detector (see Note)
 - Scale factor ($\mu\text{g/l}$ -volts, $\mu\text{g/l}$ -counts, ppb/volts, or ppb/counts as applicable) = multiplier

The fluorometer comes with a calibration sheet that lists values for Dark Output and Scale Factor (see Note). Each of these values is supplied in terms of both voltage and counts. If you changed the analog scaling value (ECO-FL series only), change the Scale Factor to correspond.

Notes:

- The configuration file can only be saved as an .xmlcon file (not a .con file) if the digital output version of the ECO-FL is one of the sensors.
- Calibration sheets for older fluorometers may list **Vblank** instead of **Dark Output**. Use the Vblank value in place of Dark Output when setting up the configuration file.

Example Chlorophyll *a* Concentration Calculation in Sea-Bird Software:

Dark Output = 0.05 volts and Scale Factor = 12.35 $\mu\text{g/l}$ -volts (from calibration sheet)

Measured voltage from fluorometer = Output = 4.65 volts

Calculated concentration ($\mu\text{g/l}$) = (Output – Dark Output) * Scale Factor = (4.65 - 0.05) * 12.35 = 56.8 $\mu\text{g/l}$

While the factory-supplied Scale Factor can be used to obtain approximate values, field calibration is highly recommended. For example, the relationship between fluorescence and chlorophyll *a* is highly variable, and is not easy to determine in the laboratory. Species distribution, ambient light level, and health of the stock are just some of the factors that affect the relationship. To accurately measure chlorophyll *a* concentration with a fluorometer, perform calibrations on seawater samples with concentrations of plankton populations that are similar to what is expected *in-situ*. Determine chlorophyll *a* concentrations independently, and use those concentrations, as well as readings from the fluorometer, to determine the correct Scale Factor. **The Scale Factor is correct as long as the condition of the plankton population does not change; the condition does change with season and geographic location.**

Example Calculation of Scale Factor from field calibration:

Seawater sample analysis shows chlorophyll *a* is 50 $\mu\text{g/l}$ when fluorometer reads 3.2 volts; measured signal for dark output is 0.05 volts.

concentration ($\mu\text{g/l}$) = (Output – Dark Output) * Scale Factor → 50 = (3.2 - 0.05) * Scale Factor

Solving: Scale Factor = (50) / (3.2 - 0.05) = 15.87 $\mu\text{g/l}$ → Enter new Scale Factor in configuration (.xmlcon) file.

Turbidity Meter Calibration Coefficients

The turbidity meter has a response that is linear over the measurement range provided.

ECO-NTU

Measurement range for the analog output version of this single-channel sensor can be adjusted with the analog scaling value. To change the range, connect the ECO-NTU directly to the computer and use the ECOView software to enter a new analog scaling value.

Analog Scaling Value/Range	1	2	4 (factory default)
Nominal range, NTU	0–30	0–60	0–125
Nominal range, NTU	0–250	0–500	0–1000

ECO-FLNTU

The measurement range for this combination fluorometer and turbidity meters is factory-configured, and cannot be adjusted in the field. For the turbidity meter channel, the range is 0 to 10, 25, 100, 200, or 1000 NTU (see *Fluorometer Calibration Coefficients* above for the fluorometer channel).

ECO-NTU as part of the Triplet

When the ECO-NTU is part of the Triplet, the measurement range is factory-configured and cannot be adjusted in the field. For the turbidity meter channel, the range is 0–10, 0–25, 0–300, or 0–1000 NTU.

Setting Up Configuration (.xmlcon) File for Turbidity Meter

- Use the Configure Inputs menu in Seasave V7 (real-time data acquisition software), or the Configure menu in SBE Data Processing (post-processing software), to create / modify the .xmlcon file (see software Help files):
 - For the voltage output ECO NTU: *OBS/Nephelometer/Turbidity – Turbidity*, *WET Labs*, *ECO-NTU* for one of the external voltage channels on the CTD.
 - For the RS232 output ECO NTU (SBE 16*plus* V2, 16*plus*-IM V2, or 19*plus* V2 CTDs only): Select *Turbidity Meters – Turbidity Meter*, *WET Labs*, *ECO-NTU* for one of the RS232 channels on the CTD.
- The software prompts for Dark Output and Scale Factor and calculates concentration as:
$$\text{Turbidity (NTU)} = (\text{Output} - \text{Dark Output}) * \text{Scale Factor} \quad (\text{see Note})$$

where:

 - Output (volts for analog output sensor; counts for digital output sensor) = *in-situ* output of the turbidity meter
 - Dark Output (volts for analog output sensor; counts for digital output sensor) = measured output for a seawater blank (pure, de-ionized water) with black tape over detector
 - Scale factor (NTU/volts or NTU/counts, as applicable) = multiplier

The turbidity meter comes with a calibration sheet that lists values for Dark Output and Scale Factor. Each of these values is supplied in terms of both voltage and counts. If you changed the analog scaling value (single channel ECO-NTU only), change the Scale Factor to correspond.

Note that the configuration file can only be saved as an .xmlcon file (not a .con file) if the digital output version of the ECO-NTU is one of the sensors.

While the factory-supplied Scale Factor can be used to obtain approximate values, field calibration is highly recommended. The relationship between turbidity and NTU is highly variable, and is not easy to determine in the laboratory. Particle shape and size are some of the factors that affect the relationship. To accurately measure NTU with a turbidity meter, perform calibrations on seawater samples with distributions of particles that are similar to what is expected *in-situ*. Determine NTU independently, and use those values, as well as readings from the turbidity meter, to determine the correct Scale Factor. **The Scale Factor is correct as long as the distribution of particle sizes and shapes does not change; the condition does change with season and geographic location.**

Setting Up Configuration File for Calibration Coefficients for Scattering Meter in $m^{-1} sr^{-1}$

1. Use the Configure Inputs menu in Seasave V7 (real-time data acquisition software), or the Configure menu in SBE Data Processing (post-processing software), to create or modify the .xmlcon file.
 - For the voltage output ECO-bb: Select *OBS/Nephelometers/Turbidity – Turbidity Meter, WET Labs, ECO bb* for one of the **external voltage channels** on the CTD.
 - For the RS232 output ECO-bb (SBE 16*plus* V2, 16*plus*-IM V2, or 19*plus* V2 CTDs only): Select *Turbidity Meters – Turbidity Meter, WET Labs, ECO-BB* for one of the RS232 channels on the CTD.
2. The software prompts for Scale Factor and Dark Output, and calculates:
$$\beta(\theta c) = (\text{Output} - \text{Dark Output}) * \text{Scale Factor} \quad (\beta(\theta c) \text{ in units of } m^{-1} sr^{-1})$$

where:

 - Output (volts for analog output sensor; counts for digital output sensor) = *in-situ* output of ECO-BB
 - Dark Output (volts for analog output sensor; counts for digital output sensor)
= measured output for a seawater blank (pure, de-ionized water) with black tape over detector
 - Scale factor ($\beta(\theta c)$ /volts for analog output sensor; ($\beta(\theta c)$ /counts for digital output sensor) = multiplier

Note: The configuration file can only be saved as an .xmlcon file (not a .con file) if the ECO-bb is one of the sensors.