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# Calculating Calibration Coefficients for Turner Cyclops-7 Fluorometer or Turbidity Sensor

The Cyclops-7 provides a 0 to 5 volt output voltage proportional to fluorescence or turbidity. The Cyclops-7 is factory-configured at Turner to detect one of the following:

| **Measuring** | Chlorophyll *a* | Rhodamine WT tracer dye | Phycocyanin | Phycoerythrin | Turbidity | CDOM | Crude Oil |
|---|---|---|---|---|---|---|---|
| **Designation on sensor** | C | R | P | E | T | U | O |

The user can customize the 0-5V Cyclops-7 range to correspond to the expected data range by changing the interface cable, thus improving data resolution. The ranges are:

| **Cable Gain** | **Chlorophyll *a* (µg/l)** | **Rhodamine WT tracer dye (ppb)** | **Phycocyanin or Phycoerythrin (cells/ml)** | **Turbidity (NTU)** | **CDOM (ppb QS*)** | **Crude Oil (ppb QS*)** |
|---|---|---|---|---|---|---|
| **X100** | 0 – 5 | 0 – 10 | 0 – 1500 | 0 – 30 | 0 - 25 | 0 - 15 |
| **X10** | 0 – 50 | 0 – 100 | 0 – 15,000 | 0 – 300 | 0 – 250 | 0 – 150 |
| **X1** | 0 - 500 | 0 - 1000 | 0 – 150,000 | 0 - 3000 | 0 - 2500 | 0 – 1500 |

* QS = Quinine Sulfate

*Example:* You have a Cyclops-7, factory-configured to detect Chlorophyll *a* (range 0 – 500, 0 – 50, or 0 – 5 µg/l, depending on interface cable). You expect a range of 0 – 20 µg/l for chlorophyll *a* fluorescence. If using an X1 cable, the maximum voltage will be approximately 0.2 V (= 20 µg/l / [500 µg/l / 5 V] ). This limits the resolution and multiplies the noise level. Changing the range to 0 - 50 µg/l (using an X10 cable) provides the best results.

When interfacing a Cyclops-7 to a Sea-Bird CTD, Sea-Bird defines the concentration as:

concentration = (scale factor * voltage) + offset

The factory range can be used to calculate the factory default scale factor and offset (see page 2 for field calibration):

scale factor = Range / 5 V

offset = - scale factor * measured voltage at 0 concentration (i.e., blank voltage)

To determine the blank voltage, place the Cyclops-7 in its field configuration (with or without a flow-through cap, as applicable) in de-ionized water and take a voltage reading.

## Setting Up Configuration (.con or .xmlcon) File in Seasave or SBE Data Processing

**Change range by changing interface cable, as needed, before setting up configuration file in Sea-Bird software**.

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 / modify the .con or .xmlcon file (see software Help files).

2. Select the Turner SCUFA **fluorometer** (Note: You must select the SCUFA because the Cyclops is not available as a choice in the current software version. However, the calculation for the SCUFA is of the same form as for the Cyclops, so the software will calculate fluorescence or turbidity correctly for the Cyclops.).
   The software prompts for scale factor, offset, and units, and calculates:
   - **Chlorophyll *a*** – Equation shown is for units of µg/l; other units available
     chlorophyll *a* (µg/l) = (scale factor * voltage) + offset
     *where* Scale Factor is in µg/l-volt and Offset is in µg/l
   - **Rhodamine** - Equation shown is for units of ppb; other units available
     Rhodamine (ppb) = (scale factor * voltage) + offset
     *where* Scale Factor is in ppb/volt and Offset is in ppb

- **Phycocyanin or Phycoerythrin** – Equation shown is for units of cells/ml.
  Phycocyanin or Phycoerythrin = (scale factor * voltage) + offset
  *where* Scale Factor is in cells/mL-volt and Offset is in cells/ml
  ***Note concerning Phycocyanin or Phycoerythrin units***: The current software version does not allow the user to select cells/mL as output units for the Turner SCUFA. Calculate and input the scale factor in cells/ml-volt and the offset in cells/ml. Select any units in the software, and be aware when you view and process the data that the units are actually cells/ml.
- **Turbidity** – Equation shown is for units of NTU.
  Turbidity = (scale factor * voltage) + offset
  *where* Scale Factor is in NTU/volt and Offset is in NTU.
- **CDOM or Crude Oil** – Equation shown is for units of ppb QS.
  CDOM = (scale factor * voltage) + offset
  *where* Scale Factor is in ppb QS/volt and Offset is in ppb QS.

**Note:** The software dialog box also shows grayed out fields for MX, MY, and B; these calibration parameters are applicable only when a Turner OBS has been selected for another voltage channel (intended for use with a Turner SCUFA with an optional turbidity channel).

*Example of Chlorophyll a Concentration Calculation:*
If
scale factor = 10.5 µg/l-volts,
offset = - 0.03 µg/l, and
measured voltage from fluorometer = 2.65 volts:
Calculated concentration (µg/l) = (scale factor * voltage) + offset = (10.5 * 2.65) - 0.03 = 27.80 µg/l

## Note on Field Calibration

While the nominal scale factor and offset based on factory range and your measured blank voltage can be used to obtain approximate values, **field calibration for chlorophyll *a*, Phycocyanin, Phycoerythrin, or turbidity is highly recommended**.

- The relationship between fluorescence and **chlorophyll *a***, **Phycocyanin**, or **Phycoerythrin** 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 concentrations, perform calibrations on seawater samples with concentrations of plankton populations that are similar to what is expected in situ. Determine concentrations independently, and use those concentrations, as well as readings from the Cyclops-7 (with or without a flow through cap, as applicable), to determine the correct Scale Factor. It is only through the use of these calibrations that a meaningful and accurate measure of these parameters can be obtained. **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.**
- The relationship between Cyclops-7 **turbidity** sensor output and turbidity is somewhat variable, and is not easy to determine in the laboratory. Particle shape and size are just some of the factors that affect the relationship.
  To accurately measure concentrations, perform calibrations on seawater samples with concentrations of particles that are similar to what is expected in situ. Determine concentrations independently, and use those concentrations, as well as readings from the Cyclops-7, to determine the correct Scale Factor. It is only through the use of these calibrations that a meaningful and accurate measure of turbidity can be obtained. **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.**

To accurately measure the offset, perform a calibration on a blank (de-ionized water) sample, with the Cyclops-7 in its field configuration (with or without a flow-through cap, as applicable).

**See Turner's Cyclops-7 manual for calibration details.**