



**APPLICATION NOTE NO. 74**

**Revised August 2010**

**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 <i>a</i>	Rhodamine WT tracer dye	Phycocyanin	Phycocerythrin	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 <i>a</i> (µg/l)	Rhodamine WT tracer dye (ppb)	Phycocyanin or Phycocerythrin (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 *Fluorometer - Turner Cyclops* as a voltage sensor when editing the configuration file (the Turner Cyclops fluorometer was added to the list of voltage sensors in software version 7.20g; earlier software versions do not list it). The software prompts for scale factor, offset, and measured parameter, 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
- **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 configuration file can only be saved as an .xmlcon file (not a .con file) if Turner Cyclops fluorometer is selected as one of the sensors.

*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.

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## Application Note Revision History

<b>Date</b>	<b>Description</b>
July 2004	Initial release
November 2004	Add information on Phycoocyanin and Phycoerythrin fluorometers.
February 2005	Remove reference to units being calibrated at Turner factory. Turner is no longer providing a calibration sheet with their instruments, so user is responsible for determining blank voltage.
March 2009	Updated to reflect Turner's changes in fluorometer ranges.
July 2009	Updated to add Turner Cyclops-7 Turbidity Sensor.
March 2010	<ul style="list-style-type: none"><li>• Remove old ranges.</li><li>• Add information on .xmlcon configuration file.</li><li>• Update Sea-Bird address.</li></ul>
June 2010	<ul style="list-style-type: none"><li>• Modify ranges to match Turner's latest specification.</li><li>• Add CDOM and Crude Oil sensors.</li></ul>
August 2010	SBE Data Processing and Seasave 7.20g software revision: Turner Cyclops added to list of fluorometers (previously needed to select Turner Scufa for this sensor)