

Using the Explorer for Direct Concentration Calibration of the Cyclops Submersible Sensor



Background Information

The Turner Designs Cyclops Submersible Sensor is an accurate single-channel detector that can be used for many different applications. It is designed for integration into systems from which it receives power and delivers a voltage output proportional to the concentration of the fluorophore of interest in water. This voltage output is interpreted as a Relative Fluorescence Unit (RFU) that is reported as qualitative data. Relative Fluorescence Units can be correlated to actual concentrations by calibrating the Cyclops with standards of known concentrations.

The Explorer is a simple lab tool that interfaces with your Cyclops-7 or Cyclops-6K allowing you to analyze samples, perform functional checks, determine instrument limits, and become familiar with how to use your Cyclops sensor using intuitive software that can be downloaded directly from Turner Designs' website. Plugging directly into the USB port on a computer, the Explorer guides the user through simple GUI controls for more detailed analyses such as determining growth rate of algal cultures, estimating dye concentrations, and exploring physical, chemical, or biological effects on fluorescence properties of materials or organisms.

The Cyclops can be used in one of three modes:

1. Uncalibrated - Raw Fluorescence Mode

Values in the Raw Fluorescence Mode are referred to as “Relative Fluorescence Units” (RFU). It is important to note that these values are not blank subtracted or scaled to a standard. They are relative values.

2. Uncalibrated - Raw Fluorescence Blank Subtracted Mode

Values in the Raw Fluorescence Blank Subtracted Mode are noted as RFUB.

These values are blank subtracted to account for background fluorescence that may be present in the sampling conditions but are not scaled to a standard. They are relative values.

3. Direct Concentration Mode

Values reported in the Direct Concentration Mode are blank subtracted and scaled to a standard solution that has a predetermined standard value.

This presentation steps through using the Explorer to do a Direct Concentration calibration of the Cyclops to ensure values are reported as Blank Subtracted Concentrations in your units of choice.

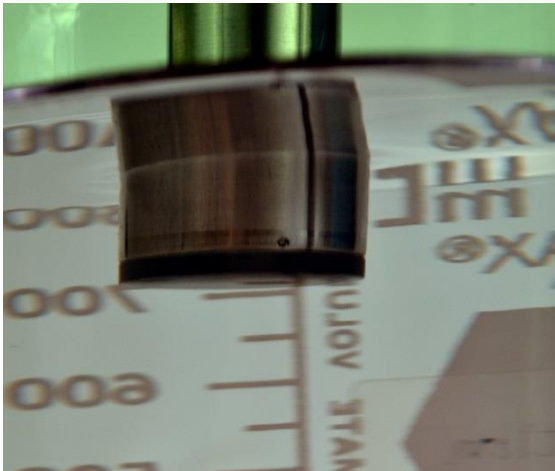
A Turner Designs DataBank <http://www.turnerdesigns.com/t2/doc/tech-notes/S-0173.pdf> or a digital volt meter can also be used to calibrate the Cyclops.

The tools required for this example are:

- The Explorer, AC power source and computer loaded with Explorer software.
- Cyclops-7 configured with Rhodamine optics.
- Two glass containers and a non-reflective black surface. The containers should be large enough to ensure that the sensor face can be submerged with more than 3 inches above the bottom of the container and more than 2 inches clearance between the circumference of the sensor and the inside surface of the container.
- If you want, you can use a shade cap as an optical backstop for the sensor. If you do, a smaller volume container can be used, as long as the shade cap and sensor face can be submerged. If using the shade cap, you do not need a non-reflective black surface.
- Deionized or ultrapure water
- Rhodamine Calibration Standard - 100ppb concentration.

The first step is to prepare your blank for calibration:

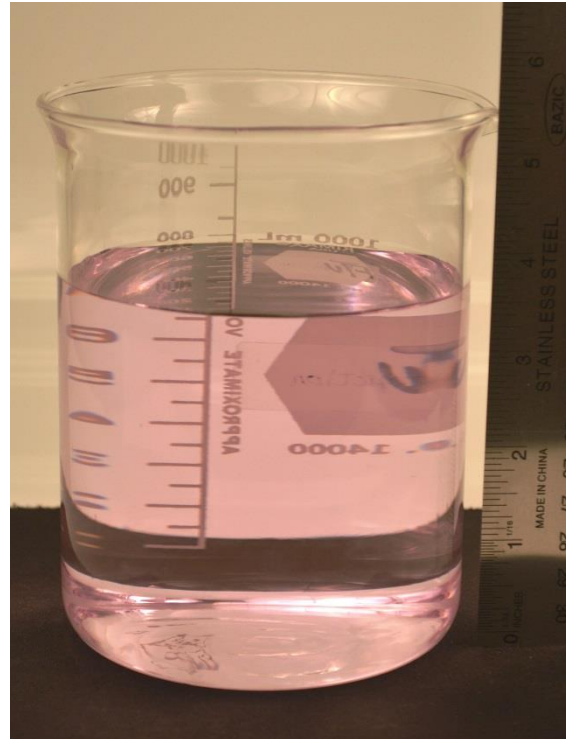
Fill your glass container with deionized or ultrapure water and set aside. Fill the container full enough that there are more than 3 inches of water from the bottom. This will ensure that you are able to completely submerge the optical face of the sensor and still have the recommended 3 inches of water above the bottom of the container. If you are using the shade cap you want to be sure that there is enough water to fully submerge the shade cap as well as the optical face of the sensor.



Next you need to prepare your Rhodamine Calibration Standard:

Fill another glass container with the Rhodamine Calibration Standard and set aside.

This container should also be filled with roughly the same volume of standard as the blank container.



Explorer Setup

This presentation assumes that you have installed the Explorer Driver and Software onto a computer. Explorer Software and instructions are available on the Turner Designs Website:

Explorer Software & Firmware

[Explorer Driver](#)

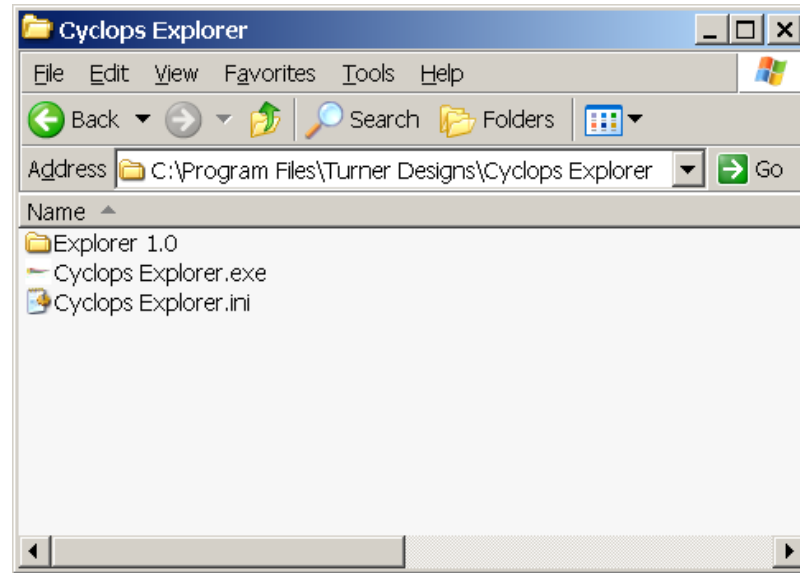
[Explorer Software](#)

[Installation and Operating Instructions](#)

Please contact our [Technical Support](#) department if you have questions.

Now get the Explorer Software up and running.

Start Explorer software located in the Turner Designs folder accessible from the Windows Start menu.

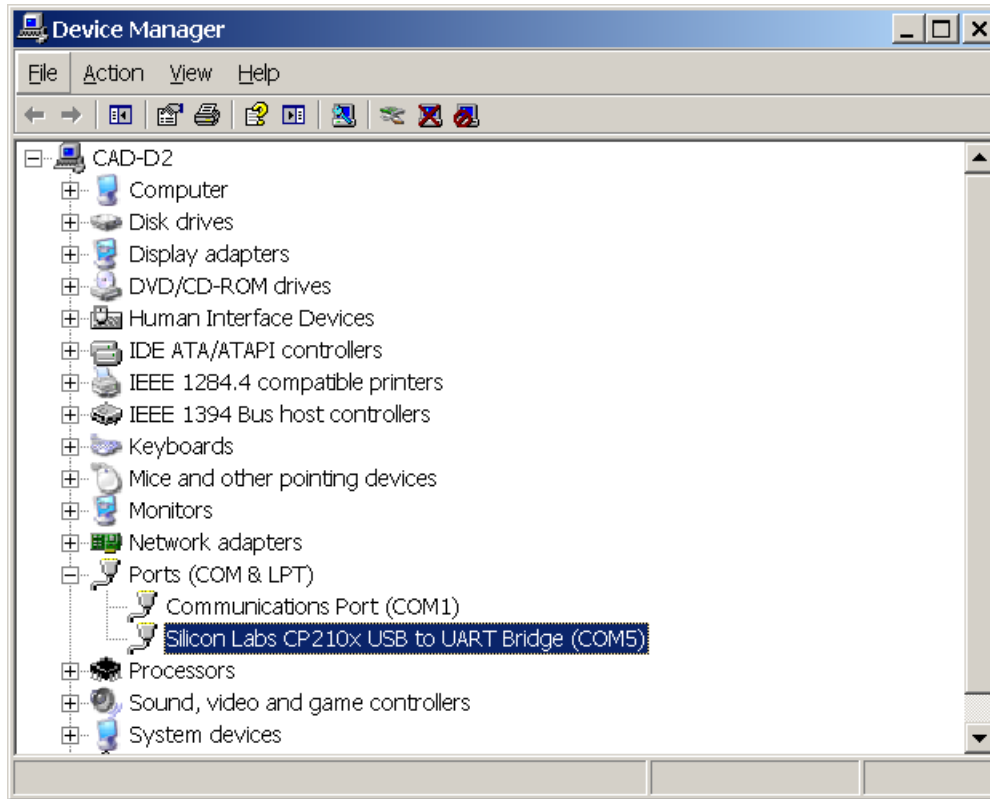


Once the software is started, connect your Cyclops to the Explorer. Be sure to align the pins carefully and tighten the locking sleeve to secure the sensor.

Then, connect the Explorer to a USB port of your computer.

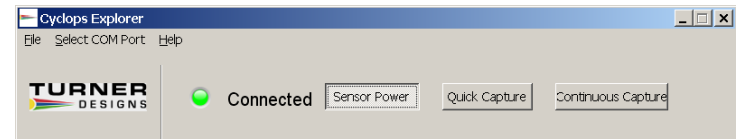
Finally, supply power to the Explorer via the power connector.

Make sure the Explorer is connected to the correct COM port on your computer.
Open the Device Manager and confirm the COM port.



Click the “Sensor Power” button to power the Cyclops sensor. The LED on the sensor should illuminate. If you are using a PTSA, Crude Oil, Refined Fuels, CDOM/FDOM, Optical Brighteners, or Tryptophan Cyclops with a UV LED, **do not look directly at the optical face of the sensor as it may cause damage to your eye.** Hold a white sheet of paper in front of the optical face. You should see blue light on the sheet of paper indicating the UV LED is functioning properly.

Cyclops Application	Light Source
Tryptophan	Deep UV LED
Refine Fuels	
PTSA	UV LED
Crude Oil	
Optical Brighteners	
CDOM/FDOM	
Fluorescein Dye	Blue LED
Chl <i>a in vivo</i> (Blue Excitation)	
Phycocerythrin (Marine Cyanobacteria)	Green LED
Rhodamine Dye	
Phycocyanin (Freshwater Cyanobacteria)	Yellow LED
Chl <i>in vivo</i> (Red Excitation)	Red LED
Turbidity	IR LED



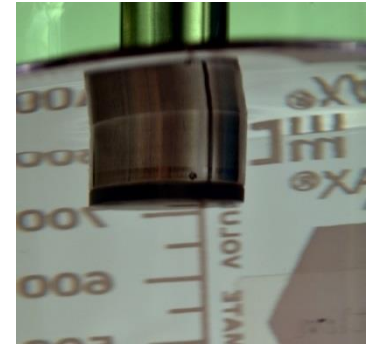
Cyclops sensors can be used to collect data in any of 3 gain settings. Each gain setting has its own range of concentrations

- The 100x gain is the most sensitive and is used for very low concentration detection, but offers the smallest overall range.
- The 10x gain is the most appropriate to use if you are unsure of what is best for your specific samples. This gain has good minimum detection limit as well as a good detectable range of concentrations.
- The 1x gain is the least sensitive and is recommended for utilizing the complete range of the instrument.

If you do not want to specify a gain, the Explorer has an Auto Gain feature.

When selected the Explorer software will automatically select the best gain for the sample being read.

For this example start with the 100x, the most sensitive gain setting. Select the 100x gain button and place the sensor in your blank solution. Make sure there are no bubbles on the optical face.

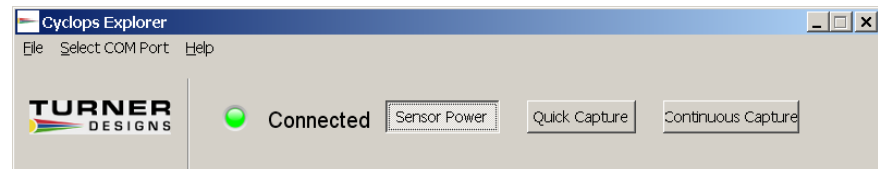


At this point you can either select Quick Capture or Continuous Capture.

Quick Capture – is used to capture one data point with each click of the “Quick Capture” button.

Continuous Capture – is used to capture data continuously at a given sample interval. Once the “Continuous Capture” button is clicked, data will be displayed in the Data View section of the screen at the set sample interval. To stop continuous capture, simply click the button again.

We are selecting Continuous Capture.



Data for the sensor in the blank solution is now appearing on the screen.

The screenshot shows the Cyclops Explorer software interface. The window title is "Cyclops Explorer" and the menu bar includes "File", "Select COM Port", and "Help". The Turner Designs logo is in the top left. The status bar shows "Connected" with a green indicator light. There are buttons for "Sensor Power", "Quick Capture", and "Continuous Capture". A large display shows "235 mV" and a "Show Graph" checkbox. Below this is a data table with the following columns: Date, Time, Gain, and mV. The table contains 14 rows of data, with the last row showing a reading of 235 mV. On the left side, there are buttons for "Clear Data", "Auto Gain", and three gain selection buttons: "1x Gain", "10x Gain", and "100x Gain". The "100x Gain" button is currently selected. Below the gain buttons is a "Continuous Capt Interval" section with input fields for Hr., Min., and Sec., currently set to 0, 0, and 1 respectively.

Date	Time	Gain	mV
10/22/2013	15:27:44	100x	311
10/22/2013	15:27:45	100x	282
10/22/2013	15:27:46	100x	242
10/22/2013	15:27:47	100x	217
10/22/2013	15:27:48	100x	215
10/22/2013	15:27:49	100x	222
10/22/2013	15:27:50	100x	187
10/22/2013	15:27:51	100x	201
10/22/2013	15:27:52	100x	192
10/22/2013	15:27:53	100x	217
10/22/2013	15:27:54	100x	224
10/22/2013	15:27:55	100x	206
10/22/2013	15:27:56	100x	210
10/22/2013	15:27:57	100x	235

You can change the gain setting from 100x to 10x or 1x by selecting the appropriate buttons on the screen. Observe how the voltage response changes depending on the gain setting selected.

10X

The screenshot shows the Cyclops Explorer software interface. The status bar at the top indicates 'Connected'. The main display shows a reading of 45 mV. The gain is set to 10x. The data table below shows a series of measurements over time, all at 10x gain.

Date	Time	Gain	mV
10/22/2013	15:29:25	10x	45
10/22/2013	15:29:26	10x	49
10/22/2013	15:29:27	10x	57
10/22/2013	15:29:28	10x	63
10/22/2013	15:29:29	10x	49
10/22/2013	15:29:30	10x	40
10/22/2013	15:29:31	10x	40
10/22/2013	15:29:32	10x	40
10/22/2013	15:29:33	10x	40
10/22/2013	15:29:34	10x	43
10/22/2013	15:29:35	10x	38
10/22/2013	15:29:36	10x	40
10/22/2013	15:29:37	10x	40
10/22/2013	15:29:38	10x	45

1X

The screenshot shows the Cyclops Explorer software interface. The status bar at the top indicates 'Connected'. The main display shows a reading of 24 mV. The gain is set to 1x. The data table below shows a series of measurements over time, all at 1x gain.

Date	Time	Gain	mV
10/22/2013	15:30:36	1x	22
10/22/2013	15:30:37	1x	22
10/22/2013	15:30:38	1x	24
10/22/2013	15:30:39	1x	24
10/22/2013	15:30:40	1x	24
10/22/2013	15:30:41	1x	22
10/22/2013	15:30:42	1x	24
10/22/2013	15:30:43	1x	24
10/22/2013	15:30:44	1x	24
10/22/2013	15:30:45	1x	24
10/22/2013	15:30:46	1x	24
10/22/2013	15:30:47	1x	24
10/22/2013	15:30:48	1x	24
10/22/2013	15:30:49	1x	24

Next, put your sensor in the 100ppb Rhodamine standard solution and repeat the steps above, selecting each gain setting, capturing the data and noting the voltage for each of the gain settings with a known concentration.



Cyclops Explorer

File Select COM Port Help

TURNER DESIGNS

Connected Sensor Power Quick Capture Continuous Capture

Clear Data

Auto Gain

1x Gain

10x Gain

100x Gain

Continuous Capt Interval

Hr. Min. Sec

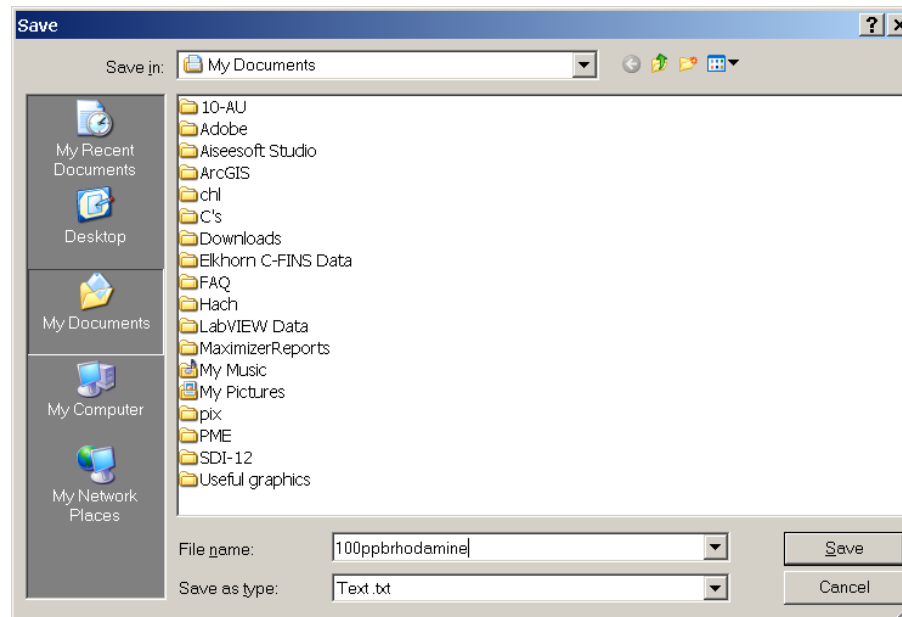
0 0 1

879 mV

Show Graph

Date	Time	Gain	mV
10/22/2013	15:32:38	100x	871
10/22/2013	15:32:39	100x	869
10/22/2013	15:32:40	100x	876
10/22/2013	15:32:41	100x	853
10/22/2013	15:32:42	100x	874
10/22/2013	15:32:43	100x	874
10/22/2013	15:32:44	100x	888
10/22/2013	15:32:45	100x	879
10/22/2013	15:32:46	100x	871
10/22/2013	15:32:47	100x	883
10/22/2013	15:32:48	100x	888
10/22/2013	15:32:49	100x	888
10/22/2013	15:32:50	100x	879
10/22/2013	15:32:51	100x	879

When data collection ends, save the collected data to a .txt file by accessing the “File” pull down menu and clicking on the “Save Collected Data” function. This will open a window asking you to navigate to a specific folder and name the file that is to be saved. The default folder in which the data will be saved is the My Documents folder. Saving the data allows you to use it for post analysis. Data cannot be retrieved once you exit the Explorer program if you have not saved it.



After all your data is taken, the following equation can be used to make a correlation to concentration values for sample measurements for each gain:

$$C_{\text{Sample}} = [(C_{\text{Std}})/(Volts_{\text{Std}} - Volts_{\text{Blank}})] * (Volts_{\text{Sample}} - Volts_{\text{Blank}})$$

Where C_{sample} = Concentration of sample

C_{Std} = Concentration value of standard used for calibration

$Volts_{\text{Std}}$ = Voltage reading from standard concentration

$Volts_{\text{Sample}}$ = Voltage reading from sample(s)

$Volts_{\text{Blank}}$ = Voltage reading from blank

For Example using data we collected to determine C_{sample}

Where: $C_{\text{Std}} = 100\text{ppb}$

$Volts_{\text{Sample}} = 400$

$Volts_{\text{Std}} = 879$

$Volts_{\text{Blank}} = 205$

$$C_{\text{Sample}} = [(C_{\text{Std}})/(Volts_{\text{Std}} - Volts_{\text{Blank}})] * (Volts_{\text{Sample}} - Volts_{\text{Blank}})$$

$$C_{\text{Sample}} = [(100\text{ppb})/(879 - 205)] * (400 - 205)$$

$$C_{\text{Sample}} = [(100\text{ppb})/(674)] * (195)$$

$$C_{\text{Sample}} = (0.148) * (195)$$

$$C_{\text{Sample}} = 28.93 \text{ ppb}$$

To power down the Cyclops, click the “Sensor Power” button and the instrument will stop functioning. Next, unplug the power connection to the Explorer cable. Finally, unplug the Explorer cable from the PC or laptop. The Cyclops is now ready for use and you may begin measuring samples.

