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Let's Solve Water

27 June 2019

Collecting High Quality Data with YSI

EXPERT TIPS FOR SENSOR CALIBRATION

SmartQC Handbook

Improved calibrations lead to improved data!

- Learn about our scoring system
- Quick reference for each sensor
- ...and more!

https://www.ysi.com/File%20Library/Documents/Guides/EXO-SmartQC-Handbook-E135.pdf

How Sensors Work:
5-Part Series on Water Quality Monitoring

Once a month, we will discuss why it is important to monitor five critical water quality parameters.

cleveland water alliance

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June 11
1:00pm (EDT)

July 9
1:00pm (EDT)

August 6
1:00pm (EDT)

September 10
1:00pm (EDT)

October 8
1:00pm (EDT)

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Best Practices

Maintenance Tips

Follow cleaning procedures outlined in the manual.

- Rinsing a sensor with DI water is not really cleaning it.
- Most cleaning should include a cleanser of some type.
- Use the provided brush to clean the conductivity sensor ports.
- Flush the depth sensor with a jet of water.
- Be very careful if you try to wipe the pH probe with a cotton ball or swab.
- The pH glass bulb is very fragile and will break when under the slightest amount of physical pressure.

Use krytox to keep o-rings and wet-mate connectors from cracking.

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Calibration Standards

- Make sure your work area is clean to avoid contamination
- Properly store standards
- Don’t leave stuff in your truck!
  - Temperature variations
  - Contributes to contamination

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Calibration Standards

- Always use fresh standards
  - Check expiration dates
  - Do not re-use standards
- Use recommended standards
  - NIST traceable for pH and Conductivity
  - Be careful using homemade standards
  - YSI AMCO Clear or Formazin for turbidity
  - DI water may not be the correct dilution media
  - Rhodamine dye and Quinine sulfate must be prepared and stored according to specific instructions.

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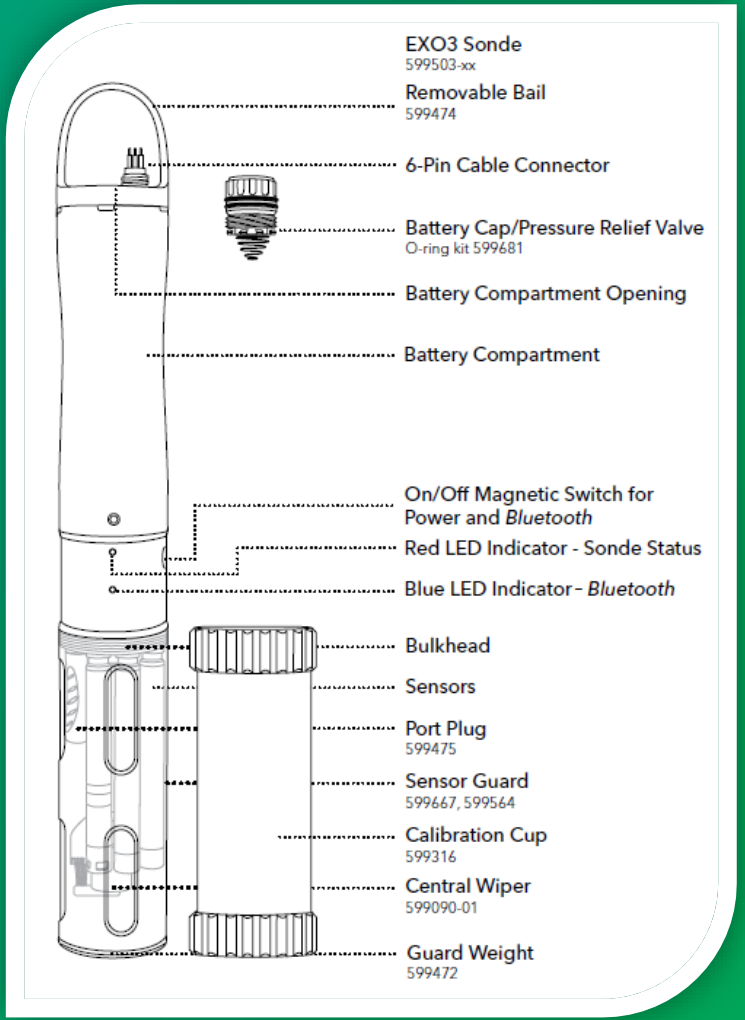
Calibration Hardware

- The sensor guard and cal cup should be used
  - Using beakers, etc. may compromise the calibration integrity
- Thoroughly clean!
- Dedicate a sonde guard and cal cup for this purpose
- Remove the wiper



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Calibration Standards

- Always rinse sufficiently between standards
  - Use the next standard as your rinse
  - Three rinses is recommended
    - Or whatever your SOP states
  - Use today's cal standard as tomorrow's rinse
    - Be sure to clearly label the rinse bottles

TIP: EXO sondes allow multiple probes of the same type to be calibrated simultaneously so you can save time, standard, and money.

AND since the probes retain the calibrations internally you can easily move them to another sonde without having to recalibrate.

Calibration Standards

- Never accept calibrations with errors.
  - “Error” ≠ “yellow QC”
- Wait for stabilization cues in the software.
- SmartQC: understand how to interpret.

- Perform a post calibration verification prior to deployment.
  - Use an aerated water bath
  - Log data in the sonde for several hours or overnight.
  - Check for stability and reasonable readings to ensure maximum data collection accuracy.

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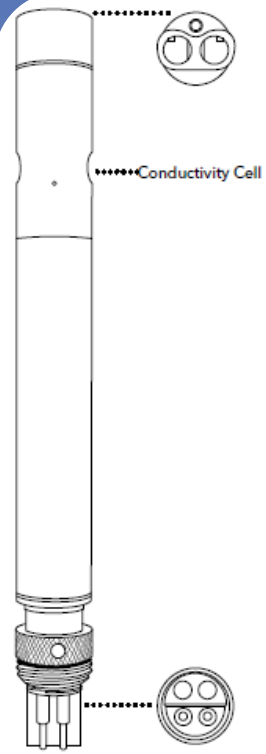
2

Calibration Order and Precautions

Temperature

“Master Parameter”

- Often overlooked since no calibration can be performed.
- Use a NIST traceable thermometer or another trusted temperature sensor to verify accuracy.
- Be sure to check for reasonable stable readings.
  - You should have a good idea of typical room temp
- Once proper function is verified ensure the sensor is submerged in the standards during calibrations.



Specifications

Conductivity

Default Units	microSiemens/centimeter
Temperature *Operating* *Storage*	 -5 to +50°C -20 to +80°C
Range	0 to 200 mS/cm
Accuracy	0-100 mS/cm: ±0.5% of reading or 0.001 mS/cm, whichever is greater; 100-200 mS/cm: ±1% of reading
Response	T63<2 sec
Resolution	0.0001 to 0.01 mS/cm range-dependent
Sensor Type	4-electrode nickel cell

Temperature

Default Units	°Celsius
Temperature *Operating* *Storage*	 -5 to +50°C -20 to +80°C
Accuracy	-5 to 35°C: ±0.01°C 35 to 50°C: ±0.05°C
Response	T63<1 sec
Resolution	0.001°C
Sensor Type	Thermistor

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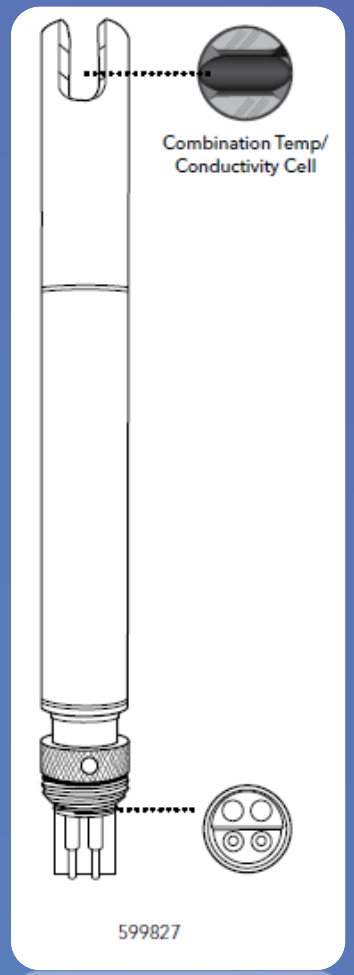
Conductivity (Specific Conductance, Salinity)

Step 1: clean and dry to make sure it is reading near zero. (within 2.0 µS/cm)

- Rinse the sensor in DI or distilled water before drying.
- Calibrating one conductivity-related UOM successfully will calibrate all of the others.
- Recommend: Specific Conductance.
  - Conductivity calibration standards typically have a value printed on the bottle based on a 25°C temperature.
- Use a standard of 1000 µS/cm or higher.
- Submerge the probe completely and watch for air bubbles.



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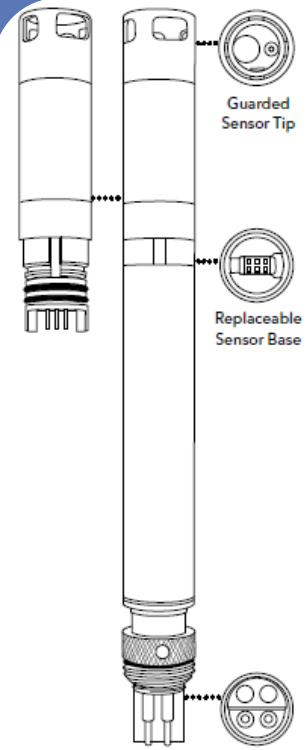
pH

- This sensor is most susceptible to improper handling
  - Drying out, storing in DI or distilled water, failure to clean
  - The probes life is ticking from the day it is manufactured.
  - 12 – 18 months is a typical life span
- Perform at least a 2-point calibration
- Millivolts will give you the raw readings and provide clues to probe health.
  - 7 buffer ~ 0 +/- 50 mV
  - 4 buffer ~ 165 – 180 mV away from buffer 7 reading in the positive direction
  - 10 buffer ~ 165 – 180 mV away from buffer 7 in the negative direction



599701, 599702, 599705, 599706; 599795-01, 599795-02, 599797-01, 599797-02 modules

Specifications

pH

Units	pH units
Temperature *Operating* *Storage*	 -5 to +50°C 0 to 60°C
Range	0 to 14 units
Accuracy	±0.1 pH units within ±10°C of calibration temperature; ±0.2 pH units for entire temp range
Response	T63<3 sec
Resolution	0.01 units
Sensor Type	Glass combination electrode

ORP

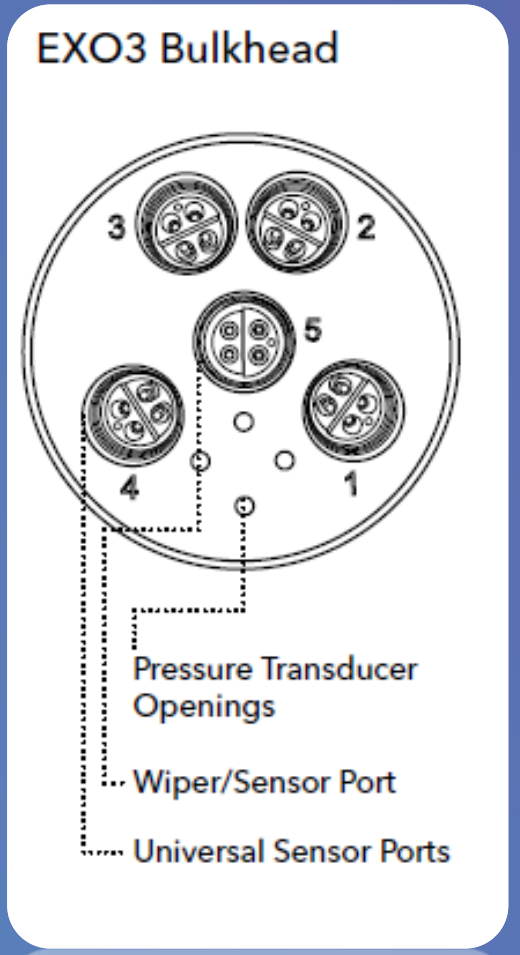
Units	millivolts
Temperature *Operating* *Storage*	 -5 to +50°C 0 to 60°C
Range	-999 to +999 mV
Accuracy	±20 mV in Redox standard solution
Response	T63<5 sec
Resolution	0.1 mV
Sensor Type	Platinum button

Depth

- Flush the depth port with soapy water
- Use vinegar to remove hard growth
- Never use tools to clean the depth sensor

- Zero the sensor by performing a one point calibration
  - Perform cal at the site when there are elevation changes
  - Make note of the barometric pressure if you want to make corrections

  - TIP: Remember that salinity is part of the depth calculation so make sure you perform a successful conductivity calibration.



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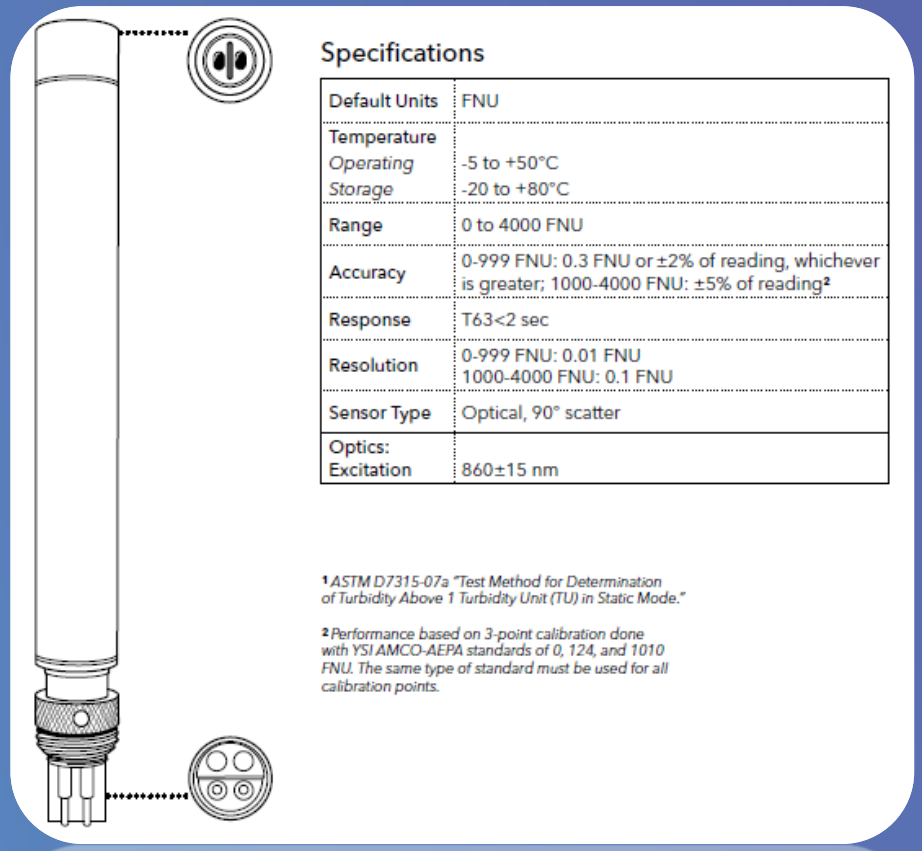
Turbidity

- *Ensure the calibration vessels are clean!*
  - Designated hardware for calibrations minimizes the errors caused by contamination from insufficient cleaning.
- Remove the wiper brush during calibration.
- Use lint free cloths.
- Perform at least a two-point calibration

- Only use YSI-branded AMCO clear or Formazin.
  - Standards purchased from other manufacturers have not been verified by YSI.
  - Beyond 1000 Formazin might give yellow QC
  - SmartQC is based on AMCO clear



Specifications

Default Units	FNU
Temperature *Operating* *Storage*	 -5 to +50°C -20 to +80°C
Range	0 to 4000 FNU
Accuracy	0-999 FNU: 0.3 FNU or ±2% of reading, whichever is greater; 1000-4000 FNU: ±5% of reading[2]
Response	T63<2 sec
Resolution	0-999 FNU: 0.01 FNU 1000-4000 FNU: 0.1 FNU
Sensor Type	Optical, 90° scatter
Optics: Excitation	 860±15 nm

[1] *ASTM D7315-07a "Test Method for Determination of Turbidity Above 1 Turbidity Unit (TU) in Static Mode."*

[2] *Performance based on 3-point calibration done with YSI AMCO-AEPA standards of 0, 124, and 1010 FNU. The same type of standard must be used for all calibration points.*

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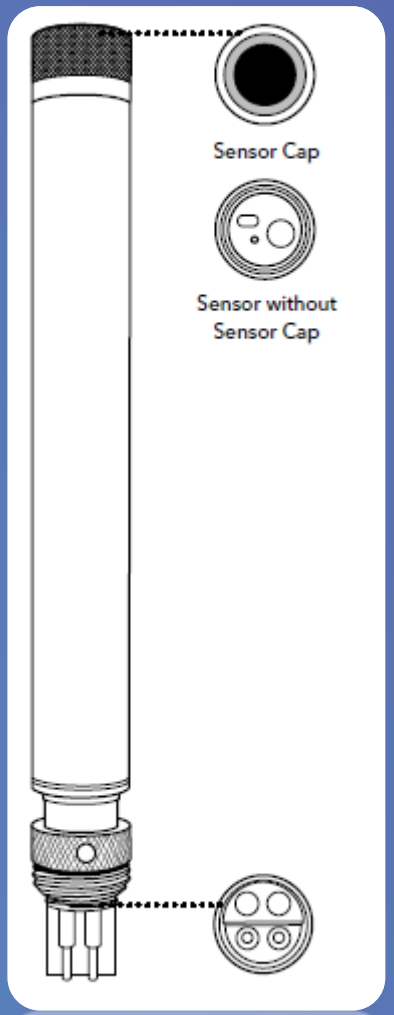
Dissolved Oxygen

- Keep the sensing element hydrated.
  - Store in moist air environment.
  - Soak it in water for several hours if it dries out.
- For best results calibrate in water saturated air or air saturated water.
  - A bucket with an air stone creates a great environment for D.O. calibration.
  - Be careful calibrating using the Winkler method.
- Perform a two-point calibration to maximize accuracy if you are expecting D.O. readings less than 1.0 mg/L.

- TIP: The D.O. concentration (mg/L) relies on the salinity reading as part of its calculation.



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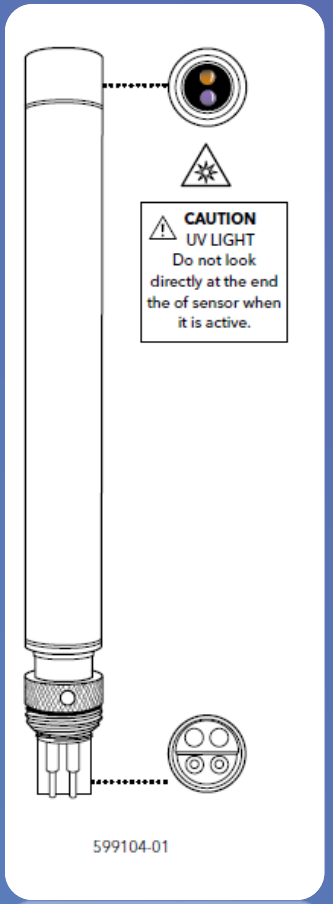
fDOM

- Always use lint free cloths when preparing the sonde
  - Lint from paper towels will reflect and give false positives
- Remove ALL copper components prior to calibration
  - Including copper tape and wiper
- Perform at least a two point calibration
- Ensure the quinine sulfate standard has been prepared according to YSI recommendations.

- DO NOT look directly into the sensor face when the sensor is active. CAUTION UV LIGHT!



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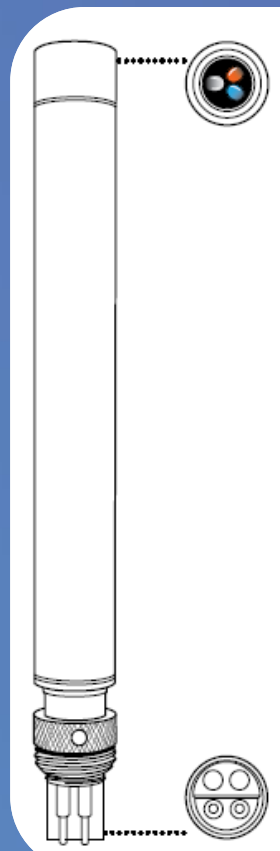
Total Algae

- Use this probe for trend analysis.
- Analyze grab samples taken alongside probe measurements to correlate the readings to nominal values (for cfu/mL or ppb).
- Use recommended Rhodamine WT for calibration (see EXO manual for specific dilutions).
  - Rhodamine is a *secondary calibrator*.
  - Pay attention to the temperature compensation required during calibration.



Specifications

Units	
Chlorophyll	RFU, µg/L Chl
PC	RFU, µg/L PC
PE	RFU, µg/L PE
Temperature	
Operating	-5 to +50°C
Storage	-20 to +80°C
Range	*Chl:* 0-100 RFU, 0-400 µg/L Chl*; *PC:* 0-100 RFU, 0-100 µg/L*; *PE:* 0-100 RFU, 0-280 µg/L*
Response	T63<2 sec
Resolution	*Chl:* 0.01 RFU, 0.01 µg/L Chl; *PC:* 0.01 RFU, 0.01 µg/L; *PE:* 0.01 RFU, 0.01 µg/L
Sensor Type	Optical, fluorescence
Linearity	*Chl:* R^2>0.999 for serial dilution of Rhodamine WT solution from 0-400 µg/L Chl equivalents *PC:* R^2>0.999 for serial dilution of Rhodamine WT solution from 0-100 µg/L PC equivalents; *PE:* R^2>0.999 for serial dilution of Rhodamine WT solution from 0-280 µg/L PE equivalents
Optics: Chl Excitation	470±15 nm
PC Excitation	590±15 nm
PE Excitation	525±15 nm
Emission	685±20 nm

https://www.ysi.com/ysi-blog/water-blogged-blog/2018/05/are-you-ready-for-harmful-algal-bloom-season

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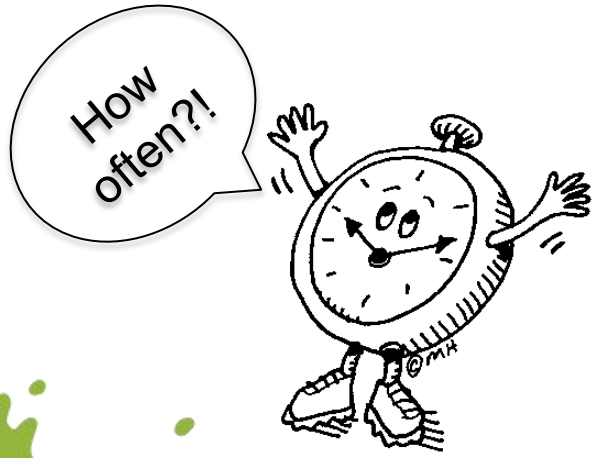
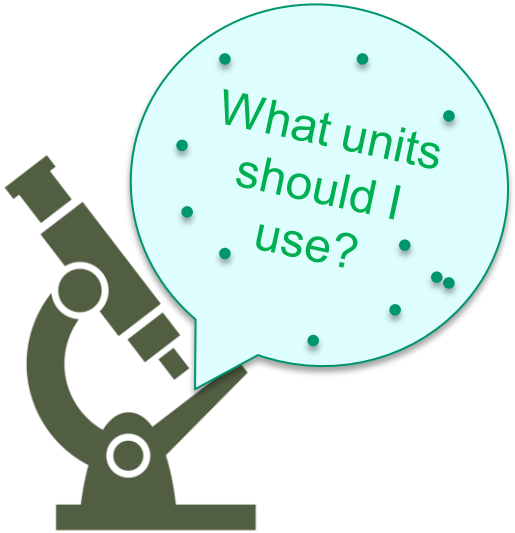
TAL Calibration

Calibration Curiosities

If I calibrate RFU, does that calibrate µg/L?





How do I use this?

Temp (˚C)	RFU Chl	µg/L Chl	RFU BGA-PC	µg/L BGA-PC	RFU BGA-PE	µg/L BGA-PE
30	14.0	56.5	11.4	11.4	37.3	104.0
28	14.6	58.7	13.1	13.1	39.1	109.0
26	15.2	61.3	14.1	14.1	41.0	115.0
24	15.8	63.5	15.0	15.0	43.0	120.0
22	16.4	66	16.0	16.0	45.0	126.0
20	17.0	68.4	17.1	17.1	47.0	132.0
18	17.6	70.8	17.5	17.5	49.2	138.0
16	18.3	73.5	19.1	19.1	51.4	144.0
14	18.9	76	20.1	20.1	53.6	150.0
12	19.5	78.6	21.2	21.2	55.9	157.0
10	20.2	81.2	22.2	22.2	58.2	163.0
8	20.8	83.8	22.6	22.6	60.6	170.0

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Calibration Units

- **Recommended: Raw Fluorescent Units (RFU)**
  - Default unit
  - Enables monitoring of drift and normalization of fleet of sensors
  - Calibrates the 0-100% scale of the sensor's output

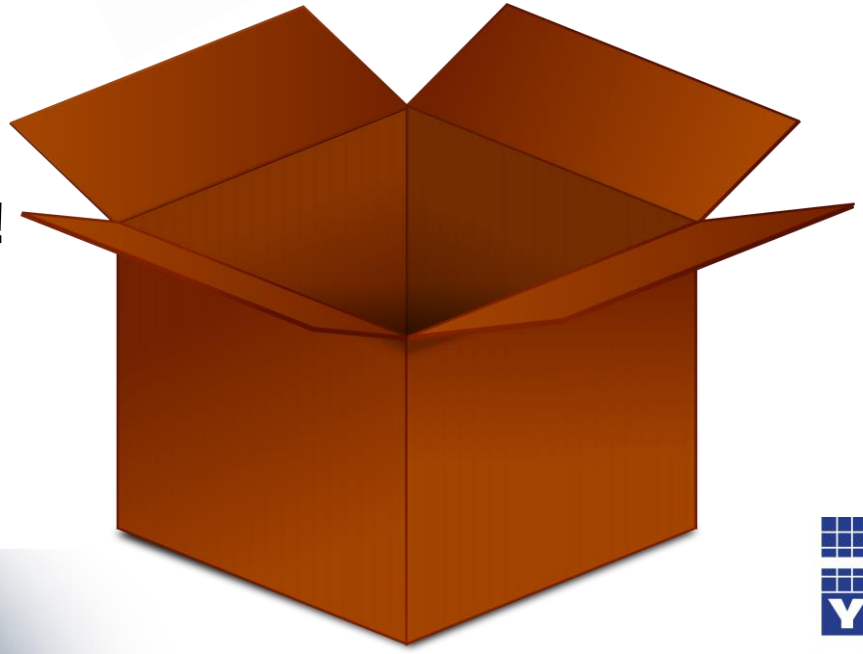
- µg/L of pigment equivalents (ppb)
  - Estimated concentration of chl and either PC or PE (*not RhoWT!)*
  - Developed with laboratory cultures and extractions
  - Ideally, users should check how well their site lines up with our ppb

Congratulations on your new TAL Sensor!

Your TAL sensor was calibrated in the factory, and yes, it can be used right away. However…

- *Is it going to be incorporated into a larger sensor network?*
- *Do you want to compare data among sensors?*
- *How will you know if/when it has drifted?*

Recommendation: Perform a two-point calibration!



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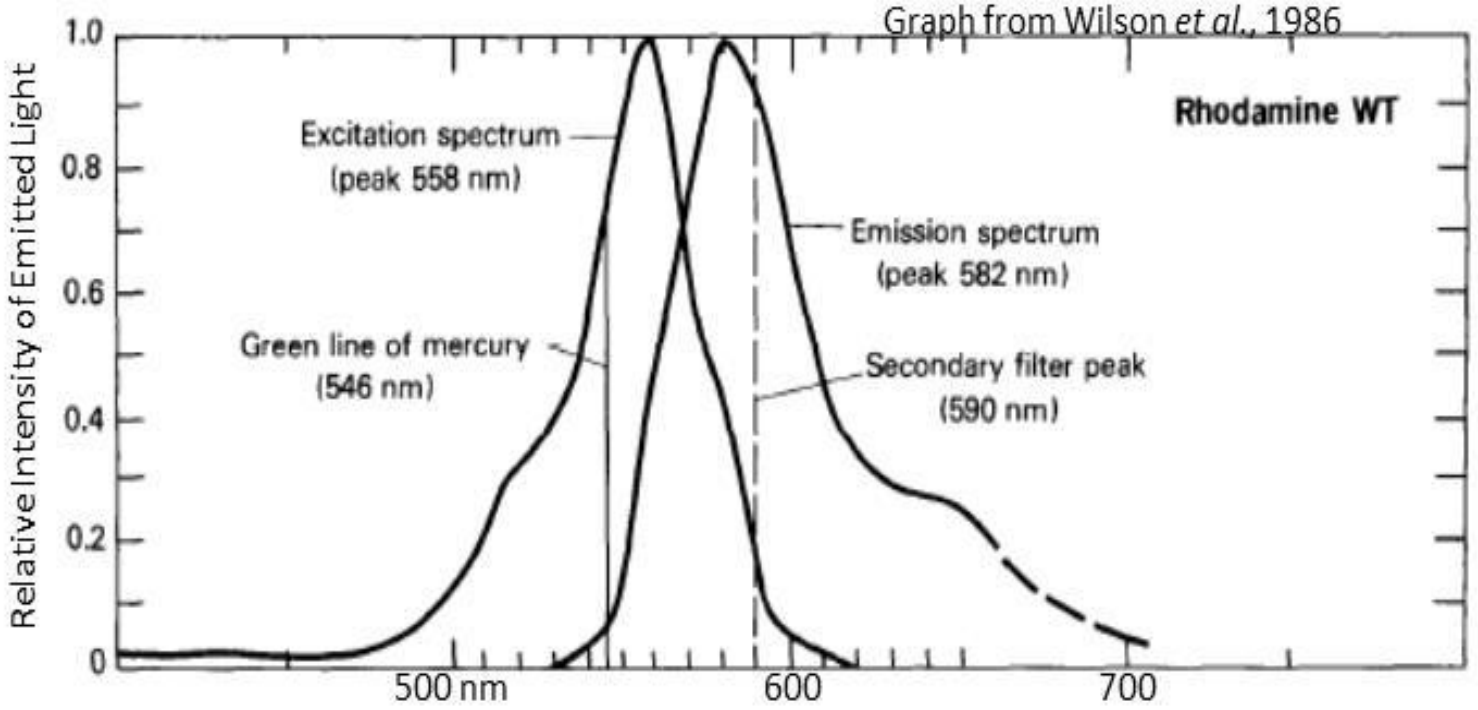
Why Rhodamine?

- “Secondary” calibrator
- Stable, reproducible
- Affordable, available

Graph from Wilson *et al.*, 1986



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2-point calibration

Step 1: Prepare Rhodamine WT Calibration Solution(s)

0.625 mg/L RhoWT

Chl

PC

0.025 mg/L RhoWT

PE

Step 1:
Prep solutions

Step 2:
Tempco values

Step 3:
Calibrate

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2-point calibration

Step 1: Prepare Rhodamine WT Calibration Solution(s)

Kingscote
Item 106023
2.5% RhoWT

5 mL

Bring to 1000 mL
With DI water
125 mg/L
RhoWT

Chl

PC

5 mL

Bring to 1000 mL
with DI water
0.625 mg/L
RhoWT

0.2 mL

PE

Bring to 1000 mL
with DI water
0.025 mg/L
RhoWT

Step 1:
Prep solutions

Step 2:
Tempco values

Step 3:
Calibrate

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2-point calibration

Step 2: Place sensors in solution and find your temperature-compensated values in the manual

Use the reading from the CT sensor!

Temp (°C)	RFU Chl	µg/L Chl	RFU BGA-PC	µg/L BGA-PC	RFU BGA-PE	µg/L BGA-PE
30	14.0	56.5	11.4	11.4	37.3	104.0
28	14.6	58.7	13.1	13.1	39.1	109.0
26	15.2	61.3	14.1	14.1	41.0	115.0
24	15.8	63.5	15.0	15.0	43.0	120.0
22	16.4	66	16.0	16.0	45.0	126.0
20	17.0	68.4	17.1	17.1	47.0	132.0
18	17.6	70.8	17.5	17.5	49.2	138.0
16	18.3	73.5	19.1	19.1	51.4	144.0
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12	19.5	78.6	21.2	21.2	55.9	157.0
10	20.2	81.2	22.2	22.2	58.2	163.0
8	20.8	83.8	22.6	22.6	60.6	170.0

Pigment µg/L ≠ RhoWT µg/L

Step 1: Prep solutions

Step 2: Tempco values

Step 3: Calibrate

2-point calibration

Step 3: Calibrate

1. In Kor or the handheld:
   - Enter temp-corrected RFU or µg/L
   - Stabilize the reading
   - Apply the calibration to the sensor

2. Repeat for all channels, all units of interest

Step 1: Prep solutions

Step 2: Tempco values

Step 3: Calibrate

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