RBR*tridente*
RBR*quadrante*

INSTRUMENT GUIDE

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1 Multi-channel sensor packages

The RBR*tridente* and RBR*quadrante* are part of the RBR family of cabled smart sensors with high accuracy, low power consumption, and ability to endure harsh conditions. These completely sealed units have titanium housing and can accommodate deep deployments. These realtime streaming sensors are easy to integrate into any RBR multi-parameter instrument, or connect directly via RS-232. Attach an MCIL connector with serial and power lines, and the data will stream.

- RBR*tridente* - chlorophyll *a*, fDOM, phycocyanin, phycoerythrin, rhodamine, fluorescein, backscatter, turbidity
- RBR*quadrante* - photosynthetically active radiation, narrow-band light radiation

> In addition to continuous sampling mode, the RBR*quadrante* and RBR*tridente* support aggregate mode, where measurement bursts are taken at a selected period. See Ruskin User Guide: Sensors.

Fig. 1. RBRtridente and RBRquadrante

A dry-bay variant of the RBR*tridente* (shown in Fig. 2), designed specifically for OEM users, is compatible with existing vehicle payload bays. Integrate the RBR*tridente* on AUVs, gliders, floats, or any other underwater vehicle (shown in Fig. 3), and stream your RS-232 data via a Micro-Fit connector.

Fig. 2. An RBRtridente dry-bay variant

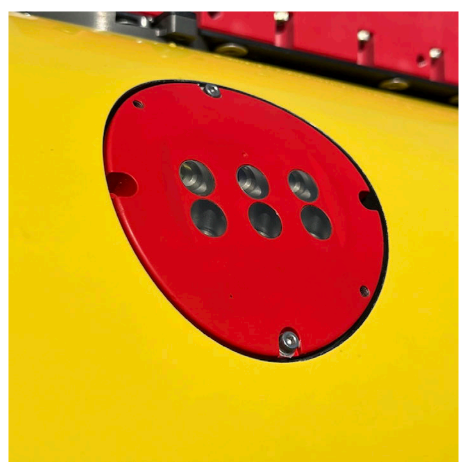


Fig. 3. An RBRtridente deployed on a glider

2 Specifications

The RBR multi-channel sensor packages have highly competitive specifications. They are designed for streaming data via RS-232 cable and thus have no onboard memory. Both RBR*tridente* and RBR*quadrante* offer a variety of parameter choices. Please contact the RBR sales team to discuss your needs and to select the perfect configuration for your applications.

2.1 RBRquadrante

The RBR*quadrante* is a four-channel radiometer, capable of measuring multiple wavebands simultaneously, including PAR. It leverages the same optical design and components as our RBRcoda single-channel radiometers and PAR sensors. During deployments, orient the RBR*quadrante* facing upwards to the surface as shown in Fig. 4.

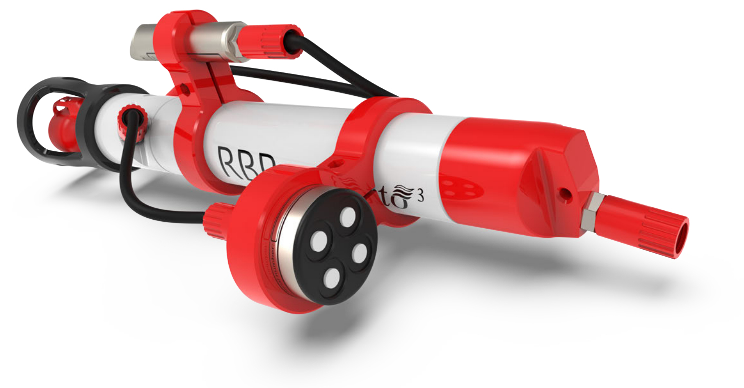


Fig. 4. An RBRconcerto³ C.T.D.ODO.QUAD with an RBRquadrante clamped facing upwards

Optical radiometry

Parameter	**Value**
Dynamic range	>5.5 decades (nominal)
Initial accuracy*	±2%
Linearity	±1%
Operating temperature range	-5°C to 35°C
Cosine response error (water)	±5% at 0-60°C , ±10% at 61-82°C
Azimuth error (water)	±1.5% at 45°C
Out-of-band rejection**	>25dB (typical), OD 2.5

* RBR calibrates radiometers with NIST traceable references.
** Out-of-band rejection is wavelength-dependent for narrow-band radiometers.

PAR

Parameter	**Value**
Wavelength range	400nm to 700nm
Full scale range	0 to 5000µmol/m²/s (minimum)
Resolution	±0.010µ mol/m²/s

Narrow-band channels

Parameter	Value
Centre wavelengths (CWL)*	380 / 413 / 445 / 475 / 488 / 508 / 532 / 560nm
Full width at half-maximum (FWHM)	10nm (25nm for CWL 475nm)
Full scale range	0 to ≥200µW/cm^2/nm (full sun)
Resolution**	±0.001µW/cm^2/nm

* Other CWL options within the 300-1100nm range are available upon request. Contact RBR for more information.

** Resolution is wavelength-dependent for narrow-band radiometers.

Dark offset is internally temperature-compensated.

Physical

Parameter	Value
Housing	Titanium
Diameter	63.3mm
Length	57mm, 93mm (with connector)
Weight	435g (in air), 250g (in water)
Depth rating	Up to 2000m
Sampling rate	Up to 32Hz

Power

Parameter	Value
Supply voltage	4.5V to 30V (12V nominal)
Power	4mJ per sample (4Hz or slower) 3mA/36mW (8Hz or faster)
Sleep current	10µA

2.2 RBRtridente

The RBR*tridente* is an optical sensor with three channels, capable of making multiple fluorescence and backscatter or turbidity measurements simultaneously. A dry-bay variant, designed for vehicle integration applications, offers the same channel options as the standard, wet-bay version.

The RBR*tridente* uses multiple gains, allowing exposure to full sunlight. However, when exposed to high background ambient light, the resolution of some channels may decrease. For this reason, during deployments, orient the RBR*tridente* facing downwards as shown in Fig. 5. See Deployment for more details.

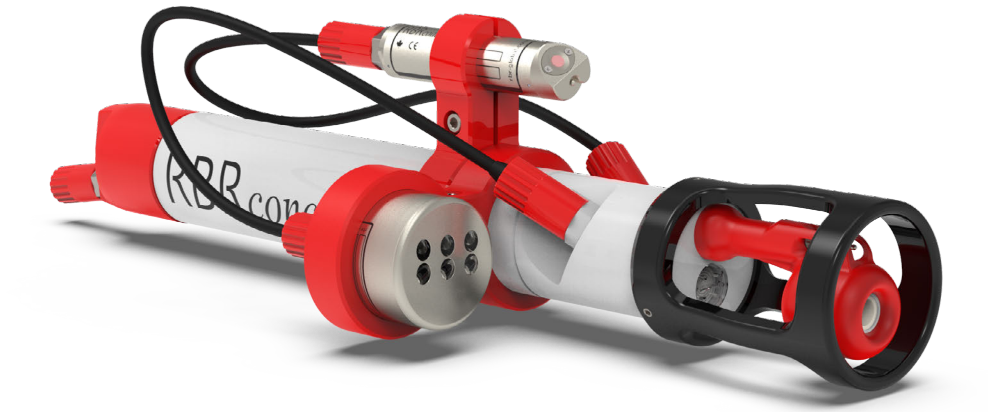


Fig. 5. An RBRconcerto³ C.T.D.ODO.TRI with an RBRtridente clamped facing downwards

Optical

Parameter	Value
Centroid angle	120°
Sensing volume	~1.3mL
Linearity, R^2	0.99
Initial accuracy	5%

Chlorophyll *a*

Parameter	Value
Channel wavelength (excitation/emission)	470nm/695nm or 435nm/695nm
Calibrated range*	0-50µg/L
Measurement range	0-500µg/L
Detection limit*	0.010µg/L

* Scaled to the fluorescence response from a monoculture of *Thalassiosira weissflogii*.

fDOM*

Parameter	Value
Channel wavelength (excitation/emission)	365nm/450nm
Calibrated range	0-500ppb
Measurement range	0-1500ppb
Detection limit	0.030ppb

* fDOM can be used as a proxy for cDOM.

Phycocyanin

Phycoerythrin

Parameter	Value
Channel wavelength (excitation/emission)	590nm/654nm
Calibrated range	0-500µg/L
Measurement range	0-10000µg/L
Detection limit	0.200µg/L

Parameter	Value
Channel wavelength (excitation/emission)	525nm/600nm
Calibrated range	0-6000µg/L
Measurement range	0-10000µg/L
Detection limit	2.0µg/L

Rhodamine

Parameter	Value
Channel wavelength (excitation/emission)	550nm/600nm
Calibrated range	0-1000µg/L
Measurement range	0-1000µg/L
Detection limit	0.015µg/L

Fluorescein

Parameter	Value
Channel wavelength (excitation/emission)	470nm/550nm
Calibrated range	0-500µg/L
Measurement range	0-1500µg/L
Detection limit	0.010µg/L

Backscatter

Parameter	Value
Channel wavelength	470nm, 525nm, 650nm, or 700nm
Calibrated range*	$0\text{-}0.05m^{-1}sr^{-1}$
Measurement range	$0\text{-}1.5m^{-1}sr^{-1}$
Detection limit	$1x10^{-6}m^{-1}sr^{-1}$

* Response becomes non-linear above $0.05m^{-1}sr^{-1}$.

Turbidity

Parameter	Value
Channel wavelength	650nm or 700nm
Calibrated range*	0-500FTU
Measurement range	0-1500FTU
Detection limit	0.001FTU

* Response becomes non-linear above 500FTU.

Physical

Parameter	Value
Housing	Titanium
Diameter	63.3mm
Length	57mm, 93mm with connector 56mm with cap (dry-bay)
Weight	460g in air, 275g in water 250g in air, 50g in water (dry-bay)
Depth rating	6000m, 1250m (dry-bay)
Sampling rate	Up to 32Hz

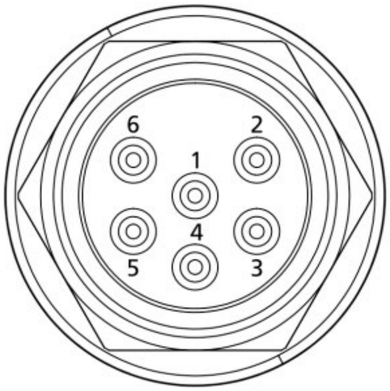
Power

Parameter	Value
Supply voltage	4.5V to 30V, 32mA (12V nominal)
Power	20mJ/sample (4Hz or slower) 384mW (8Hz or faster)
Sleep current	10µA

3 Connector pinouts

3.1 MCBH connector

Standard RBR*tridente* and RBR*quadrante* have an **MCBH-6-MP** connector to connect to your computer or to use for integrations with the RBR standard instruments. The data will stream via a patch cable (ordered separately).



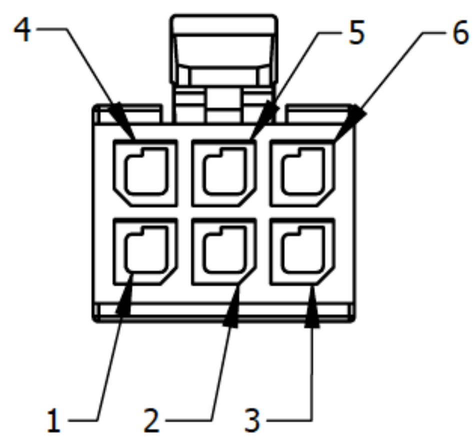
Pin No.	RS-232
1	Ground
2	Power
3	From the sensor (Tx)
4	Into the sensor (Rx)
5	N/C
6	N/C

Fig. 6. An RBRquadrante with an MCBH connector

3.2 Micro-Fit connector

The dry-bay variant of the RBR*tridente* uses a Micro-Fit six-pin connector for integrating inside the hull of the glider.

Micro-Fit connector pinout



Pin No.	Signal
1	Ground
2	Power
3	RS-232 data from the sensor
4	RS-232 data to the sensor
5	Chassis ground
6	N/C

Fig. 7. An RBRtridente (dry-bay) with a Micro-Fit connector

Fig. 8. A Micro-Fit connector

4 Maintenance

4.1 Deployment

The RBR*tridente* and RBR*quadrante* are robust and reliable multi-channel sensor packages. However, there are several things to keep in mind when deploying them. Deploying your instrument correctly will ensure faultless operation and preserve your data.

The RBR*tridente* consists of three detector-LED pairs, angled towards each other, as shown in Fig. 9. To distinguish the detectors from the LEDs, there is a machined mark near the row of detector windows, highlighted in Fig. 10.

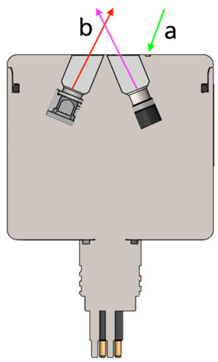


Fig. 9. Cross section of the RBRtridente. (a) Machined mark. (b) Angled detector-LED pair, with red and pink arrows, respectively.

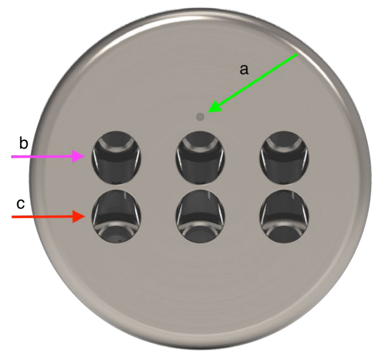


Fig. 10. A detailed view of the face of an RBRtridente. (a) Machined mark. (b) Detector window row (c) LED windows row.

Deployment orientation for the RBR*quadrante*

Deploy the RBR*quadrante* face up, so that sensors are pointing towards the surface.

Deployment orientation for the RBR*tridente*

Deploy the RBR*tridente* face down to avoid exposure to direct sunlight.

If you have to deploy it horizontally (e.g., on a glider), ensure that the machined mark is on top, so that the detectors are facing down into the water column. Fig. 11 shows an RBR*tridente* installed horizontally in a glider hull.

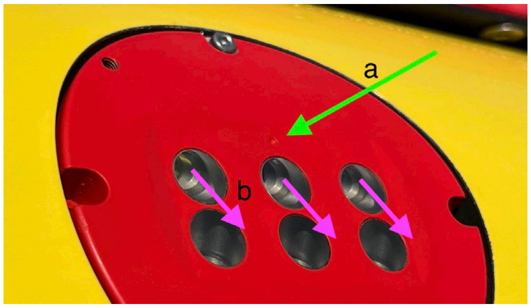


Fig. 11. An RBRtridente mounted horizontally. (a) Machined mark. (b) The downward direction of the detectors.

Unobstructed volume

The optical geometry of the RBR*tridente* constrains the bulk of the measurement to a 1.3ml volume that extends approximately 26mm in front of the sensor. However, the backscatter and turbidity channels are sensitive to repeated light ray reflections originating from a much larger volume. The signal from these light rays, which have undergone secondary or tertiary reflections, is small. Nonetheless, the sensor will still detect objects within this larger measurement volume. Fig. 12 shows the unobstructed volume. Ensure this volume is clear to mitigate erroneous measurements.

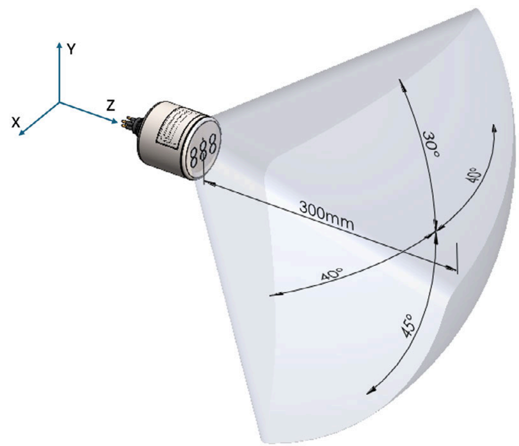


Fig. 12. The RBRtridente with the recommended unobstructed volume. The machined mark above the middle window serves as a reference for the detector windows. The mark is also used for orientation, indicating the top direction.

Mounting guide

When mounting the RBR*tridente*, make sure that the unobstructed volume is clear of any obstructions (e.g., sensors, mounting cables or ties, or mooring hardware). If it is mounted facing downwards (e.g., on a logger), it should be oriented with the machined mark closer to the logger, see Fig. 13. This points the detectors away from the instrument body and into the water.

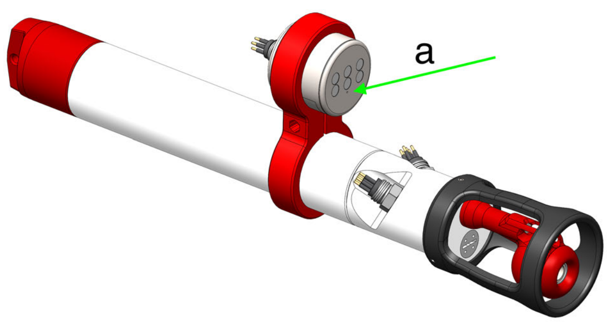


Fig. 13. The RBRtridente mounted to an RBRconcerto. (a) The machined mark is closest to the instrument, pointing the detectors away from the instrument into the water.

> RBR recommends testing your setup in water before use to ensure optimal performance. Environmental conditions, such as water clarity and variations in optical channels, may alter the sensitivity to objects within the unobstructed volume.

Clamping

The type of clamp required to hold the RBR*tridente* will depend on the instrument to which it is clamped. For the RBR*concerto* you can use either a straight or an angled clamp. For the RBR*maestro* you must use an angled clamp. In both cases, the RBR*tridente* should be clamped as close to the SEC as possible. When the instrument is in a cage, instead of clamping near the SEC, it is more important to clamp so that the face is approximately in line with the nearest cage rung, as illustrated in Fig. 14.

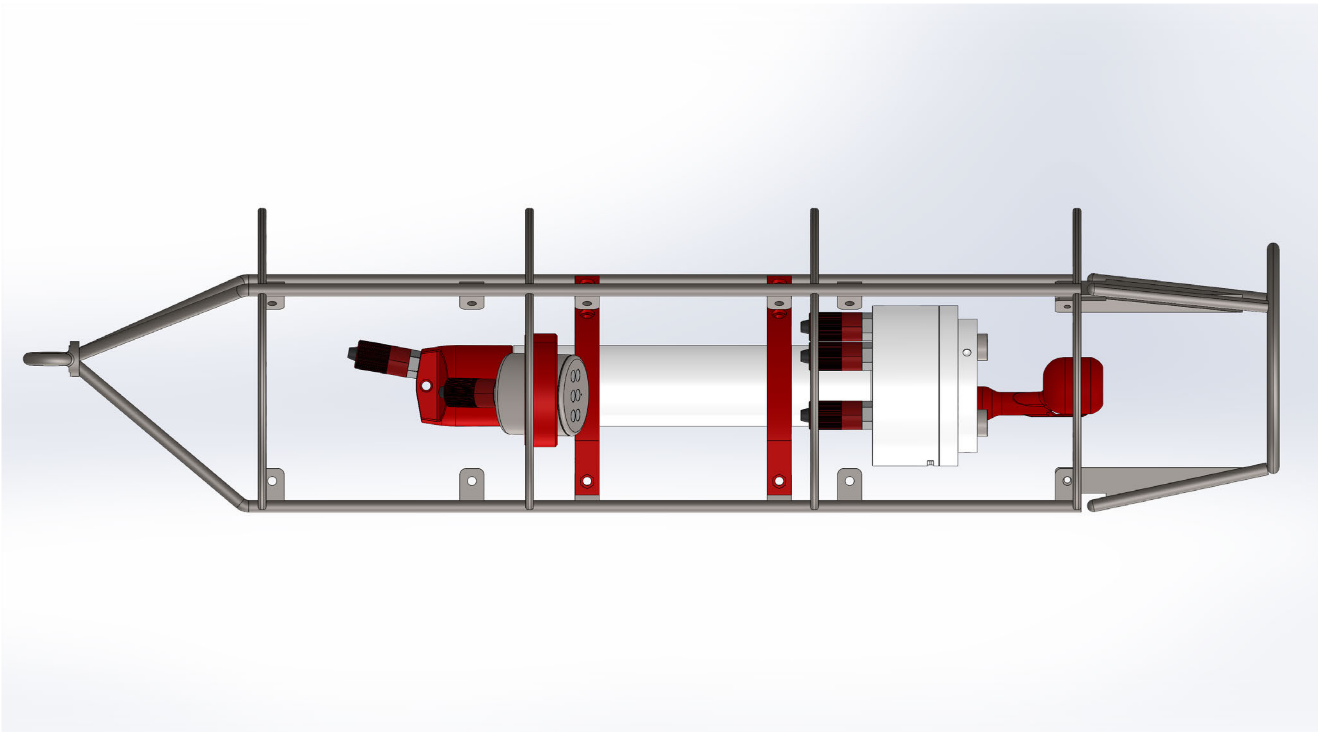


Fig. 14. The RBRtridente mounted on an RBRmaestro in a cage. In this scenario, the RBRtridente is nearly aligned with the second cage rung from the left.

Flow through chamber

It is possible to mount the RBR*tridente* in a flow-through chamber with dimensions encroaching into this unobstructed volume. However, the material should be non-reflective to minimise the effect on the backscatter and turbidity measurements.

For example, an RBR*tridente* mounted at the edge of a matte black chamber that is 130mm in diameter and 150mm in length will not change the background scattering signal, but if this chamber is reflective stainless steel, it can induce a signal of >$0.015m^{-1}sr^{-1}$ / 6FTU (wavelength dependent).

Removing an offset

The background signal caused by a flow-through chamber or an object in the unobstructed volume can be removed as an offset, provided the water volume scattering function (VSF) or turbidity is <$0.045m^{-1}$ sr^{-1} or <20FTU, respectively. For details on how to remove the offset see Ruskin C0 correction: Sensor or Ruskin C0 correction: Logger mounted

Precautions

1. Do not exceed the maximum depth rating.

> ⚠ All RBR sensors are individually rated to a maximum depth in meters, as indicated on the label.
> RBR*tridente* (wet-bay): 6000m
> RBR*tridente* (dry-bay): 1250m
> RBR*quadrante*: 2000m

2. Do not apply physical stress to the housing.

> ⚠ Stress due to improper mounting may cause the RBR sensors to leak, resulting in the loss of valuable data or permanent damage to the electronics.
> Any type of clamp or bracket which concentrates the stress on the housing is not recommended for use in mooring, mounting, and/or other deployment.
> Contact RBR for proper mooring and mounting clamps suited to your specific application.

Do not attempt to open the sensor.

> ⚠ All RBR sensors are sealed and cannot be opened by the user. Any attempt to do so will damage the sensor and void all warranty.

4.2 Cables and connectors

Cable bend radius

The smallest bend radius for RBR supplied cables is 15cm.

Lubricating the connectors

Lubrication improves watertight sealing, prevents corrosion, and reduces the force required to de-mate the connector. Use the silicone compound provided with your instrument:

- Apply the silicone compound to all female connectors before every mating
- Ensure each connector hole is filled with approximately 30% lubricant

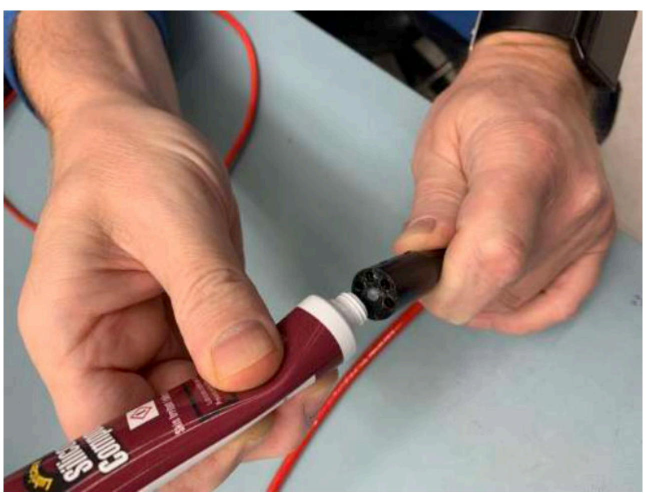


Fig. 15. Applying silicone compound to the female connectors.

Fig. 16. Cross section of a connector with 30% lubricant fill.

Reducing mechanical stress

- Do not pull on the cable
- Hold onto the connector to pull out the cable
- Disconnect by pulling straight out, not at an angle
- Avoid sharp bends at the point where the cable enters the connector
- Avoid angular loads on the connector

4.3 RBRtridente sensor safety precautions

For fDOM measurements, the RBR*tridente* uses UV LEDs (ultraviolet light emitting diodes) and should be handled with care.

Ultraviolet radiation is invisible so it may not be obvious when the instrument is active. Exercise caution to avoid any associated health risks to the eyes.

> ✖ Avoid looking at the LEDs. Wear approved safety glasses with side protection and UV filter lenses.

Storage cap

Whenever possible, keep the storage cap on your fluorometers.

Fig. 17. RBRtridente with a storage cap on.

Eye protection

If the storage cap is removed, use protective eyewear. RBR recommends UV-blocking safety glasses of the highest available rating.

Safe operation

Never look at the LEDs as their optical power (ultraviolet and visible) can be hazardous to eyes.

Whenever handling an active fluorometer, place the unit face down on a non-abrasive surface to avoid shining the light into the eyes.

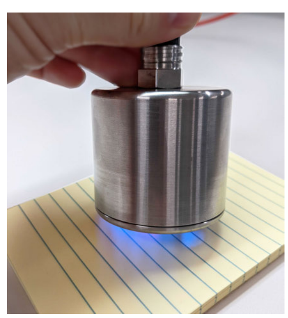


Fig. 18. RBRtridente facing down.

RBR realtime sensors continue streaming data as long as power is provided. When the fluorometer does not need to be active, disconnect it from the power supply.

When the fluorometer does not need to be active, disable sampling on Ruskin by selecting **Stop**. Refer to the Ruskin User Guide: Sensors for more details.

4.4 Cleaning

Clean the instrument after each extended deployment to remove deposits that may have accumulated.

> Do not use an ultrasonic bath to clean your instruments! Ultrasonic vibrations can break the wire bonding inside the transducers.

Type	Procedure	Notes
General/biofouling	To clean the exterior, soak in a mild detergent, then scrub the instrument with a soft brush.	Avoid scratching the plastic (scratches make future cleaning more difficult).
Calcification, encrustation	Soak in vinegar for six hours, then scrub the surface using a soft brush.	Soaking in vinegar for more than 24 hours may damage the O-ring and increase the chances of a leak.

Cleaning RBR*quadrante*

When dirty, carefully wipe the sensors with a soft cloth. To remove encrustation, soak in water until soft. It may take hours or days, depending on the severity.

> Do not use abrasive cloths as scratched faces can affect calibration.
> Do not use solvents or cleaners as these could affect optical properties of the window.

Cleaning RBR*tridente*

RBR*tridente* design makes it resilient to corrosion and thus allows for more rigorous handling than other fluorometers.

See the table above for cleaning procedures.

4.5 Calibration

Factory calibration coefficients are calculated for each sensor, and the coefficients are stored on the instrument.

RBR calibration certificates contain calibration equations, coefficients, and residuals for each sensor.

Calibration certificates are available for download:

- If using Ruskin, connect your instrument and go to **Information**, then click the **Download** button at the bottom
- For OEM instruments, go to https://oem-lookup.RBR-global.com, select **OEM lookup by serial number**, and search by the serial number and authorisation key

RBR recommends calibrating your instrument before any critical deployment, periodically once a year, or if you suspect the readings to be out of specifications.

Discuss your calibration requirements with RBR. In some cases, the instrument will need to be returned to RBR to have it checked and recalibrated.

Please contact RBR for our current calibration fees.

4.6 Repairs

RBR supports all our products. Contact us immediately at support@rbr-global.com or via the RBR website if there are any issues with your instrument. Please have the model and the serial number of the unit ready. Our support team will work to resolve the issue remotely. In some cases, you may have to return your instrument to RBR for further servicing.

> There are no user-repairable parts of the instrument. Any attempt to repair without prior authorisation from RBR will void the warranty. Refer to the RBR warranty statement.

To return a product to RBR for an upgrade, repair, or calibration, please contact our support team to obtain a return merchandise authorisation code (RMA) and review the detailed shipping information on the RBR website.

5 Revision history

Revision No.	Release date	Notes
A	15-October-2024	Initial release
B	15-November-2024	Added a note on aggregate mode to the introduction.
C	31-December-2024	Added rhodamine and fluorescein to the list of RBR*tridente* parameters in the introduction and specifications. Added guidance on sensor orientation to the Deployment section.
D	25-July-2025	UV added to Narrow-band wavelength specs table. Added unobstructed volume and mounting information to the Deployment section.

6 Appendix

6.1 Ruskin C0 correction

To apply a correction to the tridente C0 to compensate for the detection of its mounted logger/flow through chamber

Sensor

Take a measurement of the tridente VSF or FTU in a large vessel that does not encroach on the unobstructed volume.

Open the realtime.rsk and record the average reading

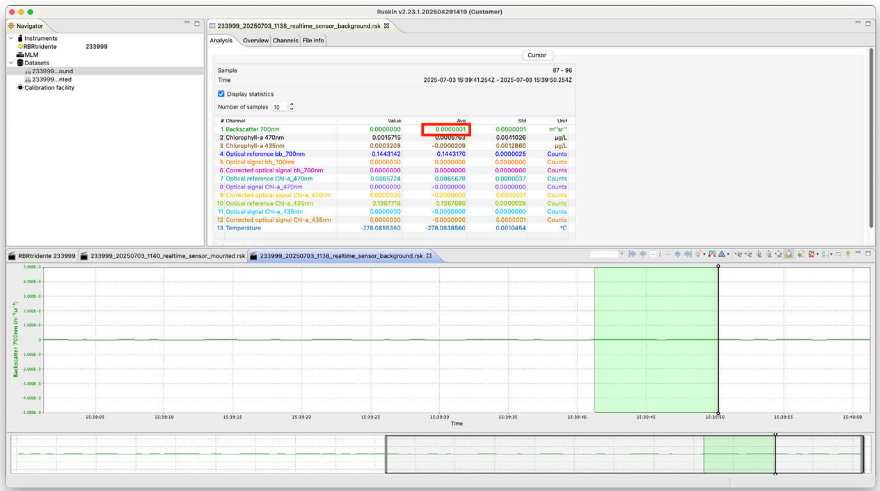


Fig. 19. Unobstructed volume average reading

Take a measurement of the tridente VSF or FTU when it is mounted in the flow through chamber, or clamped to its instrument

Open the realtime.rsk and record the average reading

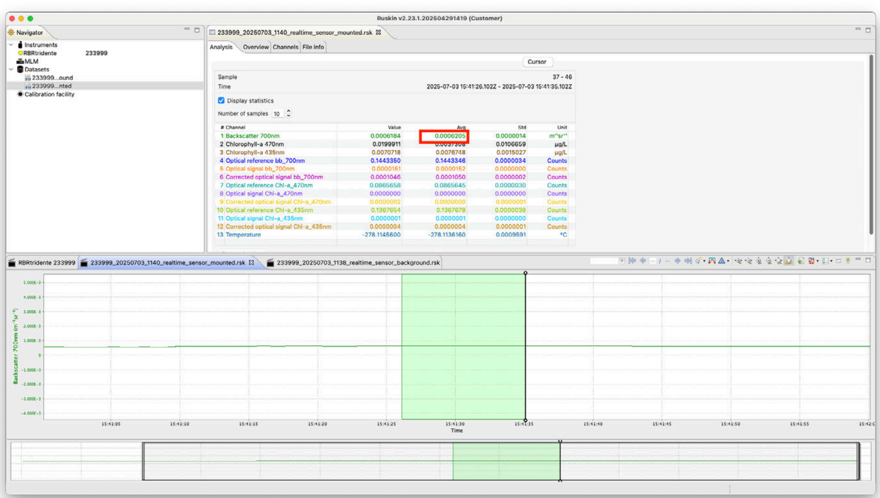


Fig. 20. Mounted or clamped average reading

Derive the offset. This will be the average value from the mounted or clamped measurement, subtracting the unobstructed volume average.

In this example, the offset would be

```
0.0006205-0.0000001 = 0.0006204
```

Go to the intruments **Calibration** tab. Record the Tridente C0 reading.

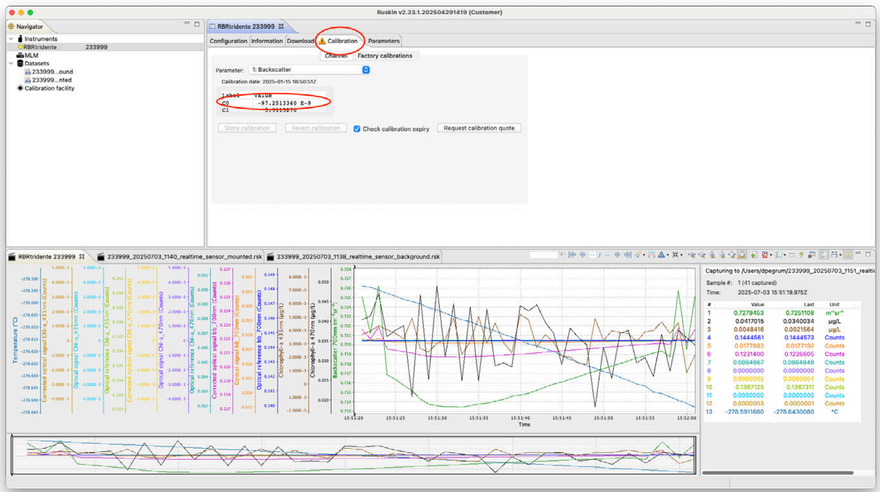


Fig. 21. The calibration tab showing the Tridente C0

Subtract the offset from the Tridente C0 reading

In this example, the new C0 would be

```
-97.251E-9 - 0.6204E-3 = ~0.6205E-3
```

Logger mounted

Take a measurement of the tridente VSF or FTU in a large vessel that does not encroach on the unobstructed volume.

Download the rsk file, and toggle the channel visibility to show the raw channel. Record the average reading

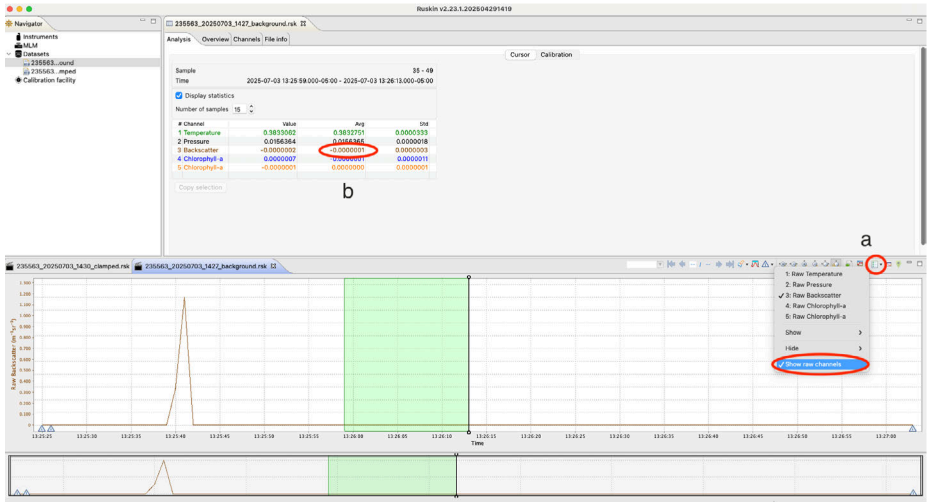


Fig. 22. (a) Toggle channel visibility. (b) Unobstructed average reading

Take a measurement of the tridente VSF or FTU when it is mounted in the flow through chamber, or clamped to its instrument.

Download the rsk file, and toggle the channel visibility to show the raw channel. Record the average reading

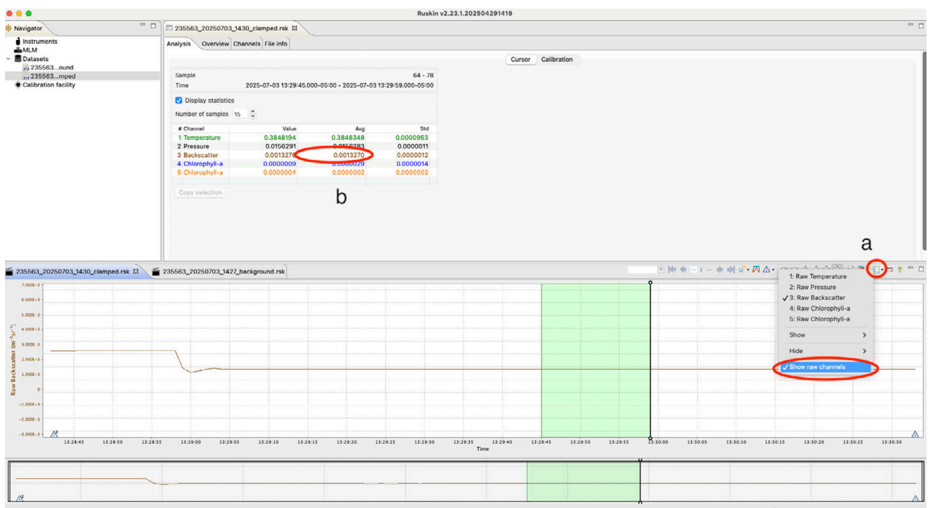


Fig. 23. (a) Toggle channel visibility. (b) Mounted or clamped average reading

Derive the offset. This will be the average value from the mounted or clamped measurement, subtracting the unobstructed volume average.

In this example, the offset would be

`0.001327-(-0.0000001) = ~0.001327`

Go to the intruments **Calibration** tab. Record the Tridente C0 reading.

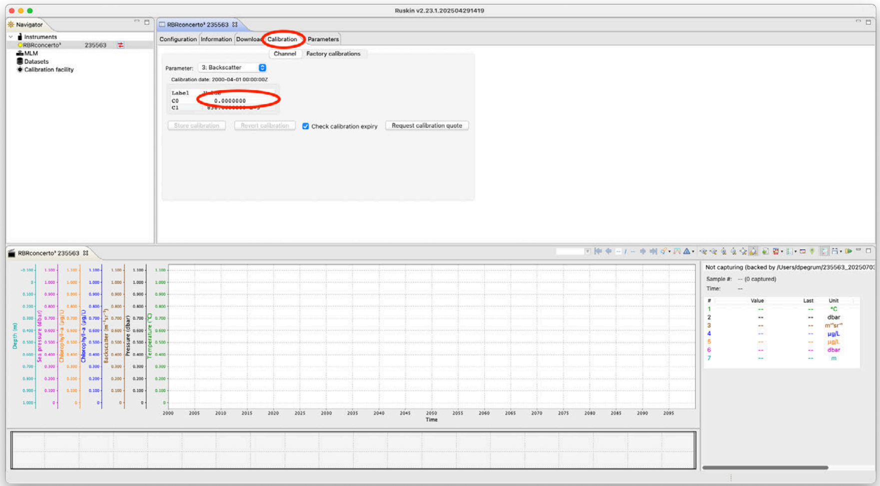


Fig. 24. The calibration tab showing the Tridente C0

Subtract the offset from the Tridente C0 reading

In this example, the new C0 would be

```
0.0000 – 0.001327= ~-0.001327
```