RBR COMPACT INSTRUMENTS

RBR*solo*³
RBR*duet*³

INSTRUMENT GUIDE

rbr-global.com

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1 Compact instruments

RBR manufactures two types of compact instruments, the RBR*solo*³ and RBR*duet*³.

The RBR*solo*³ is a family of single-channel instruments, whereas the RBR*duet*³ instruments are dual-channel. Both are small, lightweight, stable, and provide highly accurate measurements during long deployments. Low power consumption, large memory, and ability to endure harsh conditions make them a perfect choice for many oceanographic applications. Only one software tool, Ruskin, is required to operate them. See Ruskin User Guide: Compact Instruments³ for more information.

All RBR compact instruments support the following features:

- High accuracy
- Long deployments
- Compact and lightweight
- One AA battery
- Up to 32Hz sampling*
- USB-C download

* Select from several | fast sampling variants, such as | fast8, | fast16, | fast32, | tide16, and | wave16, depending on your needs.

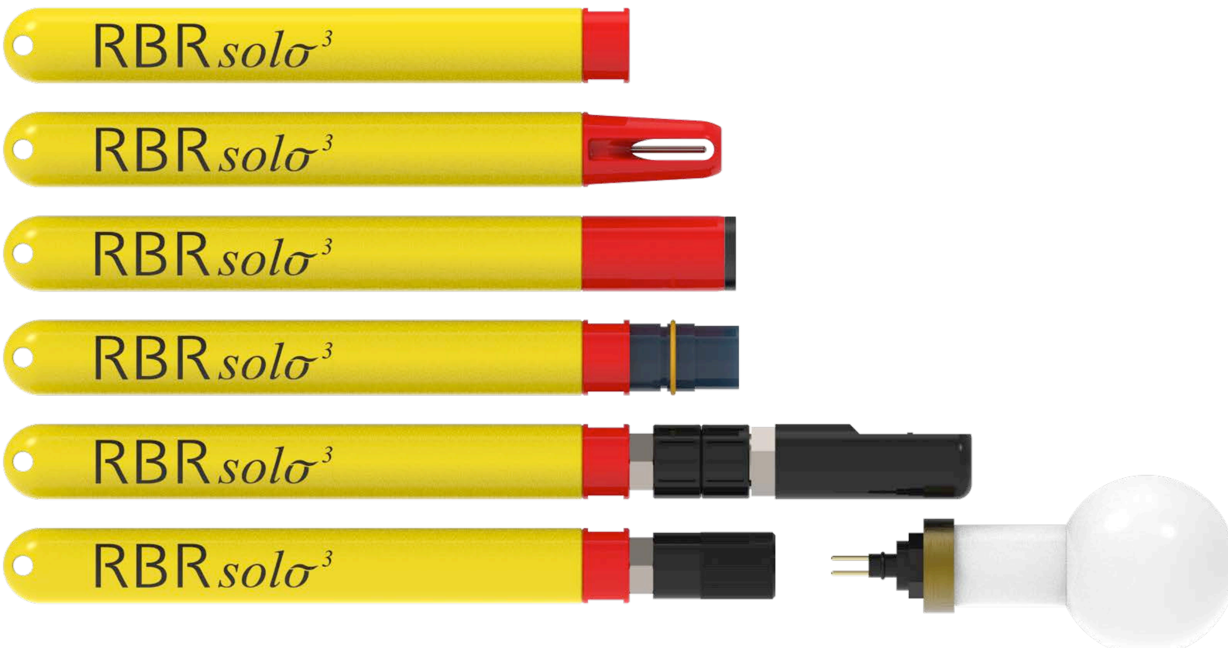
> ⓘ In most cases, standard, | slow, and | fast sampling variants look identical.
> The only exception is RBR*solo*³ T | deep | slow, which has an embedded thermistor.

Some compact instruments are also available in titanium housing, which resists all forms of marine corrosion and is suitable for deepwater applications (| deep). All RBR instruments within the | deep family provide accurate and stable measurements in the most challenging environments. Several configurations are rated for the full ocean depth, thus being deployable as deep as the bottom of the Marianas Trench.

1.1 RBR*solo*^{3}

The RBR*solo*^{3} is a family of small single-channel, long-autonomy instruments which come in several variants:

- RBR*solo*^{3} D - depth
- RBR*solo*^{3} T - temperature
- RBR*solo*^{3} PAR - photosynthetically active radiation
- RBR*solo*^{3} rad - narrow-band light radiation
- RBR*solo*^{3} DO - dissolved oxygen (with the OxyGuard® DO sensor)
- RBR*solo*^{3} Tu - turbidity (with the Seapoint® Tu sensor)
- RBR*solo*^{3} PAR (LI-COR) - photosynthetically active radiation (with the LI-COR® PAR sensors, cosine or spherical)



RBR*solo*^{3} family*

* The RBR*solo*^{3} PAR and RBR*solo*^{3} rad look identical, third instrument from top.

Several configurations are also available in titanium housing for deepwater applications (| deep), designed to endure harsh conditions:

- RBR*solo*^{3} D | deep - depth
- RBR*solo*^{3} T | deep - temperature
- RBR*solo*^{3} PAR | deep - photosynthetically active radiation
- RBR*solo*^{3} rad | deep - narrow-band light radiation
- RBR*solo*^{3} Tu | deep - turbidity (with the Seapoint Tu sensor)

RBR*solo*^{3} | deep family*

* The RBR*solo*^{3} PAR | deep and RBR*solo*^{3} rad | deep look identical, third instrument from top.
In most cases, standard, | slow, and | fast sampling variants of the same instrument look identical, with the exception of RBR*solo*^{3} T | deep | slow, which has an embedded thermistor.

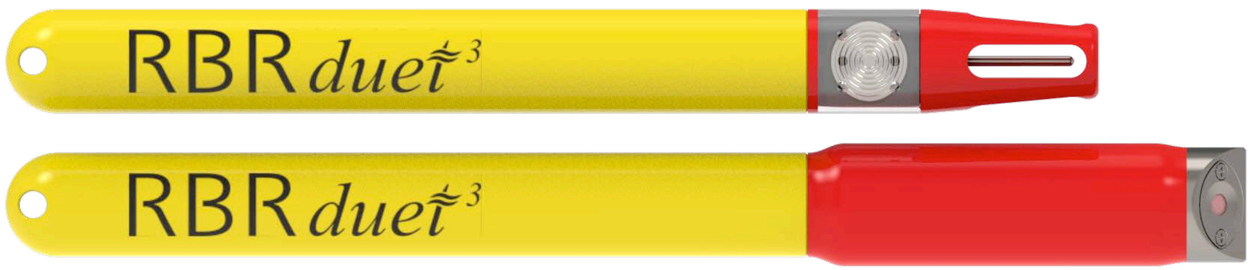
RBR*solo*^{3} T | deep | slow with embedded thermistor

> ⓘ RBR offers cabled versions of the RBR*solo*^{3} D, T, PAR, rad, DO, and PAR (LI-COR) under the brand name of "RBR*coda*^{3}". Sensor specifications are the same between the two lines of instruments.

1.2 RBR*duet*^{3}

The RBR*duet*^{3} is a family of small dual-channel, long-autonomy instruments which can be configured with either of the two options:

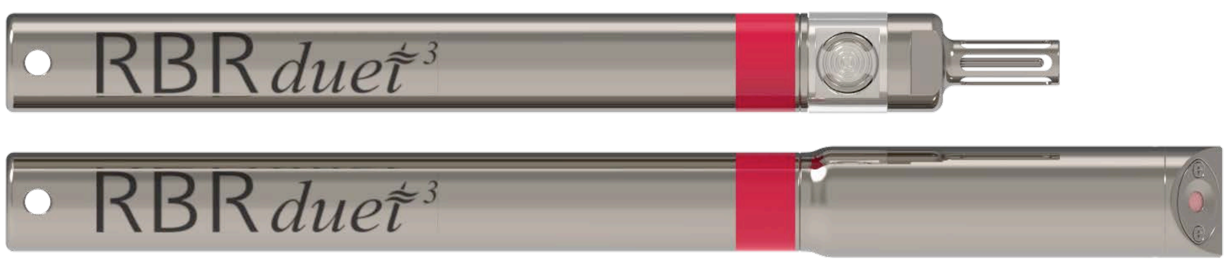
- RBR*duet*^{3} T.D - temperature and depth
- RBR*duet*^{3} T.ODO - temperature and optical dissolved oxygen



RBR*duet*^{3} family

Both variants are also available in titanium housing for deepwater applications (| deep):

- RBR*duet*^{3} T.D | deep - temperature and depth
- RBR*duet*^{3} T.ODO | deep - temperature and optical dissolved oxygen



RBR*duet*^{3} | deep family*

*Standard, | slow, and | fast sampling variants look identical.

> ⓘ RBR offers cabled versions of the RBR*duet*^{3} T.D and T.ODO under the brand name of "RBR*coda*^{3}". Sensor specifications are the same between the two lines of instruments.

2 Physical specifications

RBR*solo*^{3} and RBR*duet*^{3} common specifications

Parameter	Value
Storage	~130 million readings
Power*	One AA-type cell
Communications	USB-C
Clock drift**	±60 seconds per year
Housing diameter	25.4mm (plastic), 25mm (Ti)
Housing length without the sensor end-cap	195.7mm (plastic), 200mm (Ti)

*Lithium thionyl chloride batteries are only recommended for T, D, and T.D instruments. Other sensors will not work correctly on this type of battery. See Ruskin User Guide: Compact Instruments^3 for suitable battery chemistries.
**The realtime clock is not maintained when there is no power.

RBR*solo*^{3} weight, length, and depth rating

Instrument	Weight	Total length	Depth rating
RBR*solo*^{3} D RBR*solo*^{3} D | deep	130g in air, 30g in water 330g in air, 230g in water	211mm 221mm	1000m 10000m
RBR*solo*^{3} T RBR*solo*^{3} T | deep	120g in air, 20g in water 320g in air, 220g in water	242mm 240mm | fast, 225mm | slow	1700m 10000m
RBR*solo*^{3} DO (OxyGuard)	150g in air, 30g in water	249mm	1700m
RBR*solo*^{3} PAR RBR*solo*^{3} PAR | deep	140g in air, 15g in water 320g in air, 195g in water	248mm 252mm	1000m 2000m
RBR*solo*^{3} Tu (Seapoint) RBR*solo*^{3} Tu | deep	220g in air, 70g in water 420 in air, 270g in water	327mm 333mm	1700m 6000m
RBR*solo*^{3} PAR (with LI-192) RBR*solo*^{3} PAR (with LI-193)	420g in air, 200g in water 200g in air, 60g in water	261mm, cable 0.6m 261mm, cable 0.6m	560m 350m

RBR*duet*^{3} weight, length, and depth rating

Instrument	Weight	Total length	Depth rating
RBR*duet*^{3} T.D RBR*duet*^{3} T.D | deep	150g in air, 30g in water 350g in air, 240g in water	266mm 266mm	1000m 10000m
RBR*duet*^{3} T.ODO RBR*duet*^{3} T.ODO | deep	200g in air, 20g in water 400g in air, 240g in water	303mm 307mm	1000m 6000m

RBR*solo*[3] deployment estimates for select sampling rates

Instrument	Speed	Time	Number of samples
RBR*solo*[3] D	32Hz	~24 days	66 million
	2Hz	~62 days	11 million
RBR*solo*[3] T	32Hz	~50 days	130 million
	2Hz	~5 months	25 million
RBR*solo*[3] DO	32Hz	~35 days	99 million
	2Hz	~58 days	10 million
RBR*solo*[3] PAR (LI-COR)	32Hz	~29 days	80 million
	2Hz	~42 days	7 million
RBR*solo*[3] PAR, RBR*solo*[3] rad	2Hz	~ 7 days	1 million
	1Hz	~14 days	1 million
RBR*solo*[3] Tu	10s	~9 days	80 thousand
	30s	~1 month	75 thousand

RBR*duet*[3] deployment estimates for select sampling rates

Instrument	Speed	Time	Number of samples
RBR*duet*[3] T.D	32Hz	~16 days	45 million
	2Hz	~2 months	10 million
RBR*duet*[3] T.ODO	2Hz	~2 days	330 thousand
	30s	~26 days	75 thousand

ⓘ Deployment times above are estimated for instruments with the highest capacity battery available for each variant. For deployment estimates specific for your configuration and sampling options, use Ruskin autonomy engine. See Ruskin User Guide: Compact Instruments[3] for details.
Note that deployment estimates are the same for shallow and deep variants.

3 Sensor specifications

Most RBR compact instruments have only one channel (RBR*solo*^{3}), but some include two (RBR*duet*^{3}). While temperature and pressure remain the most popular choices, specialised sensors are available to meet various requirements. Refer to the following subsections for more information.

Please contact the RBR sales team to discuss your needs and to select the perfect configuration for your applications.

3.1 Pressure (D)

The RBR*solo*^{3} D and RBR*duet*^{3} T.D instruments (including their |deep, |fast, |tide, and |wave variants) use the piezoresistive pressure sensor. The sensor is protected by a clear plastic guard. During deployments, always orient it downwards to reduce debris collecting on the membrane of the pressure sensor.

RBR*solo*^{3} D - Pressure sensor

Parameter	Value
Range*	20 / 50 / 100 / 200 / 500 / 1000dbar (plastic) 1000 / 2000 / 4000 / 6000 / 10000dbar (Ti)
Initial accuracy	±0.05% full scale
Resolution	<0.001% full scale
Typical stability	±0.05% full scale / year
Time constant	<10ms

* Recommended depth for wave measurements is less than 50m.

3.2 Temperature (T)

The RBR*solo*^{3} T and RBR*duet*^{3} T.D (including their | deep, | fast, | tide, and | wave variants) use the same thermistor-type temperature sensor.

RBR*solo*^{3} T

Parameter	Value
Range*	-5°C to 35°C
Initial accuracy	±0.002°C
Resolution	<0.00005°C
Typical stability	±0.002°C / year
Time constant	<0.1s | fast, <1s standard, <15s | slow

*A wider temperature range is available upon request. Contact RBR for more information.

3.3 Radiometers (PAR, rad)

RBR offers PAR radiometers and narrow-band radiometers with a fixed channel width. Additionally, we support PAR sensors from LI-COR.

PAR sensors measure intensity of visible light at frequencies associated with photosynthesis. Narrow-band radiometers are available in a variety of wavebands.

RBR radiometers

The RBR*solo*^{3} PAR and RBR*solo*^{3} rad instruments look identical and share several specifications.

RBR*solo*^{3} PAR

The RBR*solo*[3] PAR and RBR*solo*[3] PAR | deep use the cosine photosynthetically active radiation sensors which can measure light within one hemisphere.
The RBR*solo*[3] rad and RBR*solo*[3] rad | deep use radiometers measuring narrow-band light with a fixed channel width, available in various 10nm- and 25nm-wide channels. Both centre wavelength and channel width are factory-configured.

Optical radiometry

Parameter	Value
Initial offset error*	±0.0025% full scale
Resolution**	±0.0002% full scale
Dynamic range	>5.5 decades (nominal)
Absolute calibration***	±5%
Linearity	±1%
Time constant	<5ms
Operating temperature range	-5°C to 35°C
Gain temperature dependence	0.15% / °C
Cosine response error (water)	±5% at 0-60°, ±10% at 61-82°
Azimuth error (water)	±1.5% at 45°
Out-of-band rejection**	>25dB (typical), OD 2.5

* Dark offset is internally temperature-compensated.
** Out-of-band rejection and resolution are wavelength dependent for narrow-band radiometers.
*** RBR calibrates radiometers with NIST traceable references.

PAR

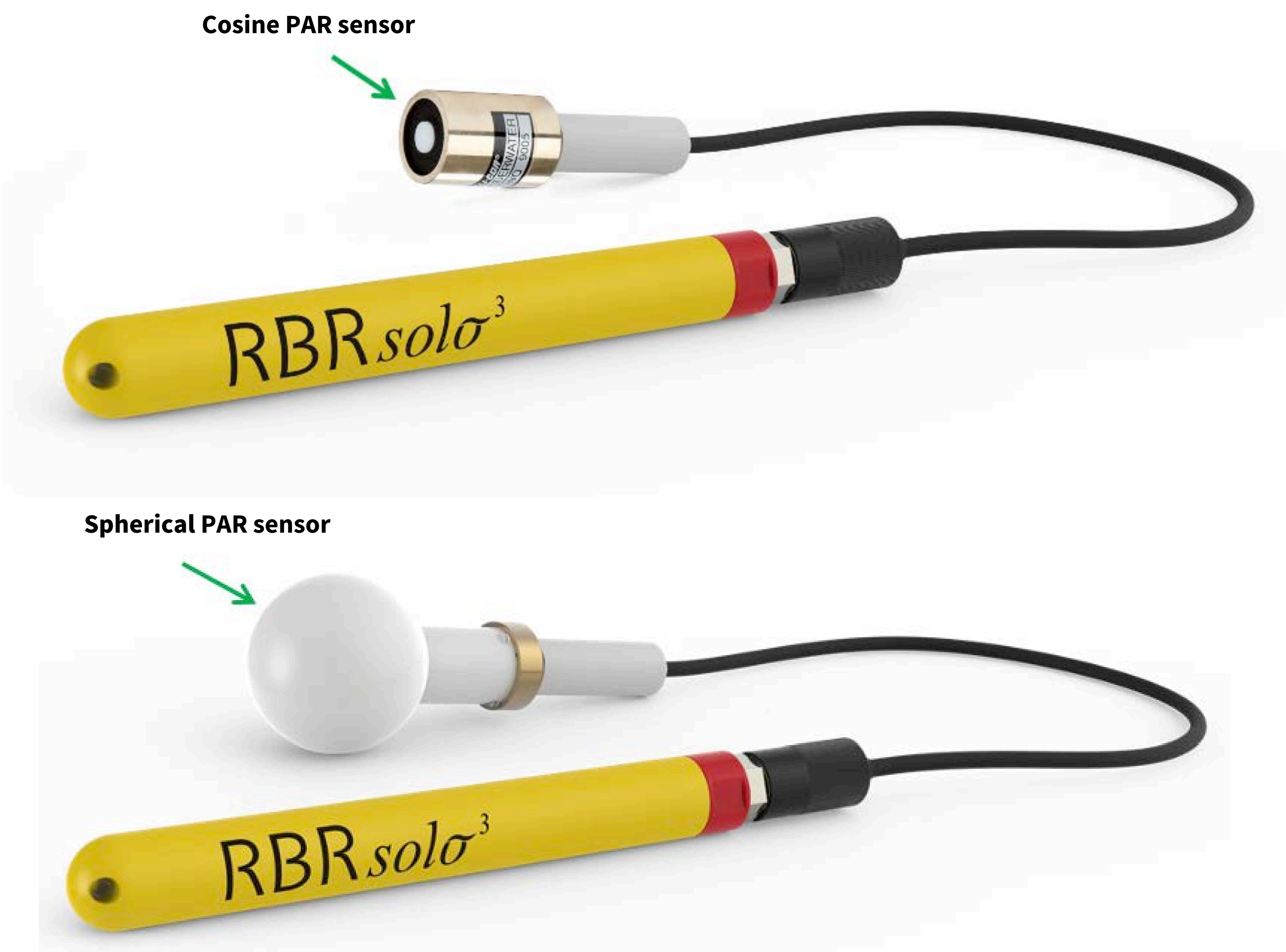
Parameter	Value
Wavelength range	400 to 700nm
Full scale range	0 to 5000µmol/m²/s (minimum)
Initial offset error*	±0.125µmol/m²/s
Resolution	±0.010µmol/m²/s

Narrow-band channels

Parameter	Value
Centre wavelengths (CWL)	413/ 445/ 475/ 488/ 508/ 532/ 560nm
Accuracy (for CWL)	±3nm (for all CWLs except 475nm) ±5nm (for CWL 475nm only)
Full width at half-maximum (FWHM)	10nm (for all CWLs except 475nm) 25nm (for CWL 475nm only)
Accuracy (for FWHM)	±3nm
Full scale range	0 to 400µW/cm²/nm (minimum)
Initial offset error*	±0.010µW/cm²/nm
Resolution**	±0.001µW/cm²/nm

PAR (LI-COR)

The RBR*solo*^{3} PAR (LI-COR) instruments use cabled cosine (one hemisphere, LI-192) or spherical (omnidirectional, LI-193) PAR sensors.



RBR*solo*^{3} PAR (LI-COR) variants

Parameter	Value
Wavelength range	400 to 700nm
Calibrated range	0 to 10000µmol/m^2/s
Initial accuracy	±2%

3.4 Dissolved oxygen (ODO, DO)

Optical dissolved oxygen (ODO)

The RBR*duet*³ T.ODO, and RBR*duet*³ T.ODO | deep use the optical dissolved oxygen sensor. During deployments, always orient the sensor downwards to reduce debris collecting on the sensing foil and minimise direct sunlight. Store the sensor in the dedicated storage cap, included with the instrument. Rehydrate for five days before deployment. See RBR ODO sensor care and maintenance for more information.

RBR*duet*³ T.ODO

Parameter	Value
Calibrated range Concentration Saturation Temperature	 0-500µmol/L 0-120% 1.5°C to 30°C
Initial accuracy	Maximum of ±8µmol/L or ±5%
Resolution	<1µmol/L (saturation 0.4%)
Time constant	~1s (|fast), ~8s (standard), ~30s (|slow)

Dissolved oxygen (DO)

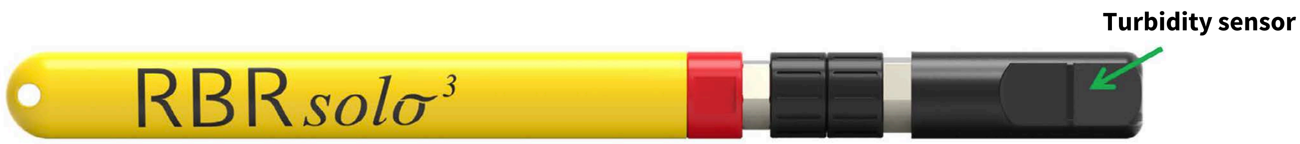
The RBR*solo*³ DO uses the OxyGuard galvanic dissolved oxygen sensor. The sensor consumes oxygen from the environment and thus produces most accurate measurements when in a stirred environment. During deployments, always orient the sensor downwards to reduce debris collecting at the membrane. Store the sensor in the dedicated storage cap, included with the instrument.

RBR*solo*³ DO (OxyGuard)

Parameter	Value
Range	0 to 600%
Initial accuracy	±2% oxygen saturation
Resolution	1% of saturation
Response time	~10s, 90% step change at 20°C

3.5 Turbidity

The RBR*solo*[3] Tu and RBR*solo*[3] Tu | deep use the Seapoint turbidity sensor which detects light scattered by solid particles suspended in water. During deployments, minimise direct sunlight.



RBR*solo*[3] Tu

Parameter	Value
Light source wavelength	880nm
Sensing distance	<5cm from windows
Time constant	0.1s
Measurement range	0-4000FTU
Linearity	<2% deviation for 0-1250FTU range*
Depth rating	6000m

* Response becomes non-linear above 1250FTU.

4 Derived parameters

Ruskin software calculates the derived parameters.

You can select alternative derivation options for some parameters in the **Parameters** tab.

See Ruskin User Guide: Compact Instruments[3] for details.

4.1 Sea pressure

Sea pressure is the difference between the pressure measured underwater by your RBR instrument and atmospheric pressure. The units of measurement are **dbar** (decibars).

$$Sea\, pressure = absolute\, pressure - atmospheric\, pressure$$

where pressure (in dbar) is the value measured directly by your RBR instrument.

Enter atmospheric pressure (in dbar) manually in the table under the **Parameters** tab in Ruskin. See Ruskin User Guide: Compact Instruments[3]. If not entered, a default value of 10.1325dbar will be used.

4.2 Depth

Depth is a function of sea pressure and seawater density. The units of measurement are **m** (metres).

$$Depth = \frac{sea\ pressure}{density \cdot g}$$

where seawater density is in g/cm^3 and sea pressure is in dbar, and g is the acceleration of gravity and equals 9.8m/s^2 .

Sea pressure is also a derived parameter:

$$Sea\, pressure = absolute\, pressure - atmospheric\, pressure$$

Enter atmospheric pressure (in dbar) and seawater density (in g/cm^3) manually in the table under the **Parameters** tab in Ruskin. See Ruskin User Guide: Compact Instruments[3]. If not entered, default values of 10.1325dbar and 1.0281g/cm^3 will be used.

4.3 Oxygen concentration

The RBR*solo*[3] DO supports a third-party DO sensor from OxyGuard, which measures dissolved oxygen saturation.

When a sensor measures oxygen saturation, we derive oxygen concentration using the Weiss equation. See The solubility of nitrogen, oxygen and argon in water and seawater by R.F. Weiss for details.

The units of measurement may be **µMol/L, mg/L,** or **mL/L**.

The Weiss equation requires values for absolute temperature (in °K) and salinity, which are derived from measured temperature and conductivity. As your instrument does not measure conductivity, a default value of 35PSU will be used. Alternatively, enter conductivity manually in the table under the **Parameters** tab in Ruskin. See Ruskin User Guide: Compact Instruments[3].

4.4 Oxygen saturation

The RBR*duet*[3] T.ODO measures dissolved oxygen concentration.

When a sensor measures oxygen concentration, we derive oxygen saturation using the Garcia and Gordon equation. See Oxygen solubility in seawater: better fitting equations by F. H. Garcia and I. I. Gordon for details.

The units of measurement are **%**.

The Garcia and Gordon equation requires values for absolute temperature (in °K) and salinity, which are derived from measured temperature and conductivity. As your instrument does not measure conductivity, a default value of 35PSU will be used. Alternatively, enter conductivity manually in the table under the **Parameters** tab in Ruskin. See Ruskin User Guide: Compact Instruments[3].

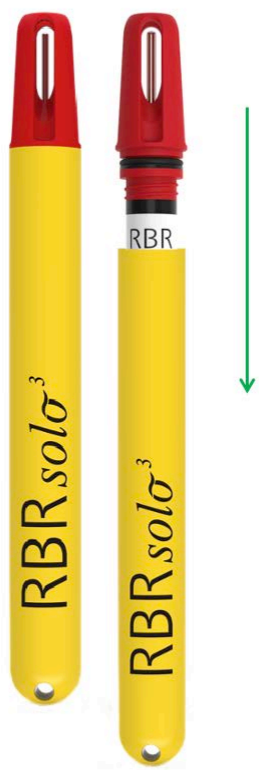
5 Hardware

5.1 Opening and closing a compact instrument

RBR compact instruments have two O-rings. Remember to keep the O-rings clean and avoid scratching the O-ring mating surfaces. Carefully inspect the O-rings before deploying the instrument.

Opening the instrument

1. Hold the instrument with the sensor end-cap up.
2. Unscrew the sensor end-cap, counterclockwise.
3. Once fully unscrewed, slide the housing away from the sensor end-cap to reveal the sensor carriage. The sensor carriage contains the battery compartment, desiccant holder, and USB-C port.



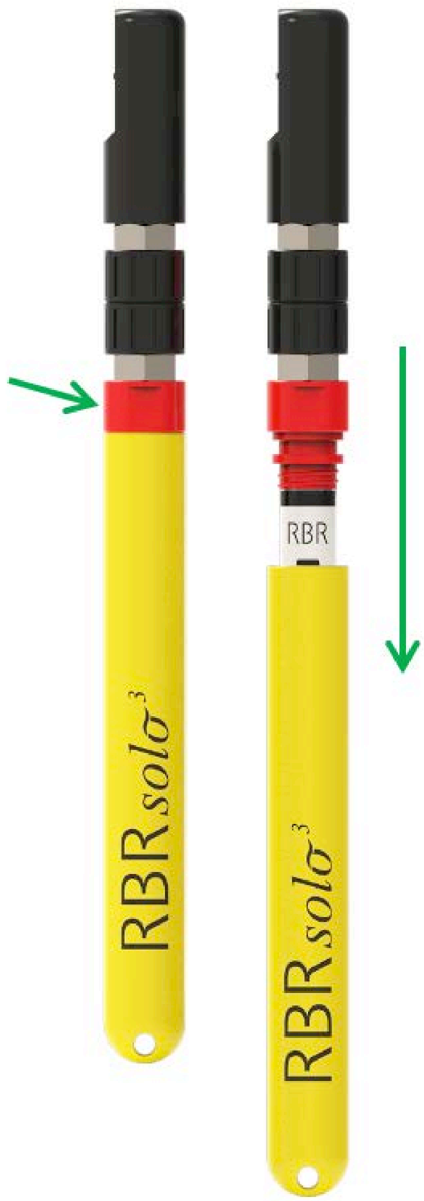
Opening a compact instrument

Sensor carriage

Closing the instrument

1. Insert the sensor carriage into the housing.
2. Screw the sensor end-cap back on, clockwise.

⚠ When opening the RBR*solo*^{3} Tu, make sure to unscrew the end-cap at the red ring. The black coupler is part of the turbidity sensor end-cap and should stay intact. See Coupling of the turbidity sensor.



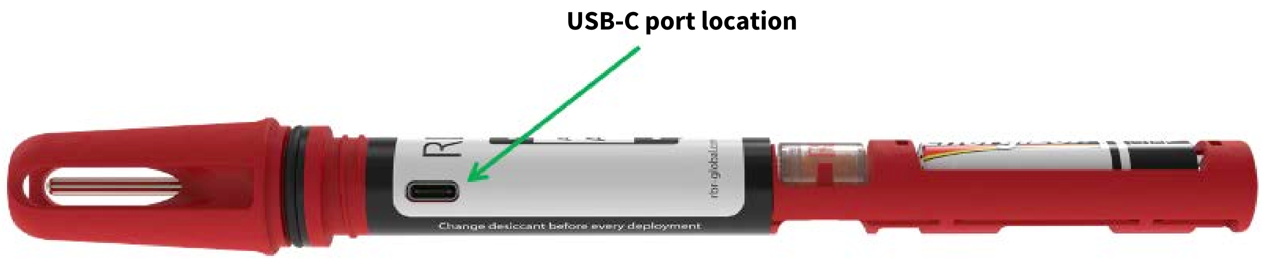
Opening RBR*solo*^{3} Tu

5.2 Instrument interface

> ⓘ Refer to Opening and closing a compact instrument for details on accessing connection ports.

USB-C port

RBR compact instruments provide an internal USB-C port.



The RBR support kit includes a USB-C data cable, which will connect the instrument to your computer.

Deployment

- Connect the instrument to your computer using the USB-C cable
- Find the instrument on Ruskin
- Review the settings and click "Enable"

Data download

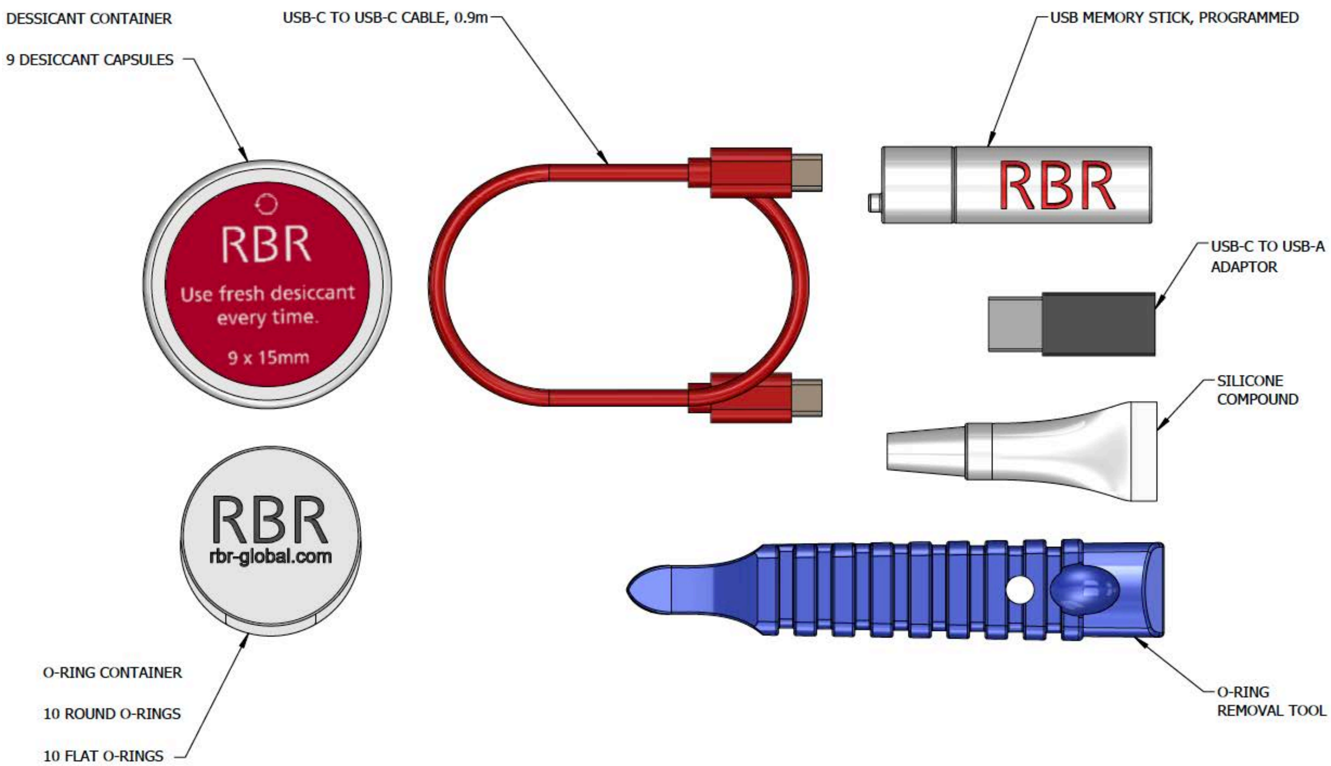
- Connect the instrument to your computer using the USB-C cable
- Find the instrument on Ruskin
- Click "Download..." and select a location to save the measurements

6 Maintenance

6.1 Support kits

RBR provides one support kit per every three instruments ordered. If you need more units, contact RBR.

The RBR support kit for compact instruments contains an assortment of basic accessories and spare parts.



RBR support kit for compact instruments

The RBR support kit for compact instruments includes the USB-C desktop cable. This cable is used to download data from the instrument's internal port to a computer.

RBR offers an OxyGuard sensor support kit in addition to the support kit for compact instruments. See OxyGuard DO sensor care and maintenance.

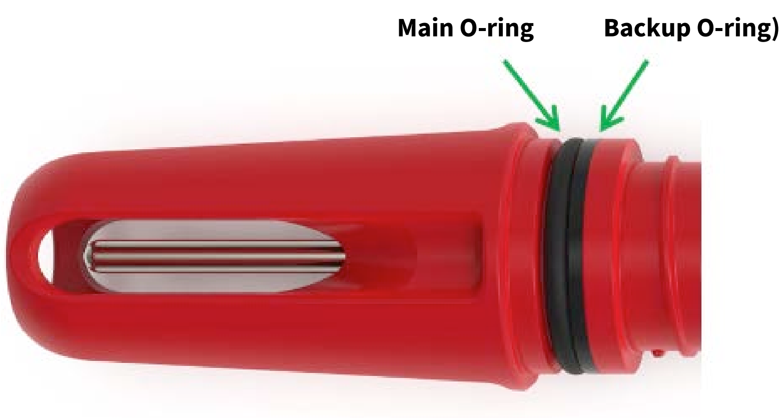
6.2 Replacing the O-rings

ⓘ Refer to Opening and closing a compact instrument for details on accessing the O-rings.
The O-ring removal tool and silicone compound are available in the support kit.

Care for the O-rings is the single most important item of maintenance on any submersible RBR instrument. A water leak can damage the circuit board beyond repair and cause complete data loss. Every instrument's seal depends upon its O-rings, and proper O-ring maintenance is crucial.

ⓘ The O-rings may lose elasticity over time, even when the instrument is not deployed. RBR strongly recommends replacing the O-rings regularly.

RBR compact instruments use two O-rings. One is the main O-ring, and the other is the backup. Both are required to protect the instrument from flooding.



Location of the O-rings

To access the O-rings, open the instrument.

Inspecting the O-rings and mating surfaces

Visually inspect the O-rings, paying attention to the following areas:

- The surface of the O-ring itself should be smooth and free of nicks or damage
- The mating surface on the inside of the case between the threads and the open end
- The groove in the end-cap where the O-ring sits

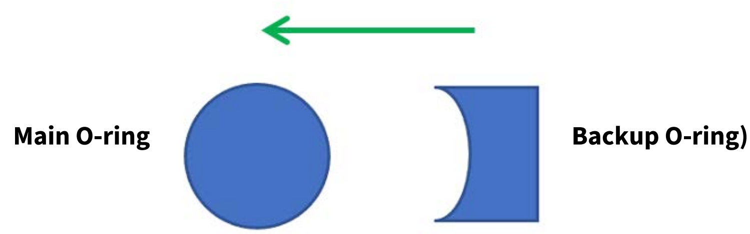
> ⚠ When handling the O-rings:
> - Avoid using any object that could scratch the O-ring or any of its mating surfaces.
> - If dirt is present in the O-ring groove, remove the O-ring as described below and thoroughly clean the groove.
> - Do not return this old O-ring to the instrument! If you remove the O-ring from the instrument for any reason, always replace it with a new one.
> - If the surfaces of the O-ring groove are scratched, pitted, or damaged, contact RBR for advice.

Replacing the O-rings

Correct placement and orientation of the two O-rings are critical to maintaining depth rating integrity.

The main O-ring has a round profile. It must be installed first.

The backup O-ring is flat on one side, and concave on the other. When installed, the concave side must face the main O-ring.



Orientation of the O-rings

1. Use the plastic O-ring tool (included with the support kit) to remove the O-rings from the groove. The O-ring may need to stretch quite a bit as it is pushed off; this requires some effort but can be done by hand.
2. Clean the groove thoroughly using a soft, lint-free cloth and compressed air if necessary.
3. Select the proper O-rings and inspect them for damage.
4. Lubricate with a very light film of silicone grease (included in the support kit).
5. Install the main O-ring by sliding it over the electronic housings and popping it into its groove.
6. Install the backup O-ring, ensuring that the concave side is facing toward the main O-ring.
7. Once in place, inspect the O-rings once more for scratches and debris, and wipe away any silicone compound deposited on the carriage.
8. Once the inspection is complete, close the instrument.

6.3 Replacing the battery

ⓘ Refer to Opening and closing a compact instrument for details on accessing the battery.

RBR ships new instruments with fresh, highest capacity batteries included. Replace the batteries before each deployment to maximise the operational time, and prevent data loss.

Ruskin software allows users to estimate the remaining battery life during deployment (assuming fresh batteries) by tracking power consumption in mAh. See Ruskin User Guide: Compact Instruments[3] for more information on predicting battery life.

Replacing the battery

1. Open the instrument and pull out the sensor carriage.
2. Push the battery out of its holder using your finger or a blunt tool.
3. Insert a new AA-type battery into the holder.
4. Check for correct battery polarity.
5. Insert the sensor carriage into the housing and close the instrument .

Push the old battery out

Insert a new battery, ensuring correct polarity

6.4 Replacing the desiccant capsule

ⓘ Refer to Opening and closing a compact instrument for details on accessing the desiccant.

Replace the desiccant capsule before each deployment.

Fresh desiccant will keep the instrument compartment dry and prevent malfunction. Water damage may occur if condensation forms inside the instrument.

As a preventative measure, RBR recommends servicing the instrument in a cool, dry place (when possible).

Replacing the desiccant capsule

1. Open the instrument and pull out the sensor carriage.
2. Push the desiccant capsule out of its holder using your finger or a blunt tool.
3. Insert a new desiccant capsule into the holder.
4. Insert the sensor carriage into the housing and close the instrument.

Push the desiccant capsule out

All instruments ship with fresh reusable desiccant capsules. They use a cobalt-free colour changing indicator dye. Orange indicates fresh desiccant, while green indicates it is saturated (about 15% water by weight). Once exhausted, the capsules can be replaced with new ones (available from RBR), or refreshed.

Fresh (orange) and saturated (green) desiccant capsules

Refreshing the desiccant

Follow the steps below to refresh the desiccant.

1. Remove the saturated silica beads from their capsule.
2. Place them in the oven and heat at 120°C (250°F) for about two hours.

> Always remove the beads from their capsule before refreshing!
> The capsule will deform if heated to 120°C.

3. Take the refreshed beads out of the oven and return them to the capsule.

> Return the refreshed beads to the capsule immediately after reheating!
> If left outside the capsule, the desiccant will trap moisture and go back to green.

4. Wait until the silica beads cool down. Once cool, the desiccant is ready to be reused.

6.5 Coupling the turbidity sensor

The turbidity sensor in the RBR*solo*^{3} Tu is connected to the instrument via a coupler. The instrument has a custom-made female connector, which fits the male connector of the sensor. The coupler has two flanges with opposing threads. New instruments are shipped with the coupler securely tightened, making this connection watertight.

Typically, you will never need to disconnect the sensor from the instrument. However, before deploying the RBR*solo*^{3} Tu, it is important to verify that the coupler has not become loose. If that happens, you will see a small gap between the sensor and the coupler, or between the coupler and the base of the connector. Gently tighten the flanges to protect your instrument during deployment.

Coupler on the RBR*solo*^{3} Tu

In rare instances, it may becomes necessary to disconnect and reconnect the turbidity sensor. Follow the steps below.

RBR*solo*³ Tu, with the sensor disconnected

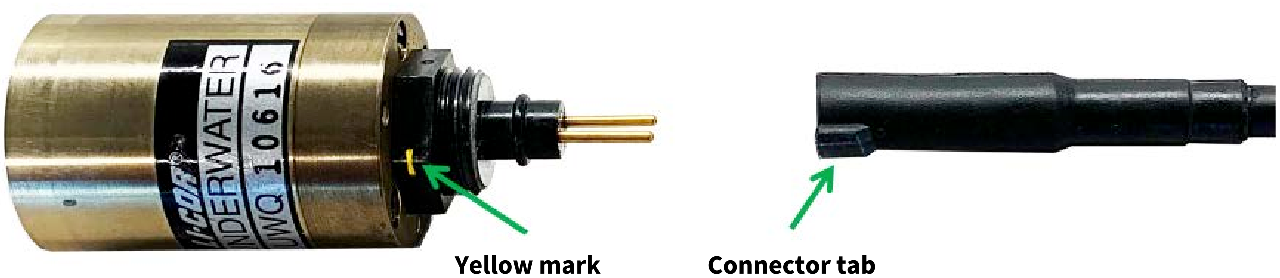
Step	Description
1	Disconnect the sensor 1. Take the instrument in your left hand and hold it horizontally, with the sensor oriented to the right. 2. With your left index finger and thumb, prevent the left flange from moving. 3. With your right hand, hold the sensor tightly. 4. With your right index finger and thumb, twist the right flange clockwise until loose. 5. The sensor will drop into your hand.
2	Access the female connector 1. Twist the left flange counterclockwise. 2. Remove the coupler.
3	Lubricate the female connector (see Cables and connectors)
4	Reconnect the sensor 1. Place the coupler back on the instrument. 2. Twist clockwise until tight. 3. Very carefully mate the sensor to the instrument (the pins on the sensor must be aligned with the corresponding holes). 4. Press the sensor into the instrument to make sure the pins are inserted. 5. Continue to hold the instrument with your left hand. 6. With your right hand, hold the sensor tightly. 7. With your right index finger and thumb, twist the right flange counterclockwise while slightly pushing the sensor in with your palm. 8. Verify the tightness of both flanges. ⚠ Occasionally, the left flange may begin to loosen while you are tightening the right one. It usually means that the pins did not mate properly. Carefully align the pins again and press harder. Wiggle the sensor gently to make sure the pins are inserted.

6.6 Connecting the cabled PAR sensor (LI-COR)

Proper connection between the PAR sensors (LI-COR) and their cable is crucial for deployment success.

Both LI-192 and LI-193 have a two-pin connector with a small yellow mark on the side.

Always align this yellow mark with the tab on the side of the cable connector when connecting the sensor to its cable.



Orientation

After connecting the cable to the PAR sensor, confirm that the yellow mark and the connector tab are aligned, and then put the white locking sleeve in place. The sensor is ready for deployment.

> Ensure proper orientation of the yellow mark and the tab before each deployment. Inverted connection of your PAR sensor will result in incorrect or lost data.

6.7 Cables and connectors

The RBR*solo*[3] PAR with a spherical sensor (LI-193) includes a customised cable, which connects the PAR sensor to the instrument. This cable has two connectors, which need to be lubricated any time when they are disconnected and reconnected. Similarly, the female connector in the RBR*solo*[3] Tu needs to be lubricated whenever the turbidity sensor is disconnected and reconnected.

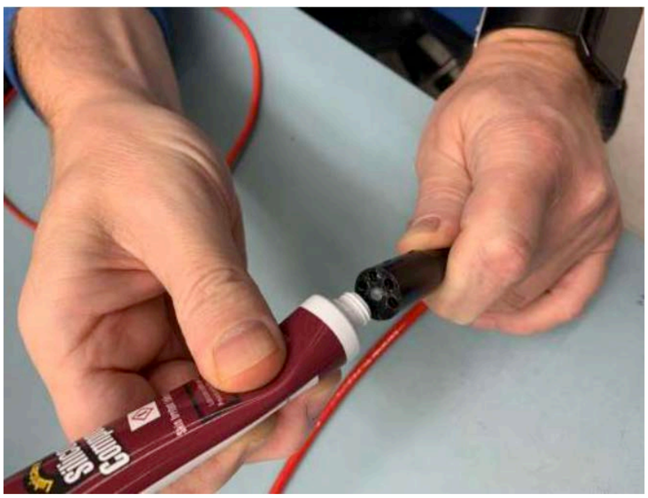
Cable bend radius

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



Lubricating a connector

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

6.8 RBR ODO sensor care and maintenance

The RBR optical dissolved oxygen sensors have an oxygen-sensitive substrate that requires special care. Any damage will permanently affect performance.

> Avoid direct sunlight.
> Never touch the sensitive element while cleaning or handling.
> Use the storage cap when the sensor is not in use.

Storage

Store the RBR optical dissolved oxygen sensor in the dedicated storage cap to protect it from damage.

Storage caps are provided with the instrument. Contact RBR if a replacement is needed.

- ***Short-term storage (three weeks or less)***

1. Fill the storage cap with clean water until about 50% full.
2. Place the cap on the sensor and gently push it past the locking pin.
3. Refill the water periodically during storage. The cap is semi-watertight and will leak overtime.

Push the storage cap past the locking pin

- ***Long-term storage (more than three weeks)***

> For longer storage periods, store your sensor dry. Rehydrate for **five** days before deployment.

1. Place an empty cap on the sensor and gently push it past the locking pin.
2. Before deployment, fill the storage cap with clean water like for short-term storage, place it on the sensor, and rehydrate for **five** days.

> It takes up to five days for a dry ODO sensor to equilibrate after being placed in water. Insufficient hydrating time before deployment may lead to unreliable data.

RBR*duet*³ T.ODO ready for storage

First deployment

RBR ships the RBR*duet*³ T.ODO instruments with a hydrated storage cap on, so that the instrument is ready for its first deployment.

However, long transportation times and low cabin pressure may may result in the loss of water. Verify that the storage cap is still wet. If not, rehydrate the sensor for **five days** before deployment.

Calibration

Check your sensor calibration before each deployment in saturated fresh water. If the readings are not within 1% of 100% saturation, recalibrate the instrument using a one-point calibration. Typically, | fast instruments may need recalibration more often than standard or | slow. See Ruskin User Guide: Compact Instruments[3] for user calibration instructions.

6.9 OxyGuard DO sensor care and maintenance

Storage

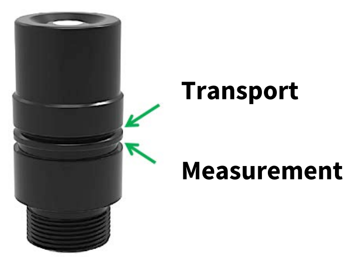
Store the OxyGuard dissolved oxygen sensor in the dedicated storage cap to minimise fluid loss. Storage caps are provided with the instrument. Contact RBR if a replacement is needed.

O-ring

The red O-ring of the OxyGuard sensor serves two purposes:

- To retain the electrolyte during storage
- To balance pressure during deployments

There are two positions for O-ring on the OxyGuard sensor, "Transport" and "Measurement".



During transportation or storage, move the red O-ring of the Oxyguard sensor to the "Transport" position, closing off the port on the side of the cell.

Before deployment, move the O-ring to the "Measurement" position to maintain the pressure balance.

After deployment, return the O-ring to the "Transport" position.

Transport position

Measurement position

Support kit

RBR offers an OxyGuard sensor support kit that includes:

- Membrane tool
- Electrolyte solution (250ml)
- Fast response membranes
- Replacement O-rings
- Oxyguard Support Kit and Refurbishment Guide

Check the state of your DO sensor before deployment. Look for any damage to the membrane, cloudiness of the electrode, and buildup on the anode. If you find any damage, refurbish and recalibrate the sensor.
Refer to Oxyguard Support Kit and Refurbishment Guide, included with the support kit, for instructions on refurbishing your sensor. See Ruskin User Guide: Compact Instruments[3] for instructions on calibration.

6.10 Cleaning the instrument

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

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	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.
Encrustation	Ultrasound bath	Do not use ultrasound on pressure transducers <50dbar.

Cleaning the pressure sensor

> Avoid touching the diaphragm when cleaning the sensor! Any deformation will permanently affect performance.

1. Unscrew the sensor guard using a coin or a large flat head screwdriver. Do not apply excessive force, especially when using the screwdriver.
2. Rinse the area under running water. If this fails to remove the deposits, try soaking in vinegar or immersing in an ultrasound bath. Do not use ultrasound on pressure transducers <50dbar.
3. If unsuccessful, contact RBR.

Cleaning PAR, rad, ODO, turbidity, and third-party fluorescence sensors

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.

6.11 Calibrating the instrument

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. Hard copies are provided with each shipment. RBR can replace lost or misplaced calibration certificates upon request.

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.

6.12 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.

7 Revision history

Revision No.	Release date	Notes
A	30-November-2021	Original
B	28-February-2022	Updated storage capacity to 130 million readings. Added MCBH pinout to Specifications, description of the PAR sensor (LI-COR) connector to Hardware, care instructions for the DO sensor (OxyGuard) to Maintenance.
C	30-November-2022	Improved page hierarchy for Specifications. Updated the link to Ruskin User Guide. Updated instructions for refreshing the desiccant. Added the Derived parameters section.
D	31-March-2023	Added a note on battery chemistries to and removed the MCBH pinout from Physical specifications. Added storage instructions for the ODO sensor to Maintenance. Moved Connecting instructions for Tu and PAR sensors from Hardware to Maintenance. Updated cleaning instructions for optical sensors in Cleaning.
E	30-April-2023	Updated the RBR ODO sensor subsections in Sensor specifications and Maintenance.