RBR CT and CTD INSTRUMENTS

RBRconcerto3
RBRbrevio3
RBRduo3

INSTRUMENT GUIDE

rbr-global.com

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1 CT and CTD instruments

> ⚠ This guide focuses on CT- and CTD-only instruments.
> For information on other sensors and instruments, refer to the RBR Standard Instrument Guide.

RBR offers several standard instruments dedicated specifically to determining salinity:

- RBR *duo*^{3} C.T - conductivity and temperature
- RBR*concerto*^{3} C.T.D - conductivity, temperature, and pressure
- RBR*brevio*^{3} C.T.D - conductivity, temperature, and pressure

All RBR standard instruments support the following features :

- High accuracy
- Extended deployments
- Large memory
- Flexible schedules
- Twist activation
- USB-C download
- Realtime communication
- Wi-Fi

The RBR CT and CTD instruments are uniquely designed to determine salinity by measuring the conductivity and temperature of water. Their rugged inductive cell is not affected by surface contaminants or freezing conditions. For profiling applications, the co-located thermistor reduces salinity spiking, thus increasing data accuracy.

Equipped with a piezoresistive pressure channel, the CTD instruments provide more accurate salinity data when the instrument is sampling at varying depths.

The RBR *duo*^{3} C.T, RBR*concerto*^{3} C.T.D, and RBR*brevio*^{3} C.T.D are also available in titanium housing for deep applications (| deep), designed to resist all forms of marine corrosion. All RBR instruments within the | deep family provide accurate and stable measurements in the most challenging environments.

The RBR CT and CTD instruments facilitate optimal measurement schedules, whether moored, towed, or profiling. Select from several | fast sampling variants, such as | fast8, | fast16, | fast32, | tide16, and | wave16, depending on your needs.

The instruments come with a Wi-Fi module and twist activation. Large storage capacity and reliable battery power facilitate long deployments with higher sampling rates. Downloads are quick with USB-C. A dedicated holder makes it simple to replace desiccant before each deployment. The calibration coefficients are stored on the instrument, and only one software tool, Ruskin, is required to operate it. Datasets can be read directly in Matlab, or exported to Excel, OceanDataView®, or text files.

For a detailed description of using the Ruskin software, see Ruskin User Guide: Standard Instruments[3].

1.1 RBR*duo*³C.T

The RBR*duo*³ C.T determines salinity by measuring the conductivity and temperature of water. Select this configuration when the instrument remains at a constant depth, for example, mounted to a stationary platform, fixed to a dock under the surface, or used in laboratory environment.

RBR*duo*³ C.T and RBR*duo*³ C.T | deep

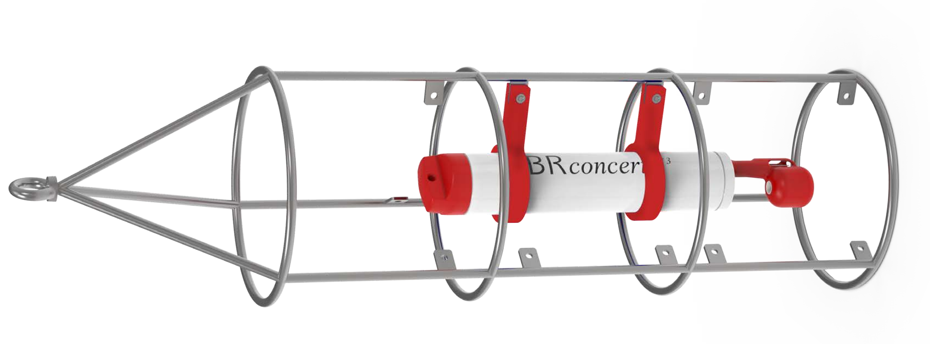
For moored applications, you may also opt for the variant with a black conductivity cell, whose simpler design makes it easier to clean and maintain.

RBR*duo*³ C.T with a black cell

1.2 RBR*concerto³* C.T.D

The RBR*concerto³* C.T.D is our most popular standard instrument, which determines salinity of seawater via measuring the conductivity, temperature, and pressure.

Use the RBR*concerto³* C.T.D for moored, towed, and profiling applications; shallow and deep deployments; fast, averaging, and burst sampling. It can be deployed with a cage or without.



RBR*concerto³* C.T.D in a cage

In addition to salinity and specific conductivity, the RBR*concerto³* C.T.D can derive sea pressure, depth, density anomaly, and speed of sound, thanks to its piezoresistive pressure sensor.

RBR*concerto³* C.T.D and RBR*concerto³* C.T.D | deep

1.3 RBR*brevio*^{3} C.T.D

The RBR*brevio*^{3} C.T.D is the shortest of RBR standard instruments, best suited for applications where size and weight are critical. The RBR*brevio*^{3} C.T.D has all of the same features as the RBR*concerto*^{3} C.T.D, just in a smaller form factor.

RBR*brevio*^{3} C.T.D and RBR*brevio*^{3} C.T.D | deep

2 Physical specifications

Instrument

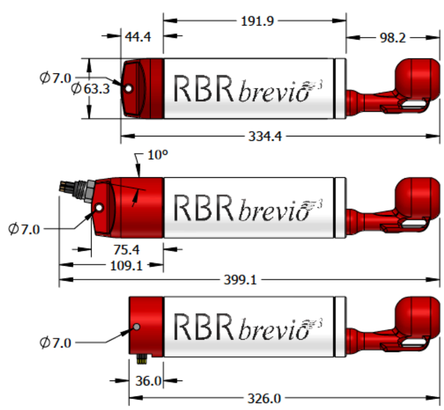
Specification	Description
Max number of readings	240 million
Power	8 AA-type cells*
External power	4.5 to 30V
Communications	Internal: USB-C External: USB and RS-232 / RS-485
Clock drift	±60 seconds/year
Housing	Plastic or titanium
Diameter	63.3mm (plastic), 60.3mm (Ti)
Depth rating	up to 6000m
Sampling rate	2Hz; options up to 32Hz

*RBR ships the CT and CTD instruments with lithium thionyl chloride batteries. See Ruskin User Guide: Standard Instruments[3] for other suitable battery chemistries.

Length and weight

Instrument	Length*	Weight in air*
RBR*duo*^{3} C.T	~420-490mm	~1.3kg (plastic), ~2.8kg (titanium)
RBR*brevio*^{3} C.T.D	~330-400mm	~0.9kg (plastic), ~1.7kg (titanium)
RBR*concerto*^{3} C.T.D	~420-490mm	~1.3kg (plastic), ~2.8kg (titanium)

*Configuration dependent. The total length and weight of an instrument depend on the battery end-cap type.



RBR*brevio*^{3} dimensions with three different battery end-caps

Power supply selection

If connected, an external power supply will be used preferentially over the internal batteries as long as the voltage remains 4.5V or greater. If it drops below 4.5V or complete disconnection occurs, the system automatically switches to the internal batteries.

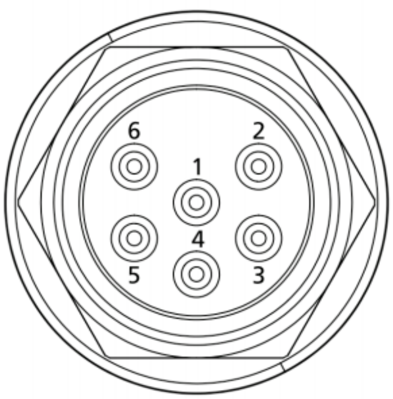
Clock

The instrument clock is maintained during brief disconnections. This time is usually sufficient to change batteries. If the clock is lost, the time will revert to January 2000. In this case, check the power supply and synchronise with the computer again.

USB-C power

The USB-C cable provides power sufficient for configuration or data download. However, the instrument requires an internal or external power supply to perform sampling.

External MCBH-6-MP connector pinout



Pin No.	USB	RS-232	RS-485
1	Ground		
2	Power +4.5 to +30V		
3	N/C	Data output from the instrument (Tx)	Data output from the instrument (Tx-)
4	VUSB +5V	Data input into the instrument (Rx)	Data input into the instrument (Rx+)
5	D-	N/C	Data input into the instrument (Rx-)
6	D+	N/C	Data output from the instrument (Tx+)

For deployment estimates specific for your instrument configuration and sampling options:

- Go to Ruskin and click the "Instruments" tab
- Select "Simulate an instrument...", find your logger under "Standard instruments", and click "OK"
- Adjust variable parameters under "Configuration" to match your needs
- Ruskin autonomy engine will calculate the **End** date and indicate when your deployment is likely to stop

Note that deployment estimates are the same for shallow and deep variants.

3 Sensor specifications

The RBR*duo*[3] C.T instruments use conductivity and temperature sensors.

The RBR*concerto*[3] C.T.D and RBR*brevio*[3] C.T.D instruments use conductivity, temperature, and pressure sensors.

3.1 Conductivity (C)

RBR CT and CTD instruments use integrated inductive conductivity sensors which measure the ability of seawater to conduct electric current.

Parameter	Value
Range	0 to 85mS/cm
Initial accuracy	±0.003mS/cm
Resolution	<0.001mS/cm
Typical stability	0.010mS/cm/year
Max depth rating	6000m

Conductivity measurements are performed using a rugged inductive cell that can be frozen into ice. RBR used computational fluid dynamics (CFD) to optimise its design. The conductivity sensor is streamlined for hydrodynamic flushing through and around it, and does not require a pump, thus ensuring totally silent operation.

While 80% of its volumetric measurements happens inside the cell, they also extend up to 15 cm away and thus may be affected by conductive and non-conductive objects within this distance. RBR calibrates conductivity sensors to account for static objects, such as cages, guards, and other sensors.

To maintain optimal accuracy, deploy your instrument with the same cage or guard as used during calibration and at least 15cm away from other objects.

Conductivity measurements are temperature compensated.

3.2 Temperature (T)

RBR CT and CTD instruments use the thermistor-type temperature sensors.

While RBR thermistors are rated for depths up to 10km, the C.T and C.T.D instruments can operate at depths up to 6000m (the conductivity sensor depth rating).

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

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

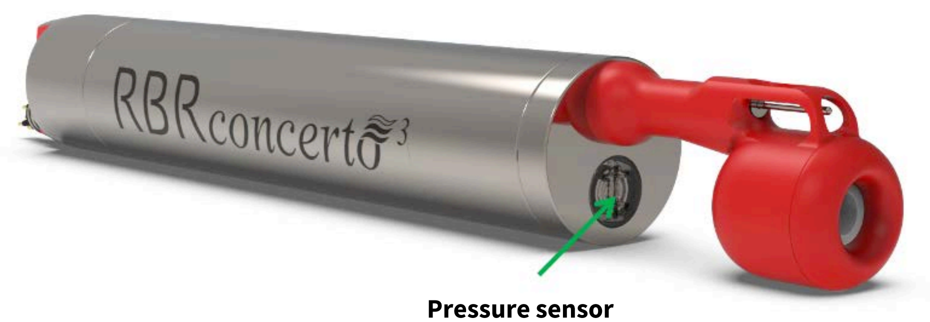
3.3 Pressure (D)

RBR CTD instruments use piezoresistive pressure (depth) sensors.

The sensor is protected by a clear plastic guard. During moored deployments with sediment in the environment, orient it downwards to reduce debris collecting on the housing.

Parameter	**Value**
Range	20 / 50 / 100 / 200 / 500 / 750dbar (plastic) 1000 / 2000 / 4000 / 6000dbar (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



4 Derived parameters

Calculate derive parameters using Ruskin software or on the RBR instrument itself, depending on how it is configured. Both routes use the same equations and produce identical results.

All derived parameters will be calculated on Ruskin:

- when the data storage format is set to **Desktop** and **Realtime** is set to **None**

As a result, the RSK file will only store raw data. This option enables post-processing on Ruskin, with the flexibility of changing the variables.

To obtain derived parameters, download the dataset to your laptop and open it on Ruskin, then input physical parameters into the **Parameters** tab. Furthermore, Ruskin has alternative derivation options for some parameters, which you can also select in the **Parameters** tab. See Ruskin User Guide: Standard Instruments[3] for details.

> The **Desktop** storage format is a preferred option. Having the raw data keeps more options open in the long term.
> However, when you are managing your deployments using a smartphone, it is more efficient to derive parameters in realtime than post-process a large RSK file with raw data, due to limited capabilities of mobile devices.

All derived parameters will be calculated on the instrument:

- when the data storage format is set to **Mobile**
  or
- when the data storage format is set to **Desktop** and **Realtime** is set to **Serial** or **USB**

As a result, the RSK file will store the data with calibration coefficients already applied and derived parameters already calculated.

CT measurements allow for deriving salinity, specific conductivity, speed of sound, and density anomaly.

CTD measurements allow for deriving salinity, specific conductivity, speed of sound, density anomaly, sea pressure, and depth.

4.1 Salinity

Salinity is defined as the ratio of the mass of dissolved material to the mass of seawater. It is impossible to measure absolute salinity directly. However, we can derive practical salinity from measurable properties: electrical conductivity, temperature, and pressure, obtained by your RBR CTD instrument, such as the RBR*concerto*[3] C.T.D or RBR*brevio*[3] C.T.D. The units of measurement are **PSU** (dimensionless Practical Salinity Units).

RBR uses the algorithm recommended by PSS78, the world standard for practical salinity calculation. It enables calculation of practical salinity in a range 2 to 42PSU from conductivity S (mS/cm) measured at temperature T (ºC) and hydrostatic pressure p (dBar). Refer to Practical Salinity Scale of 1978 (PSS78) for more details.

The RBR*duo*[3] C.T will calculate salinity if you enter depth in the table under the **Parameters** tab in Ruskin. See Ruskin User Guide: Standard Instruments[3].

> If the PSS78 calculation generates an error, the instrument will report a salinity of 0. This might occur when, in air, the conductivity report a small negative value. This does not apply if one of the measured parameters is already flagged as an error.

4.2 Specific conductivity

Specific conductivity is a function of conductivity and temperature. This parameter is mostly applicable in studies of freshwater and brackish water. The units of measurement are **µS/cm** (microsiemens per centimetre).

RBR uses the algorithm described in Standard Methods for the Examination of Water and Wastewater by L.S. Clesceri et al, which yields specific conductivity normalised to 25°C.

$$Specific\ conductivity = \frac{0.001 \cdot conductivity}{1 + 0.0191(temperature - 25)}$$

where conductivity in mS/cm and temperature in °C are values measured by your RBR instrument, and 0.0191 is the default specific conductivity coefficient.

The specific conductivity coefficient is defined as the change in conductivity (in %) per 1°C. Its default value corresponds to an increase in conductivity of 1.91%. However, it depends on temperature and ionic composition of the water, ranging between 0.0175 and 0.0214 for natural lakes and rivers. You may be able to find the value specific to your body of water in literature or experimentally. In this case, adjust the specific conductivity coefficient manually in the table under the **Parameters** tab in Ruskin. See Ruskin User Guide: Standard Instruments[3].

This method enables calculation of specific conductivity in a range 0 to 6000µS/cm and is valid in the temperature range -2°C to +35°C.

4.3 Speed of sound

Speed of sound in seawater is a function of salinity, temperature and pressure. The units of measurement are **m/s** (metres per second).

It is not always possible to measure the speed of sound in seawater directly. However, we can derive it from measurable properties: electrical conductivity, temperature, and pressure, obtained by your RBR CTD instrument, such as the RBR*concerto*^{3} C.T.D or RBR*brevio*^{3} C.T.D.

The RBR*duo*^{3} C.T will calculate the speed of sound if you enter depth in the table under the **Parameters** tab in Ruskin. See Ruskin User Guide: Standard Instruments^3.

We derive salinity first, via the PSS78 method, and then use it in the algorithm, often referred to as the UNESCO equation. See Speed of sound in seawater as a function of salinity, temperature, and pressure by G.S.K. Wong and S. Zhu for more details.

In the oceans, the speed of sound varies between 1450 and 1570m/s. It increases about 1.3m/s per each 1PSU increase in salinity, 4.5m/s per each 1°C increase in temperature, and 1.7m/s per each 1dbar increase in pressure.

4.4 Density anomaly

Density anomaly, or negative thermal expansion, is the paradoxical tendency of water to expand during cooling. This behaviour manifests in anomalous decrease in water density when the temperature drops below 4°C. The units of measurement are **kg/cm^3** (kilograms per cubic centimetre).

It is not possible to measure the density anomaly directly. However, we can derive it from measurable properties: electrical conductivity, temperature, and pressure, obtained by your RBR CTD instrument, such as RBR*concerto*^{3} C.T.D or RBR*brevio*^{3} C.T.D. The RBR*duo*^{3} C.T will calculate density anomaly if you enter depth in the table under the **Parameters** tab in Ruskin. See Ruskin User Guide: Standard Instruments^3.

We derive salinity first, via the PSS78 method, and then use it in the algorithm, often referred to as the UNESCO equation of state:

$$Density\ anomaly = \left(\frac{1}{V(S,t,p)}\right) - 1000kg/m^3$$

where V (S, t, p) is specific volume of seawater derived from salinity, temperature and pressure and 1000kg/m^3 is density of freshwater.

See UNESCO (1981), Tenth report of the joint panel on oceanographic tables and standards for details.

> ⚠ The UNESCO equation of state is applicable within these ranges: 2 < practical salinity < 42, −2°C< temperature < 35°C.
> If salinity values are lower than 2PSU (freshwater), density anomaly values will not be accurate.

4.5 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: Standard Instruments[3]. If not entered, a default value of 10.1325dbar will be used.

4.6 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: Standard Instruments[3]. If not entered, default values of 10.1325dbar and 1.0281g/cm^3 will be used.

5 Hardware

5.1 Opening and closing the instrument

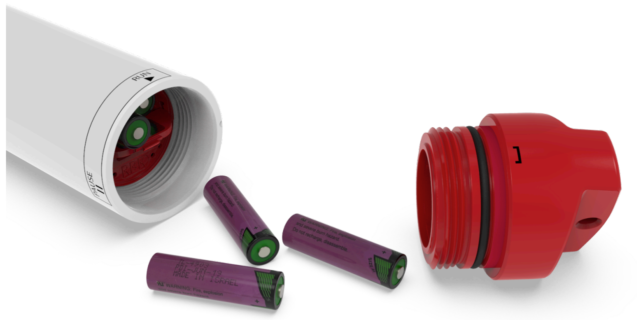
⚠ Remember to keep the O-ring clean and avoid scratching the O-ring mating surfaces. Carefully inspect the O-ring before deploying the instrument.

Opening the instrument with a standard end-cap

1. Twist the battery end-cap counterclockwise.
2. Once fully unscrewed, pull the end-cap away from the housing.

Closing the instrument with a standard end-cap

1. Place the end-cap back on the instrument until almost fully closed.
2. Twist the end-cap clockwise until aligned with **PAUSE**.



Open instrument with a standard end-cap

Opening the instrument with a connectorised end-cap

1. Twist the battery end-cap counterclockwise.
2. Once fully unscrewed, pull the end-cap away from the housing.
3. Unplug the umbilical cable.

Closing the instrument with a connectorised end-cap

1. Plug the mini-display port connector into the instrument as shown.
2. Twist the end-cap counterclockwise two full rotations to unwind the umbilical cable.
3. Twist the end-cap clockwise back on the instrument until aligned with **PAUSE**.

Open instrument with a connectorised end-cap

5.2 Instrument interface

The RBR standard instruments provide an internal USB-C port and, depending on the end-cap type, an external MCBH-6-MP connector.

ⓘ Refer to Opening and closing the instrument for details on accessing connection ports.
Refer to Physical specifications for the external MCBH-6-MP connector pinout diagram.

USB-C connection

Remove the battery end-cap to access the USB-C port located inside the instrument body.

A USB-C desktop cable is supplied in the instrument support kit. Use this cable to download data from the instrument to your computer.

Mini-display port

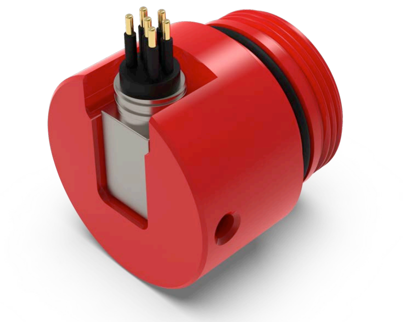
The mini-display port is located next to the USB-C port. This is the port to use for the umbilical cable from the connectorised end-cap.

End-cap types

RBR standard instruments are compatible with three different end-caps. These end-caps are interchangeable between instruments.

Standard end-cap

Connectorised end-cap



Right-angle connectorised end-cap

MCBH connectors

Only connectorised battery end-caps have the external MCBH-6-MP connector. Depending on your needs, they may be wired to support the USB, RS-232, or RS-485 communication (selected at the time of order).

.

MCBH connectors

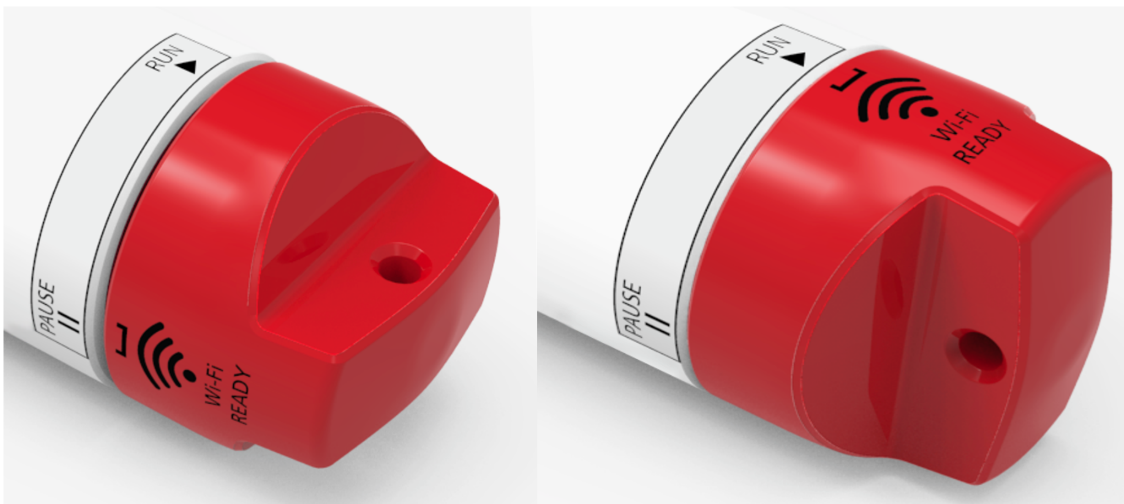
ⓘ Patch cables and underwater extension cables are sold separately. See RBR Cable Guide for details.

5.3 Twist activation

Sampling

Twist activation allows you to start or pause the instrument without the need to connect to a computer. All RBR Generation[3] standard instruments are equipped with twist activation as a standard feature. See Ruskin User Guide: Standard Instruments[3].

When you select "Twist activation" in Ruskin, the instrument starts to sample based on the twist **PAUSE**/**RUN** position rather than a schedule. To start sampling, first click "Enable" in Ruskin to enable logging. The status will then become "Paused". Turn the battery end-cap to the **RUN** position. The instrument will vibrate with one long pulse and start sampling. To pause it, turn the battery end-cap to the **PAUSE** position. The instrument will vibrate with three short pulses to indicate it has paused logging.



Twist activation mode

Wi-Fi

Twist activation allows you to connect to the instrument over the Wi-Fi when using a mobile device. Instruments equipped with a Wi-Fi module have the **WI-FI READY** icon on the end-cap. This module needs to be enabled at the time of purchase. Contact RBR if you have any question about this feature.

You can activate the Wi-Fi by twisting the end-cap in either direction. The WI-Fi will stay on for 60 seconds, waiting for you to connect. See Ruskin User Guide: Standard Instruments[3] for the required steps.

> ⚠ The Wi-Fi is disabled after 60 seconds of inactivity. Twist the end-cap to **RUN** or **PAUSE** to re-activate the Wi-Fi.

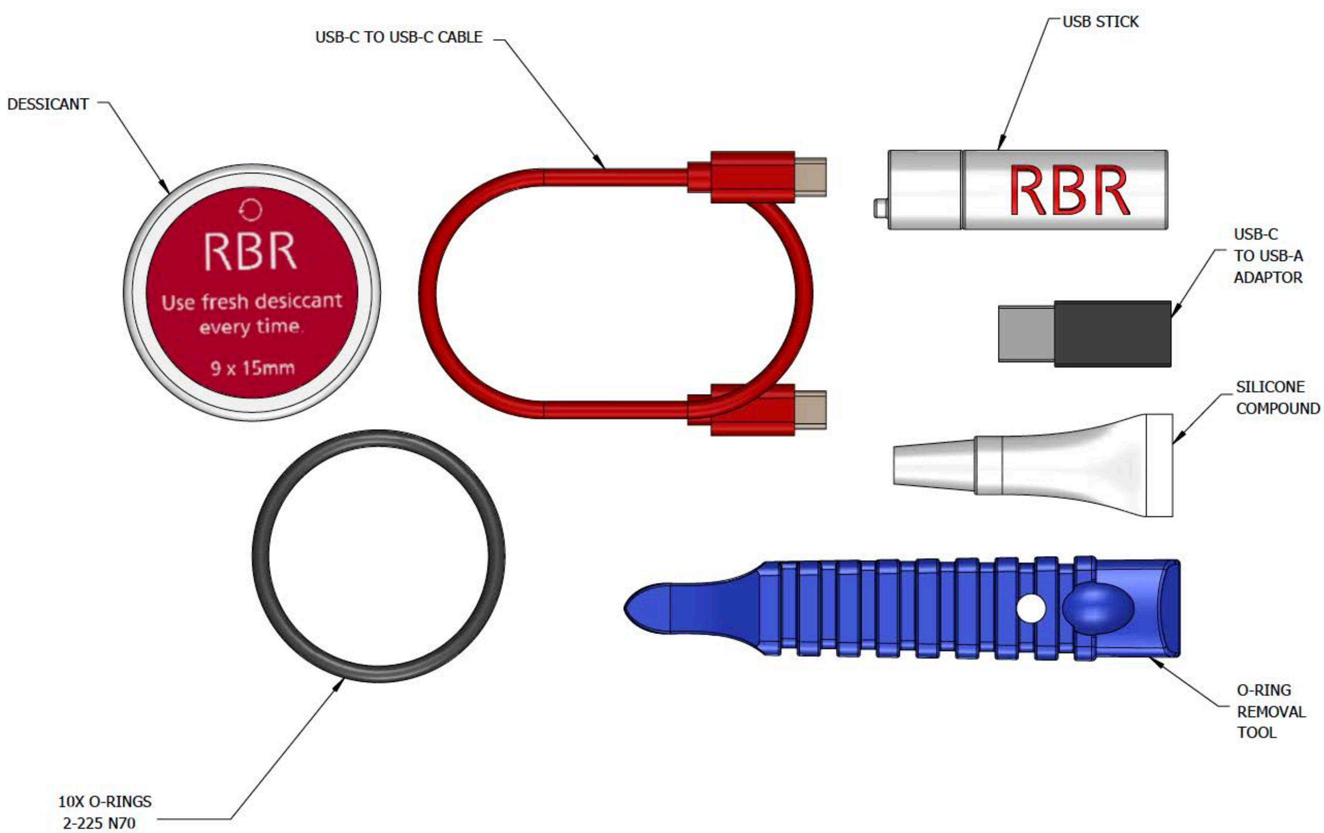
> ⚠ Twisting the end-cap to the **RUN** or **PAUSE** position will activate the Wi-Fi. However, twisting to the **PAUSE** position will also pause the instrument, as described above.

6 Maintenance

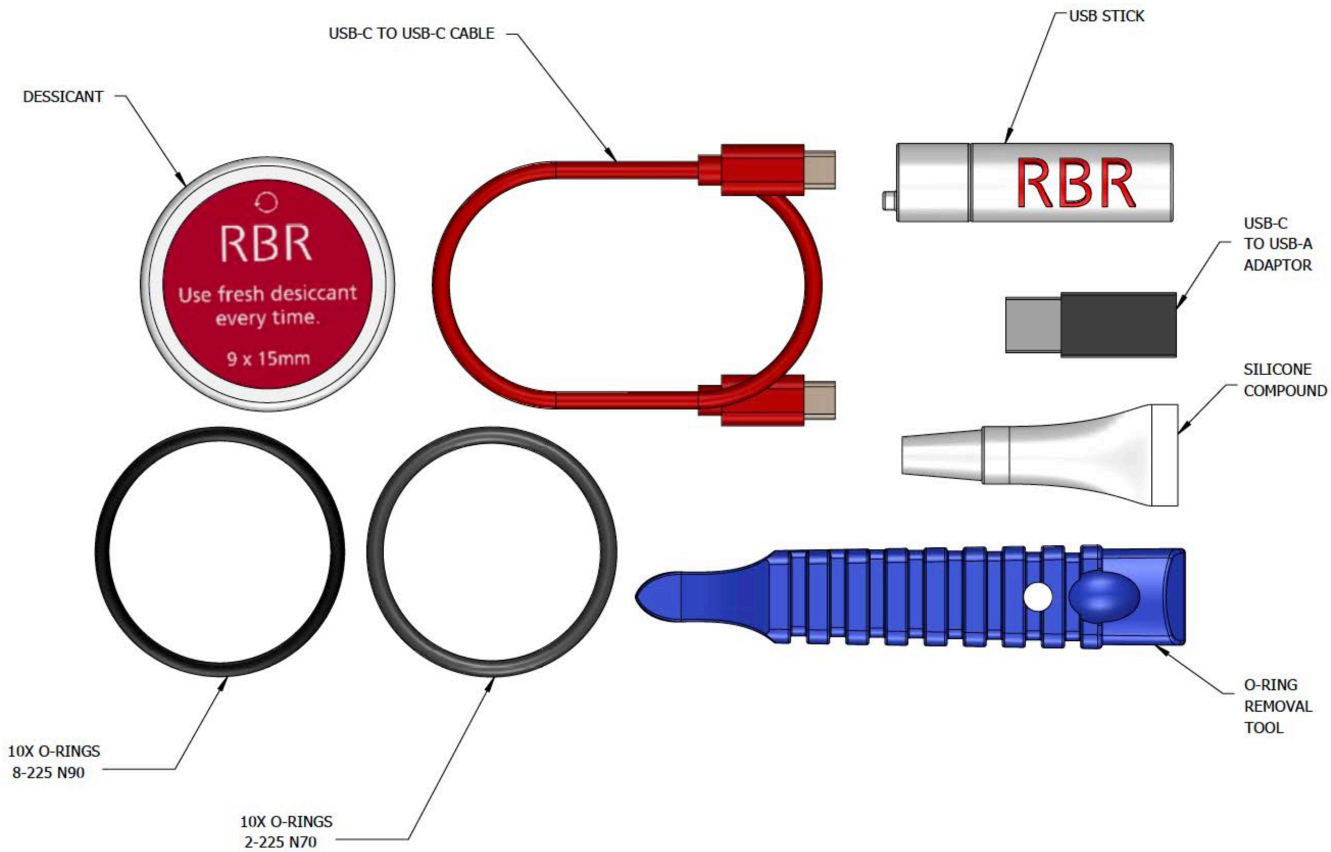
6.1 Support kits

RBR provides one support kit per every three instruments ordered. If you need more units, contact RBR.
There are two types of RBR support kits for standard instruments, for the ones in plastic housing and for those in titanium. The difference is the O-rings included in the support kit. Instruments in titanium housing are used for deep deployments and must endure harsher conditions. An additional O-ring serves as a backup protection from flooding.

The RBR support kits contain an assortment of basic accessories and spare parts, as presented below.



RBR support kit diagram (for plastic)



RBR support kit diagram (for titanium)

See Replacing the O-rings for more information on the | deep variants.

6.2 Replacing the O-rings

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

Care for the O-ring 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-ring, not the end-cap tightness. Therefore, proper O-ring maintenance is crucial.

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

Location of the O-ring

To access the O-ring, open the instrument.

Inspecting the O-ring

Visually inspect the new O-ring for nicks and scratches before installing it. Pay attention to the following areas:

- The surface of the O-ring itself
- 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.

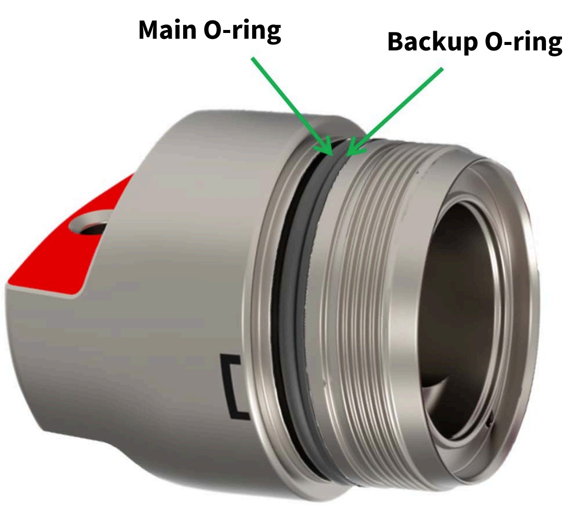
Replacing the O-ring

> Do not use metal screwdrivers or any other metal tool! They may scratch the O-ring groove and render the end-cap useless.

1. Use the plastic O-ring removal tool (included in the support kit) to remove the old O-ring from its 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 with a soft, lint-free cloth and compressed air, if necessary.
3. Select a new O-ring and inspect it for damage.
4. Lubricate with a very light film of silicone compound (included in the support kit).
5. Install the new O-ring by pushing it into place and popping it into its groove.
6. Once in place, inspect it once more for scratches and debris, and wipe away any silicone compound deposited on the end-cap.
7. Close the instrument.

O-rings on | deep variants

The | deep variants of standard 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. To access the O-rings, open the instrument.



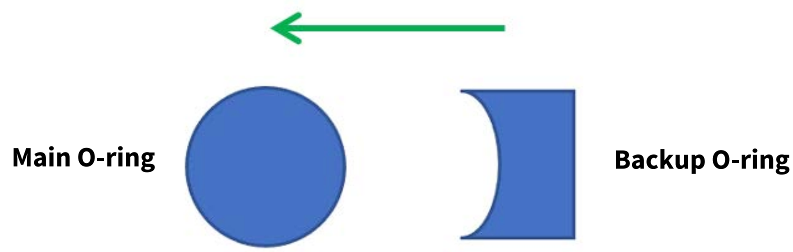
Location of the O-rings, | deep

Orienting the O-rings on | deep variants

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

6.3 Replacing the batteries

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: Standard Instruments[3] for more information on predicting battery life.

RBR standard instrument with batteries removed

Replacing the batteries

1. Remove the battery end-cap.
2. Using both thumbs, press down on the "+" symbols on the battery cover and slide in the direction of the arrow.
3. Remove the eight old batteries from the battery carriage.
4. Insert eight new batteries.
5. Check for correct battery polarity.
6. Put the end-cap back on the instrument and twist clockwise until aligned with **PAUSE**.

6.4 Replacing the desiccant capsules

Replace desiccant capsules 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 desiccant capsules

1. Remove the battery end-cap.
2. Remove the used desiccant capsules from their sockets.
3. Insert fresh desiccant capsules into their sockets, face out.
4. Once all the capsules are secured, place the battery end-cap back in its place.
5. Put the end-cap back on the instrument and twist clockwise until aligned with **PAUSE**.

Location of the desiccant capsules

Direction of insertion

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 Cables and connectors

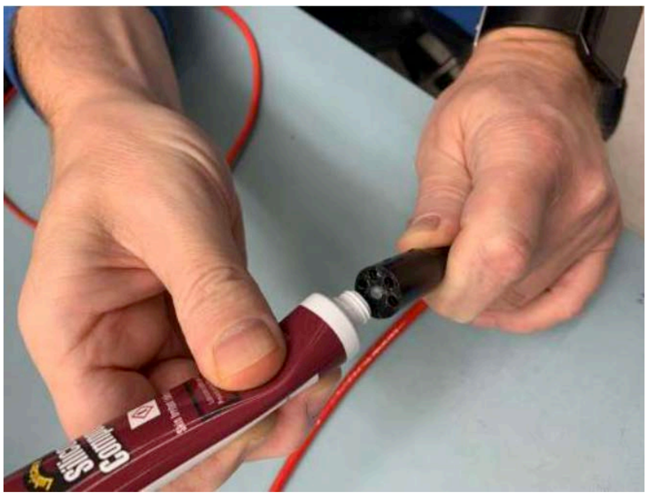
Cable bend radius

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



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

6.6 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.

6.7 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 re-calibrated.

Please contact RBR for our current calibration fees.

6.8 Repair

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-2022	Original