RBR*quartz*³ BPR|zero INSTRUMENT GUIDE

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1 RBR*quartz*^{3} BPR | zero

The RBR*quartz*^{3} BPR | zero is a special version of the robust RBR*quartz*^{3} BPR (Bottom Pressure Recorder) with the additional advantage of the AzeroA correction technique.

The instrument integrates one or two Paroscientific Digiquartz® pressure gauges, an internal quartz barometer, and a switching valve. It is the switching valve that provides *in situ* reference measurements to correct for the long term drift in the pressure gauge. The resulting drift is several hundred times lower than with uncompensated measurements.

The RBR*quartz*^{3} BPR | zero is intended for deep, long-term deployments where high stability and resolution of absolute pressure measurements are critical. Its applications include detection of natural disasters, such as avalanches, earthquakes, severe weather, tsunamis, and wake turbulence.

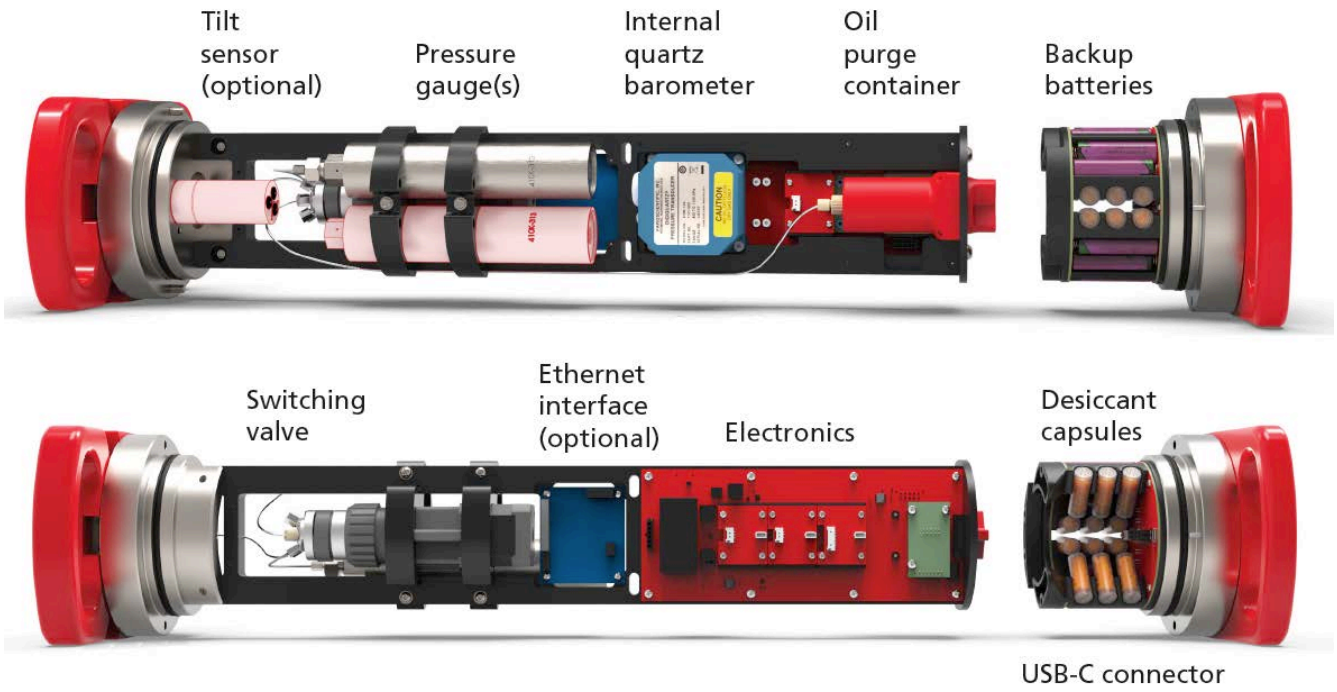
Key features of the RBR*quartz*^{3} BPR | zero are:

- AzeroA drift correction
- High accuracy
- Quartz stability
- Long deployments

Extend deployment times even further using external power supply from the RBR*fermata* (power) or the RBR*cervata* (power and memory) canisters. Alternatively, use an extension cable to connect the instrument to an observatory for external power and realtime data access. See RBR Cable Guide for options.

The RBR*quartz*^{3} BPR | zero may include an optional built-in tilt sensor (accelerometer).

For a detailed description of bottom pressure recording using the RBR*quartz*^{3} BPR | zero, see Ruskin User Guide: Standard Instruments[3].



RBR*quartz*^{3} BPR | zero

2 Specifications

Instrument

Specification	Description
Maximum number of readings*	~240 million
Power	Internal: 8 AA cells (for backup power only) External: 9.5V to 30V
Communications	Internal: USB-C External: RS-232, RS-485, or Ethernet
Clock drift	±60 second/year
Depth rating	7000m
Housing	Titanium
Diameter	~140mm
Length	~788mm
Weight (single Paroscientific unit, with batteries)	30Kg in air, 18Kg in water

*Each sample can include multiple readings.

Temperature sensor

Specification	Description
Range	-5 to 35°C*
Initial accuracy	±0.002°C
Resolution	0.00005°C
Typical stability	±0.002°C/year
Time constant	~3min

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

Pressure sensor

Specification	Description
Range*	1000 / 2000 / 4000 / 7000dbar
Initial accuracy	±0.01% full scale
Resolution**	10ppb (at 1Hz sampling rate)

*Exceeding the absolute maximum pressure will damage the instrument.
**Based on an integration time of ~750ms.

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. The internal batteries are sufficient to maintain sensor operation without the switching valve. The external power supply and cables shall support inrush currents of up to 4A at 24V input, for proper valve operation.

External power with voltage of 9.5V or higher is required to operate the switching value.

Clock

The instrument's clock is maintained during brief disconnections. This time is usually sufficient to change batteries.

USB-C power

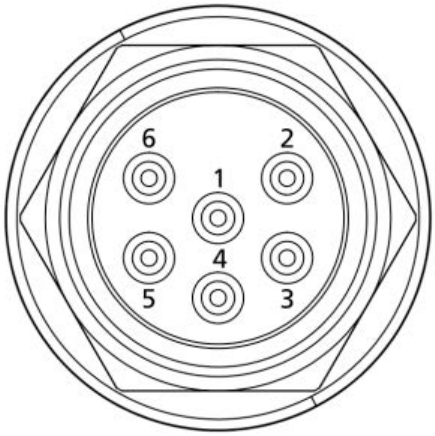
The USB-C cable provides power sufficient for configuration or data download. However, the instrument requires an internal or external power supply to perform sampling.

Deployment estimates

Deployment times are estimated for lithium thionyl chloride batteries based on both memory and internal battery capacity.

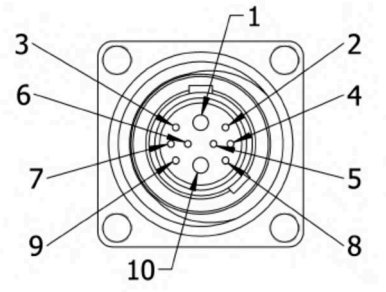
	Internal LTC batteries only (no valve operation)		**RBR*fermata* with LTC batteries (with the valve activated every 20 days)**	
Speed	**Time (days)**	**Number of samples**	**Time (days)**	**Number of samples**
8Hz	32	22M	75	45M
4Hz	32	11M	150	45M
2Hz	32	5.6M	300	45M
1Hz	32	2.8M	610	45M

External MCBH-6-MP connector pinout



Pin No.	USB	RS-232	RS-485	Ethernet
1	Ground			
2	Power 9.5V to 30V			
3	N/C	Data output from the instrument (Tx)	TD (A)-	Data output from the instrument (Tx-)
4	VUSB +5V	Data input into the instrument (Rx)	RD (B)+	Data input into the instrument (Rx+)
5	D-	N/C	RD (A)-	Data input into the instrument (Rx-)
6	D+	N/C	TD (B)+	Data output from the instrument (Tx+)

External MINK-10-FCR connector pinout



Pin No.	RS-232	RS-485	Ethernet
1	Power 9.5V to 30V		
2	N/C	RD(A)	Data output from the instrument (Tx+)
3	N/C	N/C	Data input into the instrument (Rx+)
4	Data output from the instrument (Tx)	RD(B)+	Data output from the instrument (Tx-)
5	Ground		
6	Data input into the instrument (Rx)	TD(B)+	N/C
7	N/C	N/C	Data input into the instrument (Rx-)
8	N/C		
9	N/C	TD(A)-	N/C
10	Ground		

3 Hardware

3.1 Opening and closing the instrument

⚠ When opening the instrument, make sure to keep the O-rings clean and avoid scratching the O-ring mating surfaces.

Opening the instrument

1. Place the RBR*quartz*^{3} BPR | zero vertically with the battery end-cap up and the sensor end-cap down. Alternatively, you can lay it on the side.
2. Unscrew and remove the two cap screws using a 5mm hex key.
3. Rest the battery end-cap on the side of the instrument, as shown.

Locations of cap screws

Open instrument, with the end-cap resting on the side

Disconnecting the umbilical cable

1. Locate the small latch on the side of the connector.
2. Press the latch with your thumb and pull the connector down.
3. Set the battery end-cap aside.

> Do not pull on the wires attached to the connector!

Closing the instrument

1. If disconnected, insert the umbilical cable back in its socket.
2. Align the battery end-cap with the slot on the instrument housing and gently push down to ensure it fits in place.
3. Reinstall the two cap screws and tighten to 1/4 turn past tight (10Nm max).

3.2 RBR*quartz*^{3} BPR | zero interface

The RBR*quartz*^{3} BPR | zero instrument provides an internal USB-C port and several external communication options. Select from RS-232, RS-485, and Ethernet at the time of order, and RBR will wire the battery end-cap to support your preferred external connection.

> Patch cables and underwater extension cables are sold separately.

USB-C connection

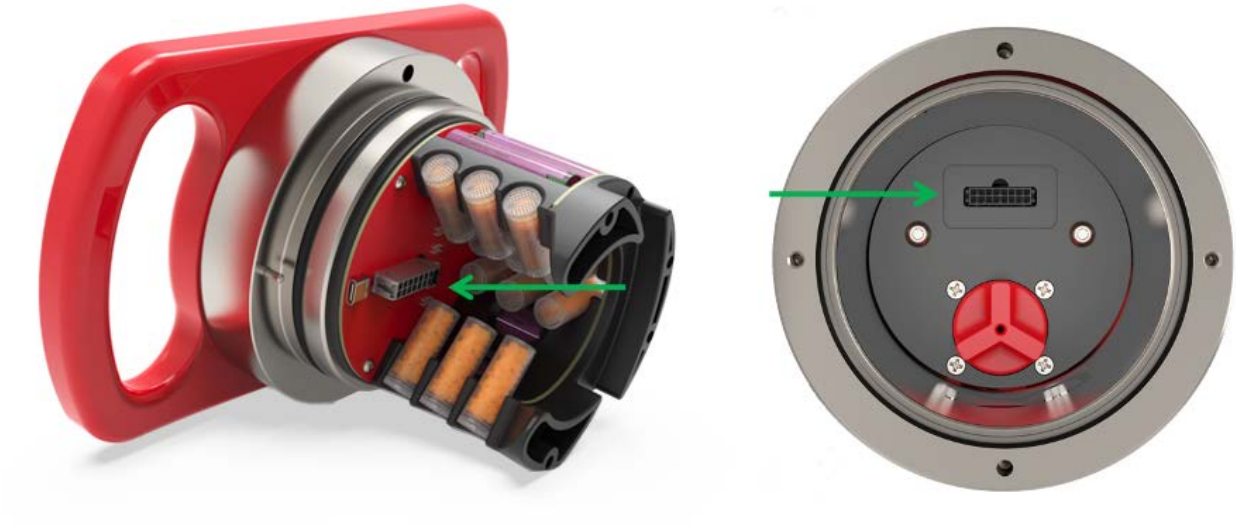
The USB-C port is located under the battery end-cap.

USB-C port

> Refer to Opening and closing the instrument for details on accessing the internal USB-C port.

Umbilical connection

The umbilical cable connects the RBR*quartz*^{3} BPR | zero to the connectorised end-cap. There are two ports: one under the end-cap and one inside the instrument.



Umbilical ports

End-cap types

The RBR*quartz*^{3} BPR | zero battery end-caps may support a MINK-10-FCR connector, two MINK-10-FCR connectors, or two MCBH-6-MP connectors, depending on the type.

Dual MINK battery end-cap **MINK battery end-cap** **Dual MCBH battery end-cap**

Refer to Specifications for the external connector pinout diagrams.

3.3 Orientation and datum location

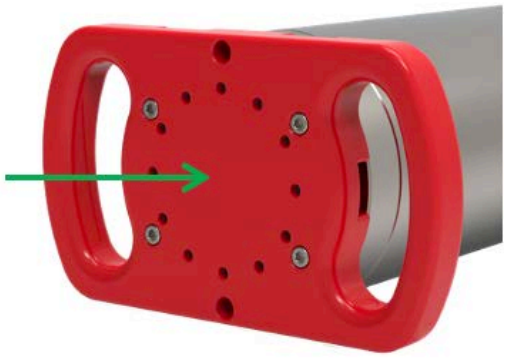
Vertical deployment (recommended)

RBR performs an offset adjustment with the pressure sensor facing downwards, as shown in the first image. It is recommended to deploy the instrument vertically to match the way it was calibrated.

When deployed vertically, the datum for the pressure measurements for the RBR*quartz*^{3} BPR | zero is located at the centre of the pressure sensor port, at the lowest surface of the instrument.

> Avoid deploying the instrument vertically with the sensor end-cap up! Such orientation will affect performance of the pressure sensor due to increased build-up of sediment.

Recommended orientation: sensor end-cap down



Datum location

Horizontal deployment

It is acceptable to deploy the RBR*quartz*³ BPR | zero horizontally if necessary. Note that, with the instrument on its side, there will be a significant change to the datum due to the internal head values. Assess the correct offset to your preferred datum point before deployment.

3.4 Deployment extenders

Extend deployment times even further using external power supply from the RBR*fermata* (power) or the RBR*cervata* (power and memory) canisters.

RBRfermata

RBR offers optional battery canisters which can extend deployment of any underwater instrument.

The RBR*fermata* automatically configures the internal arrangement of batteries to provide a nominal 14V or 28V output, regardless of cell voltage or chemistry, supplying up to 2.8kWh of energy. This is about forty times greater than our standard battery carriage capacity.

A built-in resettable fuse ensures overcurrent protection, resetting automatically after a fault. The end-cap features three mounted MCBH connectors, and the battery pack design accommodates 48 individual D-cells.

An innovative battery carrousel coupled with quick-release handles facilitates simple, tool-free battery replacement. A variant with low-profile handles is available for flexible integration with the Wirewalker (DMO).

RBR*fermata* (low-profile handles)

RBR*fermata* | deep (quick-release handles)

See RBRfermata Underwater Battery Canister Guide for more information.

RBRcervata

The RBR*cervata* is the fusion of the RBR*fermata* underwater battery canister with the RBR*cervello* data controller, designed to support RBR standard instruments. With its 3.3kWh capacity (when using Li batteries) and 128GB of external memory, it may add up to four years to deployment times. The 56 D-cell battery pack provides a nominal 12V output.

Your RBR*quartz*^{3} BPR | zero can be connected to or disconnected from the RBR*cervata* at any time. Power delivery to an attached instrument is constant, regardless of the state of the data controller, including during deep sleep mode. The RBR*cervata* downloads the data from your instrument to its memory card at set intervals. It also facilitates advanced deployment management: reconfiguring the instrument, synchronising the realtime clock, and rotating the memory to accommodate longer deployments.

The RBR*cervata* comes with either three MCBH connectors or a combination of MINK and penetrators, and is equipped with the same resettable fuse and pressure release valve as the RBR*fermata*.

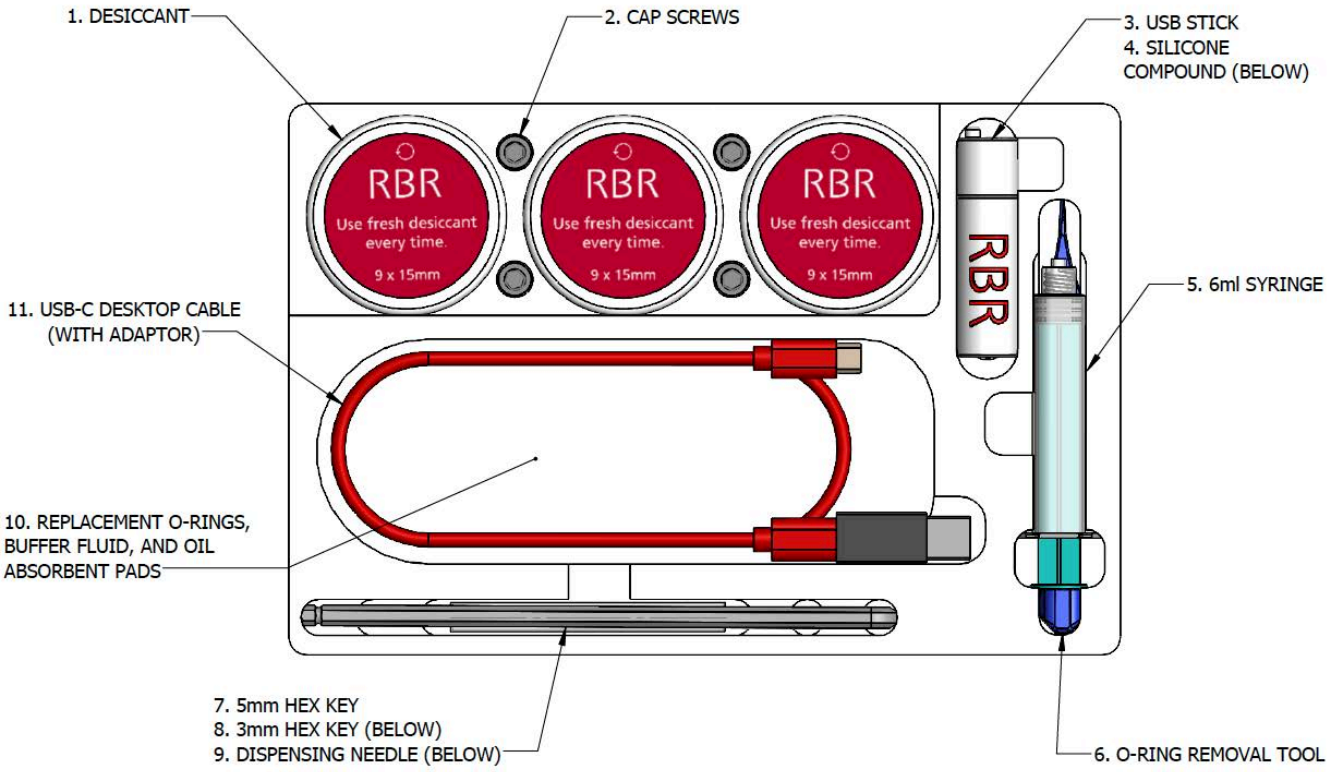
4 General maintenance

4.1 Support kit

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

RBR*quartz*^{3} BPR | zero support kit

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



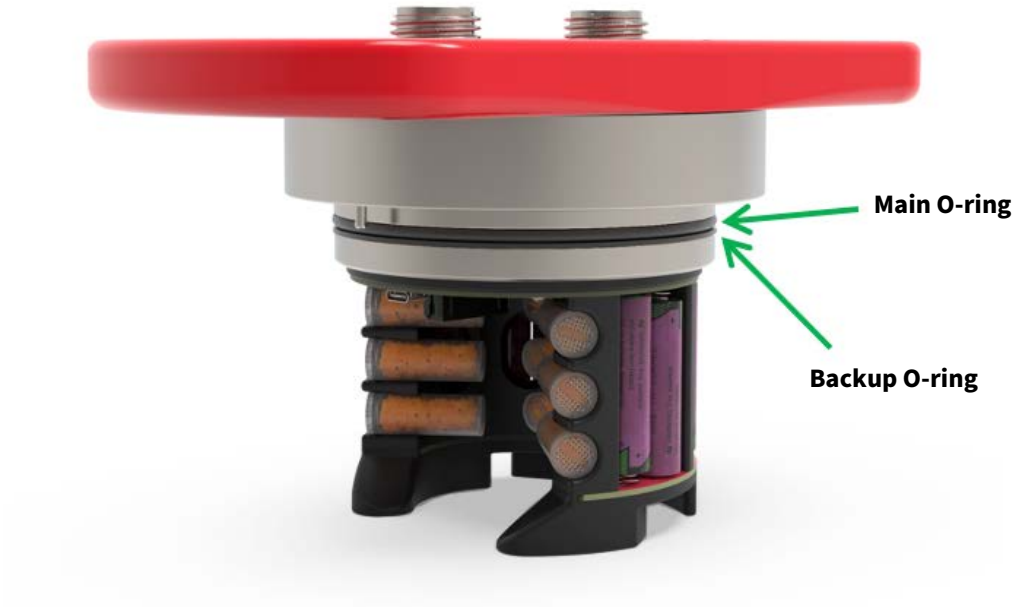
RBR*quartz*^{3} BPR | zero support kit diagram

4.2 Replacing the O-rings

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, not the end-cap tightness. Therefore, 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.

The RBR*quartz*^{3} BPR | zero uses 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

Inspecting the O-rings and mating surfaces

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 O-rings:

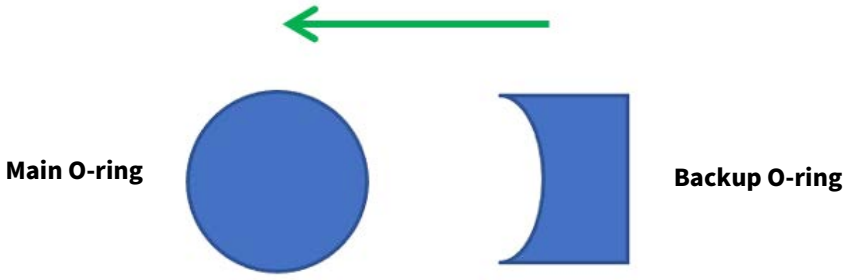
- Avoid using any object that could scratch the O-ring or any of its mating surfaces.
- If dirt is present in the O-ring groove, remove the O-ring as described below and thoroughly clean the groove.
- Do not return this old O-ring to the instrument! If you remove the O-ring from the instrument for any 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

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 tool (included in 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 with a soft, lint-free cloth and compressed air, if necessary.
3. Select the proper O-rings and inspect it for damage.
4. Lubricate with a very light film of silicone compound (included in the support kit).
5. Install the main O-ring by pushing it into place 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 end-cap.
8. Once the inspection is complete, close the instrument.

4.3 Replacing the batteries

RBR ships new instruments with lithium thionyl chloride batteries included. Replace batteries before each deployment to maximise the operational time and prevent data loss.

Ruskin software estimates the remaining battery life during deployment by tracking power consumption in mAh. When setting up your deployment on Ruskin, check "Fresh" to indicate that new batteries are installed.

If using the same batteries for a subsequent deployment, do not check "Fresh" and continue power tracking from the previously recorded level.

See Ruskin User Guide: Standard Instruments[3] for more information on predicting battery life.

Replacing the batteries

1. Remove the battery end-cap. See Opening the instrument.
2. Remove the eight old AA-type cell batteries.
3. Insert eight new AA-type cell batteries.
4. Check for correct battery polarity.
5. Return the end-cap back in its place. See Closing the instrument.

Location of the batteries

Always remove the batteries from your instrument during long-term storage!
Doing so will prevent internal damage due to battery leakage and/or corrosion.

4.4 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 the desiccant capsules

1. Remove the battery end-cap. See Opening the instrument.
2. Locate the desiccant holder inside the battery end-cap.
3. Remove the used desiccant capsules from their sockets.
4. Insert fresh desiccant capsules into their sockets.
5. Once all the capsules are secured, insert the battery end-cap back in its place. See Closing the instrument.

Location of the desiccant capsules

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.

4.5 Cables and connectors

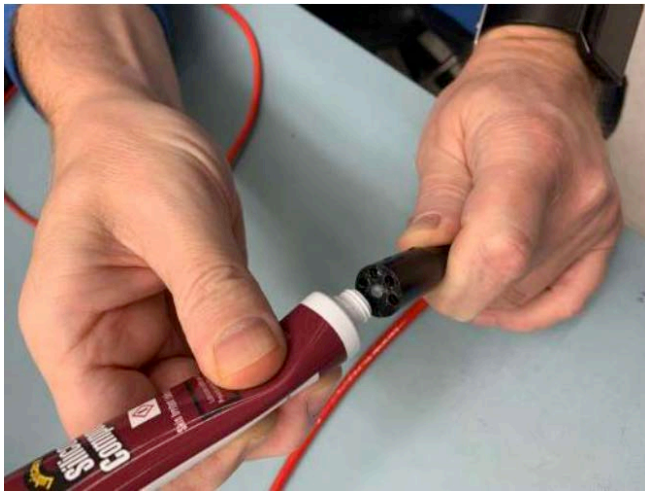
Cable bend radius

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

4.6 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).
Sensor antifouling mesh	Scrub the antifouling mesh with a soft brush. Replace the antifouling mesh if needed.	See instructions on removing the antifouling mesh for more information.
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.

4.7 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 recalibrated.

Please contact RBR for our current calibration fees.

5 Oil purge container maintenance

The RBR*quartz*^{3} BPR | zero uses one or two Paroscientific Digiquartz® sensors, with AzeroA drift correction.

A switching valve facilitates reference measurements of internal housing pressure. These data are monitored by an internal quartz barometer which corrects the drift of the sensors over time. Activation of the switching valve pushes a small amount of buffer oil out of the buffer tube into the housing, where it is captured in the oil purge container.

By cleaning the container and replacing the absorbent pad after each deployment you will maintain the pressure sensor accuracy and extend its life.

ⓘ All required materials for this procedure are provided in the support kit.

Required materials

- 5mm hex key
- O-ring
- Silicone compound
- Replacement absorbent pads

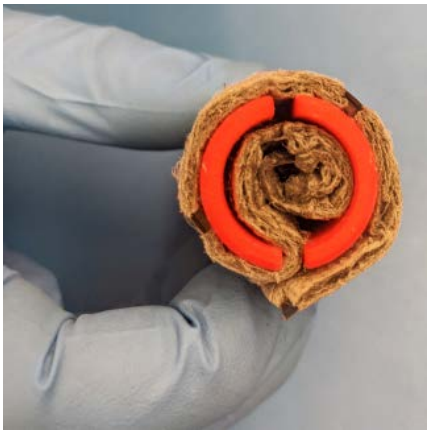
Recommended handling materials

- Latex or nitrile gloves
- Eye protection
- Protective coat

⚠ Buffer oil is not a hazardous substance, but it is recommended to practice good industrial hygiene and safety practices, and to use this material in a well-ventilated space.

Cleaning the oil purger container

Step	Description	Image
1	Unscrew the battery end-cap and remove the umbilical cord (see Opening and closing the instrument)	
2	Remove the container 1. Turn the red handle counterclockwise at least one full rotation 2. Pull the handle out, with the container	

Step	Description	Image
3	Remove the absorbent pad contaminated with buffer oil ⚠ Dispose the contaminated pad in accordance with local regulations.	
4	Replace the O-ring on the oil purge container (see Replacing the O-rings for details on handling O-rings)	
5	Replace the absorbent pad 1. Roll one side of a clean pad and insert it into the container's central compartment, letting the rest of the pad out through the slit on the side 2. Wrap the remaining pad around the container going clockwise once 3. If any length of the pad is left, loosen it so that there is only one full layer wrapped around the container (any additional layers will make it difficult to insert)	
6	Reinstall the container 1. Hold the pad so that it does not unravel 2. Insert the container back into the instrument 3. Turn the red handle clockwise one full rotation	
7	Return the battery end-cap back onto the instrument (see Opening and closing the instrument)	

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.

7 Revision history

Revision No.	Release date	Notes
A	04-May-2020	Initial release.
B	30-November-2021	Updated Specifications, Hardware, General maintenance, Pressure sensor maintenance, and Repair sections. Added information on the external pressure adaptor kit, removing the oil bladder, and servicing the valve. Removed the Warranty section (available on the RBR website) and Appendices. Minor updates throughout the document.
C	11-August-2023	Added a link to RBR Cable Guide on the introductory page. Added a note on the pressure sensor integration time and updated power requirements for valve operation in the Specifications section. Added guidance on horizontal deployment to the Orientation and datum location section. Renamed the Underwater Battery Canister section (now Deployment extenders) and added a subsection on the RBR*cervata*. Added a warning to the Replacing the batteries section. Updated the Replacing the desiccant capsules section.