RBR SENSORS

RBR*coda*
RBR*coda*^{3}

INSTRUMENT GUIDE

rbr-global.com

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1 RBR sensors

The RBR*coda* and RBR*coda*^{3} small smart sensors (Fig. 1), as well as multi-channel sensors RBR*tridente* and RBR*quadrante*, are a family of cabled instruments with high accuracy, low power consumption, and ability to endure harsh conditions. These realtime streaming sensors are easy to integrate into any RBR multi-parameter instrument, or connect directly via RS-232. Attach an MCIL connector with serial and power lines, and the data will stream.

The RBR sensors are a perfect choice for many oceanographic and limnology applications where realtime streaming of data is desired, such as borehole monitoring, remotely operated underwater vehicles, stream gauging, or harbour water levels. These completely sealed units are available in plastic or titanium housings to accommodate shallow or deep deployments. Select from several sampling variants, such as | fast8, | fast16, | fast32, and | tide16, depending on your needs.

> The RBR*coda*^{3} D | tide16 and RBR*coda*^{3} T.D | tide16 take averages of pressure readings over extended periods of time, providing accurate tide level data.

> The RBR*quadrante*, RBR*tridente,* and RBR*coda* Tu support aggregate sampling mode, where measurement bursts are taken over a selected period.

Shallow variants

- RBR*coda*^{3} D: pressure (depth)
- RBR*coda*^{3} T: temperature
- RBR*coda*^{3} T.D: temperature, pressure
- RBR*coda* DO (OxyGuard®): dissolved oxygen
- RBR*coda* PAR: photosynthetically active radiation
- RBR*coda* rad: narrow-band light radiation
- RBR*coda* PAR (LI-COR®): photosynthetically active radiation

Deep variants

- RBR*coda*^{3} D | deep: pressure (depth)
- RBR*coda*^{3} T | deep: temperature
- RBR*coda*^{3} T.D | deep: temperature, pressure
- RBR*coda* ODO: temperature, optical dissolved oxygen
- RBR*coda* OpH: temperature, optical pH
- RBR*coda* Tu: turbidity
- RBR*coda* chl-*a:* chlorophyll-*a*
- RBR*coda* PAR | deep: photosynthetically active radiation
- RBR*coda* rad | deep: narrow-band light radiation

Fig. 1. The RBRcoda and RBRcoda^3 small smart sensors

> The RBR*coda* ODO, RBR*coda* OpH, RBR*coda* chl-*a,* and RBR*coda* Tu are only available as a deep variant in titanium housing.

> For multi-channel sensor variants, see the dedicated RBR*tridente* and RBR*quadrante* Instrument Guide.

2 Specifications

The RBR smart realtime sensors have highly competitive specifications. They are designed for streaming data via RS-232 cable and thus have no onboard memory. Most have only one channel, but some include two. For details of each sensor refer to the individual pages for the RBR*coda*^{3} D, RBR*coda*^{3} T, RBR*coda*^{3} T.D, RBR*coda* ODO, RBR*coda* OpH, RBR*coda* chl-*a*, RBR*coda* Tu, and RBR*coda* PAR / RBR*coda* rad, as well as our instruments with third-party sensors, the RBR*coda* DO (OxyGuard) and the RBR*coda* PAR (LI-COR®).

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

2.1 RBRcoda^3 D

The RBR*coda*^{3} D and RBR*coda*^{3} D | deep (Fig. 2) use the piezoresistive pressure sensors.

The sensor is protected by a clear plastic guard. During deployments, always orient the sensor downwards to reduce debris collecting in the housing.

Fig. 2. RBRcoda^3 D and RBRcoda^3 D | deep

Pressure

Parameter	Value
Range	20 / 50 / 100 / 200 / 500 / 1000dbar (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

Physical

Parameter	Value
Connector	MCBH-6-MP
Communications	RS-232
Housing	Plastic or titanium

Parameter	Value
Diameter	25mm
Length	~200mm (~235mm with connector)
Weight	170g in air, 70g in water (plastic) 370g in air, 270g in water (Ti)
Depth rating	Up to 1000m (plastic) Up to 6000m (Ti)
Sampling rate	2Hz standard, 8Hz | fast8, 16Hz | fast16, | tide16 32Hz | fast32

Power

Parameter	Value
Supply voltage	6V to 18V (12V nominal)
Power	10mA (120mW)

Calibration equations

Raw pressure

$$P_{raw} = C_0 + C_1 \cdot VR + C_2 \cdot VR^2 + C_3 \cdot VR^3$$

where:

$C_0 - C_3$ are unit-specific calibration coefficients determined in the laboratory.

VR is the measured Voltage Ratio

Temperature compensated pressure

$$P_{meas} = Pcal + \frac{(P_{raw} - P_{cal}) - X_1 \cdot (T_{pres} - Tcal) - X_2 \cdot (T_{pres} - Tcal)^2 - X_3 \cdot (T_{pres} - Tcal)^3}{1 + X_4 \cdot (T_{pres} - Tcal)}$$

where:

P_{raw} is the uncorrected pressure

P_{cal} is the nominal pressure while performing the temperature calibration segment (stored as "X0" in the instrument)

T_{pres} is the temperature of the pressure sensor

$Tcal$ is the average temperature during the room-temperature pressure calibration run (stored as "X5" in the instrument).

$X_1 - X_4$ are unit-specific calibration coefficients determined in the laboratory

2.2 RBRcoda³ T

The RBR*coda*³ T and RBR*coda*³ T | deep use the same thermistor-type temperature sensor. The thermistor on the RBR*coda*³ T | slow | deep is embedded, making the sensor extremely robust and deployable in the most challenging environments, such as boreholes and industrial settings. Fig. 3 illustrates the three models.

Fig. 3. RBRcoda³ T, RBRcoda³ T | deep, and RBRcoda³ T | slow | deep with embedded thermistor

Temperature

Parameter	Value
Range[1]	-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

[1]A wider temperature range is available upon request. Contact RBR for more information

Physical

Parameter	Value
Connector	MCBH-6-MP
Communications	RS-232
Housing	Plastic or titanium
Diameter	25mm
Length	~210mm (~245mm with connector) ~195mm (~230mm with connector) | slow | deep
Weight	160g in air, 60g in water (plastic) 390g in air, 280g in water (Ti)

Parameter	Value
Depth rating	Up to 1700m (plastic) Up to 6000m (Ti)
Sampling rate	1Hz | slow, 2Hz standard 8Hz | fast8, 16Hz | fast16, 32Hz | fast32

Power

Parameter	Value
Supply voltage	6V to 18V (12V nominal)
Power	10mA (120mW)

Calibration equations

Temperature

$$T_m = \ln\left(\left(\frac{1}{V}\right) - 1\right)$$

$$T_c = \frac{1}{(C_0 + C_1 T_m + C_2 T_m^2 + C_3 T_m^3)} - 273.15$$

where:

T_m = Intermediate variables

V = Raw temperature channel voltage ratio output (unique with each individual measurement)

C_0 = Cubic function regression calibration coefficient

C_1 = Cubic function regression calibration coefficient

C_2 = Cubic function regression calibration coefficient

C_3 = Cubic function regression calibration coefficient

T_c = Temperature in celsius

2.3 RBRcoda³ T.D

The RBR*coda*³ T.D and RBR*coda*³ T.D | deep (Fig. 4) use the thermistor-type temperature sensors and piezoresistive pressure sensors. The pressure sensor is protected by a clear plastic guard.

Fig. 4. RBRcoda³ T.D and RBRcoda³ T.D | deep

Temperature

Parameter	Value
Range[1]	-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

[1]A wider temperature range is available upon request. Contact RBR for more information.

Pressure

Parameter	Value
Range	20 / 50 / 100 / 200 / 500 / 1000dbar (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

Physical

Parameter	Value
Connector	MCBH-6-MP
Communications	RS-232
Housing	Plastic or titanium
Diameter	25mm
Length	~265mm (~300mm with connector)
Weight	190g in air, 70g in water (plastic) 390g in air, 280g in water (Ti)

Parameter	Value
Sampling rate	2Hz standard 8Hz | fast8 16Hz | fast16, | tide16 32Hz | fast32

The depth rating of the RBR*coda*³ T.D and RBR*coda*³ T.D | deep instruments is determined by the depth rating of the pressure sensor installed. For example, the RBR*coda*³ T.D in plastic housing with a 200dbar pressure sensor cannot be used at depths greater than 200m, even though the temperature sensor is rated at 1700m.

Power

Parameter	Value
Supply voltage	6V to 18V (12V nominal)
Power	10mA (120mW)

2.4 RBRcoda ODO

The RBR*coda* ODO (Fig. 5) uses the optical dissolved oxygen sensor, with three time constant options available: 1s, 8s, and 30s. The | fast (1s time constant) variant is well suited for profiling applications. The | slow (30s time constant) version has a protective layer to facilitate automated cleaning by a wiper to keep it free from biofouling during long-term moored deployments.

During deployments, always orient the sensor downwards to reduce debris collecting at the aperture and minimise exposure to 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.

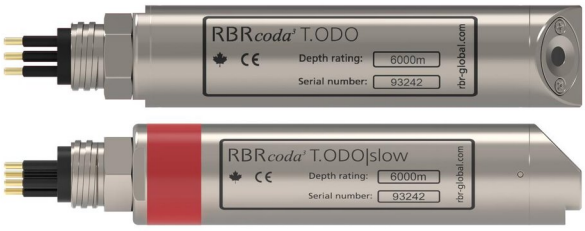


Fig. 5. RBRcoda ODO | fast and RBRcoda ODO | slow

Dissolved oxygen

Parameter	Value
Measurement range	0-1000µmol/L
Calibrated range Concentration Saturation Temperature	 0-500µmol/L 0-120% 1.5 to 30°C
Initial accuracy For | fast For standard, | slow	 Maximum of ±8µmol/L or ±5% Maximum of ±2µmol/L or ±1.5%
Resolution For | fast For standard For | slow	 <1µmol/L (saturation 0.4%) <0.5µmol/L (saturation 0.2%) <0.1µmol/L (saturation 0.04%)
Time constant	<1s | fast, <8s standard, <30s | slow

Optical dissolved oxygen measurements require pressure correction for highest accuracy. When installed on an instrument with a pressure sensor, this correction is done automatically.
If deployed as a standalone sensor or installed on a moored instrument with no pressure sensor, enter the known absolute pressure value manually in the table under the **Parameters** tab in Ruskin.

Temperature

Parameter	Value
Range[1]	-5°C to 35°C
Initial accuracy	±0.002°C
Resolution	<0.00005°C
Typical stability	±0.002°C / year
Time constant	<1s

[1]A wider temperature range is available upon request. Contact RBR for more information.

Physical

Parameter	Value
Connector	MCBH-6-MP
Communications	RS-232
Housing	Titanium
Diameter	28mm
Length	~125mm, (~160mm with connector)
Weight	180g in air, 110g in water
Depth rating	Up to 6000m
Sampling rate	24hr to 1Hz

Power

Parameter	Value
Supply voltage	7V to 15V (12V nominal)
Power	10mA for 300ms (36mJ/sample) | fast 10mA for 300ms (36mJ/sample) standard 10mA for 500ms (60mJ/sample) | slow
Sleep current	60µA

Output values

- Temperature (°C)
- Dissolved O_2 concentration (µmol/L)
- Dissolved O_2 concentration (salinity compensated, µmol/L)
- Dissolved O_2 saturation (%)
- Dissolved O_2 phase (°)

Calibration equations

Uncompensated concentration

Corrected phase shift

$$\phi = c_2 + c_3\phi_{corrected}$$

Concentration in µMol/L

$$\begin{aligned} C(t,\phi) = {} & c_4 + c_5 t + c_6 t^2 + c_7 t^3 \\ & + c_8 \phi + c_9 \phi t + c_{10} \phi t^2 + c_{11} \phi t^3 \\ & + c_{12} \phi^2 + c_{13} \phi^2 t + c_{14} \phi^2 t^2 + c_{15} \phi^2 t^3 \\ & + c_{16} \phi^3 + c_{17} \phi^3 t + c_{18} \phi^3 t^2 + c_{19} \phi^3 t^3 \\ & + c_{20} \phi^4 + c_{21} \phi^4 t + c_{22} \phi^4 t^2 + c_{23} \phi^4 t^3. \end{aligned}$$

Linear adjustment of the uncorrected concentration

$$C_u = c_0 + c_1 C(t,\phi)$$

2.5 RBRcoda OpH

The RBR*coda* OpH (Fig. 6) is an optical pH sensor, which measures the response of a pH sensitive foil. It is best suited for mooring applications.

Fig. 6. An RBRcoda OpH sensor

During deployments, always orient the sensor downwards to reduce debris collecting at the aperture and minimise exposure to direct sunlight. Store the sensor dry, in the dedicated storage cap included with the instrument. Rehydrate for 24 hours before deployment. See RBR pH sensor care and maintenance for more information.

pH

Parameter	Value
Measurement range	7 to 9pH$_T$
Initial accuracy at 35PSU and atmospheric pressure [1]	±0.05pH within pH 7.5–9
Resolution	<0.003pH
Time constant [2]	<80s

[1] Salinity and pressure dependence is described in the Appendix (Section 7.1).

[2] Measured at 25°C.

Optical pH measurements require pressure and salinity correction for highest accuracy. When installed on an instrument with pressure and/or a conductivity sensor, these corrections are applied automatically.

If deployed as a standalone sensor or installed on a moored instrument without a pressure or conductivity sensor, manually enter the known absolute pressure and/or salinity value in the table under the **Parameters** tab in Ruskin.

Temperature

Parameter	Value
Range [1]	-5 to 35°C
Initial accuracy	±0.002°C
Resolution	<0.00005°C
Typical stability	±0.002°C / year
Time constant	<1s

[1] Foil should not be allowed to freeze.

Physical

Parameter	Value
Connector	MCBH-6-MP
Communications	RS-232
Housing	Titanium
Diameter	28mm
Length	~125mm, (~160mm with connector)
Weight	180g in air, 110g in water
Depth rating	Up to 6000m
Sampling rate	24hr to 2Hz
Operating temperature [1]	-5 to 35°C

[1] Foil should not be allowed to freeze.

Power

Parameter	Value
Supply voltage	4.5 to 30V (12V nominal)
Power	75mJ/sample (0.5Hz or slower) 4mA (48mW) (1Hz or faster)
Sleep current	10µA

Calibration equations

pH

$$pH = c5\,(1 + c4\,(T - 20))\,\log_{10}\left(\frac{c1\,(1 + c0\,(T - 20)) - R}{R - c3\,(1 + c2\,(T - 20))}\right) + c7 + c6\,(T - 20) + c8$$

pH corrected

$$pH_{corrected} = pH - \frac{1}{2}\,c0\left(\frac{\sqrt{S/50}}{1 + \sqrt{S/50}} - 0.2791745 - c1\left(\frac{S}{50} - 0.15\right)\right) - c2\,P$$

2.6 RBRcoda PAR, RBRcoda rad

The RBR*coda* PAR *and RBRcoda* rad instruments (Fig. 7) look identical and share several specifications.

Fig. 7. RBRcoda PAR and RBRcoda PAR | deep

The RBR*coda* PAR and RBR*coda* PAR | deep use the cosine photosynthetically active radiation sensors which can measure light within one hemisphere.

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

[1] RBR calibrates radiometers with NIST traceable references.

[2] Out-of-band rejection is wavelength-dependent for narrow-band radiometers.

PAR

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

Narrow-band channels

Parameter	Value
Centre wavelengths (CWL)[1]	380 / 413 / 445 / 475 / 488 / 508 / 532 / 560nm
Full width at half-maximum (FWHM)	10nm (25nm for CWL 475nm)
Full scale range	0 to 400µW/cm²/nm (minimum)
Resolution[2]	±0.001µW/cm²/nm

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

[2] Resolution is wavelength-dependent for narrow-band radiometers.

Dark offset is internally temperature-compensated.

Physical

Parameter	Value
Connector	MCBH-6-MP
Communications	RS-232
Housing	Plastic or titanium
Diameter	25mm
Length	~235mm (~270mm with connector)
Weight	170g in air, 40g in water (plastic) 330g in air, 200g in water (Ti)
Depth rating	Up to 1000m (plastic) Up to 2000m (Ti)
Sampling rate	Up to 16Hz

Power

Parameter	Value
Supply voltage	6 to 18V (12V nominal)
Power	77mJ per sample (1Hz or slower) 15mA (180mW) (2Hz or faster)

Calibration equations

PAR

$$\mathrm{PPF}_c = C_0 + C_1 * C_2 * (V + X_0 + X_1 * (T - X_3) + X_2 * (T - X_3)^2)$$

Irradiance

$$Irr_c = C_0 + C_1 * C_2 * (V + X_0 + X_1 * (T - X_3) + X_2 * (T - X_3)^2)$$

2.7 RBRcoda Tu

The RBR*coda* Tu (Fig. 8) is a realtime turbidity sensor with two independent optical channels for optimising linearity and sensitivity. Its high dynamic range permits exposure to full sunlight with very low detection limits, while power consumption and depth rating have been tailored for use in a wide variety of applications.

The turbidity channel of the RBR*coda* Tu ensures high sensitivity in the low range (0-1000FTU), while the optical backscatter channel is designed for high-turbidity applications (up to 20000FTU). RBR calibrates the optical backscatter channel to ensure the highest accuracy around and above 1000FTU, thus achieving alignment between these two channels through their intended measurement conditions.

All optical components of the RBR*coda* Tu are robust and durable, selected to minimise ageing due to UV/sunlight exposure, and thus show no change in properties over extended deployments. Its sapphire windows facilitate automated cleaning by a wiper to keep them free of biofouling during long-term moored deployments.

> When used as a standalone sensor, the RBR*coda* Tu has the additional capability to sample in aggregate mode. See Ruskin User Guide: Sensors for details.

Fig. 8. RBRcoda Tu

Turbidity

Parameter	Value
Channel wavelength	880nm
Centroid angle	90°
Linearity, R^2	0.99
Initial accuracy	5%
Calibrated range[1]	0-1000FTU
Measurement range[1]	0-1500FTU
Detection limit	0.005FTU

[1] Response becomes non-linear above 1000FTU.

Turbidity (optical backscatter)

Parameter	Value
Channel wavelength	880nm
Centroid angle	135°
Linearity, R^2	0.99
Initial accuracy	5%
Calibrated range[1]	1000-4000FTU
Measurement range[1]	0-20000FTU
Detection limit	2.0FTU

[1] Response is linear between 500 and 15000FTU.

Physical

Parameter	Value
Connector	MCBH-6-MP
Communications	RS-232
Housing	Titanium
Diameter	25mm
Length	~70mm (~105mm with connector)

Parameter	Value
Weight	110g in air, 70g in water
Depth rating	Up to 6000m
Sampling rate	Up to 32Hz

Power

Parameter	Value
Supply voltage	4.5V to 30V (12V nominal)
Power	3mJ/sample (4Hz or slower) 5mA (60mW) (8Hz or faster)
Sleep current	10µA

Calibration equations

Turbidity

$$Tu_{(FTU)} = C_0 + C_1 * V_r$$

Backscatter

$$BB_{(m-1sr-1)} = C_0 + C_1 * V_r$$

2.8 RBRcoda chl-a

The RBR*coda* chl-*a* (Fig. 9) is a 6000m capable realtime chlorophyll-a sensor designed to ensure sensitivity to low concentrations across the measurable range (0-500µg/L). Its compact form, fast sampling rates, low power consumption, and high depth rating make it well suited for use in a wide variety of applications. This dedicated chlorophyll-*a* fluorometer brings laboratory grade precision to the ocean environment while maintaining the ruggedness, reliability, and compact design required for field deployments.

All optical components of the RBR*coda* chl-*a* are robust and durable, selected to minimise ageing due to UV/sunlight exposure, and thus show minimal change in properties over extended deployments. Its sapphire windows facilitate automated cleaning by a wiper to keep them free of biofouling during long-term moored deployments.

Deploy the RBR*coda* chl-*a* with the detection window facing down and the connector end-cap pointing upwards to avoid unnecessary exposure to direct sunlight.

Fig. 9. The RBRcoda chl-a

Chlorophyll-*a*

Parameter	Value
Wavelength	470nm/695nm (excitation/emission)
Calibrated range[1]	0-50µg/L
Measurement range	0-500µg/L
Detection limit[1]	0.020µg/L

[1] Scaled for the *in vivo* fluorescence response.

Optical

Parameter	Value
Linearity, R^2	0.99
Initial accuracy	5%

Physical

Parameter	Value
Connector	MCBH-6-MP
Communications	RS-232
Housing	Titanium
Depth rating	6000m
Diameter	25mm
Length	~68mm (~104mm with connector)
Weight	110g in air, 70g in water
Operating temperature range	-5°C to +35°C
Sampling rate	Up to 32Hz

Power

Parameter	Value
Supply voltage	4.5V to 30V (12V nominal)
Power	6.5mJ/sample (4Hz or slower) 15mA (180mW) (8Hz or faster)
Sleep current	10µA

Calibration equation

Chlorophyll *a*

$$Chl_{(\mu g/L)} = (C_0 + C_1 * V_r) * C_2$$

2.9 RBRcoda DO (OxyGuard)

The RBR*coda* DO (Fig. 10) uses the OxyGuard galvanic dissolved oxygen sensor. The sensor consumes oxygen from the environment and thus produces the most accurate measurements when in a stirred environment. During deployments, always orient the sensor downwards to reduce debris collecting at the aperture and minimise exposure to direct sunlight. Store the sensor in the dedicated storage cap, included with the instrument.

Fig. 10. RBRcoda DO (OxyGuard)

Dissolved oxygen

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

Physical

Parameter	Value
Housing	Plastic
Diameter	25mm
Length	~125mm (~160mm with connector)
Weight	190g in air, 70g in water
Depth rating	Up to 1700m
Sampling rate	2Hz

Power

Parameter	Value
Supply voltage	6V to 18V (12V nominal)
Power	10mA (120mW)

2.10 RBRcoda PAR (LI-COR)

The RBR*coda* PAR (LI-COR) instruments (Fig. 11) use cabled cosine (one hemisphere, LI-192) or spherical (omnidirectional, LI-193) sensors.

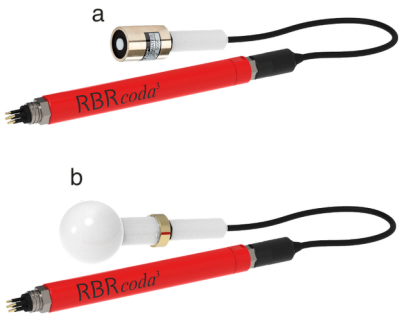


Fig. 11. RBRcoda PAR (LI-COR) variants. (a) Cosine PAR sensor. (b) Spherical PAR sensor

PAR

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

Physical

Parameter	Value
Housing	Plastic
Diameter	~25mm
Length	~265mm (~300mm with connector) cable 0.6m
Weight	460g in air, 240g in water (cosine) 400g in air, 100g in water (spherical)
Depth rating	Up to 560m (cosine) Up to 350m (spherical)
Sampling rate	2Hz

Power

Parameter	Value
Supply voltage	6V to 18V (12V nominal)
Power	10mA (120mW)

3 Derived parameters

The RBR realtime smart sensors stream the data already calibrated, with all the parameters derived.

See Ruskin User Guide: Sensors for instructions on configuring your instrument.

3.1 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).

$$\text{Sea pressure} = \text{absolute pressure - atmospheric pressure}$$

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

Enter atmospheric pressure (in dbar) manually in the table under the **Parameter** tab in Ruskin. See Ruskin User Guide: Sensors. If not entered, a default value of 10.1325dbar will be used.

3.2 Depth

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

$$\text{Depth} = \frac{\text{absolute pressure - atmospheric pressure}}{\text{density} \cdot g}$$

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:

$$\text{Sea pressure} = \text{absolute pressure - atmospheric pressure}$$

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

3.3 Oxygen concentration

The RBR*coda* 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 **Parameter** tab in Ruskin. See Ruskin User Guide: Sensors.

3.4 Oxygen saturation

The RBR*coda* 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 %.

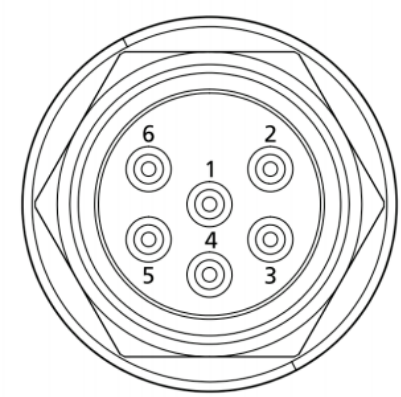
The Garcia and Gordon equation requires values for absolute temperature (in °K) and salinity, which are derived from measured temperature and conductivity. As your instrument does not measure conductivity, a default value of 35PSU will be used. Alternatively, enter conductivity manually in the table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

4 Connector pinouts

4.1 MCBH connectors

All RBR smart sensors have an **MCBH-6-MP** connector (see Fig. 12) to connect to your computer or to use for integrations with the RBR standard instruments. The data will stream via a patch cable (ordered separately).

Fig. 12. RBRcoda Tu with an MCBH connector



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

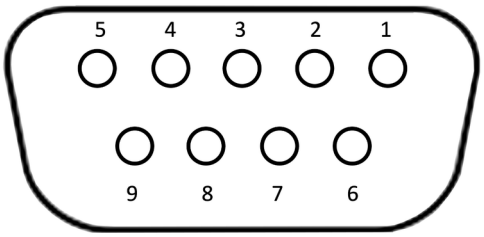
4.2 DB9 connectors

RBR smart sensors use RS-232 patch cables (see Fig. 13) for connecting to your computer and power supplies. Depending on the ordered configuration, your patch cable may have an embedded converter and either a USB connector or a **DB9-F** connector.

Refer to the RBR Cable Guide for available options.

Fig. 13. RBRcoda³ D with an RS-232 cable, DB9-F connector

Patch cable DB9-F connector pinout



Pin No.	RS-232
1	N/C
2	From the instrument (Tx)
3	Into the instrument (Rx)
4	N/C
5	Drain/Ground
6	Ground
7	Auxiliary
8-9	N/C

5 Maintenance

5.1 Deployment

The RBR smart realtime sensors are robust and reliable, but there are several things to keep in mind when deploying them. Proper deployment will ensure faultless operation and preserve your data.

Precautions

1. Do not exceed the maximum depth rating.

> All RBR sensors are individually rated to a maximum depth in metres, as indicated on the label. See Fig. 14.

Fig. 14. Maximum depth rating label

1. Do not apply physical stress to the housing.

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

2. Do not attempt to open the sensor.

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

5.2 Cables and connectors

Cable bend radius

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

Lubricating the connectors

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

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

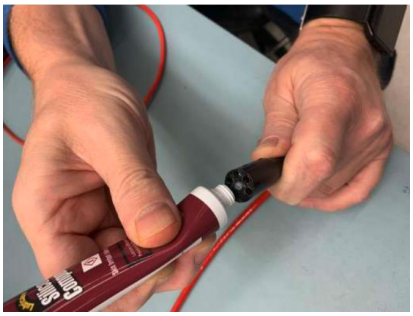


Fig. 15. Applying silicone compound to the female connectors.

Fig. 16. Cross-sectional view of a connector with 30% lubricant fill.

Reducing mechanical stress

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

5.3 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 over time.

Fig. 17. The RBRcoda ODO with storage cap: note the red arrow showing the location of 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 as 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.

Fig. 18. RBRcoda ODO ready for storage

Storage cap variants

RBR ODO sensors intended for vehicle integration are shipped with a specialised storage cap, designed for a sensor mounted inside the glider. This storage cap has an opening for refilling the water with a syringe. See the quick start guide provided with your sensor for more information.

Fig. 19. RBRcoda ODO for vehicle integration

First deployment

RBR ships the RBR*coda* 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 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

Before each deployment, check your sensor calibration 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: Sensors for user calibration instructions.

5.4 RBR pH sensor care and maintenance

General care

The RBR optical pH sensors have a pH-sensitive substrate that requires special care. Any damage will permanently affect performance.

Avoid direct sunlight.

Never touch the sensing foil while cleaning or handling.

For long-term storage (> 1 week), store the sensor cleaned and dry, with the storage cap installed when not in use. Storing the sensor wet will degrade the sensing foil.

After a deployment

Soak the sensor face in deionised water for 10 minutes after deployment, then let it dry before storage to minimise the formation of salt crystals on the foil.

Storage

- Store the RBR optical pH 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.
- Store in a dry, dark place at room temperature.
- High humidity or exposure to sunlight will destroy the sensor over time.

Avoiding damage to the foil

- Do not use any organic solvents or surfactant solutions. Surfactants can cause irreversible damage.
- Do not use commercially available pH electrode buffers (coloured or uncoloured). Stabilisers in those buffers will irreversibly damage the sensor.

Calibration

It is recommended to calibrate the RBR*coda* OpH before each deployment. For details on how to calibrate your instrument see Ruskin User Guide: Sensors.

Replacing OpH foil

Required materials

- RBR*coda* OpH sensor
- Phillips #0 screwdriver
- Replacement foil package
- Soft-tipped or plastic tweezers

Unscrew the foil cover using a screwdriver.

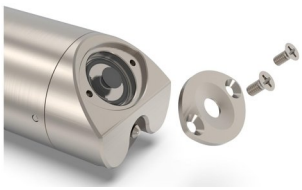


Fig. 20. Fully remove the foil cover

Remove the foil cover fully. Remove the foil which may be stuck to the foil cover or to the window.

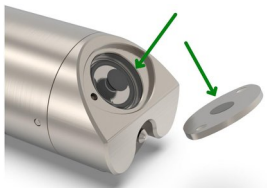


Fig. 21. Check locations indicated for the old foil before attaching a new one.

Remove the cover foil from the paper holding the pH foils. The top side of the spot is the sensitive pH layer, which has to be in contact with the sample/environment. See Fig. 65a.

Using tweezers, remove a foil from the holding sheet

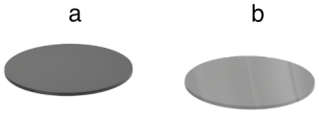


Fig. 22. The pH foils have a matt dark grey sensor side (a) and glossy plastic back side (b).

Place the foil in the middle of the window on the instrument. The foil must cover the entirety of the optical fibre (circular, clear part at the centre of the window)

Fig. 23. Foil is covering the entire optical fibre

Place the foil cover back on the sensor, and make sure the foil is properly placed in the middle of the foil cover

Tighten screws to secure foil cover. Alternate screw every 1/4 turn to ensure even clamping. Tighten screws 1/4 turn past snug.

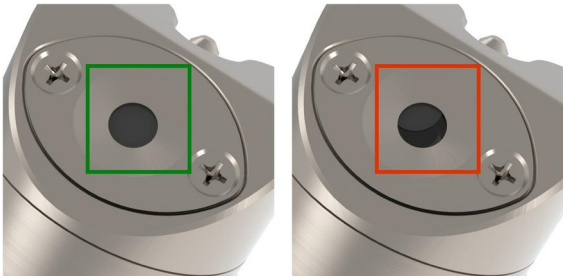


Fig. 24. Left: Correct placement of foil. Right: Incorrect placement of foil

Place the sensor face in water to hydrate the new foil for at least 12 hours prior to calibration

Fig. 25. Sensor face should be completely submerged

5.5 DO sensor (OxyGuard) care and maintenance

Check the state of your DO sensor before deployment. Look for any damage to the membrane, cloudiness of the electrode, and build-up on the anode. If you find any damage, refurbish and recalibrate the sensor. Refer to the OxyGuard Support Kit and Refurbishment Guide, included with the support kit, for instructions on refurbishing your sensor. See Ruskin User Guide: Sensors for instructions on calibration.

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

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.

Fig. 26. Storage cap

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".

Fig. 27. Location of the transport (top) and measurement (bottom) positions

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.

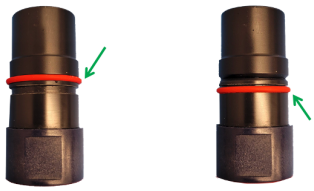


Fig. 28. Transport position (left), measurement position (right)

5.6 PAR sensor (LI-COR) connector alignment

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.

Fig. 29. The LI-COR PAR sensor: note the location of the yellow mark

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

Fig. 30. The orientation of the yellow mark and the connector tab

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.

5.7 Cleaning

These instructions are for RBR sensors only, for 3rd party sensors refer to the manufacturers best practices for cleaning.

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

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

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

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 flathead 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.
3. If unsuccessful, contact RBR.

Cleaning the RBR*coda* T.ODO

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

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

Cleaning the RBR*coda* Tu and RBR*coda* chl-*a*

Clean the optical face of the sensor with a lint-free cloth and isopropyl alcohol.

Ensure you are wearing gloves, oil from fingerprints easily soils the windows.

Fig. 31. Dirty

Fig. 32. Clean

5.8 Calibration

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

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

Calibration certificates are available for download:

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

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

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

Please contact RBR for current calibration fees.

5.9 Repairs

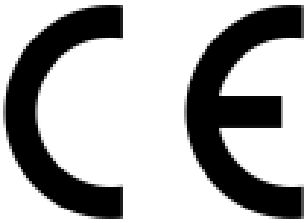
RBR supports all our products. Contact us immediately at support@rbr-global.com or via the RBR website if there are any issues with your instrument. Please have the model and the serial number of the unit ready. Our support team will work to resolve the issue remotely. In some cases, you may have to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

6 Revision history

Revision No.	Release date	Notes
A-K	2021-2024	Various
L	15 November 2024	Added a note on aggregate mode to the introduction. Updated specifications for the RBR*coda*^{3} PAR, RBR*coda*^{3} rad. Removed the RBR*quadrante* and RBR*tridente* sections (now available as a dedicated instrument guide). Added the RBR*coda* Tu section. Updated the Calibration section for downloading instructions.
M	5 March 2026	Added UV to narrow-band wavelength specs table Updated length of Tu sensor housing Added RBR*coda* chl-*a* to sensor specifications section Updated cleaning section
N	28 July 2026	Updated Tu power specs Added RBR*coda* OpH section Added RBR pH care and maintenance section
O	25 September 2026	Updated OpH specs page Migrated. Reformatted and reviewed.
P	6 October 2026	Updated RBR*coda* OpH specs



7 Appendix

7.1 Pressure and salinity sensitivity for the RBRcoda OpH sensor

Pressure sensitivity

RBR measured the pressure response directly on the PK8T sensor spot across its full 0 to 6000dbar rating and applies a correction of 0.023 ± 0.002pH per 1000dbar. Wirth et al. (2024) assessed the same optical pH sensor and reported a comparable value of 0.029pH per 1000dbar, which was only validated to 2000dbar. RBR extended the measurement to the full 6000dbar rating, and the pressure response showed no measurable hysteresis.

Salinity sensitivity

If logged salinity data is not available, an approximate value is sufficient in seawater: near 35PSU, a salinity input within 10PSU of the true value changes the reading by less than 8mpH. The effect is larger in low-salinity water: near 5PSU, an input off by only 2PSU changes the reading by roughly 19mpH.

Equations

Corrected pH equation as used in the RBR*coda* OpH is a condensed version of the full salinity compensation shown in equations (2) and (3).

$$pH_{corrected} = pH - \frac{1}{2}\,g0\left(\frac{\sqrt{IS}}{1+\sqrt{IS}} - 0.2791745 - g1\,(IS - 0.15)\right) - k\,P, \quad IS = \frac{20\,S}{1000} = \frac{S}{50} \;(1)$$

where **pH** is the uncompensated reading, **S** is salinity (g/L), **P** is pressure (dbar), **g0** = 0.970 and **g1** = 0.126 are the ionic-strength (activity) coefficients, and **k** = 2.337 × 10^{-5}pH/dbar is the pressure sensitivity. The salinity term is zero at the reference ionic strength IS = 0.15 (S = 7.5g/L).

Full expanded form (substituting the uncompensated conversion, with raw ratio R and temperature-corrected coefficients c1′, c3′, c5′, c7′):

$$pH_{corrected} = c5'\,\log_{10}\left(\frac{c1' - R}{R - c3'}\right) + c7' + c8 - \frac{1}{2}\,g0\left(\frac{\sqrt{IS}}{1+\sqrt{IS}} - 0.2791745 - g1\,(IS - 0.15)\right) - k\,P \;(2)$$

Salinity sensitivity of pH, full correction equation. This is the derivative ∂pH/∂S of the salinity term in equation (1), independent of the pH reading and temperature:

$$\frac{\partial pH}{\partial S} = -\frac{g0}{100}\left(\frac{1}{2\sqrt{IS}\,(1+\sqrt{IS})^2} - g1\right) \quad [\text{per g/L}]\;(3)$$

Verified against equation (1) with g0 = 0.970, g1 = 0.126. In seawater (~35g/L) the sensitivity is about −0.5 mpH per PSU; it grows sharply below ~15PSU (about −4mpH per g/L at 10g/L), which is why low-salinity deployments need an accurate salinity value.

Salinity (g/L)	Correction (mpH)	∂pH/∂S (mpH per g/L)
5	+16	−7.6
10	−11	−4.0

Salinity (g/L)	Correction (mpH)	∂pH/∂S (mpH per g/L)
20	−37	−1.7
35	−52	−0.5
45	−55	−0.1

Reference

Wirth, T., Takeshita, Y., Davis, B., Park, E., Hu, I., Huffard, C. L., Johnson, K. S., Nicholson, D., Staudinger, C., Warren, J. K., & Martz, T. (2024). Assessment of a pH optode for oceanographic moored and profiling applications. *Limnology and Oceanography: Methods*, 22(11), 805–822. https://doi.org/10.1002/lom3.10646