

RBR: SENSOR INNOVATION

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ABSTRACT

RBR Ltd is a Canadian CTD manufacturer of instrumentation for physical oceanography with users around the world. Its product line is dominated by autonomous battery powered instruments that arrive in their own pressure housings, but an increasing number of platform builders choose to use RBR OEM sensors in their own systems, including MRV and Teledyne Webb.

1. BACKGROUND

RBR was born eponymously as Richard Brancker Research Ltd in 1973. It occupied Richard's garage in Ottawa, Canada, but quickly grew and displaced the founder from his own home. Fortunes were tied to the cycles of federal government budgets with the main output being bespoke electronics for a wide variety of instrumentation requirements.

In 1985, Frank Johnson (another English ex-pat engineer, this one with a PhD in biomedical engineering) joined RBR upon his arrival in Canada and developed some of the first underwater temperature recorders. Frank took a 10 leave of absence and also worked at the Ottawa Heart Institute on a second-generation artificial heart. He returned in 1999 along and took over the reigns of the company from Richard. In the following year, he pivoted the company from being project- to product-focused, and thus began the oceanographic company known today. The company name officially changed to RBR Ltd in 2006.

In 2009, the third English ex-pat engineer joined the company in the form of Greg Johnson. His background in electronics had been augmented by a doctorate in materials science and x-ray instrumentation. In the following years, Greg took the helm and now steers a company based in the Ottawa high tech corridor, Kanata.

To avoid confusion in the community, Greg often refers to himself as "Greg Johnson the Lesser" due to a certain Pacific North West professor who was also given the same appellation, albeit some years earlier.

2. PRODUCTS

RBR offers a complete line of instrumentation for physical oceanography, and concentrates on the highest measurement accuracy while keeping laser focused on low power consumption and extreme ease of use.

Our compact loggers are designed for one or two channel applications (RBR*solo*, RBR*duet*) and measure temperature, pressure, dissolved oxygen, PAR, and turbidity. These are 1" (~25mm) in diameter, and powered by a single AA battery. Sleep currents are ~3μA, almost indistinguishable from the self-discharge of the cell while on the shelf, and permit 25M readings to be taken in a single deployment. Accuracies are as expected for physical oceanography – ±2mK for temperature, for example. Deployments have been undertaken in all depths, with housings available in OSP and also titanium.

The standard loggers, with a 2.5" diameter (~65mm) permit a semi-custom configuration of sensors to be integrated. CTD is the most common core, but oxygen (both galvanic and optical), pH, turbidity, and a wide array of others are all facilitated.

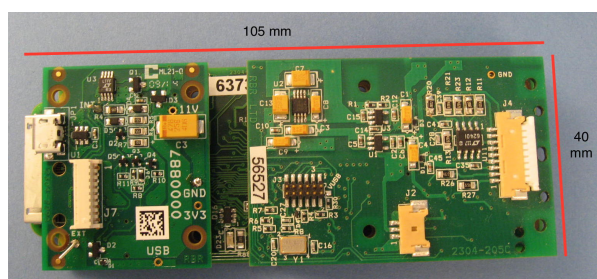


Figure 1 RBR CTD electronics, 105mm x 40mm

The internal construction of the standard loggers consists of a battery carriage, which double as an

electronic support, and small modular circuit boards tailored to manage each sensor optimising accuracy and power consumption simultaneously. This design permits end-users to receive a complete instrument complete with power management and internal battery supply inside a pressure vessel, but the electronics and sensors are ready for integration in platforms stripped of those encumbrances. (Figure 1)

3. TECHNOLOGIES

Inductive conductivity cells are unaffected by surfactant fouling due to the lack of metallic contact with the water. In addition, the low aspect ratio of the cell permits flushing without artificial forcing. Without a pump, measurements through the upper layers of the ocean are straightforward (and the air measurement provides a zero reference useful in assessing long term stability). The circulating current caused by an inductive cell is corrected for by calibrating the entire sensor end cap as a single unit, prior to assembly on the float. In fact, this is the same calibration process used for glass conductivity cells, so there are no negative impacts of this requirement.

RBR conductivity cells are tolerant of a wide range of environmental conditions. In addition to tolerance of air deployment shocks, the RBR conductivity cell also accepts being frozen into ice for extended periods. No damage, nor change to calibration occurs during the freeze-thaw cycle.

Comprehensive work at the WHOI double-diffusive tank facility has led to hydrodynamic improvements reducing salinity spiking and providing lower entrainment.

All recent RBR conductivity cells contain internal thermistors to aid in resolving questions of thermal inertia. We are convinced that rather than attempting to model the behaviour of a complex thermo-mechanical system, measurement of the primary parameters is more useful and leads to a direct result for correction.

In addition to our standard RBR*argo* 2000m CTD, recent work on a 6000m CTD has produced results that will be presented to the ARGO steering team in March 2017. Deployment by Uchida et al from the R/V Kairei in January 2017 to 3000m, 5000m, and 6000m has produced some exciting data. Both the Deep APEX and Deep SOLO (glass sphere floats) will be amenable to a side-by-side comparison between multiple CTDs, and we are actively seeking partners for further evaluation.



Figure 2 RBRcoda ODO oxygen optode. $\phi 28\text{mm}$, integrated $\pm 2\text{mK}$ accuracy thermistor

RBR has developed its own optode technology – the RBRcoda ODO - aimed at oxygen measurements. The measurement specifications are equivalent to the AADI 4831F (with a 40 point calibration after Uchida), but the power consumption is only 12mW for 300ms (36mJ/sample) – a reduction of a factor of 4. In addition, the optode is fully exposed to air during the surface phase of any float, and measurements at that stage can be used to assess drift characteristics. It may also be flush mounted with the top cap of a float to help keep external geometry streamlined and robust. (Figure 2)

The RBRcoda ODO is currently available with both a normal ($\sim 8\text{s}$ tau) and slow ($\sim 20\text{s}$ tau) foil, but we are developing a fast foil that should produce $\sim 1\text{s}$ time constant behaviour – although drift due to photo bleaching will be considerably higher.

The RBR instrument philosophy comprises using as much in-situ processing as is necessary to provide high quality data, low telemetry costs, and reduced post-processing complexity. For this reason, we timestamp every measurement (whether depth-averaged or instantaneous), provide the ability to enable or disable channels on a per-profile basis (conductivity vs salinity, sound speed, correction temperatures, optical sensors); perform onboard data compression; permit a number of data formats for the controller; generate ascent speeds; etc. As thermal inertia correction algorithms stabilise, these will be optionally implemented inside our electronics, with no changes required by platform controllers.

4. APPLICATIONS

A variety of platforms have incorporated RBR sensor packages, including Teledyne Webb APEX floats, MRV ALAMO floats, MetOcean telematics NOVA floats, Wirewalker profilers, and others.



Figure 3 MRV ALAMO float with RBR CTD+PAR

As discussed in the paper contributed to this workshop by Steve Jayne et al., the hurricane monitoring program using the ALAMO float developed by MRV has been using a temperature-pressure sensor suite contributed by RBR. This has performed robustly during air-deployments both from stern decks of C-130s and also from the sonobuoy tube. MRV has also integrated the RBR CTD, as well as our PAR interface for the Li-Cor diode, and these floats will be deployed shortly. (Figure 3)

The ARGO program in particular has shown great interest in having a low power CTD that, while preserving the measurement goals of the platform, increases the autonomy of the float.



Figure 4 Webb APEX float with RBRargo CTD

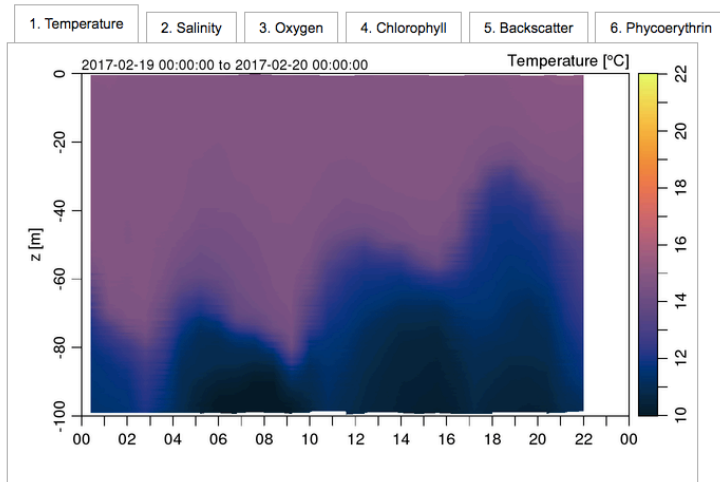
Teledyne Webb offers two version of the APEX 2000m float: the first with the SBE-41cp, the second with the RBRargo CTD. As seen by the Argo Steering Team at AST-17 in Yokohama, a side-by-side float comparison by Susan Wijffels, CSIRO, that has been running since 2015 has provided valuable input on long term RBR CTD stability. This is particularly reassuring for the community given the previous experience with another inductive cell. Data to be presented at AST-18 in Hobart in March 2017 will demonstrate the dynamic behaviour of the cell. (Figure 4)

The figures from the WEBB floats suggest that the SBE-41cp requires approximately 3.5kJ to perform a nominal 2000dbar profile, whilst the RBR requires 0.7kJ. This lowered contribution to the overall energy budget of the float results in an increased number of profiles during the lifetime of the platform.



Figure 5 Wirewalker including RBRconcerto CTD with DO and turbidity, also RBRfermata battery canister

Rob Pinkel and team have developed the Wirewalker over the past 15 years – a wave powered profiler with small surface expression and suspended weight. This “no-power” profiler is ideally suited to RBR instrumentation, not least because all data can be passed up the jacketed line via an inductive modem link, and then telemetered back to shore using GSM or Iridium communications. (Figure 5)



A number of deployments have occurred world-wide, and the current Scripps canyon deployment has been running for six months. Sampling is performed at 6Hz with CTD, DO, backscatter, and chlorophyll amongst the measured parameters. (Figure 6)

Figure 6 Temperature from 24h of WW profiles - every 10 minutes to 100m

5. FUTURE

RBR sees the future in widespread autonomous platforms that are tailored to the deployment area of interest. Mesh networks and self-organising fleets, responding to measurements directly and tailoring the experimental protocol, will become possible. Measurement accuracy has hit a plateau for a number of parameters, but power consumption continues to hinder most platforms and this will be an area of continued interest for us.

6. ACKNOWLEDGEMENTS

None of this would be possible without the helpful conversations, hard work, and late nights with friends. Amongst those: Breck Owens, Susan Wijffels, Brian King, Tero Purokoski, Ray Schmitt, Pelle Robins, Clark Richards, Steve Jayne, Mark Halverson, Neil Bogue, Fred Maas, Pete Furze, Rob Pinkel, Drew Lucas, Mike Goldin, Tyler Hughen.