ROCKLAND SCIENTIFIC

User Manual

VMP-250-IR-RDL

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Revision 1.4

2022-02-10

Rockland Scientific International Inc. | 520 Dupplin Road, Victoria BC V8Z 1C1 Canada | tel +1-250-370-1688 toll free 1-877-370-1688 | e info@RocklandScientific.com w www.RocklandScientific.com

info@rocklandscientific.com
tel: +1 250 370 1688

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Revision History

Revision	Date	Description
1.0	2020-11-06	First version for Rockland Data Logger (RDL) systems
1.1	2020-12-01	Updated TN 052 and fixed minor typos
1.2	2021-01-07	Updated required software and recommended line. Other minor corrections.
1.3	2021-12-06	Updating for P113R03 board.
1.4	2022-02-10	Add the drag net.

Warnings

Symbol Description

Throughout the manual, symbols and colours are used to highlight important information. This information is categorized as follows:

✋	Information that is *critical* to the safety of the user.
⚠	Information that *improves* the performance of the instrument and the quality of the data.
ⓘ	Information that is *helpful*.

Lithium battery shipping restrictions

The VMP-250-IR contains a 4-cell, 14.8 V, 26.6 Watt-hour Lithium Polymer (rechargeable) battery, that has passed UN 38.3 Testing. This battery is classified under UN 3481 (Lithium ion batteries contained in equipment), and must follow Packing Instruction 967 Section II.

However, because the battery is below 100 Wh, it can be shipped without additional restrictions (does not require a lithium battery mark). For more information, refer to the IATA Lithium Battery Guidance Document, found on IATA's website:

http://www.iata.org/whatwedo/cargo/dgr/Pages/lithium-batteries.aspx

Pressure buildup due to battery short circuit

For instruments that have a battery installed[1] (i.e. Rockland Battery Packs, MicroCTD, various VMP's), such batteries can sometimes generate a great amount of heat if short circuited, because the electrical energy in these batteries is significant. In addition, the chemical contents of these batteries can catch fire if damaged or if improperly handled. In the event this has occurred, the environment inside the pressure case of the instrument could become pressurized. As a precaution, your instrument has been designed to allow for venting of the air inside the instrument while preventing the bulkheads from separating completely. This is accomplished by having the assembly sealing nut still retain the rear bulkhead after the bulkhead to tube seal is separated.

[1] The CR2032 battery, which is located on the Rockland Data Logger board is small and thus is not a concern for generating dangerous pressure buildup inside the instrument.

Limitations

This oceanographic instrument is a complex piece of equipment and is equipped with sensitive (and delicate) sensors. It is the user's responsibility to be familiar with the instrument's capabilities and limitations. This instrument manual assumes that the user has already received appropriate training on the usage of the instrument, reducing the risk of damage incurred to your instrument during its operation.

In addition, the quality of the measurements obtained with the instrument is directly affected by your operation of the instrument and by your level of care and maintenance.

Before processing the data acquired by your instrument, it is also assumed that you have sufficient knowledge of the fundamentals of the sensors equipped on the instrument as well as the theory of turbulence measurements.

Contact Information

Rockland Scientific is committed to enabling science by helping our customers obtain high quality data and have successful deployments of our instrumentation.

If you are uncertain about any aspect of operations, handling, sensor installation, data processing and configuration, please contact Rockland Scientific. We provide an array of technical training courses and workshops. We are always happy to assist you.

For support, including emergencies, contact us via:

- Email: support@rocklandscientific.com
- Phone: 250-370-1688 (9am - 5pm, Pacific Time)

1 Getting Started

The VMP-250-IR is a coastal-zone, vertical profiler for measuring turbulence microstructure. The VMP-250-IR has a depth rating of 500 m and is designed for operation from small vessels (e.g. Zodiacs), or where electrical power facilities are limited (e.g. ice camps). A full overview of the instrument is given in Section 2.

The following Getting Started section provides basic information to prepare the instrument for deployment, but it – in no way – serves as a replacement for the detailed content contained within this manual. The recommendations and proposed timelines below are only suggestions, due to the variability of cruise preparations and the nature of your research.

> ⓘ It is expected that any user of the VMP-250-IR is familiar with the operation of the instrument. If you have any questions about this instrument or the content contained within this document, please contact Rockland Scientific.

1.1 Receipt of Goods

Immediately after you receive your instrument, you should:

1. Inspect all equipment for possible damage incurred during shipping. If damage is found, contact the shipper immediately to start the claims process. *Most shippers have a time limit on claims, so start the process promptly.*
2. Check the contents of the shipping case(s) against the packing list. Confirm that all items on the list are in the case(s) to ensure you have received all items ordered.
3. Confirm that you have received the tools/equipment for operating the instrument (Section 2.3.2).
4. Confirm that you have received a kit that includes spare components (i.e. O-rings, fasteners) for your instrument (Section A.6).
5. Check the instrument battery voltage/charge the instrument battery (Section 4.3).
6. Conduct an electronics bench test (Section 4.4).

If there are any concerns with the items listed above, please contact Rockland Scientific.

> ⓘ Inspect your instrument **as soon as possible** to maximize the time between the receipt of goods and your scheduled field work. It may take some time to resolve any issues.

1.2 Several Months Before your Deployment (in the lab)

We recommend that you inspect and communicate with your instrument at a **minimum of three months** in advance of your cruise because instrument repairs, if necessary, can often take several weeks. The following recommendations are *critical for instruments that have been stored for prolonged periods*, but should also be carried out for new instruments:

1. **Check the mechanical integrity of your instrument:**
    - Disassemble your instrument (Section 3.6) and inspect all components for evidence of bio-fouling, corrosion, and physical damage.
    - Inspect the O-rings (Section 5.2) and sealing surfaces (Section 5.3). Replace your O-rings annually or before every cruise.
    - Confirm mechanical connection to the host platform or vehicle. See platform manufacturer's instructions for more details.
    - Visually inspect pressure sensor diaphram for dents and scratches.
    - Inspect all anodes and replace worn anodes (Section 5).
2. **Check and/or replace batteries:**
    - Check the voltage of your Li-Ion battery and charge if necessary (Section 4.3).
    - Check the recommended replacement date labelled on the CR2032 battery (Section 2.5.6 and Figure 10), and replace if necessary.
3. **Gather and inspect probes:**
    - Ensure that you have enough probes for your upcoming deployment. Probes are fragile and we recommend having a few spares on board.
    - Check the calibration dates of your probes (refer to the Calibration Certificates). We recommend that FP07s be calibrated *in-situ*[2] and that shear probes are calibrated annually at Rockland's facility.
    - Shear probes: Inspect for signs of damage (Section 5.5.1) and, if possible, review the most recent data acquired with sensor to confirm it was functioning properly.
    - FP07 themistors: Verify that the tiny sensing tip is intact (Section 5.5.2), and, if possible, review the most recent data acquired with this sensor to confirm that it was functioning properly.
4. **Establish communication with your instrument:**
    - Connect your instrument to a computer (Section 4.2). If possible, use the laptop(s) you plan to use during the deployment.
    - Check and update your `setup.cfg` configuration file (Refer to Section A.3).
    - Perform a bench test (Section 4.4).

[2]See Technical Note 039 for details of *in-situ calibration*

- Confirm communication, integration, and configuration with host platform or vehicle. See platform manufacturer's instructions for more details.

5. **Gather the required equipment and documentation:**
   - Assemble the suggested tools (Section 2.3.2).
   - Verify the integrity of the instrument tether (Section 2.3.4).
   - Check your spares kit and ensure that it has all necessary supplies (Section A.6).
   - Download the relevant documentation, drivers and software (Section 2.3.1) to your field computer. You may not have high bandwidth internet access in the field.
   - If shipping your instrument to the deployment or field site, ensure that you have proper documents for transit.

1.3 Several Hours Before Deployment (on the ship)

Assuming your instrument is in good working order, proceed with the following deployment preparations:

1. Connect the instrument to your computer (Section 4.2).
2. Check the battery voltage (Section 4.3).
3. Verify the contents in the configuration file, `setup.cfg`, match the configuration of the instrument (Refer to Section A.3).
4. Complete an electronics bench test (Section 4.4).
5. Inspect the O-rings and sealing surfaces (Section 5.2 and Section 5.3).
6. Assemble the tail section and brushes (Section 3.2), and set aside.
7. Prepare the tether, feed it through the tail section and securely attach it to the instrument (Section 3.4).
8. Secure the tail section to the instrument (Section 3.5).
9. Discuss the ship operations with the captain and crew (Section 4.5.3).

1.4 Several Minutes Before Deployment (on the ship)

1. Ensure that the battery is charged (Section 4.3).
2. Confirm mechanical integrity of all components:
   (a) Sealing nut is tightened to 25 in · lb (Section 3.7).
   (b) Connectors on rear bulkhead are tightened.
   (c) Cap screws holding CT sensor (and CLTU sensor, if installed) on front bulkhead are tight.
   (d) Sensor guard is secure.

   (e) Tail section is secure.
   (f) Drag element (i.e. net or brush) is secure.
   (g) There are no loose components that could cause unwanted vibrations.
3. Correctly install the microstructure probes into the appropriate probe ports (Section 3.8).
4. Record the serial numbers of the probes in your deployment notes (Figure 25).
5. Turn the instrument on and verify that the LED exhibits the expected behaviour (Section 4.1).
6. Double-check the tether (Section 4.5.2).

> ⚠ A detailed pre-deployment checklist is provided in Section 4.5.1.

2 Overview of the VMP-250-IR

2.1 What is the VMP-250-IR?

The VMP-250-IR (Figure 1) is a coastal-zone, vertical profiler for the measurement of turbulence microstructure. The VMP-250-IR is designed for operation from small vessels with limited deck space (e.g. Zodiacs), or where electrical power facilities are limited or missing (e.g. ice camps). In addition to the microstructure sensors, a VMP-250-IR comes with a compact conductivity-temperature (CT) sensor installed. Additional sensors (i.e.chlorophyll-turbidity (CLTU) sensor and a dissolved oxygen sensor) are also available.

The VMP-250-IR ("internally recording") records data internally, eliminating the requirement for a deck-side power supply and data recording system. The onboard datalogging computer (RDL) provides a flexible and powerful datalogging system. It is configured to automatically start and stop datalogging with the ON/OFF magnet. The user connects through USB like any USB memory stick to transfer data files and to update the datalogging configuration file. The VMP-250-IR is powered by an internal polymer lithium-ion battery of nominally 14.8 V and 1.8 Ah capacity. The battery and internal memory allow for up to 10 hours of continuous operation with the base unit, with a power consumption of approximately 2.1 W[3].

It is possible to repeat profiles without having to recover the profiler between deployments. At the end of the profiling series, the recorded data can be downloaded and the battery charged using the supplied deck cable which connects to the instrument via an underwater connector located on the instrument's rear bulkhead.

Figure 1: VMP-250-IR

[3]For the standard configuration and rated battery capacity (see Table 7). Battery life and power consumption is dependent on the configuration of the instrument, as well as environmental and operating conditions. For example, if the optional micro-Conductivity, or CLTU sensors are added, the battery performance will be reduced. Cold temperatures will reduce battery life.

2.2 General Specifications

2.2.1 Instrument Specifications

The basic specifications of the instrument are summarized in Table 1. Refer to Section A.7 for the Outline Drawing. All specifications are subject to change without notice.

Table 1: General Specifications

Model	VMP-250-IR-RDL
Depth Range	0–500 m (1000 m optional)
Fall/Rise Rate	0.75–1.00 m s^{-1}
Weight in Air/Water	11 kg / 3 kg *other weights available*
Housing Length/Overall Length	1.1 m / 1.6 m
Sampling Rate	512 Hz / 64 Hz (fast channel / slow channel) *up to 2048 Hz available*
Data Acquisition	Internally Recording
Data Storage	Up to 2100 hours of data with 64 GB of storage. *based on continuous sampling, 8 columns in the address matrix* (Section 2.5.8)
Battery Life	5.8–10 hours of continuous operation *depending on instrument configuration* (Section 2.5.7)
Power Consumption (Nominal)	2.1–3.7 W (Section 2.5.7)

2.2.2 Configuration and Sensor Specifications

The VMP-250-IR includes several sensors that measure (i) the turbulent properties of the flow, (ii) the physical characteristics of the water, and (iii) the performance of the instrument. The specifications of the sensors and the quantity included with your instrument are summarized in Table 2. Optional sensors are also listed, but changes to the electronic boards may be required to use these sensors. **Please contact Rockland Scientific before modifying the configuration of your instrument.**

Notes:

- Other bandwidths are available upon request.
- To calibrate the FP07 thermistor, we recommend performing an *in situ* calibration which is outlined in Technical Note 039. Upon request, Rockland can perform a 3-point calibration using a WOCE quality, pumped CT sensor accurate to 0.005°C.

Table 2: Sensor specifications and instrument configuration.

Quantity	Sensor	Parameter Measured	Range	Accuracy	Resolution	Bandwidth
1	**PA-10L**	pressure	0–10 bar	0.1 % of FS	5×10^{-4} bar	0–2.5 Hz
1	**inclinometer**	instrument tilt	Dual Axis, ±90 °	0.1 °	0.015 °	
2	**piezo-accelerometer (1-axis)**	instrument vibrations	±1 g	2 %	3×10^{-3} g	0.1–100 Hz
2	**Shear Probe**	velocity shear	0–10 s^{-1}	5 %	1×10^{-3} s^{-1}	0.1–100 Hz
2[a]	**FP07**	temperature	−5–35 °C	0.005 °C	1×10^{-5} °C	0–25 Hz
Optional	**SBE7**	conductivity	0–70 mS cm^{-1}	0.005 mS cm^{-1}	0.001 mS cm^{-1}	0–100 Hz
1	**CT**	temperature	−3–45 °C	0.01 °C	0.001 °C	0–16 Hz
		conductivity	2–65 mS cm^{-1}	0.001 mS cm^{-1}	0.001 mS cm^{-1}	0–16 Hz
Optional	**CLTU**	chlorophyll	0–400 ppb	1 % of FS	0.01 ppb	0–100 Hz
		turbidity	0–1000 FTU	0.3 FTU or 2 % of measured value	0.03 FTU	0–100 Hz
Optional	**Rinko-FT**	dissolved oxygen	0–425 µmol L^{-1}	12 % of measured value or 12 µmol L^{-1}	0.001 µmol L^{-1}	0–100 Hz
		temperature	−3–45 °C	0.01 °C	0.001 °C	0–100 Hz

[a] If the optional SBE7 is included, then only 1 FP07.

2.3 Requirements

Proper use of the VMP-250-IR requires additional software, tools, equipment and documentation that are summarized below.

2.3.1 Minimum Required Software and Documentation

Instrument communication requires:

- Computer with USB Support
- At least one USB Type-A connection

Data analysis with Zissou Essentials requires:

- PC running Windows 10 (or newer) or macOS High Sierra 10.13.6 (or newer)
- 64-bit Operating System

Data analysis with Matlab requires:

- MATLAB 8.4 (R2014b) or newer

The following additional software and documentation is supplied by Rockland Scientific:

- Zissou Essentials (stand-alone software for data visualization)
- ODAS MATLAB Library (Matlab based software for data visualization and processing)
- ODAS MATLAB Library User Manual

2.3.2 Minimum Required Tools

The VMP-250-IR is shipped with a tool kit that contains all the necessary tools for assembly, disassembly and maintenance of your instrument. This tool kit is summarized in Table 3.

Table 3: Minimum Required Tools (supplied by Rockland)

Tools	Description/Size	Application/Use	Qty
Wrench	Custom Rockland wrench	Probe Holder	1
Torque Wrench	25 in · lb 1/4” drive	Sealing Nut	1
Deep Socket	7/16 inch 1/4” drive	Sealing Nut	1
Wrench, Adjustable	0-1 inch (0-25 mm)	Sensor guard, 8-Pin MCBH connector, LED indicator	1
Hex Key	3 mm	Sensor Port Cover Plates (if applicable)	1
Nut Driver	7/16 inch (11 mm)	Sensor guard	1
Nut Driver	5/16 inch (8 mm)	All hose clamps	1

2.3.3 Recommended Tools

A list of tools that are recommended by Rockland are summarized in Table 4.

Table 4: Recommended Tools (not supplied by Rockland)

Tools	Description/Size	Application/Use	Qty
Vulcanizing (Self-Fusing) Tape	EPR Rubber	Repairing underwater cables	1
Multi-meter	Fluke(R) Digital Multi-meter	Electrical diagnostics	1
Wire Cutting Pliers	Flush Cutting	Cutting Cable Ties, Waxed Lacing	1
Waxed Lacing Tape		Tying down Wiring Harnesses	1
Screwdriver, Phillips	Size #1	Circuit Board Screws	1
Screwdriver, Slotted	1/2-inch	Anode Assembly Screw (if applicable)	1
Wrench	1/4-inch	Circuit Board Standoffs, SMC Connectors	1
Aluminum Foil	Roll	Electromagnetic Shielding	1
Electrical Tape	Roll	General use	1
Duct Tape	Roll	General use	1
Compressed Air	Canister	Cleaning components	1
Isopropyl Alcohol	Small Bottle	Cleaning components	1
Kimwipes	Soft, lint-free tissue	Cleaning o-rings/sensitive equipment	1
Heat Gun	Weller 6966C	Heat shrink tubing	1

2.3.4 Recommended Line/Tether

It is important to minimize the effects of the tether during freefall of your instrument. Therefore, we recommend that you source a tether that is flexible and has a density similar to the density of the instrument (Specific gravity of 1.3 - 1.4). To reduce the effects of hockling (twist) of the tether, we also recommend a braided rope over a laid line (twisted rope). Finally, the tether should be strong to account for shock loading due to varying sea states or possible snag of the instrument on the bottom. The tether should have a small enough diameter to reduce its drag, however also have a large enough diameter to be easy to handle (especially in inclement weather).

> Recommend line: Samson Ultra-Tech, Technora®, Double Braid, 5–7 mm (3/16 inch – 5/16 inch) diameter, or equivalent.

2.3.5 Additional Reading

Table 5 contains a list of technical notes useful for understanding how the VMP-250-IR measures turbulence data, as well as information for data processing using Rockland's software products. These technical notes are available for download from the "Technical Notes" section of Rockland's website www.rocklandscientific.com.

Table 5: Recommended Technical Notes

Note	Description
TN 002	**Digital Signal Processing to Enhance Oceanographic Observations** A paper explaining the theory behind using signal pre-emphasis on critical channels to maximize the signal-to-noise ratio.
TN 005	**Converting Shear Probe, Thermistor and Micro-Conductivity Signals into Physical Units** Gives a detailed explanation of how raw counts are converted to physical units.
TN 010	**Design and Optimization of Anti-aliasing Filters** Gives a detailed explanation of the filtering required for ocean turbulence measurements to produce sampled data that is free from aliased components.
TN 015	**Modeling the Spatial Response of the Air Foil Shear Probe Using Different Sized Probes** A paper describing the wave number response of the shear probe.
TN 028	**Calculating the rate of dissipation of Turbulent Kinetic Energy (TKE)** Describes the algorithm used to compute the rate of dissipation of TKE from the shear measured with an air-foil type shear probe.
TN 033	**Probe Preparation and Treatment of the SBE7 Micro-Conductivity Sensor** Maintenance procedures for the (optional) micro-conductivity sensor.
TN 039	**A Guide to Data Processing** A guide to using the ODAS Matlab library to process Rockland Scientific data files, including how to perform an *in situ* calibration of the FP07 thermistor using data from a Sea-Bird CT or JFE Advantech CT sensor.
TN 040	**Noise in Temperature Gradient Measurements** Provides a method for estimating the noise in measurements of the gradient of temperature fluctuations obtained with a Rockland instrument.
TN 042	**Noise in Shear Probe Measurements** Provides a method for estimating the noise in measurements of the velocity shear obtained with a Rockland instrument.
TN 046	**RSI Inclinometers** Describes the functionality of the inclinometer in Rockland instruments.
TN 047	**Why Calibrate the FP07 Thermistor?** Describes the reasons for and against calibrating the FP07 thermistor.
TN 048	**Interpreting the Results of Calibrate All** Provides a guide to interpreting the results of the `cal -all` function for common instrument channels found on standard Rockland Instruments
TN 049	**Tow-Yoing with the VMP-250-IR** Describes deployment technique of tow-yoing that is possible with the VMP-250-IR
TN 051	**Rockland Data File Anatomy** Describes the anatomy and format of Rockland `.P` data files
TN 052	**Rockland Data Logger (RDL)** Gives an overview of the Rockland Data Logger and describes differences between RDL and CF2 Persistor systems

2.4 Mechanical Systems Overview

This section gives an overview of the mechanical components of the VMP-250-IR. Details of the operations – including assembly and disassembly of the instrument – can be found in Section 3.

2.4.1 Coordinate System

The coordinate system of the VMP-250-IR is as follows (Figure 2):

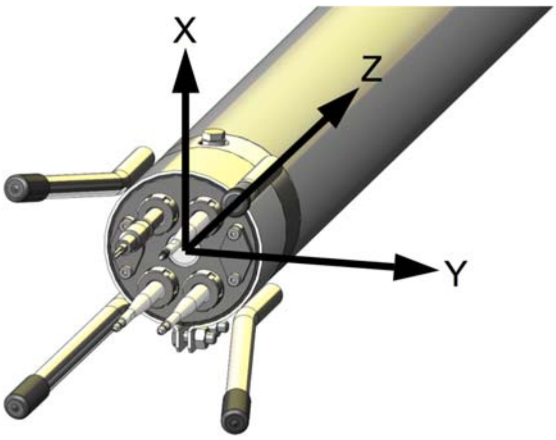

Figure 2: Coordinate System

- x-axis: It is directed through the threaded hole which is used for the “ON” magnet (Figure 2). Nominally, horizontal on a vertical profiler.
- y-axis: Orthogonal to the x-axis, nominally horizontal on a vertical profiler and positive to port.
- z-axis: Parallel with the axis of the instrument running from the front bulkhead to the rear bulkhead. Nominally vertical and directed upwards on a vertical profiler.

2.4.2 Sensors

The front bulkhead of the VMP-250-IR contains all the external sensors on the instrument (Figure 3). The specifications for each sensor are detailed in Table 2 and necessary calibration information is provided in the Calibration Report that is shipped with your instrument.

> The FP07 thermistor(s) are typically uncalibrated. We recommend performing a post-deployment *in situ* calibration, which is outlined in Technical Note 039.

The microstructure sensors (shear, FP07, and optional SBE7) are assembled onto the front bulkhead via their coaxial connection (SMC). The fundamentals of the microstructure sensors are described in Technical Note 005 (Table 5). The sensors are secured and sealed to the front bulkhead using Rockland probe holders. Details of the probe holders can be found in Section 3.8. The instrument will be shipped with test probes (Section 2.4.3) installed in the microstructure locations.

The pressure transducer is the thin diaphragm located in the centre of the front bulkhead. The JAC[4] CT (conductivity and temperature) and (optional) CLTU (chlorophyll and turbidity) sensors are assembled onto the front bulkhead using two socket head cap (a.k.a. hex) screws (size M4) and are sealed to the front bulkhead with an O-ring in a face seal configuration. If the CLTU is not included, a blank plate will be installed in its location.

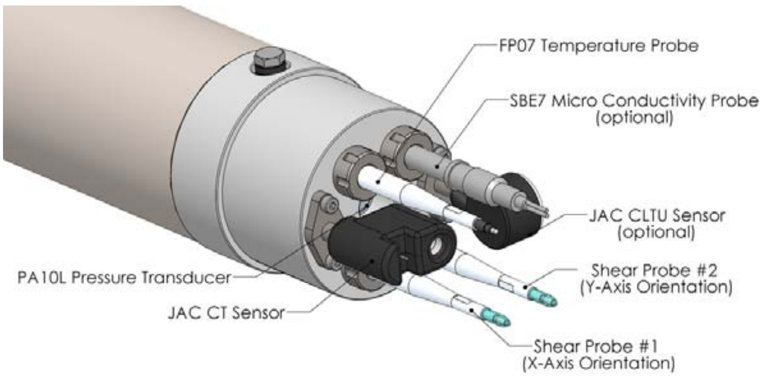

Figure 3: VMP-250-IR Sensors

Two vibration sensors are installed on a mounting block that is located inside the instrument (Figure 4). Each vibration sensor is a piezo-accelerometer that is fixed in position and cannot be adjusted or removed. The vibration sensors are alternating current (AC) sensors and are treated like shear probe channels. Their primary purpose is to sense the vibrations of the instrument in the x- and y-directions (Figure 2). Common-mode vibrations measured by both the vibration sensors and the shear probes (such as vibrations induced from the instrument) can be removed from the shear signals during post-processing of the data.

[4] JAC is an acronym for JFE Advantech Co. that is commonly used as shorthand notation for drawings and data visualization purposes

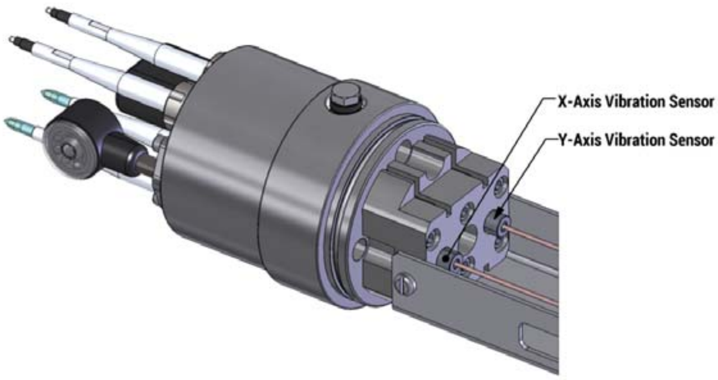

Figure 4: Vibration Sensors

There is a 2-axis tilt sensor installed on the power supply board that is located inside the instrument. The sensor measures the DC and low-frequency response to tilting and has an accuracy of $\pm 0.1°$ over the oceanic temperature range. **For vertically profiling instruments, the inclinometer is only sensitive to rotations about the x-axis.** The other axis of the inclinometer is sensitive to rotations around the instrument's y-axis, however, in the vertical position, the inclination is 90°, which is the upper limit of the inclinometer range.

2.4.3 Test Probes

Test probes (Figure 5) are used as place holders for real microstructure probes and must **always** be installed in place of real probes during deployment if measurements are not desired on a particular channel. They should **always** be used when storing or shipping your instrument, and when performing an electronics bench test (Section 4.4). The test probes protect internal wiring and electronics, as well as containing internal electronics that bring measured values to approximately mid-scale. More specifically, the temperature and conductivity test probes have internal termination resistors whereas, shear test probes are un-terminated.

> It is good practice to **install test probes into the correct ports**. It is *necessary* during an electronics bench test, and optional otherwise.

Figure 5: Test probe with an SMC connector.

2.4.4 Sensor Guard

The sensor guard clamps to the front bulkhead (Figure 6). It is designed to:

- Provide protection to the external sensors on the front of the instrument, including the microstructure probes

- Not interfere with the sensor measurements.
- Minimize vibrations from vortices shedding around the guard

Figure 6: Sensor Guard

2.4.5 Rear Bulkhead

Located on the rear bulkhead of the instrument are the following components (Figure 7):

- A lifting ring (eyebolt) for attaching to the instrument tether.
- Sealing nut for installation or removal of the rear bulkhead to access the internal components.
- A LED status indicator, which flashes at the start of data acquisition (Section 4.1.3)
- An active aluminium anode to help prevent corrosion to the external metallic components on the VMP-250-IR.[5]
- A 8-Pin MCBH connector which provides the connection to the deck cable.

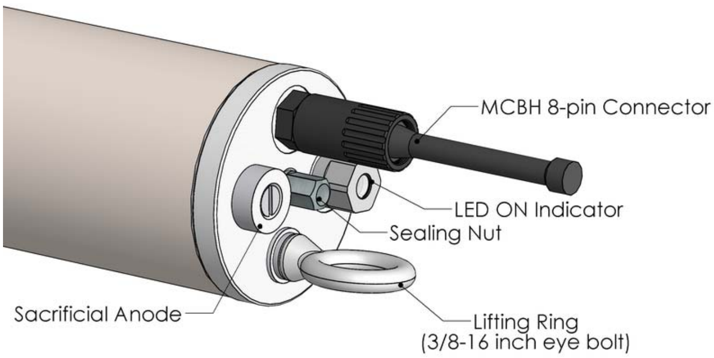

Figure 7: Rear Bulkhead

[5] A blog post pertaining to the aluminium anode and general corrosion prevention can be found here: https://rocklandscientific.com/support/corrosion-prevention-anodes-nail-polish-continuity-checks/

2.4.6 Drag Element and Tail Section

The drag element on the VMP-250-IR (Figure 8) serves two purposes:

1. it helps control the speed of the instrument during profiling, and
2. it increases the pitch stability of the instrument.

Without a drag element, the profiler speed would need to be controlled by a small difference in density between the instrument and the water. However, by using a drag element (in conjunction with increasing the density of the instrument), the instrument's speed is much less affected by changes in density of the water, or tether drag. In addition, because the drag element is located far away from the instrument's centre of mass, the instrument has very high pitch stability (i.e. it is less likely to wobble).

The VMP-250-IR uses drag elements with a high ratio of drag to cross-sectional area. In addition, there is a low coherency amongst the eddies shed by the drag element, reducing the vibrations during profiling. VMP250 instruments shipped before Dec 31, 2021 came with two drag brushes. Instruments shipped after January 1, 2022 come with one drag net.

The drag brushes or net are attached to the rear bulkhead of the VMP-250-IR using a plastic tail section (Figure 8). The tail section provides extra length to the instrument while also providing a mounting point for the drag elements. A rubber coupler connects the tail section to the pressure case and assists in damping vibrations created by the drag elements and tail section. Either one or two drag brushes can be installed, or one drag net. The estimated profiling speeds are given in Table 6.

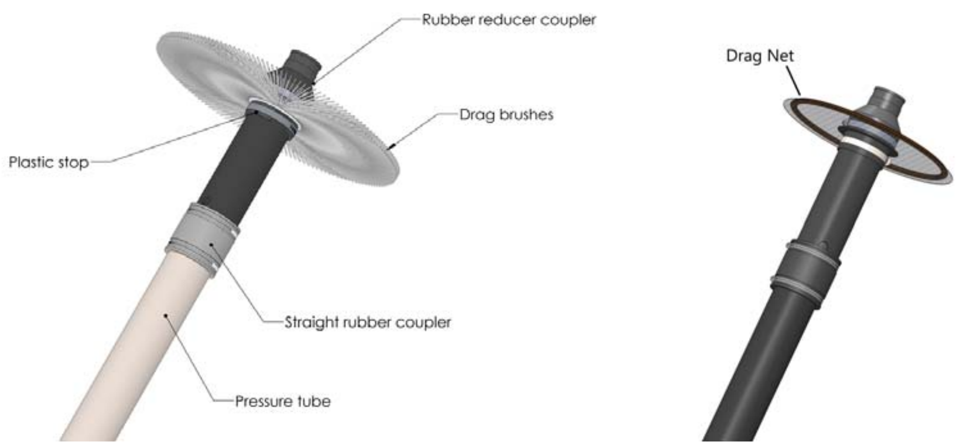

Figure 8: Drag elements and tail section.

Table 6: Estimated downwards profiling speeds for different drag element configurations.

Configuration	Speed
1 Brush	0.90 m s^{-1}
2 Brushes	0.75 m s^{-1}
1 Drag Net	0.75 m s^{-1}

2.5 Electrical Systems Overview

The electrical system that is present within the VMP-250-IR is designed to take the signals measured by the sensors and transmit them to the Rockland Data Logger where the data acquisition is controlled.

The system block diagram is shown in Figure 9 and each of the components are described in the following subsections.

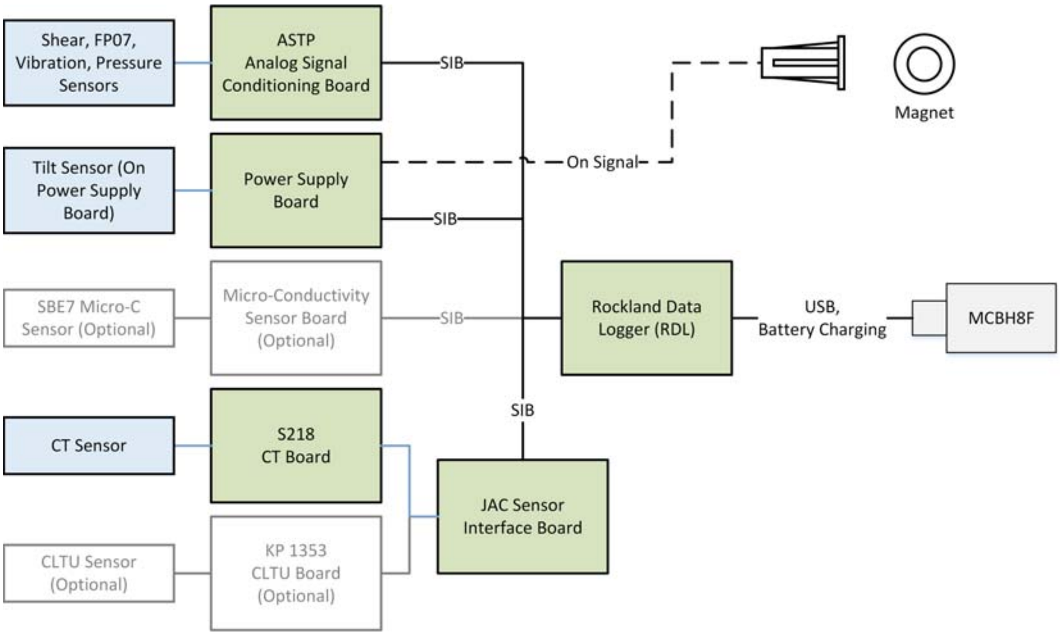

Figure 9: Instrument sensor and electronics system block diagram

2.5.1 Serial Instrument Bus (SIB)

Data is conveyed over a serial "bus". In Rockland instruments, it is called the serial instrument bus (SIB). The SIB is a 14-conductor ribbon cable connecting circuit boards (Figure 9). Its conductors are used for the distribution of power, clocking signals, addresses (request for data) and for the data itself.

2.5.2 ASTP Analog Signal Conditioning Board

The analog signal conditioning (ASTP) board supports two 1-axis piezo-accelerometers (vibration sensors), two shear probes, two FP07 thermistors, and a pressure transducer. This board is the heart of the data acquisition system and it is extensively calibrated and tested for noise.

> Each instrument is supplied with a calibration certificate documenting the performance of this board.

The ASTP board also provides anti-aliasing filtering. The microstructure and vibration sensor signals are low-pass filtered at 101 Hz, and the pressure signal is low-pass filtered at 2.5 Hz.

The data are sampled at 512 Hz for the "fast" micro-structure signals and at 64 Hz for the other "slow" channels. The numeric assignment of the signal channels is detailed in Technical Note 039.

Analog to digital conversion of the data is done using an ultra-linear, extremely low-noise 16-bit analog-to-digital converter.

2.5.3 Micro-Conductivity Board (P059) – Optional

This board is used to convert the analog output from the SBE7 micro-conductivity sensor to a 16-bit digital signal and to transfer that signal to the SIB. It is ONLY present in instruments that are configured to have the optional SBE7 sensor.

2.5.4 JAC Sensor Interface Board (P058B)

The JAC Sensor Interface board provides two key functions:

1. converts the digital outputs from the JFE Advantech Co. CT Board (S218) and, if the instrument is equipped with a chlorophyll and turbidity sensor, JFE Advantech Co. CLTU Board (KP 1353) to be compatible with the Serial Instrument Bus (SIB).
2. takes the raw voltage output from the power supply board and converts it to the correct voltage required by each JFE Advantech sensor.

For each JFE Advantech sensor installed, there will be a small daughter board (P058A) between the corresponding JFE Advantech board (i.e. S218 and/or KP1353) and the interface board (P058B).

2.5.5 Rockland Data Logger (RDL) board (P113)

The Rockland Data Logger (RDL) board runs a Linux operating system and handles the data acquisition.

The internal processor on the board controls the data acquisition using information contained in a configuration file (`setup.cfg`), which is a plain text file that can be edited to change certain aspects of the data acquisition, such as which channels to record and at what rate. See Section A.3 for more information.

The Rockland Data Logger board handles all communication of data samples using the Serial Instrument Bus (SIB). The board works closely with the power supply board to provide graceful shutdown of the instrument after it is signalled to turn off. Additionally, the RDL board has a supercapacitor to provide enough energy to ensure that the data logging can shutdown properly in the event of power loss. Interactions with the RDL are done using the USB connection provided by the deck cable. This provides USB Mass Storage capability for file transfer (Section 4.2.1) and basic interaction with the instrument using Zissou Essentials (Section 4.2.2).

Instruments with P113R01 or P113R02 boards will have a 5x20mm cartridge fuse wired between the electronics and the rear bulkhead. The P113R03[6] instruments have a polyswitch resettable fuse on the P113R03 board itself.

The Rockland Data Logger board also carries a 3V CR2032 lithium battery (Figure 10). The CR2032 battery maintains the onboard Time of Day clock.

> ⓘ The CR2032 battery has a life of several years. Rockland recommends replacing every 4 years.

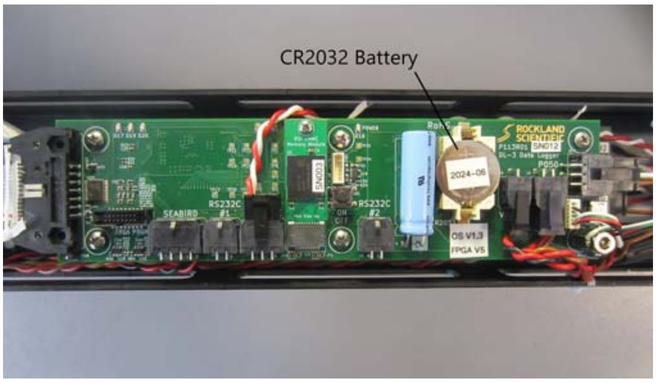

Figure 10: CR2032 Battery on Rockland Data Logger board

2.5.6 Power Supply Board (P050)

The power supply board provides a +5 VDC power rail to all analog components, a 3.3 VDC rail for all digital components, and provides "raw power" equal to its input voltage (i.e. from an

[6] In general, new instruments with SN400 to SN418 will have R01 or R02 boards. SN419 and greater will have R03.

internal battery, or external source), less 1 V for optional equipment (i.e. JFE Advantech circuit boards, micro-conductivity board). The power supply board measures the raw input voltage and it is recorded by the data acquisition system (typically named `V_Bat`).

The power supply board monitors the ON/OFF switch. Shortly after the instrument is turned on, it will start recording a new data file. Shortly after the instrument is instructed to turn off, it will terminate data acquisition, close the data file and signal to the power supply board that it is safe to turn the instrument off. While the instrument is off, it draws no power from the main battery.

The power supply board also carries the 2-axis inclinometer.

2.5.7 Li-Ion Battery

The VMP-250-IR uses a 1.8 Ah, Polymer Lithium-ion rechargeable battery with a nominal voltage of 14.8 V. (*UN38.3 Passed. Refer to the Warnings section at the beginning of this document for more information.*) A fully charged Li-ion battery has a voltage of 16.8 V and the battery itself will turn off if its voltage falls below 12.6 V, but this should never happen during data acquisition. Instead, when the voltage drops to about 13.2 V, the instrument will shut down the data acquisition process, close all data files, and shutdown the power supply board.

At room temperature, the battery has a capacity of 26.6 Wh (i.e. 14.8 V$\times$ 1.8 Ah). Typical power consumption and expected battery life is detailed below (Table 7).

> ⓘ The instrument will not turn on again until the battery has been charged to above ∼14 V.

> ⓘ It takes about four hours to charge a fully depleted battery to full capacity.

> ⚠ The battery must always be charged with the charger provided. See Section 4.3.2 for details. Battery life is a nominal 300 cycles based on full discharge and recharge.

Table 7: Estimated power draw and expected battery life for various configurations. Note: "Standard Sensors" include two shear probes, one FP07 thermistor and the CT.

Configuration	Power Draw [W]	Battery Life [hours]
Standard Sensors (i.e. Shear, FP07, CT)	2.1	10
Standard Sensors + SBE7	2.7	8
Standard Sensors + CLTU	2.7	8
Standard Sensors + SBE7 + CLTU	3.3	6.6
Standard Sensors + SBE7 + CLTU + Rinko-FT	3.7	5.8

> Expected battery life is calculated based on 80% of the rated battery capacity to account for cold temperatures.

2.5.8 Data Storage

Data acquired by the instrument are recorded internally on a proprietary RDL Memory Module that can be mounted on a computer as the Data Drive (Section 4.2.1). The rate of data recorded is approximately:

$$\textit{Data Rate}\ [\textit{bytes}/\textit{s}] = \textit{columns in address matrix} \times 2\ [\textit{bytes}/\textit{column}] \times \textit{Sampling Rate}\ [\textit{Hz}]$$

For the VMP-250-IR, with a typical address matrix of 8 columns and a sampling rate of 512 Hz, this works out to just greater than 8 kB/s. In this configuration, a 64 GB RDL Memory Module would allow for approximately 2100 hours of recorded data.

> Use your address matrix and sampling rate to get a more exact estimate of the expected data storage. Ensure there is sufficient free space on your memory module before any deployment.

2.6 Software Systems Overview

2.6.1 Data Acquisition and Data Download

The VMP-250-IR acquires data with the custom Rockland Data Logger board (P113) using the data acquisition software. The data acquisition is controlled using the configuration file `setup.cfg`. For more information, refer to Section A.3.

The VMP-250-IR is configured to launch data acquisition after the instrument is turned ON (Section 4.1) and the Rockland Data Logger completes its boot up sequence (~40 seconds). Data acquisition is stopped when the instrument is turned OFF.

> Note: The instrument will not log data if the instrument is connected to a computer and the Rockland Data Logger is connected as a USB Mass Storage device (Section 4.2.1).

To transfer the data files to your computer, connect to the VMP-250-IR (Section 4.2) and transfer the data files as you would to/from a USB Drive.

The Zissou Essentials software package[7] can be used to interact with the Rockland Data Logger and perform basic tasks (Section 4.2.2). More specifically, the software can be used to:

- Retrieve the version numbers of the software, firmware, and operating system (OS)
- Check the battery voltage
- Set the instrument clock
- Review the instrument log file
- Determine the free space on the Data Drive
- Check for warnings or errors
- Display channel statistics from a specific record in a previously recorded datafile.

2.6.2 Data Viewing and Processing

The Zissou Essentials software package can be used to convert the data to physical units and to inspect the data with simple visualization tools. It is a stand-alone package that does not require any additional software and it is common to all instruments made by Rockland Scientific. The software allows you to:

- analyze bench test data collected with test probes
- convert P files to MATLAB format
- convert acquired data to physical units
- visualize data for a customized range of interest

[7] Version 1.6 released November 2020

- calibrate FP07 thermistors using in-situ CTD data
- compute spectra for a segment of data and estimate the rate of dissipation for the chosen range

To obtain the latest version of Zissou Essentials, email support@rocklandscientific.com.

Alternatively, the ODAS MATLAB Library[8] of functions can be used for more comprehensive data viewing and processing. The library provides all the basic functionality included in Zissou Essentials (i.e. listed above), and also has the following advanced features:

- automated profile selection
- advanced despiking visualization tools
- calculation of the rate of dissipation of turbulent kinetic energy over an entire profile
- simple visualization of a series of spectral estimates
- calculation of quality control metrics for the spectra and dissipation rates

Further information on the use of the ODAS MATLAB Library can be found in Technical Note 039: "A Guide to Data Processing" . The technical note, the latest version of the library and its User Guide can be obtained by emailing support@rocklandscientific.com.

[8] Version 4.4 released July 2019

3 Assembly and Disassembly

The following subsections outline assembly and disassembly of your VMP-250-IR. This information is critical for deployment preparations, instrument maintenance (Section 5) and troubleshooting (Section 6).

> The VMP-250-IR is shipped with the sensor guard assembled and with test probes installed; the only assembly required to begin downward profiling is to attach the tail section, drag element, and tether, and then to install your microstructure probes. **However, always perform pre-cruise deployment checks (Section 4.5).**

3.1 Assembling the Sensor Guard

The sensor guard attaches to the front bulkhead by clamping around the diameter of the bulkhead with a hex head cap screw and Nylok nut. The guard needs to be orientated such that it does not interfere with the measurements. It is recommended that the prongs of the guard are aligned with the x- and y-axes as shown in Figure 11. This orientation simplifies the installation/removal of the microstructure sensors. It also ensures that the sensing volume of the fluorometer (if installed) is not affected by the wake of the prongs.

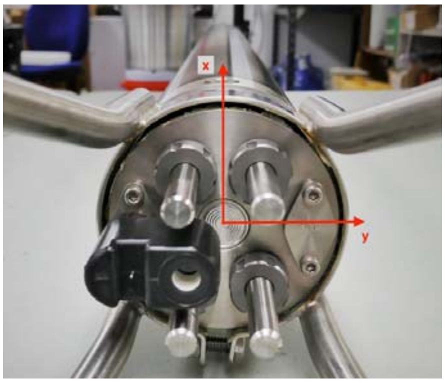

Figure 11: Alignment of the sensor guard

3.2 Assembling the Tail Section and Brushes

The procedure to assemble the tail section and brushes is as follows:

1. Select the number of brushes required to achieve the desired fall rate for your profile (Table 6). Ensure that the drag brush filaments are not bent.

> If the brush filaments become bent, place them on a flat surface in a warm environment to allow them to spring back to a straight form. See additional maintenance tips in Section 5.6.

2. Slide the drag brush(es) onto the detached tail section and attach the rubber reducer coupler over the end of the tail (Figure 12). Ensure that the brushes are adjacent to the plastic stop on the tail. If necessary, you can adjust the location of the plastic stop by loosening the stop's hose clamp and sliding the stop along the tail. Remember to retighten the hose clamp on the stop ring and the rubber coupler.

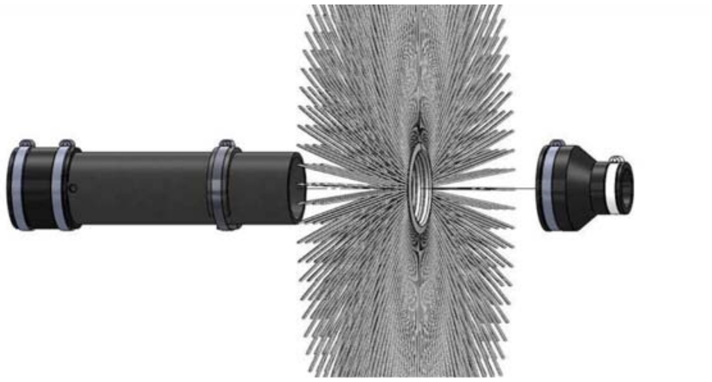

Figure 12: Assembling the brushes and rubber coupler onto the tail section.

3. Ensure that the metal brush rings are tight together between the plastic stop and the rubber coupler. Tighten the hose clamp on the rubber coupler.

> ⚠ Ensure that the metal brush rings are tight together to reduce rattling and vibrations.

4. Before attaching the tail section to the instrument, attach the tether (Section 3.4).

3.3 Assembling the Tail Section and Drag Net

The procedure to assemble the tail section and drag net is as follows:

1. Slide the drag net onto the detached tail section with the collar towards the straight coupler and the net towards the reducer.

Figure 13: Assembling the drag net and rubber coupler onto the tail section.

2. Attach the reducer to the tail and secure with the hose clamp.
3. Push the drag net up against the reducer and secure the net with the #52 hose clamp.
4. Before attaching the tail section to the instrument, attach the tether (Section 3.4).

3.4 Attaching the Tether

To attach the instrument tether to the VMP-250-IR:

1. Pass the tether through the tail section.
2. Tie a secure knot (e.g. bowline with half hitches and seize) to the end of the tether through the eyebolt on the rear bulkhead of the instrument (Figure 14).

> We do not recommend using a shackle to attach the tether to the eyebolt. The metal to metal contact between the shackle and the instrument tether will cause large vibrations that will contaminate the data.

> Before deploying the instrument, check the eyebolt to ensure that it has not loosened from the rear bulkhead.

Figure 14: Tether tied and secured to the instrument with a bowline. Note: Tail section not shown for clarity.

3.5 Attaching the Tail Section to the Pressure Tube

1. Pass the tether through the tail section and secure to the instrument (Section 3.4).
2. Attach the tail section to the pressure case using the straight rubber coupler, **leaving approximately an inch of space between the pressure case and the tail** (Figure 15). The straight rubber coupler is designed to separate vibrations caused by the tail section and drag element from the main instrument body.

> ⚠ Do not allow the tail section to come in direct contact with the rear bulkhead.

3. Tighten the hose clamps on the straight rubber coupler, **ensuring that the axis of the tail section is in line with the axis of the pressure case.**

Figure 15: Installing the Tail Section

3.6 Disassembling the Pressure Case

The following subsections outline the steps to disassemble the instrument pressure case.

3.6.1 Removing the Rear Bulkhead

To remove the rear bulkhead for access inside the pressure case of the instrument:

1. Remove the sealing nut from the rear bulkhead using the provided 7/16-inch (11 mm) deep socket and torque wrench. Alternatively, a socket wrench (with extension), or nut driver can be used (Figure 16).

Figure 16: Removing the sealing nut

2. Gently rock the rear bulkhead as you slowly separate it from the pressure tube. **Do this slowly, being careful not to pull the wiring harnesses connected to the inside of the rear bulkhead.**
3. Gently disconnect the Molex connectors between the rear bulkhead and the internal electronics (Figure 17).

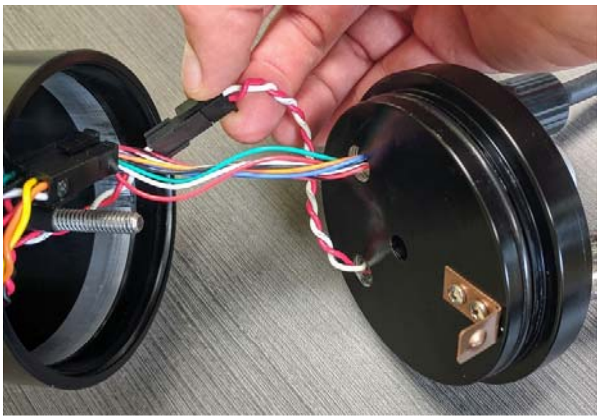

Figure 17: Disconnecting the rear bulkhead Molex connectors.

3.6.2 Removing Components from the Rear Bulkhead

During instrument maintenance (Section 5.1.2), it is recommended that you remove the components of the rear bulkhead. The following tools can be used to unthread the components:

- LED indicator, 8-Pin MCBH connector, lifting ring: 0-1 inch (0-25 mm) adjustable wrench (supplied)
- Retaining post: 3 mm hex driver
- Anode: 3/8-inch or 10 mm slotted screwdriver

3.6.3 Removing the Pressure Tube

After the rear bulkhead has been removed, the pressure tube can be removed as follows:

1. Separate the pressure tube from the front bulkhead by gently rotating and wiggling the tube as you slowly pull the tube away from the front bulkhead.
2. Slowly slide the pressure tube past the internal frame (Figure 18), exposing the internal electronics.

> ⚠ Take extra caution to avoid scratching the inside of the tube on the threaded rod located at the rear end of the internal frame. Be very careful not to damage the internal faces of the pressure tube. These are sealing surfaces and must remain smooth and clean.

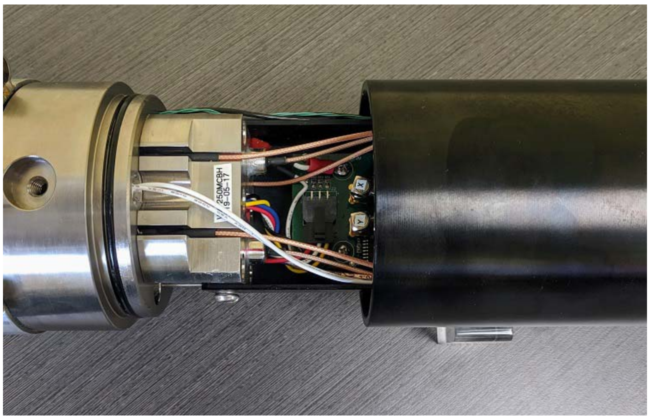

Figure 18: Sliding electronics out of pressure tube

3.7 Reassembling the Pressure Case

Before reassembling the nose cone, pressure tube, and rear bulkhead back together, **check for scratches or debris that could compromise the seals**. Clean surfaces with isopropyl alcohol and apply grease to the O-rings, if necessary. Replace any O-rings that show signs of damage. If there are any scratches on any sealing surfaces, contact Rockland Scientific.

> ⚠ In particular, check the O-ring seals between (1) the nose cone and pressure tube, (2) rear bulkhead and pressure tube, and (3) the sealing nut. See Section 5 for more information on instrument maintenance.

3.7.1 Reassembling the Rear Bulkhead

If components on the rear bulkhead were removed, re-install them. Ensure that the lifting ring is properly oriented. The entire lifting ring eye should be within the diameter of the instrument (Figure 19).

> ⓘ If while reinstalling the lifting ring, the ring's final orientation after tightening doesn't allow the tail section to be able to be mounted properly, add washers to shim the lifting ring until proper orientation is achieved. Additional washers can be found in the Spares Kit.

Figure 19: VMP-250-IR Rear Bulkhead. Note the lifting ring is rotated such that it is entirely within the diameter of the instrument. The lifting eye orientation can be adjusted using washers as shims.

3.7.2 Reassembling the Pressure Tube

To reassemble the pressure case do a reversal of the disassembly procedure. More explicitly, the procedure is as follows:

1. Slide the pressure tube over the internal frame, while carefully ensuring you do not scratch the inside surfaces of the tube when sliding the tube past the internal frame.
2. Reconnect the wiring harnesses on the rear bulkhead to the electronics and insert the threaded rod on the end of the frame through the centre hole on the rear bulkhead. Ensure that the internal wires and pressure tube O-rings are not pinched.
3. Attach the sealing nut and thread the nut to pull the bulkheads and the tube together, resealing the pressure case. Tighten the sealing nut with the provided torque wrench (Figure 20) to a torque of 25 in · lb (3 N m).

> ⚠ Do not exceed this torque or you can cause damage to the instrument's internal frame.

Figure 20: Tightening the Sealing Nut

3.8 Installing Microstructure Probes

> ⚠ Before removing any probes, use canned clean air to blow away all water around the probe holder, probe, and bulkhead.
> When the probe is removed, immediately dry the SMC cable, and blow out the inside of the probe holder cavity.
> IT IS CRITICAL THAT THE CAVITY, CABLE, AND SMC CONNECTOR REMAIN DRY!

Each of the microstructure probes are secured to the front bulkhead using a probe holder cap, and sealed using a ferrule and O-ring (Figure 21).

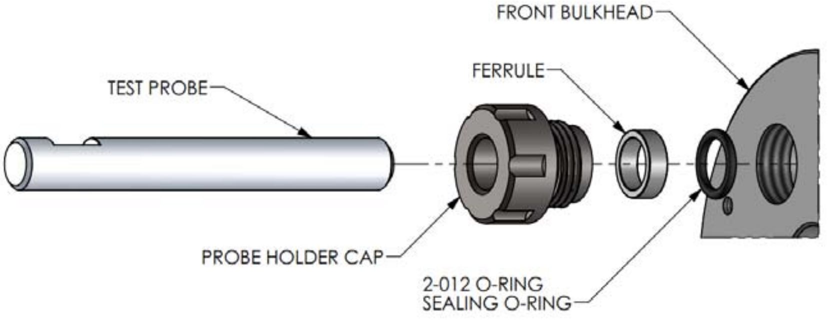

Figure 21: An exploded view of the Probe Holder components.

> Before removing or installing probes, place the instrument on a stable platform such that the instrument is fully supported and cannot roll.

To remove a probe (either a real sensor or a test probe):

1. Loosen the probe holder cap using the probe wrench (Figure 22). Usually a half to three-quarter turn (counter-clockwise) is enough. You do not need to fully remove the cap.

Figure 22: Loosening the probe holder using the custom probe wrench.

2. Remove the test probe by pulling on it until the label on its SMC cable is visible (Figure 23). **A gentle pull is all that is required.** Pulling with higher force or a distance beyond the label could cause damage to the cable.

Figure 23: Removing the test probe. Note the clear heat shrink tubing around the SMC connector.

3. Disconnect the SMC cable and leave it hanging out of the probe holder. Please note that the test probes are labelled (S1, S2, T1, T2 or C1) and these identifications must match the tags on the SMC cables attached to the probes.

> ⚠ When tightening or loosening an SMC connector, rotate either the probe or the end of the connector while preventing the cable from rotating. Twisting the cable will damage the cable and connector over time.

4. Inspect the SMC cable on each probe port. A layer of clear heat shrink tubing should cover all exposed metallic components on the connector, electrically isolating the connector from the front bulkhead. **Damaged heat shrink must be replaced.** Detailed instructions are provided in Technical Note 023 and in a blog post[9]. Also check for any tarnishing, corrosion or biofouling on the cable, around the connector, or beneath the label (Section 5.4.2). If found, contact Rockland Scientific.

To install a probe:

1. Connect and tighten the microstructure probes to their appropriate SMC cables. Insert the sensors into the probe holders.

> ⓘ Make sure the probes are fully seated. You should be able to hear the metal base of the probe contacting the base of the probe port. If the probe does not easily seat, try rotating the probe and reseating. Make sure the probe holder caps are loosened so that the O-ring is not being squeezed around the probe.

[9] https://rocklandscientific.com/support/replacing-clear-heat-shrink-tubing-smc-cables/

⚠ Probes are fragile. Be careful. It is advised that you insert the temperature probes LAST because they are the most fragile.
Keep the SMC connector, probe, and probe cavity dry.

2. Tighten the probe holder caps using your fingers until they can no longer be easily tightened by hand. Then, use the probe wrench to tighten the caps an additional **1/8 or 1/4 turn** (Figure 22). At the proper tightness, it should be difficult to rotate the probes by hand.

⚠ The probe holders should not be over-tightened because it will deform the plastic ferrule and affect the integrity of the O-ring seal.

3. As you tighten the probe holders, ensure that the shear probes are oriented correctly (Figure 24). Typically, one shear probe is aligned with the instrument's x-axis (through the magnet), and the other with its y-axis (Figure 2). The sensitivity on a shear probe is in the direction normal to the flat section of the sensor's serial number (Figure 25).

ⓘ As you tighten the probe holder cap, the shear probes will want to rotate with the cap. This is because of the friction from the O-ring inside the probe holder hole. If this occurs, make sure that the O-ring is properly lubricated. In some cases, this does not fix the problem and the probes will need to be rotated before tightening so that after tightening they have the proper alignment.

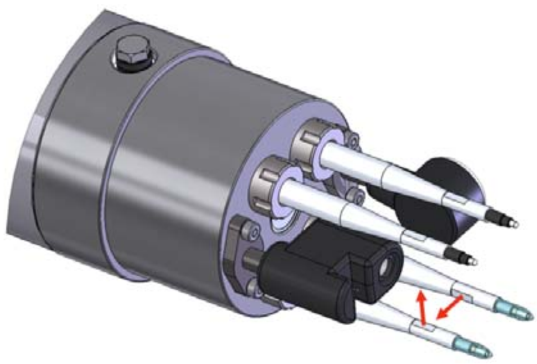

Figure 24: Orthogonal alignment of the shear probes.

4. In your deployment notes, record the serial numbers (Figure 25) of the microstructure sensors you have installed in each port. If possible[10], update your configuration file with

[10] The setup file can be modified post-deployment, if necessary.

their respective serial numbers and their sensitivities (if they are provided for that given sensor).

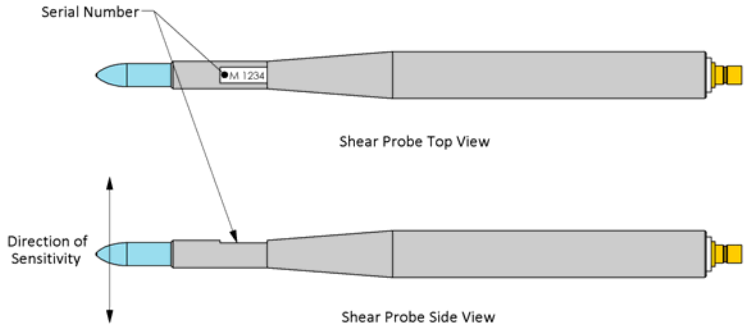

Figure 25: Shear probe direction of sensitivity.

4 Operations

This section outlines the best practices for operating and deploying your instrument.

4.1 Turning the Instrument ON/OFF

4.1.1 Turning the Instrument On

The VMP-250-IR is turned on by attaching the supplied magnet assembly to the front bulkhead of the instrument (Figure 26).

Figure 26: Connecting the ON switch magnet to the instrument.

> Once the instrument has been turned on, it will complete a boot up sequence, and then start data acquisition. After the boot up sequence, the LED on the rear bulkhead will become solid ON for 60 seconds and shut off if data acquisition was successfully started (Section 4.1.3).

4.1.2 Turning the Instrument Off

The VMP-250-IR is turned off by removing the magnet.

> If the instrument is recording data, data acquisition will be stopped prior to turning off completely.

4.1.3 LED Behaviour

The LED flashes slowly (1 second ON, 1 second OFF) during the boot up sequence. Once data acquisition commences, **the instrument LED will be solid ON for 60 seconds after which the LED will remain OFF**. If an error occurs, the LED will blink quickly (0.25 seconds on, 0.25 seconds off). Consult the log file for more information on the error that has occurred (see Section A.4 for additional details).

4.2 Connecting the Instrument to a Computer

There are two methods to connect to the instrument: (1) as a mass storage device (i.e. as the Data Drive) to transfer files (Section 4.2.1), or (2) using Zissou Essentials to perform basic tasks (Section 4.2.2). Both methods require the following:

- Instrument
- Deck Cable
- Computer (with a USB-A connection)

The connection can then be established as follows:

1. Remove the magnet from the VMP-250-IR to ensure that the instrument is OFF.

> The ON magnet must be removed and the instrument must be OFF when connecting the instrument to a computer. Unexpected behaviour can occur otherwise.

2. Remove the Dummy Cap from the 8-Pin MCBH connector on the rear bulkhead.
3. Connect the deck cable to the 8-Pin MCBH connector.
4. Connect the deck cable to a USB port on your computer. This will turn ON the Rockland Data Logger board, but not the instrument as a whole. Data acquisition will NOT be started.

> If the pins on the deck cable connector are not lubricated, use O-ring grease to lubricate the pin connections. See Section 5.4.3

Figure 27: Connecting the deck cable to the instrument.

4.2.1 Connecting to the Instrument as a USB Mass Storage Device

Connecting to the instrument as a USB Mass Storage device is similar to connecting to other mass storage devices, such as a USB Drive or an external hard drive. When connecting a computer to the instrument with the deck cable, the RDL Memory Module contained in the instrument will appear as an external USB Drive on your computer (i.e. the "Data Drive").

Detailed instructions for connecting to the instrument as a Data Drive are as follows:

1. Connect the deck cable to the VMP-250-IR .
2. Make sure no external power is supplied from either the platform or the deck cable.
3. Connect the USB to your Computer
4. The USB connection will power the onboard computer only to allow for file transfer.
5. Wait for the Data Drive to be detected. A notification from the computer should indicate when the connection has been established.

> ⓘ It can take up to 30 seconds for a connection to be established because the instrument's operating system must boot up first.

6. Open the folder by following the prompts on your computer, or go to the built-in file manager (e.g. File Explorer, Finder) to find the Data Drive.
7. Double click on the Data Drive to open it and view the contents of the RDL Memory Module on the instrument (Figure 28).

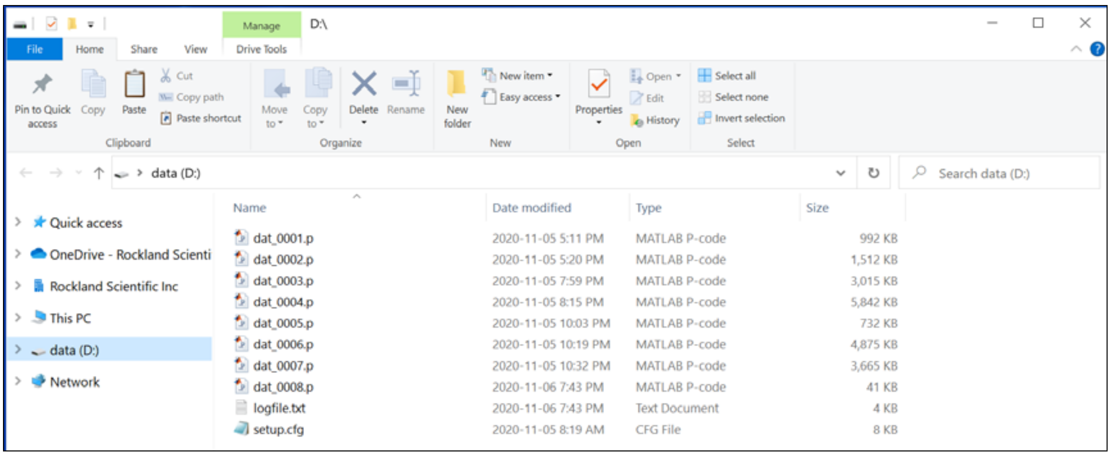

Figure 28: Connecting to the instrument as a mass storage device.

8. Transfer files on and off the instrument as necessary. The transfer can be done using all standard methods (e.g. drag and drop, copy and paste).
9. When ready, instruct your computer to properly eject the Data Drive before physically disconnecting the instrument from the computer.

> Ensure that you instruct your computer to properly eject the Data Drive before disconnecting the instrument from the computer. Taking this step will reduce the chances of corrupting the memory module's File Allocation Table (FAT).

4.2.2 Connecting to the Instrument using Zissou Essentials

Connecting to the instrument using the Zissou Essentials software provides additional functionality via the "Instrument Dashboard" (Figure 29). For more information, refer to the Help menu of the Zissou Essentials software program. When the connection is made with the Instrument Dashboard, the computer will simultaneously connect to the Data Drive (as described in Section 4.2.1) to allow file transfer. The additional functionalities of the Instrument Dashboard include:

- Setting the instrument clock
- Checking the battery voltage
- Displaying the software version on the instrument
- Reviewing the instrument log file
- Determining the free space on the memory module
- Checking for warnings or errors
- Displaying channel statistics from a specific record in a previously recorded data file

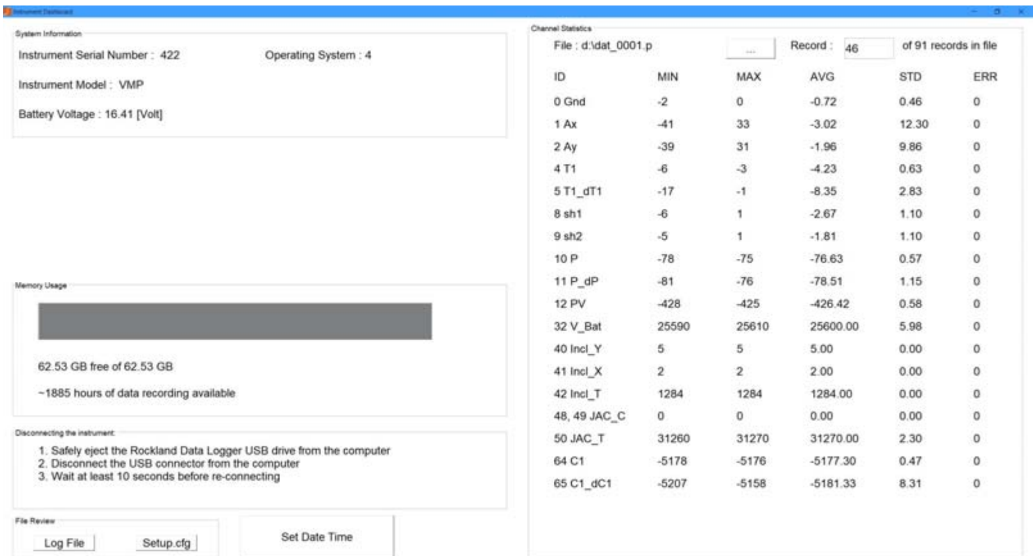

Figure 29: Viewing the Rockland Data Logger status with Zissou Essentials.

To connect to the Rockland Data Logger via Zissou Essentials:

1. Open Zissou Essentials on your computer.
2. On the software home page, hit the “Instrument Dashboard” button (Figure 30). The option is also available under the “Tools” drop-down menu.

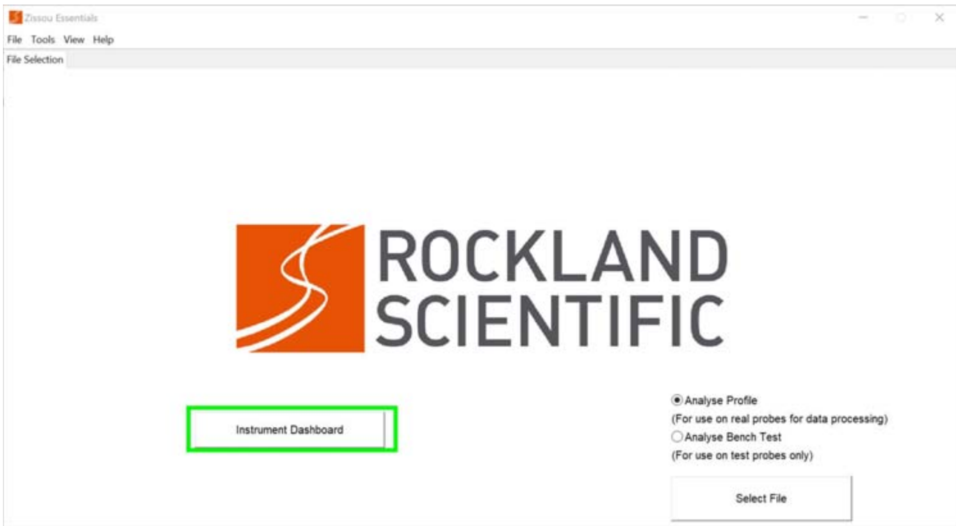

Figure 30: The “Instrument Dashboard” button (green) on the Zissou Essentials home page.

3. Ensure that the instrument is OFF.
4. Connect the deck cable to the instrument, but do NOT plug the USB into the computer.
5. Hit the “Connect Instrument” button (Figure 31).

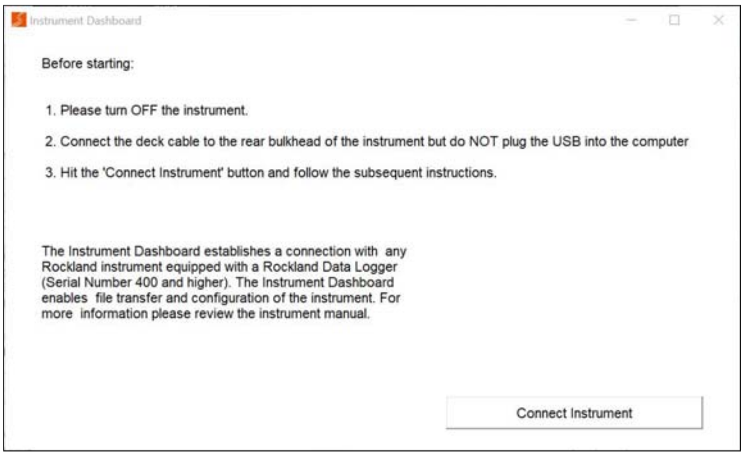

Figure 31: Connecting to the instrument with Zissou Essentials.

6. When prompted (Figure 32), plug the USB end of the deck cable to the computer and wait for the RDL Memory Module to be detected (up to 2 minutes). A notification should indicate when the connection has been established.

It can take up to two minutes for the connection to be established because the instrument's operating system must boot up first and the software needs to be initialized.

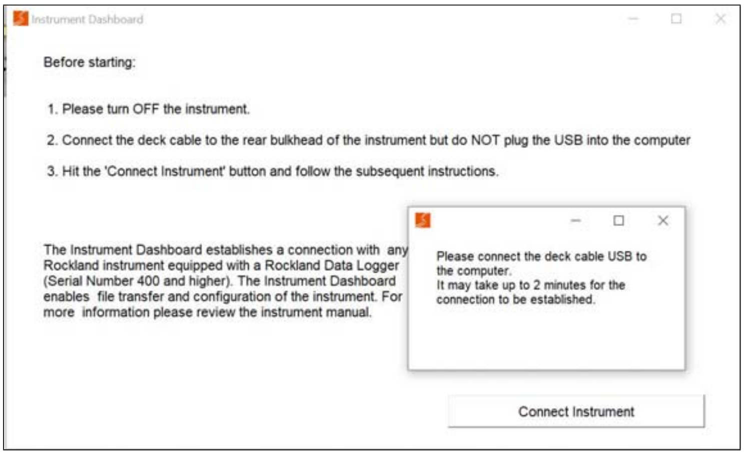

Figure 32: Zissou Essentials Prompt to Connect USB to Computer.

7. The Instrument Dashboard will appear and provide you information about your instrument and your Rockland Data Logger (Figure 29). Refer to the "Help" menu of the Zissou Essentials software program for more information about the dashboard.
8. When completed, eject the RDL Memory Module from your computer.

Ensure that you instruct your computer to properly eject the memory module before disconnecting the instrument from the computer. Taking this step will reduce the chances of corrupting the memory module's File Allocation Table (FAT).

4.3 Checking and Charging the Instrument Battery

The required equipment/tools to check and charge the instrument's battery are:

- Instrument
- Instrument Deck Cable
- Charging Cable (Power cord with AC adapter)
- Voltmeter
- Tool Kit

4.3.1 Checking the battery voltage

The battery voltage can be checked using either a voltmeter, or by communicating with the instrument using a computer. To perform the latter, please use the Instrument Dashboard tool within the Zissou Essentials software (Section 4.2.2). The procedure to check the voltage using a voltmeter is as follows:

1. Connect the deck cable to the rear bulkhead 8-Pin MCBH connector (Figure 27).
2. Connect the cable containing two banana jacks to the mating barrel-jack connector located on the other end of the deck cable (Figure 33).
3. Measure the main battery voltage by connecting a voltmeter to the banana jack cable (Figure 33).

> The battery is fully charged if the voltage is above 16.7 V. For the instrument to turn on, the voltage needs to exceed 14 V (Section 2.5.7).

Figure 33: Connecting banana jack cable to deck cable and measuring the battery voltage

4.3.2 Charging the battery

The procedure to charge the instrument is as follows:

1. Ensure the magnet is removed from the front bulkhead and the deck cable is not plugged into a computer. This ensures that the instrument is off, so that the battery will receive a complete charge (see note).
2. Plug the charger into an AC 100-240 V, 50-60 Hz source. The LED on the charger will flash red and green twice to indicate it is functioning correctly.
3. Connect the charger to the barrel-jack connector on the deck cable. The LED on the charger will turn red to indicate charging.

Figure 34: Connecting the AC adapter cable to the Deck Cable

4. Once the battery is fully charged, the LED will turn green. Re-measure the battery voltage to confirm.

⚠ **The instrument should be powered OFF while charging.** If the instrument is ON, a green LED on the charger may not accurately indicate a full charge. This inaccuracy occurs because the depletion of the battery will not be detected by the charger and, hence, the charger may not fully charge the battery.

4.4 Performing an Electronics Bench Test

The purpose of an electronics bench test is to confirm that the internal electronics of the instrument are functioning properly. Data is collected on all channels and several plots are generated to visualize the signals and assess the electronic noise level. The test is completed as follows:

1. Ensure that **test probes** (Section 2.4.3) are installed.

> ⚠ **Test probes need to be installed into the correct ports** because the probes have internal electronic components that bring the readings to approximately mid-scale. The test probes are identified by a label (e.g. T1, S1, S2) on the flat surface of the probe (Figure 5).

2. Rest the VMP-250-IR horizontally on a table or bench, preferably on something soft like open cell foam.
3. Ensure that the USB deck cable connection is NOT plugged into the computer.

> ⓘ If applicable, wait 10 seconds after disconnecting USB Mass Storage from your computer before proceeding.

4. Turn the instrument ON with the magnet (Section 4.1) and wait for 2 minutes. This allows the instrument to boot up and to acquire at least one minute of data. Note: The LED on the rear bulkhead will turn solid when the data logging begins and will turn off after one minute, even though data logging will continue (Section 4.1.3).
5. Turn the instrument OFF by removing the magnet.
6. Connect the USB deck cable to your computer (Section 4.2).
7. Once the mass storage device appears on your computer, transfer the latest data file to your computer.
8. Use either Zissou Essentials or the `quick_bench.m` function found within the ODAS Matlab Library to process the data. This generates at least two figures[11] – time series of the signals measured by the ASTP and inclinometer channels, and spectra computed from the ASTP signals.
9. Verify that the sensor signals are as expected[12]. Values and expected ranges are provided in the Bench Test Checklist (Section A.1).

[11] Additional figures may be generated depending on the installed sensors.
[12] If you have concerns, please contact support@rocklandscientific.com

4.5 Pre-Deployment

The following section provides guidance on the critical steps and checks that should be carried out in the *hour or so* before the deployment of your instrument. It is assumed that regular maintenance on the instrument and general cruise preparation has already been performed.

> ⚠ Pre-deployment preparations and checks must be performed before the instrument is deployed. Do not assume the the instrument is ready for deployment immediately after it is shipped from Rockland.

> ⓘ A one-page summary of the pre-deployment checks is provided in Section A.2. It is encouraged to retain a completed version of the provided checklist and sensor configuration with your deployment notes.

4.5.1 Preparing the instrument

The following checklist describes the steps that should be taken (or re-taken) to prepare your instrument for deployment:

1. Ensure all O-rings and sealing surfaces are clean and undamaged (no scratches or corrosion). O-rings should be lightly greased.
2. Ensure all screws and bolts are tight.
3. Ensure that there is no visible gap between the pressure tube and the front and rear bulkheads.
4. Connect the instrument to your computer (Section 4.2) and use Zissou Essentials to verify that the time of day clock is set correctly to UTC time and that your RDL Memory Module has sufficient space (Section 4.2.2).
5. Ensure that the `setup.cfg` file is updated as necessary before running the bench test (Section A.3).
6. Perform an electronics bench test (Section 4.4) to check that all electronics are functioning properly. Complete a bench test checklist (Section A.1) for your records.
7. If you know which probes you are going to use in your deployment, update the configuration file (`setup.cfg`) with the serial number and calibration values of installed microstructure sensors (if they are calibrated).

   > ⓘ The channel section of your configuration file can be updated during post processing, assuming critical information was recorded in deployment notes.

8. If you are satisfied with your bench test and are finished editing the `setup.cfg` file, seal the MCBH8 connector with its mating dummy plug and secure with the locking sleeve.

9. Ensure the instrument is fully assembled and that all fasteners (including hose clamps) are tight.
10. Assemble the tail section and drag element (Section 3.2), **but do NOT yet attach it to the pressure tube**. Ensure that the brushes are tight together.
11. Ensure that the eyebolt is threaded securely to the rear bulkhead and does not twist.
12. Check the tether and prepare it for deployment (Section 4.5.2).
13. Feed the tether through the tail section and securely attach it to the eyebolt on the rear bulkhead of the instrument (Section 3.4).
14. Attach the tail section to the pressure case. Ensure that the tail section is aligned with the pressure tube.
15. Pre-mark the tether at approximately 5 m and 10 m from the instrument. If using a large vessel, markings at 15 m and 20 m may also be useful. The markings will give a visual indication of how far away the instrument is when recovering (Section 4.6.1).
16. Select and install your microstructure sensors (Section 3.8). Visually inspect each sensor to ensure that there is no obvious damage (Section 2.4.2).
17. Record the serial numbers of the sensors (Figure 25) on the pre-deployment checklist (Section A.2) to include in your records. For the shear probes, you should also note the orientation with respect to the instrument coordinate system (Figure 2).

    > ⓘ It is also recommended that you take a picture of the probe configuration for added record-keeping.

18. The instrument should now be ready for deployment. Turn the instrument on (Section 4.1) if deployment is imminent.
19. Ensure that you have discussed deployment and recovery with the crew and captain before proceeding (Section 4.5.3).

4.5.2 Checking the tether

The importance of the tether cannot be overstated – it is the only way to retrieve the instrument from the water. Prior to deployment:

1. Confirm the tether is in good mechanical condition, so it has its full strength.
2. Confirm that the tether is well attached to the profiler so that it cannot come loose during deployment. We recommend tying the tether to the instrument with a bowline and securing the loose end with either a secondary knot or with electrical tape (Figure 14).

4.5.3 Discussing Ship Operations

Prior to deployment, discuss your operations with the captain and crew of your ship so that they clearly understand that you will be deploying the profiler with an **intentionally slack tether**.

A slack tether deployment is an unusual operation on most ships and the crew may not be familiar with the procedures.

We recommend that you deploy from a ship only if you have a clear and continuous method of communicating with the ship's crew. A leading cause of instrument loss is poor communication with the ship's crew.

Recommendations for items to discuss are as follows:

- **Ship position:** The ship should be oriented so that the tether naturally moves away from the ship. Good practice is to deploy on the windward side, because the wind will push the ship (because of its cross-sectional area) faster than the surrounding water which tends to pull the tether away from the ship. Depending on the intended depth of a profile, local currents may also need to be taken into account. If deploying from the stern, the crew may be able to use the bow thruster (if equipped) to maintain a position such that the stern is pointing into the wind and the tether moves away from the ship.
- **Propeller operating mode:** It is best to deploy the instrument while the propeller is NOT spinning; however, because most ships have variable-pitch motors, there is endless confusion over the terminology of "stopping" the propeller. The correct English language terminology is **"de-clutching"** the propeller, which means the shaft to the propeller is mechanically decoupled from the drive motor. This differs from simply "stopping the propeller", which most captains and mates will interpret as a request to set the pitch angle to zero, while the propeller continues to spin.
- **Contingency plan:** In reality, it is not always possible to operate a ship with a de-clutched propeller. Weather conditions, ship limitations and/or deployment logistics may require that the captain maintain control of the ship's position or orientation. It is important to understand the position of the ships propeller relative to the deployment location on deck. Having a well-established plan for what happens if the tether goes under the ship is of utmost importance. The immediate response should be to de-clutch the propeller, but if the safety of the vessel and/or the crew are threatened, the tether will need to be cut.

4.6 Deployment

After completing the pre-deployment checklist (Section 4.5.1), checking the tether (Section 4.5.2), and discussing ship operations (Section 4.5.3), you are ready for deployment.

> At this point, it is helpful to inform all persons on deck who will be assisting with deployment and recovery that the sensors on the VMP-250-IR are extremely delicate and that the nose of the instrument should be avoided.

> ⚠ Before putting the instrument in the water, turn the instrument on by attaching the magnet. Wait for the LED indicator on the rear of the instrument to become solid ON, indicating that it is recording. The LED will turn off after the 60 seconds (Section 4.1.3).

4.6.1 Downward Profiles

For a downward profile, it is crucial that you manage the tether so that the instrument can fall freely without any ship motions getting transmitted to the instrument through the tether. For very shallow work and for work from very small vessels, the cable can be stored in a large container and the tether is paid out and pulled in by hand. For deeper deployments, a winch is often used to help recover the instrument.

A schematic of the deployment technique for a downward profile is shown in (Figure 35). The procedure is as follows:

1. Turn the instrument on, and ensure that the LED becomes solid for one minute to indicate data acquisition (Section 4.1.3).
2. Lower the instrument into the water by the tether until the instrument is completely submerged. Repeatedly pull on the tether while the instrument is submerged to assist in purging air that may be trapped around the instrument body.
3. Before releasing the instrument, it is useful to flake extra tether in your free hand.
4. Note the time, and then release the instrument.
5. Pay out the tether at a rate faster than the rate at which the instrument is moving away from the ship. You achieve this condition when there are one to two loops (5-10 m) of slack tether near the surface (Figure 35, left). The exact amount is not critical but it is always good to have a few extra meters floating in the water in case you momentarily must stop paying out the tether – for example, to undo a snag.

   > ⚠ Be careful not to provide too much slack near the surface since changing environmental conditions (orientation of the ship, change in wind, etc.) can occur without notice and excess line at the surface can easily be caught by a propeller or thruster.

6. Once the instrument reaches the desired profiling depth based on the “time of flight” (see below), hold the tether until there is tension in the line.
7. Recover the instrument by pulling it to the surface using the tether (Figure 35, right).
8. If doing repeat profiles, you can redeploy the instrument without needing to bring the instrument back on deck. Simply repeat this profiling procedure, starting at step #3. The data for individual profiles can be extracted in post-processing.

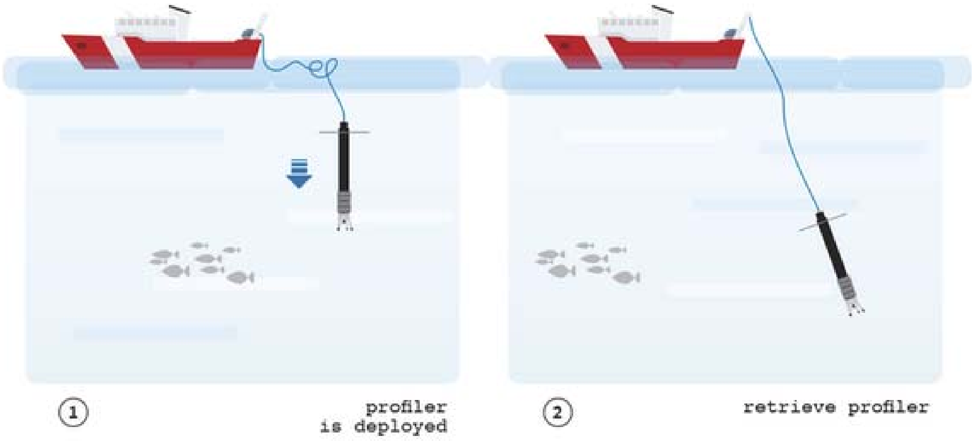

Figure 35: Downward profile of a vertical profiler from the stern of a ship

Profiler Depth Based on "Time of Flight" and Estimated Speed

It is useful to pre-mark the tether in increments of 5-10 m (depending on your target depth of profile); however, the actual amount of line required will increase in windy conditions and strong currents. The most effective way to estimate the depth of the instrument during profiling is by its "time of flight" and estimated speed. The fall-rate (strictly speaking, the rate-of-change of pressure) usually varies by less than 1 or 2 %, unless there is significant drag on the line. A simple procedure to estimate the profiler speed is:

1. Perform an initial short-cast (i.e. half of deployment depth).
2. Measure the time between releasing the instrument and the time you start pulling back the line.
3. Recover the instrument back on deck and download the data from your profile.
4. Observe the depth of the profile using either Zissou Essentials or the `show_ch.m` function in the ODAS MATLAB library.
5. Calculate the fall-rate, either from the figure generated by Zissou Essentials or the `quick_look.m` function.
6. Use these calculations to estimate the time to reach your target depth for your next profile (i.e. time = depth / speed).
7. You may have to add extra time to your estimate (depending on the depth of profile) to account for the time it takes to remove all the slack in the line as the instrument is descending, especially if you plan to profile close to the bottom.

> ⚠ If profiling close to the bottom, use caution because the sensors will likely break if they contact the bottom.

4.6.2 Additional Deployment Tips

Even if you believe you have achieved a "good profile" on your first cast, it is always good practice to perform multiple profiles at a station. This will allow you to compare the data between profiles, which will increase your confidence in the quality of your data. Multiple profiles will also insure you against bad profiles due to poor execution during deployment.

4.7 Post-Deployment

Once you have completed your profiling, recover the instrument and lift it back on deck. It is then recommended that you:

1. Turn the instrument off by removing the magnet.
2. Monitor the instrument's battery, especially if you are deploying it often. When possible, connect the instrument to the battery charger to charge between profiles (or stations).

   > ⓘ A VMP-250-IR with a full configuration of sensors can maintain a full battery if allowed to charge for 20 min for every few hours of profiling.

3. If possible, download and review your data. Although there is an estimated 2100 hours for 64 GB of storage, reviewing and copying your data off the instrument frequently is encouraged. It can help to:
   - identify poor quality profiles (i.e. due to poor deployment execution)
   - identify broken probes
   - identify corruption of the memory module
   - back up the data in case of memory module corruption or loss of your instrument

   Refer to the Section 4.2 for instructions on how to safely download the data files.
4. If you are finished data collection for an extended period, it is recommended that you thoroughly rinse the instrument with fresh water and replace your microstructure sensors with test probes.

   > ⚠ Rinse all sensors with fresh water and ensure they are dry before storage. The microstructure probes should be very gently rinsed with a stream of fresh water to remove any residual salt from the stainless steel stings and sensing tips. Probes should then be dried with dry air (i. e. compressed air). **It is extremely important to avoid getting water or debris inside the probe cavity or on the probe connector.**

5 Maintenance

This section discusses best practices and critical steps for maintaining your instrument and its sensors. General procedures are outlined in the following sections and should be followed after every deployment. Suggested timelines are described in Section 5.1 and specific details about O-rings, sealing surfaces and corrosion prevention are outlined in Sections 5.2, 5.3 and 5.4, respectively. The maintenance of particular sensors is described in Section 5.5. The tools and supplies required to perform essential maintenance on the instrument are listed in Table 8. The maintenance drawing is provided in Section A.8.

> ⚠ Post-cruise maintenance MUST be performed upon returning to shore after every cruise. Good maintenance is critical to prevent corrosion during storage.

Table 8: Tools and supplies required to perform maintenance on the VMP-250-IR

Item	Purpose
Tools supplied with instrument	Disassembly of the instrument (See Section 3)
Spare O-rings (Spares Kit)	Replacing O-rings (annually or as needed)
Spare anodes (Spares Kit)	Replacing anodes (as needed)
Source of fresh water	Rinsing the instrument after deployment
Container of fresh water	Rinsing small components
Wood or plastic tooth pick (or similar)	Removing O-rings from grooves
Lint-free wipes (e.g. Kimwipes)	Cleaning O-rings and sealing surfaces
Isopropyl Alcohol	Cleaning O-rings and sealing surfaces
Wax string	Removing O-rings from bulkhead connectors
O-ring grease (e.g. Dow Corning 4)	Lubricating O-rings

5.1 Timelines

The integrity of your instrument can be ensured through proper maintenance practices that are carried out during and after every cruise. It is also important to ensure that your instrument is properly stored.

5.1.1 During Cruises

During a cruise, it is recommended that you **rinse the VMP-250-IR with fresh water whenever the instrument is on deck** for an extended period of time. Remove as much saltwater as possible.

> ⚠ Be careful to not direct any high-pressure water at the pressure transducer.

5.1.2 Immediately after Last Deployment

On deck, after the last deployment:

1. Thoroughly rinse the VMP-250-IR with fresh water.
2. Before removing the probes from the instrument, gently rinse the microstructure probes with fresh water.
3. Dry the stings of the microstructure probes and around the probe nuts using dry, compressed air.
4. Carefully remove the microstructure probes ensuring water does not enter probe ports.

> ⚠ Avoid getting water on the SMC connector of a probe as it may cause damage to the connector.

5. Install test probes (Section 3.8).
6. Flush pressure port with fresh water, soak for 60 seconds then blow dry with clean dry air. Ready for storage.

5.1.3 Post-Cruise Disassembly and Maintenance

As soon as possible after the last deployment (and possibly back on shore):

1. Gather maintenance supplies (Table 8). Have a pail of clean fresh water available.
2. Disassemble the instrument. As you disassemble the instrument, place small components into the fresh water to remove any residual salt or debris. The disassembly sequence is as follows:
   i) Remove sensor guard (Section 3.1).
   ii) Remove the test probes (Section 3.8). Clean each probe O-ring.
   iii) Remove rear bulkhead (Section 3.6.1). Clean pressure tube O-ring.
   iv) Remove components from the rear bulkhead (Section 3.6.2) and clean O-rings. Refer to Section 5.2.2 for particular guidance on the bulkhead connectors.
   v) Remove pressure tube (Section 3.6.3). Clean O-ring on front bulkhead. (Note: You will have to slide it over the internal electronics frame.)
3. Wipe sealing surfaces with a damp, lint-free cloth or towel using fresh water to remove residual salt. Clean sealing surfaces with isopropyl alcohol.
4. Inspect O-rings and replace any that are no longer in good working condition (see Section 5.2).
5. Once components are rinsed and dry, reassemble the instrument in the reverse order. As necessary (Section 3.7):
   - Inspect sealing surfaces for debris, corrosion and/or scratches (Section 5.3).
   - Re-grease and re-install O-rings.
6. Ensure VMP-250-IR's battery is fully charged (Section 4.3).

5.1.4 Annually

To ensure the longevity of your instrument, it is recommended that you perform annual maintenance on your VMP-250-IR. In particular, you should:

- Complete the post cruise maintenance disassembly procedure (Section 5.1.3).
- **Replace O-rings with new O-rings** (See Section 5.2 for more details).
- Ensure VMP-250-IR's battery is fully charged (Section 4.3).
- Perform a 60 second electronics bench test on the VMP-250-IR. See Section 4.4 for detailed instructions.

> Rockland provides an annual instrument maintenance package for the VMP-250-IR. For more information, contact support@rocklandscientific.com.

5.1.5 Preparation for Storage and Shipping

To prepare your instrument for **storage**:

1. Perform post-cruise maintenance (Section 5.1.2).

   > Ensure the VMP-250-IR and all of its exposed (i.e. wetted) components have been rinsed with clean fresh water and dried.

2. Ensure VMP-250-IR's battery is fully charged (Section 4.3).
3. Place in a clean and dry storage area.

To prepare your instrument for **shipping**:

1. To avoid corrosion, please ensure instrument is completely dry before putting in shipping case.
2. Please see relevant shipping regulations for shipping Li-Ion battery.

   > See Li-Ion battery information and specification sheet in Section A.9.

3. Rockland recommends shipping the Li-Ion battery at 30% capacity.
4. If flying with the VMP-250-IR as checked luggage, remove the Li-Ion battery and put it in carry on luggage. The CR2032 can remain inside the assembled instrument, but any spare CR2032 batteries need to be in carry on luggage. Because rules about air transport of batteries change frequently, please be sure to check the latest regulations.

5.2 O-Rings

O-rings are a critical component of your instrument. They provide the barrier that prevents water ingress into your instrument. Proper maintenance, care and installation of O-rings is very important. O-rings are inexpensive and disposable components that need to be replaced regularly. The locations of the O-rings in the VMP-250-IR are summarized in Table 9 and identified in Section A.8.

⚠ O-rings stored under compression must be replaced **annually** to avoid water ingress due to compression set (flattening). When in doubt, replace used O-rings with a fresh set.

Table 9: O-rings and replacement recommendations for the VMP-250-IR

O-ring location	Qty.	Specification	Replacement Interval
Pressure tube to bulkheads	2	2-150 Buna-N, 70A	Annually or pre-deployment
Microstructure Probes	1/probe	2-012 Buna-N, 70A	Annually or pre-deployment
Sealing nut	2	2-012 Buna-N, 70A	Annually or pre-deployment
LED Indicator	1	2-014, Buna-N, 70A	Annually or pre-deployment
MCBH Connector	2	2-014, Buna-N, 70A	Annually or pre-deployment
CT/CLTU sensor port dummy cap	1	JIS-2401, P10A Buna-N, 70A	Annually or pre-deployment
CT to front bulkhead	1	JIS-2401, P10A Buna-N, 70A	Annually (by Rockland)
CLTU to front bulkhead	1	JIS-2401, P10A Buna-N, 70A	Annually (by Rockland)

5.2.1 Inspecting and installing an O-ring:

In general, O-rings can be inspected and maintained as follows:

1. Remove the O-ring from the instrument.
2. Rinse with clean fresh water.
3. Clean with isopropyl alcohol.
4. Dry with lint-free wipes (e.g. Kimwipes).
5. Inspect the O-ring for debris and/or imperfections such as scratches, wear and tear or compression set. If in poor condition, or an O-ring has been installed for one year or more, then replace it. **If in doubt, then replace.**

To install an O-ring:

1. Re-inspect the O-ring for debris and/or imperfections such as scratches or disfiguration.

2. Grease the O-ring.

> A variety of O-ring grease brands may be used. Rockland Scientific recommends Dow Corning 4 Electrical Insulating Compound.

3. Install the O-ring into the correct location ensuring it isn't pinched.

5.2.2 Helpful Tips for the VMP-250-IR O-rings

- **Microstructure Probes**: The one O-ring for each of the microstructure sensors should only have a very light coating of grease; there should be no excess.

> Excess grease on microstructure probe O-rings can make it easier for a probe to be rotated after the probe holder has been properly tightened.

- **Bulkhead Connector(s)**: To remove the connector O-rings, thread string around the O-ring and pass both ends of the string through the threaded hole (Figure 36). Gently pull on the string to pass the O-ring through the hole and around the wiring harness. Reverse these steps to replace this O-ring.

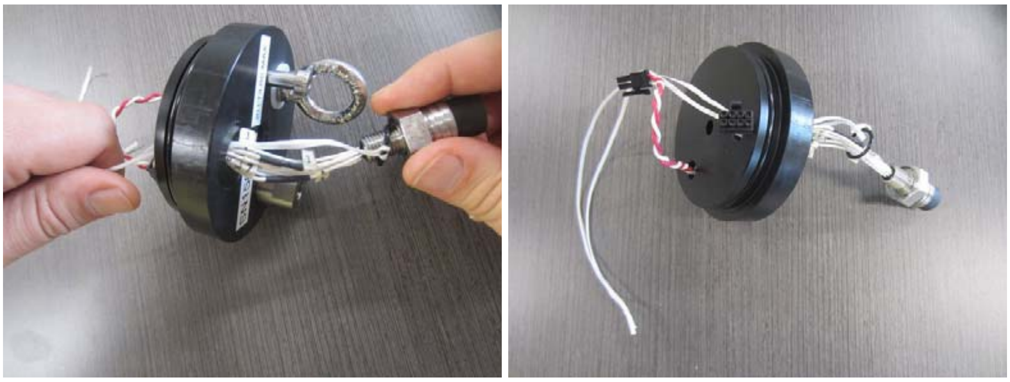

Figure 36: Removal of an O-ring from an MCBH connector (a MicroCTD is pictured).

- **CT/CLTU Sensors**: The O-rings located behind the CT and CLTU (optional) sensors are not user replaceable and we recommend the user contact Rockland Scientific for their replacement. This can be completed during the recommended annual maintenance and inspection of your instrument by Rockland.
- **CT/CLTU Sensor Port Dummy Cap**: If you do not have a CLTU installed, in its place will be a diamond shape dummy cap. Replace the O-ring behind the dummy cap annually. After replacing the O-ring, re-assemble the dummy cap, ensuring there is no gap between the cap and the front bulkhead. Do not overtighten the screws on the cap.

5.3 Sealing Surfaces

Sealing surfaces are the surfaces that O-rings contact to create a water tight seal (Figure 37). Sealing surfaces are carefully engineered to ensure your instrument remains watertight. Any debris, corrosion, scratches or damage to sealing surfaces may allow water to leak past the O-ring and enter your instrument. Proper maintenance and inspection of sealing surfaces is critical to ensure your instrument does not flood with water when deployed.

⚠ Clean sealing surfaces with isopropyl alcohol. Then inspect each sealing surface visually for damage or debris. It may be helpful to use a flashlight and/or pass your finger over the surface to feel for the presence of scratches or debris.

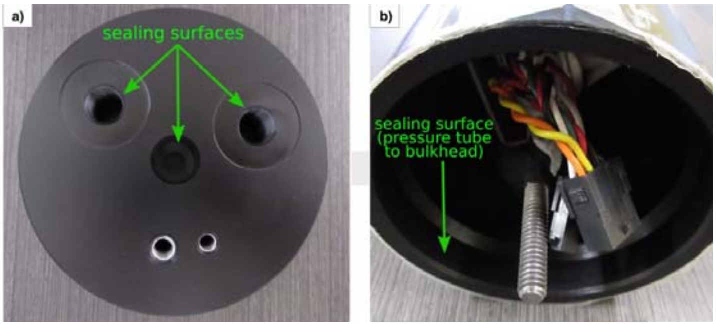

Figure 37: Typical sealing surfaces for a (a) rear bulkhead, and (b) pressure tube. (Note: A MicroCTD bulkhead and tube are pictured.)

5.4 Corrosion Prevention

Corrosion prevention is an easy to overlook, yet critical practice for operating in the corrosive environment of the ocean. Early detection and good maintenance practices are the best defense to protect your instrument against extensive corrosion.

⚠ To best avoid corrosion, ensure the instrument has been rinsed with clean freshwater and dry thoroughly before storing or returning to the shipping case. Post cruise maintenance must be performed soon after deployment.

5.4.1 Pressure Tube and Bulkheads

The pressure tube and rear bulkhead of the VMP-250-IR are made of aluminum and are, therefore, susceptible to corrosion. Three components of the VMP-250-IR that are designed to protect it against corrosion are:

1. **Black anodization layer:** The pressure tube and rear bulkhead have an oxidization layer added to their surfaces that protects the aluminum from corrosion when in contact with

seawater. Note that this layer is non-conductive.

> ⚠ Avoid scratching the black anodized layer. It is recommended that any scratches in the anodization layer be washed, dried and treated with nail polish. See blog post link provided in the footnote.

2. **Copper tab:** The tab on the inside of the rear bulkhead contacts the inside of the pressure tube where the anodized layer has been intentionally removed. This tab electrically connects the tube to the rear bulkhead and its anode.

   > ⚠ Ensure that the copper tab is not bent and is contacting the inside of the pressure tube. Polish the top of the tab to make it shiny.

3. **Aluminum anode:** An aluminum anode is located on the rear bulkhead and is electrically connected to both the rear bulkhead and the pressure tube.

   To check the functionality of the anode, use a multimeter to confirm that it is electrically connected to the bulkhead and pressure tube. More specifically:

   (i) remove the main pressure tube,

   (ii) place the rear bulkhead into one end of the tube,

   (iii) use a multimeter to conduct check electrical connectivity between the anode and the bare aluminium strip inside the other end of the pressure tube.

   If there is no continuity, try bending the copper tab slightly so it makes contact with the pressure tube (Figure 38).

Additional information on corrosion protection is provided in a detailed blog post on Rockland Scientific's website[13].

> ⚠ The anodic protection only works while the instrument is submerged in seawater. When in air, any residual sea water will cause corrosion to occur at vulnerable sites.

Despite these precautions, **corrosion can still occur**, particularly during long deployments. Pitting is a common manifestation of corrosion that can vary in severity. If it occurs on or around any of the sealing surfaces (Figure 39, left) the affected component should be replaced, whereas pitting on the exterior surface of your instrument (Figure 39, right) may not require immediate replacement, however should be monitored. In many cases, the depth of a pit is much greater than the width and even if the corrosion is away from a sealing surface, it

[13] https://rocklandscientific.com/support/corrosion-prevention-anodes-nail-polish-continuity-checks/

can severely compromise the structural integrity of the pressure case component.

> ⚠ For ALL cases of corrosion, please contact support@rocklandscientific.com and, if possible, include photos of the corrosion to help Rockland staff identify the severity of the problem.

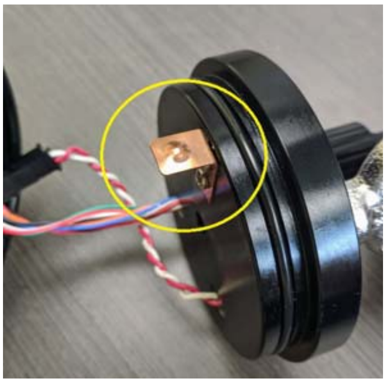

Figure 38: The copper tab provides electrical continuity between the rear bulkhead and the bare aluminium strip inside the end of the pressure tube.

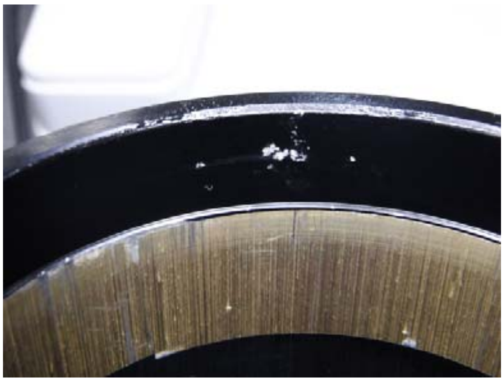

Figure 39: Pitting corrosion on the sealing surface of a VMP-250-IR Pressure tube near where the O-ring sits.

5.4.2 Probe SMC Connectors

Each probe connects to a SMC connector (Figure 40). The connector is susceptible to corrosion because it is frequently in proximity of water. To minimize the likelihood of corrosion, it is recommended that you:

- Always ensure the area around the probe nut is dry before removing the probe from the instrument.
- Avoid handling the probe connectors with wet hands.
- Avoid installing or removing probes when there is risk of water entering the probe port.

Conducting a bench test with test probes installed (Section 4.4), can help to reveal if corrosion is causing noise in the microstructure channels. Contact support@rocklandscientific.com if your bench test fails the Bench Test Checklist (Section A.1)[14].

Figure 40: Green corrosion on the inside pin of an SMC connector. Without corrosion, the pin would appear shiny and gold.

5.4.3 Underwater Connectors

Corrosion can appear on the metallic pins of an underwater connector. This is an indication that the connector was either not connected properly or the seals in the parts of the connection have failed. Check and change the O-rings and check all the sealing surfaces for contamination or damage.

The bulkhead connectors on the VMP-250-IR can be treated with O-ring grease as per the manufacturer's specifications (Figure 41).

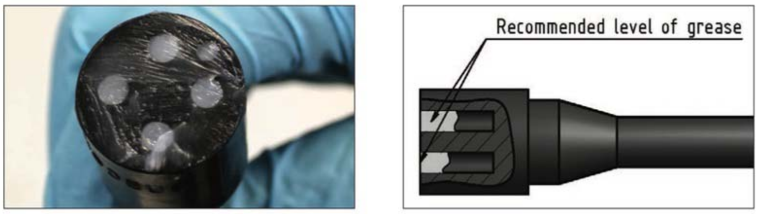

Figure 41: Applying grease to a MCBH connector. (Image source: SubConn and McCartney Underwater Connector Group (2018). *Underwater and Harsh Environment Connectors*. p. 122.[15])

[14] The ASTP Calibration Report that shipped with your instrument can also be used as a reference for the expected noise spectra.

[15] https://www.macartney.com/what-we-offer/systems-and-products/connectors/subconn/subconn-book/

5.5 Probes and Sensors

The probes and sensors on the VMP-250-IR are very fragile and need to be properly maintained. Recommended procedures are outlined below.

5.5.1 Shear Probe

Shear probes are extremely fragile and should be handled carefully. Before removing the shear probe from the instrument, rinse it with gently flowing water and allow it to dry. Blow away residual water with compressed clean dry air (e.g. compressed air can). Between deployments, store the probes in their protective sheaths.

> ⚠ The shear probe is extremely fragile. Never touch the silicone tip with any solid object, including hair, clothing or a Kimwipe.

To determine if a probe is broken, first conduct a visual inspection to check if the white mantle housing the peizo ceramic beam inside the probe tip is straight in line with the main axis of the probe. A bent mantle and beam almost certainly means the probe is broken (Figure 42).

Figure 42: A shear probe with a crack in the silicone tip.

The integrity of the piezo-ceramic can be checked by measuring the capacitance and the resistance (see note) of the probe using a high quality digital multimeter and a high quality Giga-ohm meter. Nominal values are:

- capacitance: greater than 0.7 nF
- resistance: greater than 50 GΩ

If the capacitance is 0.7 nF or less, then the probe is broken. Check the probe capacitance value listed on the most recent shear probe calibration report. A significant drop in capacitance (near half the original value) is a clear sign the probe is broken.

> ⚠ To check the resistance, use a Giga-ohm meter with an input voltage of no more than 50 V. Otherwise you will damage the probe.

To avoid electric shock, do not hold the shear probe when testing the resistance with the Giga-ohm meter.

Even for an unbroken shear probe, **the sensitivity can change over time** due to aging and repeated use. While there is no observed historical trend for sensitivity changes of our shear probes, we recommend that the probes are recalibrated annually, or before and after a deployment.

If you wish to recalibrate your probes before your cruise, we recommend you allow 4 - 6 weeks before you need your probes back before your cruise.

5.5.2 FP07 Temperature Probe

The FP07 temperature probes are extremely fragile and should be handled carefully. When installing microstructure probes (Section 3.8), it is recommended that you install the FP07s last (i.e. after the shear and SBE7 probes). Similarly, you should also remove the FP07 probes first. Before removing the FP07 probe from the instrument, rinse it with gently flowing water and allow it to dry. Blow away residual water with compressed clean dry air (e.g. compressed air can). Between deployments, store the probes in their protective sheaths.

The FP07 temperature probe is extremely fragile. Never touch glass tip with any solid object including hair, clothing, or a Kimwipe.

To determine if a probe is broken, confirm by visual inspection (using a microscope or magnifying lens) that the glass tip is free of cracks or fissures. Also, confirm that the small sensing tip on top of the glass body is visible and intact (Figure 43).

Figure 43: FP07 thermistor. The small sensing tip is indicated by the red arrow.

The health of the probe can also be checked using a high quality digital multimeter (Fluke brand) to measure the resistance of the probe (in air). At room temperature, the resistance should be approximately $\sim$2 kΩ ($\pm$25%). An open circuit or short circuit means the probe is broken.

> Be careful not to damage the small pin in the probe connector when measuring resistance.

Temperature sensors are typically un-calibrated. We recommend using the reference CT data to perform an *in situ* calibration. For more information refer to the Zissou Essentials User Guide or Technical Note 039 (Section 2.3.5). If you ordered a calibrated temperature sensor, note that **its sensitivity can change over time** due to aging and use of the sensor. While there is no observed historical trend for sensitivity changes of our temperature probes, we recommend that they are recalibrated annually, or before or after a cruise.

> Temperature sensors are typically un-calibrated, however, if you wish to recalibrate your probe before your cruise, we recommend you allow 4 - 6 weeks before you need your probe back before your cruise.

5.5.3 SBE7 Micro-Conductivity Sensor (Optional)

The SBE7 sensor is manufactured by Sea-Bird and their recommendations for preparing and storing their conductivity sensors are described in Technical Note 033.

To determine if the micro-conductivity sensor is broken, first do a visual inspection. Bent or broken probe tips are a clear sign of damage. Check (with a magnifying glass or microscope) for any deposits on the black contact surfaces of the tips.

If the micro-conductivity sensors have visible discoloring on their tips (e.g. gray or brown spots), we recommend cleaning the micro-conductivity sensor as follows:

1. Soak the sensors in 1% Triton X-100[16] for 10 minutes. Triton X-100 is a powerful wetting agent that quickly removes particulate stains and some oils and greases.
2. Rinse the sensors with distilled water and let them dry.
3. Conduct a visual inspection with magnifying glass and confirm that the electrodes return to a “jet black” appearance.
4. Soak the sensors in 0.1% Triton X-100 for 16 hours.
5. Rinse with distilled water. Air dry for one hour.
6. The micro-conductivity sensors should be stored with their “syringe” style protectors and kept dry.

[16]Triton X-100 is Octyl Phenol Ethoxylate produced by the J.T. Baker Company. This, or its equivalent, should be readily available from a local chemical supplier.

> ⚠ Subsequent reuse of these sensors should be preceded with a soaking in 0.1% Triton X-100 for one hour, followed by a quick rising with clean water. Pre-soaking the probe tips is essential for retaining the sensitivity of the probe.

5.5.4 Pressure Sensor

The pressure sensor (transducer) is located on the nose of the instrument (Figure 3), it is protected by the probe clamp plate. The front face of the transducer contains a thin diaphragm that is very delicate. Care should be taken to prevent accidental puncture or damage to this sensor (Figure 44). Rinsing with fresh water is sufficient to clean this sensor. If you suspect that your pressure sensor is damaged, contact support@rocklandscientific.com.

> ⚠ Do not wipe or poke the pressure sensor.

Figure 44: A dent visible on the thin diaphragm of a PA10L pressure sensor

5.5.5 JFE Advantech CT Sensor

For maintenance of the CT sensor, it is recommended that you return the VMP-250-IR back to Rockland Scientific because it is not possible for the user to replace the O-ring behind this sensor. It is also recommended that the instrument be returned to Rockland for re-calibration of the CT because this sensor is used as a stable reference for the FP07 and (optional) SBE7 measurements.

> ⓘ **Cleaning the CT Sensor:** If you observe biofouling on the CT sensor or the sensor is dirty, the sensor manufacturer advises to wash the sensor with water and gentle soap. A pipe cleaning brush with soft bristles can be used in the conductivity cell. Be careful not to damage the temperature sensor when cleaning.

5.5.6 JFE Advantech CLTU Sensor (Optional)

For maintenance of the CLTU sensor, it is recommended that you return the VMP-250-IR back to Rockland Scientific because it is not possible for the user to replace the O-ring behind this sensor.

The CLTU sensor has six blue LEDs and two infra-red emitters (Figure 45). If the LEDs do not light up, there is likely a problem with your sensor.

> ⓘ Avoid touching the glass sensing face. Oils from fingers may skew the measurements.

Figure 45: A functioning CLTU sensor.

5.6 Drag Brushes

After a deployment, drag brushes should be rinsed to remove any residual salt. The brushes should be stored flat when not in use for prolonged periods of time to keep the filaments from bending. Bent filaments will cause the brush to produce uneven drag around its circumference.

> ⚠ If the brush filaments become bent, place them on a flat surface in a warm environment to allow them to spring back to a straight form.

5.7 Drag Net

After a deployment, drag nets should be rinsed to remove any residual salt and allowed to dry. Inspect for any damage. The net should be stored flat when not in use for prolonged periods of time.

6 Troubleshooting

This section discusses how to troubleshoot some commonly reported issues you may experience. If the information below does not address the issue you are experiencing or you are still having difficulties, contact Rockland Scientific.

6.1 Unable to turn the instrument on

If the Data Drive doesn't appear when the USB is plugged in to the computer, then it is possible that the laptop or computer USB port can't supply power or has a poor USB link. Use the supplied USB Hub cable between the deck cable and the computer to ensure a good connection.

If the instrument refuses to turn on when the magnet is attached to the front bulkhead (see Section 4.1) – check the voltage of the rechargeable lithium-ion battery pack (see Section 4.3). If the Li-ion battery pack is above 14 V, then it is likely that a fuse has blown.

To troubleshoot the issue, it is recommended that you:

1. For the instruments equipped with a R01 or R02 P113 RDL board there is an input power fuse wired between the rear bulkhead and the Rockland Data Logger board (Figure 46). Check the fuse on a R01 or R02 can be done by opening the fuse holder and removing the cartridge fuse. The fuse is blown if the fine wire inside the glass body is broken, or if a measurement across the fuse indicates "open" on the multi-meter. For instruments equipped with the R03 P113 board there is a resetting fuse on the board. There is no in-line cartridge fuse in the wiring. If the instrument fails to turn on when the main battery is fully charged this fuse may have tripped. Wait 15 minutes for the fuse to reset before trying again. If the resetting fuse trips again there is a problem elsewhere in the electronics that is causing the high current draw. Contact Rockland for support.

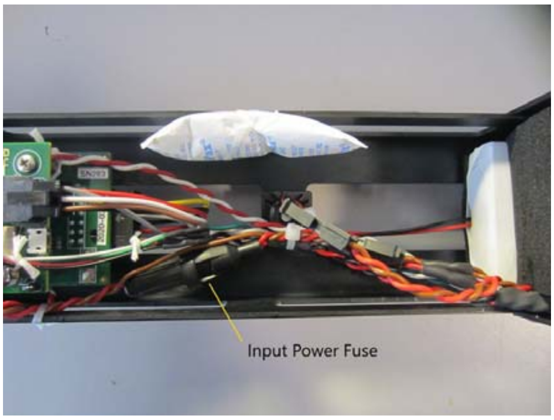

Figure 46: Input fuse wired in-line between the rear bulkhead and the Rockland Data Logger board for instruments with R01 or R02 RDL boards.

2. If that fuse is functional, then check the 1 A fuse, labelled "R1", that is located on the underside of the power supply board (Figure 47). To check while the fuse is installed, first disconnect the main battery and then use your multi-meter to measure the resistance of the fuse. It should be greater than 0 Ω.

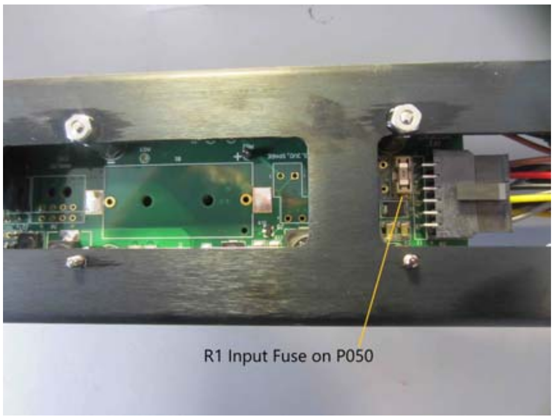

Figure 47: R1 fuse on the Power Supply board (P050).

6.2 Instrument is not charging correctly

If the instrument is not charging correctly follow the steps below:

- Try plugging the charger into the power socket before plugging in to the instrument.
- Try charging the instrument when the instrument is turned off.
- Confirm correct output – i.e. 17 VDC – of the Smart Charger using a multimeter.
- Determine the age of the main battery, it may need to be replaced. The main battery is only designed for approximately 1000 charge cycles (typically 3 to 5 years depending on use). If the main battery is old, the performance may be reduced. Contact Rockland to request a replacement battery.

6.3 Cannot establish a connection to the instrument

If the instrument turns on, but the mass storage does not appear, then use a USB powered hub to boost the power and communication connection. If you are still unable to communicate with the instrument, contact Rockland Scientific.

6.4 Data corruption

The Rockland Data Logger board is equipped with a supercapacitor to provide the system with the required resources to gracefully shutdown even in instances of power loss. This design significantly reduces the odds of corrupting the File Allocation Table (FAT) of the RDL Memory Module; however, it is still possible to corrupt the drive.

In the event of FAT corruption, the Rockland Data Logger board will not mount the drive, and your instrument will not launch data acquisition. FAT corruption can be fixed by the following procedure:

- Connect your instrument to a computer (Section 4.2).
- Use the disk formatting tool provided by your operating system to reformat the memory module as `exFAT`. This will result in all files on the drive being deleted.
- Copy back your `setup.cfg` file onto the Data Drive; otherwise, if data logging is started when no `setup.cfg` file is on the drive, the Rockland Data Logger will use the factory default `setup.cfg` that is stored in the onboard memory. If the factory default is used, a file named `MISSING_SETUP_FACTORY_SETUP_USED.txt` will be placed in the directory.

> Ejecting the Rockland Data Logger drive before disconnecting the instrument reduces your chances of corrupting the memory module's FAT.

6.5 Noisy data on microstructure channels

Noisy data, which is broad-banded in frequency, can be an indication of damaged electronics or a broken probe (refer to Section 6.8). Damaged electronics are most likely caused by the presence of moisture and/or salt and caution MUST be taken to **ensure that water does not contact the probe connections (SMC)**. To check for the presence of moisture and/or salt:

1. Visually inspect the probe port.
2. Inspect the SMC connector on the Test Probes and the real probes. Check the SMC cables and feedthroughs for signs of discolouration (i.e. biological growth, corrosion). Ensure the clear heatshrink is in place on the SMC connectors on the cables.
3. Check each probe port o-ring and ferrule assembly. Verify the o-rings are in good shape and the ferrules are not distorted. Check the o-ring sealing surface in the port.
4. Conduct an electronics bench test with the test probes installed (Section 4.4). Ensure that your test probes do not show signs of damage and/or corrosion.
5. Review your bench test and compare it with the bench test in your ASTP Calibration Report. Water damage to your connectors will result in increased noise across the frequency spectrum.
    - If you observe increased noise on a **shear** channel, then we suggest the following tests:
        (i) Remove the test probe and do a bench test. If the problem is resolved by the

removal of the probe, then the *test probe may need to be replaced*. On the other hand, if the noise still persists, contact Rockland support[17].

- If you observe increased noise on one of the **thermistor** channels, then we suggest the following tests if you have two T test probes:
    (i) Swap the T1 and T2 test probes and do a bench test. If the noise is now on the opposite channel, then the *test probe may need to be replaced*.

> ⚠ If you suspect that saltwater has contacted the probe connections and/or you want assistance interpreting your bench test data, contact Rockland Scientific.

6.6 The instrument isn't falling correctly

Most problems with unsteady speed during profiling are due to improper use of the tether during deployment. Refer to the deployment section (Section 4.6) of this manual for guidance on how to perform a proper profile.

6.7 The speed of the instrument is being calculated incorrectly

If your profiling speed is erroneous, or if the measured pressure on deck is not within ±1 dbar, check the pressure coefficients in your configuration file and compare them to the values in your ASTP calibration report. If the issue still exists or you require assistance, contact Rockland Scientific.

6.8 Broken probes and sensors

Refer to Section 5.5 for instruction on determining if your probes or sensors are broken.

6.9 There are large vibrations in the spectra data

If the vibrations in the spectra are substantially large, inspect all all fasteners and components. Make sure they are secured. If the issue still exists or you require assistance, contact Rockland Scientific.

[17] support@rocklandscientific.com

Appendices

A.1 Bench Test Checklist

The bench test checklist included on the following pages provides guidance on the expected signals from an electronics bench test (Section 4.4). If the signals deviate from the expected values, please forward the checklist and the data file to support@rocklandscientific.com.

> The values provided are for a standard instrument.
> Results may vary for custom configurations.

ROCKLAND SCIENTIFIC INTERNATIONAL INC.
520 Dupplin Road, Victoria, B.C. V8Z 1C1
Canada

web: www.RocklandScientific.com
tel: +1-250-370-1688 | fax: +1-250-370-0234
Business No.: 82695-5544

ROCKLAND SCIENTIFIC

Bench Test Review Checklist

Please note that the document format has been optimized for Adobe Acrobat Reader

Conducted by: ______________________________ Date: ____________________

Reviewed by: ______________________________ Date: ____________________

Instrument Type: ___________________________ SN: ______________ Data File: ______________

Notes: ____

Bench Test Instructions:

1. Ensure that test probes are installed on the instrument.
2. Rest the instrument horizontally on a table or bench, preferably on something soft (e.g. open cell foam), with the pressure port/magnet centered and facing up.
3. Collect a minimum 60s data file and transfer to your computer, minimizing vibrations and shocks.
4. Generate figures using Zissou Essentials or the ODAS Matlab Library.

Please refer to your instrument user manual for further details on performing a bench test.

Are there any known factors that could affect the quality of the bench test? E.g. located at the top of a tall urban building, on a ship at sea, excessive electronic noise in the lab, people moving near the instrument?

Time Series Figure

- ☐ Ax and Ay counts are typically within ±500 counts. *Range:* ______________________________
  - ☐ Are there any large spikes in Ax or Ay? ______________________________
- ☐ Ax and Ay are similar to each other, with Ax typically larger than Ay.
- ☐ Incl_T is at a reasonable, constant value (i.e. near room temperature). *Value:* ______________
- ☐ Incl_Y and Incl_X are at reasonable, constant values (based on instrument orientation). *Values:* ____________________
- ☐ T1_dT1 and T2_dT2 counts are typically within ±40 counts. *Range:* ______________________
- ☐ T1_dT1 and T2_dT2 offset values are less than 100 counts (specified in figure legend). *Values:* ____________________
- ☐ sh1 and sh2 counts have a mean of less than 10 counts. *Mean:* ___________________________
- ☐ sh1 and sh2 counts are typically within ±30 counts. *Range:* ______________________________
- ☐ P counts are typically within ±2 counts. *Range:* ____________________
- ☐ P_dP counts are typically within ±10 counts and seemingly random (i.e. no spikes or patterns at regular intervals). *Range:* __________________
- ☐ (If applicable) The C1_dC1 counts are typically within ±50 counts. *Range:* ________________
- ☐ (If applicable) The C1_dC1 offset value is less than 6000 counts (specified in figure legend). *Value:* ______________________

Notes:

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520 Dupplin Road, Victoria, B.C. V8Z 1C1
Canada

web: www.RocklandScientific.com
tel: +1-250-370-1688 | fax: +1-250-370-0234
Business No.: 82695-5544

Spectra Figure

- ☐ P_dP shows a spectral density everywhere less than 10^1 counts^2/Hz.
- ☐ The peak of P_dP is less than 3 counts^2/Hz, and rolls off at approximately 2 Hz.
- ☐ The spectral peaks of Ax and Ay are below 10^2 counts^2/Hz, provided the instrument is well cushioned.
- ☐ Ax and Ay are similar to each other.
- ☐ T1 and T2 are similar to each other.
- ☐ T1 and T2 follow rising curves with spectral density of approximately 10^{-1} counts^2/Hz near 10^2 Hz.
- ☐ sh1 and sh2 are similar to each other.
- ☐ sh1 and sh2 follow rising curves with spectral density of approximately 10^{-2} counts^2/Hz near 10^2 Hz.
- ☐ (If applicable) C1 follows a rising curve with spectral density of approximately 10^0 counts^2/Hz near 10^2 Hz.

Please note that the spectra are expected to follow smooth curves, * *however, narrow band spikes may be visible due to explainable sources, such as: AC electrical field (50 or 60 Hz), EM sensor (15 Hz), and corresponding resonant frequencies. Broad band noise, particularly occurring in only one channel, should be investigated. Please note the presence of any spikes in the Notes below.*

Notes:

* Refer to the ASTP Calibration Report for reference.

Rockland Scientific International Inc.
520 Dupplin Road, Victoria, B.C. V8Z 1C1
Canada

web: www.RocklandScientific.com
tel: +1-250-370-1688 | fax: +1-250-370-0234
Business No.: 82695-5544

(If applicable) CT/CLTU Time Series Figure

- ☐ JAC_T counts are typically within ±50 counts. *Range:* ____________________
- ☐ JAC_C_I counts are typically within ±5 counts. *Range:* ____________________
- ☐ JAC_C_V counts are on the order of 10^4 and have a typical range within ±100 counts. *Range:* ______________
- ☐ Turbidity counts are typically within ±50 counts. *Range:* __________________
- ☐ Chlorophyll counts are typically within ±50 counts. *Range:* ________________

Optional Test: To test for a signal response in the CT and/or CLTU sensors, blow on the temperature sensor and pass a fluorescent object in front of the CLTU sensors. Please note observed responses (i.e. changes in the signal) below.

- ☐ A response is observed after blowing on the temperature sensor. *Response:* ____
- ☐ A response is observed after passing a fluorescent object in front of the turbidity sensor. *Response:* ____
- ☐ A response is observed after passing a fluorescent object in front of the chlorophyll sensor. *Response*: ____

Notes:

(If applicable) EM Current Meter Figure

- ☐ The EMC_Cur (upper plot) signal appears to be of uniform amplitude over the entire dataset. Note: the middle plot shows the first second of this signal.
- ☐ The EMC_Cur (middle plot) signal shows a consistent 15 Hz pattern (i.e. 15 peaks visible over the 1 second interval).
- ☐ Narrow band spikes are visible at 15 Hz intervals (bottom plot). The first spike should occur at 15 Hz, and every second spike will be smaller than the previous one.

Notes:

(If applicable) U_EM Sensor Figure

- ☐ U_EM counts are typically within ±2000 counts. *Range:* __________________
- ☐ In the spectrum, peaks are visible at 10 Hz intervals. The first peaks should occur at approximately 10 Hz.

Notes:

A.2 Pre-Deployment Checklist

The pre-deployment checklist should be completed before EVERY deployment. It is encouraged to retain a completed version of the checklist with your deployment notes.

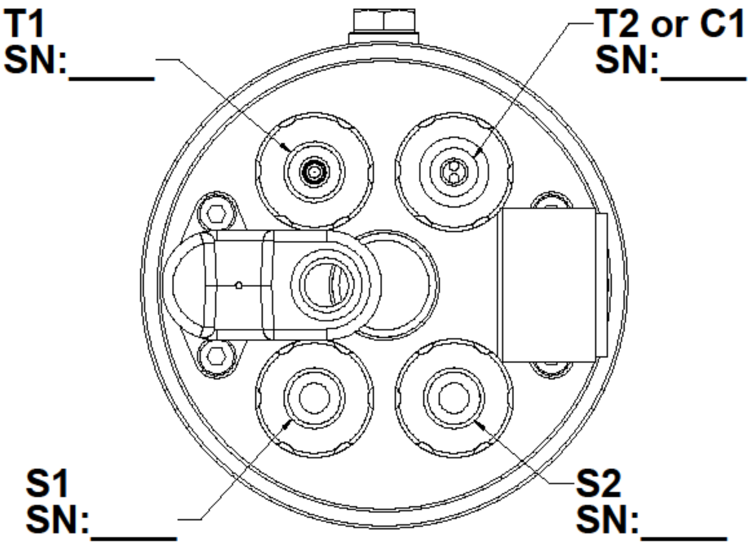
PRE-DEPLOYMENT CHECKLIST

This device is a very sensitive scientific instrument. To ensure proper operation and optimal results please follow the instructions in the instrument user manual.

This checklist summarizes essential pre-deployment steps.

VMP250-IR

- [ ] Read and understand the instrument manual
- [ ] Inspect all sealing surfaces & o-rings on instrument & confirm their integrity
- [ ] Complete bench test checklist with test probes & confirm data acquisition
- [ ] Ensure all probe ports have a greased o-ring and a white ferrule
- [ ] Ensure o-ring and ferrule are in correct order - consult manual for diagram
- [ ] Ensure that all bolts & connectors are secure (consult manual for safe torque rating)
- [ ] Securely attach drag brush, tail assembly & buoyancy collar (if applicable)
- [ ] Tie tether securely to eye bolt
- [ ] Ensure all probes are fully inserted
- [ ] Confirm shear probes are oriented correctly
- [ ] Ensure probe holders are tightened correctly - consult manual
- [ ] Turn on instrument with magnet and monitor LED for confirmation



A.3 Configuration Files

The Rockland configuration file is a standard ASCII[18] text file. The instrument ships with a configuration file on the RDL Memory Module, created specifically for your instrument. The Rockland configuration file serves three purposes:

1. The file contains all settings required to configure the data acquisition. Upon start-up, the data acquisition software parses the configuration file to acquire data accordingly and provide the behaviour specified in the configuration file.
2. The configuration file is also used to store parameters required to convert the recorded raw data to physical units.
3. Finally, the file enables users to store additional information that will be useful for data processing, such as deployment location, cruise information and comments.

A.3.1 Anatomy of a Configuration File

The configuration file is an ASCII file that contains "parameters" and "comments", which are grouped into "sections". Definitions of these components are outlined below.

Parameters

Parameters are information that are stored within a configuration file. Parameters consist of two parts delimited by an equal sign: (i) a name, and (ii) a value. The syntax to specify a parameter is as follows:

```
name=value
```

Each line can have a maximum of one parameter, and an equal sign must separate the name of a parameter from its value. Extra white-space surrounding the name or value is ignored. Thus, `name=value` is equivalent to `name = value`.

Comments

Comments are all characters that follow a semicolon (;). Comments are ignored in data acquisition and data processing, but are still valuable because they can assist in understanding the meaning and value of a parameter. Examples of the use of comments include:

```
; A generic example showing comments.

[section] ; Description of section

parameter = value; Value from probe calibration on 2020-04-22
```

Sections

Sections are used to define groups of parameters. A section declaration must be on its own line and consist of the `name` string enclosed in square brackets ([ ]), i.e.

[18] Configuration files can only contain 7-bit characters - values from 0x00 to 0x7F.

```
[section]
```

The declaration of a section automatically ends the previous section. Sections are referenced by their section identifier, which is a value constructed in one of two ways. First, sections are scanned for a parameter with the name `name`. If present, this parameter value is used as the section identifier. If not found, the `name` in brackets is used as the section identifier.

Root

Parameters declared before the first section declaration are automatically assigned to the root section `[root]`. The parameters in the `root` are used for data acquisition. The `[root]` section may contain parameters that determine the data acquisition and instrument functionality. If parameters are not listed, the default values will be used.

> Using the default parameters for the root section is recommended by Rockland.

An example of a typical root section is:

```
; -----------------
; The [root] section may contain parameters that determine the data
; acquisition and instrument functionality.  If parameters are not listed,
; the default values are recommended, and will be used if applicable to the
; instrument.  For more information about available [root] section parameters,
; refer to your instrument manual or contact support@rocklandscientific.com.
; The [root] section determines the data acquisition parameters.
[root]
; maxFileDuration = 3600 ; in seconds
; maxFileSize = 1 ; in MB
```

For instruments with a Rockland Data Logger, all other parameters in the `[root]` section do NOT need to be specified in the configuration file because they have default values. It is recommended that you use these default values, but in some situations you may wish to change the following data acquisition parameters:

- `prefix`: Controls the naming of the files written to the memory module. The files will be named incrementally with the prefix followed with an incremental number of the file.

  Default = DAT_

- `maxFileDuration`: Controls the length of each data file, <u>in seconds</u>. There is no time delay and therefore no data lost between closing and creating a new file. A new data file will automatically be started once the max file duration has been reached.

  Default = 14400 seconds (4 hours or 117 MB[19])

[19] for an address matrix with eight columns and a sample rate of 512 Hz, see Section 2.5.8

- `maxFileSize`: Controls the maximum size of each data file, in megabytes. There is no time delay and therefore no data lost between closing and creating a new file. A new data file will automatically be started once the max size duration has been reached.

  Default = 200 MB (approximately 6.8 hours[20])

> Both `maxFileDuration` and `maxFileSize` can be declared. The software will create a new file when the smaller of the two conditions is met.

Other parameters in the `[root]` section control the sampling rate and the battery type. Please contact Rockland Support at support@rocklandscientific.com if you wish to change these parameters.

Matrix

The matrix section is used to configure the order of channels acquired and their rate of sampling. Each number in the address matrix corresponds to a channel id. Channel 0 (ground reference) is sometimes used as a filler to maintain the shape of the address matrix. Each row is acquired at the sampling rate (512 Hz if not specified).

```
; -----------------
; The [matrix] section is used to configure the order of channels acquired and
; their rate of sampling.  Each number in the address matrix corresponds to a
; channel id.  Channel 0 (ground reference) is often used as a filler to maintain
; the shape of the address matrix.  Each row is acquired at the sampling rate
; (512 Hz if not specified), therefore, the channels of the first 2 columns will
; be acquired at 64 Hz (512 Hz/8 rows) and the other channels will be acquired
; at 512 Hz.

[matrix]
row01 =  0    0   1   2   5   8   9   52   53   64   65
row02 =  32   40  1   2   5   8   9   52   53   64   65
row03 =  41   42  1   2   5   8   9   52   53   64   65
row04 =  4    0   1   2   5   8   9   52   53   64   65
row05 =  10   11  1   2   5   8   9   52   53   64   65
row06 =  12   48  1   2   5   8   9   52   53   64   65
row07 =  0    49  1   2   5   8   9   52   53   64   65
row08 =  0    50  1   2   5   8   9   52   53   64   65
```

Channels

Channel sections are used to identify each of the channels sampled by the data acquisition system. Each channel listed in the address matrix has a unique channel section which iden-

[20] for an address matrix with eight columns and a sample rate of 512 Hz, see Section 2.5.8

tifies the `name` and `id` of the channel. Additional parameters used to convert the raw data to physical units may also be included in the channel section.

Optional sections

Additional sections can be added to the configuration file to provide additional information that may be relevant for record keeping and/or data-processing. Any relevant information can be stored in these optional sections. For example, your instrument typically ships with an `[instrument_info]` section which includes details about the instrument type and serial number:

```
; -----------------
; This section identifies your instrument.  The vehicle parameter is used for data
; processing.  The other values are for reference only.
[instrument_info]
 vehicle    =  vmp          ; downward-profiling, comment parameter for upward-profiles.
 ; vehicle  =  rvmp         ; upward profiling, uncomment for upward-profiling.
 model      =  VMP250IR-RDL ; the actual model.
 sn         =  401          ; the serial number of the instrument.
```

It is also recommended that you include a `[cruise_info]` section to identify details about the deployment.

A.3.2 Modifying the Configuration File

Adding Values

Information can be added to a configuration file but the resulting file must adhere to the format described in Section A.3.1. In addition, Rockland instruments expect certain sections and parameters to exist, so please exercise care when modifying your configuration file and confirm that it performs data acquisition as expected before your deployment by collecting data with the updated `setup.cfg` file and processing the data.

When adding a new section to the configuration file, make sure that it has a unique name. Never use a parameter with the name `id` because that is used in conjunction with the `[matrix]` section to identify a channel and to demultiplex the data (unless, of course, that channel exists on the instrument and it is identified in the `[matrix]` section).

> ⚠ After making any changes to the configuration file, confirm that it performs data acquisition as expected. Errors in the format of the configuration file may prevent the instrument from collecting data.

Updating Coefficients

Coefficients used for the conversion to physical units may need to be updated, particularly after installing a new probe or sensor or after performing an *in situ* calibration. More specifically, your `setup.cfg` file will need to be updated in the following scenarios:

- After installing a new shear or temperature probe.
- After performing an *in situ* calibration of an FP07 temperature probe.
- After the annual (recommended) shear probe re-calibration.
- After the bi-annual (recommended) JAC-CT sensor re-calibration.
- To zero the pressure sensor (see below).
- After replacing a circuit board.

Zeroing the Pressure Sensor

To zero the pressure sensor, the coefficient `coef0` for the `P` channel needs to be modified. The following method is recommended:

1. Take a one minute data file at the time and place where the pressure should be set to zero (e.g. in air at the deployment location). The procedure to collect the data file is the same as performing an electronics bench test (Section 4.4).
2. Load the data file into Zissou Essentials and plot the pressure channel[21].
3. Estimate the average value of the pressure from the plot.
4. Use this value to adjust the `coef0` in the `P` channel section by subtracting from the existing value. The `setup.cfg` file can be modified using either Zissou Essentials or any text editor.
5. Save the updated `setup.cfg` file to the Data Drive.
6. Take another data file to verify that the value has been zeroed.

[21]The ODAS Matlab Library can also be used to plot the pressure time series using the command `show_ch(filename,'P')`.

A.4 Log files

Your instrument records events that occurred during data acquisition in a log file on the memory module. The log file is named `logfile.txt`. An example of such log file is shown below:

```
5e9f6e24 11 0000 Undefined  --- 2020-04-21 22:05:24.348 - "power applied"
5e9f6e56 10 0000 Undefined  --- 2020-04-21 22:06:14.352 - "start signal received"
5e9f6e56 0b 0001 dat_0002.p --- 2020-04-21 22:06:14.371 - "starting data file"
5e9f7065 0d 01d6 dat_0002.p --- 2020-04-21 22:15:01.030 - "bad buffer"
5e9f7082 11 0000 Undefined  --- 2020-04-21 22:15:30.205 - "power applied"
5e9f70ce 10 0000 Undefined  --- 2020-04-21 22:16:46.212 - "start signal received"
5e9f70ce 0b 0001 dat_0003.p --- 2020-04-21 22:16:46.236 - "starting data file"
```

A.4.1 Log-file Format

Each line in a log-file describes a single event. The first part of each line is in a machine-readable form to support automated scripts. The second part of each line is in human-readable form.

Events are recorded using the following format:

```
          EVENT = {MACHINE_FORMAT} --- {HUMAN_FORMAT}

 MACHINE_FORMAT = {time} {event_type} {record#} {data_file_name}
   HUMAN_FORMAT = {human_time} - "{event_description}" [additional_info]
```

The above fields are defined in Table 10.

Field	Description
`time`	Time of the event, as given by the UNIX "`time`" function. Value is in hexadecimal format and always uses the first 8 characters.
`event_type`	Type of event identified by a two digit hexadecimal number. See Technical Note 052 for a list of event types.
`record#`	The record number during which the event occurred. Formatted as a 4-character hexadecimal value.
`data_file_name`	Name of the data file. If a data file has not been created, the value "`unknown`" is used. This entry always has a width of 10 characters.
`human_time`	Time of the event (HH:MM:SS).
`event_desc`	The event type.
`additional_info`	Optional extra information for the event.

Table 10: Description of log file entries

Refer to Technical Note 052 (Section A.5) for the complete list of event types and differences with CF2 Persistor systems.

A.5 TN 052 – Rockland Data Logger (RDL)

Technical Note 052, which gives an overview of the Rockland Data Logger (RDL), is contained in the following Appendix. The Technical Note discusses important differences between instruments with the RDL and the CF2 Persistor.

RSI Technical Note 052

Rockland Data Logger (RDL)

Overview and Comparison with CF2 Systems

Peter Stern

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Rockland Scientific International Inc.
520 Dupplin Rd
Victoria, BC, CANADA, V8Z 1C1
www.rocklandscientific.com

Contents

1 Revision History

Revision	Date	Description
1.0	2020-11-06	Initial Version
1.1	2020-12-01	Minor typos and phrasing corrections
1.2	2021-01-07	JMM - Removed extra item in table of event types. Fixed typos.
2.0	2021-11-30	Updated for P113R03 hardware and OSv4 Image.

2 Rockland Data Logger (P113 board) Overview

The Rockland Data Logger (RDL) is a third-generation data logging board designed for instruments manufactured by Rockland Scientific Inc. (Rockland). The RDL is designed to replace second-generation data logging systems, which use a Persistor CF2 computer. The RDL is based on a Linux Operating System with custom data acquisition software. The standard mass storage for data is a proprietary 64 GB memory module that is referred to as the “RDL memory module”. The Rockland Data Logger board has a built-in backup energy source (supercapacitor) to ensure that the data logging can shutdown properly when power is removed. There is also a small CR2032 3 V battery that maintains the onboard real-time clock. This battery should be replaced every 4 years. The recommended replacement date is labelled with a sticker at the production facility when the instrument is manufactured.

Previous versions of this TN052 related to the R01 and R02 versions of the RDL hardware and software. This v2.0 adds the P113R03 and OSv4 software capabilities released in the fourth quarter of 2021. The new version of the RDL (R03 for short) adds the capability for ”sleep” mode while datalogging to reduce average power draw; the use of ”interface” software modules to better organize the commands used to interact with the datalogging software; and several other extensions of previous functions.

3 Computer Connection and File Transfer (USB Drive)

The RDL eliminates the need to connect to internally recording instruments using a terminal. Therefore, the only required interaction with the instrument is by viewing the contents of the RDL memory module by connecting to it via the built-in file manager found on any personal computer (i.e. File Explorer, Finder). This has been made possible on the RDL through USB Mass Storage capability. When the USB connector on the deck cable is plugged into the computer, a drive, referred to as the “RDL USB Drive”, will appear in the file manager, similar to viewing a USB thumb drive or external hard drive. Subsequently, files can be opened, deleted or transferred (i.e. drag and drop) between the computer and the instrument.

To access files on the instrument from a computer with read and write permissions:

1. Ensure that the instrument is OFF.

> ⓘ To access the files with read and write permissions, the RDL board must be receiving power (5 V) only from the USB connection.

2. Connect the instrument to your computer (refer to Instrument User Manual).
3. After connecting the USB, wait for the RDL memory module to be detected by the computer. A notification from the computer should indicate when the connection has been established.

> ⓘ It can take up to 60 seconds for a connection to be established because the instrument's operating system must boot up first.

4. Access the files using the built-in file manager (i.e. File Explorer, Finder) on the computer.

> ⓘ When the deck cable USB is disconnected from the computer it is important to wait at least 10 seconds before re-connecting it. This allows time for the electronics to properly shut off.

> ⓘ If data logging is started while connected to the RDL USB Drive, the File Manager will reset and reconnect to the drive. Files on the RDL USB Drive will have read only permission while data acquisition is active. The new files will not be visible while they are being created by the data logging process.

> ⚠ If the RDL memory module becomes corrupted, the File Manager will detect the problem, likely indicating that the RDL USB Drive needs to be reformatted. Use the disk formatting tool of the computer's operating system to reformat the RDL USB Drive. This will delete all the files on the drive, so the `setup.cfg` file will need to be copied back to the RDL USB Drive. If data logging is started when there is no `setup.cfg` file on the drive, the RDL will use the factory default `setup.cfg` that is stored in the onboard memory. A file named `MISSING_SETUP_FACTORY_SETUP_USED.txt` will be placed on the RDL USB Drive if the factory default `setup.cfg` is used.

4 User Interface with Zissou Essentials

The Zissou Essentials software package[1] can be used to interact with the RDL and perform basic tasks. More specifically, the software can be used to:

- Set the instrument clock
- Check the battery voltage
- Display the software version on the instrument
- Review the instrument log file
- Determine the free space on the memory module
- Check for warnings or errors
- Display channel statistics from a record in a previously recorded data file

> Consult the Instrument User Manual for details on how to connect to the instrument with Zissou Essentials.

5 Boot-Up and LED Behaviour

Boot Time

The boot time of a RDL varies depending on the usage of the instrument. More specifically:

- The boot time can take up to two (2) minutes, when the instrument is booted for the first time, or after it has been in storage. This is because the backup energy source needs to charge.
- The boot time is about 40 seconds when the instrument is in regular use because the backup energy source is already charged.

Most instruments, particularly those with an internal battery (e.g. VMP-250-IR, MicroCTD) are configured to start data acquisition automatically, immediately after the boot process is complete.

Instruments that are managed by a host platform may be configured to wait for commands from the host to start and stop data logging. In these configurations, the host platform is connected via a serial port to the RDL.

[1] Version 1.6 released November 2020

LED Behaviour

Instruments that have an external LED installed (e.g. VMP-250-IR, MicroCTD) use the light to indicate the status of the RDL board. More specifically:

1. When the instrument is turned on, the LED will blink 1 second on and 1 second off until the boot process is complete (approximately 40 to 120 seconds).
2. When data logging starts, the LED will turn solid red.
3. After approximately 64 seconds of data logging, the LED will turn off, but data logging will continue.

> ⓘ Rockland instruments that do not have an external LED installed (e.g. MicroRider-1000) follow the same boot up sequence.

6 Power Draw

The RDL draws approximately 0.4 W more power than the CF2 Persistor. The P113R03 hardware and OSv4 software allow for a "sleep" mode to be enabled. When sleep is enabled the system will reduce power consumption when actively datalogging by shutting down the CPU when the data buffers are filling up. The system will wake up to transfer data or when interrupted by external requests. For the power draw of a specific instrument and sensor configuration, consult your Instrument User Manual, or contact Rockland Support at support@rocklandscientific.com.

7 System Shutdown Settings

To protect the system from unexpected power loss there are software and hardware settings to shut the system down gracefully.

For R01 and R02 boards:

- The hardware setting is configured at the factory on the P050 Power Supply circuit board. This will shutdown the instrument when the supply voltage declines to the set cutoff limit.
- In the configuration file (`setup.cfg`) there is a `minSystemVoltage` parameter which is set to 6 V. This is done to allow the hardware setting to be the primary shutdown control (Section 9). In the R01/R02 systems this software setting only stops datalogging, it does not power off the electronics.

> ⓘ This software parameter will stop only the data logging. The RDL board and all other electronics will continue drawing power until the cutoff on the Power Supply is triggered.

For R03/OSv4 boards:

- The P050 hardware setting is set to 7.3 V by default. This is the fail-safe shutdown used if the shutdown signal from the P113 does not work.
- The software controlled shutdown signal is set in the P113-DAQ-INI file with `vbat_cutoff`. This will be appropriately set at the factory for the instrument and its application. The user should not have to change or override this and should not do so without consulting Rockland Support. This software shutdown signals the P050 Power Supply to shutdown the instrument, and only works when the system is awake and logging data.

8 Data Logging

For data logging to start the following conditions must be met:

1. Raw input power applied (7-18VDC)
2. Onboard super-capacitor is fully charged
3. `setup.cfg` file exists and it is correct
4. ON signal applied
5. instrument software is configured to start data logging automatically on boot

For both RDL and CF2 Persistor systems, data is logged in standard Rockland `*.P` format (See Technical Note 051 for more information). A `logfile.txt` is also created and updated to note key events during data acquisition (Section 10).

There are several notable differences between the RDL and CF2 Persistor systems. For RDL systems:

- The control settings for data acquisition are built into the system or are set in the `setup.cfg` configuration file. The user only has the ability to start or stop data acquisition. Unlike for CF2 Persistor systems, the user does not have to set any command line flags to begin data acquisition.
- Data is logged continuously when multiple files are created. This implies that there is no data lost when the software closes the current file and starts a new file.
- Damaged data records, i.e. "bad buffer" events, are now automatically flagged in the data file to reduce any errors during data processing.
- The `logfile.txt` has different event codes (Section 10).

- If data logging exits with an error, then an error log file is copied to the RDL USB Drive. This file will be named `error_log_YYYY-MM-DD_HH-MM-SS`. It contains a series of verbose statements from the different scripts. The file is human readable and may help in troubleshooting the error.

Instruments can be controlled through the command line accessed through the RS232 port. This is typically done with MicroRider class instruments where the supporting vehicle starts and stops datalogging, sets the date/time, and so on.

9 Configuration File (`setup.cfg`)

The `setup.cfg` file for a RDL system is very similar to the file used for the CF2 Persistor systems; however, they are NOT interchangeable. Differences between the `setup.cfg` file for RDL and CF2 Persistor systems are outlined below. A full description of the `setup.cfg` file can be found as an Appendix in the Instrument User Manual.

⚠ The `setup.cfg` file for an instrument with a RDL board **cannot** be used for an instrument with a CF2 Persistor (and vice versa).

Special Character

The special character, i.e. `ch=255`, is **not used** for RDL systems. This character was used to test the integrity of the communication in CF2 Persistor systems.

Root Section

The parameters used for data acquisition are specified in the `[root]` section of the `setup.cfg` file. The parameters used in RDL systems are different than those In CF2 systems. More specifically, the following parameters are **no longer used for RDL systems**:

- `disk`
- `recsize`
- `no-fast`
- `no-slow`
- `num_rows`
- `stop_after_release`
- `max_pressure`
- `man_com_rate`

The other significant difference in the `root` section is that for RDL systems, all parameters have default values that will be used for data acquisition if they are not specified.

> For RDL systems, each parameter in the root section has a default value so it does NOT need to be specified.

For RDL systems, the available parameters in the `[root]` section, and their default values (in square brackets), are as follows:

- `prefix = [DAT_]`
  Controls the naming of the files written to the memory module. The files will be named incrementally with the prefix followed with an incremental number of the file.
- `maxFileDuration = [14400]` seconds (4 hours)
  Controls the length of each data file, in seconds. There is no time delay and therefore no data lost between closing and creating a new file. A new data file will automatically be started once the max file duration has been reached.
- `maxFileSize = [200]` MB (approximately 6.8 hours[2])
  Controls the maximum size of each data file, in megabytes. There is no time delay and therefore no data lost between closing and creating a new file. A new data file will automatically be started once the max size duration has been reached.
- `minSystemVoltage = [xx]` Volts
  For R01/R02 systems this is set to 6 V. For R03 systems this parameter overrides the factory shutdown setting and therefore it is not defined and not used. Do not use this without consulting Rockland Support.

> Both `maxFileDuration` and `maxFileSize` can be declared. The software will create a new file when the smaller of the two conditions is met.

SeaBird Sensor Coefficients

For instruments that have a Seabird SBE3/4 installed, the value of the coefficient `coef5` is different for RDL and CF2 Persistor systems due to hardware differences. More specifically:

- For RDL systems: `coef5 = 38.4e6`
- For CF2 Persistor systems: `coef5 = 24e6`

Pressure Sensor Coefficients (i.e. Zeroing the Pressure Sensor)

In both RDL and CF2 Persistor systems, the parameter `coef0` is used to zero the pressure sensor. For RDL systems, the following method is recommended to determine the coefficient, and hence zero the pressure sensor:

1. Take a one minute data file at the time and place where the pressure should be set to zero (e.g. in air at the deployment location). See the "Electronics Bench Test" section of the Instrument User Manual for detailed instructions.

[2]For an address matrix with eight columns and a sample rate of 512 Hz

2. Load the data file into Zissou Essentials and plot the pressure channel[3].
3. Estimate the average value of the pressure from the plot.
4. Use this value to adjust the `coef0` in the `P` channel section by subtracting from the existing value. The `setup.cfg` file can be modified using either Zissou Essentials or any text editor.
5. Save the updated `setup.cfg` file to the RDL.
6. Take another data file to verify that the value has been zeroed.

Release Parameters

For instruments that are using the release function, such as a VMP-6000 with a ballast release, the parameters in the `setup.cfg` file for RDL systems are all different from those for CF2 Persistor instruments.

To configure the release for RDL systems, the following options, and their default values (in square brackets), can be used:

- `ReleaseEnable = [NO]`
  The global release flag that either allows or prevents the generation of release events. When set to "NO", all release events are prevented. When set to "YES", all configured release mechanisms can generate release events. There is one exception to this rule in that the software can explicitly generate a release even when the release is disabled. All other release events are generated by the FPGA.
  Acceptable Values = `YES` or `NO`
- `PressureReleaseEnable = [YES]`
  Enables release events when pressure exceeds a specified value. This is the most common form of release.
  Acceptable Values = `YES` or `NO`
- `ReleasePressure = [500]` dbar
  Maximum operating pressure and the point at which a release signal should be generated. Value in dBar so it corresponds to approximately 1 count per meter.
  Acceptable Values = Number > 0 and $<12{,}000$
- `PressureChannel = [P]`
  Name of channel from which to acquire the pressure. The calibration coefficients and type of this channel must be correct in order to work as expected.
  Acceptable Values = String matching a channel name with known channel type and channel ID that is being sampled.
- `DeltaPressureReleaseEnable = [YES]`
  Trigger a release when an instrument is stuck and stops falling. Some instruments, such as those mounted on gliders, could appear stuck when they actually are not so

[3]The ODAS Matlab Library could also be used with the command `show_ch(filename,'P')`.

this release event can be disabled.
Acceptable Values = `YES` or `NO`

- `MinDeltaPressure = [0.2]` dbar per second
  The change in pressure required for an instrument to be considered moving. When the change of pressure is less then this value for a full second, a release can be triggered.
  Acceptable Values = Number < 10

- `StartDeltaPressure = [50] dBar`
  To prevent the release from triggering at the surface, a minimum pressure value is required to enable this release event.
  Acceptable Values = Number > 0 and < 12,000

- `PowerReleaseEnable = [NO]`
  Trigger a release when the input power drops to an unsafe level. Instruments with dedicated release batteries do not require this option and can use the loss of input power to trigger a release. However, some instruments have no such battery so the release must be triggered before the main battery power is fully depleted.
  Acceptable Values = `YES` or `NO`

- `ReleasePowerChannel = [V_Bat]`
  Channel on which the input power voltage can be observed.
  Acceptable Values = String containing channel name with a known type and sampled channel ID.

- `MinValidPower = [7]` Volts
  When the observed input power voltage is below this value for a full second, trigger a power release event.
  Acceptable Values = Number $\geq$ 0 and < 40

- `BrownoutReleaseEnable = [YES]`
  When the CPU stops interacting with the FPGA, a release can be triggered. This protects against software bugs that could prevent a release and expedites the retrieval of an instrument that, for some reason, is not recording data. This option is only valid when recording data. The mechanisms used to detect brownout conditions can change depending on the hardware in use.
  Acceptable Values = `YES` or `NO`

- `SoftwareReleaseEnable = [YES]`
  A software release is when the CPU triggers the release in place of the FPGA. An example would be the release generated when data acquisition exits. There could also be other future events covered by the software release label.
  Acceptable Values = `YES` or `NO`

A typical example of a `[release]` section for a VMP is:

```
[release]
ReleaseEnable = YES
ReleasePressure = 2200
```

With these settings, the release would be triggered when the instrument reaches a depth of 2200 dBar. A `P` channel with correct calibration coefficients is required.

10 Logfile (logfile.txt)

The log file is reported in the same format as is generated with a CF2 Persistor. An example of a RDL produced log file is shown below:

```
5e9f6e24 11 0000 Undefined  --- 2020-04-21 22:05:24.348 - "power applied"
5e9f6e56 10 0000 Undefined  --- 2020-04-21 22:06:14.352 - "start signal received"
5e9f6e56 0b 0001 dat_0002.p --- 2020-04-21 22:06:14.371 - "starting data file"
5e9f7065 0d 01d6 dat_0002.p --- 2020-04-21 22:15:01.030 - "bad buffer"
5e9f7082 11 0000 Undefined  --- 2020-04-21 22:15:30.205 - "power applied"
5e9f70ce 10 0000 Undefined  --- 2020-04-21 22:16:46.212 - "start signal received"
5e9f70ce 0b 0001 dat_0003.p --- 2020-04-21 22:16:46.236 - "starting data file"
```

A traditional log file `logfile.txt` is generated by the data acquisition software on the RDL. This log file is designed to have the same format as those on CF2 Persistor systems; however, there are some key differences in the log file event types due to differences in the data acquisition systems. These differences are highlighted below in Table 1. The colour scheme is as follows:

- White events can occur on both CF2 and RDL systems.
- Blue events can occur on CF2 only systems.
- Red events are no longer used on either system.

Table 1: Possible event types within your log file. Colors are such that white events can occur on both CF2 and RDL systems, red events are no longer used on either system, and blue events can occur only on CF2 systems.

Code	Event Name	Description
01	pressure release	Release triggered because the pressure exceeded max pressure.
02	fall rate release	Release triggered because the fall rate was less than 0.2 dbar/s for 4 consecutive seconds.
03	timeout release	Release triggered because the duration of data acquisition exceeded max time
04	power is bad	Release triggered due to insufficient supply voltage. The power-good signal from the power-supply board (PS) is disabled.
05	power good signal received	The power-good signal from the PS board received. This event has not been used since v4 of the ODAS5IR data acquisition software.
06	switch is off	The power ON/OFF switch was set to OFF.
07	manual stop	Acquisition was stopped manually by an operator.
08	marker	Not used.
09	maximum file size	Data file reached its maximum allowed size.
0a	out of disk space	Disk space was insufficient for data storage.
0b	starting data file	Data acquisition started. The event time corresponds with the creation of a new data file.
0c	acquisition stop	Data acquisition stopped.
0d	bad buffer	Record contains a bad buffer.
0e	maximum file time	Data file reached its maximum allowed time.
0f	10s data timeout	No data observed for 10 seconds. This indicates a serious error.
10	start signal received	A start signal was received. This occurs when data acquisition is first launched but before data acquisition starts.
11	power applied	Instrument switched on and power applied. There will be a delay of 1 to 2 seconds between when the power is applied and when the event is logged.
12	data file trimmed	This event corresponds with power being shut off before data acquisition has stopped. The last record in the data file is removed because it contains invalid data.
13	release due to low voltage	Release triggered because the input voltage fell below the minimum valid voltage specified in the configuration file.
14	release triggered by software	Release triggered by the CPU instead of the FPGA. An example is a release generated when data acquisition exits.

– End of document –

A.6 Spares Kit

The contents of the spares kit is outlined on the following page. Prior to any deployment or cruise it is recommended that you ensure your spares kit is complete. Contact Rockland at support@rocklandscientific.com if you need any replacement items.

tel +1-250-370-1688
fax +1-250-370-1688
toll free 1-877-370-1688
Business No.: 82695-5544

web www.RocklandScientific.com
email info@RocklandScientific.com
520 Dupplin Road, Victoria BC V8Z 1C1
Canada

ROCKLAND SCIENTIFIC

Bill of Materials
037-134-20 REV1
VMP-250DL3-IR (MCBH) Spares Kit

O-Rings

Item No.	Part Number	Revision	Description	Use	Qty
1	591-011-10	-	O-Ring, 2-012 Buna-N, 70A	Probe Holders and Sealing Nut	10
2	591-013-10	-	O-Ring, 2-014 Buna-N, 70A	LED Indicator, MCBH Connector	2
3	591-098-10	-	O-Ring, 2-150 Buna-N, 70A	Main Bulkhead Piston Seals	2
4	593-009-10	-	O-Ring, JIS-2401, P10A Buna-N, 70A	JFE Sensors/Port Covers	2

Fasteners

Item No.	Part Number	Revision	Description	Use	Qty
~~5~~			Not Used		
6	630-251-10	-	Screw, Cap, Hex Head, 1/4-20 x 1, Full Thread, SS316 (anti-seize compound applied to the ends of the thread)	Sensor Guard	2
7	630-508-10	-	Screw, Cap, M4 x 0.7mm x 10mm length, Hex Socket Hd, Titanium	JFE Sensors/Sensor Port Covers	2
8	633-049-10	-	Washer, Flat, 3/8 x 0.875OD, SS316	Lifting Ring	2
9	633-020-10	-	Washer, Lock, Helical Split, 3/8", 316SS	Lifting Ring	1
10	633-034-10	-	Washer, Sealing, 1/4 inch, 316SS with PVC Seal	Anode	3
11	634-025-10	-	Nut, Nylok, 1/4-20, 316SS	Sensor Guard	2

Electrical Items

Item No.	Part Number	Revision	Description	Use	Qty
13	240-002-10	-	1A, 125 V, fast blow SMF fuse	LP-Power Circuit Board ("R1" upper side)	2

Miscellaneous Items

Item No.	Part Number	Revision	Description	Use	Qty
15	013-069-20	2	Assembly, ON Magnet, VMP-250	"ON" Switch Magnet Assembly	2
16	500-027-10	3	Probe Holder Ferrules	Probe Holders	4
17	750-018-10	-	Rubber caps	Sensor Guard Assembly	4
18	013-124-20		Assembly, Anode, 0.4"	Anode	1
19	501-052-10	0	1/4 inch diameter clear heat shrink tubing x 8 mm length	Probe SMC cable connector insulation	4
20	013-175-20	-	Grease, 1oz Dow DC-4, Bottle with Yorker Cap	All O-Ring Seals	1

Containers

Item No.	Part Number	Revision	Description	Use	Qty
21	977-011-10	-	Container, Storage Box, 10 compartment, 8x4-3/4x1-3/4in	Spares Kit Container	1

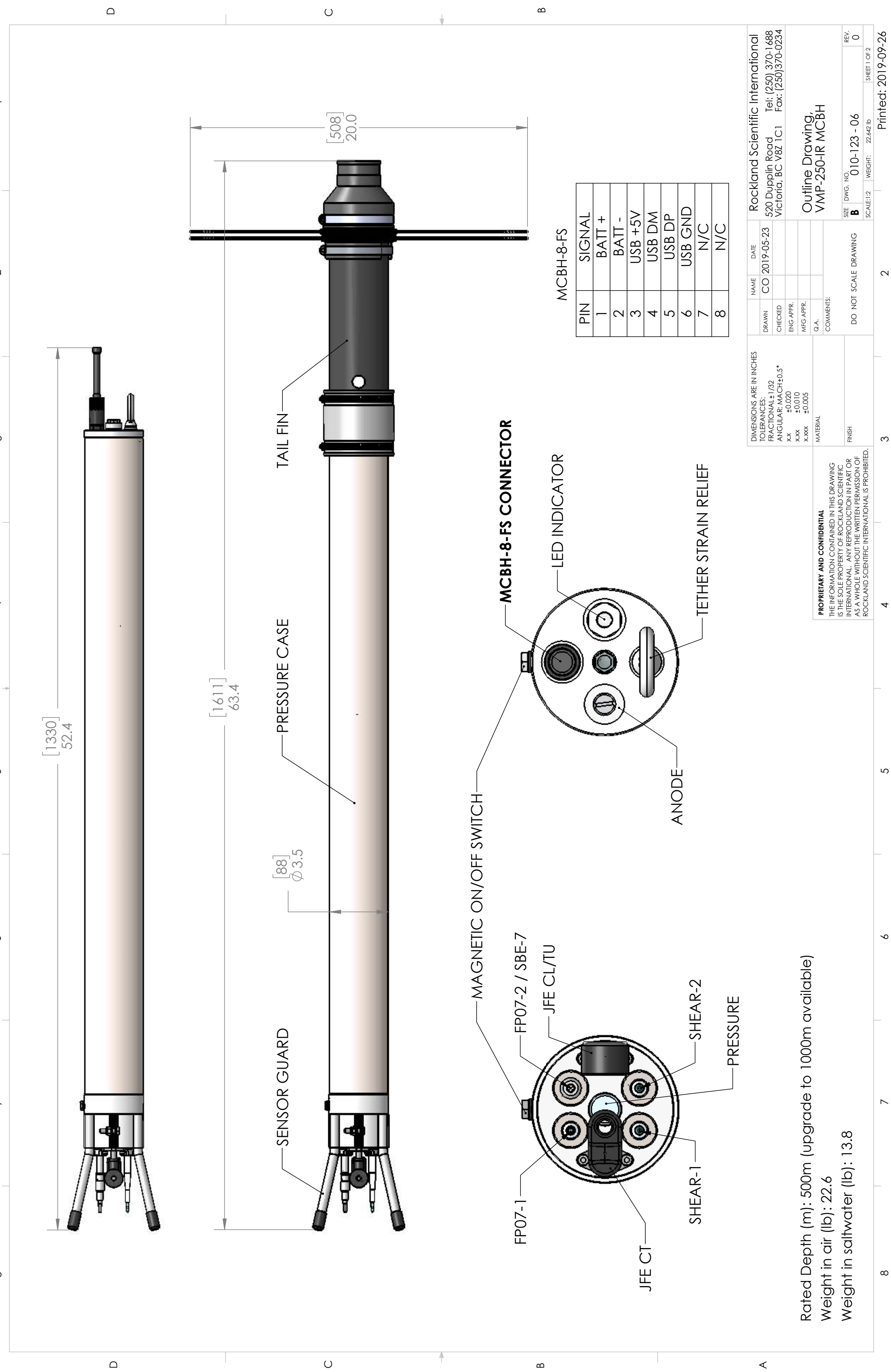
Option for Instruments with P113R01 and P113R02 instruments only

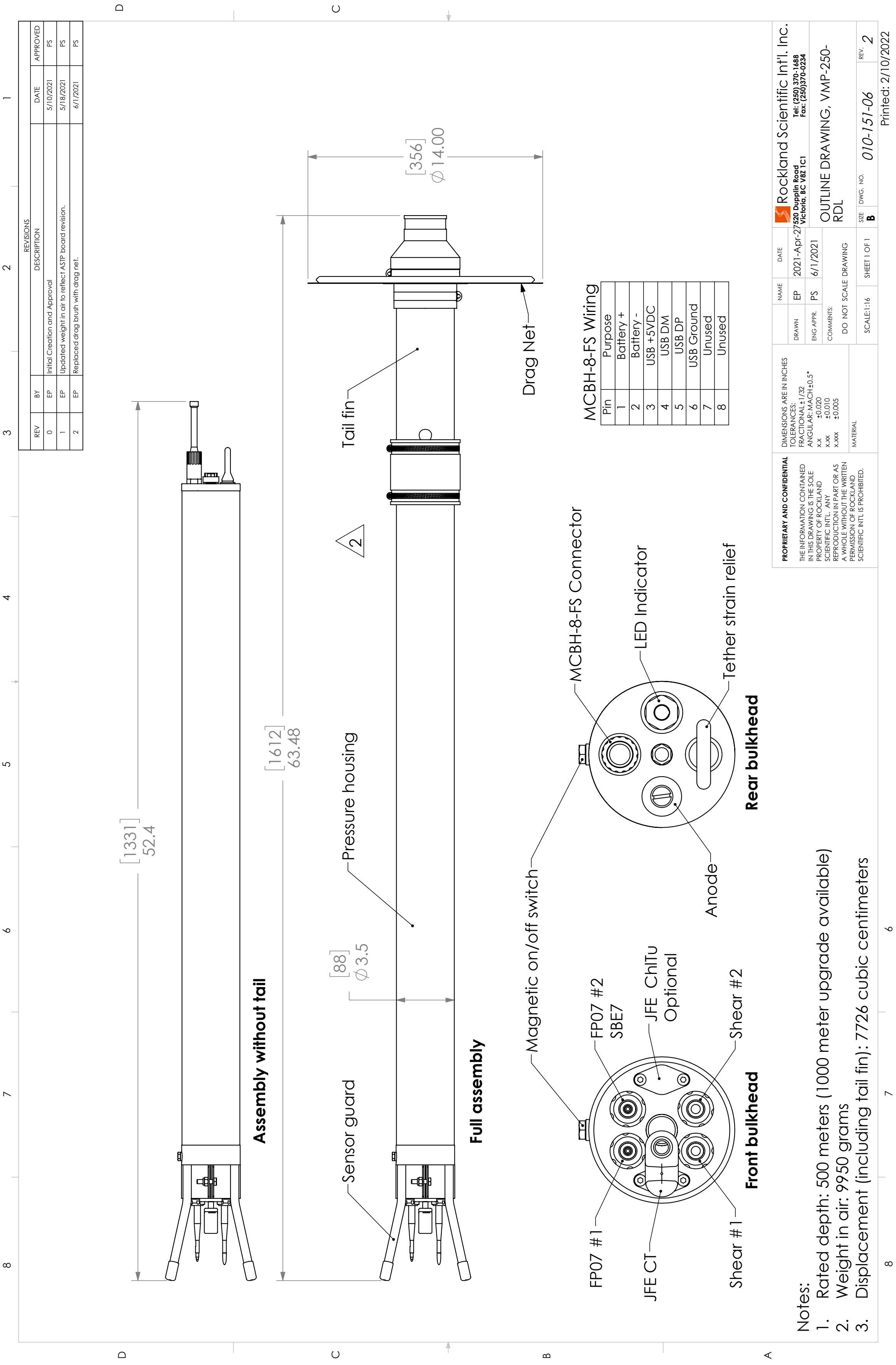
Item No.	Part Number	Revision	Description	Use	Qty
12	240-005-10		Fuse, Glass, 1A, 250VAC, 5 X 20 mm	In-Line fuse for P113R01 instruments	2

037134_R1 VMP-250DL3_IR_MCBH Spares Kit.xlsx **Rockland Scientific International Inc.** Page 1 of 1

A.7 Outline Drawing

The outline drawing on the following page(s) shows the components of the VMP-250-IR and its dimensions.

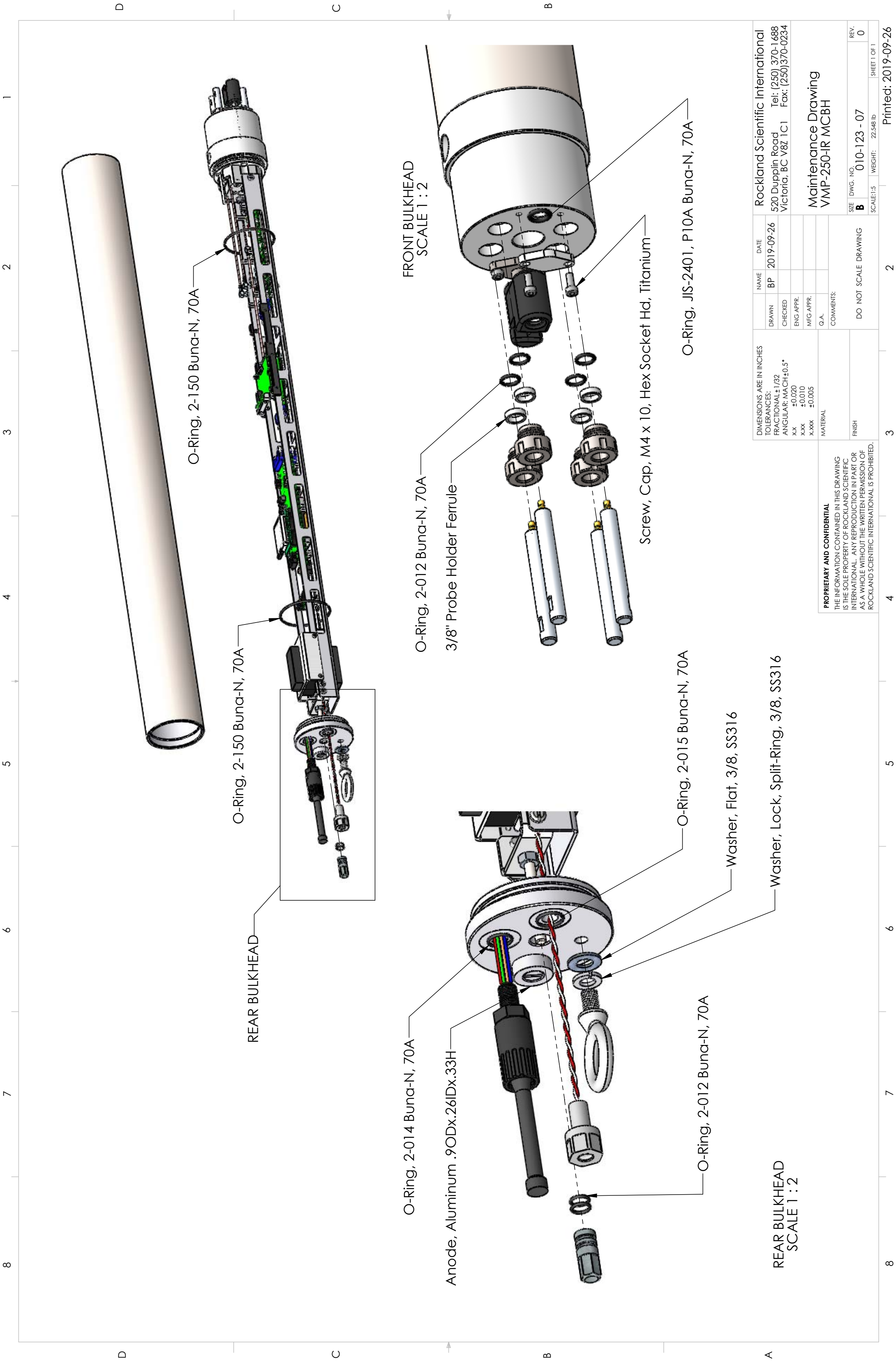

[508]
20.0
[1611]
63.4
[1330]
52.4
[88]
Ø3.5
TAIL FIN
PRESSURE CASE
SENSOR GUARD
MCBH-8-FS
PIN SIGNAL
1 BATT +
2 BATT -
3 USB +5V
4 USB DM
5 USB DP
6 USB GND
7 N/C
8 N/C
MCBH-8-FS CONNECTOR
LED INDICATOR
TETHER STRAIN RELIEF
ANODE
MAGNETIC ON/OFF SWITCH
FP07-2 / SBE-7
JFE CL/TU
SHEAR-2
PRESSURE
SHEAR-1
FP07-1
JFE CT
Rated Depth (m): 500m (upgrade to 1000m available)
Weight in air (lb): 22.6
Weight in saltwater (lb): 13.8
Rockland Scientific International
520 Dupplin Road
Victoria, BC V8Z 1C1
Tel: (250) 370-1688
Fax: (250)370-0234
Outline Drawing,
VMP-250-IR MCBH
010-123 - 06
CO 2019-05-23
DO NOT SCALE DRAWING
Printed: 2019-09-26



REVISIONS
REV | BY | DESCRIPTION | DATE | APPROVED
0 | EP | Initial Creation and Approval | 5/10/2021 | PS
1 | EP | Updated weight in air to reflect ASTP board revision. | 5/18/2021 | PS
2 | EP | Replaced drag brush with drag net. | 6/1/2021 | PS
[1331] 52.4
Assembly without tail
[1612] 63.48
[88] ⌀3.5
Sensor guard
Pressure housing
Tail fin
Full assembly
[356] ⌀14.00
Drag Net
MCBH-8-FS Wiring
Pin | Purpose
1 | Battery +
2 | Battery -
3 | USB +5VDC
4 | USB DM
5 | USB DP
6 | USB Ground
7 | Unused
8 | Unused
Magnetic on/off switch
FP07 #2
SBE7
JFE ChlTu
Optional
Shear #2
FP07 #1
JFE CT
Shear #1
Front bulkhead
MCBH-8-FS Connector
LED Indicator
Tether strain relief
Anode
Rear bulkhead
Notes:
1. Rated depth: 500 meters (1000 meter upgrade available)
2. Weight in air: 9950 grams
3. Displacement (including tail fin): 7726 cubic centimeters
Rockland Scientific Int'l. Inc.
OUTLINE DRAWING, VMP-250-RDL
010-151-06
Printed: 2/10/2022

A.8 Maintenance Drawing

The maintenance drawing on the following page(s) shows the internal components of the VMP-250-IR. Locations of the O-rings are identified.


O-Ring, 2-150 Buna-N, 70A
O-Ring, 2-150 Buna-N, 70A
REAR BULKHEAD
FRONT BULKHEAD
SCALE 1 : 2
O-Ring, 2-012 Buna-N, 70A
3/8" Probe Holder Ferrule
Screw, Cap, M4 x 10, Hex Socket Hd, Titanium
O-Ring, JIS-2401, P10A Buna-N, 70A
O-Ring, 2-015 Buna-N, 70A
Washer, Flat, 3/8, SS316
Washer, Lock, Split-Ring, 3/8, SS316
O-Ring, 2-014 Buna-N, 70A
Anode, Aluminum .9ODx.26IDx.33H
O-Ring, 2-012 Buna-N, 70A
REAR BULKHEAD
SCALE 1 : 2
Rockland Scientific International
520 Dupplin Road
Victoria, BC V8Z 1C1
Tel: (250) 370-1688
Fax: (250)370-0234
Maintenance Drawing
VMP-250-IR MCBH
DRAWN BP 2019-09-26
DO NOT SCALE DRAWING
010-123 - 07
Printed: 2019-09-26
PROPRIETARY AND CONFIDENTIAL

A.9 Li-Ion Battery Material Safety Sheet (MSDS)

The VMP-250-IR contains a Li-Ion battery. The safety sheet provided by the manufacturer is included on the following pages.

AA Portable Power Corp
www.batteryspace.com, Email: Sales@batteryspace.com

Safety Data Sheets (SDSs)

Section 1 - Identification

Product Name: Lithium Ion/Lithium Polymer Rechargeable Battery ($LiCoO_2$)
Manufacturer / Distributor Name: AA Portable Power Corp
Address: 825 S 19th Street, Richmond, CA 94804, **Tel:** 510-525-2328 **Fax:** 510-439-2808
Email: sales@batteryspace.com
Emergency Tel (Within USA and Canada): CHEMTREC 1-800-424-9300
Emergency Tel (Outside USA and Canada) for Shipment to USA: CHEMTREC +1 703-527-3887
Recommended Use: General use
Restrictions on Use: N/A

Section 2 – Hazard(s) Identification

Intact batteries present no specific hazards. If batteries show signs of leaking, AVOID skin or eye contact with the material leaking from the battery. If battery is burning, put out the fire by using right extinguisher.

Potential Health Hazards:
Eye: No particular hazards for proper use. It will cause severe irritation or chemical burn when batteries are broken.
Skin: No particular hazards for proper use. It will cause skin severe irritation by inhalation of EC and Routes of Entry: DMC or chemical burn when batteries are broken.
Inhalation: It will irritate breath system by being exposed to fumes when batteries are broken.
Ingestion: It is deleterious by swallowing battery. Broken batteries will cause severe chemical burn to mouth, esophagus and gastro enteric system
Environment hazards: It will cause different harms to man and environment.
Burning and exploding hazards: When the battery is short-circuited, over charged or over heated, it may cause electrolyte of the battery leaked out or the battery exploding.

Required Label Elements: N/A

Section 3 – Composition/Information on Ingredients

Ingredient	Content (percent of total weight)	CAS Index No.	EINECS
Lithium Cobalt Oxide($LiCoO_2$)	**50%**	12190-79-3	235-362-0
Carbon(Graphite)	10%	7782-42-5	231-955-3
PP	5	9003-07-0	N/A
PVDF	2	24937-79-9	N/A
PE	5	9002-88-4	N/A
CMC	0.5	9004-32-4	N/A
$LiPF_6$	5	21342-40-3	244-334-7
EC	5	96-49-1	202-510-0
DMC	5	616-38-6	210-478-4
Ni	2.5	7440-02-0	231-111-4
Cu	5	7440-50-8	231-159-6
Al	5	7429-90-5	231-072-3

Trade Secret Claims: N/A

AA Portable Power Corp
www.batteryspace.com, **Email: Sales@batteryspace.com**

Section 4 – First-aid Measures

Eye

Flush eyes with plenty of water for at least 15 minutes, occasionally lifting the upper and lower eyelids. Get medical aid.

Skin

Remove contaminated clothes and rinse skin with plenty of water or shower for 15 minutes. Get medical aid.

Inhalation

Remove from exposure and move to fresh air immediately. Use oxygen if available.

Ingestion

Give at least 2 glasses of milk or water. Induce vomiting unless patient is unconscious. Call a physician

Section 5 – Fire-fighting Measures

Hazard properties:

The battery may be over-heated by outside and interior short-circuit, and burning batteries may emit toxic fumes.

Hazardous Combustion products:

Metallic oxide, Carbon oxide (CO), Carbon dioxide (CO_2), etc.

Extinguishing Media:

Species D fire extinguishers of chemical dry powder, yellow sands. Do not use water.

Firemen safeguard:

Firemen should wear fire-fighting suits with a self-contained breathing apparatus

Section 6 - Accidental Release Measures

Steps to be taken in case Material is Released or Spilled

If the battery is accidentally broken and organic electrolyte leaks out, wipe it up with a cloth, and dispose of it in a plastic bag and put into a steel can. The preferred response is to leave the area and allow the batteries to cool and vapors to dissipate. Provide maximum ventilation. Avoid skin and eye contact or inhalation of vapors. Remove spilled liquid with absorbent and incinerate.

Waste Disposal Method

It is recommended to discharge the battery to the end, to use up the metal lithium inside the battery, and to bury the discharged battery in soil.

Section 7 - Handling and Storage

Handling:

- Do not vibrate the battery excessively.
- Avoid short-circuiting the battery. Though short-circuit for little time will not influence badly the battery, short-circuit for long time will lose the battery's energy and bring plenty of heat which will burn skin and cause fire or explosion indeed.
- The equipments of metal which are used for battery pack such as coin, metal accouterments, metal worktable, metal strip, etc. are source of short-circuit.
- It should be provide with effective measures to prevent short-circuit during transportation and storage.
- Do not disassemble and damage the battery.
- The battery should be transported with 10-50% charged states.
- Do not contact the battery with water.
- Do not store the battery in the place with point-blank sunshine.

Page **2** of **8**

AA Portable Power Corp
www.batteryspace.com, Email: Sales@batteryspace.com

- The battery should be 40-60% charged for long time storage.
- The battery should be stored in the place where is cool, dry and lee.

Storage:

- High temperature may cause the battery capability loss, leakage and rustiness.
- Do not expose the battery to fire.
- Store the battery away from moisture.

Section 8 - Exposure Controls / Personal Protection

Respiratory Protection

In case of battery venting, provide as much ventilation as possible. Avoid confined areas with venting batteries. Respiratory Protection is not necessary under conditions of normal use.

Ventilation

Not necessary under conditions of normal use.

Protective Gloves

Not necessary under conditions of normal use.

Other Protective Clothing or Equipment

Not necessary under conditions of normal use.

Personal Protection is recommended for venting batteries

Respiratory Protection, Protective Gloves, Protective Clothing and safety glass with side shields.

OSHA's Permissible Exposure Limits (PELs): N/A
Threshold Limit Values (TLVs): N/A

Section 9 - Physical and Chemical Properties

Please refer most updated information by searching the product part# at www.batteryspace.com

Section 10 - Stability and Reactivity

Stability: Stable
Conditions to Avoid: Short-circuit, collision, refit, high temperature (over 100°C), point-blank sunshine and high humidity environment.
Hazardous Decomposition Products: Toxic gas brought when burning.
Hazardous Polymerization: N/A.
Incompatibility (Materials to avoid): Electric materials, water, seawater, oxidant, acid.

Section 11 - Toxicological Information

Inhalation, skin contact and eye contact are possible when the battery is opened. Exposure to internal contents, the corrosive fumes will be very irritating to skin, eyes and mucous membranes. Overexposure can cause symptoms of non-fibrotic lung injury and membrane irritation.

Numerical Measures of Toxicity: No toxicity.

AA Portable Power Corp
www.batteryspace.com, Email: Sales@batteryspace.com

Section 12 - Ecological Information

Ecological toxicity:
The chemicals of the battery will cause harm to the environments if it is discarded to the surroundings.

Biodegradability: No information available.

Non- biodegradability: No information available.

Section 13 - Disposal Considerations

APPROPRIATE METHOD OF DISPOSAL OF SUBSTANCE OR PREPARATION

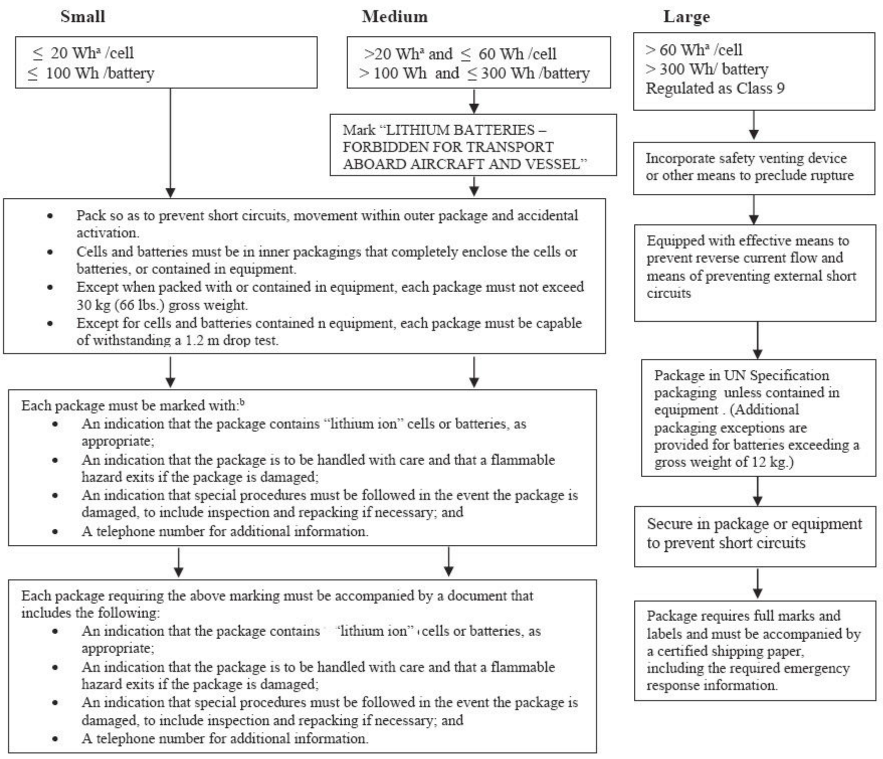
If batteries are still fully charged or only partially discharged, they can be considered a reactive hazardous waste because of significant amount of unreacted or unconsumed lithium remaining in the spent battery. The batteries must be neutralized through an approved secondary treatment facility prior to disposal as a hazardous waste. Recycling of battery can be done in authorized facility, through licensed waste carrier.

Section 14 - Transport Information

All cells and batteries (regardless small/medium/large batteries) must be proven to meet the requirement of each test in the UN Manual of Tests and Criteria.

AA Portable Power Corp
www.batteryspace.com, Email: Sales@batteryspace.com

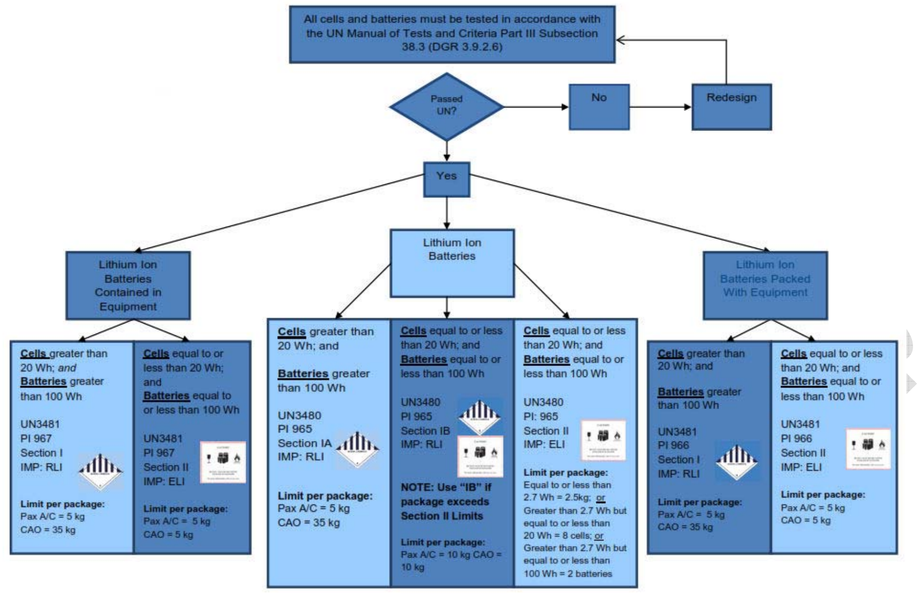
By Ground



a. Wh = Watt-hours rating
b. Does not apply to a package containing button cells installed in equipment or no more than four cells or two batteries installed in equipment

AA Portable Power Corp
www.batteryspace.com, Email: Sales@batteryspace.com

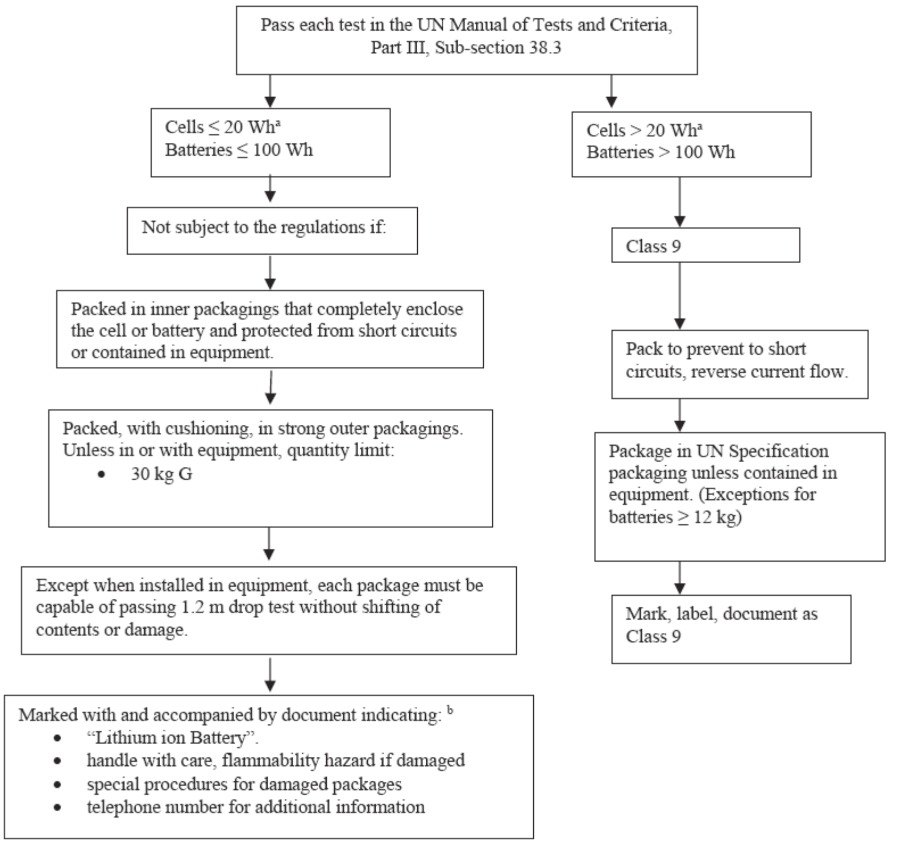
By Air



AA Portable Power Corp
www.batteryspace.com, **Email: Sales@batteryspace.com**

By Ocean

Lithium-Ion (Rechargeable) Batteries by Ocean



a. Wh = Watt-hours rating
b. Does not apply to a package containing button cells installed in equipment or no more than four cells or two batteries installed in equipment

Separate Li-ion batteries when shipping to prevent short-circuiting. They should be packed in strong packaging for support during transport. In the case of transportation, confirm no leakage and no overspill from a container. Take in a cargo of them without falling, dropping and breakage. Prevent collapse of cargo piles and wet by rain. The container must be handled carefully. Do not give shocks that result in a mark of hitting on a cell. Please refer to Section 7-HANDLING AND STORAGE also.

AA Portable Power Corp
www.batteryspace.com, Email: Sales@batteryspace.com

Section 15 - Regulatory Information

Law Information

《Dangerous Goods Regulation》
《Recommendations on the Transport of Dangerous Goods Model Regulations》
《International Maritime Dangerous Goods》
《Classification and code of dangerous goods》
IATA 2015 DGR 56th edition
49CFR 173.185
OSHA Hazard Communication Standard Status
Toxic Substances Control Act (TSCA) Status
SARA Title III
RCRA
In accordance with all Federal, State and Local laws.

Section 16 - Other Information

The above information is based on the data of which we are aware and is believed to be correct as of the data hereof. Since this information may be applied under conditions beyond our control and with which may be unfamiliar and since data made available subsequent to the data hereof may suggest modifications of the information, we do not assume any responsibility for the results of its use. This information is furnished upon condition that the person receiving it shall make his own determination of the suitability of the material for his particular purpose.
SDSs Creation Date: January 22, 2010
SDSs Revision Date: July 22, 2015

A.10 Li-Ion Battery 38.3 Test Report

The test report for the Li-Ion battery is included on the following pages.

PONY
Pony Testing International Group

报告编号**(Report ID):** 1009163-029a

锂电池UN38.3测试报告

Lithium Battery UN38.3 Test Report

样品名称 (Samples)	Lithium Polymer Battery Pack 14.8V 1800mAh
委托单位 (Client)	AA Portable Power Corp.
生产单位 (Manufacturer)	AA Portable Power Corp.

PONY 谱尼测试
Pony Testing International Group
www.ponytest.com

PONY

Pony Testing International Group

I、 SAMPLE DESCRIPTION

Sample Name	Lithium Polymer Battery Pack		Battery Type	14.8V 1800mAh	
Client	AA Portable Power Corp.				
Manufacturer	AA Portable Power Corp.				
Nominal Voltage	14.8V	Rated Capacity	1800mAh	Limited Charge Voltage	16.8V
Charge Current	1800mA	Maximum Continuous Charge Current	1800mA	End Charge Current	90mA
Cut-off Voltage	11V	Maximum Discharge Current	1800mA	Use	Portable power
Cells Number	4PCS	Cell Model	385085	Rated Capacity	1800mAh
Manufacturer of cell	AA Portable Power Corp				
Chemical component	$LiCoO_2$				
Client date	2010-09-11		Finished date	2010-09-30	

II、 STANDARD

Recommendations on transport of dangerous goods，manual of test and criteria，section 38.3 lithium batteries.

III、 TEST ITEM

1. Altitude simulation
2. Thermal test
3. Vibration
4. Shock
5. External short circuit
6. Impact (for component cell)
7. Overcharge
8. Forced discharge (for cell)

IV、 CONCLUSION

ITEM	SAMPLE NUMBER	STANDARD	CONCLUSION
Altitude simulation	N1~N4 C1~C4	UN38.3	PASS
Thermal test			PASS
Vibration			PASS
Shock			PASS
External short circuit			PASS
Impact (for component cell)	N9~N18		PASS
Overcharge	N5~N8 C5~C8		PASS
Forced discharge(for cell)	---		N/A (Not applicable)

The submitted battery and component cell were complied with the stated requirements of UN38.3.

Technique Controller： Liyou

Approval Date： September 30, 2010

PONY

Pony Testing International Group

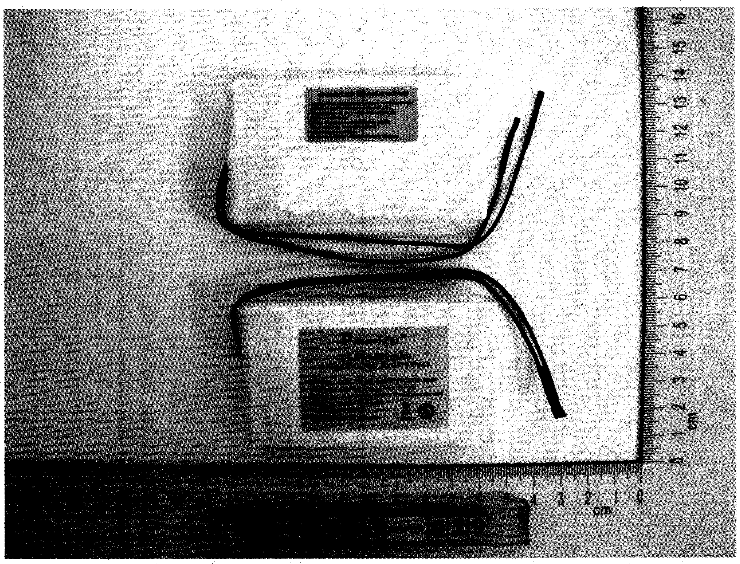
Notes:

Batteries of N1~N8 are full charged after one cycle;

Component cells of N9~N18 are 50% charged after one cycle;

Batteries of C1~C8 are full charged after fifty cycles.

V、 PHOTO OF THE SAMPLE



Authenticate the photo on original report only

PONY

Pony Testing International Group

VI、 TEST METHOD

Test 1 to 5 must be conducted in sequence on the same battery.

In order to quantify the mass loss, the following procedure is provided:

$$\textit{Mass loss(\%)} = (M1-M2) / M1 \times 100\%$$

Where M1 is the mass before the test and M2 is the mass after the test. When mass loss does not exceed the value in table blow, it shall be considered as "no mass loss".

Mass M of cell or battery	Mass loss limit
M<1g	0.5%
1g<M<5g	0.2%
M≥5g	0.1%

In test 1 to 4, cells and batteries meet this requirement if there is no mass loss, no leakage, no venting, no disassembly, no rupture and no fire and if the open circuit voltage of each test cell or battery after testing is not less than 90% of its voltage immediately prior to this procedure. The requirement relating to voltage is not applicable to test cells and batteries at fully discharged states.

1. Altitude simulation

Test batteries or cells shall be stored at a pressure of 11.6 kPa or less for at least six hours at ambient temperature(20±5℃).

2. Thermal test

Test cells and batteries are to be stored for at least six hours at a test temperature equal to 75±2℃, followed by storage for at least six hours at a test temperature equal to - 40±2℃. The maximum time interval between test temperature extremes is 30 minutes. This procedure is to be repeated 10 times, after which all cells and batteries are to be stored for 24 hours at ambient temperature(20±5 ℃). For large cell and batteries the duration of exposure to the test temperature extremes should be at least 12 hours.

3. Vibration

Cells and batteries are firmly secured to the platform of the vibration machine without distorting the cells in such a manner as to faithfully transmit the vibration. The vibration shall be a sinusoidal waveform with a logarithmic sweep between 7 Hz and 200 Hz and back to 7 Hz traversed in 15minutes. This cycle shall be repeated 12 times for a total of 3 hours for each of three mutually perpendicular mounting positions of the cell. One of the directions of vibration must be perpendicular to the terminal face.

The logarithmic frequency sweep is as follows: from 7 Hz a peak acceleration of 1 g is maintained until 18 Hz is reached. The amplitude is then maintained at 0.8 mm (1.6 mm total excursion) and the frequency increased until a peak acceleration of 8 g occurs (approximately 50 Hz). A peak acceleration of 8 g is then maintained until the frequency is increased to 200 Hz.

PONY

Pony Testing International Group

4. Shock

Test cells and batteries shall be secured to the testing machine by means of a rigid mount, which will support all mounting surfaces of each test battery. Each cell or battery shall be subjected to a half-sine shock of peak acceleration of 150 g and pulse duration of 6 milliseconds. Each cell or battery shall be subjected to three shocks in the positive direction followed by three shocks in the negative direction of three mutually perpendicular mounting positions of the cell or battery for a total of 18 shocks.

5. External short circuit

The cell and battery to be tested shall be temperature stabilized so that its external case temperature reaches 55±2℃ and then the cell or battery shall be subjected to a short circuit condition with a total external resistance of less than 0.1 ohm at 55±2℃. This short circuit condition is continued for at least one hours after the cell or battery external case temperature has returned to 55±2℃. The cell or battery must be observed for a further six hours for the test to be conclude.

Cells and batteries meet this requirement if their temperature does not exceed 170℃ and there is no disassembly, no rupture and no fire within six hours of this test.

6. Impact (for component cell)

The test sample cell or component cell is to be placed on a flat surface. A 15.8 mm diameter bar is to be placed across the center of the sample. A 9.1 kg mass is to be dropped from a height of 61±2.5 cm onto the sample.

A cylindrical or prismatic cell is to be impacted with its longitudinal axis parallel to the flat surface and perpendicular to the longitudinal axis of the 15.8 mm diameter curved surface lying across the center of the test sample. A prismatic cell is also to be rotated 90 degrees around its longitudinal axis so that both the wide and narrow side will be subjected to the impact. Each sample is to be subjected to only a single impact; Separate samples are to be used for each impact.

Cells and component cells meet this requirement if their external temperature does not exceed 170 ℃ and there is no disassembly and no fire within six hours of this test.

7. Overcharge

The charge current shall be twice the manufacturer's recommended maximum continuous charge current. The minimum voltage of the test shall be as follows:

(a) When the manufacturer's recommended charge voltage is not more than 18V, the minimum voltage of the test shall be the lesser of two times the maximum charge of the battery or 22V.

(b) When the manufacturer's recommended charge voltage is more than 18V, the minimum voltage of the test shall be 1.2 times the maximum charge voltage.

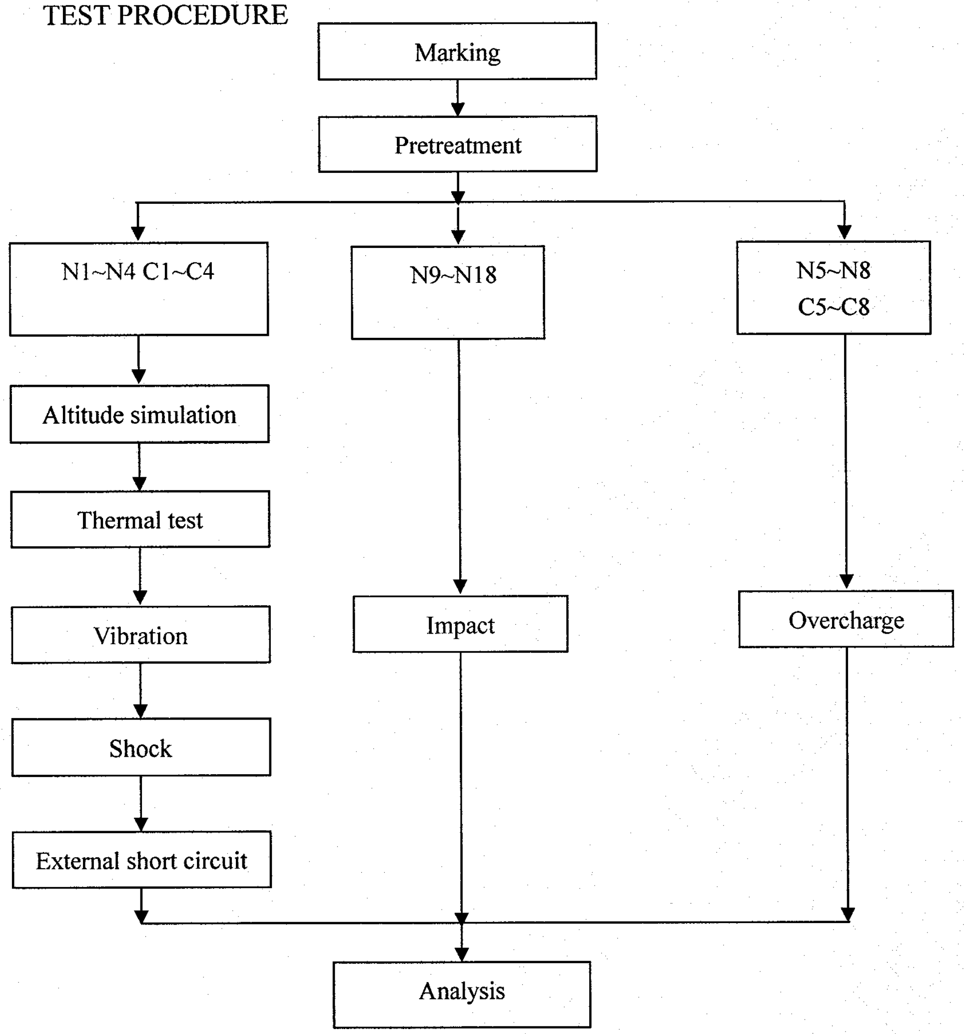
Tests are to be conducted at ambient temperature; the duration of the test shall be 24 hours.

Rechargeable batteries meet this requirement if there is no disassembly and no fire within seven days of the test.

PONY

Pony Testing International Group

VII、 TEST PROCEDURE



VIII、 MAIN TEST APPARATUS

- SZSB-121 Rechargeable battery test system
- SZSB-120 Temperature circulation chamber
- SZSB-080 Vibration test instrument
- SZSB-077 DC regulated power supply
- SZSB-090 Digital multimeter
- SZSB-037 Vacuum desiccation
- SZSB-082 Shock test instrument
- SZSB-081 Impact test instrument
- SZSB-125 Electronic balance
- SZSB-185 Thermoelectric pair

PONY

Pony Testing International Group

IX、 DATA

1. Altitude simulation

No.	Pre-test		After test		Mass loss (%)	Voltage loss (%)	Status
	Mass (g)	Voltage (V)	Mass (g)	Voltage (V)			
N1	149.982	16.68	149.980	16.67	0.001	0.06	PASS
N2	149.760	16.67	149.760	16.67	0.000	0.00	PASS
N3	149.696	16.66	149.695	16.66	0.001	0.00	PASS
N4	149.808	16.68	149.808	16.68	0.000	0.00	PASS
C1	150.142	16.68	150.142	16.68	0.000	0.00	PASS
C2	149.852	16.67	149.851	16.67	0.001	0.00	PASS
C3	149.915	16.68	149.912	16.67	0.002	0.06	PASS
C4	149.722	16.67	149.722	16.67	0.000	0.00	PASS

2. Thermal test

No.	Pre-test		After test		Mass loss (%)	Voltage loss (%)	Status
	Mass (g)	Voltage (V)	Mass (g)	Voltage (V)			
N1	149.980	16.67	149.928	16.48	0.035	1.14	PASS
N2	149.760	16.67	149.716	16.48	0.029	1.14	PASS
N3	149.695	16.66	149.646	16.47	0.033	1.14	PASS
N4	149.808	16.68	149.761	16.48	0.031	1.20	PASS
C1	150.142	16.68	150.089	16.48	0.035	1.20	PASS
C2	149.851	16.67	149.805	16.47	0.031	1.20	PASS
C3	149.912	16.67	149.871	16.48	0.027	1.14	PASS
C4	149.722	16.67	149.673	16.48	0.033	1.14	PASS

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3. Vibration

No.	Pre-test		After test		Mass loss (%)	Voltage loss (%)	Status
	Mass (g)	Voltage (V)	Mass (g)	Voltage (V)			
N1	149.928	16.48	149.928	16.48	0.000	0.00	PASS
N2	149.716	16.48	149.716	16.48	0.000	0.00	PASS
N3	149.646	16.47	149.645	16.46	0.001	0.06	PASS
N4	149.761	16.48	149.761	16.48	0.000	0.00	PASS
C1	150.089	16.48	150.089	16.48	0.000	0.00	PASS
C2	149.805	16.47	149.803	16.46	0.001	0.06	PASS
C3	149.871	16.48	149.871	16.47	0.000	0.06	PASS
C4	149.673	16.48	149.672	16.46	0.001	0.12	PASS

4. Shock

NO.	Pre-test		After test		Mass loss (%)	Voltage loss (%)	Status
	Mass (g)	Voltage (V)	Mass (g)	Voltage (V)			
N1	149.928	16.48	149.928	16.48	0.000	0.00	PASS
N2	149.716	16.48	149.715	16.46	0.001	0.12	PASS
N3	149.645	16.46	149.645	16.46	0.000	0.00	PASS
N4	149.761	16.48	149.760	16.46	0.001	0.12	PASS
C1	150.089	16.48	150.088	16.47	0.001	0.06	PASS
C2	149.803	16.46	149.803	16.46	0.000	0.00	PASS
C3	149.871	16.47	149.870	16.46	0.001	0.06	PASS
C4	149.672	16.46	149.672	16.46	0.000	0.00	PASS

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5. External short circuit

No.	Peak temperature (℃)	Status
N1	55	PASS
N2	59	PASS
N3	56	PASS
N4	58	PASS
C1	57	PASS
C2	55	PASS
C3	56	PASS
C4	55	PASS

6. Impact (for component cell)

No.	Peak temperature (℃)	Status
N9	93	PASS
N10	97	PASS
N11	89	PASS
N12	92	PASS
N13	97	PASS
N14	94	PASS
N15	96	PASS
N16	98	PASS
N17	92	PASS
N18	99	PASS

7. Overcharge

No.	Status
N5	PASS
N6	PASS
N7	PASS
N8	PASS
C5	PASS
C6	PASS
C7	PASS
C8	PASS

8. Forced discharge (for cell)

N/A (Not applicable)

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