



User Manual

MicroCTD

Standard Configuration

Revision 2.1

2020-01-02

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Revision History

Revision	Date	Description
2.0	2019-05-23	Updated format of MicroCTD Manual
2.1	2020-01-02	Addition of an index and Bench Test Checklist. Updated Power Draw table. Change of JAC to JFE Advantech. Addition of Zissou Essentials reference. Updated format of appendices for consistency with other manuals. Minor typo and phrasing corrections.

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 MicroCTD 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 installed¹ (i.e. RSI 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.

¹The CR123 battery, which is located on the Power Supply 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 to obtain high quality data and to 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:

- Website: [Technical Support form](#)
- Email: support@rocklandscientific.com
- Phone: 250-370-1688 (9am - 5pm, Pacific Time)

1 Getting Started

The MicroCTD is a combination CTD and microstructure turbulence profiler for lakes, reservoirs, estuaries and shallow coastal applications. The instrument has a depth rating of 100 m and is designed for use on small vessels. A full overview of the instrument is given in [Section 2](#).

The following guide provides the basic information to prepare your 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 MicroCTD 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.3](#)).
5. Check the instrument battery voltage/charge the instrument battery ([Section 4.3](#)).
6. Install the required software on your computer (refer to the ODAS5-IR User Guide).
7. Establish communication with your instrument (refer to the ODAS5-IR User Guide). This will involve connecting with the instrument via the supplied deck cable ([Section 4.2](#)).
8. Ensure your memory card contains the proper files (refer to the ODAS5-IR User Guide).
9. Conduct an electronics bench test ([Section 4.5](#)).

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.
- Visually inspect pressure sensor diaphragm for dents and scratches.

2. Check and/or replace batteries:

- Check the voltage of your Li-Ion battery and charge if necessary ([Section 4.3](#)).
- Ensure that you have a fresh CR123 battery installed ([Section 2.5.6](#)).

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 this sensor to confirm that 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 ODAS5-IR User Guide).
- Perform a bench test ([Section 4.5](#)).

5. Gather the required equipment and documentation:

- Assemble the suggested tools ([Section 2.3.2](#)).
- Verify the integrity of the instrument tether ([Section 2.3.3](#)).
- Check your spares kit and ensure that it has all necessary supplies ([Section A.3](#)).

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

- 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. Establish communication with the instrument (Refer to the ODAS5-IR User Guide).
3. Check the battery voltage ([Section 4.3](#)).
4. Complete an electronics bench test ([Section 4.5](#)).
5. Inspect the O-rings and sealing surfaces ([Section 5.2](#) and [Section 5.3](#)).
6. Assemble your instrument for upward or downward profiles by attaching the ballast, drag element, and, if necessary, the flotation ([Section 3.3](#)).
7. Prepare the tether and securely attach it to the instrument ([Section 3.4](#)).
8. Verify the contents in the configuration file, `setup.cfg`, match the configuration of the instrument.
9. Discuss the ship operations with the captain and crew ([Section 4.6.3](#)).

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) Drag element (i.e. net or brush) is secure.
 - (f) Ballast collars are secured.
 - (g) Flotation (if uprising configuration) is secured.
 - (h) There are no loose components that could cause unwanted vibrations.

3. Install the microstructure probes into the correct probe ports ([Section 3.1](#)).
4. Record the serial numbers of the probes in your deployment notes ([Figure 16](#)).
5. Turn the instrument on and verify that the LED starts flashing ([Section 4.1](#)).
6. Double-check the tether ([Section 4.6.2](#)).



A detailed pre-deployment checklist is provided in [Section 4.6.1](#).

2 Overview of the MicroCTD

2.1 What is the MicroCTD?

The MicroCTD ([Figure 1](#)) is a combination microstructure turbulence and CTD profiler for lakes, reservoirs, estuaries and shallow coastal applications. The MicroCTD was designed in consultation with estuarine physicists for turbulence measurements in the unique operating environments of tidally influenced shallow waters. The profiler is shortened in length so that it can be easily handled on small vessels, e.g. Zodiac, while maximizing the profiling range in the water column. The MicroCTD uses the same microstructure sensor suite as the Vertical Microstructure Profiler (VMP) series of profilers, with an oceanographic reference Conductivity-Temperature (CT) sensor now included as standard.

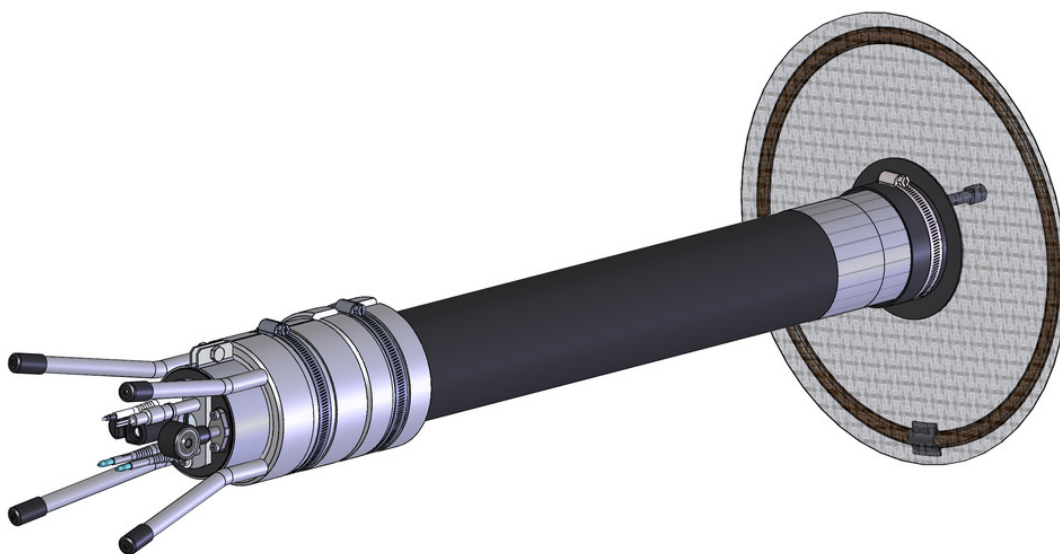


Figure 1: MicroCTD

2.2 General Specifications

2.2.1 Instrument Specifications

The basic specifications of the instrument are summarized in [Table 1](#). Refer to [Section A.4](#) for the Outline Drawing. All specifications are subject to change without notice.

Table 1: General Specifications

Model	MicroCTD
Depth Range	0–100 m
Fall/Rise Rate	0.4–0.8 m s ⁻¹ <i>depending on ballast configuration</i>
Weight in Air/Water	8 kg / 3 kg <i>Approximate</i>
Housing Length/Overall Length	0.78 m / 1 m
Uprising Configuration	Requires floatation and weight release (included) <i>Requires release line and ~7 kg ballast (not included)</i>
Sampling Rate	512 Hz / 64 Hz (fast channel / slow channel) <i>up to 2048 Hz available</i>
Data Acquisition	Internally Recording
Data Storage	Up to 100 hours of data with a 4 GB card <i>based on continuous sampling, 8 columns in the address matrix (Section 2.5.9)</i>
Battery Life	7–12 hours of continuous operation <i>depending on instrument configuration (Section 2.5.8)</i>
Power Consumption (Nominal)	1.7–2.9 W (Section 2.5.8)

2.2.2 Configuration and Sensor Specifications

The MicroCTD 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.
- Higher accuracy CT temperature calibrations 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, $\pm 90^\circ$	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 %	10 ⁻³ s ⁻¹	0.1–100 Hz
1	FP07	temperature	-5–35 °C	0.005 °C	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

2.3 Requirements

Proper use of the MicroCTD requires additional software, tools, equipment and documentation that are summarized below.

2.3.1 Minimum Required Software and Documentation

Instrument communication and data analysis require:

- PC running Windows 7 (or newer) with at least one USB 2.0 Port
- MATLAB 8.4 (R2014b) or newer

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

- ODAS MATLAB Library and its User Manual
- Zissou Essentials and its User Manual
- Motocross Terminal Software
- RSI Link Software
- ODAS5-IR User Guide

2.3.2 Minimum Required Tools

The minimum tools that are supplied by Rockland are summarized in [Table 3](#). Refer to [Section A.2](#) for a list of additional recommended tools.

Table 3: Minimum Required Tools (supplied by Rockland)

Tools	Description/Size	Application/Use	Qty
Torque Wrench	25 in · lb 1/4 inch drive	Sealing Nut	1
Deep Socket	7/16 inch 1/4 inch drive	Sealing Nut	1
Wrench, Adjustable	0-1 inch (0-25mm)	Sensor guard, MCBH connector, LED indicator	1
Hex Driver, Ball End	3 mm	Eyebolt retaining post, JAC Sensor Port Cover Plate (if applicable)	1
Hex Driver, Ball End	5/32 inch (4 mm)	O-Ring compression plate (microstructure sensors)	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 Line/Tether

It is important to minimize the effects of the cable 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 hocking (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).



For these reasons, we recommend Samson Validator II rope, 5 - 7 mm (3/16 inch - 5/16 inch) diameter.

2.3.4 Additional Reading

Table 4 contains a list of technical notes useful for understanding how the MicroCTD measures turbulence data before the data is stored on the internal memory card, as well as information for data processing when using Rockland Scientific's data processing software tools. These technical notes are available for download from the "Technical Notes" section of Rockland's website www.rocklandscientific.com.

Table 4: 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 011	Serial Instrument Bus Protocol Explains how digital data is transferred within the instrument. Useful only to those wanting deeper knowledge of the workings inside of the instrument.
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 019	Pressure Calibration Procedures Determination of pressure coefficients from the Keller Factory calibration sheets.
TN 020	Using the μ-Conductivity Board, P053R01 Describes the usage of the micro-conductivity board that has been specifically designed to work with RSI's "low-power" line of instruments.
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 <i>in situ</i> 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 an RSI instrument.
TN 042	Noise in Shear Probe Measurements Provides a method for estimating the noise in measurements of the velocity shear obtained with an RSI 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 <code>cal -all</code> function for common instrument channels found on standard Rockland Instruments

2.4 Mechanical Systems Overview

This section gives an overview of the MicroCTD mechanical system.

2.4.1 Coordinate System

The coordinate system of the MicroCTD is as follows ([Figure 2](#)):

- x-axis: If your instrument is sitting horizontally on a table with the shear probes ([Figure 3](#)) closest to the table and the CT sensor located to the left (if you are looking at the front bulkhead), the x-axis is the direction pointing upward.
- y-axis: Is the direction leading away from the CT sensor (i.e. to the right if you are looking at the front bulkhead and the shear probes are the closest sensors to the table).
- z-axis: Is the direction along the pressure tube, leading from the front bulkhead to the rear bulkhead. Nominally vertical and directed upwards during downward profiles.

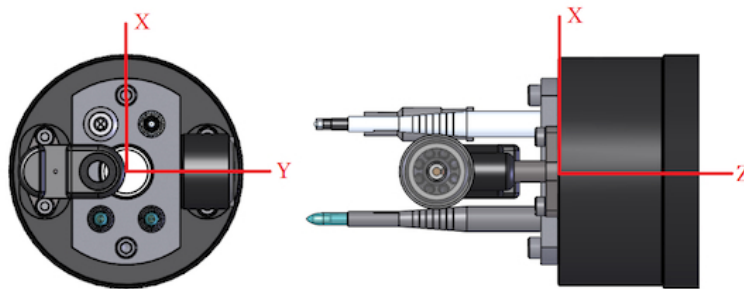


Figure 2: Coordinate System

2.4.2 Sensors

The front bulkhead of the MicroCTD 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, optional SBE7) are assembled onto the front bulkhead via their coaxial connection (SMB). The fundamentals of the microstructure sensors are described in Technical Note 005 ([Table 4](#)). The sensors are secured and sealed to the front bulkhead with an O-ring in a crushed seal configuration using the seal compression plate. Details of the seal compression plate can be found in [Section 3.1](#). 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

JAC³ 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 M3) 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.

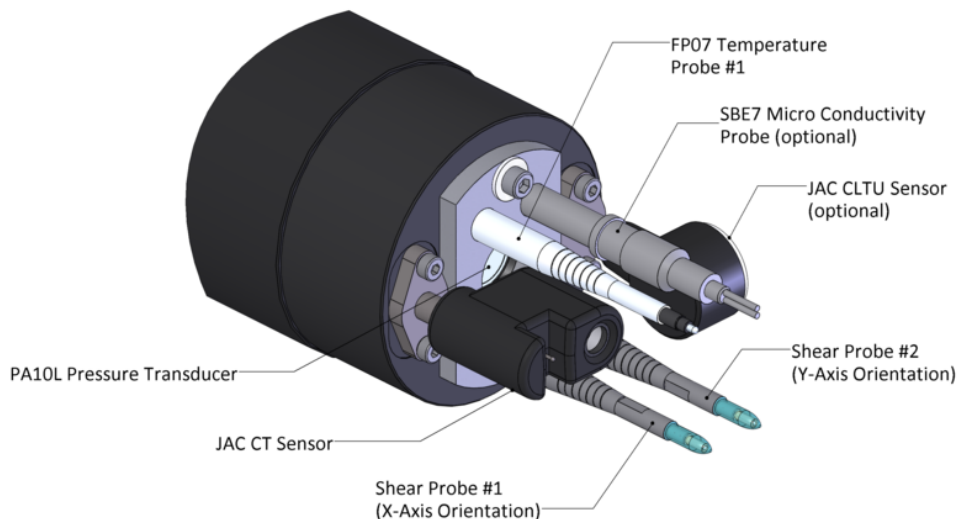


Figure 3: MicroCTD Sensors

Two vibration sensors are installed on the frame 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.

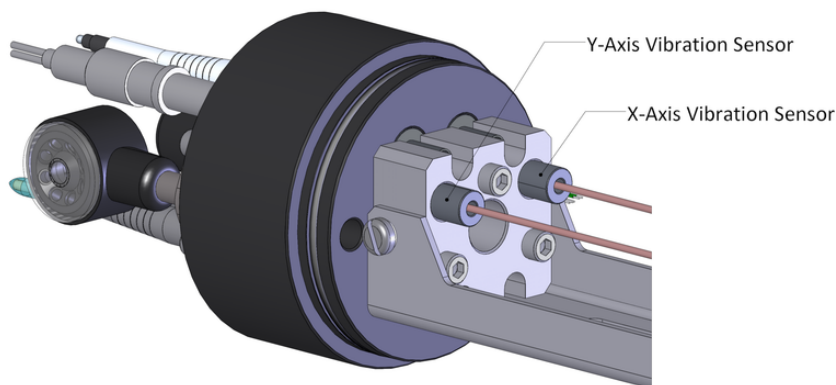


Figure 4: Vibration Sensors

³JAC is an acronym for JFE Advantech Co. that is commonly used as shorthand notation for drawings and data visualization purposes

There is also 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 $\pm 0.1^\circ$ 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. They can be used during deployments if measurements are not desired on a particular channel, and should **always** be used when storing or shipping your instrument, and when performing an electronics bench test (Section 4.5). The test probes have 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 SMB connector.

2.4.4 Sensor Guard

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

- Provide protection to the external sensors
- 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
- A retaining post to prevent full rotation of the lifting ring
- A 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](#))
- A 8-Pin MCBH connector which provides the connection to the deck cable and ON/OFF plug

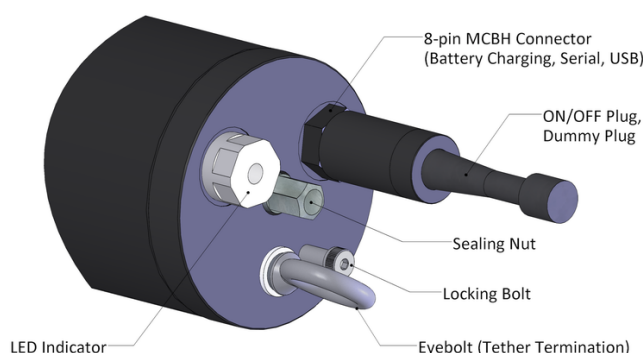


Figure 7: Rear Bulkhead

2.4.6 Drag Net

The drag element on the MicroCTD ([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 MicroCTD uses a net because it is effective at having a low coherency of eddies it sheds, reducing vibrations during profiling, while having a high ratio of drag to cross-sectional area.



Figure 8: Drag Net

2.4.7 Ballast Collars

The profiling speed of the MicroCTD is configured using ballast collars. There are two collars that are shipped with the instrument and both collars are shown in [Figure 9](#). The smaller collar has a mass of approximately ~ 1.7 kg; the larger collar has a mass of ~ 2.3 kg. The estimated fall rate (in seawater) of the instrument for each ballast collar configuration is listed in [Table 5](#). **Actual speeds will vary depending on the configuration of the instrument, the density of the water and tolerance variations of the flotation and drag net.**



An acceptable range of profiling speeds for high quality shear measurements is $0.15\text{--}1.15\text{ m s}^{-1}$. A profiling speed of 0.8 m s^{-1} is recommended.

Table 5: Estimated downward profiling speeds for various configurations of ballast weights.

Configuration	Speed
1.7 kg ballast collar	0.2 m s^{-1}
2.3 kg ballast collar	0.3 m s^{-1}
1.7 kg + 2.3 kg ballast collar	0.8 m s^{-1}



Figure 9: MicroCTD with both ballast collars installed for a downward profile

2.4.8 Uprising Configuration

Although the MicroCTD is optimized for profiling downward, the MicroCTD is equipped with a flotation collar designed to make the profiler buoyant for uprising profiles ([Figure 10](#)). The upwards configuration should be used when measurements are desired for the upper 5 m of the water column.



The flotation has a depth rating of only 30 meters and thus should not be used beyond this depth.

To maintain the stability of the instrument, and to ensure that the nose end is pointed upwards, **the MicroCTD still requires the ballast collars for uprising profiles**. The collars are attached to the rear end of the pressure tube, which shifts the center of mass toward the rear of the instrument.

Uprising profiles will require an extra tether, which will be attached to a release mechanism and some form of ballast. The ballast must be of sufficient mass to easily pull the instrument downward ([Figure 22](#)) and provide enough resistance when jerking on the release tether to release the instrument. For the MicroCTD we recommend approximately 7 kg of ballast to be added to the release tether. Refer to [Section 4.7.2](#) for guidance on preparing the tether.

The release mechanism that is shipped with the MicroCTD is a snap shackle. An electrically powered weight-release system, complete with ballast, an electrical-mechanical tether and release controller is an available option.

Table 6: Estimated rise rates for various configurations of ballast weights and flotation.

Configuration	Speed
Flotation + 1.7 kg ballast collar	0.9 m s ⁻¹
Flotation + 2.3 kg ballast collar	0.8 m s ⁻¹
Flotation + 1.7 kg + 2.3 kg ballast collar	0.3 m s ⁻¹

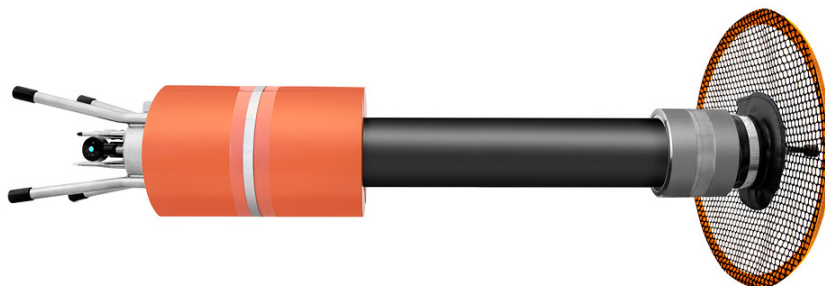


Figure 10: MicroCTD with uprising kit installed

2.5 Electrical Systems Overview

The electrical system that is present within the MicroCTD is designed to take the signals measured by the sensors and transmit them to the Persistor computer where the data acquisition is controlled.

The system block diagram is shown in [Figure 11](#) and each of the components are described in the following subsections. The internal electronics frame for a standard MicroCTD is shown in [Figure 12](#).

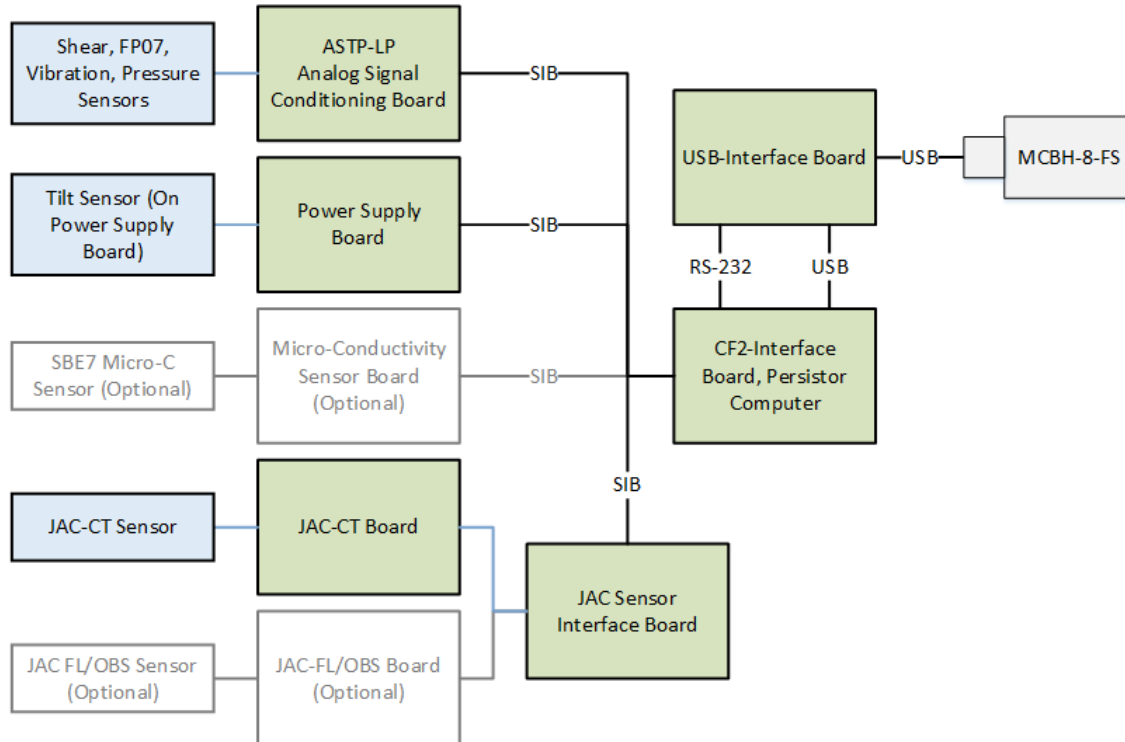


Figure 11: Instrument sensor and electronics system block diagram

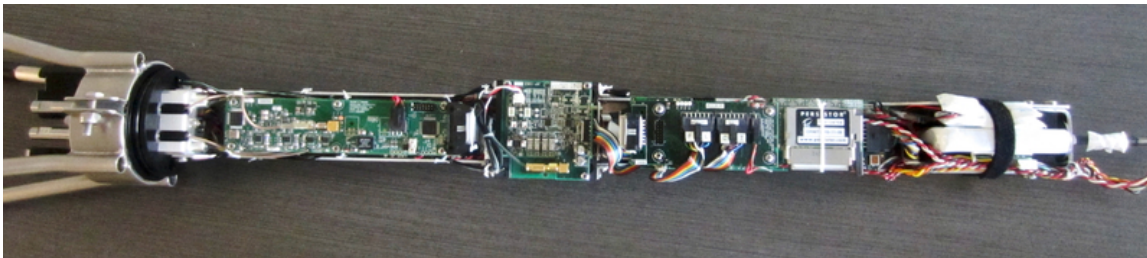


Figure 12: Internal electronics frame

2.5.1 Serial Instrument Bus (i.e. SIB)

Data is conveyed over a serial “bus”. In RSI instruments, it is called the serial instrument bus (SIB). The SIB is a 14-conductor ribbon cable connecting circuit boards (Figure 11). Its conductors are used for the distribution of power, clocking signals, addresses (request for data) and for the data itself. Details are given in Technical Note TN-011.

2.5.2 ASTP Analog Signal Conditioning Board (P049)

The analog signal conditioning (ASTP-LP) 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-LP 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 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 the ODAS5-IR User Guide.

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 CF2-Interface Board (P040) and Persistor computer

The CF2-Interface board holds the Persistor computer that runs the PicoDOS operating system and handles the data acquisition. The CF2-Interface and its Persistor controller are sometimes called the data logger.

The Persistor processor 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 the ODAS5-IR User Guide for more information.

The CF2-Interface board handles all communication of data samples using the SIB. The interface board works closely with the power supply board to provide a graceful shutdown of the instrument after it is signaled to turn off. The computer setup is done through the RS-232 serial connection and the data download is done over USB.

2.5.6 Power Supply Board (P050)

The power supply board provides an isolated +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 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 file⁴. 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 and a 3V lithium battery (CR123). The CR123 battery powers the monitoring circuit that is used to turn the instrument on and off.



The CR123 battery should be replaced annually, or before every cruise.

2.5.7 USB Interface Board (P079)

The USB Interface board acts as both a USB hub and serial-to-USB converter. This board takes the USB and RS-232 outputs from the CF2-Interface board and allows both to be transmitted along one USB cable.

⁴Provided the instrument has an auto-executable file (`autoexec.bat`) located in the same directory as the data acquisition software

2.5.8 Li-Ion Battery

The MicroCTD 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 V (i.e. remaining charge is less than 5%), 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.



The battery must always be charged with the charger provided.

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

Configuration	Power Draw [W]	Battery Life [hours]
Standard Sensors (i.e. Shear, FP07, JAC CT)	1.7	12
Standard Sensors + SBE7	2.3	9
Standard Sensors + JAC CLTU	2.3	9
Standard Sensors + SBE7 + JAC CLTU	2.9	7



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

2.5.9 Data Storage

Data acquired by the instrument are recorded internally on a CompactFlash card. The rate of data recorded is approximately:

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

For the MicroCTD, 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 4 GB CompactFlash card would allow for approximately 100 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 CF card before any deployment.

2.6 Software Systems Overview

2.6.1 Data Acquisition and Data Download

The MicroCTD acquires data with a Persistor CF2 processor using the ODAS5-IR software.

The ODAS5-IR User Guide provides a full description of communication and file transfer, and gives all details regarding the data acquisition software, including user configuration files. Effective use of the instrument requires a full understanding of the ODAS5-IR software. The ODAS5-IR User Guide is provided on the USB key that was shipped with your instrument.

2.6.2 Data Viewing and Processing

The Zissou Essentials software package⁵ 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
- 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 Library⁶ 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.

⁵Version 1.0 released July 2019

⁶Version 4.4 released July 2019

3 Assembly and Disassembly

The following subsections outline assembly and disassembly of your MicroCTD. This information is critical for deployment preparations ([Section 4.6](#)), instrument maintenance ([Section 5](#)) and troubleshooting ([Section 6](#)).



The MicroCTD is shipped with the sensor guard and ballast assembled, and with test probes installed. To begin downward profiling, the only assembly required is to attach the drag net and tether, and to install your microstructure probes. Refer to [Section 1](#) for more details on getting started with your instrument.

3.1 Installing Microstructure Probes

The microstructure probes on the MicroCTD are both retained and sealed using a seal compression plate ([Figure 13](#)). Before removing or installing probes, place the instrument horizontally on a stable platform.



Make sure the area around the seal compression plate is dry. This will reduce the risk of salt water entering the probe cavity.

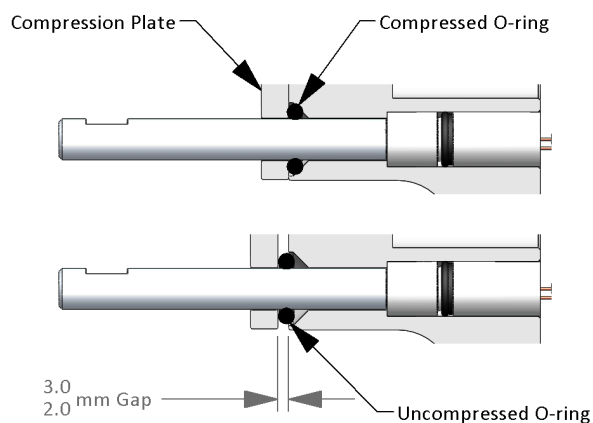
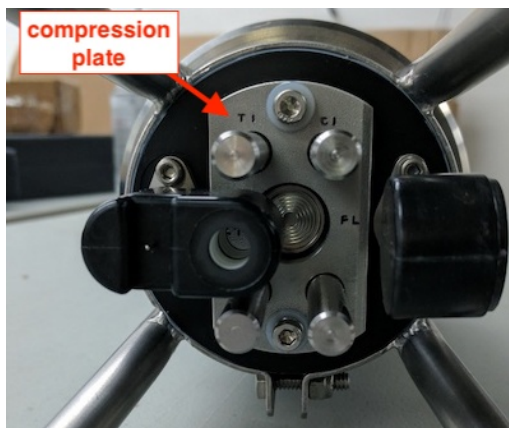


Figure 13: Front view (left) and side view (right) of the seal compression plate that both retains and seals microstructure probes.

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

1. Loosen both screws located on each end of the plate (Figure 14). A gap of 2 – 3 mm between the plate and the front bulkhead is required to completely decompress the O-ring.



Loosening the screws as much as 4 mm is not advised since it allows the O-rings to slip out of their respective cavities once their test probe is removed.



Removing a probe while the O-ring is compressed will create a vacuum within the probe cavity causing any salt water around the probe cavity to disperse inside the probe cavity and onto the SMB plug connector.

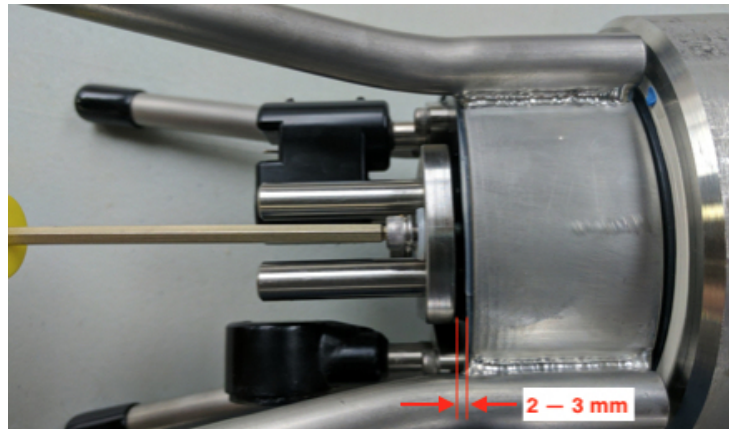


Figure 14: Loosening the Seal Compression Plate

2. Once the seal compression plate has been sufficiently loosened, gently pull on the probe to free it from its connection inside the bulkhead (Figure 15). Be careful to avoid contacting other sensors during the removal of a probe.



Figure 15: Removal of a test probe

In the event an O-ring slips out of its cavity while the probes are being removed, simply re-insert the O-ring back into the groove (ensuring that the O-ring has not picked up any debris and is clean before re-inserting). All test probes should be easily rotated by hand.



Ensure these O-rings have only a very thin coating of grease. Excessive grease can cause the O-rings to stick to the bulkhead and will increase the risk of a vacuum within the probe cavity.

To install a probe:

1. Insert the probe, leading with the connector end of the probe, into the microstructure port. You should be able to feel a click when the probe is fully seated into the connector. **Note that you must insert the correct type of sensor into each port.** The ports are labelled on the seal compression plate. (i.e. "S1", "S2", "T1", and either "T2" or "C1", depending on your instrument's configuration).



It is advised that you insert the temperature probes LAST because they are the most fragile.

2. Orient the shear probes' axes of sensitivity relative to the instrument axes ([Figure 2](#)). Typically, "S1" is aligned with the x-axis and "S2" is aligned with the y-axis. The sensitivity on a shear probe is in the direction normal to the flat surface that indicates the probe's serial number (i.e. M1234), which is highlighted in [Figure 16](#). Note: The orientation of other microstructure sensors (FP07 temperature probes, SBE7 micro-conductivity probes) do not matter.

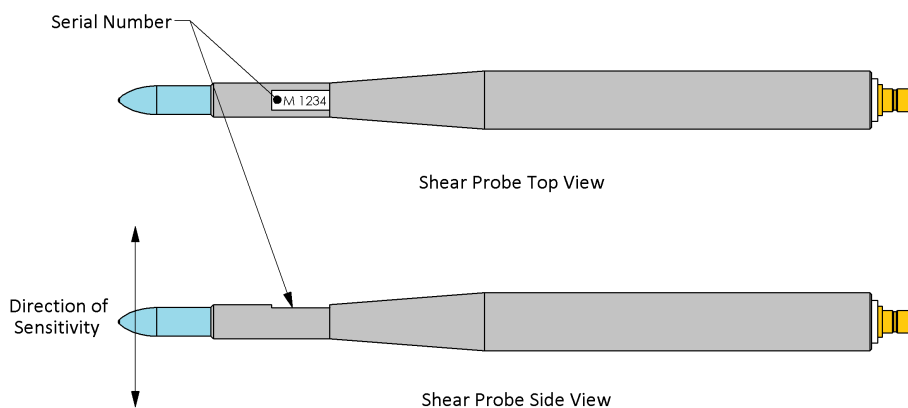


Figure 16: Shear probe direction of sensitivity.

3. Once all microstructure sensors have been installed, fully seated and properly oriented, tighten the screws on the seal compression plate **ONLY** until NO gap exists between the plate and the front bulkhead.



Do not tighten compression plate further as you risk damaging the thread in the front bulkhead. The compressed O-rings will prevent accidental loosening of the screws.

4. In your deployment notes, record the serial numbers of the microstructure sensors you have installed in each port. If possible, update your configuration file with their respective serial numbers and their sensitivities (if they are provided for that given sensor).
Note: The setup file can be modified post-deployment, if necessary.

3.2 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 17](#). 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.

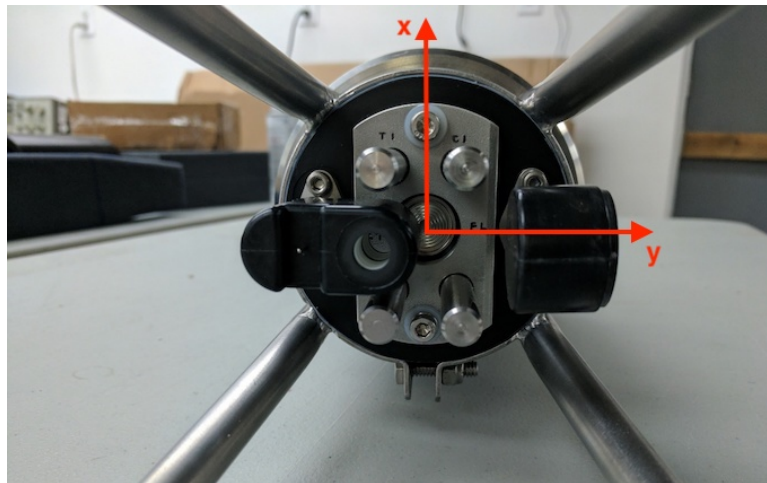


Figure 17: Alignment of the sensor guard

3.3 Assembling the Ballast Collars, Flotation Collars and Drag Net

The ballast collars, flotation collars and drag net can be attached to the MicroCTD using hose clamps, which can be assembled with either a slotted screwdriver or 5/32-inch (8 mm) nut driver. The recommended sizes are as follows:

- Flotation (Uprising only): Size #104 (Figure 18, left).
- Ballast Collars: Size #60 (Figure 18, middle).
- Drag Net: Size #52 (Figure 18, right).



Attach the **ballast** to the **front** end of the pressure tube for **downward** profiles (Figure 9), or the **rear** end of the pressure tube for **upward** profiles (Figure 10).



Do not overtighten the hose clamp on the **flotation** – doing so will crack the foam. The rubber strip located on the inside of the flotation provides sufficient friction against the pressure tube, such that the flotation is secure under light tension.

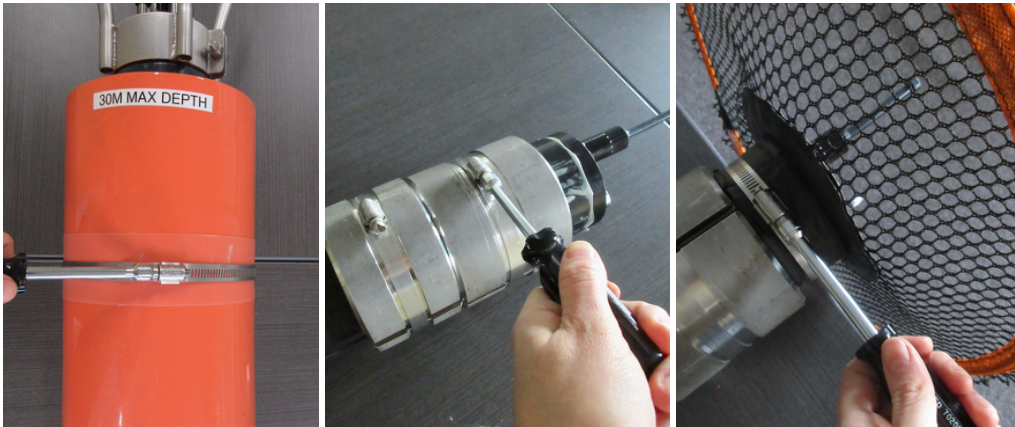


Figure 18: Installing the flotation (left), ballast (middle) and drag net (right) for uprising profiles.

3.4 Attaching the Tether

To attach the instrument tether to the MicroCTD, 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 19).



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 19: Tether tied and secured to the instrument. (Note: A VMP-250 is pictured.)

3.5 Uprising Release Mechanism and Tether

For upward profiles, a release mechanism, additional ballast, and a second tether (a.k.a. the release tether) are required. The release mechanism is shipped with the instrument, however the release tether and additional ballast need to be sourced by the instrument user. We recommend approximately 7 kg of ballast, but the exact mass is not critical.

To prepare the release tether:

1. Tie a bight (loop) in the instrument tether approximately one meter from the instrument end of the tether (Figure 20).



Figure 20: Bight (loop) tied one meter from instrument

2. Ensure the thin blue Spectra line is routed through the snap shackle as shown in [Figure 21](#).



Figure 21: Preparing the release tether

3. Attach your release tether to the thin blue Spectra line.
4. Attach your ballast to the D-shackle.
5. Lay the instrument tether and the release tether on the deck, ensuring that the two are not tangled and attach the snap shackle to the bight ([Figure 22](#)).

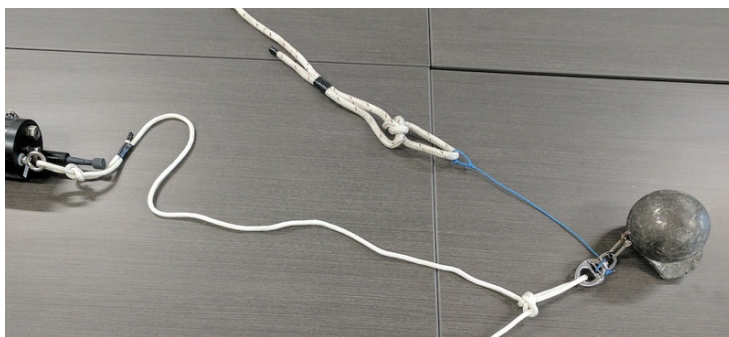


Figure 22: Weight release mechanism fully assembled

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) socket or nut driver ([Figure 23](#)).



Figure 23: 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 24](#)).

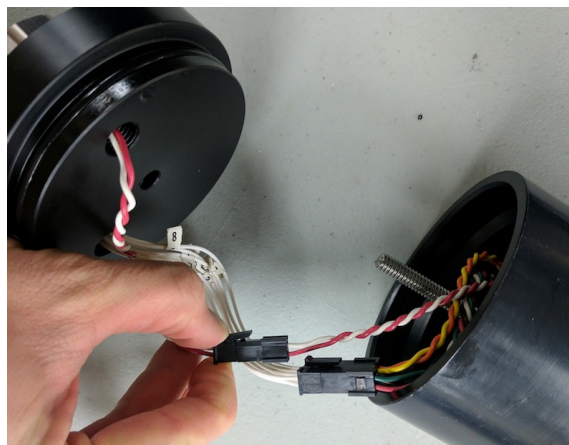


Figure 24: Disconnecting the rear bulkhead Molex connectors

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, MCBH connector, lifting ring: 0-1 inch (0-25 mm) adjustable wrench (supplied)
- Retaining post: 3 mm hex driver

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 25), 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.

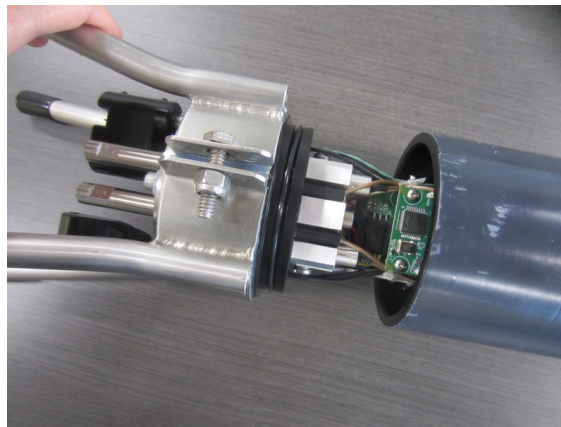


Figure 25: Sliding electronics out of pressure tube

3.7 Reassembling the Pressure Case

Before reassembling the 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 (1) the O-ring seals on the inside of the tube, (2) the sealing surfaces on the front and rear bulkheads, 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. 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 26](#)) 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.

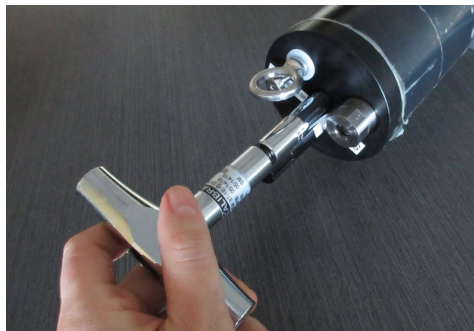


Figure 26: Tightening the Sealing Nut

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 MicroCTD can be turned **ON** two ways:

1. Connecting the ON/OFF shorting plug to the 8-Pin MCBH connector on the rear bulk-head of the instrument ([Figure 27](#)).



Figure 27: Connecting the ON/OFF plug to the instrument.

2. Connecting the instrument to a computer using the deck cable (See [Section 4.2](#)).



Once the instrument has been turned on, it will complete a boot up sequence, and then start data acquisition. An LED on the rear bulkhead of the MicroCTD will flash 32 times when data acquisition starts ([Section 4.1.3](#)).

4.1.2 Turning the Instrument Off

The MicroCTD can be turned **OFF** by disconnecting the ON/OFF shorting plug or the deck cable from the 8-Pin MCBH connector on the rear bulkhead.



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

4.1.3 LED Behaviour

The LED flashes once when the instrument is powered on, followed by a delay as the instrument boots up. Once data acquisition commences, **the instrument blinks once every second for a total of 32 times, after which the LED will remain off** unless the following software events occur:

- A bad buffer event, which occurs when there is an issue with data transfer. This event will cause the LED to start blinking every second for a total of 32 times before turning off (i.e. the same behaviour as when DAQ starts).
- A release event, which will cause the LED to stay permanently ON until the instrument is turned off, or reset. Note: Only untethered profilers⁷ are equipped with release electronics. However, a release event can still occur when using the MicroCTD because the events are triggered by the data acquisition software (ODAS5-IR), which is common among internally recording instruments.



A “fall rate” release event will be triggered if the instrument’s speed falls below 0.2 m s^{-1} AND the pressure is greater than 100 m. For more information, refer to the ODAS5-IR Software User Guide.

4.2 Connecting the Instrument to a Computer

Connecting the MicroCTD to a computer allows for instrument communication, and is also one method to turn the instrument on. The connection requires the following:

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

The connection can then be established as follows:

1. Remove the dummy cap from the 8-pin MCBH bulkhead connector on the rear bulkhead.
2. Connect the MCIL connector on the deck cable to the MCBH connector ([Figure 28](#)).

⁷e.g. VMP-6000 and VMP-X



Figure 28: Connecting the deck cable to the instrument.



If the pins on the deck cable connector are dry, use O-ring grease to lubricate the pin connections.

3. Connect the USB connector on the deck cable to your computer ([Figure 29](#)). Note that when a USB connection is established, the instrument will turn on and automatically begin a boot-up sequence. Data acquisition will commence after the completion of the boot-up sequence.



Figure 29: Connecting the deck cable to the computer.

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 refer to the ODAS5-IR User Guide. 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 28](#)).
2. Connect the cable containing two banana jacks to the mating barrel-jack connector located on the other end of the deck cable ([Figure 30](#)).
3. Measure the main battery voltage by connecting a voltmeter to the banana jack cable ([Figure 30](#)).



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 2.5.8](#)).



Figure 30: 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 USB connector on the deck cable is disconnected from the computer. This ensures that the instrument is off, enabling the battery to 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 31: 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 will remain off.

4.4 Communicating with the Instrument

Instrument communication and data acquisition are achieved using the ODAS5-IR software. Please refer to the ODAS5-IR User Guide for details on the following:

- Establishing communication with the instrument
- Generation of data files
- Structure of data files and log files
- Transferring files between the instrument and your computer
- Anatomy of a configuration file

4.5 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. Shield your instrument from environmental electromagnetic (EM) radiation by (i) completely covering the pressure case and both bulkheads with aluminium foil ([Figure 32](#)), and (ii) electrically connecting the foil shielding to the sealing nut on the rear bulkhead ([Figure 33](#)). The test can be performed without shielding, however 50 or 60 Hz AC signal or other electronic noise present near the instrument will penetrate the plastic pressure case and be picked up by the analog electronics.



Figure 32: Reducing environmental EM radiation by shielding the entire instrument (including the nose cone and sensors) with aluminum foil.

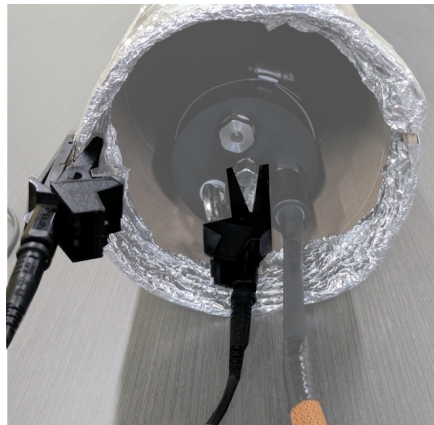


Figure 33: Grounding the electronics by connecting the aluminum shielding to the sealing nut. (The contrast of the image has been modified to highlight the connection points of the cable.)

3. Rest the MicroCTD horizontally on a table or bench, preferably on something soft like open cell foam.
4. Connect your computer to the instrument using the deck cable ([Section 4.2](#)).
5. Establish communication with the instrument and take a **minimum 60 second** data file (See ODAS5-IR User Guide). During this time, ensure that the instrument remains stationary and that any sources of vibration have been minimized.

6. Transfer the data file to your computer using RSI Link (See ODAS5-IR User Guide).
7. 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 figures⁸ – time series of the signals measured by the ASTP and inclinometer channels, and spectra computed from the ASTP signals.
8. Verify that the sensor signals are as expected⁹. Values and expected ranges are provided in the Bench Test Checklist ([Section A.1](#)).

⁸Additional figures may be generated depending on the installed sensors.

⁹If you have concerns, please contact support@rocklandscientific.com

4.6 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.

4.6.1 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 that there is no visible gap between the pressure tube and the front and rear bulkheads.
3. Connect the deck cable to the instrument and check the battery voltage to make sure that it is fully charged ([Section 4.3](#)).
4. Connect the instrument to your computer ([Section 4.2](#)) and ensure that you can establish communication with it (Refer to the ODAS5-IR User Guide). With the connection established, carry out the following:
 - (a) Ensure that the CF card contains the proper files and is in the proper format. Check the time of day clock to make sure that it is set to the proper time (Refer to the ODAS5-IR User Guide).
 - (b) Run ODAS5-IR in “calibration” mode (Refer to the ODAS5-IR User Guide).
 - (c) Perform an electronics bench test ([Section 4.5](#)) to check that all electronics are functioning properly.
5. If you are satisfied with your bench test, disconnect the deck cable from the instrument and replace it with the test plug until ready to deploy the instrument.
6. Ensure the instrument is fully assembled and that all fasteners (including hose clamps) are tight.
7. Ensure that the eyebolt is threaded securely to the rear bulkhead and does not twist.
8. Check the tether and prepare it for deployment ([Section 4.6.2](#)).
9. Securely attach the tether to the eyebolt on the rear bulkhead of the instrument ([Section 3.4](#)).

10. Select and install your microstructure sensors ([Section 3.1](#)). Visually inspect each sensor to ensure that there is no obvious damage ([Section 2.4.2](#)).
11. In your deployment notes, record the serial numbers of the sensors you have installed and the orientation (with respect to the instrument coordinate system) of each shear probe ([Section 3.1](#)).
12. If sufficient time, update your configuration file (`setup.cfg`) with the serial number of your installed microstructure sensors and the sensitivity values of your sensors (if they are calibrated).



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



The configuration file can be updated during post processing, assuming critical information was recorded in deployment notes.

13. Ensure that you have discussed deployment and recovery with the crew and captain before proceeding ([Section 4.6.3](#)).
14. The instrument should now be ready for deployment.

4.6.2 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 that the tether is in good mechanical condition, so that 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 19](#)).

4.6.3 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 cable**. A slack cable 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 ship’s 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.

4.7 Deployment

After completing the pre-deployment checklist ([Section 4.6.1](#)), checking the tether ([Section 4.6.2](#)), and discussing ship operations ([Section 4.6.3](#)), 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 MicroCTD 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 ON/OFF shorting plug. Wait for the LED indicator on the rear of the instrument to begin flashing, indicating that it is recording.

4.7.1 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 34). The procedure is as follows:

1. Turn the instrument on, and ensure that the LED starts flashing 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 34, 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 34, 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.

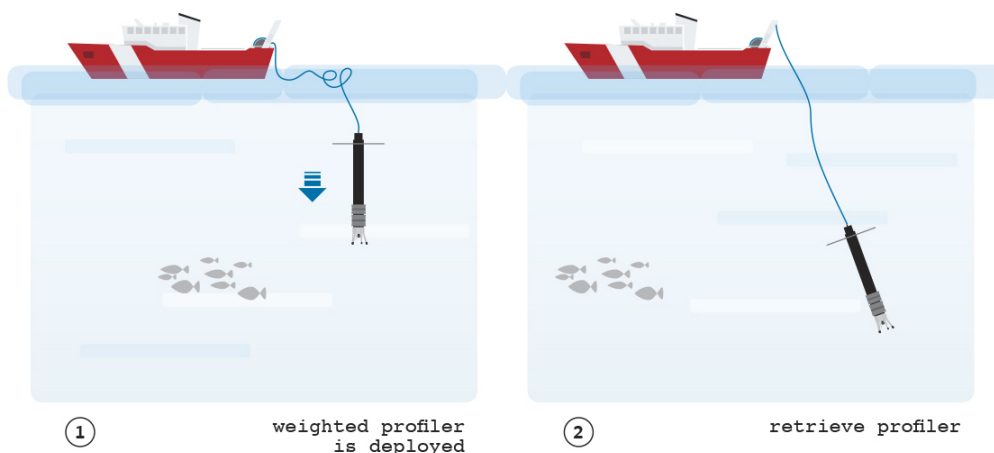


Figure 34: Downward Profile

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. $\text{time} = \text{depth} / \text{speed}$).
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.

4.7.2 Uprising Profiles

To perform an uprising profile, the MicroCTD must be inverted and equipped with (1) the flotation collar close to the front bulkhead, and (2) ballast attached close to the rear bulkhead (Figure 10). A second tether (i.e. the “release tether”), additional ballast and a release mechanism are also required to lower the instrument. Once the desired depth is reached, the release mechanism will trigger and the instrument will rise at a nearly constant speed until it reaches the surface.



The assembly of the release mechanism and tether is provided in [Section 3.5](#).

The progression of an uprising profile is shown in [Figure 35](#). The deployment technique is similar to that for a downward profile, however, two people are needed – one for the instrument tether and one for the release tether. The two people should position themselves as far apart as the vessel will allow. The deployment procedure is then as follows:

1. Lower the instrument using the instrument tether, while paying out the release tether at

the same rate.



You must maintain **tension** in the instrument tether and **slack** in the release tether.

2. Once the instrument has reached the desired depth (estimated by the amount of line in the water), wait until sufficient time has passed for the wake generated by the instrument during lowering to dissipate. Typically 60 to 120 seconds is sufficient, however this should be verified with your collected data files.
3. Release the instrument by abruptly transferring the tension from the instrument tether to the release tether (Figure 35, top left). This will cause the snap shackle to release and the instrument to rise. You may need to tug on the line once or twice. Give the instrument tether extra slack if necessary.
4. As the instrument rises, continue paying out the instrument tether (in the same manner as you would during a downward profile). This will ensure that the instrument tether remains slack and the resulting U-shaped line will allow the profiler to rise vertically (Figure 35, top right).
5. Once the instrument has breached the surface, recover the ballast using the release tether (Figure 35, bottom left) and the instrument using the instrument tether (Figure 35, bottom right).

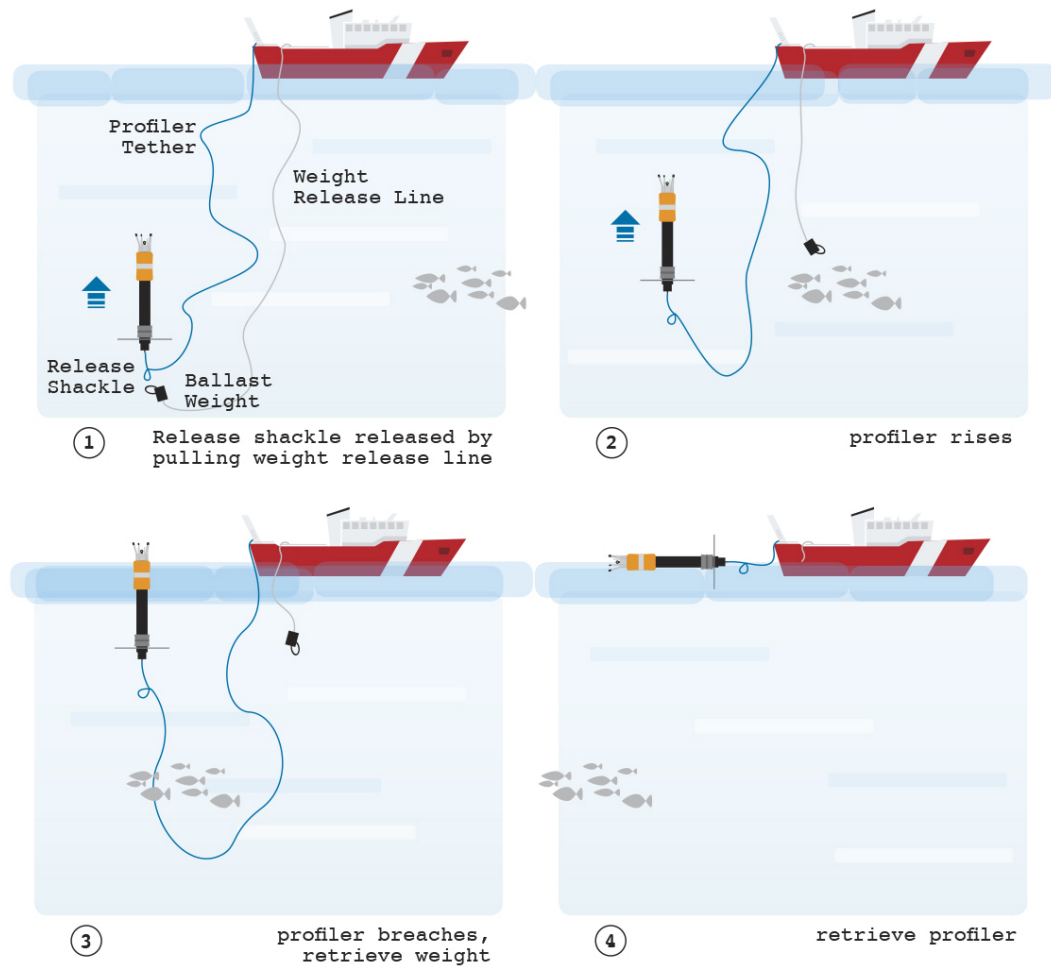


Figure 35: Uprising Profile

4.7.3 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.

4.8 Recovery

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 disconnecting the ON/OFF shorting plug from the MCBH bulkhead connector and replacing it with the dummy plug.
2. Monitor the instrument's battery, especially if you are deploying it often. When possible, connect the instrument to a power source to charge between profiles (or stations).



A MicroCTD 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 100 hours of data storage on a 4 GB memory card, reviewing your data will allow for detection of unexpected issues such as:
 - to identify poor quality profiles (i.e. due to poor deployment execution)
 - corruption of the memory card
 - to identify broken probes
 - potential loss of your instrument

Refer to the ODAS5-IR User Guide 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.



Wipe the shaft of the sensors with a damp cloth/paper towel (using fresh water) to remove any residual salt, however, avoid getting water on the connector of a sensor.

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.5](#).



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 MicroCTD

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)
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 MicroCTD (including the drag net) 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 MicroCTD with fresh water.
2. Gently rinse the microstructure probes with fresh water.
3. Dry the stings of the microstructure probes using dry, compressed air.
4. Carefully remove the microstructure probes ensuring water does not enter probe ports, and then install test probes ([Section 3.1](#)).



Avoid getting water on the SMB connector of a sensor as it may cause damage to the connector.

5. When the instrument is dry, place it in the case.

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 3.2](#)).
 - ii) Remove the test probes ([Section 3.1](#)). 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 MicroCTD'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 MicroCTD. 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).
- Replace the CR123 battery on power supply board.
- Ensure MicroCTD's battery is fully charged ([Section 4.3](#)).
- Connect your computer to the instrument and perform a 60 second electronics bench test on the MicroCTD. See [Section 4.5](#) for detailed instructions.



Rockland provides an annual instrument maintenance package for the MicroCTD. 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 MicroCTD and all of its exposed (i.e. wetted) components have been rinsed with clean fresh water and dried.

2. Ensure MicroCTD'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.6](#).

3. Rockland recommends shipping the Li-Ion battery at 30% capacity.
4. If flying with the MicroCTD as checked luggage, remove the Li-Ion battery and the CR123 battery and put 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 MicroCTD are summarized in [Table 9](#).



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 MicroCTD

O-ring location	Qty.	Specification	Replacement Interval
Pressure tube to bulk-heads	2	2-150 Buna-N, 70A	Annually or pre-deployment
Microstructure probes	4	2-204 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-8-FS to rear bulkhead	1	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)



Refer to the maintenance drawing ([Section A.5](#)) for more information on the location of each O-ring.

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 MicroCTD O-Rings

- **Microstructure Probes:** The one O-ring in each of the microstructure sensor ports should only have a **VERY LIGHT** coating of grease; there should be no excess.



This seal design relies on using friction to prevent the probe from easily spinning. Excessive grease will reduce the friction between the O-ring and the probe.



Excess grease on microstructure probe O-rings can prevent air from escaping the probe port cavity when removing the probes. This will create a vacuum inside the probe port cavity and increase the risk of saltwater droplets being suctioned into the cavity after complete removal of the probe.

- **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.

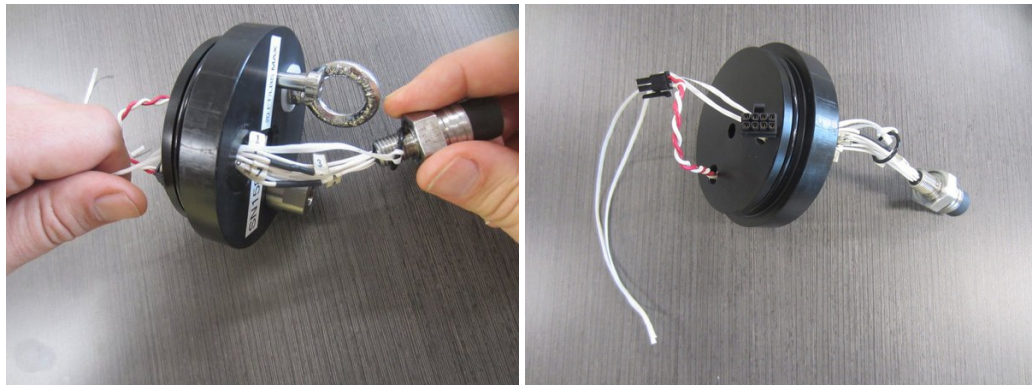


Figure 36: Removal of an O-ring from an MCBH connector (a MicroCTD is pictured).

- **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.

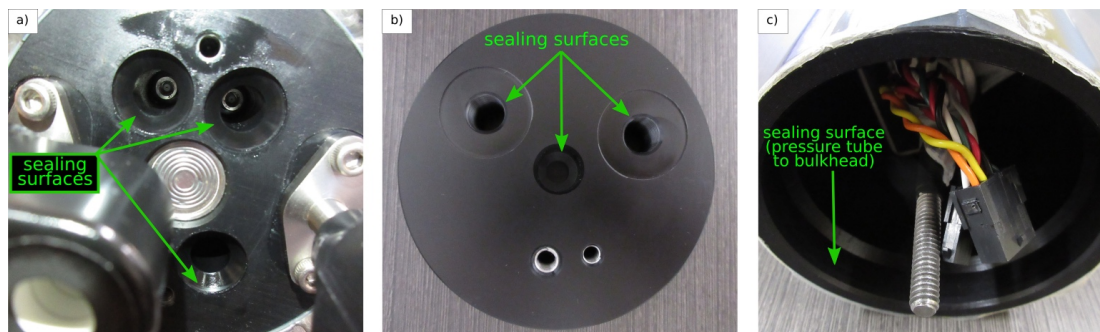


Figure 37: Sealing surfaces for the (a) microstructure probes, (b) rear bulkhead, and (c) pressure tube.

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 bulkheads of the MicroCTD are made of non-metallic materials and are therefore not susceptible to corrosion. However, metallic materials are used for the following components:

- probe guard
- bulkhead connectors
- microstructure probes
- probe holder faceplate

These components are made of stainless steel and other materials which can withstand corrosion. Therefore, there is **low risk of corrosion occurring while the instrument is deployed, unless the instrument is underwater for long periods of time such as hours or days**. Corrosion is more likely to occur when the instrument is in air, particularly if salt water remains on the instrument.

5.4.2 Probe SMB Connectors

Each probe connects to a SMB connector ([Figure 38](#)). 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:

- Avoid handling the probe connectors with wet hands.
- Avoid installing or removing probes when there is risk of water entering the probe port.
- Avoid installing or removing probes when there is a large difference in temperature between the instrument and the surrounding air. This will prevent condensation on the SMB connectors.

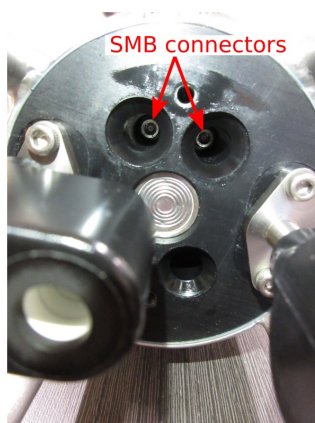


Figure 38: SMB connectors visible inside probe ports

Conducting a bench test with test probes installed (Section 4.5), 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)¹⁰.

5.4.3 Underwater Connectors

Underwater connectors are also susceptible to corrosion because they come in frequent contact with seawater. The corrosion typically appears on the metallic pins.

The bulkhead connectors on the MicroCTD can be treated with O-ring grease as per the manufacturer's specifications (Figure 39).

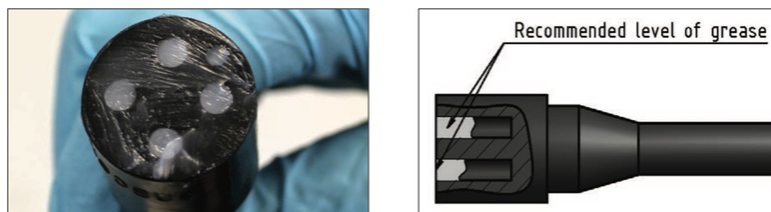


Figure 39: Applying grease to a MCBH connector. (Image source: SubConn and McCartney Underwater Connector Group (2018). *Underwater and Harsh Environment Connectors*. p. 122.¹¹)

5.5 Probes and Sensors

The probes and sensors on the MicroCTD are very fragile and need to be properly maintained. Recommended procedures are outlined below.

¹⁰The ASTP Calibration Report that shipped with your instrument can also be used as a reference for the expected noise spectra.

¹¹<https://www.macartney.com/what-we-offer/systems-and-products/connectors/subconn/subconn-book/>

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 piezo 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 40).



Figure 40: 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 3.1](#)), 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 41](#)).

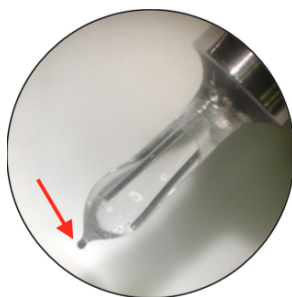


Figure 41: FP07 thermistor. The small sensing tip is indicated by the red arrow.

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 $\sim 2 \text{ k}\Omega$ ($\pm 25\%$). 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 2.3.4](#)). 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-100¹² 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.
6. Air dry for 1 hour.
7. The micro-conductivity sensors should be stored with their “syringe” style protectors and kept dry.



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

¹²Triton 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. (If you are located at a university, your chemistry shop on campus may even have it.)

5.5.4 Pressure Sensor

The pressure sensor (transducer) is located on the nose of the instrument (Figure 3). 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 42). 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 42: 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 MicroCTD 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 MicroCTD 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 43). 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.

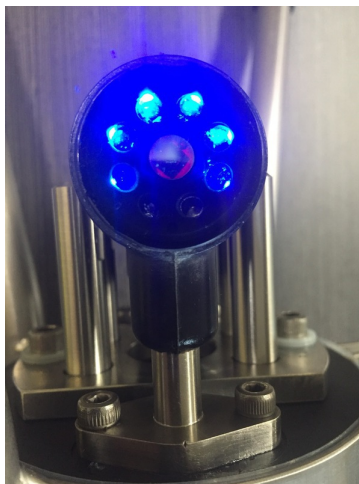


Figure 43: A functioning CLTU sensor.

6 Troubleshooting

This section discusses how to troubleshoot some commonly reported issues you may experience during usage. 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 instrument refuses to turn on – either by connecting the ON/OFF plug or by connecting the instrument to the deck cable and plugging in the USB to your computer (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 the CR123 battery ([Figure 44](#)) is depleted, or a fuse on the Power Supply board has blown.

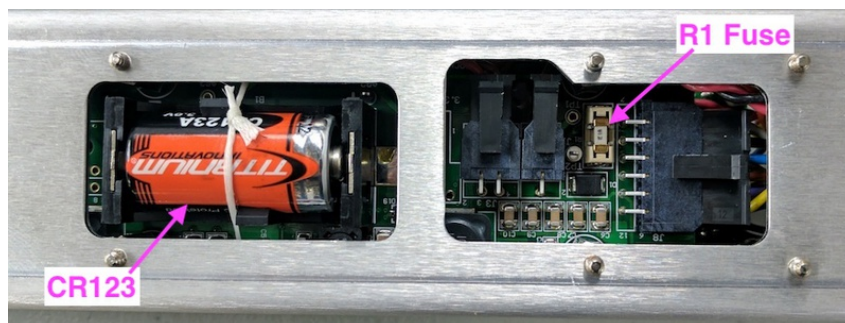


Figure 44: CR123 battery and 1 A fuse (Power Input)

A 1 A fuse for the input power to the instrument, labelled “R1”, can be found on the same side of the power supply board as the CR123 battery ([Figure 44](#)). In the event that the instrument is unable to be switched on and the CR123 has been replaced, replace this fuse. If the instrument is still unable to be switched on, contact Rockland Scientific.

A second fuse of 0.25 A, labelled “F1”, is located on the opposite side of the power supply board ([Figure 45](#)). This fuse is to prevent damage if the user accidentally installs the CR123 battery backwards.

The 14.8 V Li-ion battery has a 5A internal resettable fuse, which is not user serviceable.



After a battery replacement, the time and date of the clock in the Persistor computer must be reset to its proper value.



Figure 45: 0.25 A Fuse (for CR123 battery)

6.2 Instrument is not charging correctly

If your 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 of the Smart Charger using a multimeter. The output should be 17 VDC.
- 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 you can turn on the instrument but are unable to communicate with it, refer to the ODAS5-IR User Guide for information on how to communicate with your instrument. If you are still unable to communicate with your instrument, contact Rockland Scientific.

6.4 Data corruption

The operating system on the Persistor computer (PicoDOS) utilizes a File Allocation Table (FAT) for identifying the physical location of data on the memory card. Reducing the number of changes made to the FAT will reduce the amount of fragmentation on the card and reduce the risk of FAT corruption. It also takes a long time to erase files and there is no on screen feedback during the deletion progress so it is easy to believe that the Persistor has frozen. If you cycle power during this time, you will likely corrupt the FAT. For these reasons, we recommend that you keep your data files on the card instead of erasing individual data files when downloaded. When your cruise is complete or you have an extended time, and have the files downloaded, use the RESTORE command to format the card and reinstall the system files. This will reduce the amount of changes made to the FAT, reducing the risk of FAT corruption. Refer to the ODAS5-IR User Guide. If your FAT is corrupted, contact Rockland Scientific. In some cases, it is possible for Rockland to recover your data and the chances of recovering your data is increased if there is less fragmentation of data on the card.

6.5 Noisy data on microstructure channels

Noisy data 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 (SMB)**. To check for the presence of moisture and/or salt:

1. Visually inspect the probe port.
2. Inspect the gold SMB connector inside the probe port and look for signs of discolouration (i.e. biological growth, corrosion).
3. Conduct an electronics bench test with the test probes installed ([Section 4.5](#)). Ensure that your test probes do not show signs of damage and/or corrosion.
4. 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, proceed with test (ii).
 - (ii) Open up the instrument and disconnect the shear probe's SMC connection to the ASTP board ([Figure 46](#)). Do a bench test. If the problem is resolved, then the SMB connector is likely damaged and the *SMC cable assembly may need to be replaced*.
 - If you observe increased noise on one of the **thermistor** channels, then we suggest the following tests:
 - (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*. On the other hand, if the noise still persists on the same channel, proceed with test (ii).
 - (ii) Open up the instrument and swap the two thermistor SMC connections to the ASTP board ([Figure 46](#)). Do a bench test. If the noise is now on the opposite channel, then the SMB connector is likely damaged and the *SMC cable assembly 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.

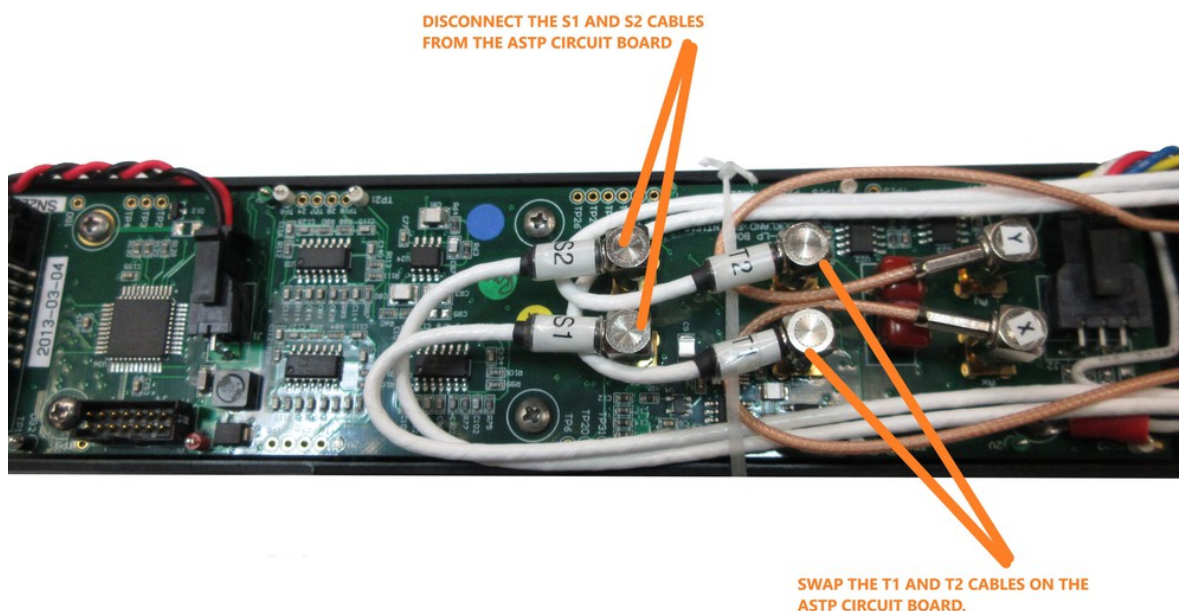


Figure 46: Modifying SMC connections on the ASTP board to identify the cause of noisy data.

6.6 The instrument isn't falling correctly

Most problems with unsteady speed during profiling is due to improper use of the tether during deployment. Refer to the deployment section ([Section 4.7](#)) 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 fasteners and components. Make sure they are secured. If the issue still exists or you require assistance, contact Rockland Scientific.

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 4.5](#)). 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.

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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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Spectra Figure

- ☐ P_{dP} shows a spectral density everywhere less than 10^1 counts²/Hz.
- ☐ The peak of P_{dP} is less than 3 counts²/Hz, and rolls off at approximately 2 Hz.
- ☐ The spectral peaks of A_x and A_y are below 10^2 counts²/Hz, provided the instrument is well cushioned.
- ☐ A_x and A_y 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} counts²/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} counts²/Hz near 10^2 Hz.
- ☐ (If applicable) C₁ follows a rising curve with spectral density of approximately 10^0 counts²/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.

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(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 Recommended Tools/Equipment

The following tables list the tools provided with the instrument and the additional tools and equipment that are recommended.

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MicroCTD Tool Kit

Item No.	Part Number	Tool	Description/Size	Application/Use	Qty
1	750-067-10	Torque Wrench	25in.lb 1/4" drive	Sealing Nut	1
2	750-072-10	Deep Socket	7/16" 1/4" drive	Sealing Nut	1
3	750-084-10	Adjustable Wrench	0-1 inch (0-25 mm)	Sensor Guard, MCBH Connector, LED Indicator	1
4	750-085-10	Hex Driver, Ball End	3 mm	Sensor Port Cap (if applicable)	1
5	750-086-10	Hex Driver, Ball End	5/32 inch (4 mm)	O-Ring Compression Plate (Microstructure sensors)	1
6	750-126-10	Nut Driver	7/16 inch (11 mm)	Sensor Guard	1
7	750-127-10	Nut Driver	5/16 inch (8 mm)	All hose clamps	1
8	977-012-10	N/A	2.6L Plastic Case	Tool Kit Container	1

Recommended Tools and Equipment (Not-Included)

Item No.	Part Number	Tool	Description/Size	Application/Use	Qty
1	-	Vulcanizing (Self-Fusing) Tape	EPR Rubber	Repairing underwater cables	1
2	-	Multi-meter	Fluke® Digital Multimeter	Electrical diagnostics	1
3	-	Compact Flash Card Reader		Reading information directly from the CF card	1
4	-	Wire Cutting Pliers	Side Cutting	Cutting Cable Ties, Waxed Lacing	1
5	-	Waxed Lacing		Tying down Wiring Harnesses	1
6	-	Screwdriver, Phillips	Size #1	Circuit Board Screws	1
7	-	Screwdriver, Slotted	3/8 inch wide, 8 inch length	Internal Frame Screws	1
8	-	Wrench	1/4 inch	Circuit Board Standoffs, SMC Connectors	1
9	-	Electrical Tape		General use	1
10	-	Duct Tape	Roll	General use	1
11	-	Aluminum Foil	Roll	Electromagnetic Shielding	1
12	-	Compressed Air	Canister	Cleaning components	1
13	-	Isopropyl Alcohol	Small Bottle	Cleaning components	1
14	-	Kimwipes	Soft, lint-free tissue	Cleaning o-rings/sensitive equipment	1
15	-	Instrument Stands	(Drawings Included with User Manual)	Supporting the VMP before deployment	1
16	-	Rubber Tie-Down Straps	"Bungee" straps	Securing the VMP to the Stand before deployment	2
17	-	Ratcheting Tie-down Straps		Securing the VMP and/or stands on deck	2

A.3 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.

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 Canada



MicroCTD Spares Kit

O-Rings

Item No.	Part Number	Revision	Description	Use	Qty
1	591-011-10	-	O-Ring, 2-012 Buna-N, 70A	Sealing Nut	2
2	591-013-10	-	O-Ring, 2-014 Buna-N, 70A	MCBH Connector	2
3	591-098-10	-	O-Ring, 2-150 Buna-N, 70A	Main Bulkhead Piston Seals	2
4	591-130-10	-	O-Ring, 2-204 Buna-N, 70A	O-Ring Compression Plate	4
5	593-009-10	-	O-Ring, JIS-2401, P10A Buna-N, 70A	JFE Sensors/Port Covers	4

Fasteners

Item No.	Part Number	Revision	Description	Use	Qty
6	630-392-10	-	Screw, Cap, 10-32 x 3/4, Socket Head, SS316	O-Ring Compression Plate	2
7	630-251-10	-	Screw, Cap, Hex Head, 1/40-20 x 1, Full Thread, SS316	Sensor Guard	1
8	630-508-10	-	Screw, Cap, M4 x 0.7mm x 10mm length, Hex Socket Hd, Titanium	JFE Sensors/Sensor Port Covers	2
9	633-010-10	-	Washer, Flat, #10, Nylon	O-Ring Compression Plate	2
10	633-011-10	-	Washer, Flat, 1/4, Nylon	Lifting Ring	1
11	633-018-10	-	Washer, Lock, Split-Ring, 1/4, SS316	Lifting Ring	1
12	634-025-10	-	Nut, Nylok, 1/4-20, 316SS	Sensor Guard	2
13	859-013-10	-	Hose Clamp, 1/2" band, 2-3/4 -- 3-3/4, 70-95mm dia, 300SS, (SAE No. 52)	Drag Net	1
14	859-016-10	-	Hose Clamp, 1/2" band, 2-1/2 -- 4-1/2, 64-114mm dia, 300SS (SAE No. 64)	Ballast Collars	1
15	859-021-10	-	Hose Clamp, 1/2" band, 5 -- 7, 127-178mm dia, 300SS (SAE No. 104)	Flotation Collar	1

Electrical Items

Item No.	Part Number	Revision	Description	Use	Qty
16	185-002-10	-	CR123 Lithium battery	LP-Power Circuit Board	1
17	240-001-10	-	250 mA, 125 V, fast blow SMF fuse	LP-Power Circuit Board ("R1" upper side)	2
18	240-002-10	-	1A, 125 V, fast blow SMF fuse	LP-Power Circuit Board ("F1" lower side)	2

Miscellaneous Items

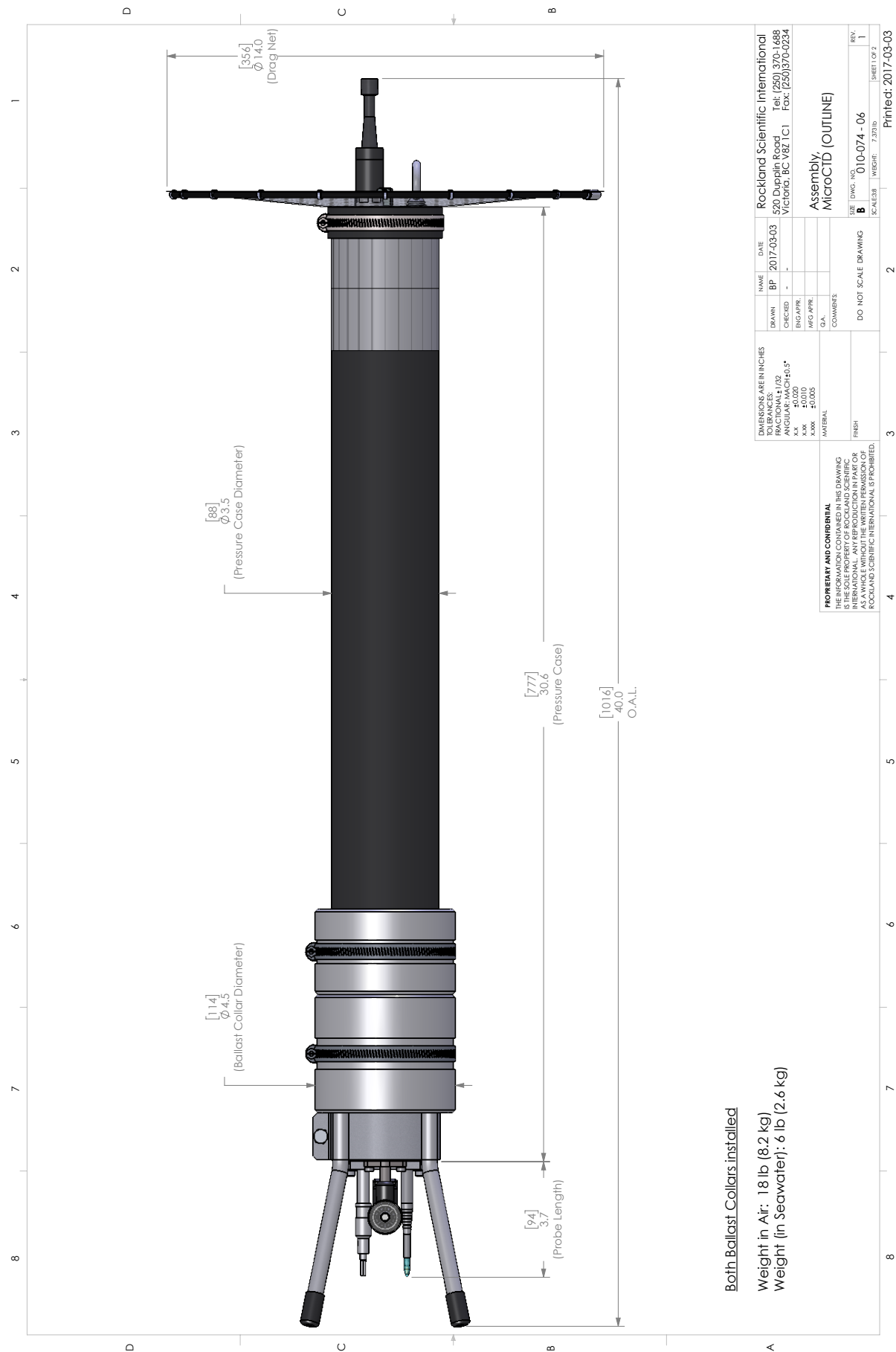
Item No.	Part Number	Revision	Description	Use	Qty
19	750-018-10	-	Rubber caps	Sensor Guard Assembly	4
20	975-000-10	-	O-Ring grease (1 oz container)	All O-Ring Seals	1

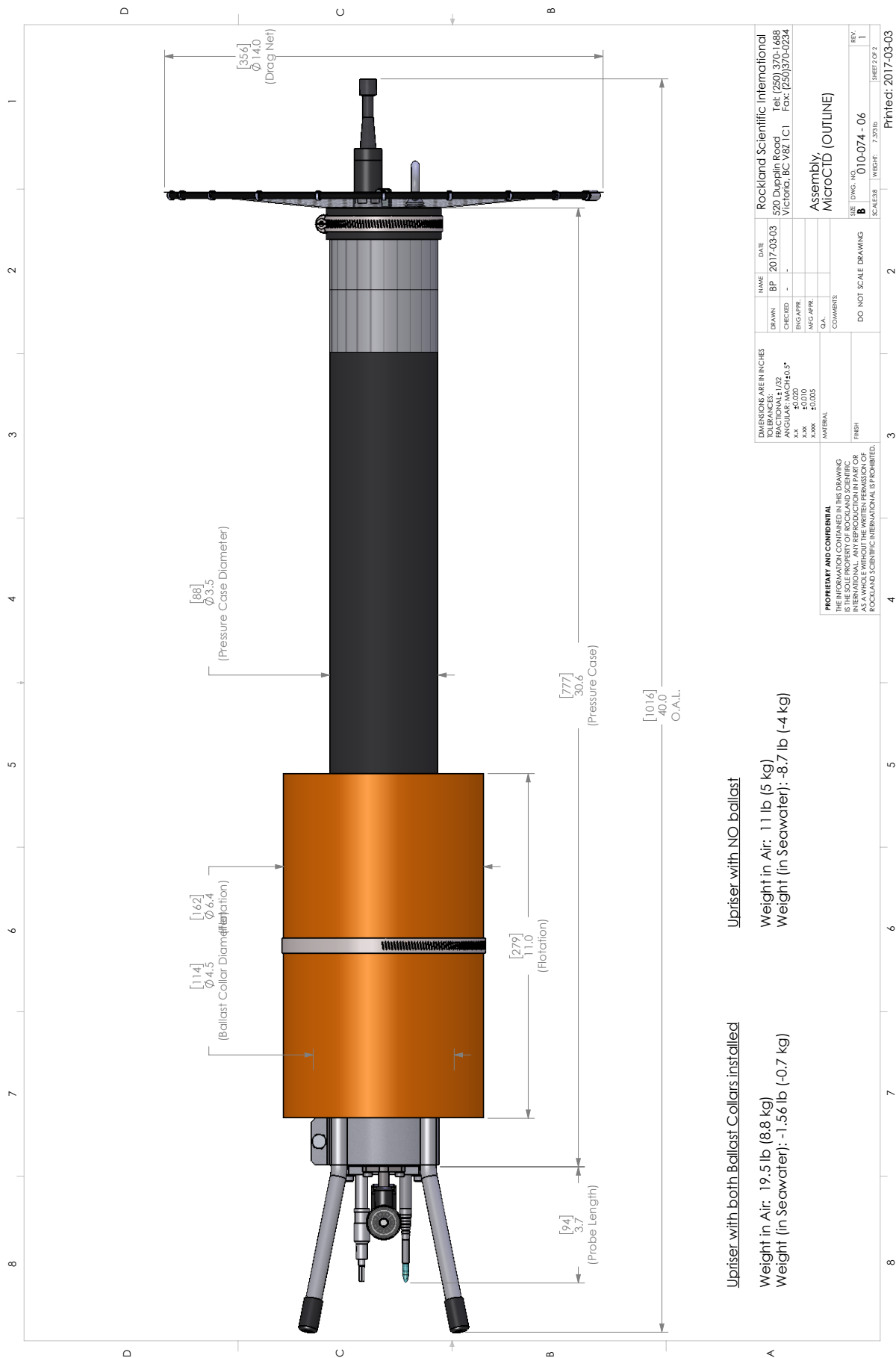
Containers

Item No.	Part Number	Revision	Description	Use	Qty
21	977-011-10	-	Container, Storage Box, 10 compartment, 8x4-3/4x1-3/4in, ACE (2418069)	Spares Kit Container	1

A.4 Outline Drawing

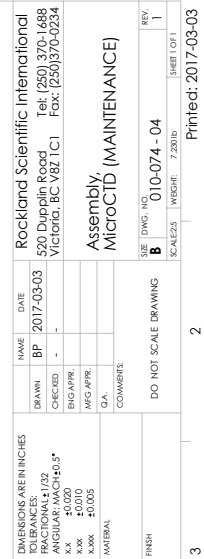
The outline drawing on the following page(s) shows the components of the MicroCTD and its dimensions.





A.5 Maintenance Drawing

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



A.6 Li-Ion Battery Material Safety Sheet (MSDS)

The MicroCTD 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 (LiCoO₂)

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



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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 (CO₂), 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.

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- 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.



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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.

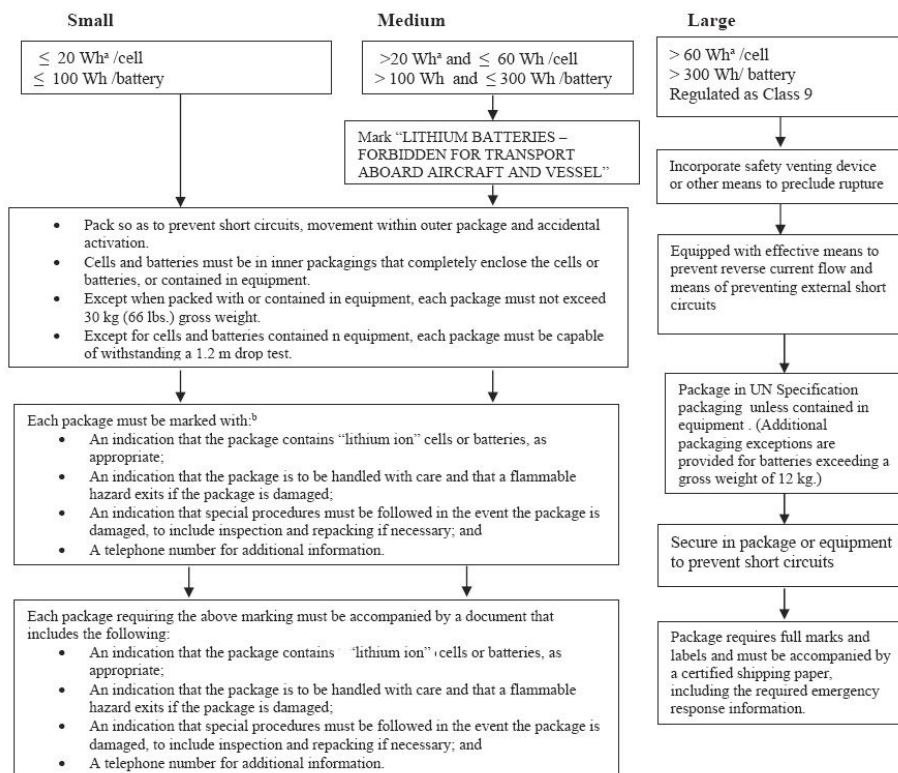
Section 14 - Transport Information

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.



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By Ground



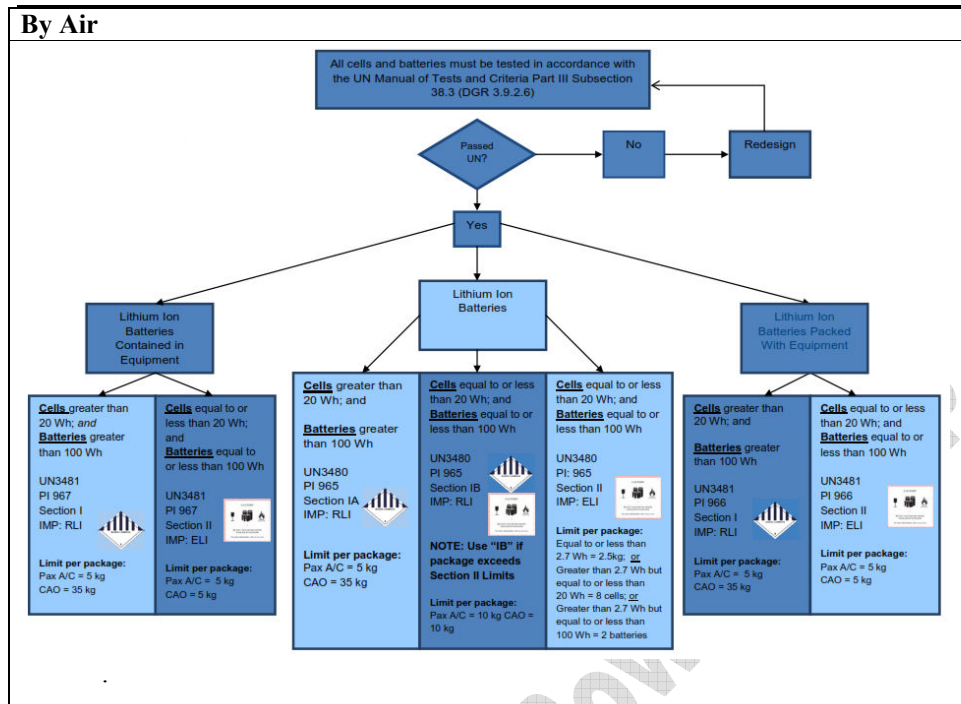
a. Wh = Watt-hours rating

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



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By Air

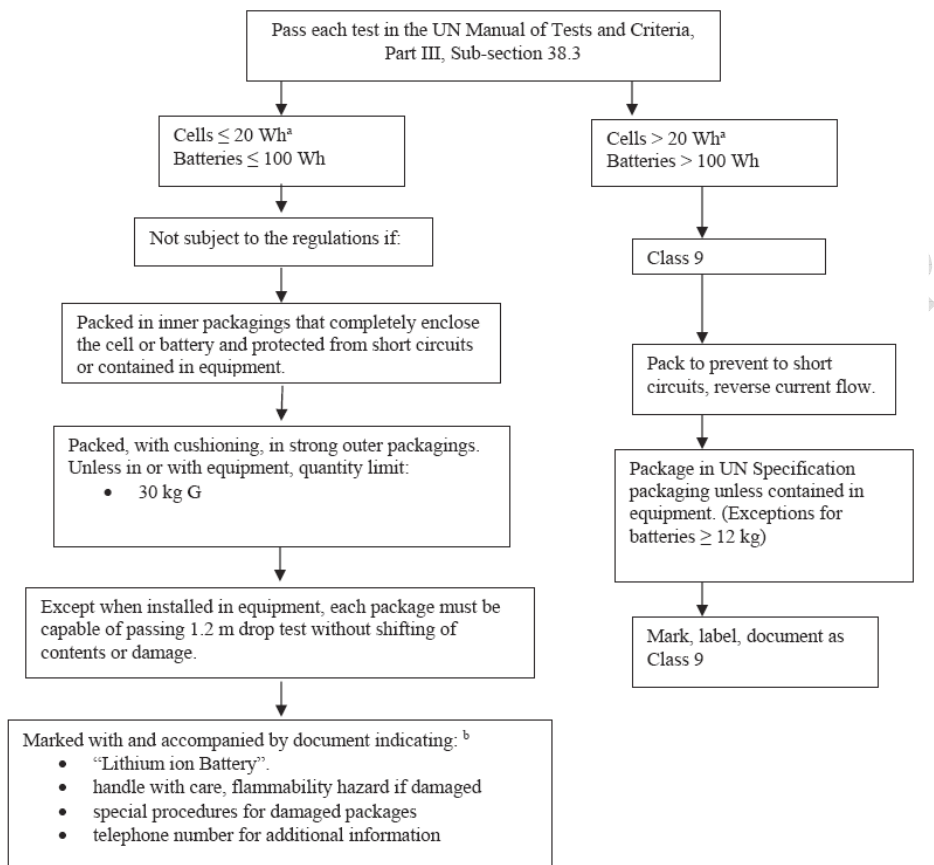




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By Ocean

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.



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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.7 Li-Ion Battery 38.3 Test Report

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



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

IV、CONCLUSION

V. 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: *Liyon*

Approval Date: September 30, 2010

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(2)《检测报告》采用特制防伪纸张印制, 纸张表面带有“PONY”防伪纹路, 该防伪纹路不支持复印, 即复制件不会带有“PONY”防伪纹路;
(3)《检测报告》采用的防伪纸张内部亦加带有高科技“PONY”防伪水印, 只有在验钞机等紫外线照射下方可显出无色荧光防伪字样;
(4)《检测报告》所盖防伪骑缝章中的一部分加盖于本检测单位的留底报告上, 《检测报告》与本检测单位留底报告的骑缝章应拼合完整无缺。



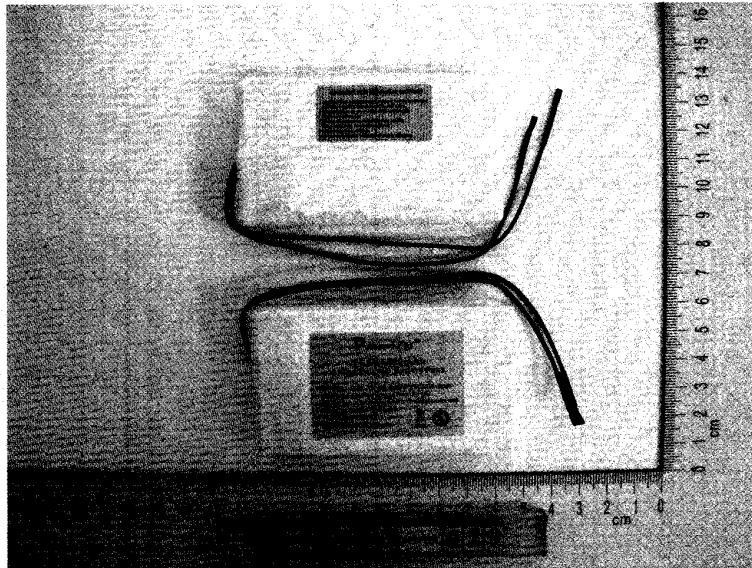
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Notes:

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

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(4)《检测报告》所盖防伪骑缝章中的一部分加盖于本检测单位的留底报告上，《检测报告》与本检测单位留底报告的骑缝章应拼合完整无缺。



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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:

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

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
$M < 1\text{g}$	0.5%
$1\text{g} < M < 5\text{g}$	0.2%
$M \geq 5\text{g}$	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($20 \pm 5^\circ\text{C}$).

2. Thermal test

Test cells and batteries are to be stored for at least six hours at a test temperature equal to $75 \pm 2^\circ\text{C}$, followed by storage for at least six hours at a test temperature equal to $-40 \pm 2^\circ\text{C}$. 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($20 \pm 5^\circ\text{C}$). 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.

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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 $55 \pm 2^\circ\text{C}$ 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 $55 \pm 2^\circ\text{C}$. This short circuit condition is continued for at least one hour after the cell or battery external case temperature has returned to $55 \pm 2^\circ\text{C}$. The cell or battery must be observed for a further six hours for the test to be concluded.

Cells and batteries meet this requirement if their temperature does not exceed 170°C 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°C 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:

- 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.
- 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.

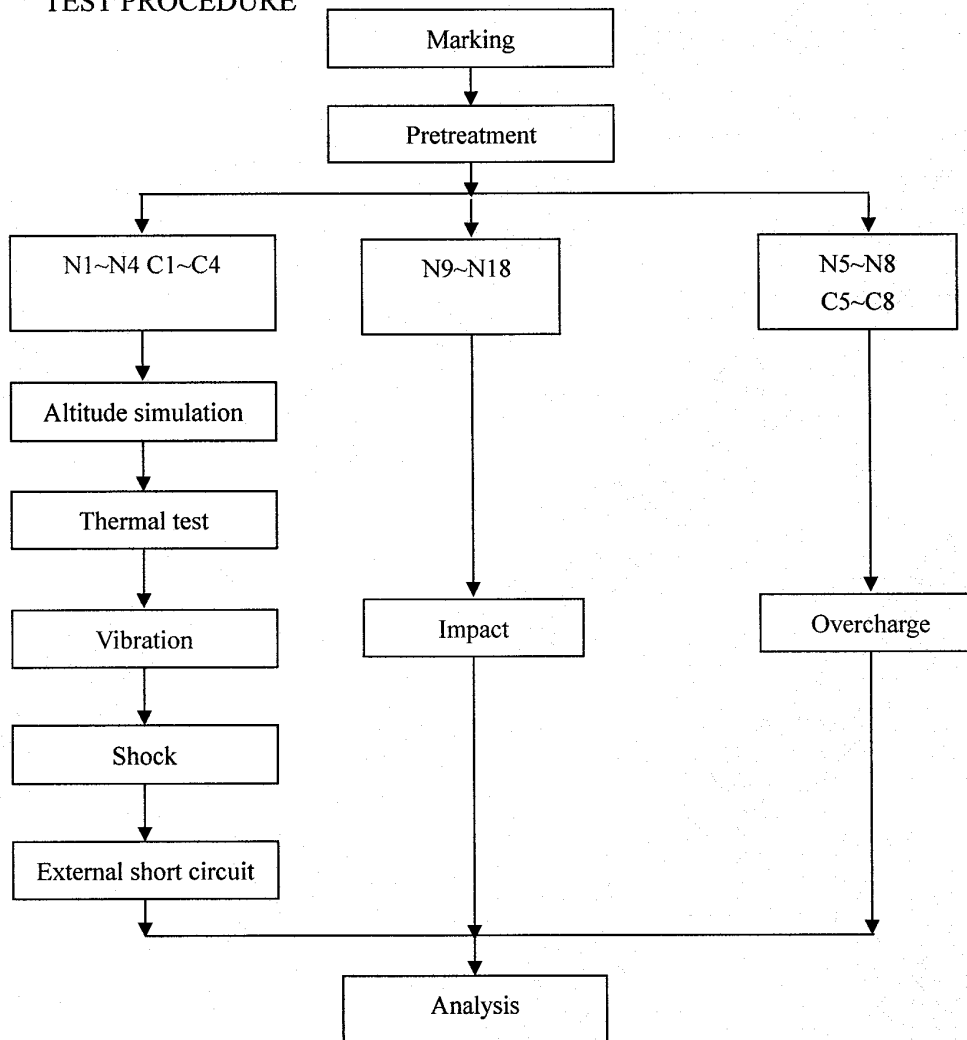
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VII、 TEST PROCEDURE



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

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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

PONY TESTING

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5. External short circuit

No.	Peak temperature (°C)	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 (°C)	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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