



Installation and Operation Guide

SeaPower™ **57-Ah Battery Documentation**



Document Version History

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Version	Date	Author	Reviewer	Change
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1 Introduction

This document provides a comprehensive guide to the **installation, commissioning, operation, and maintenance** of SeaPower™ lithium-ion battery systems when integrated into host-controlled environments. In this context, the battery functions as a managed power component within a larger system.

The guide does **not** cover charger design, external diagnostic tools, or non-battery system components unless they directly influence battery performance.

Intended Audience

This document is intended for:

- **System Integrators & Design Engineers** embedding the battery into host-controlled platforms and defining interface requirements.
- **Operators & Field Technicians** responsible for installation, diagnostics, testing, and field issue resolution.
- **QA & Manufacturing Teams** verifying correct functionality during assembly, integration, and final system checks.

Scope & Structure

The document is organized to support the full lifecycle of the SeaPower™ battery, from installation to decommissioning. The major sections include:

- **Battery Commissioning** – Procedures for first installation, integration, and post-storage checks.
- **Operation in Host-Controlled Systems** – Communication, telemetry monitoring, and discharge/standby modes.
- **Charging** – Recommended profiles, thermal considerations, and parallel charging guidance.
- **Balancing & Heater Activation** – Cell equalization procedures and temperature-dependent operation.
- **Relay Logic & Diagnostics** – BMS relay behavior, fault handling, and monitoring functions.
- **Recovery & Reset** – Procedures for clearing faults and deep discharge recovery.
- **Inspection & Maintenance** – Periodic checks, cleaning, and handling practices.
- **Firmware Updates** – Process for applying software revisions using official Kraken tools.

2 Battery Commissioning

This procedure must be followed during **first installation, system integration, or after extended storage**. Commissioning ensures the battery is mechanically secure, electrically connected, communicating properly, and operating within specification.

Safety Precautions

- **Heavy Lifting:** Use only rated lifting equipment (forklift + spreader beam). Never lift manually.
- **Visual Inspection Required:** Do **not** install a damaged, swollen, or leaking battery.
- **Connector Integrity:** Improper handling can cause **short circuits, water ingress, or permanent connector damage**. Always clean, grease, and mate correctly.
- **Electrical Isolation:** Ensure all system power is disconnected before making or breaking connections.

2.1 Lifting the Battery out of the Zarges Box

- Slide the spreader beam onto the forks of the electric forklift and secure it.
- Attach lifting straps of equal length to the battery's designated lifting points.
- Position the forklift so that the spreader beam is centered above the battery.
- Place the straps securely onto the designated mounting bolts.
- Carefully lift the battery out of the Zarges box and transport it to the installation location.



Figure 1 – Lifting the battery out of the Zarges Box

2.2 Visual and Physical Inspection

Before installation, inspect the unit for signs of damage:

- Examine the carbon fiber frame for cracks, deformation, or other structural issues.
- Inspect the housing for silicone leakage or discoloration.
- Check for any signs of swelling or soft spots on the housing.

 **Do not proceed with installation or operation if any damage is observed.**



Figure 2 – Physical and Visual Inspection

2.3 Mounting the Battery

- Secure the battery using the **side rails, top plate, or bottom surface** of the housing.
- Note: The housing includes **machined sections** to reduce weight and allow visual inspection of cells. These areas are protected by fiberglass mesh but must still be handled with care during installation.
- Avoid applying angular forces or excessive pressure to the enclosure or connectors.
- Refer to the **Interface Control Document (ICD)** for approved mechanical mounting locations.



Figure 3 - Example of battery mounting with brackets

2.4 Electrical and Communication Connections

Care

- Do not expose SubConn® connectors to extended heat or direct sunlight.
- If a connector becomes dry, soak it in fresh water before use.
- With proper handling, SubConn® connectors and cables should last for **>500 mate/de-mate cycles**.
- Avoid pulling on cables or creating sharp bends near the entry point.
- Ensure no angular loads are applied to bulkhead connectors.

Inspection

- Check cables for damage, dirt, or excessive brittleness.
- For **circular connectors** – inspect locking sleeves, threads, and retaining rings.
- For **low-profile connectors** – inspect the strap and sealing surfaces.
- If damage is visible, do **not** attempt to mate the connector.

Cleaning

- Remove debris with a spray-based contact cleaner (e.g., isopropyl alcohol).
- Use dry, clean, unlubricated air to remove excess water from male pins and female sockets.
- Reapply grease after cleaning.

Greasing

- Apply **Molykote 44 Medium** grease before each mating.
- Apply grease to approx. $\frac{1}{3}$ **socket depth** of the female connector.
- Ensure a thin transparent film covers the connector face.
- After mating, remove excess grease from the joint.

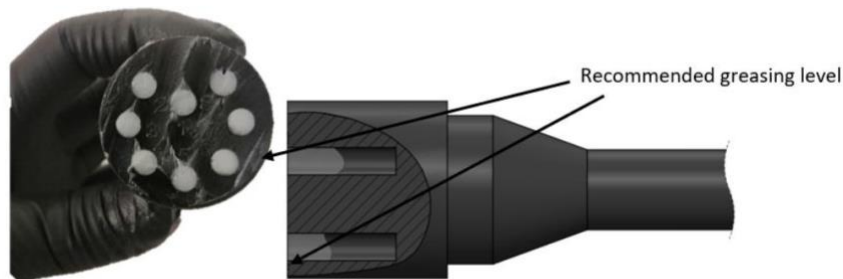


Figure 4 - Recommended greasing level

Mating

- Do not force connectors. If resistance occurs, reapply grease.
- Verify locking sleeves are fully engaged after mating.
- Reattach protective covers when not in use.
- Confirm all connections are secure and insulation integrity is intact.



Figure 5 - Electrical and Communication Connections

3 Battery Operation (Host-Controlled)

The SeaPower™ battery is designed for integration into a **host-controlled system**. The host governs charging, enables discharging, and monitors telemetry via a dedicated communication interface. The Battery Management System (BMS) ensures safe operation by supervising cell health, relay status, and protection thresholds.

Safety Precautions

- **Host Responsibility:** The battery cannot operate autonomously. The host must issue correct commands to enable charge/discharge.
- **Do Not Bypass BMS:** Relays and protections are safety-critical. Never force current through the system if relays are open.
- **Telemetry Monitoring Required:** Continuous monitoring of SOC, voltages, and temperature is mandatory during operation.
- **Fault Handling:** If the battery enters Fault Mode, determine and correct the root cause before issuing a reset.

3.1 Battery Communication

Battery communication follows the SeaPower™ protocol (see firmware ICD). A standard sequence includes:

1. Power on the BMS by closing the contact between **BMU_ON** and **RETURN** pins.
2. Wait <1 s for BMS startup and self-check.
3. Send handshake command.
4. Receive handshake response.
5. Request system parameter data and verify the response.
6. Request system monitoring data.
7. Confirm key BMS metrics:
 - State of Charge (SOC)
 - Cell voltages
 - Temperatures
 - Balancing status
8. Ensure no active faults or warnings before proceeding.

3.2 Monitor Operational Telemetry

During operation, the host must continuously log and evaluate telemetry:

- **Pack voltage**
- **Current (charge/discharge)**
- **Cell and module temperatures**
- **Relay status**
- **Fault and warning flags**

Protection Response:

- If a fault occurs, the BMS opens relays and enters **Error State**.
- The host must diagnose the issue and take corrective action.
- Once resolved, the system can be restarted using the System Reset command.

3.3 Battery Discharge

1. From Standby, issue host command **Set_Mode = Discharge**, or close the **POWER_ON** contact pin.
2. Once safety checks pass and pre-charge is complete, the BMS closes the discharge relay.
3. Wait for **acknowledgement response** from the BMS.
4. Verify system-level isolation before applying load.

3.4 End of Mission/Shutdown

Command Battery to Standby

- Use host command **Set_Mode = Standby**.
- Confirm relays open and current falls to zero.
- Open the connection pins between **BMU_ON** and **RETURN** to power down the BMS.

Disconnect System

5. Disconnect communication lines first, then power connectors.
6. For **circular connectors**: unscrew locking sleeve; inspect threads and seals.
7. For **low-profile connectors**: remove strap; inspect strip and base of bulkhead connector.
8. Use compressed air or absorbent cloth to remove water.
9. Clean connectors with isopropyl alcohol if debris is present.
10. Reinstall dummy plugs and protective covers on unused connectors.
11. After saltwater operation, rinse connectors thoroughly in fresh water and allow to dry before transport or maintenance.

4 Battery Charging

Kraken strongly recommends using a **Kraken-approved charger** and charging the battery **submerged in water** to ensure optimal performance, safety, and thermal management. Charging instructions are model-specific and provided in the charger's manual. This section covers general charging procedures when performed via the host system or manually.

The SeaPower™ battery must always be charged using a **CCCV (Constant Current / Constant Voltage)** profile.

Safety Precautions

- **Approved Equipment Only:** Use only Kraken-approved chargers unless specifically authorized.
- **Thermal Risk:** Charging in air requires reduced current; exceeding thermal limits can cause overheating or trigger BMS protection.
- **SOC Monitoring:** Always monitor State of Charge, voltage, and temperature during charging.
- **Parallel Charging:** Only permitted when all safety conditions (matching models, diodes, SOC alignment) are met.

4.1 Thermal Considerations

Charging in Water (Recommended): Enables full-rate charging by maximizing heat dissipation.

Charging in Air (Permitted with Restrictions): Charge current must be reduced to remain within thermal limits. Refer to the product datasheet for maximum allowable air charge current. Exceeding this may cause overheating, reduced cycle life, or thermal protection activation.

4.2 Single Unit Charging Profile

The standard charging sequence is:

1. Set **Mode = Charge** using the host system.
2. After safety checks and pre-charge, the BMS closes the charge relay.
3. Wait for **acknowledgement response** from the BMS.
4. Verify system isolation.
5. **Constant Current (CC) Phase** – supply current (within thermal limits) until voltage setpoint is reached.
6. **Constant Voltage (CV) Phase** – hold set voltage while current tapers down.
7. **Charge Termination** – stop charging when current falls below cutoff threshold or when maximum cell voltage is reached.

4.3 Parallel Charging Procedure

Kraken batteries may be charged in parallel with a single CCCV charger if the following requirements are strictly met:

4.4 Required Conditions

- **All batteries must be the same model and chemistry.**
- **All batteries must be set to Charge Mode.**
- **Each battery must include a directional (blocking) diode on the charge input to prevent reverse current.**

4.5 Process Steps

1. **Assess SOC:** Identify the battery with the **lowest SOC or terminal voltage**.
2. **Set CV Voltage:** Configure the charger's CV setpoint based on the lowest-SOC battery.
3. **Activate Charge Mode:** Set all batteries to **Charge** before enabling charger output.
4. **Begin CCCV Charging:** Lower SOC batteries will naturally draw more current.
5. **Adjust Voltage if Necessary:** As voltages converge, stepwise increase the charger's CV setpoint toward the nominal full-charge voltage.

 **Caution:** Never begin charging with a CV setpoint higher than the lowest battery voltage if SOC's differ significantly. This may cause current surges or BMS faults.

5 Monitoring and Diagnostics

Monitoring battery performance in real time is essential for safe and efficient operation of the SeaPower™ system. The integrated **Battery Management System (BMS)** continuously measures and records critical telemetry from cells and modules, and makes this data available to the host system through a dedicated communication interface.

5.1 Interface Overview

SeaPower™ batteries communicate via **RS-485 serial interface** by default. Data exchange uses a **HEX-based protocol**, defined in the **Firmware ICD**.

The following parameters are monitored and updated in real time:

Parameter	Description
Pack Voltage	Total voltage across the entire battery pack
Current	Charge or discharge current (directional)
State of Charge (SOC)	Estimated remaining capacity, expressed as a percentage
Cell Temperatures	Temperature readings from sensors within each module
Relay Status	Indicates whether charge/discharge relays are open or closed
Protection Flags	Fault indicators (e.g., overvoltage, undervoltage, ..)
Operating Mode	Current BMS state (Standby, Charge, Discharge, Fault)

6 Battery Storage and Packing

Proper storage and packing of SeaPower™ lithium-ion batteries ensures safe handling, compliance with transport regulations, and preservation of long-term performance.

6.1 Storage State of Charge (SOC)

- Store at **30–60% SOC** for long-term health.
- Avoid >90% SOC or <10% SOC storage for extended periods.
- For storage >6 months, check SOC every 3 months and recharge if below 30%.

6.2 Environmental Conditions

- Temperature: **+5 °C to +25 °C recommended. Short-term –20 °C to +45 °C permissible.**
- Humidity: **Store in a clean, dry environment (<85% RH, non-condensing).**

Note: Humidity control protects connectors, seals, and external hardware during storage.

- **Avoid exposure to direct sunlight, corrosive atmospheres, or mechanical vibration.**

6.3 Packing Procedure

1. **Connector Protection** – Install dummy plugs on all SubConn® connectors and secure dummy plugs with bracket as shown in fig. 5 with secure bracket, apply Molykote 44 grease before packing.
2. **Protective Case** – Place each battery in a **Kraken-supplied storage/shipping case** constructed with heat-resistant materials, surround the battery with **non-combustible, non-conductive insulation** to prevent heat buildup.



Figure 6 - Protective case with non-combustible insulation

3. **Fire-Resistant Foam** – Ensure the case's **integrated fire-resistant black foam** is in place to minimize vibration and prevent battery movement.



Figure 7 -Fire-Resistant Foam

4. **Labeling** – Apply the following labels clearly to each container:
 - Lithium-ion Class 9 hazard labels
 - Battery model, serial number, SOC level, and packing date
5. **Palletizing** – Strap cases securely to a pallet (**170 × 120 × 24 cm recommended**) with enough clearance for forklift handling.
6. **Stacking Limit** – Do not stack more than **two cases high**.

 **Caution:** Never store or ship a battery in a fully discharged condition. Permanent cell damage may result.

7 Balancing Operation and Behavior

The SeaPower™ Battery Management System (BMS) performs **passive resistive balancing** of the cells. Balancing only occurs when the battery is **connected to a charger** and the user explicitly **initiates the balancing function**.

Balancing helps ensure consistent State of Charge (SoC) across cells, maximizing usable capacity and maintaining accuracy of SoC estimation.

7.1 When Balancing is Required

Balancing is **not continuous** during normal operation. Perform balancing under the following conditions:

- After multiple cycles if cell voltage spread exceeds allowable limits
- When SoC estimation is inconsistent across modules
- As part of periodic maintenance
- After storage or before critical deployments

Recommended trigger: Balance the pack if the **maximum cell voltage difference (highest–lowest)** is **> 0.100 V with no load** and at approximately **50% SOC**.

7.2 Initiating the Balancing Process

Balancing must be initiated while the battery is in **Standby Mode** (relays open; no charge/discharge). Start it via the **host system** or **charger**.

1. Place the battery in Standby Mode.
2. Verify cell voltages are within the defined balancing voltage window (see specifications).
3. Determine the max cell ΔV (highest minus lowest).
4. If $\Delta V > 0.100$ V at ~50% SOC and no load, proceed.
5. Issue the balancing command via the host system (see communication protocol).

7.3 What Happens During Balancing

- The BMS enables internal **bleed resistors** to reduce higher cell voltages.
- External charge/discharge is **disabled** (no current at the terminals).
- Balancing runs until cell voltages are within tolerance, or until a timeout or power-off occurs.

Caution

1. **Balance the battery** in water—dissipative balancing generates heat.
2. **Use balancing as a conditioning/maintenance step, not a recovery method** for degraded cells.

8 Heater Activation & Temperature Thresholds

The SeaPower™ battery incorporates an **internal heater system** to enable safe charging in low ambient temperatures. Heater activation is controlled by the **host system**; the BMS does not autonomously manage heater power.

8.1 When Heater Activation is Required

Charging lithium-ion batteries at sub-zero temperatures can cause **irreversible cell damage** and **capacity loss**. The heater system is designed to:

- **Preheat the cells** before charging when temperatures fall below the safe charging threshold.
- Be activated by issuing a **heater activation command** through the charger (see charger documentation).

8.2 Heater Activation Thresholds.

Trigger Condition	Threshold	Behavior
Charging	< 0 °C	Host must activate heater; charging blocked
Heater deactivates	≥ ~10 °C	Charging permitted; heater disengages automatically

Additional considerations:

- Heater operates only in Charge Mode.
- The BMS blocks charging until temperature rises above the safe threshold.
- Heaters are embedded within the battery module, between cells, ensuring uniform warming.
- Heaters are powered by the external charger.

9 Relay Logic and State Transitions

The SeaPower™ battery uses internal **solid-state relays** controlled by the Battery Management System (BMS). These relays isolate or enable the high-voltage pathways, determining when the battery can accept or deliver current. They act as the **primary control mechanism** for both safety protections and operational mode transitions.

9.1 Relay Functions

Relay Type	Function
Discharge Relay	Connects the battery's power output to the external load system
Charge Relay	Connects the battery's power input to the external charging source

Both relays are normally open. They only close when the BMS confirms that all monitored conditions are within safe limits.

9.2 Relay Default Behavior: Standby Mode

When the battery first powers on (via applied system voltage or wake signal), it enters **Standby Mode**. In this state, the battery remains isolated **until either the Power On pin is asserted or a valid state change command is received from the host system**.

- Both Charge and Discharge relays remain open.
- The BMS is active, monitoring all cells and sensors.
- Communication is enabled.
- No current flows in or out of the pack.

This provides a **safe, non-energized state**, where telemetry is available but power delivery is blocked.

9.3 Relay Logic for Mode Transitions

The BMS controls relay closure based on operational mode, safety thresholds, and external commands from the host system.

Mode	Charge Relay	Discharge Relay
Standby	Open	Open
Charge	Closed	Open
Discharge	Open	Closed
Fault / Error	Open	Open

9.4 Relay Logic for State Transitions

The BMS transitions between operating states using telemetry, host commands, and fault inputs:

From State	To State	Trigger	Conditions Required
Standby	Charge	Host command (Set_Mode = Charge)	- Cell temp ≥ 0 °C - No active fault - SOC < 100%
Standby	Discharge	Host command (Set_Mode = Discharge)	No active fault
Charge	Standby	Charging complete or Host command (Set_Mode = Standby)	SOC $\geq$ target
Discharge	Standby	Host command (Set_Mode = Standby)	
Any State	Fault	Fault triggered	Fault occurred (e.g., OV, OT)
Fault	Standby	Host command (Set_Mode = System Reset)	All monitored values return to nominal range

9.5 Relay Fault Lockouts

When a **fault occurs**, the BMS immediately opens both relays, electrically isolating the battery. This places the system into a **protection state**.

- Recovery may occur automatically once conditions return to normal, depending on configuration.
- Certain faults may require a **system reset** command from the host system.
- Persistent or recurring lockouts should be reported to Kraken Robotics for diagnostics.

10 Recovery and Reset Procedures

The SeaPower™ battery protection system can recover from most fault conditions either **automatically once the fault clears**, via a **System Reset command**, or through **manual intervention**, depending on severity. This section outlines reset methods and deep discharge recovery..

10.1 System Reset Command

A reset can be issued remotely over the communication interface:

- Send the **System_Reset** command as defined in the **Software ICD**.
- The BMS reboots into **Standby Mode** once reset completes.

10.2 Hard Reset

If communication is unavailable, perform a hard reset:

1. Disconnect communication.
2. Ensure dummy plugs are installed where required.
3. Wait 10–15 seconds for internal power-down.
4. Reconnect communication line.
5. Battery will boot in Standby mode.
6. Verify communication handshake.
7. Use handshake or charger GUI to confirm BMS is responding.
8. Poll for fault flags.
9. Confirm all active errors have cleared.
10. If faults persist, check against the Troubleshooting document.

10.3 Deep Discharge Recovery

During a **deep discharge event**, the BMS shuts down automatically to protect the cells. Recovery differs by model:

- **BM513V45** – The BMS can be reactivated briefly via the **BMU_ON trigger**, allowing the pack to enter **Charge Mode** for recovery.
- **BM57V311** – The BMS requires an **external power cable** to re-energize and enable charging. For detailed recovery procedures, refer to **Battery Recovery from DDR** (dedicated section).

11 Inspection & Maintenance

The SeaPower™ battery system is designed for minimal field maintenance. However, regular inspection is essential to ensure long-term safety, reliability, and compliance with operational specifications.

11.1 Periodic Inspection Checklist

Perform the following checks **before and after each deployment**, or at regular service intervals:

Inspection Item	What to Look For
Battery frame	Cracks, deformation, soft spots, look for deep scratches or visible silicone leaks
SubConn® bulkhead connectors	Debris, bent pins, corrosion, dry seals
Dummy plugs (when installed)	Tight fit, no water ingress, undamaged seals
Connector mating surfaces	Excessive grease, water pooling, or contamination
Labels and serial number plates	Legibility, correct identification for configuration

11.2 Acceptable Cell and System Voltages

Check these values via telemetry or GUI before operation:

Measurement	Acceptable Range	Notes
Cell Voltage	3.0 V – 4.2 V	Cells at 2.8 V or lower are considered damaged -
Pack Voltage	Depends on model	Refer to battery ICD
ΔV	0.1 V	Excessive difference may require balancing

11.3 Signs of Degradation or Damage

Investigate immediately if any of the following are observed:

- Swollen or soft housing (possible outgassing or pressure imbalance).
- Repeated undervoltage flags despite full charging.
- Fluctuation on SoC.
- Excessive cell voltage delta even after balancing.
- Abnormal internal temperature distribution (e.g., cold spots despite heater active).
- Non-responsive telemetry or unstable communication.

11.4 Cleaning and Handling Practices

Follow these practices to maintain system integrity:

Action	Best Practice
Saltwater rinse	Rinse thoroughly with fresh water after exposure
Drying	Allow battery to dry completely before servicing
Connector cleaning	Use isopropyl alcohol spray , not acetone or gasoline
Re-greasing	Apply Molykote 44 to connector seals before each mating
Connector mating/unmating	Always pull straight; avoid angular stress or cable twist
Storage between use	Use dummy plugs; store dry, upright, at moderate temperature

12 Updating the Battery Firmware

Kraken Robotics continuously improves its SeaPower™ batteries and firmware.

If a software issue is suspected:

1. Email customersupport@krakenrobotics.com with the battery model and current firmware version.
2. Kraken will verify whether the issue is known and if a firmware update is available.
3. If required, Kraken Support will provide the correct firmware file and guide you through the flashing process.

12.1 Required Equipment

- Official SeaPower™ firmware hex file, matching the battery model (e.g., KrakenBMS-1.3.0-BM57V311.hex)
- SeaPower™ Flash Cable (model-specific — contact Kraken for correct part number)
- Windows 10 (or newer) PC with a USB-A 2.0 port
- Latest Kraken SeaPowerFlash software (provided by Kraken upon request)

12.2 Flashing Procedure

11. Disconnect all cables from the battery.
12. Connect the SeaPower Flash Cable to the battery:
 - Single-connector variant: connect to J1X3; ensure dummy connectors are installed on unused ports.
 - Three-connector variant: connect to J1X1, J1X2, and J1X3.
13. Connect the Flash Cable to the PC.
14. Open the Kraken SeaPowerFlash software.
15. Select the COM port associated with the battery connection.
16. Browse and select the correct firmware .hex file.
17. Verify firmware name, battery model, and version number (e.g., KrakenBMS-1.3.0-BM57V311.hex).
18. Click Start to write the firmware.
 - Log should display: Success: _____ bytes written.
 - Bus address will be shown.
19. Enter the desired serial number (SN) in the Bus Address field (e.g., 043).
 - Using the battery's actual serial number is strongly recommended to prevent communication conflicts.
20. Click Start again to write the serial number.
 - Log should display: Success: 256 bytes written.
 - Confirm bus address matches entered SN.

12.3 Troubleshooting

- **No COM port available:** Verify Flash Cable is properly connected to the battery and PC.
- **Flashing stops or fails:** In SeaPowerFlash, enable the SlowFlash option and retry from Step 8.

13 Permanent Decommissioning

When a SeaPower™ battery is permanently removed from service, it must be handled according to Kraken Robotics' safety, environmental, and intellectual property (IP) protection guidelines.

Procedure:

- Follow all **storage guidelines** prior to shipment or disposal.
- Discharge and maintain the battery at **≤ 30% State of Charge (SOC)**.
- Contact **Kraken Robotics** for:
 - Return authorization and instructions
 - Approved recycling or disposal vendor options
 - End-of-life handling procedures (including hazardous material compliance)

13.1 Intellectual Property Protection

Authorized disposal companies must:

- Obtain **written authorization** from Kraken Robotics before processing any SeaPower™ battery.
- Agree **not to reverse engineer, photograph, or otherwise document** internal components.

Caution

Do not attempt to disassemble, incinerate, or dispose of the battery through conventional waste streams. Lithium-ion cells require **specialized recycling and handling** to prevent fire, toxic release, or environmental harm.

14 Legal Notices & Contact Information

14.1 Copyright and Trademarks

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14.2 Disclaimer

- Kraken must be consulted regarding the proper **integration, calibration, and configuration** of any Kraken-designed system.
- This document is intended as **supplementary information only**. Any modifications to system integration or configuration must be discussed with Kraken Robotics.
- Failure to operate the product in a **safe and responsible manner** may result in injury, property damage, or product failure.
- It is essential to **read all documentation** pertaining to the product and follow all safety instructions and warnings prior to setup or use.
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For technical assistance and customer support: CustomerSupport@krakenrobotics.com

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