LOW-TEMPERATURE BATTERY ENDURANCE TEST RESULTS

LOW-TEMPERATURE BATTERY ENDURANC

Q4 2023 PERFORMANCE ANALYSIS REPORT

Polar Dynamics Robotics, Inc.

Document Reference: PDR-TECH-2023-Q4-BET-001

1. EXECUTIVE SUMMARY

This document presents the official test results and performance analy

BlueCore(TM) Battery System's low-temperature endurance capabiliti

2023, conducted in accordance with ISO/IEC 60068-2-1 (Environmen

Polar Dynamics Robotics' Proprietary Testing Protocol PDR-TP-2023-

2. TEST PARAMETERS

1. Test Environment Specifications:

- Primary Test Chamber: Tenney T30C-2.0
- Temperature Range: +5 C to -40 C
- Humidity Control: 15% to 85% RH
- Atmospheric Pressure: 101.3 kPa 1%

2. Test Subject Specifications:

- Battery Model: BlueCore(TM) BC-4000-LT

- Serial Numbers: BC4K-2023-Q4-001 through BC4K-2023-Q4-010

- Nominal Capacity: 4000Wh

- Nominal Voltage: 48V

- Chemistry: Lithium Iron Phosphate (LiFePO4)

3. METHODOLOGY

1. Testing Protocol:

Duration: 90 days (October 1, 2023 - December 31, 2023)

-

Cycle Count: 500 complete charge/discharge cycles

-

Load Profile: Variable according to PDR Standard Operating Profile v3

-

Data Collection Interval: 5-minute intervals

2. Performance Metrics:

-

Discharge capacity retention

-

Voltage stability under load

-

Internal resistance variations

-

Temperature differential monitoring

-

Self-discharge rate

-

Charge acceptance rate

4. TEST RESULTS

1. Capacity Retention:

-

Beginning of Test (BOT) Average: 4012Wh

-

End of Test (EOT) Average: 3886Wh

Capacity Retention Rate: 96.86%

-

Standard Deviation: 1.2%

2. Cold Start Performance:

-

Successful starts at -30 C: 100%

-

Average start-up time at -30 C: 2.8 seconds

-

Power delivery stability: 99.4%

3. Cycle Life Performance:

-

Cycle efficiency at -20 C: 94.2%

-

Average voltage sag under peak load: 2.1V

-

Internal resistance increase: 8.4%

5. COMPLIANCE AND CERTIFICATION

1. The testing procedures and results comply with:

-

UL 2580 (Batteries for Use in Electric Vehicles)

-

UN 38.3 (Transportation Testing for Lithium Batteries)

-

IP67 Environmental Protection Standard

CE/FCC Class A Requirements

2. Quality Assurance:

- ISO 9001:2015 Certified Testing Facility

- NIST-Traceable Calibration

- Third-party verification by T V S D America

6. CONCLUSIONS AND RECOMMENDATIONS

1. Performance Achievements:

-

Exceeded design specifications for cold-weather operation

- Demonstrated consistent performance across all test units

- Validated thermal management system effectiveness

2. Recommendations:

- Implement enhanced monitoring for units operating below -35 C

- Update maintenance schedule for extreme condition deployments

- Consider firmware optimization for cold-start procedures

7. CONFIDENTIALITY AND LEGAL NOTICES

1. This document contains confidential and proprietary information be

2. The test results contained herein are valid only for the specific units

8. AUTHENTICATION

Certified and authenticated by:

Dr. James Barrett

Chief Robotics Officer

Polar Dynamics Robotics, Inc.

Date: January 5, 2024

Marcus Chen

Chief Technology Officer

Polar Dynamics Robotics, Inc.

Date: January 5, 2024

Dr. Sarah Wong

Director of Quality Assurance

Polar Dynamics Robotics, Inc.

Date: January 5, 2024

9. DOCUMENT CONTROL

Document Number: PDR-TECH-2023-Q4-BET-001

Version: 1.0

Release Date: January 5, 2024

Review Date: January 5, 2025

Distribution: Authorized Personnel Only