POWER DISTRIBUTION SYSTEM SPECIFICATIONS

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Classification: Confidential - Technical Documentation

1. SCOPE AND PURPOSE

1. This document specifies the power distribution system requirements for Polar Dynamics Robotics, Inc.'s ("Company") autonomous mobile robot ("AMR") platforms, specifically designed for operation in extreme cold environments ranging from -40 C to +25 C.

2. These specifications govern all power distribution components, subsystems, and interfaces utilized in the Company's IceNav-enabled AMR products, including but not limited to the Arctic Series (AS-200, AS-300) and Polar Series (PS-400, PS-500) robots.

2. DEFINITIONS

1. "Power Distribution System" or "PDS" means the integrated network of electrical components that manage and distribute power from the primary power source to all subsystems within the AMR.

2. "Critical Operating Temperature Range" or "COTR" means the temperature range of -40 C to +25 C within which all PDS components must maintain specified performance parameters.

3. "Thermal Management System" or "TMS" refers to the proprietary active/passive cooling and heating systems that maintain optimal operating temperatures for PDS components.

3. TECHNICAL REQUIREMENTS

1. Power Source Specifications

a) Primary Battery: Lithium Iron Phosphate (LiFePO4)

- Nominal Voltage: 48V DC
- Capacity: 100-150 Ah
- Cold Weather Rating: -40 C

b) Backup Power System

- Type: Supercapacitor array

- Capacity: 5 kW-hr
- Response Time: <10ms

2. Distribution Network

a) Main Power Bus

- Rated Current: 200A continuous
- Peak Current: 300A (30 seconds max)
- Voltage Drop: <2% at maximum load

b) Secondary Distribution

- Isolated 24V DC circuits
- Redundant power paths for critical systems
- Smart load shedding capability

3. Protection Systems

a) Circuit Protection

- Electronic circuit breakers with thermal compensation
- Overcurrent protection response time: <1ms
- Short circuit protection: 10kA interrupt rating

b) Environmental Protection

- IP67 rated enclosures
- Conformal coating on all PCBs
- Condensation prevention system

4. SAFETY AND COMPLIANCE

1. Standards Compliance

- UL 1012 (Power Units Other Than Class 2)
- IEC 61508 (Functional Safety)
- ISO 13849-1 (Safety of Machinery)
- NFPA 79 (Electrical Standard for Industrial Machinery)

2. Safety Features

a) Emergency Power Shutdown

- Multiple activation methods
- Response time: <100ms
- Fail-safe design

b) Isolation Systems

- Galvanic isolation between subsystems
- Ground fault monitoring
- Insulation resistance monitoring

5. MONITORING AND DIAGNOSTICS

1. Real-time Monitoring Parameters

- Current draw per subsystem
- Voltage levels at distribution nodes
- Temperature at critical points
- Power quality metrics
- Battery state of charge

2. Diagnostic Capabilities

- Continuous system health monitoring
- Predictive failure analysis
- Performance trend analysis
- Fault logging and reporting

6. MAINTENANCE AND SERVICEABILITY

1. Preventive Maintenance Requirements

- Quarterly inspection of all power connections
- Bi-annual thermal imaging analysis
- Annual replacement of environmental seals
- Battery capacity testing every 500 cycles

2. Service Access

- Tool-free access to main distribution panel
- Quick-disconnect connectors for major components

- Modular design for component replacement

7. WARRANTY AND DISCLAIMER

1. The specifications contained herein are proprietary to Polar Dynamics Robotics, Inc. and are protected under applicable intellectual property laws.

2. These specifications are subject to change without notice and represent minimum requirements for power distribution systems in Company's AMR products.

3. Compliance with these specifications does not guarantee system performance or suitability for specific applications.

8. REVISION HISTORY

Version | Date | Description | Approved By

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2 | 2024-01-15 | Updated thermal specifications | M. Chen, CTO

1 | 2023-09-20 | Added backup power requirements | J. Barrett, CRO

0 | 2023-06-15 | Major revision for Arctic Series | E. Frost, CEO

9. APPROVAL

APPROVED AND ADOPTED by Polar Dynamics Robotics, Inc.

By:

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