PDR-AMR-203: Autonomous Mobile Robot Power Management Specifications

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Classification: CONFIDENTIAL

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1. Purpose and Scope

1. This specification document ("Specification") defines the mandatory power management requirements and operational parameters for Polar Dynamics Robotics' Autonomous Mobile Robot ("AMR") systems operating in temperature-controlled environments.

2. This Specification applies to all Series X-500 and X-700 AMR platforms manufactured by Polar Dynamics Robotics, Inc. ("Company") after March 1, 2024.

2. Definitions

1. "Cold Environment Operation" refers to sustained AMR operation in ambient temperatures between -30 C and +5 C.

2. "Power Management System" or "PMS" refers to the integrated hardware and software components controlling power distribution, charging, and monitoring.

3. "Thermal Management Module" or "TMM" refers to the proprietary system maintaining optimal battery and electronics temperature.

3. Power System Requirements

1. Primary Power Source

- 3.1.1. Lithium Iron Phosphate (LiFePO4) battery pack
- 3.1.2. Nominal voltage: 48V DC
- 3.1.3. Minimum capacity: 280Ah
- 3.1.4. Cold-rated cells with operating range -40 C to +60 C

2. Backup Power System

- 3.2.1. Redundant 24V DC lithium-ion battery
- 3.2.2. Minimum 30-minute runtime at full load
- 3.2.3. Automatic failover capability
- 3.2.4. Independent thermal management system

4. Thermal Management Specifications

1. Battery Heating System

- 4.1.1. Integrated resistive heating elements
- 4.1.2. Temperature maintenance between +5 C and +35 C
- 4.1.3. Maximum power consumption: 800W
- 4.1.4. Dual-redundant temperature sensors

2. Electronics Environmental Control

- 4.2.1. Sealed enclosure maintaining +10 C minimum
- 4.2.2. Active dehumidification system
- 4.2.3. Condensation prevention protocols

5. Power Management Controls

1. State of Charge (SOC) Management

- 5.1.1. Real-time monitoring with 2% accuracy
- 5.1.2. Automated charge scheduling
- 5.1.3. Dynamic power allocation based on mission parameters

2. Charging Specifications

- 5.2.1. Compatible with IceNav(TM) Charging Stations
- 5.2.2. Maximum charging current: 100A
- 5.2.3. Charging temperature range: -30 C to +45 C
- 5.2.4. Authentication required for charging initiation

6. Safety and Protection Systems

1. Overcurrent Protection

- 6.1.1. Multi-stage circuit breakers

- 6.1.2. Electronic current limiting
- 6.1.3. Fault isolation capability

2. Temperature Protection

- 6.2.1. Automatic shutdown at battery temp >60 C
- 6.2.2. Low-temperature operation lockout at <-40 C
- 6.2.3. Thermal runaway prevention protocols

7. Monitoring and Reporting

1. Required Parameters

- 7.1.1. Battery voltage, current, and temperature
- 7.1.2. Charging status and efficiency
- 7.1.3. Fault conditions and warnings
- 7.1.4. Power consumption by subsystem

2. Data Logging

- 7.2.1. 30-day rolling storage
- 7.2.2. 1-second sampling rate
- 7.2.3. Encrypted data transmission

8. Compliance and Certification

1. The power management system shall comply with:

- 8.1.1. IEC 61508 SIL 2
- 8.1.2. UL 1564
- 8.1.3. IP65 environmental rating
- 8.1.4. CE marking requirements

9. Proprietary Notice

10. Document Control

1. Revision History

- Version 3.2: January 11, 2024
- Version 3.1: October 15, 2023
- Version 3.0: July 1, 2023

2. Approvals

APPROVED BY:

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Date: January 11, 2024

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