

MOTION CONTROL SYSTEM SPECIFICATIONS

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Classification: CONFIDENTIAL

1. SCOPE AND APPLICATION

1 This specification document ("Specification") defines the technical requirements, operational parameters, and compliance standards for the IceNav(TM) Motion Control System ("System") developed and manufactured by Polar Dynamics Robotics, Inc. ("Company").

2 This Specification applies to all Series X-500 and X-700 Autonomous Mobile Robots incorporating the Company's proprietary cold-environment motion control technology.

2. DEFINITIONS

1 "Control Algorithm" means the Company's proprietary software that manages robot movement, including path planning, obstacle avoidance, and thermal compensation.

2 "Operating Environment" means industrial facilities with ambient temperatures ranging from -40 C to +25 C.

3 "Response Time" means the interval between command input and actuator response, measured in milliseconds.

3. TECHNICAL SPECIFICATIONS

1 Motion Control Parameters

- Maximum velocity: 2.5 meters per second
- Acceleration range: 0.1 to 1.2 m/s
- Positioning accuracy: 5mm at full load
- Angular resolution: 0.02 degrees
- Payload capacity: Up to 1,500 kg

2 Environmental Operating Range

- Temperature: -40 C to +25 C
- Humidity: 10% to 95% non-condensing
- Floor condition: Dry, wet, or frosted surfaces
- Maximum slope: 5% grade

3 Power Requirements

- Operating voltage: 48V DC 5%
- Peak current draw: 40A
- Standby power consumption: <50W

4. CONTROL SYSTEM ARCHITECTURE

1 Hardware Components

- Dual redundant microprocessors
- Solid-state temperature-hardened memory
- Cold-rated sensor array
- Ruggedized actuator assemblies
- Thermal management subsystem

2 Software Architecture

- Real-time operating system (RTOS)
- Proprietary IceNav(TM) control algorithms
- Adaptive thermal compensation
- Dynamic path optimization
- Safety monitoring subsystem

5. SAFETY FEATURES

1 Emergency Systems

- Redundant emergency stop circuits
- Fail-safe brake engagement
- Battery backup for critical functions
- Collision avoidance system with 360 coverage

2 Monitoring and Diagnostics

- Continuous system health monitoring
- Real-time performance logging
- Predictive maintenance alerts
- Remote diagnostic capability

6. COMPLIANCE AND CERTIFICATION

1 The System shall comply with:

- ISO/TS 15066:2016 (Robots and robotic devices)
- IEC 61508 (Functional Safety)
- UL 1740 (Industrial Robots and Robotic Equipment)
- IP65 protection rating

2 Environmental Standards

- RoHS 3 (EU 2015/863) compliant
- REACH compliant
- CE marked where applicable

7. QUALITY ASSURANCE

1 Testing Requirements

- Factory acceptance testing
- Environmental stress screening
- Load testing at temperature extremes
- EMC compatibility verification
- Runtime endurance testing (minimum 100 hours)

2 Documentation Requirements

- Test reports for each unit
- Calibration certificates
- Compliance declarations
- Installation and maintenance manuals

8. WARRANTY AND SUPPORT

1 The System carries a 12-month warranty covering:

- Manufacturing defects
- Software updates
- Technical support
- Replacement parts

2 Extended warranty options available upon request.

9. PROPRIETARY RIGHTS

1 All intellectual property rights in the System, including patents, trade secrets, and copyrights, are owned exclusively by the Company.

2 This Specification contains confidential information and trade secrets of the Company and shall not be disclosed to third parties without written authorization.

10. REVISION HISTORY

Version 3.2 - January 11, 2024

- Updated environmental operating parameters
- Added new safety compliance requirements
- Revised power specifications

Version 3.1 - July 15, 2023

- Enhanced motion control parameters
- Updated software architecture specifications

Version 3.0 - January 20, 2023

- Initial release of unified specification

APPROVAL

APPROVED BY:

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