

Motor Controller Firmware Update Guide v4.2

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Polar Dynamics Robotics, Inc.

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1. DOCUMENT CONTROL

Document Number: PDR-TECH-FW-422

Version: 4.2

Supersedes: Version 4.1 (October 15, 2023)

Classification: Confidential - Technical Documentation

Department Owner: Engineering Operations

Technical Reviewer: Dr. James Barrett, Chief Robotics Officer

Legal Reviewer: Katherine Wells, CFO

2. SCOPE AND APPLICATION

1 This document establishes the mandatory procedures for updating firmware on Polar Dynamics Robotics' proprietary ColdDrive(TM) motor controllers, specifically models MC-350X and MC-400X, deployed in IceNav(TM)-enabled autonomous mobile robots operating in sub-zero environments.

2 This guide applies to all authorized service technicians, field engineers, and certified maintenance personnel performing firmware updates on Polar Dynamics Robotics equipment.

3. LEGAL NOTICES AND WARRANTIES

1 This document contains confidential and proprietary information belonging to Polar Dynamics Robotics, Inc. ("Company"). Any unauthorized use, reproduction, or distribution is strictly prohibited.

2 The procedures outlined herein are protected under U.S. Patents 11,234,567 and 11,345,678 and associated international patents.

3 **FIRMWARE WARRANTY DISCLAIMER:** The Company provides this firmware "AS IS" and disclaims all warranties, express or implied, including but not limited to warranties of

merchantability, fitness for a particular purpose, and non-infringement.

4. SAFETY REQUIREMENTS

1 Personnel Requirements:

- Level II Certification in Cold Environment Robotics
- Current IceNav(TM) Systems Authorization
- Completion of PDR-TC-301 Training Course

2 Environmental Requirements:

- Ambient temperature: -40 C to +25 C
- Relative humidity: <85%
- Static-controlled environment

3 Required Safety Equipment:

- Class 3 cold environment PPE
- ESD-safe tools and equipment
- Emergency power shutdown access

5. UPDATE PROCEDURE

1 Pre-Update Verification

- a) Confirm robot is in maintenance mode
- b) Verify current firmware version
- c) Back up controller configuration
- d) Document all parameter settings
- e) Ensure UPS backup power availability

2 Update Process

- a) Initialize IceNav(TM) Maintenance Interface
- b) Upload firmware package PDR-MC-FW-422
- c) Verify package checksum
- d) Execute update sequence
- e) Monitor thermal parameters during flash process

3 Post-Update Validation

- a) Verify successful installation
- b) Confirm controller diagnostics
- c) Test emergency stop functionality
- d) Validate motion control parameters
- e) Document update completion

6. TECHNICAL SPECIFICATIONS

1 Firmware Package Details:

- Package Name: PDR-MC-FW-422
- Size: 2.8 MB
- Checksum: SHA-256
- Compatibility: MC-350X (Rev. G+), MC-400X (All)

2 Update Time Requirements:

- Standard Update: 12-15 minutes
- Recovery Mode: 20-25 minutes
- Validation: 10 minutes

7. TROUBLESHOOTING

1 Error Codes and Resolution:

- ERR_MC_001: Communication failure
- ERR_MC_002: Checksum mismatch
- ERR_MC_003: Flash write error
- ERR_MC_004: Parameter validation error

2 Recovery Procedures:

Detailed steps for each error condition are provided in Appendix A.

8. COMPLIANCE AND DOCUMENTATION

1 Required Documentation:

- a) Update completion form (PDR-UPD-F101)

- b) Pre/post parameter comparison log
- c) Error log (if applicable)
- d) Validation test results

2 Regulatory Compliance:

This update procedure complies with:

- ISO/IEC 60068-2-1:2007
- UL 1998:2013
- IEC 61508-3:2010

9. SUPPORT AND CONTACT

Technical Support: support@polardynamics.com

Emergency Hotline: +1 (888) 555-0123

Hours: 24/7/365

10. REVISION HISTORY

Version 4.2 - January 11, 2024

- Added support for MC-400X Rev. H
- Updated thermal monitoring parameters
- Enhanced recovery procedures

Version 4.1 - October 15, 2023

- Implemented new checksum verification
- Added ESD protection requirements

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