# LOW-TEMPERATURE ACTUATOR COMPLIANCE TEST REPORT

## LOW-TEMPERATURE ACTUATOR COMPLIA

### Q4 2023 PERFORMANCE VALIDATION RESULTS

**Polar Dynamics Robotics, Inc.**

**Document Reference: PDR-TR-2023-Q4-LTA-001**

## 1. EXECUTIVE SUMMARY

This report documents the compliance testing results for the BlueCore
3000 low-temperature actuators conducted during Q4 2023. Testing w
in accordance with ISO 9001:2015 standards and proprietary Polar Dy

Robotics test protocols PDR-TP-2023-17 and PDR-TP-2023-18.

## 2. TEST PARAMETERS

### 2.1 Test Environment

- Primary Test Facility: PDR Cold Chamber Lab 3
- Secondary Validation: Arctic Robotics Testing Center (ARTC)
- Temperature Range: +20 C to -40 C
- Humidity Range: 15% to 85% RH
- Test Duration: October 1 - December 15, 2023

### 2.2 Test Specimens

- Quantity: 25 production units
- Model: BC3000-LTA-R2
- Serial Numbers: LTA-2023-Q4-001 through LTA-2023-Q4-025
- Manufacturing Date Range: September 1-15, 2023
- Firmware Version: v4.2.7

## 3. TEST METHODOLOGY

## 3.1 Primary Test Protocols

Cold Start Performance (CSP-101)

Continuous Operation Under Load (COUL-202)

Thermal Cycling Endurance (TCE-303)

Emergency Stop Functionality (ESF-404)

Position Accuracy Verification (PAV-505)

## 3.2 Testing Equipment

-

Fluke 8845A Digital Multimeter (Cal. Date: 2023-08-15)

-

Keysight 34972A Data Acquisition System

-

FLIR E75 Thermal Imaging Camera

# 4. TEST RESULTS

## 4.1 Performance Metrics

### 4.1.1 Cold Start Performance

-

Success Rate: 100% (25/25 units)

-

Average Start-up Time: 2.3 seconds

-

Power Draw: 24.7V  0.3V

-

Compliance Status: PASS



### 4.1.2 Continuous Operation

-

Duration: 168 hours

-

Average Power Consumption: 187W

-

Temperature Variance:  1.2 C

-

Position Accuracy: 99.97%

-

Compliance Status: PASS

### 4.1.3 Thermal Cycling

Cycles Completed: 1000

-

Failure Rate: 0%

-

Average Recovery Time: 1.8 seconds

-

Compliance Status: PASS

### 4.2 Anomaly Analysis

No critical anomalies were detected during testing. Minor observations

-

Unit LTA-2023-Q4-013: 0.2mm position deviation at -38 C

-

Unit LTA-2023-Q4-019: 3% increased power draw during cycle 876

# 5. COMPLIANCE VERIFICATION

## 5.1 Regulatory Standards

-

ISO 9001:2015 Section 8.3.4: COMPLIANT

-

IEC 60068-2-1:2007: COMPLIANT

-

ANSI/RIA R15.06-2012: COMPLIANT

-

CE Marking Requirements: COMPLIANT

## 5.2 Internal Standards

-

PDR-STD-2023-001 (Cold Operation): COMPLIANT

-

PDR-STD-2023-002 (Safety Systems): COMPLIANT

-

PDR-STD-2023-003 (Reliability): COMPLIANT

# 6. CONCLUSIONS AND RECOMMENDATIONS

## 6.1 Performance Summary

The BC3000-LTA-R2 actuators have demonstrated full compliance wi
requirements and exceed performance targets in key metrics. The uni
consistent performance across the entire operating temperature range
minimal variance.

## 6.2 Recommendations

Implement enhanced monitoring for power consumption variation

Update firmware to v4.2.8 to optimize position control at extreme temp

Consider extending test duration to 336 hours in future validation cycl

## 7. CERTIFICATION

This report certifies that the tested actuators meet all specified require for deployment in extreme cold environments and are approved for pr release.

## 8. AUTHENTICATION

Prepared by:

Dr. Marcus Chen

Chief Technology Officer

Polar Dynamics Robotics, Inc.

Date: December 20, 2023

Reviewed by:

Dr. James Barrett

Chief Robotics Officer

Polar Dynamics Robotics, Inc.

Date: December 21, 2023

Approved by:

Sarah Nordstrom

Chief Operating Officer

Polar Dynamics Robotics, Inc.

Date: December 22, 2023

## 9. LEGAL DISCLAIMER

This document contains confidential and proprietary information belon
Polar Dynamics Robotics, Inc. The information contained herein is pro
due diligence purposes only and may not be reproduced or distributed
written permission. While all reasonable care has been taken in prepa
report, no responsibility or liability is accepted for errors or omissions.
test results reflect performance under specified conditions and may va
different circumstances.

Document Control Number: PDR-TR-2023-Q4-LTA-001

Revision: 1.0

Classification: CONFIDENTIAL