ARCTIC-GRADE MOTOR PERFORMANCE TEST RESULTS

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Test Report Number: PDR-2023-MT-142

Date of Testing: December 15-22, 2023

Location: Polar Dynamics Cold Environment Testing Facility, Mi

Test Supervisor: Dr. Marcus Chen, CTO

Document Classification: CONFIDENTIAL

1. EXECUTIVE SUMMARY

This document presents the performance test results for the BlueCore

motor system (the "System") developed by Polar Dynamics Robotics, Inc. Testing was conducted in accordance with ISO 9001:2015 standards and proprietary cold-environment testing protocols (PDR-TP-2023-11).

2. TEST SPECIFICATIONS

2.1 Test Equipment

- Primary Test Chamber: Thermotron S-32C
- Temperature Monitoring: Fluke 754 Calibrator
- Torque Measurement: HBM T40B
- Power Analysis: Yokogawa WT5000

Motion Control: PDR Proprietary BlueCore(TM) Controller v4.2

2.2 Environmental Parameters

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Temperature Range: +20 C to -40 C

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Humidity Range: 15% to 85% RH

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Atmospheric Pressure: 101.3 kPa 1 kPa

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Test Duration: 168 hours continuous operation

3. TEST PROCEDURES

3.1 Cold-Start Performance

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Initial temperature stabilization at -40 C for 24 hours

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50 consecutive cold starts at 15-minute intervals

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Torque measurement at startup and steady state

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Current draw monitoring during initialization sequence

3.2 Continuous Operation

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72-hour continuous operation at -30 C

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Variable load profile according to Schedule A

- Power efficiency measurements at 15-minute intervals
- Thermal imaging at 4-hour intervals

3.3 Thermal Cycling

- 24 complete cycles between -40 C and +20 C
- 2-hour dwell time at temperature extremes
- Performance monitoring during transition periods

4. TEST RESULTS

4.1 Cold-Start Performance

- Success Rate: 50/50 starts (100%)
- Average Start-up Time: 1.2 seconds
- Peak Current Draw: 42.3A
- Steady State Current: 12.8A
- Torque Ripple: < 2%

4.2 Continuous Operation Results

- Power Efficiency: 94.2% at -30 C

Temperature Rise: +15 C above ambient

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Torque Stability: 1.5%

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No mechanical failures observed

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Bearing temperature within specification

4.3 Thermal Cycling Impact

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No degradation in performance metrics

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Seal integrity maintained

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Insulation resistance >100M Ω

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No condensation formation inside motor housing

5. COMPLIANCE AND CERTIFICATION

The System has demonstrated compliance with:

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IEC 60034-1:2017

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UL 1004-1

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CSA C22.2 No. 100

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IP67 Protection Rating

6. CONCLUSIONS AND RECOMMENDATIONS

The BlueCore(TM) Mark IV motor system has successfully met or exc
performance criteria for arctic-grade operation. Specific achievements

Consistent cold-start capability at -40 C

Maintained efficiency above 90% throughout operating range

Zero mechanical failures during extended testing

Successful thermal cycling without performance degradation

7. DISCLAIMERS AND LIMITATIONS

This report contains confidential and proprietary information of Polar D
Robotics, Inc. The test results presented herein are valid only for the s
System configuration tested and may not be representative of all prod
units. PDR makes no warranties, express or implied, regarding the Sy
performance beyond the specific conditions tested.

8. CERTIFICATION

I hereby certify that the tests described in this report were conducted u
supervision and that the results presented are accurate and complete
of my knowledge.

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Dr. Marcus Chen
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Chief Technology Officer

Polar Dynamics Robotics, Inc.

Date: December 23, 2023

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Dr. James Barrett

Chief Robotics Officer

Polar Dynamics Robotics, Inc.

Date: December 23, 2023

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## 9. APPENDICES

A. Raw Test Data
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B. Calibration Certificates

C. Test Equipment Specifications

D. Photographic Documentation

E. Thermal Imaging Results

End of Report