

# **PDR-2023-334 COLD START RELIABILITY REPORT**

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**Polar Dynamics Robotics, Inc.**

*Technical Documentation - Confidential*

Report Date: December 15, 2023

### **1. EXECUTIVE SUMMARY**

This report documents the cold start reliability testing conducted on the BlueCore(TM) Generation 3.2 autonomous mobile robot (AMR) platform from September 1, 2023, and November 30, 2023. Testing was performed

with ISQ 13849-1:2015 safety standards and PDR Internal Testing Pr

## **2. TEST PARAMETERS**

### **2.1 Environmental Conditions**

-

Temperature Range: -30 C to +25 C

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Humidity Range: 15% to 85% RH

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Testing Locations:

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PDR Cold Chamber Facility (Boston, MA)

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Third-party verification at T V S D America (Minneapolis, MN)

## **2.2 Test Units**

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Sample Size: 12 production units

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Serial Numbers: BC32-2309-001 through BC32-2309-012

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Hardware Version: BlueCore(TM) 3.2

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Firmware Version: 4.5.2.891

## **3. TESTING METHODOLOGY**

### **3.1 Cold Start Protocol**

Unit stabilization at test temperature (24h minimum)

Power-up sequence initiation

System diagnostics verification

Navigation system calibration

Motion control validation

Emergency stop system verification

### **3.2 Performance Metrics**

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Start-up Time to Ready State

-

Power Draw During Initialization

-

System Component Temperature Gradients

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Navigation Sensor Accuracy

-

Drive System Torque Output

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Battery Performance Characteristics

4. TEST RESULTS

4.1 Start-up Success Rate

Temperature | Attempts | Successful Starts | Success Rate

-----|-----|-----|-----

-30 C | 144 | 141 | 97.9%

-20 C | 144 | 144 | 100%

-10 C | 144 | 144 | 100%

0 C | 144 | 144 | 100%

+25 C | 144 | 144 | 100%

## 4.2 Critical System Performance

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Navigation System Accuracy: Within 2.3cm at all temperatures

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Battery Capacity Retention: 92.4% at -30 C (vs. room temperature baseline)

-

Drive System Response Time: <150ms across temperature range

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Emergency Stop Function: 100% reliability across all conditions

## 5. FAILURE ANALYSIS

## 5.1 Observed Failures

Three start-up failures were recorded at -30 C:

Unit BC32-2309-003: Battery management system delayed initialization

Unit BC32-2309-007: Temporary sensor calibration error

Unit BC32-2309-011: Communication bus timeout

## 5.2 Root Cause Assessment

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Battery management system timing adjusted in firmware 4.5.2.892

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Sensor calibration procedure modified to include extended warm-up p

-

Communication bus timeout parameters increased for extreme cold co

## **6. COMPLIANCE VERIFICATION**

### **6.1 Standard Conformance**

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ISO 13849-1:2015 Performance Level 'd'

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IEC 61496-1:2020 Type 3 Requirements

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ANSI/RIA R15.06-2012 Safety Requirements

### **6.2 Certification Status**

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T V S D Certificate #2023-11-PDR-332

-



CE Technical File Reference: PDR-CE-2023-112

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UL Recognition File E534228

## **7. RECOMMENDATIONS**

### **7.1 Implementation Requirements**

Minimum 20-minute warm-up period required for -30 C operations

Battery pre-conditioning recommended below -25 C

Monthly sensor calibration verification in continuous cold operations

### **7.2 Operating Guidelines**

Implement graduated start-up procedure for sub -20 C conditions

Monitor battery temperature during charging cycles

Maintain firmware version 4.5.2.892 or higher

## **8. CERTIFICATION**

This report accurately represents the cold start reliability testing conducted on the BlueCore(TM) Generation 3.2 platform. All tests were performed under controlled conditions using calibrated equipment traceable to national standards.

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Date: December 15, 2023

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