

ROBOT END-EFFECTOR SAFETY CERTIFICATION

Certificate Number: SEC-EE-2024-0127

Issuance Date: January 11, 2024

Expiration Date: January 11, 2025

1. CERTIFICATION AUTHORITY

This Robot End-Effector Safety Certification (the "Certification") is issued by T V Rheinland North America, Inc., an OSHA-accredited Nationally Recognized Testing Laboratory (NRTL), in accordance with ANSI/RIA R15.06-2012 and ISO 10218-1:2011 standards for industrial robot safety requirements.

2. CERTIFIED PRODUCT DETAILS

- Product Name:** PolarGrip(TM) Adaptive End-Effector System
- Model Number:** PDR-EE-2023-X
- Manufacturer:** Polar Dynamics Robotics, Inc.
- Manufacturing Location:** 4200 Arctic Way, Dover, Delaware 19901
- Serial Number Range:** PDR23001 through PDR23500

3. TECHNICAL SPECIFICATIONS

- Operating Temperature Range:** -40 C to +50 C
- Maximum Payload Capacity:** 25 kg
- Grip Force Range:** 10-500 N
- Power Requirements:** 24V DC, 5A maximum
- Communication Protocol:** EtherCAT, ProfiNet
- Safety Category:** Category 3, Performance Level d (EN ISO 13849-1)

4. SAFETY FEATURES VERIFICATION

The following safety features have been tested and verified:

- Emergency Stop Function**
 - Response time < 100ms

- Redundant monitoring circuits
 - Fail-safe brake engagement
2. ****Force Monitoring System****
- Real-time force feedback
 - Automatic force limitation
 - Overload protection
3. ****Temperature Management****
- Thermal protection system
 - Cold-environment compensation
 - Automatic shutdown on overheating
4. ****Collision Detection****
- Multi-axis force/torque sensing
 - Programmable sensitivity thresholds
 - Automatic motion stop on impact

5. COMPLIANCE VERIFICATION

This certification confirms compliance with:

1. ****Safety Standards****
- ISO 10218-1:2011
 - ISO 10218-2:2011
 - ISO/TS 15066:2016
 - ANSI/RIA R15.06-2012
2. ****Environmental Standards****
- IEC 60529:1989+AMD1:1999+AMD2:2013 (IP65 Rating)
 - IEC 60068-2-1 (Cold Test)
 - IEC 60068-2-2 (Dry Heat Test)

6. TESTING METHODOLOGY

1. Testing was conducted under the following conditions:

- 1,000 hours of continuous operation
- Full range of motion testing
- Maximum load capacity testing
- Environmental stress testing
- EMC compatibility testing

2. All tests were performed using calibrated equipment traceable to national standards.

7. CONDITIONS AND LIMITATIONS

1. This certification is valid only for:

- Original manufacturer components
- Unmodified control software version 2023.4.2
- Installation by certified technicians
- Operation within specified parameters

2. The certification becomes void if:

- The product is modified without approval
- Safety systems are bypassed
- Maintenance procedures are not followed
- Operating conditions exceed specifications

8. MAINTENANCE REQUIREMENTS

1. ****Periodic Inspection****

- Monthly visual inspection
- Quarterly performance verification
- Semi-annual safety system testing
- Annual comprehensive assessment

2. ****Documentation****

- Maintenance records must be maintained
- Inspection results must be logged
- Incident reports must be filed

- Calibration certificates must be current

9. CERTIFICATION STATEMENT

Based on comprehensive testing and evaluation, the PolarGrip(TM) Adaptive End-Effector System meets or exceeds all applicable safety standards and is hereby certified for industrial use within the specified operating parameters.

10. AUTHORIZATION

IN WITNESS WHEREOF, this certification has been duly executed by the authorized representatives of the testing laboratory and manufacturer.

For T V Rheinland North America, Inc.:

—

Dr. Michael Schmidt

Lead Safety Certifier

Certificate No. SC-2024-0892

For Polar Dynamics Robotics, Inc.:

—

Dr. James Barrett

Chief Robotics Officer

Date: January 11, 2024

[CERTIFICATION SEAL]