ROBOT TEACHING PENDANT SAFETY CERTIFICATION

Document Number: PDR-CERT-2023-0142

Effective Date: January 15, 2024

Issuing Authority: Polar Dynamics Robotics, Inc.

Classification: Safety Critical Documentation

Revision: 3.1

1. CERTIFICATION SCOPE

1. This Safety Certification ("Certification") applies to all Robot Teaching Pendant devices ("Pendant") manufactured by Polar Dynamics Robotics, Inc. ("Company") for use with the IceNav(TM) Series Autonomous Mobile Robots in temperature-controlled environments ranging from -40 C to +25 C.

2. This Certification encompasses:

a) Model PDR-TP450-X Teaching Pendant

b) Model PDR-TP460-X Teaching Pendant

c) All associated firmware versions 4.0 and above

d) Emergency stop circuits and safety-critical control functions

2. COMPLIANCE DECLARATIONS

1. The Company hereby certifies that the above-referenced Teaching Pendants comply with:

a) ISO 10218-1:2011 Robots and robotic devices - Safety requirements

b) IEC 60204-1:2016 Safety of machinery - Electrical equipment

c) ISO 13849-1:2015 Safety of machinery - Safety-related parts of control systems

d) ANSI/RIA R15.06-2012 Industrial Robots and Robot Systems Safety Requirements

e) UL 1740 Standard for Robot and Robot Equipment

2. Performance Level (PL) Certification:

- Emergency Stop Function: Performance Level e (PLe)
- Operational Mode Selection: Performance Level d (PLd)
- Safety-Critical Commands: Performance Level d (PLd)

3. TECHNICAL SPECIFICATIONS

1. Safety Features:

- Dual-channel emergency stop circuit with continuous monitoring
- Three-position enabling device with neutral position detection
- Redundant microprocessor architecture for command verification
- Self-diagnostic system with error detection and reporting
- Galvanically isolated safety circuits

2. Environmental Specifications:

- Operating Temperature: -40 C to +25 C
- Storage Temperature: -45 C to +60 C
- IP65 Protection Rating
- Impact Resistance: IK08
- EMC Immunity per IEC 61000-6-2

4. SAFETY FUNCTIONS VERIFICATION

1. Each Teaching Pendant undergoes the following safety verification:

a) Full functional testing of all safety-critical circuits

b) Verification of emergency stop response time (<100ms)

c) Environmental chamber testing at temperature extremes

d) Drop testing from 1.5m height

e) EMC susceptibility testing

f) Software validation per IEC 61508-3

2. Quality Control:

- 100% testing of all units before shipment
- Batch testing of environmental performance
- Monthly calibration of test equipment
- Documentation retention period: 10 years

5. OPERATIONAL REQUIREMENTS

1. The Teaching Pendant shall only be operated by personnel who have:

a) Completed Company-approved safety training

b) Demonstrated proficiency in robot programming

c) Read and understood the safety manual

d) Been authorized by their employer for pendant operation

2. Maintenance Requirements:

- Annual safety inspection by certified technician
- Firmware updates as released by the Company
- Replacement of enabling device every 2 years
- Documentation of all maintenance activities

6. LIABILITY AND DISCLAIMERS

1. This Certification is valid only for Teaching Pendants:

a) Manufactured by Polar Dynamics Robotics, Inc.

b) Maintained according to Company specifications

c) Used within specified environmental conditions

d) Operated by qualified personnel

2. The Company reserves the right to revoke this Certification if:

a) Unauthorized modifications are made

b) Required maintenance is not performed

c) Safety-critical failures are detected

d) Operating conditions exceed specifications

7. CERTIFICATION AUTHORITY

This Safety Certification is issued under the authority of:

Dr. James Barrett

Chief Robotics Officer

Polar Dynamics Robotics, Inc.

Katherine Wells

Chief Financial Officer

Polar Dynamics Robotics, Inc.

Date: January 15, 2024

[CORPORATE SEAL]

8. REVISION HISTORY

Version 3.1 - January 15, 2024

- Updated compliance standards
- Added cold environment specifications
- Revised maintenance requirements

Version 3.0 - June 1, 2023

- Initial release for IceNav(TM) Series integration
- Implementation of PLe safety architecture