



ExR-1 Robot

Operating Instructions

LET'S DEVELOP
A ROBOT TOGETHER!

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1	2017-11-14	Draft issued for on-site ExR-1 testing at NAM	All	Ian Peerless
2	2018-02-27	Need for a computer microphone & details on control station shortcuts added to Section 3, drive overheating & implications of battery depletion clarified in Section 5, LORA tracking deleted from Section 6		
3	2018-06-29	UL comments included	All	Ian Peerless
4	2018-07-01	Added document register, equipotential statement, and charger electrical parameters to Section 7. Incorporated Ronald's & Keith's suggestions.	All	Ian Peerless
5	2018-09-03	Updated information in Ex label	8	Ian Peerless
6	2018-09-19	Added certification information	6, 8, 9	Ian Peerless
7	2018-09-24	Corrections to Ex information & instructions	9	Ian Peerless
8	2018-12-03	Original document divided into essential operating instructions and a new operating manual. Also optional accessories added to the robot platform.	All	Ian Peerless
9	2019-01-02	Removed IR Leak Detector and BMS from instructions	4	Ian Peerless

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1. Introduction

This document is one of two that will help operators to use their ExR-1 robots safely and effectively. The documents are the “ExR-1 Robot Operating Instructions” and the “ExR-1 Robot Manual”. The former focuses on the safe operation of the robot especially with respect to its use in potentially explosive gas environments. The latter provides additional information about the robot’s controls. If there’s a conflict between the documents, the instructions will always prevail.

Because items in these instructions are essential for the safe, secure operation of the robot its wording will not be changed without the approval of ExRobotics’ quality owner and the certification authority.

2. Safety

2.1. Environment

The ExR-1 robot operator is designed for:

- Ambient temperatures between -20°C and 50°C.
- Equipment protection level Gb (Zone 1 explosive gas environments).
- Explosion Group IIB (e.g. ethylene).
- Temperature class T4 (the robot’s maximum surface temperature is 135°C).
- Ingress protection IP54 (dust protected, splashing water resistant).

The operator will ensure that the robot will not be used outside of these constraints and will consult ExRobotics if there’s any doubt. If extreme weather is forecast the robot will be stored in a protected environment. If at any time the robot is exposed to conditions outside of its operating range it will be returned to ExRobotics for repair.

2.2. Operation

The robot is mostly controlled remotely or autonomously. However, it has two important controls mounted on its hull:

- The red emergency stop switch. When pressed downwards the robot will not move until the stop is released by rotating it and allowing it to spring upwards.
- The black on/off switch controls the power to the main electrical components. Clockwise rotation turns the power on, anti-clockwise rotation powers off. After the robot is switched on it takes up to 5 minutes for it to connect to the 4G network.

The robot will not be deployed in potentially explosive environments if:

- Any of the glass windows of the cameras, lights, sensors, or beacon is cracked or chipped.
- The hull is damaged to create a hole over 12mm wide.
- The plastic charger plate on the front of the robot is damaged.
- The emergency stop and on/off switches on top of the robot are damaged.
- There is significant damage to the camera, light, sensor, or beacon housings that might compromise their ability to contain pressure.
- The Ex label is damaged in a way that suggests that the hull has been opened.

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The robot will only be charged on an ExRobotics docking station (which will be located in a safe area) or using the optional power socket:

- The power contained in the robot is less than 1300 Watts.
- It will only be charged in a safe area.
- The location and power supply to the docking station will be agreed by ExRobotics.
- If the robot is fitted with a power socket, the cap on the socket will not be removed in a potentially explosive environment. It will be replaced before it re-enters a potentially hazardous environment.

All people that visit the robot’s deployment location should understand it’s a potential trap/trip hazard and should know how to use the emergency stop switch. It’s especially important to avoid trapping hands between the tracks and hull components.

The robot weighs between 73kg and 100 kg depending on its accessories. Ideally it should always be driven. However, if it needs to be recovered for any reason:

- Pushing the robot for more than its own length may damage the drive electronics.
- Straps and forks can be placed under the hull.
- It can be lifted by four people wearing safety gloves and boots. They should place their hands under the bottom of the tracks where they’re supported by the metal tray, under the camera housing or the rear of the hull. Do not hold the tops of the tracks because they may rotate and trap a hand between the track and a sprocket.

2.3. Maintenance

For information:

- Do not repair the flameproof joints of the robot or any of the accessories.
- The flameproof joint of the R Stahl FX15 series beacon will only be secured using fasteners supplied by R Stahl. Where fasteners are used to secure other flameproof joints they have a yield stress $\geq 450 \text{ Nmm}^2$.
- The battery pack contains 3 off Beta 6 HCNFJ-7.2 batteries.
- The battery pack is not intended to be opened.
- Do not repair the electronics box.

Apart from the tracks and gas detectors, none of the robot’s components are user-serviceable or replaceable. Its Ex label will be attached across the joint between the hull plates and the robot’s warranty will be invalidated if the label is broken.

Replacement tracks must be supplied by ExRobotics otherwise the robot’s equipotential grounding path may be compromised and there may be a risk of sparks generated by static electricity.

Operators may calibrate, adjust the settings, and replace the sensors of the Honeywell, Falco and Crowcon gas detectors. This will be done in accordance with each gas detector’s instructions. However, only ExRobotics may remove the detectors from their mountings or modify the electrical connections.

Any faulty robot will be returned to ExRobotics for repair. It will not be opened or maintained in a hazardous area or explosive atmosphere. Please contact sales@exrobotics.global or visit www.exrobotics.global for more information.

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3. Accessories

The robot may be supplied with one or more of the following accessories:

- An ExRobotics' power socket. Part number SKT-SW-002854.
- An ExRobotics' light module. Part number LED-SW-002238. IECEx UL 18.0029X. DEMKO 18 ATEX 1928X.
- An R Stahl FX15 series beacon. IECEx BAS 13.0003. BASEEFA 13 ATEX 0006.
- An Ion Science Falco 1.1 VOC monitor. IECEx FTZU 16.0011X. FTZU 15 ATEX 0113X.
- A Honeywell 3000 Mk II toxic gas monitor with S3K sensor. IECEx UL 11.0011X & IECEx UL 08.0013X. DEMKO 07 ATEX 0709149X & DEMKO 08 ATEX 0804823X.
- A Crowcon IRMAX hydrocarbon gas monitor. IECEx BAS 09.0109X. BASEEFA 09 ATEX 0206X.

4. Operating Characteristics

The electrical characteristics of the robot in operation (not being charged) are as follows:

	DC voltage	Maximum current	Maximum peak power	Maximum short circuit current
Battery pack	36 V	20 A	<1300 W	470 A
Camera module	5 V	1 A/Camera	<9 W	1.25 A/Camera
Charger	3.3 V	20 mA	<0.5 W	3 A
Drive module	36 V	10 A	360 W	20 A
Electronics box	1.8 to 36 V	20 A	<1300 W	20 A
Light module	36 V	700 mA	20W	700 mA

The **battery pack** is charged with a 43.2 VDC supply with the current limit set to 700mA. Once this voltage has been reached, the voltage is reduced to 40,5V to trickle charge the pack. The settings are at room temperature. U_m is 240V when the robot is connected to the charger in the docking station.

The **microphone** operates at 2 VDC, consumes 0.5 mA, has an output impedance of 2.2 k Ω and a capacitance of <1 μ F.

The maximum transmitted **wireless power** when using 4G or 3G communications is 0.63W.

The robot's hull and its components form an **equipotential bonding system**. The resistance between any part of this system and the ground will not exceed 10⁹ Ω .

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5. Marking

The Nameplate on the robot includes important certification information:

		ExRobotics B.V. Effenseweg 1 4838 BA Breda The Netherlands	
CE 0539	Year of manufacture	2019	
ExR-1 Robot Operator			
EXR-SW-000002	01		
IECEX UL 18.0030X		DEMKO 18 ATEX 1932X	
Ⓔ II 2G Ex db eb ib mb qb IIB T4 Gb			
-20°C ≤ T _a ≤ +50°C		<i>See Instructions</i>	
⚡ Total power housed < 1300 W · U _m = 240V · Operating < 45V DC			
 WARNING	 WARNING	 WARNING	 WARNING
THIS PRODUCT IS ONLY TO BE SERVICED BY EXROBOTICS	DO NOT REMOVE ANY PARTS	DO NOT OPEN IN AN EXPLOSIVE ATMOSPHERE	DO NOT CHARGE IN A HAZARDOUS AREA

6. Certificates and Standards

The ExR-1 robot operator is certified to operate in Zone 1 environments in accordance with:

- | | |
|-----------------------------|--------------------------|
| • IEC 60079-0 Edition 2011 | EN 60079-0:2012+A11:2013 |
| • IEC 60079-1 Edition 2014 | EN 60079-1:2014 |
| • IEC 60079-5 Edition 2015 | EN 60079-5:2015 |
| • IEC 60079-7 Edition 2015 | EN 60079-7:2015 |
| • IEC 60079-11 Edition 2011 | EN 60079-11:2012 |
| • IEC 60079-14 Edition 2013 | EN 60079-14:2014 |
| • IEC 60079-18 Edition 2014 | EN 60079-18 2015+A1:2017 |

The following additional previous editions of Standards noted under the "Standards" section of the Certificate were applied to integral components as itemized below. There are no significant safety related changes between these previous editions and the editions noted under the "Standards" section:

- IEC 60079-0 Edition 2004: R Stahl Switches 8003/121-015 and 8003/131-726-2r
- IEC 60079-0 Edition 2007: Crowcon IRMAX Hydrocarbon Gas Monitor
- IEC 60079-1 Edition 2001: R Stahl Switches 8003/121-015 and 8003/131-726-2r
- IEC 60079-1 Edition 2007: CMP Ex "d" Barrier Glands 20S16PX2KREX1RA4 and 20SPX2KREX1RA4. Raxton Breather Drain CTE1300YU. R Stahl FX15 Series Beacon. Falco 1.1 VOC Monitor. Crowcon IRMAX Hydrocarbon Gas Monitor.
- IEC 60079-7 Edition 2006: Multibox Terminal Boxes MBA 202311 and MBA 332311. Raxton Breather Drain CTE1300YU
- IEC 60079-7 Edition 2001: R Stahl Switches 8003/121-015 and 8003/131-726-2r

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