



Robot System

Deployment (Quick Start) Guide

**LET'S DEPLOY SOME ROBOTS
TOGETHER!**

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Document Change Log:

Version #	Date of re-issue	Changes Made	Page	Author of Change
1	2021-10-26	First draft		Ian Peerless
2	2021-11-16	Includes comments from "Consulted" people	All	Ian Peerless

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1. Introduction

This document is one of four that will help operators to use their robots safely and effectively:

- ExR-1 Robot Operator Operating Instructions
- ExR-2 and Docking Station Operating Instructions
- Robot System Operating Guide. (RSOG)
- Robot System Deployment (Quick Start) Guide.

All of these documents and some explanatory videos can be downloaded from [Downloads | ExRobotics](#)

The instructions focus on the safe operation of robot systems especially with respect to their use in potentially explosive gas environments. The guides provide additional information about the robot systems and their use. If there's a conflict between the documents, the instructions will always prevail.

This deployment guide describes the steps that a typical first-time user might follow immediately before and after they receive their first robot. To avoid duplication, it references one of the other three documents if it contains relevant information.

This guide will be updated and made available to robot fleet managers and first line support as new robot hardware and software is deployed.

2. Pre-deployment actions

The robot system options (gas detectors, chargers etc.) will have been detailed in a proposal that will have been agreed by the customer and supplier before a Purchase Order is placed. The proposal will specify the ambient temperature range within which the robot system can be used. The range will depend on the options installed.

The proposal will also specify whether the robot is to communicate using 4G/LTE and/or WiFi. If 4G/LTE is to be used, it will specify whether the SIM card will be supplied by the customer or by the supplier. Customer SIMs need to be sent to ExRobotics so that they can be installed in the robot before it's despatched. It's best to enable roaming while the SIM card is with ExRobotics so we can configure the SIM card and test it's working. Customers should assess the signal strength around the routes that robots will travel using a smart phone app.. Ideally there should be a bandwidth of at least 5 MBit/s and a latency less than 250 ms.

Robot routes should also be checked for obstacles. Avoid:

- Gaps that are less than 1,000mm wide or 750mm high.
- Ledges that are more than 10cm high (20cm for ExR-1 robots).

Robot routes should include a suitable location for a docking station. They're 1300mm long, 710mm wide and 270mm high. They should be located on a hard (not gravel or grass), essentially level site where there's a strong wireless signal and where robots can approach in a straight line for at least 3 meters to help with alignment. Ideally the docking station should be sheltered from climactic extremes (e.g. direct sunlight in the tropics, prevailing winds and snow in arctic environments). ExR-1 docking stations cannot be located in a hazardous zone, ExR-2 docking stations can be located in Zone 1 areas.

Read the relevant operating instructions before a robot is deployed. These instructions provide important safety information and are useful input for any risk analysis or "management of change" reviews that the customer may require before deploying the robot system.

Robots are controlled using laptops and Xbox controllers. The customer is responsible for providing these for each person that will drive the robot. See Section 3 of the RSOG.

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The customer should nominate a fleet manager to control access to the robot. The supplier will then enable the fleet manager to perform this role. Typically, when the robot is delivered the supplier's account manager and support team will have access to the robot to facilitate its deployment. However, the customer's fleet manager can remove this access at any time. See Section 7.2 of the RSOG.

3. Testing the robot system

Much of the content in this section is covered in more detail in the RSOG so it's best to review the guide before the robot arrives.

Robots are usually delivered in flight cases. After opening the flight case and before removing the robot and docking station, inspect the robot for any damage, especially the glass windows. If there's any damage contact your account manager.

There are two controls on the robot, the emergency stop and on/off switches. See Section 2 of the RSOG. To test the robot's basic functionality, with the emergency stop pressed down, switch on the robot. If the robot has a SIM installed it should connect to the internet within 5 minutes and any approved driver/viewer will be able to connect to it using the fleet management screen. See Section 5.1 of the RSOG.

Robots typically weigh at least 100kg so it's best to drive, rather than lift them. They can be removed from their flight case base by releasing the emergency stop, activating their motors using the driver screen and an Xbox controller (see Section 5.2 of the RSOG). Install a small block of wood (or similar) to help the robot drive over the base's lip and position a ramp for the robot to drive down from the lip to the ground.

Once the robot is no longer in its flight case, the customer's drivers can familiarise themselves with the controls by driving the robot around. Use this opportunity to verify that the robot's emergency stop is functioning correctly. The customer's fleet manager will need to decide which drivers have the skills to operate the robot once it's been deployed. See Section 7.1 of the RSOG. Note that all robots drift slightly to the left or right when being aimed straight ahead. This requires occasional corrections when driving robots remotely. It doesn't affect the accuracy of autonomous missions because the robot's software uses other sensors to compensate for steering inaccuracies.

It usually takes some time before a robot's docking station is operational. If the robot is provided with a quick charger, it should be used to prevent the robot's batteries from depleting. The customer may need to use an adapter to connect the quick charger to a standard power socket. Quick chargers for 110 VAC locations will be provided with a transformer that needs to be installed between the socket and the quick charger. A video showing how to install the quick charger's plug into the robot's socket is available in the download section of the ExRobotics website.

Other items that should be addressed before the robot is moved to its operational location are:

- Check that the information on the Ex label on top of the robot's hull is compatible with the operational location – especially the ambient temperature operating range.
- Calibrate the gas detectors if necessary. ExR's robots use off-the-shelf gas detectors with which customers are usually familiar. The instructions for those detectors are available in the downloads section of the ExRobotics website and they state whether calibration is necessary and how it should be performed. Section 7.7 of the RSOG describes where the gas detectors are located.

When the robot arrives at its operational location, it's good practice to drive the robot around the planned routes to verify the wireless signal is strong enough, to check there are no unexpected obstacles to navigation, and to identify any issues. Support is available from the account manager (Section 7.3 of the RSOG). The Q&As (Section 8 of the RSOG) might provide useful information.

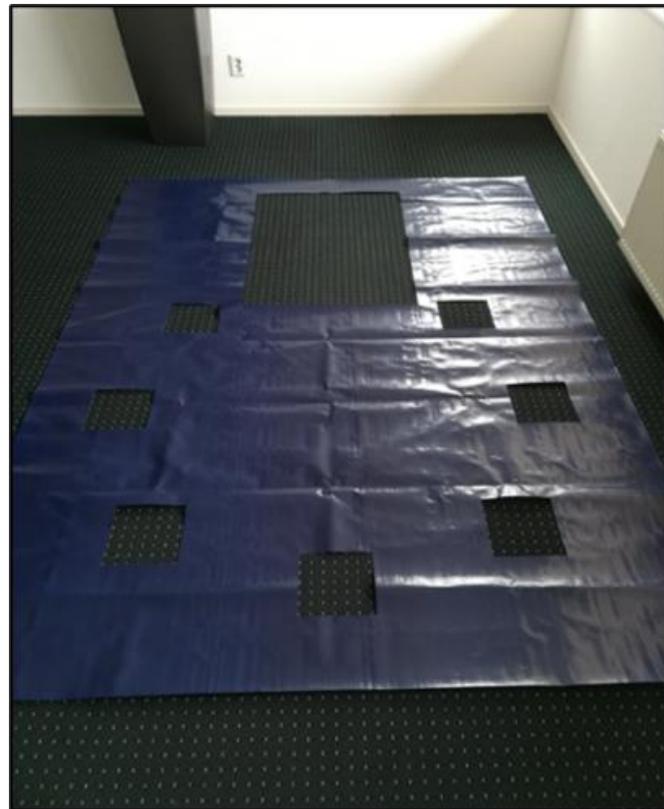
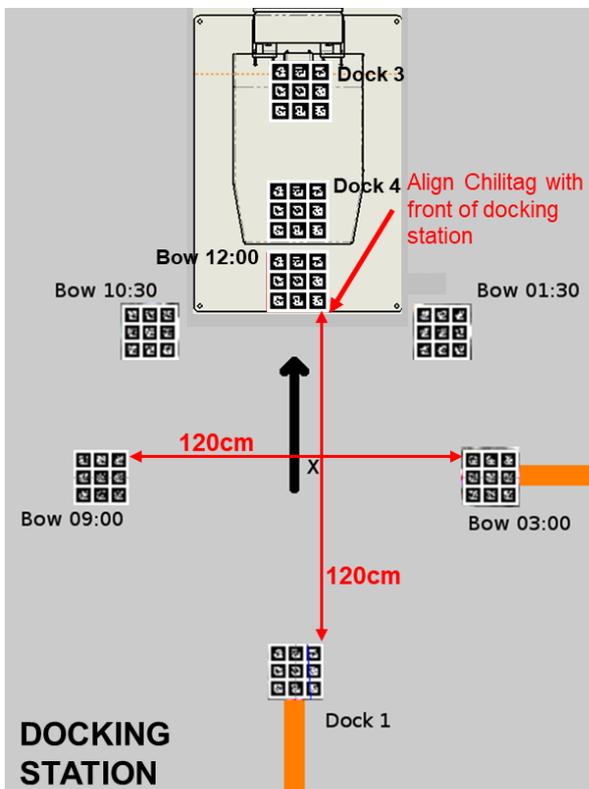
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4. Installing the docking station

Docking stations are usually transported in the flight case with the robot. They weigh around 31kg and can be lifted by two people. Customers are responsible for connecting the robot to a power supply and for supplying the connection cable. This is so that the connection complies with any local/national regulations. Details of how to connect the power supply to a docking station's high power induction charger are provided in Section 3.3 of the "ExR-2 and Docking Station Operating Instructions". Contact your account manager for information on ExR-1 docking stations. After the cable has been connected, the DIN Rail in the docking station's control box should look like the picture on the right. Robot docking is described in Section 4 of the RSOG.



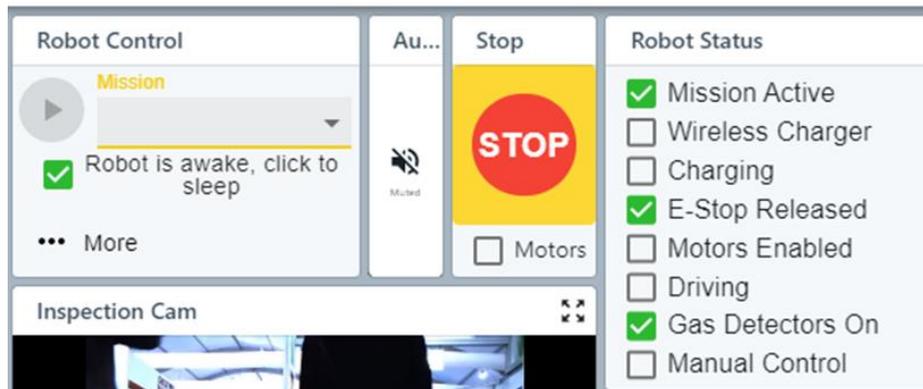
Customers will usually want their robots to dock and undock autonomously. Energy Robotics is continuously improving that mechanism but for the moment it requires a full-array of chili-tags to assist with alignment. They'll be provided with the docking station and should be arranged as indicated in the diagram below. Those on the docking station will already be fixed in place. Those off the docking station should be arranged around a circle of 1.2m diameter. A template (pictured below) can be provided to help with positioning.



ExR-2 does not require the Dock 1 chili-tag and it includes a pre-programmed mission to check that docking is working. To use this, drive the robot until it's facing the docking station with the Bow 12:00 chili-tag towards the centre of the drive camera image. Then open the "mission"

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window (see image below), select “Dock” and click “Play”. The robot should then dock itself autonomously. If it fails check that the chili-tags are positioned correctly.



Once the robot has docked it should start charging within 60 seconds. When this happens the wireless charger box in the above image will become green. Very occasionally a robot will not start charging. The robot will then autonomously try to redock another two times. If charging has not started after three attempts, contact your account manager.

5. Preparing for autonomous missions

5.1. Overview

Section 6 of the RSOG describes how to programme missions (using the mission editor screen) once the infrastructure is in place. This document describes how to install that infrastructure.

5.2. Full 3D autonomy and autonomous route repetition

These forms of autonomy use a digital map to navigate and localise. This map will be created by Energy Robotics. In future updates customers will be able to generate the map themselves.

5.3. Autonomous line-following navigation and tag-based inspections

These forms of autonomy require orange lines and chilli-tags to be installed around the robot’s route as described below.

For demonstration purposes the line will typically be of orange tape that can be provided by the supplier. Although the line is self-adhesive, it’s best to use glue for additional durability. To increase the tape’s serviceable life lay it in dry, warm conditions and try to position it so it won’t be abraded by the robot’s tracks or other vehicles.

For longer, permanent routes it’s best to use RAL2009 (orange) paint. The supplier can provide advice on paint types and line-painting machines.

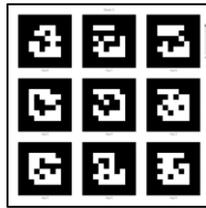
“Chilli-tags” can be positioned at up to 80 waypoints where the robot needs to perform pre-defined operations – e.g. junctions, aiming cameras, and recording sensor readings.

When setting up an autonomous route avoid sharp 90° bends because the robot will lose sight of the line. Instead use curves or multiple, smaller bends (e.g. 4 x 22.5°). For the same reason, when crossing a step, approach it in a perpendicular direction otherwise the robot may twist when mounting the step and lose sight of the line.

In congested areas the orange line needs to be carefully positioned. Straighter lines are best because a robot will stray around the line when turning corners.

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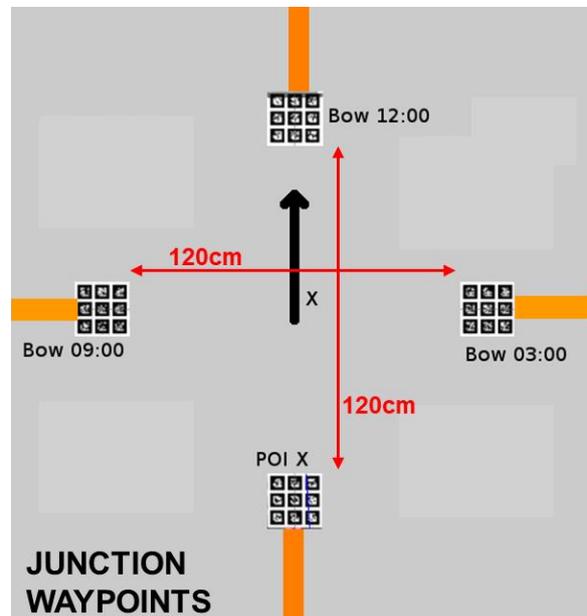
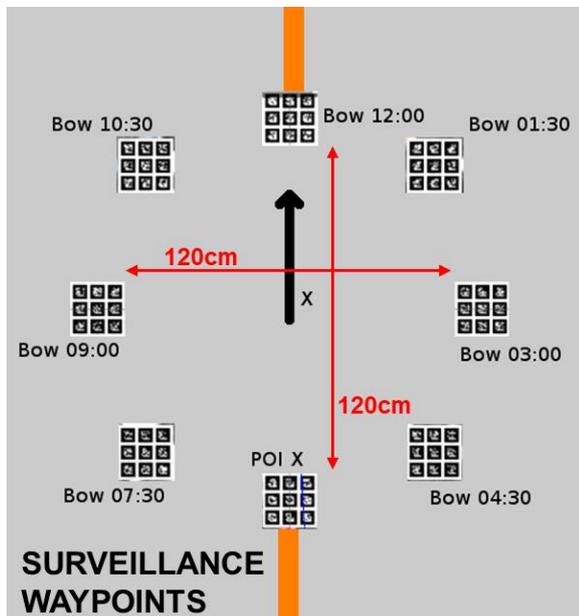
The location and tasks to be performed at a waypoint are defined by chili-tags. A typical tag is illustrated below:



Each tag carries a label at its top that defines its task and an arrow to its right that defines its orientation. There are three categories of tag:

- Dock tags are described in the previous section.
- POI tags are used to identify a waypoint. The tasks to be performed at that waypoint are programmed using the Mission Editor. (POI 1, POI 2, POI 3, etc.)
- Bow tags supplement the robot’s rotational control (they indicate points around a notional “clockface” at each waypoint). (Bow 01:30, Bow 03:00, Bow 04:30 etc.)

The positioning of the chili-tags is illustrated below. The arrow on each tag should face in the same direction as that in the diagram. The POI and Bow 12:00 tags are always required. The other Bow tags are optional. They can be used to increase the accuracy of a turn because the robot will adjust its “internal compass” if a tag is in sight. The template that’s described in the previous section can be used to position the chili-tags.



6. Using the robot

Section 7 of the RSOG describes how to operate, service and maintain the robot. Mission data is recorded in the mission report screen – see Section 5.4 of the RSOG. Customers can work with Energy Robotics to transfer information between the robot, third party software and the customer’s data lakes using the API that is provided with the robot. Use this link to familiarise yourself with the API and contact Energy Robotics if you have any questions:

<https://developer.energy-robotics.com/>

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