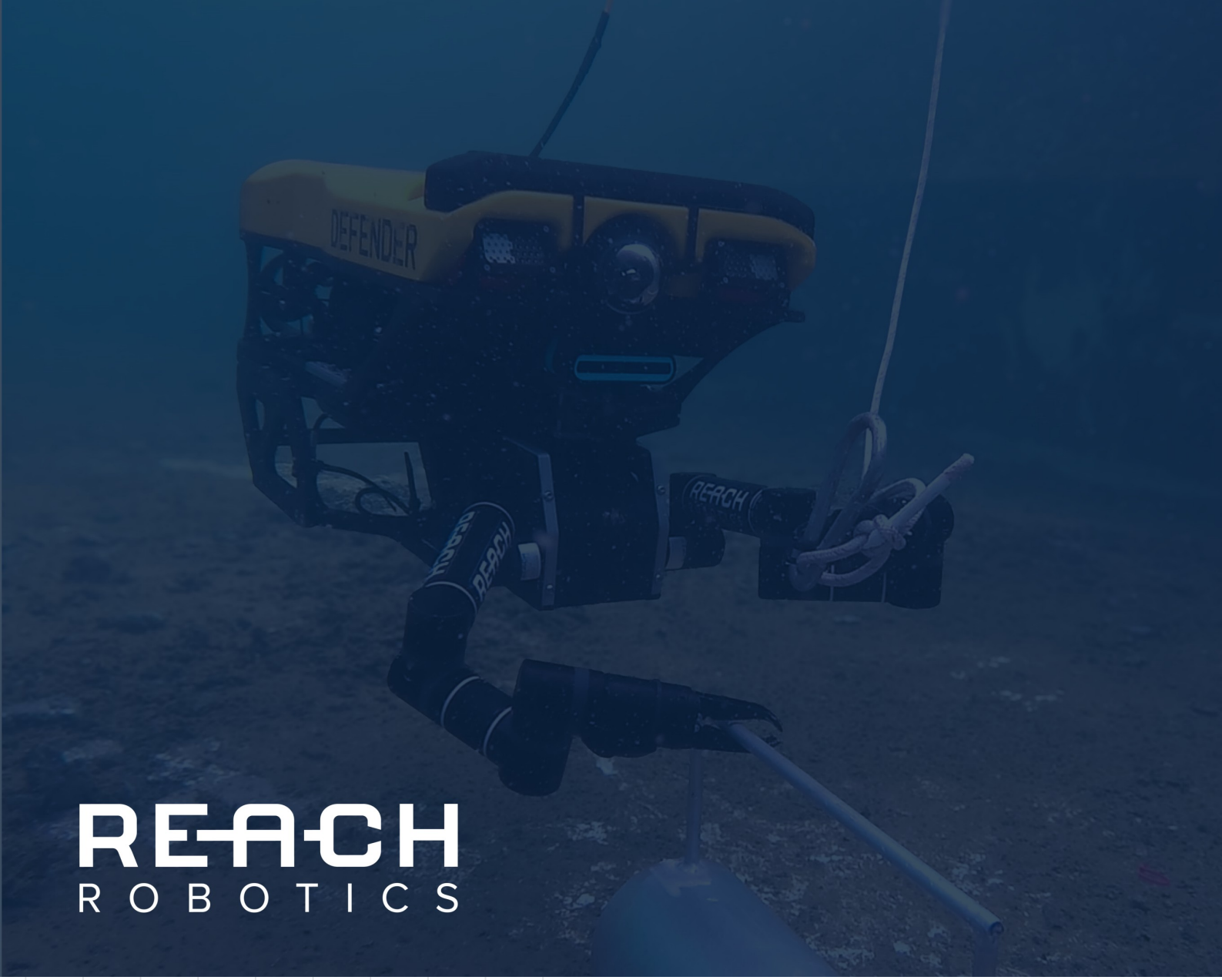


REACH ROBOTICS

Reach X Integration Manual

V1.3

Table of Contents

1 Introduction

This manual is designed help users of the Reach X get familiar with the integration and usage of the system.

Reach Robotics website and Help Centre

Our website, www.reachrobotics.com, holds all our documentation as well as FAQs, knowledge articles, and downloads. You can find some quick links below:

- Datasheets and manuals
- FAQs
- Product theory
- Software downloads

Reach Robotics contacts

If you can't find what you're looking for on our website or Help Centre, please get in touch with Reach Robotics Support at support@reachrobotics.com. You can also get in touch with us at sales@reachrobotics.com (for all sales enquiries), or info@reachrobotics.com (for any other enquiries).

Feedback

If anything in our manuals, FAQs or knowledge articles is out-of-date, poorly explained, or erroneous, please don't hesitate to let us know. We always appreciate the opportunity to improve our documentation for the benefit of all users.

2 Safety Information

This section describes the necessary safety information and precautions relevant to the setup and operation of the Reach X. To ensure correct and safe use of Reach Robotics products and to avoid injury and damage to property, carefully read this section and make yourself well acquainted with the contents. Follow any warnings and cautions included; these are highlighted by warning triangles and are shown as follows according to the level of danger. In conjunction with this manual, it is important that the users have knowledge of safety considerations and make correct judgments on safety procedures during operation.

2.1 Hazard Classification

 DANGER	Denotes a hazard with a high degree of risk that will result in death or serious injury if not mitigated or avoided.
 WARNING	Denotes a hazard with a medium degree of risk that will result in death or serious injury, or serious damage to the product, if not mitigated or avoided.
 CAUTION	Denotes a hazard with a low degree of risk that will result in moderate or minor injury, or damage to the product, if not mitigated or avoided.
 INFO	Denotes important information about a product or procedure.

2.2 Target Group

The activities described in this manual must only be carried out by technicians with the following qualifications:

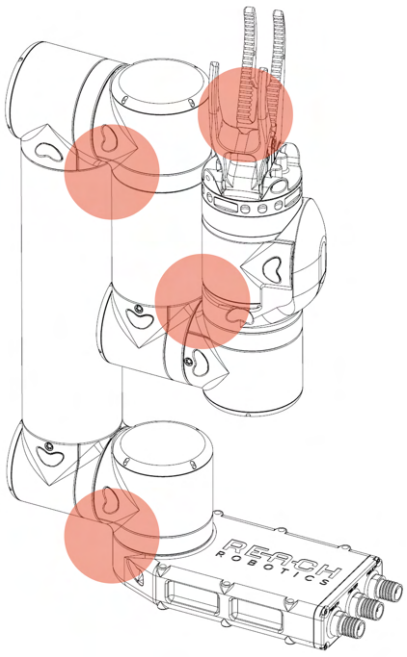
- Training in the installation and commissioning of electrical devices (qualified electrician as defined in EN 50110-1: a person with technical training, knowledge and experience sufficient to allow them to recognise and avoid the risks that might be posed by electricity)
- Extensive knowledge in the fields of electrical engineering and drive technology
- Training in electrical and mechanical hazards and the local safety requirements
- Knowledge of the relevant standards and directives
- Knowledge and observance of this document and all the safety instructions

Any employee who does not have the relevant training must be given appropriate training and instruction. The instruction is to be given by authorised personnel with the appropriate training.

2.3 Personal Safety

This section describes the necessary safety information and precautions relevant to the setup and operation of the Reach X manipulator system. To ensure correct and safe use of Reach Robotics manipulators, carefully read this section and make yourself well acquainted with the contents. Follow any warnings and cautions included. In conjunction with this manual, it is important that the users have knowledge of safety considerations and make correct judgments on safety procedures during operation.

Reach X manipulators are highly dexterous, electromechanical devices that can move with a high degree of freedom. Failure to take necessary safety measures or mishandling due to not following the instructions in this section may result in damage to the robot or injury to personnel.

DANGER	The Reach X has the potential to emit a powerful magnetic field which can pose a fatal risk to personnel with passive or active implants such as pacemakers, defibrillators, insulin pumps, etc. Personal with these life support devices must not place the device within 10 mm of the outer shell of the manipulator. This distance has been determined through empirical measurements that found the magnetic field was less than 0.5 mT (5 Gauss) when a sensor was placed further than 10 mm from the shell surface.
WARNING	Do not attempt to open the joints of the Reach X to access any part of the motors or electronics. This will void your warranty and poses a serious health risk due to crushing or electrical shock. It also risks damaging internal components, which will require repair at the Reach Robotics facility.
WARNING	The Reach X presents multiple crush and/or cut hazards: in the jaws or end-effector, and at any point where two limbs can compress together. When cutter jaws are installed, the operator must ensure that the working area of the manipulator is clear prior to operation. 

CAUTION	When bench-testing or operating the Reach X in a human environment, it is strongly recommended that the following safety procedures are adhered to: • Install and operate the unit below head height • Wear safety goggles when installing or working closely to the manipulator • Include an easily accessible E-stop button in the power circuit • Avoid physical interaction with the end-effector or limbs to prevent crush and/or cut hazards • Install barriers/signage to prevent untrained personnel from entering the manipulator workspace • Implement stop, speed and separation monitoring and torque limiting to reduce the risk of human contact and injury

2.4 Product Safety

2.4.1 Leak Detection

Each joint of the Reach X manipulator contains pressure, temperature, and humidity sensors, together termed the joint's "climate". It can easily be determined if the pressure or humidity have increased by checking the manipulator's climate panel in the provided software and identifying the colour of the data. If the colour of the pressure or humidity is orange or red, this indicates that the joint may have leaked, and steps should be taken to confirm and rectify this quickly.

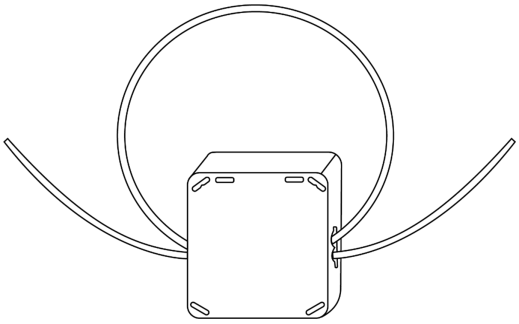
2.4.2 Obstacle Setup

Virtual obstacles can be defined within the manipulator workspace to reduce the risk of collision between the Reach X and other equipment. Care should be taken to ensure that any obstacles configured are defined correctly to cover all potential collision points. Configuring obstacles does not completely remove the risk of collision due to factors including joint compliance and excessive control input, so users should take every care to move the manipulator in a way that avoids the real-world obstacles. See the Reach Control User Manual for more information.

INFO	All standalone Reach X units with 3+ functions are shipped with a pre-configured "floor" obstacle under the base of the manipulator.

2.4.3 Electrical Installation

To ensure your product conforms to EMC directives, you must evaluate your finished product (entire system) and take necessary countermeasures. One consideration for meeting the above standard is the installation of a ferrite core on the cable connected to the manipulator. Emissions will vary depending on length and design of this cable. Reduction of emissions can be achieved by placing the ferrite bead as shown:



Reach Robotics has had success with the Wurth Elektronik Clamp-On Ferrites (P/N 74272251, 74272221) and the TDK Power Line Filter (P/N B84112G0000B080).

WARNING	Integrators must take care to install any filters in the correct orientation. Failure to do so may cause open/short circuits and pose a fire hazard. Read all relevant third-party user manuals to ensure safe operation.

Power Circuit and System Integration

The manipulator is not sold with a complete, stand-alone power supply circuit and associated control and safety systems. Instead, the manipulator should be integrated into an overall system power supply that includes the appropriate Protective Bonding Circuit and ancillary equipment according to EN60204-1. This circuit should include the appropriate current limiting, circuit break and/or fusing system to prevent inadvertent touch voltages.

Components that should be considered by the system integrator to fully comply with certain electronic equipment safety standards (e.g. EN60204-1) include:

- Supply disconnecting device
- Emergency stop
- Integration of a Protected Extra-Low Voltage (PELV) circuit where required
- Over-current Protection mechanism
- Protective Bonding Circuit (PBC) design
- Protective interlocks
- Indicator Lights and Labelling
- Any additional control inputs required

For bench level testing, it is strongly recommended to use a controlled power supply with a current limiting circuit. See Bench Setup and Acceptance Test for bench test instructions.

CAUTION	The provided power supply is intended for light bench testing only and is not rated for full performance of the manipulator system.

2.4.4 Physical Installation

Prior to operation, ensure that the manipulator is firmly secured using the supplied mounting kit, or an alternative solution with the appropriate specifications.

 WARNING	When the manipulator is under load, ensure that the mounting surface is sufficiently stable to avoid unbalancing, which may cause injury to personnel or damage to other equipment.

2.4.5 Operating Environment

The Reach X is intended for in-water operation. The system is designed and tested as partially completed machinery to be integrated into a complete underwater robotic system (please see the included Declaration of Incorporation). It is possible to use this system in ambient laboratory conditions, however, it should be noted that radiated emissions from this product may not comply with limits imposed by local authorities.

 WARNING	Explosive environments The Reach X is not ATEX compliant, and is not designed to meet explosion-proof specifications. Do not use the robot and controller in environments containing inflammable gas, gasoline, or solvent. Explosions or fire may otherwise result.
 CAUTION	Harmful substances The Reach X is not designed to operate in areas in which harmful substances as defined in EN 60721 may be encountered, such as oils, acids, gases, vapours or dusts.
 INFO	The Reach X is specified for operation in water between 5°C-30°C and storage between -10°C-80°C.
 INFO	The Reach X is depth-rated to operate at the equivalent of 300 MSW (Metres below Sea Level).

3 Compliance with EC Directives

According to 2006-42-EC - Machinery directive, the Reach X manipulator system is not, by itself, a complete robot system. Instead, the Reach X manipulator is a component of a larger system which comprises additional power, safety, and control devices. As such, the Reach X conforms to the applicable EC Directives within the scope of this framework. The customer who incorporates the Reach X manipulator system into the customer's final system, which will be shipped to or used in the regulated region, should verify that the overall system conforms to the EC Directives.

3.1 CE Marking

As the Reach X does not constitute a complete robot system, it does not comprehensively meet the requirements allowing for a CE Marking. Therefore, no CE Marking is affixed to Reach Robotics products in accordance with the requirements of 2006/42/EC Machinery directive.

Note: Differences between the Reach X series products (robots and controllers) and robot systems.

The Reach X manipulator system (both the manipulator and controllers) are components of a full robot system and therefore do not constitute a robot system. It does not include the additional equipment (power regulation, power interface, emergency stop, etc) required for a full system, according to the “Robot System” definition in Clause 3.2.20 of the EN775:1992 standard. Example systems that should be integrated for a complete system are listed in Electrical Installation.

3.2 Applicable Directives and Standards

The applicable directives and standards are available in the "Reach X – declaration of incorporation of partial machinery". As per 2006-42-EC, this document is available on request.

Under this assessment, several prescribed procedures of the harmonized standards have been omitted given the appropriate justification as described below. For applications for in-air use or high ESD environments, it is recommended that testing is conducted on the final system to ensure safety and reliability.

- As specified in Operating Environment, the Reach X system is rated for in-water use and lab environments only. EN61000-6-3:2007 ELECTROMAGNETIC COMPATIBILITY (EMC) radiated emissions procedure has been omitted due to the high attenuation of radiated EM waves in an underwater environment. Reach Robotics PTY LTD deems radiated emissions not relevant for this product. The arm is classed as Partly Completed Machinery to be integrated onto a host underwater drone system; full compliance testing is to be carried out on the fully completed system.
- EN61000-6-2:2016 Electromagnetic compatibility (EMC) immunity procedures have been omitted due to precautions in place for system installation and commissioning. The integration onto the host underwater drone system must be performed while the arm is powered off in a warehouse environment (wood or concrete floors; no active humidity control). Additionally, the commissioning and installation period is expected to be far shorter than the total lifetime of the device (minimal human contact). Reach Robotics assess that arcing due to charge build up on metallic surfaces of the underwater drone, or a discharge being coupled onto the surface of the device from nearby transient event, is a low likelihood, low severity event in the final end-application. As such Reach Robotics deems ESD discharge not relevant for this product.

3.3 Installation of External Safety Circuits

To comply with EC directives, customers using the Reach X manipulator must always build and install their own external safety circuits after selecting product components (safety relays, etc.) according to performance levels and safety categories required by the customer equipment.

3.4 Use of the Supplied RS232/RS485-to-USB Break-Out Board

The Reach X is commonly supplied with an external Printed Circuit Board (PCB) for interfacing between a USB Serial Device and the manipulator. This device does not form a core part of the manipulator system and is included as an optional setup item only. To conform with the EC directives, this device should not be used, or should be built into a compliant system.

3.5 Cautions Regarding Official Language of EU Countries

Only English, which is the official language of the EU, is utilised in the manuals, warning labels and operator interface for the Reach X manipulator.

4 Specifications

4.1 Mechanical

	Reach X 7 RX-7001	Reach X 5 RX-5001	Reach X 3 RX-3001	Reach X 2 RX-2130
Functions	7	5	3	2
Full extension reach	510 mm	390 mm	355 mm	255 mm
Dynamic full-extension lift	3 kg	4 kg	3 kg	N/A
Grabber closing force	25 kg (250 N)			
Weight (in air)	2.9 kg	2.3 kg	1.6 kg	0.95 kg
Weight (in water)*	1.8 kg	1.6 kg	0.95 kg	0.73 kg
Joint speed (24-30V)	140°/s			
Joint accuracy				

**Measured in fresh water at 21°C.*

4.2 Environmental

	All Reach X manipulators
Operating temperature range	5-30°C (water)
Storage temperature range	-10-80°C (air)
Depth rating	300 MSW
Housing material	AL6061 (Hard Anodised Type III, Class 2)

4.3 Electrical

	Reach X 7 RX-7001	Reach X 5 RX-5001	Reach X 3 RX-3001	Reach X 2 RX-2130
Input voltage	24-30 V DC			
Power draw (nominal)	180 W	120 W	90 W	60 W
Power draw (max)	240 W	150 W	135 W	90 W

4.4 Communication

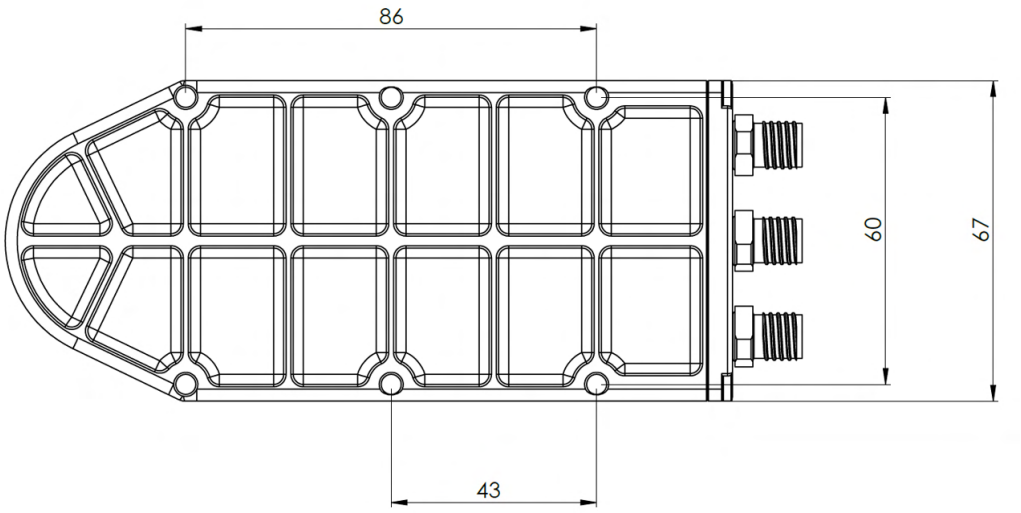
	Reach X 7 RX-7001	Reach X 5 RX-5001	Reach X 3 RX-3001	Reach X 2 RX-2130
Processor	NVIDIA TX2		N/A	
Interface low-level protocol	Ethernet, RS485 (half-duplex), RS232 (full-duplex)			
Baud	115200 bits/s			
Word length	8 bits (including parity)			
Parity	None			
Stop bits	1			
Proprietary communication protocol	Reach Robotics Reach System Communication Protocol			

Note: Please contact Sales for access to the Reach System Communication Protocol documentation.

5 Interfacing and Integration

5.1 Mechanical

The base of the RX-7001 and RX-5001 includes six mounting holes. The mounting holes are threaded to M5, but M4 bolts may be used if mounting from the top of the base.



5.1.1 Attach Jaws

CAUTION	The jaws must be calibrated in the appropriate software every time they are changed. For 5- and 7-function manipulators, use R3D. For 2- and 3-function manipulators, use Reach Control. Pre-release versions of the R3D software may reset the jaw type after a new one is selected and calibrated. Repeat the process until the jaw type is set correctly.
CAUTION	Ensure all threads and hinges on the jaws and collar are treated with marine grease to prevent corrosion and seizing.
INFO	It is easier to attach the jaws when the manipulator is powered and connected to the appropriate software, so you can move the lead screw and immediately calibrate the jaws following a change.

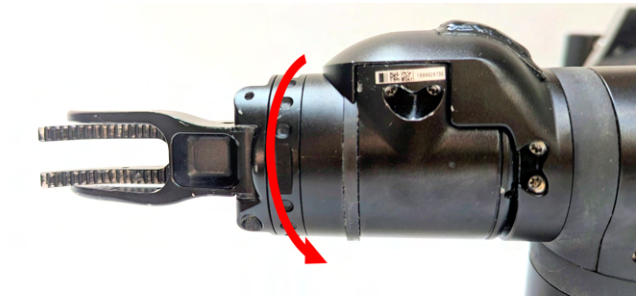
5.1.1.1 Finger/Parallel Jaws

1. Open the currently installed jaws to more than halfway, then unscrew the collar until it disengages. Rotate the jaws until they are free of the lead screw.

2. With the new jaws open, align the centre hole with the pushrod on the end of the manipulator, and screw the jaws onto the pushrod by one full turn.

3. Ensure that the flat portion of the locking mechanism aligns between the jaws and the end-effector interface.

4. Carefully align the screw collar with the threaded area on the wrist, and slowly tighten. The jaws will close as the collar tightens.



5. Calibrate the jaws using the R3D (5/7-function) or Reach Control (2/3-function) software.

5.1.1.2 Cutter Jaws (5/7-function only)

CAUTION	The cutter jaws are ~200g heavier than the standard finger/parallel jaws. Extra care must be taken with buoyancy changes when installing cutter jaws.

INFO	Reach X high-torque cutter jaws are not designed to be interchangeable for 2- and 3-function manipulators. Please contact Support for more information if required.

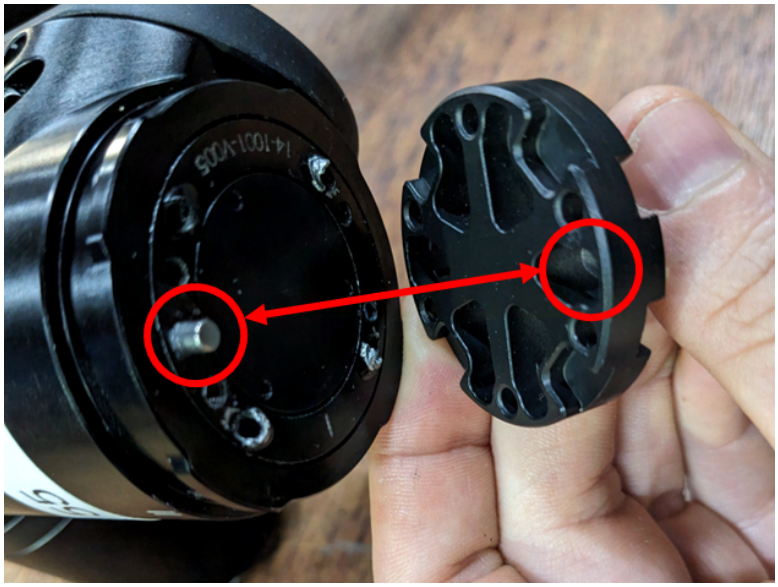
1. Open the currently installed jaws to more than halfway, then unscrew the collar until it disengages. Rotate the jaws until they are free of the lead screw.

2. Remove the plastic piston ring underneath the collar using a piston ring tool or small flathead screwdriver. Be careful not to snap the piston ring by overbending it.

3. Push the collar down into the space created by the piston ring removal, then rotate clockwise and lift off the arm.

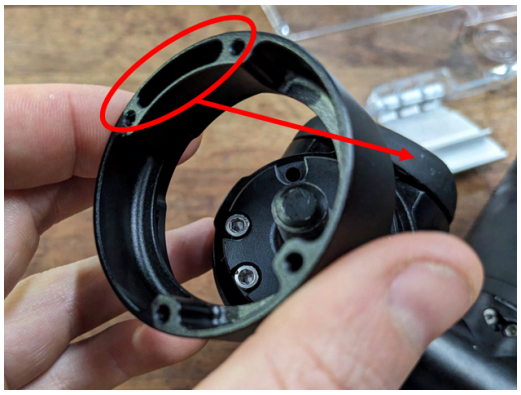
4. Remove the lead screw piece from Joint A by undoing the 4 bolts with a 2mm hex driver. Store the collar, piston ring, lead screw and bolts in a safe place with the removed jaws.

5. Apply marine grease to the cutter lead screw and bolts. Place the cutter lead screw onto the top of Joint A by lining up the guide pin with the recess on the underside of the lead screw.



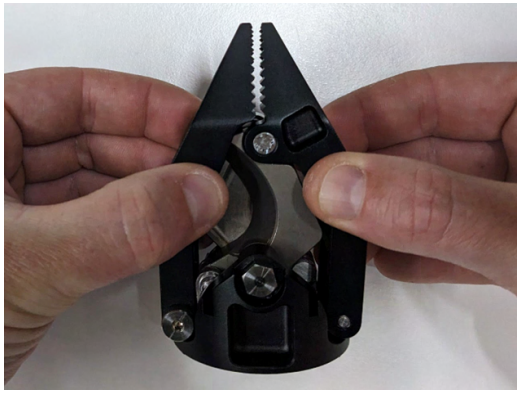
6. Secure the cutter lead screw with 4x M3x10 cap screw bolts in the displayed configuration. Tighten the bolts to 1.2 Nm using a torque driver.

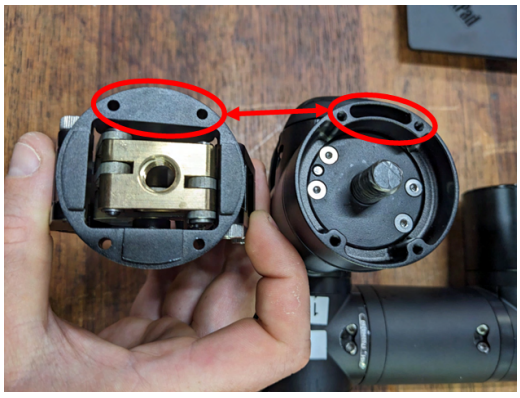
7. Slide the cutter collar onto the joint and push down, then rotate anticlockwise and pull upwards to engage the bayonets. The slot feature on the collar should line up with the A/B interconnect when the collar is in place correctly.



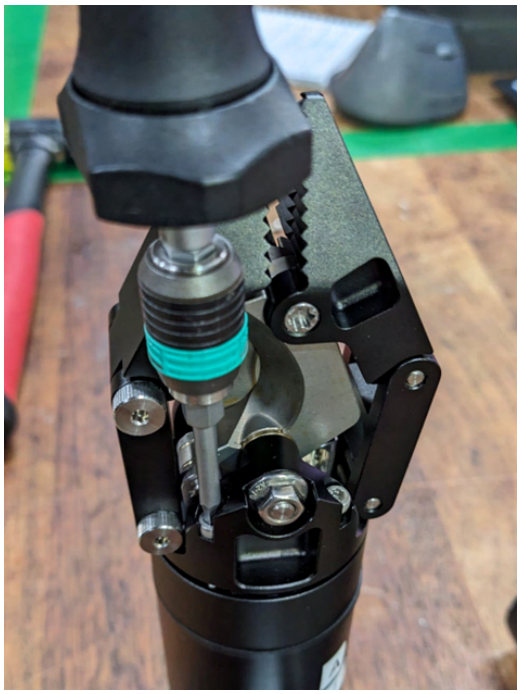
8. Install the new piston ring into the space between the collar and the top of Joint A. It should be a tight fit; use the hammer to drive it into the groove.

9. Using your hands, open the cutter jaws to approximately 10-20 mm. Rotate the jaws onto the lead screw using ~6-7 rotations until the slot feature on the collar lines up with the flat underside of the jaws.





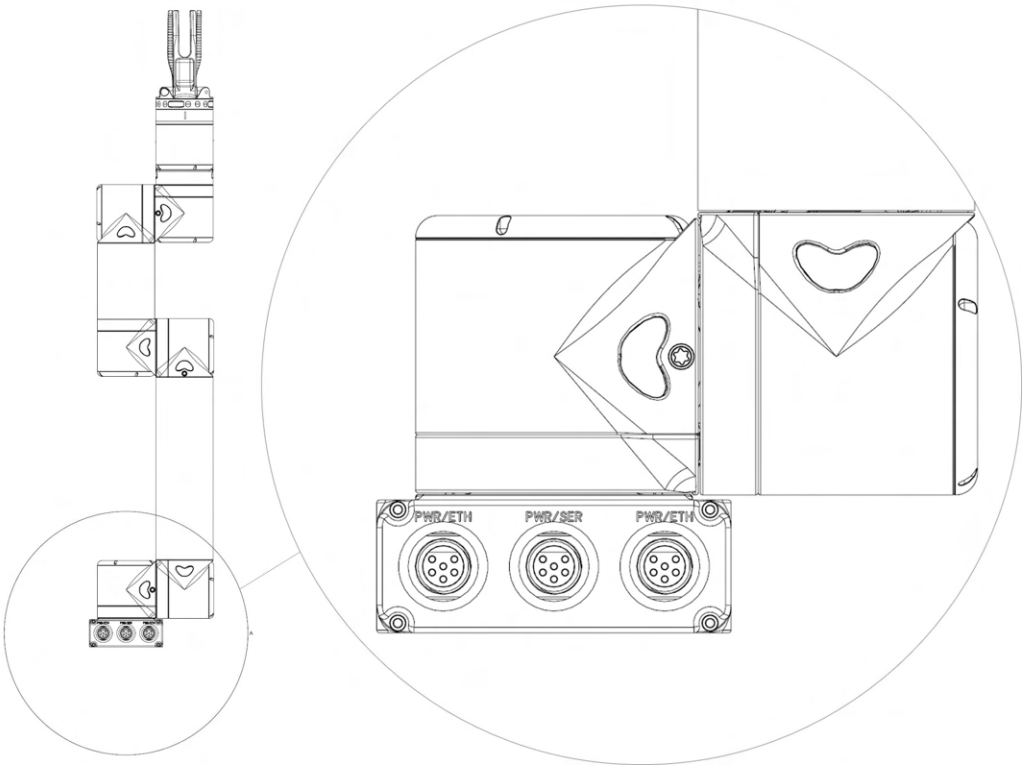
10. Using your hands, pull the jaws further apart so the base of the jaws meets the collar, ensuring that the collar slot and the flat base are still aligned. Secure the jaws with 4x M3x25 cap screw bolts and tighten them to 1.2Nm using a torque driver.

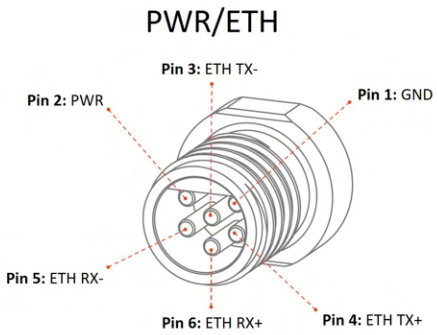


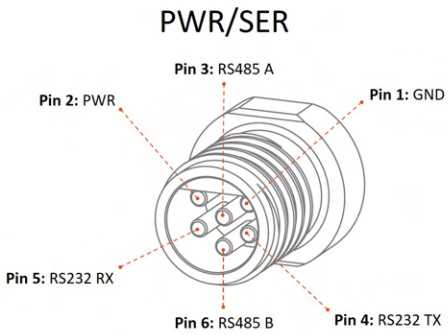
11. Calibrate the jaws using the R3D software - see this section for instructions.

5.2 Electrical

Reach X manipulators have three comms/power ports available on the base, two for Ethernet and power, and one for RS232/RS485 and power.







The Reach X base module contains an Ethernet switch, to which both ETH ports are connected. This allows multiple devices to be daisy chained using Ethernet.

WARNING	Always install the connector blanks when the connectors are not in use to avoid damage and corrosion.

CAUTION	If using the Reach X in an Advanced Intervention System (AIS) configuration, a 100 Mbps connection over the vehicle tether to allow uninterrupted communications. A lower speed connection will result in lag and other comms problems.

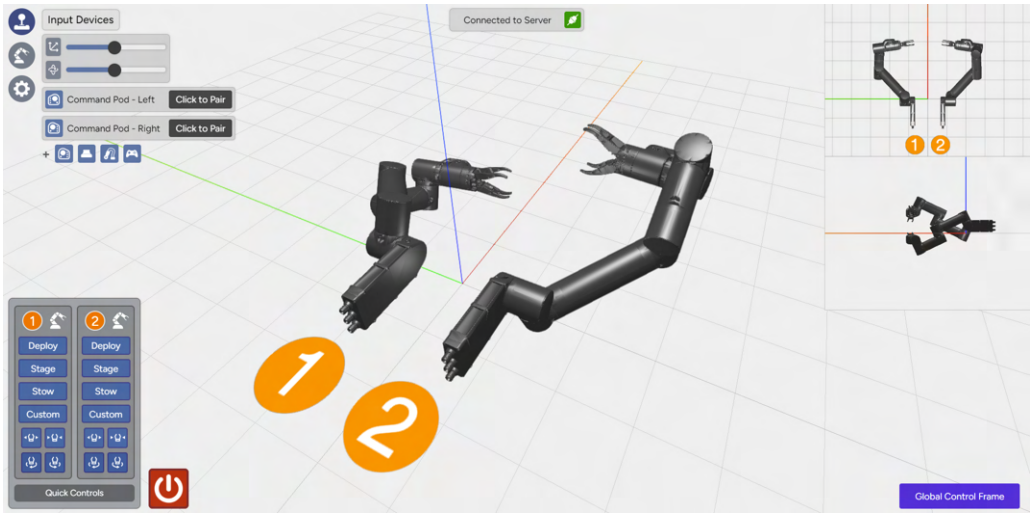
6 Control Options

6.1 Software

6.1.1 R3D

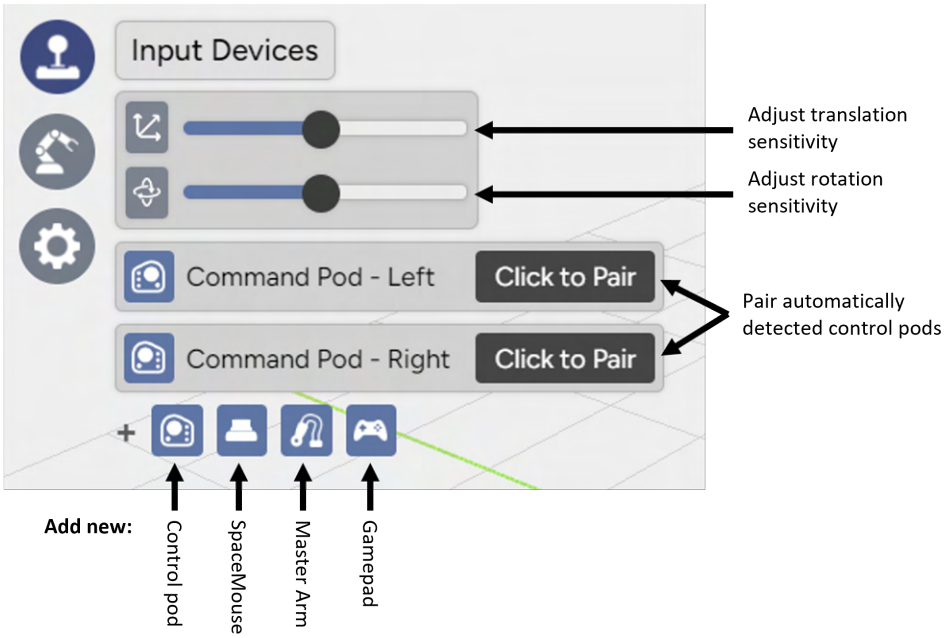
INFO	The R3D software is only supported for 5- and 7-function Reach X manipulators. For 2- and 3-function Reach X manipulators, you must use the Reach Control software.

The R3D software provides a graphical means to control each joint of the connected manipulator(s) in position or velocity mode and is stored within and accessed through the base the arm. Please see the Bench Setup and Acceptance Test for instructions on setting up the manipulator with the software.



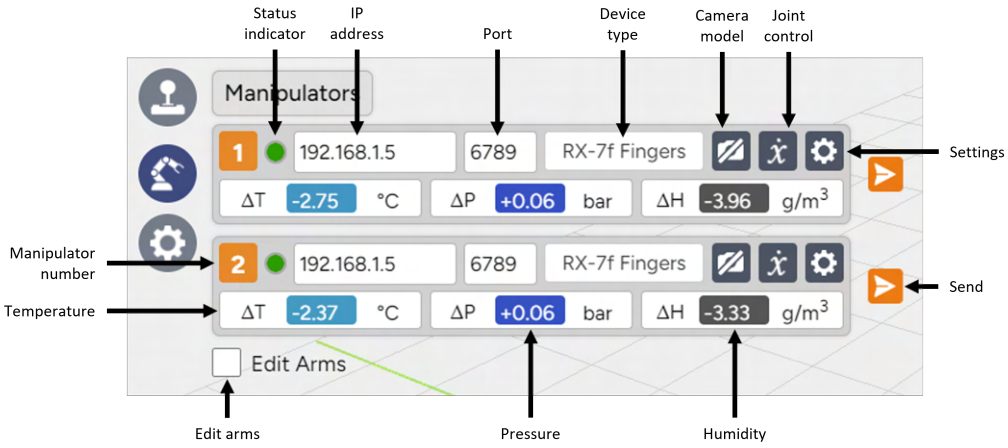
6.1.1.1 Menus

Input Devices

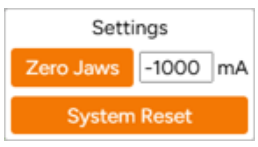


Adjusting the translation or rotation sensitivity for input devices will save the setting for that device.

Manipulators



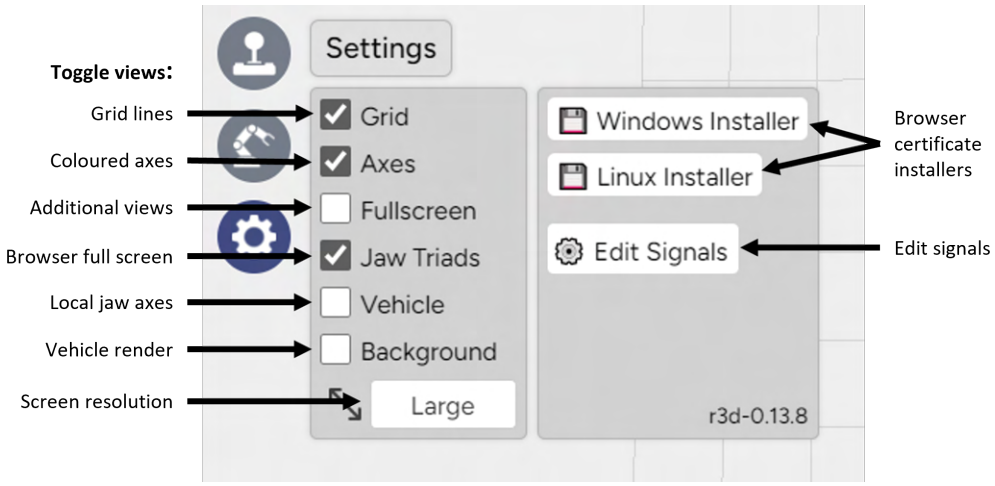
- Device type allows selection of the arm model.
- Jaw type allows a selection of the currently installed jaws.
- Joint control opens a menu from where you can control each individual joint using positive and negative inputs. You can also adjust the gain for these controls.



- Settings opens a menu from where you can zero the jaws (recommended whenever you install a new pair of jaws) and do a full reset of the system if necessary.

- Click on Temperature, Pressure or Humidity to open the full climate panel showing all joints for the selected manipulator.
- Edit manipulators allows you to delete existing manipulators and add new ones.

Settings

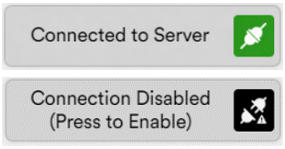


Edit Signals is an advanced menu which allows you to edit how the input controllers affect the behaviour of the manipulators. It is not recommended to change anything in this menu. If you are having problems with manipulator behaviour, please contact Reach Robotics.

6.1.1.2 Additional Tools

Digital E-stop: If the manipulators ever go out of control, click the digital E-stop to disable all joints and lock the software and other input devices from providing controls. Click it again to unlock the manipulators.

Side and top-down views: Additional views of the manipulator.



Server status: This button should be green if the software is successfully connected to the manipulator server. Click the button to disable the connection.

Note: it is easy to accidentally click the server button. Look for a red outline around the browser window to indicate if the server is disconnected.

Quick controls: Click the button corresponding to the preset (Deploy, Stage, Stow, Custom) you want to send to a specific manipulator. Control the jaws and wrist using the jaw open/close and wrist rotate buttons.

Note: the open/close jaws buttons send a command to open/close to the fullest extent of the jaws. Use a Master Arm/command pod or the joint control menu for finer jaw control.

Note: click and hold the wrist rotate buttons to control the wrist joint.

In Global mode, the manipulator will have a purple outline, and controls will be aligned with the global axes, e.g., pushing forwards on a SpaceMouse will move the end effector in the direction indicated by the red X axis in the 3D view, regardless of the orientation of the arm.

In Local mode, the manipulator will have an orange outline, and controls will be relative to the current orientation of the end effector, e.g., pushing forwards on a SpaceMouse will move the end effector forwards in the direction it is currently pointing.

To help visualise the current control frame, you can also see a small version of the axes following the end effector as it moves.

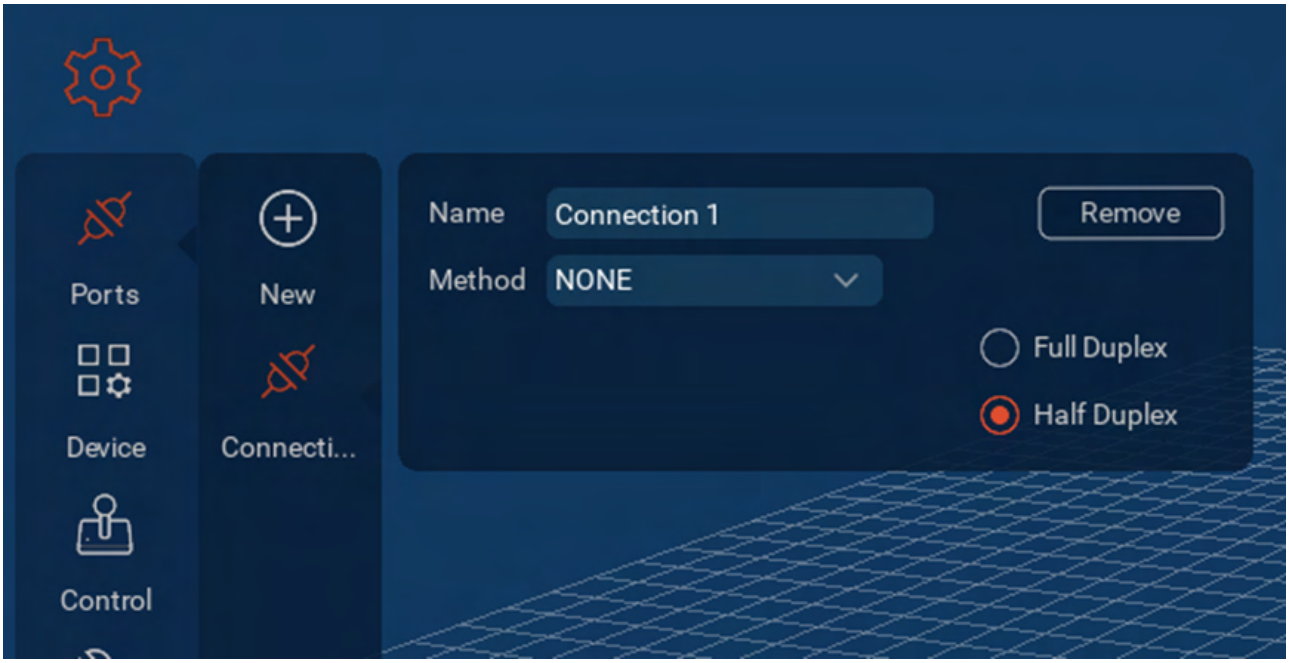
6.1.2 Reach Control

The Reach Control software is available as a free download from our website, and is used for advanced configuration of Reach X 5- and 7-function manipulators, as well as jaw calibration of the 2- and 3-function manipulators. Please see the Reach Control manual for additional information.

INFO	Reach X manipulators require Reach Control version V3.11.0 or higher.

Add a port

A manipulator connects with Reach Control through a port. To add a port, open Settings and select Ports. Click the New button and a new port will appear. Select this icon and the connection panel will open. Rename the connection if desired.

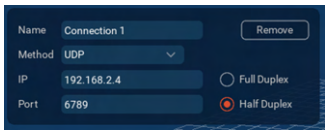


The connection method will depend on the type of device being connected and which port it is connected to on the computer.

To connect to a device over serial, select the appropriate COM port under Method.

- If you are connected over RS232, select Full Duplex.
- If you are connected over RS485, select Half Duplex.

To connect to a device over UDP or TCP, select this under Method then enter the appropriate IP address and port.



INFO

If you are unsure of the correct serial COM port, unplug the USB cable from your PC and see which COM port disappears from the list under the Method dropdown – this will be the COM port that the manipulator is using.

Add a device

Once the port has been added, a device can be connected. Go into the Settings menu and select Device. By default, an Alpha manipulator called “RIGHT ARM” will already exist under the Device menu. Select this arm to open the device panel. Rename the device if required, then select the port just created from the Port dropdown menu. Select the correct product line (Reach X), and product type (RX-2130 or RX-3XXX).

Expand the device panel by clicking the ellipsis [...].

Click the Zero Jaws button to calibrate the new jaws, which will open and close to verify the correct range of travel. The feedback will display Complete once the calibration has run successfully.

CAUTION	The jaws represent a crush/cut hazard. Ensure that there is nothing between the jaws and all personnel keep clear while the manipulator runs the calibration sequence.

INFO	Some pre-releases of Reach Control may not display a Zero Jaws button for the RX-2130 Rotating Grabber. In this case, change the Product Type to RX-3XXX Reach X 3 and run the calibration as above.

6.2 Command Pods

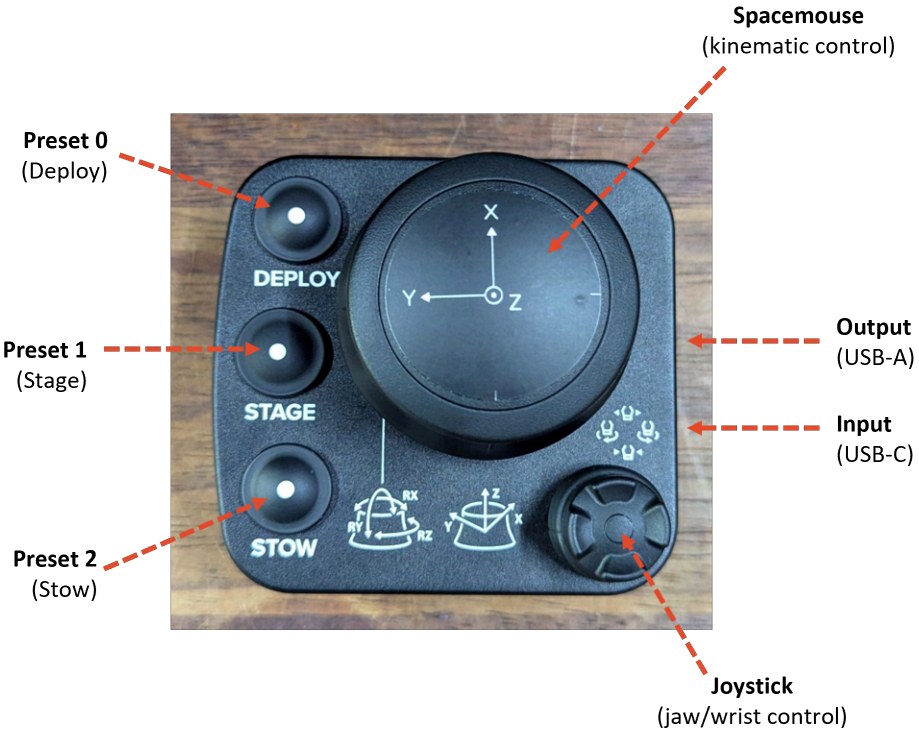
The Reach X command pods (CP) come in left and right variants and correspond to the left and right manipulators in the Reach X AIS. For a standalone Reach X, you can choose the orientation of the command pod at the point of purchase. They are connected to the PC or control unit using USB-A (PC) to USB-C (CP) cables. If you are using two command pods, they can be daisy-chained in any order.

CAUTION	The command pods must be at rest when they are first connected to a PC, not held by the SpaceMouse. The command pod calibrates upon startup based on the forces applied to it, so a force applied on startup can result in manipulator drift when the force is released.

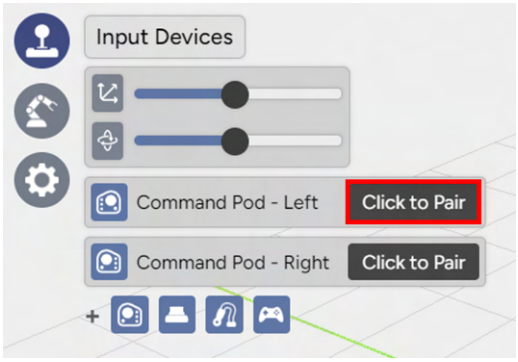
INFO	Command pods can only be used with a manipulator that is connected to the R3D software over Ethernet.
INFO	The command pods are Human Interface Devices (HIDs) and do not connect to a standard COM port on the computer. When connected, they will appear in the list of HIDs on your PC in the same way a gamepad would.

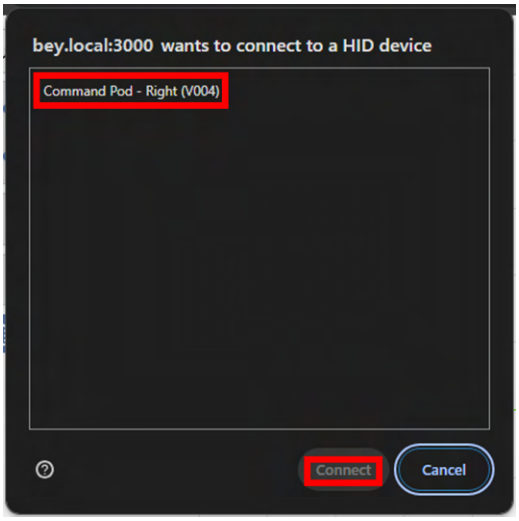
A command pod consists of a SpaceMouse, joystick, 3 preset buttons, and input/output connectors. Each command pod has their axes printed on the SpaceMouse part of the pod to aid user control.

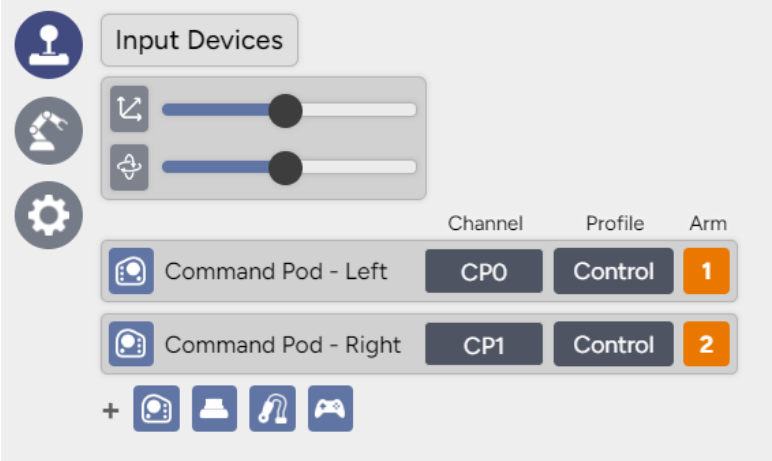
- SpaceMouse: move and rotate the SpaceMouse in three dimensions to kinematically control the entire manipulator.
- Joystick: pull down to open the jaws, push up to close the jaws, and push left/right to rotate the wrist joint in that direction.
- Preset buttons: hold down a preset button to move the manipulator to the desired position. Release the button to cancel the motion.



If one manipulator and one command pod, or two manipulators and two command pods, are connected properly to the PC, the command pods will appear and automatically configure themselves in the Input Devices menu after first being paired. Press Click to Pair and a HID device window will appear. Select the command pod and click Connect. Do the same with the second command pod and verify that you can control both manipulators with the correct pods.

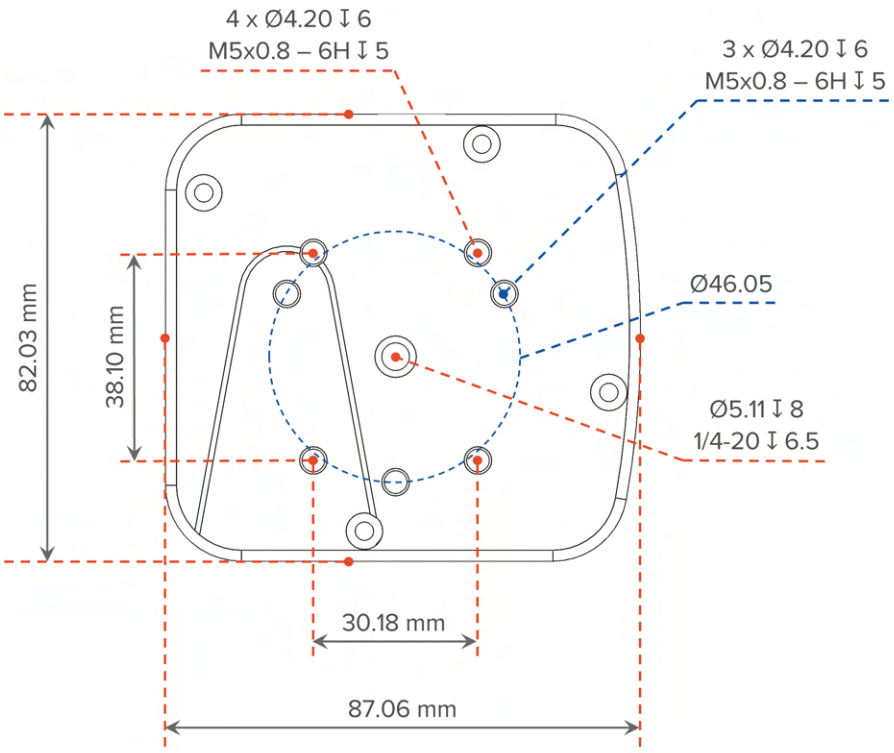






CAUTION	If you are using the command pods on a pre-setup Linux system (i.e. the web certificate has already been installed), you must run the downloaded install script again for the pods to function correctly. Failure to run the script again will result in the pods connecting but not controlling the manipulators.
CAUTION	When connecting the command pods, care must be taken with the boot-up sequence. If the command pods are already plugged in when the tablet/PC boots up, the buttons will flash blue for ~12 seconds. Once the buttons show solid blue, the command pods are connected and can be used. Do not touch any input (SpaceMouse, buttons, joystick) until the lights turn solid. If the computer is already on when the command pods are plugged in, the buttons will flash blue for ~12 seconds. Once the buttons show solid blue, the command pods are connected and can be used. You can skip this boot-up step by pressing and holding any button until the lights turn solid. Do not skip this step if the computer is booting up.
INFO	If you see that joint movement is slowed when using the joystick, try the following: • Plug the command pods directly into a USB port on the computer, especially if daisy-chaining. USB hubs often do not provide enough voltage. • Increase the sensitivity/scaling of the Command Pods in the R3D software (see Input Devices Menu).

A command pod can be mounted to a tablet or other device for easy access using the mounting holes on the back. The central mounting hole makes use of a standard ¼-20 UNC camera tripod thread to allow the use of the wide range of standard camera accessories available. The diagram below shows the left-mounted Command Pod; mirror the diagram for right-mounting.



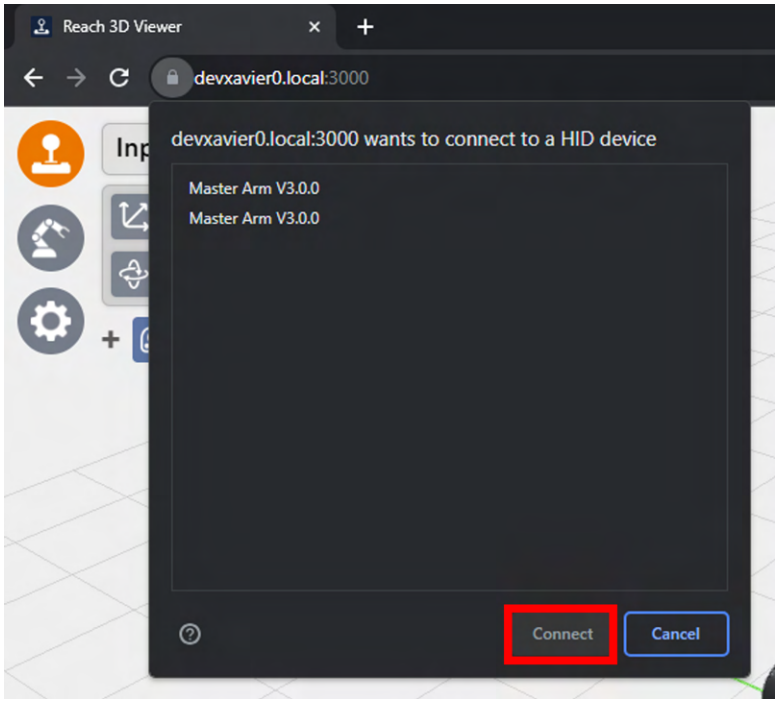
INFO

Older models of the command pods may have mounting holes on the back that are all 1/40-20.

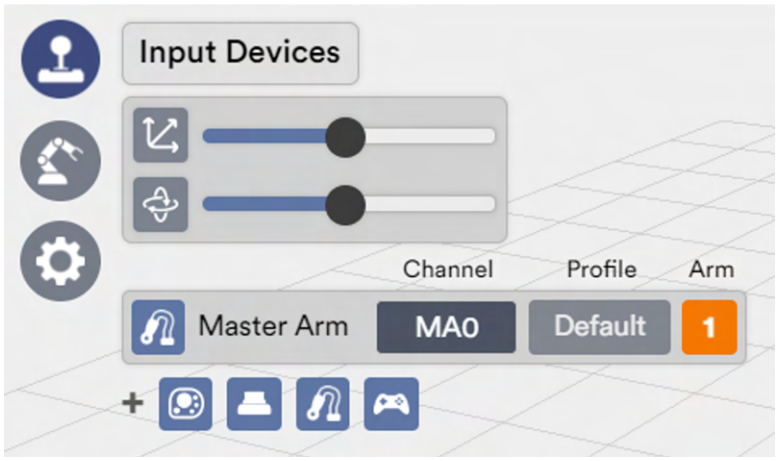
6.3 Master Arm

The Reach Robotics Master Arm system is a topside controller that maps the human operator control inputs to the movement of the manipulator's joints in a corresponding manner. In this way, the Master Arm controller allows the manipulator to "mimic" the movement of the operator.

When the Master Arm is connected via USB, give it a few moments to register with the PC. Clicking the Add Master Arm button will bring up a HID device window from where you can select one of the connected Master Arms. Click Connect to connect it to the software.



Assign the Master Arm to the correct manipulator using the Arm button. The Channel should be MA0 for the left Master Arm, and the Profile should be set automatically to Default.



INFO

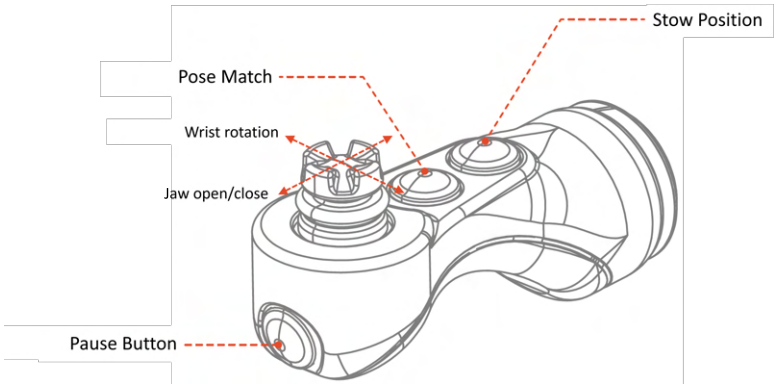
You cannot use the Orbit profile with a Master Arm.

INFO

If using two manipulators, to check that the Master Arm device and channel correspond to the intended MA unit, move the joystick back and forth and verify that the correct device icon is highlighted.

Each joint movement on the Master Arm will move the corresponding joint on the manipulator, and the buttons/joystick on the handle are assigned as below:

- Pause button: double tap to pause the manipulator, and single tap to unpause. This is useful to stop sending commands to the manipulator while you reset your position holding the Master Arm.
- Pose match: hold down while you have the Master Arm in the desired position to move the manipulator to match it.
- Stow position: hold down to move the manipulator to the stow position (Preset 0).
- Wrist rotation: side-to-side on the joystick will move the wrist joint and will override any wrist movement from the handle itself.
- Jaw open/close: push the joystick up to open the jaws, and down to close them.



CAUTION	Using the Pose Match button will unpause the Master Arm to allow for instant movement from the new position. Be aware of the Master Arm becoming active to avoid unintended movements that may damage the manipulators or equipment around them.

6.4 Gamepad

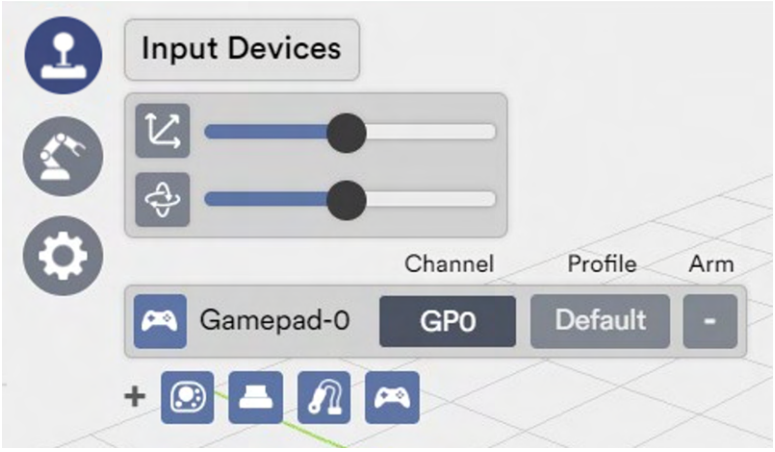
A simple HID gamepad (Reach Robotics supplied or BYO) can be used in conjunction with Reach Control. The gamepad control inputs can be customised and mapped to the different functions and joints of the manipulator. The gamepad can be used to control the manipulator in joint velocity, or end-effector Cartesian (XYZ) mode.

INFO	You must physically disconnect any command pods from the control unit if you wish to use a gamepad. If the pods remain connected the software will detect them as gamepads and corrupt the connection.

Pair the gamepad to the control unit following the manufacturer's instructions.

With the Input Devices menu open, press any button on the gamepad to allow the browser to recognise it. Click the Add Gamepad button and the gamepad will be immediately connected to

the software. The profile and channel should be auto-assigned – if not, assign the GPO0 channel and Default profile. Do not assign a manipulator, as the gamepad will control both.



INFO

You can use the gamepad on the Orbit profile to pan around the view if required.

Hold the left and right bumpers to activate the left and right manipulators, then control the selected manipulator using the mapping below:

7 Bench Setup and Acceptance Test

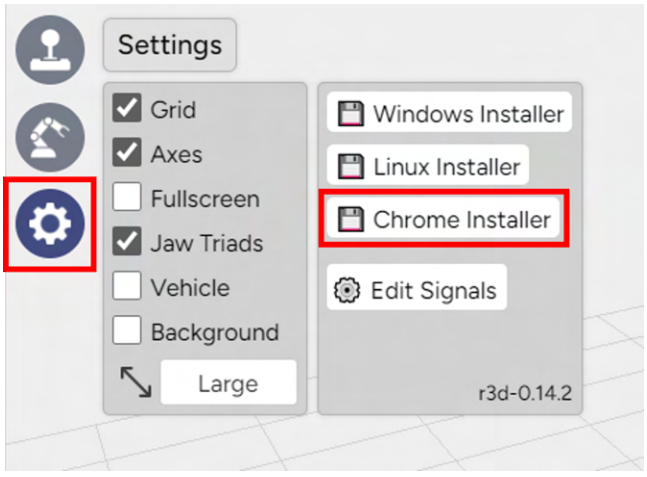
1. Once the manipulator(s) is connected and powered, you can access the software, which is contained within the manipulator itself. If you wish to use Human Interface Devices (HID) such as a Command Pod, SpaceMouse or gamepad with the Reach X, you must use the Google Chrome browser, which can be installed from the arm itself if not already installed on your computer.

2. Using a Windows or Linux computer, open a web browser and go to https://[SN].local:3000, where [SN] is the unit's serial number (visible on the base sticker).

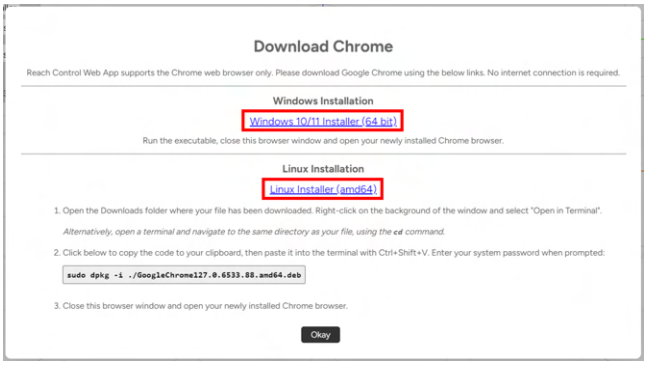
3. When you go to this URL, your browser will warn you that it is unsafe. This is because your computer does not currently have a certificate to prove that the URL is safe to visit. Once you have downloaded the certificate from the manipulator, the browser will allow you to access this page safely on this computer. If you connect the manipulators to another computer, you will need to download the certificate again.

   Click Advanced, and then click Proceed to [SN].local (unsafe). This will open the Reach 3D Viewer software.

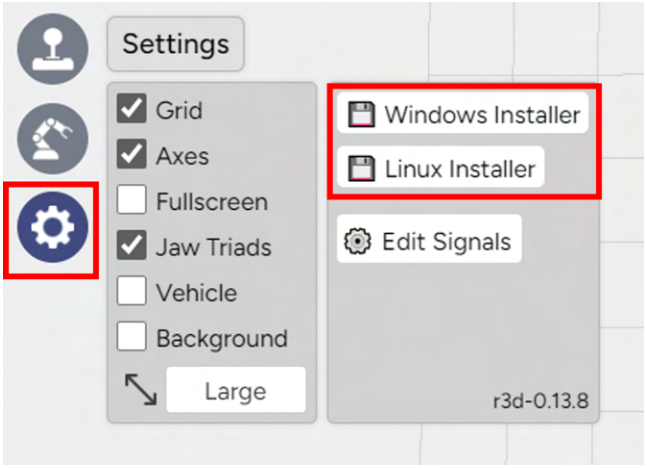
4. If using a non-Chrome browser, go to the Settings menu and click Chrome Installer. If already using Chrome, go to Step 6.



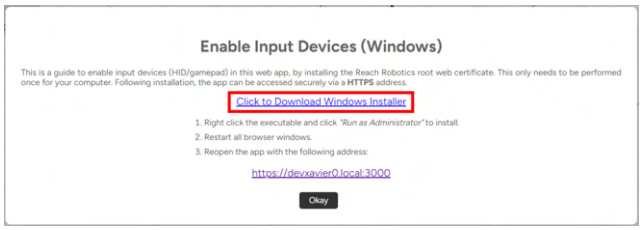
5. This will open a window where you can install Chrome for either Windows or Linux. Click the appropriate installer link and follow the instructions in the window. Open Chrome and return to https://[SN].local:3000 (you may need to go through Step 3 again).



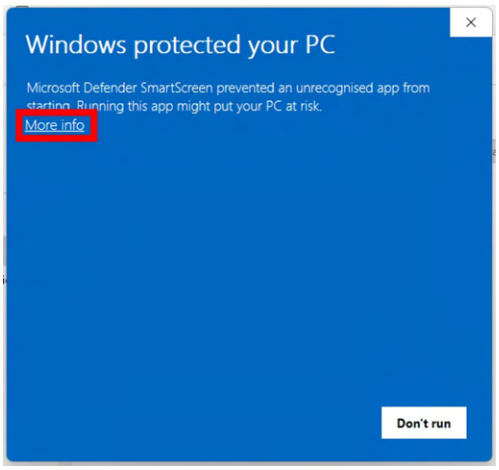
6. To download the browser certificate, go to Settings on the left-hand side (cog icon), then choose the installer that best fits your operating system.

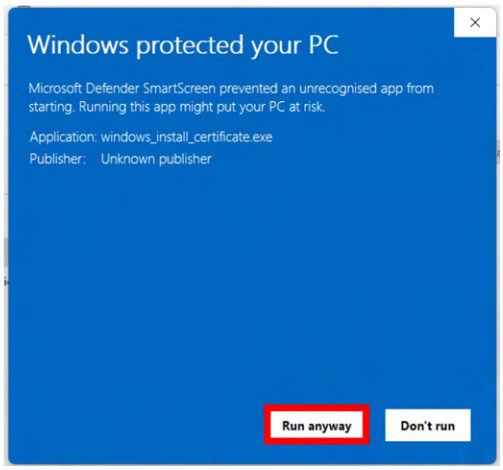


7. A window will open with instructions on how to install the certificate for your operating system. Click the link to download the certificate from Chrome.



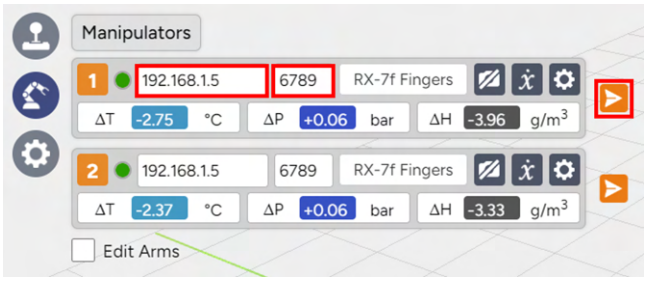
8. If using Windows, you may find that it tries to block the .exe file from running. In this case, click More info, then click Run Anyway.





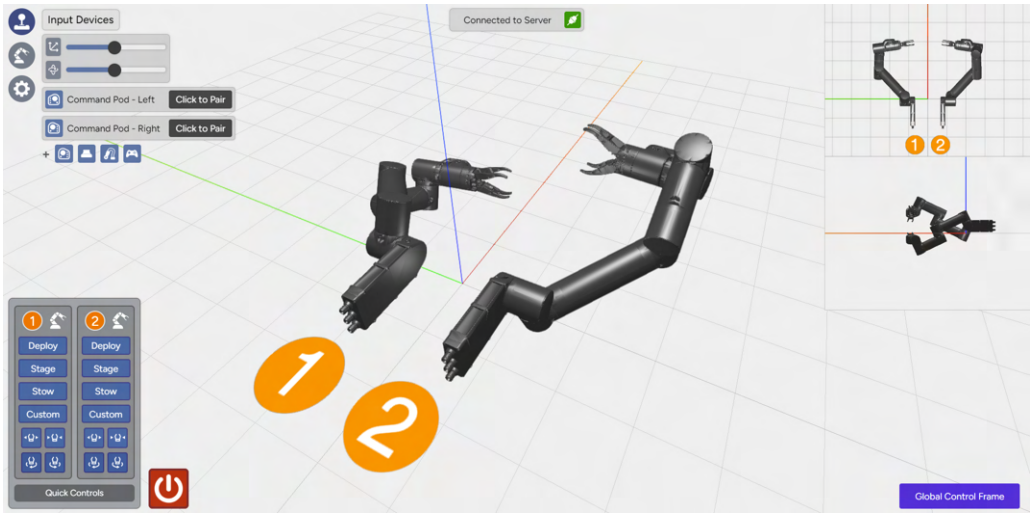
9. Follow the instructions in the installation window, and the next time you open the manipulator's URL, Chrome will recognise the page and you will connect safely.

10. Now that you have the Reach 3D Viewer software up and running, you can connect the manipulator(s) properly. There should already be two manipulators visible in the Manipulators menu on the left-hand side. Check the IP address(es) against your unit(s) (check the base stickers) and amend them if necessary. The ports should both be 6789. If you make any changes, press the Send button to commit them.



11. Once you are connected properly to the manipulator(s), you should have green status lights next to each manipulator in the Manipulators menu.

12. When you open the software in Chrome, you will have a view like below that shows the manipulators you have connected, as below.



8 Maintenance

8.1 General Product Care

Reach Robotics products are intended for use in water or air. Other fluids may have an adverse effect on the materials used in their production.

Cleaning

- Units should be cleaned thoroughly after every deployment, dry or wet.
- Ensure connector blanks are installed to prevent water entering the connector.
- After immersion in salt-water, wash units in fresh water to prevent salt deposits and corrosion.
- After immersion in water with high suspended sediment, or if the unit has come into prolonged contact with the seafloor, ensure all debris is removed from the unit, focusing particularly on joint closures and moving parts to preserve sealing surfaces.
- Do not use harsh chemicals to clean any Reach Robotics products.

Replacements

- If your unit has sacrificial zinc anodes, these should be replaced when corroded.

Connector care

- Keep connectors protected at all times when not in use.
- Do not expose connectors to heat or direct sunlight for extended periods.s
- Regularly check connector pins for signs of damage or corrosion.
- Ensure female connectors are free of debris – flush with compressed air if necessary.
- Ensure both male and female connectors are dry when mating to avoid potential insulation issues.

- Liberally apply silicon grease to both male and female connectors prior to every mating to prevent corrosion.

Cable care

- Avoid exceeding the minimum bend radius.
- When de-mating connectors, pull the connector rather than the cable to remove it.
- Consider strain relief methods if using externally powered tools at the end-effector of the unit.

8.2 Repairs

If your Reach Robotics equipment becomes damaged or faulty, it may need to be returned to Reach Robotics for investigation and repair under a Return Merchandise Authorisation (RMA). Only a Reach Robotics engineer may authorise a return to our factory; the requirement may be determined through a phone call, email, or video call/remote access to the unit. If you suspect that an RMA may be required, please fill in this form and someone from Support will be in touch: Request an RMA

RMA Process

1. Reach Robotics Support will request details of the issue to determine whether a return is necessary.
2. If so, an RMA Number (RMAXXXX-YYMMDD) will be issued to you, and the Reach Robotics engineer will request shipping details so we can organise a pickup of the equipment.
   Do not send the equipment prior to being issued an RMA Number.
3. The equipment will be shipped to Reach Robotics Headquarters in Sydney, Australia (see Notes).
4. Our Production team will conduct an initial investigation on the unit, based on the information provided. This will take an estimated 1-2 weeks. Any delays due to the complexity of the problem will be communicated to you.
5. After the initial investigation, Reach Robotics Support will contact you with the findings of our Production team. If the unit is not under warranty, a quote for the investigation, repair work and shipping costs will be included. If the unit is under warranty, you will be notified, and the repairs will be carried out free of charge.
6. To authorise a non-warranty repair, send a PO for the work to Reach Robotics Support (see Notes). Once this is received, the repair work will start, and our Accounts team will send an invoice to you.
7. Typical repair times vary post-investigation, and the exact length of time required for the repair will depend on the product being repaired, the complexity of the repair, and the availability of spare parts.
8. Any delays to the expected shipping date will be communicated to you. Priority service may be possible; please discuss this with your usual Reach Robotics Sales Engineer.
9. When the repair is completed, our Warehouse Manager will organise returning shipping and contact you with a ship date and tracking information (see Notes).

CAUTION

Health and Safety

- Any unit returned to Reach Robotics must be safe for our staff to handle and cleaned thoroughly to comply with Australian biosecurity regulations. We require you to declare if the unit may be contaminated. If the unit has been in contact with any contamination, you must provide proof that the unit is safe to handle.
- Possible contamination sources include nuclear radiation, sewage, hazardous chemicals, biowaste, marine/freshwater life, or soil/mud.
- Reach Robotics reserves the right to refuse to handle any contaminated goods and return them to you at your own expense.

Notes

- Standard Warranty of 1-year from date received is provided on all new Reach Robotics Products. There is no warranty extension for units following an RMA unless extended warranty has been purchased prior to the RMA being raised.
- An investigation fee is chargeable on all non-warranty RMAs. This is payable even if you choose not to have your unit repaired.
- If the nature of the repair is such that you feel it is uneconomical to carry out the work, a discount on a new unit may be possible; please discuss this with your usual Reach Robotics Sales Engineer. This remains at Reach Robotics' discretion, and no discount is guaranteed.
- All RMAs are shipped EXW. Any insurance desired by the customer is the customer's responsibility and Reach Robotics can take no responsibility for shipment losses or damages.
- If you do not make a decision regarding repairing, replacing, or scrapping your RMA within 12 months of its arrival at Reach Robotics, we reserve the right to charge storage fees on a weekly basis dependent on RMA unit type.

9 Declaration of Incorporation

See the following page for the Reach X Declaration of Incorporation.

REACH
ROBOTICS

EU DECLARATION OF INCORPORATION OF PARTIALLY COMPLETED MACHINERY

The Manufacturer: Reach Robotics PTY LTD of 3 Queen St, Glebe, NSW 2037, Australia,
And,
Authorised Person: Kyle McLean of 3 Queen St, Glebe, NSW 2037, Australia,
Hereby declare that a declaration of incorporation has been issued for the following partially completed machinery:
Product Description: Subsea robotic manipulator
Product Code: RX-XXXX
Product Name: Reach X

To which this declaration relates is in conformity with the following directives and standards:

2001/95/EC – General Product Safety

2011/65/EU – Restriction of the use of certain hazardous substances (RoHS)

2015/863/EU amending Annex II of Directive 2011/65/EU

2017/2102/EU amending Directive 2011/65/EU

2006/42/EC – Machinery (MD)

EN ISO12100:2015 Safety of machinery: General principles of design, risk assessment and risk reduction

IEC60068-2-27:2008 Environmental Testing: Part 2-27: Tests Ea and guidance: Shock

IEC60068-2-6:2007 Environmental Testing: Part 2-6: Tests Fc: Vibration (sinusoidal)

2014/30/EU – Electromagnetic compatibility (EMC)

EN61000-6-3:2007 Electromagnetic compatibility (EMC): Part 6-3: Generic standards; Emission standard for residential, commercial and light-industrial environments

Where required technical documentation is compiled in accordance with part B of Annex VII of 2006/42/EC and in response to a reasoned request by the national authorities, relevant information on the partly completed machinery shall be provided.

This declaration of incorporation of partially completed machinery is issued under the exclusive responsibility of the manufacturer and is provided with the understanding that the partly completed machinery must not be put into service until the final machinery into which it is to be incorporated has been declared in conformity with the provisions of all required directives.

Reach Robotics PTY LTD
Kyle McLean
Sydney Australia
11 July 2024

10 Revision History

Version	Date	Author	Notes
V1.0	05/07/2024	Ellie Best	Initial version
V1.2	29/11/2024	Ellie Best	Chrome installation instructions Change to certificate install instructions Specification updates Updated pictures of hardware EMC testing details
V1.3	08/05/2025	Ellie Best	Software update Updated mounting dimensions Jaw installation and calibration Maintenance expanded