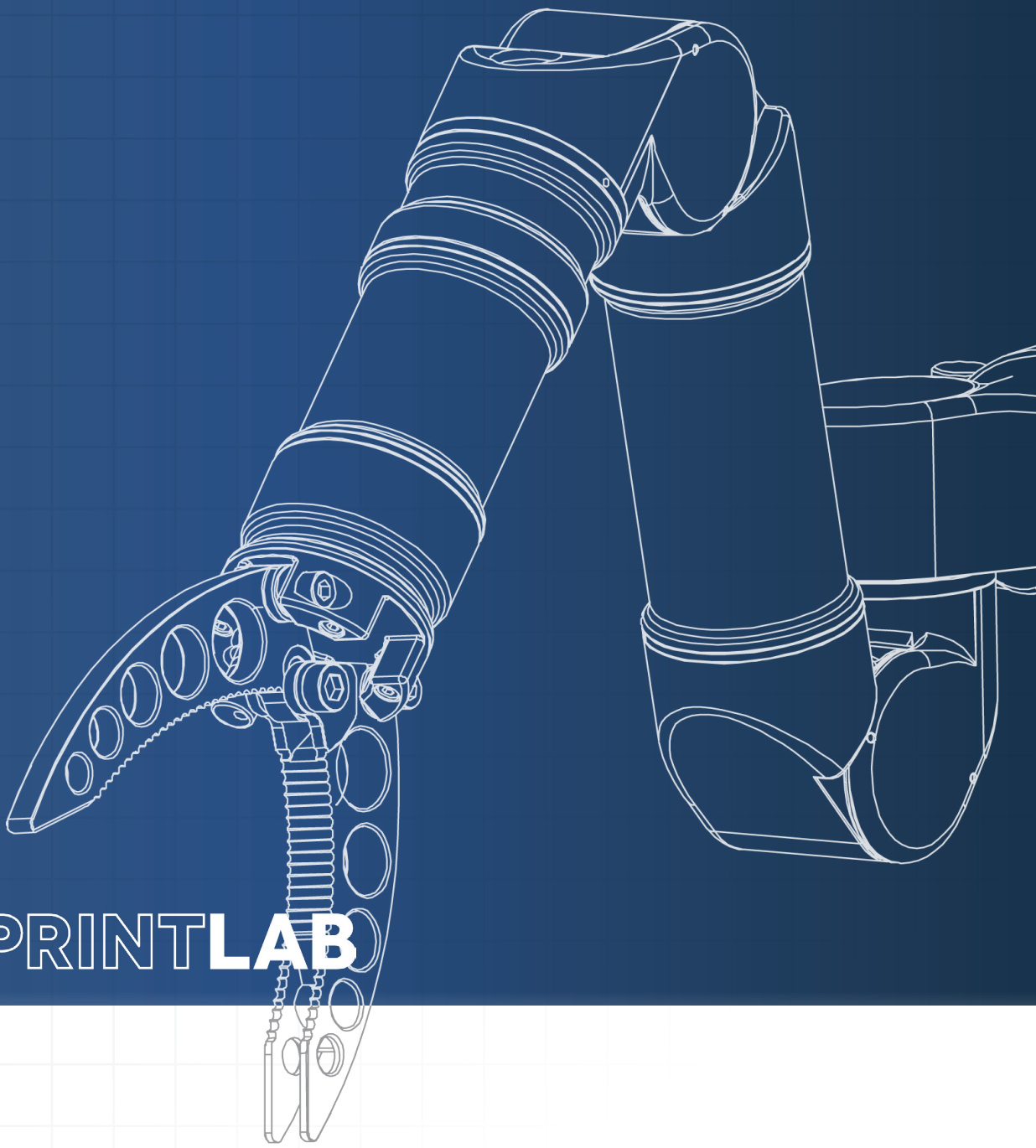


BLUEPRINTLAB

REACH ALPHA

INTEGRATION MANUAL

tel: +61 (2) 9519 7651 | email: info@blueprintlab.com

www.blueprintlab.com

Contents

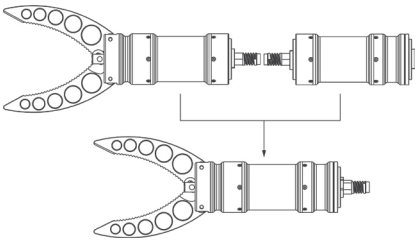
1 Overview

The Reach System is the world's smallest, lightest subsea manipulator system. We designed this advanced manipulator to open new possibilities for remote intervention and inspection in harsh environments. This manual predominantly applies to the Alpha 5 (often termed 'manipulator' in this document) but applies more generally to other Reach Mini actuators (e.g. 3 or 4-Function variants) as well.

1.1 Product Features

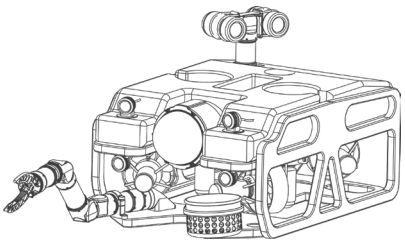
Modular by Design

The modular design allows for rapid OEM upgrades and repairs. Compatibility between modules increases reliability across the entire range and allows for ease of customization. Interchangeable end-effectors allow for quick mission-specific fit outs.



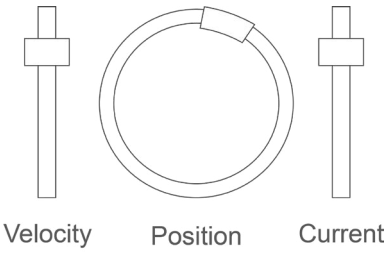
Underwater Ready

The Reach Alpha is capable of operating at depths of 300m for extended periods of time. Each unit undergoes rigorous testing prior to shipping to ensure seal and structural integrity when operating in harsh environments. Our products have been validated by customers around the world and have logged over 1000 hours at depth.



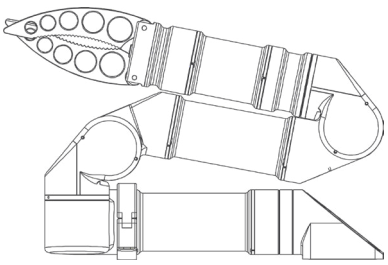
Full Control

Position, speed and current feedback extends the Reach Mini manipulator abilities to performing delicate tasks. Proprietary control algorithms ensure accurate response and enhanced control through multiple human machine interfaces.



Small Size

A standard external diameter of 40mm and weight of less than 900g in water, the Reach Alpha provides unparalleled functionality for unmanned remotely operated vehicles where size and weight are critical.



1.2 Reach Product Codes

Throughout this manual, actuators will be referred to by their product codes as listed below.

RS1-1100 - Single Function Rotate Stage
RS1-1400 - Single Function Bend Stage
RS1-1300 - Single Function Linear Stage
RS1-2140 - Dual Function Rotate/Bend Stage
RS1-2130 - Dual Function Rotate/Linear Stage
RS1-5001 - 5 Function Manipulator

2 Single & Dual Function Manipulators

2.1 Specifications

Mechanical

Specification	RS1-1100	RS1-1400	RS1-1300	RS1-2140	RS1-2130
Weight Air	200g	320g	220g	360g	360g
Weight Water	100g	220g	130g	220g	250g
Dimensions	98xΦ40mm	140xΦ40mm	103xΦ40mm	165xΦ40mm	117xΦ40mm
Torque/Force[1]	0.6Nm	10Nm	600N	10Nm/1Nm	0.6Nm/600N
Rate[1]	90-20°/s	60°/s	2.5mm/s	60°/s	60°/s / 2.5mm/s
Travel	360° Cont	360° Cont	22mm	330° x 360° Cont	330° x 22mm

[1]The rate and torque relationship can be configured to suit a specific application. Please contact us to discuss your solution.

Environmental

Specification	RS1-1100	RS1-1400	RS1-1300	RS1-2140	RS1-2130
Depth	300m Below Sea Level				
Temperature	-30°c to +45°C	-30°c to +45°C	-30°c to +35°C	-30°c to +35°C	-30°c to +35°C
Shock	200Gs/1ms				
Housing Material	Hard Anodised 6061 Aluminium				

Electrical

Specification	RS1-1100	RS1-1400	RS1-1300	RS1-2140	RS1-2130
Voltage Range[2]	18-30V DC				
Power(max)	6W	11W	6W	11W	11W
Communication	Full Duplex RS232 or Half Duplex RS485				

[2]The RS1 Series can operate as low as 10V. However, voltages below 18V will result in a decrease in max rate.

2.2 Interfacing

Mechanical

All actuators have the same mounting flange. This is to allow for easy integration of the entire range. Our tailormade mounting kit allows for the quick swap out between various components or the simple rotation of a single axis unit.

Figure 1. Mounting Flange Dimensions

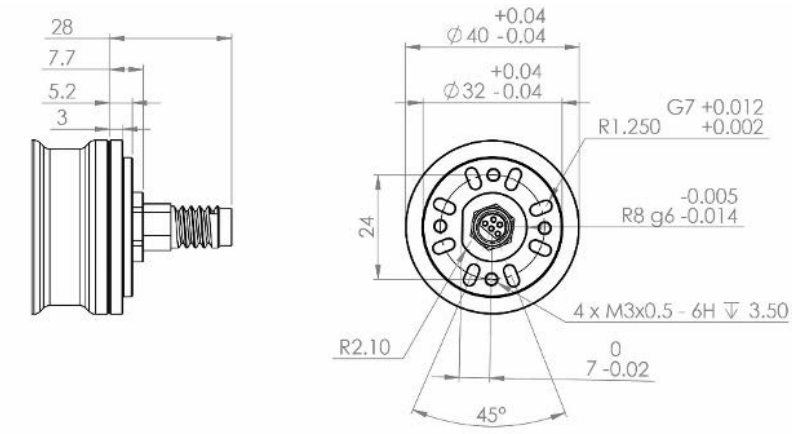
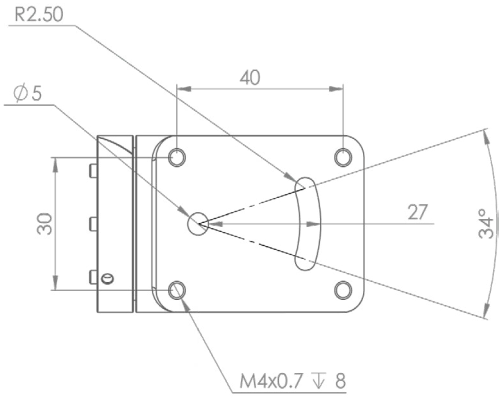


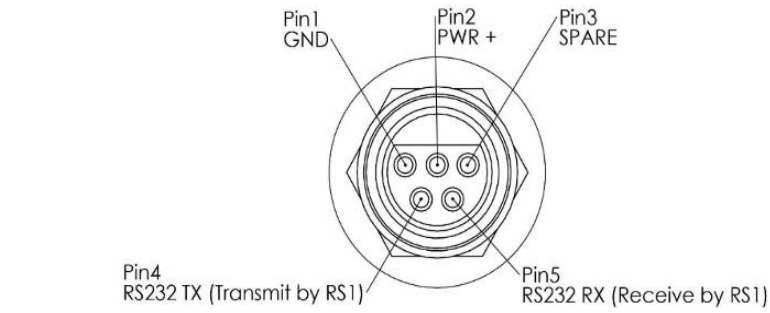
Figure 2. Mounting Kit Dimensions (Optional)



Electrical

The standard connector interface for RS1 range is a 5-PIN HUMG SeaCon Connector. The mating connector is a 5 Pin HUMG CCP. It is important that the serial device and the RS1 Actuator share a common ground. Failing to do so could damage the device.

Figure 3. 5 Pin HUMG SeaCon Connector RS232 - Male Face View



When using a RS485 version Pin 4 is A and Pin5 is B

3 Reach Alpha 5

3.1 Dimensions and Coordinates

Figure 4. Joints and Origin

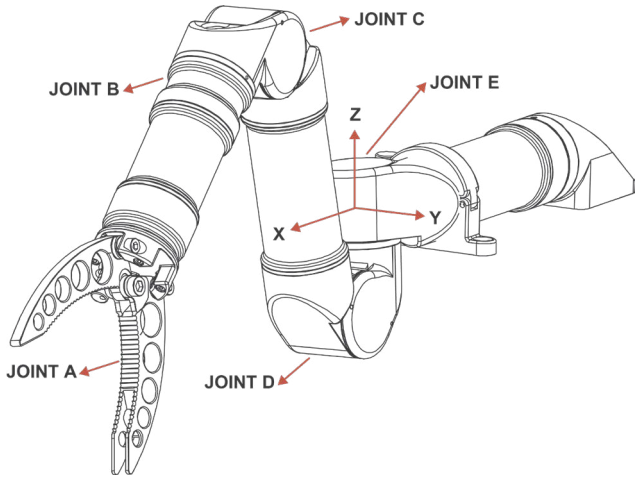


Figure 5. Joint Limits

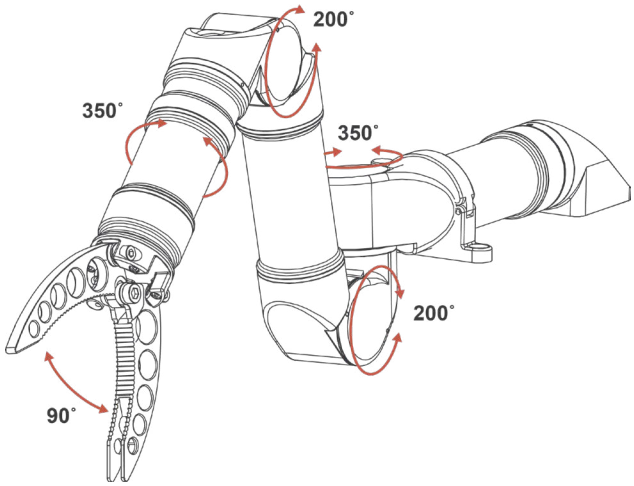
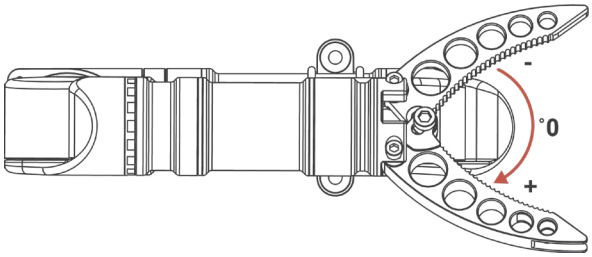


Figure 6. Zero Point/ Travel/ Direction & Zero Point



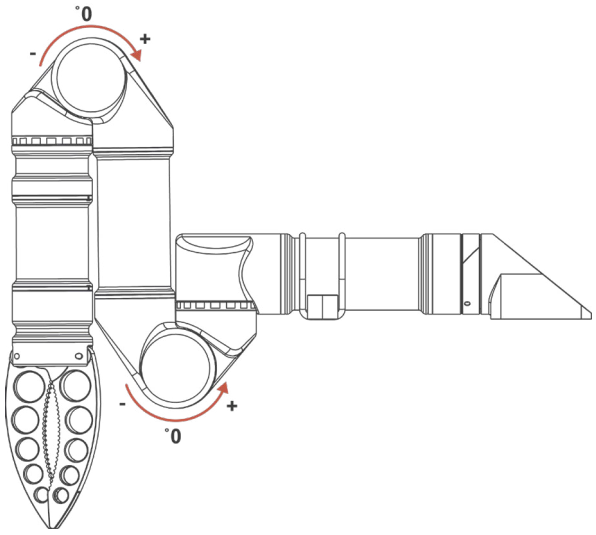
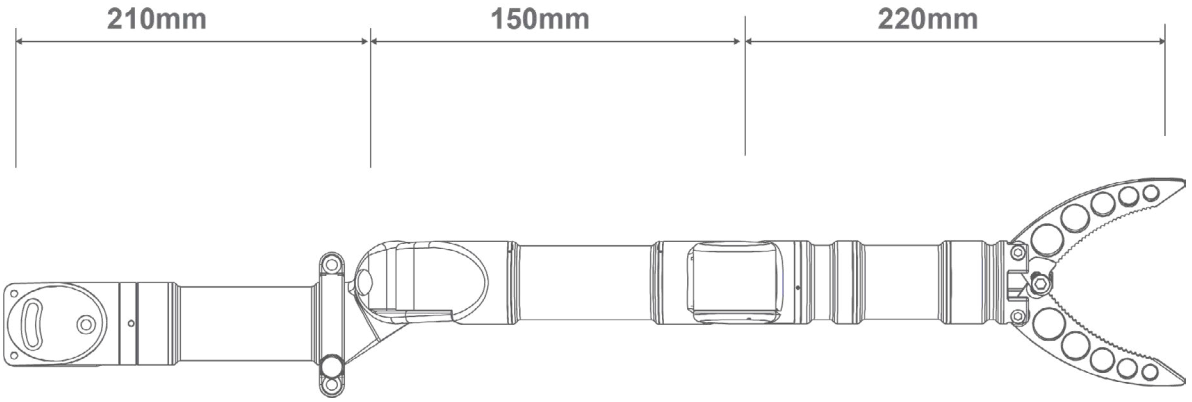


Figure 7. Axis Length



3.2 Specifications

Mechanical

Specification	Joint A	Joint B	Joint C	Joint D	Joint E
Weight Air	1250g				
Weight Water	880g				
Dimensions	570xØ40mm (Mounting Base to Jaw Tip)				
Max Lift (Full Reach)	2Kg				
Torque/Force1	600N	0.6Nm	10Nm	10Nm	10Nm
Rate	3mm/s	50°/s	30°/s	30°/s	30°/s
Travel	22mm	330°	200°	200°	350°

Environmental

Depth	300m Below Sea Level
Temperature	-10°c to +45°C
Shock	200Gs/1ms
Housing Material	Hard Anodised 6061 Aluminium

Electrical

Voltage Range	18-30V DC (Lower voltage is allowed, but will limit speed)
Power(max)	35W
Communication	Full Duplex RS232 or Half Duplex RS485
Connector	Teledyne 6 Pin IE(W)-55 Impulse

Kinematic, Dynamic, and Other Properties

The Blueprint Lab Github repository contains documents regarding the Kinematic and Dynamic properties of Reach System manipulators.
Available at: https://github.com/blueprint-lab

3.3 Interfacing

Mechanical

The Reach Alpha offers a variety of mounting configurations. These are easily implemented using the supplied two-part mounting kit. This kit is designed to absorb moderate shock to help protect the Reach Alpha from external impact.

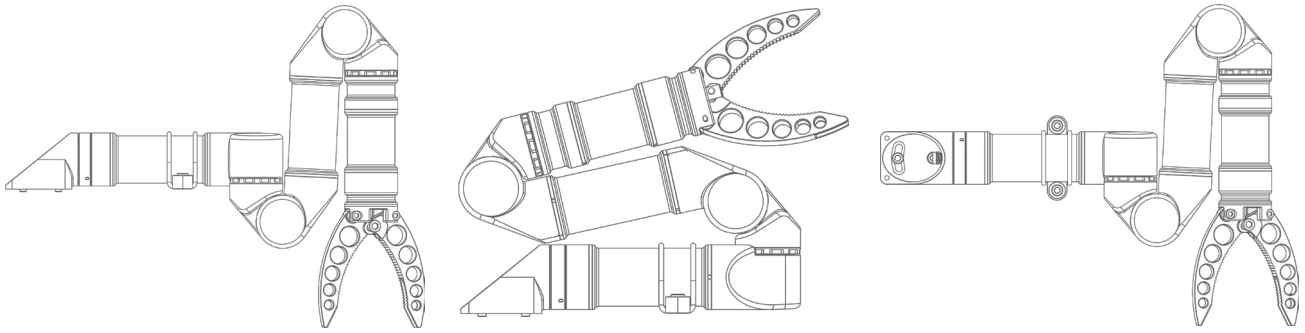
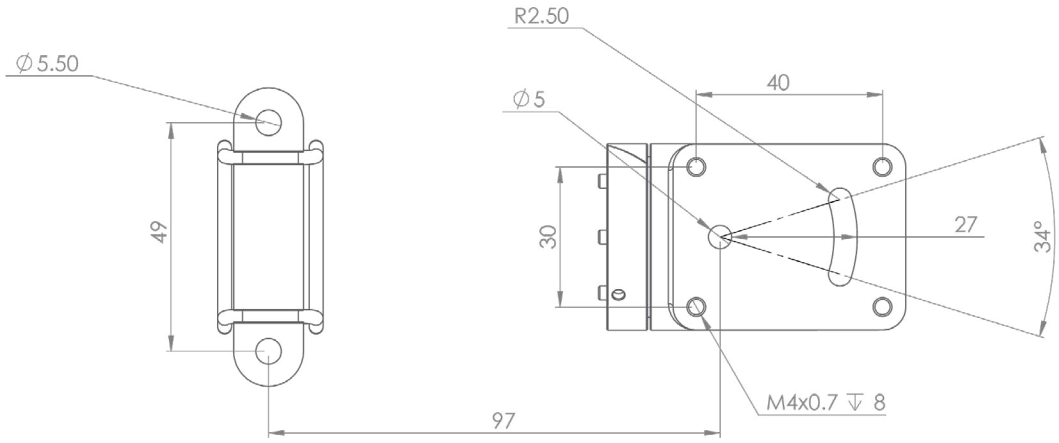


Figure 8. Mounting Dimensions of Mounting Kit



Electrical

The standard interface for the Reach Alpha is a Teledyne 6 Pin IE(W)-55 Impulse Connector. The mating connector is a Teledyne 6 Pin IE(W)-55 Impulse CCP Connector. It is important that the serial device and the Reach Alpha share a common ground. Failing to do so could damage the device.

NOTE: *If your whip has a Brown cable this is a legacy configuration. Please contact Blueprint Lab for the interface information.*

Figure 9. IMPULSE IE55 CCP Dimensions (mm)

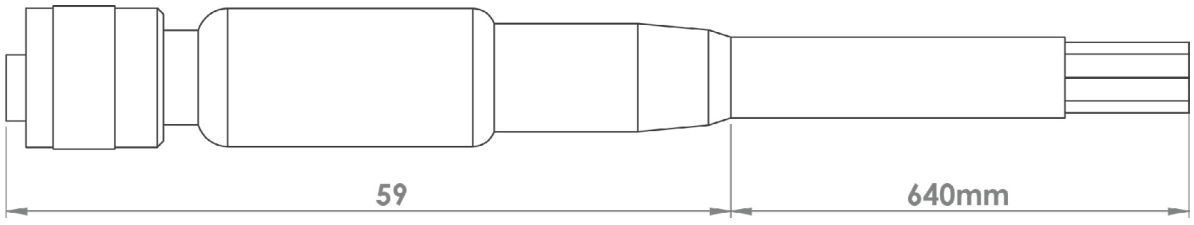
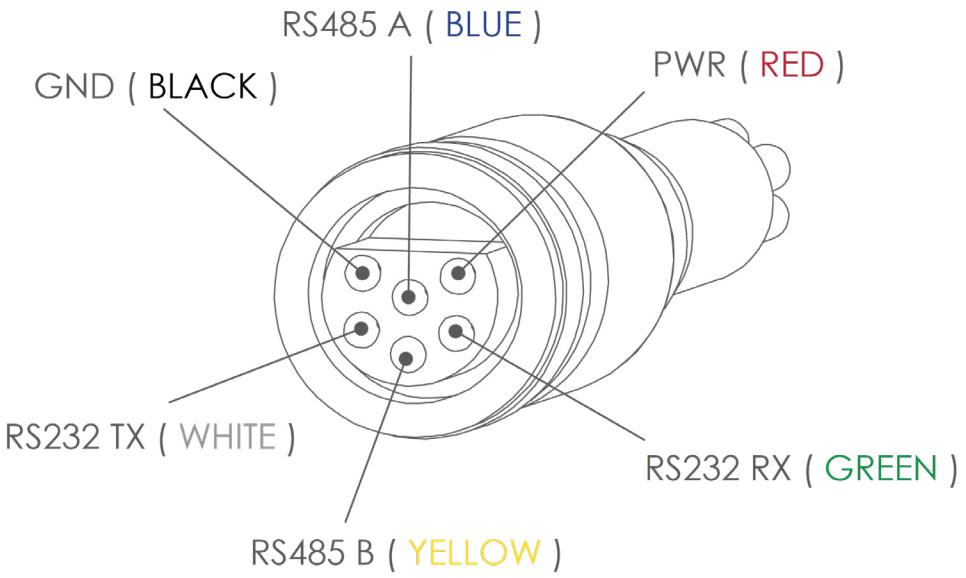


Figure 10. IMPULSE IE55 FEMALE Whip - Female Face View



Communication

The Reach Alpha communicates via a serial RS232 or RS485 interface. The serial connection should be configured via the Reach Control software suite or manually using the following specification.

Serial Specifications	
Baud	115200 bits/s
Word Length	8 bits (including parity)
Parity	None
Stop Bits	1

When using an RS232 device, the connection is full duplex whilst when using RS485 it is half duplex. The Reach Alpha will respond to demands on either RS232 or 485 without needing to be configured. Data being transmitted from the R5M will be done via both COM ports. For more information on the serial protocol please refer to the Serial Protocol Document at *https://github.com/blueprint-lab.*

4 Bench Setup

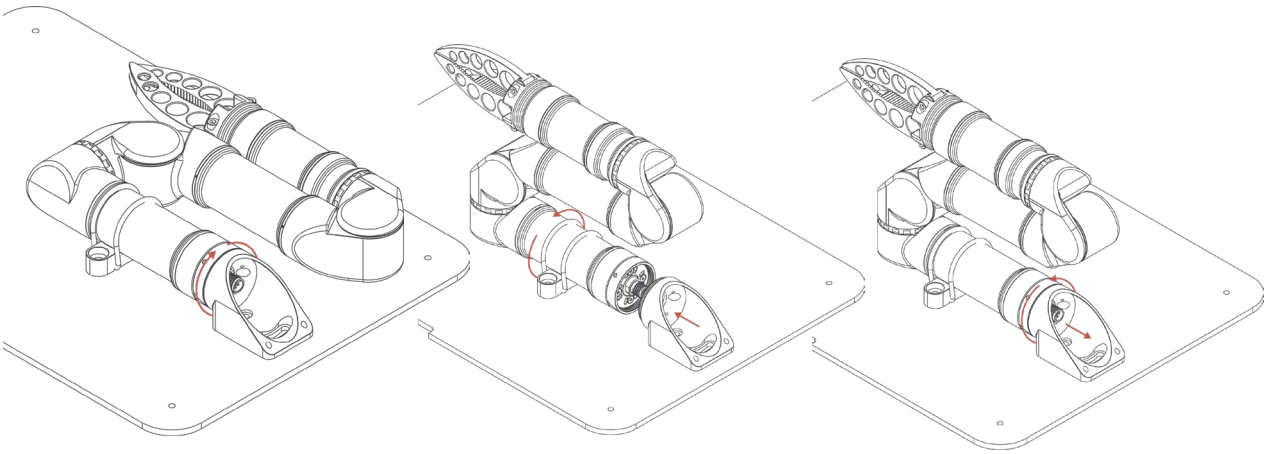
Prior to vehicle integration activities, a bench level test is recommended in the first instance. This builds familiarity from the ground up and assists with product acceptance. The following procedure will walk you through the bench setup procedure.

You Will Need

- Reach Alpha manipulator
- Test Cable
- Power Supply or Battery
- PC or Laptop running Windows
- (Optional) 3D Mouse or Gamepad
- Supplied Break-out-board with USB cable or alternative serial connection (RS232 or RS485)
- An installation of Reach Control Lite (included with purchase) or Reach Control Pro
- Reach Alpha Mounting Kit

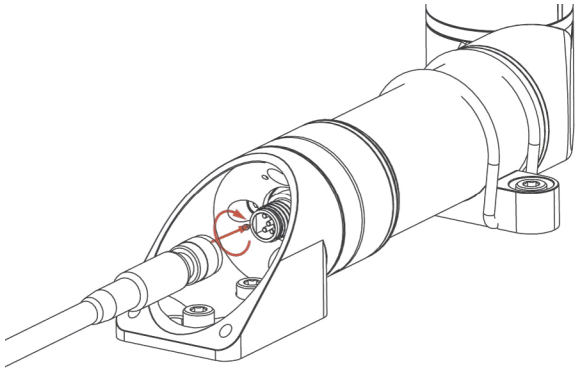
Step 1

Remove the manipulator and stand from the transport case and place on the bench. Loosen the mount locking nut, rotate the manipulator 90 degrees to the upright position, align the pins and re-tighten.



Step 2

Ensure the manipulator is upright and free from obstruction. Connect the 6-Pin Female Impulse connector to the 6-Pin Male connector on the rear of the manipulator by lining up, inserting and then rotating to fasten.



Step 3

Connect the Break-out-board to the PC/Laptop via the supplied USB cable. You may plug the USB into either the RS232 or RS485 slot as both outputs are connected to the cable whip by default.

For users who are bypassing the Break-out-board and using their own serial connection setup, ensure that TX of the manipulator goes to RX of the controller and vice versa.

Step 4 - Reach Control Setup

Install the latest version of Reach Control by double clicking on the supplier installer .exe file and following the installation wizard. Run the application on the completion of install or via the start menu.

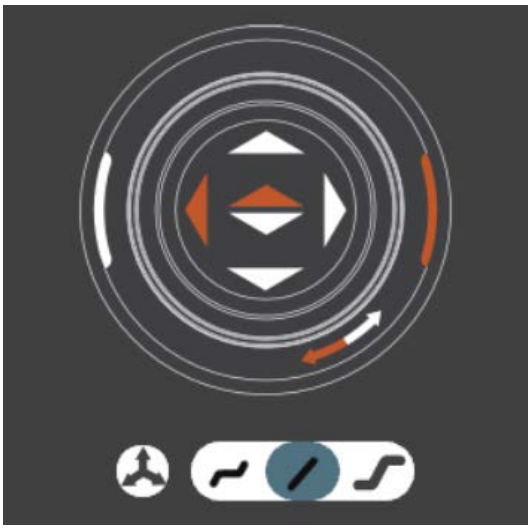
If you need a copy of Reach Control supplied, please contact Blueprint Lab (info@blueprintlab.com).

Step 5 - External Control Setup

Two external controllers can be used to control manipulators via Reach Control. These are the Gamepad (eg. Xbox Controller) and the 3Dconnexion Spacemouse. To test these controllers, plug the controller into your computer while running Reach Control and move the controller and buttons around. The arrows will light up and the 2D animation will portray a simulated response (see Figure 11).

NOTE: *If using the Master Arm controller, you can set that device up now, following the steps in the Master Arm Operator's Manual.*

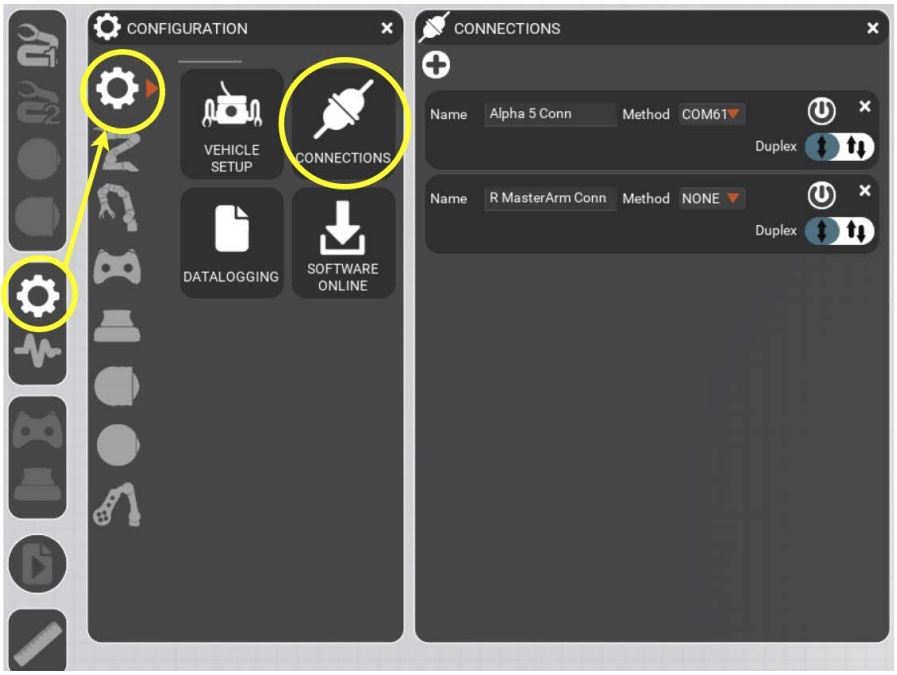
Figure 11. Space Mouse Simulation (Left), Gamepad Controller Simulation (Right). Kinematics icon will only show in the full version of Reach Control



Step 6 - Communication Setup

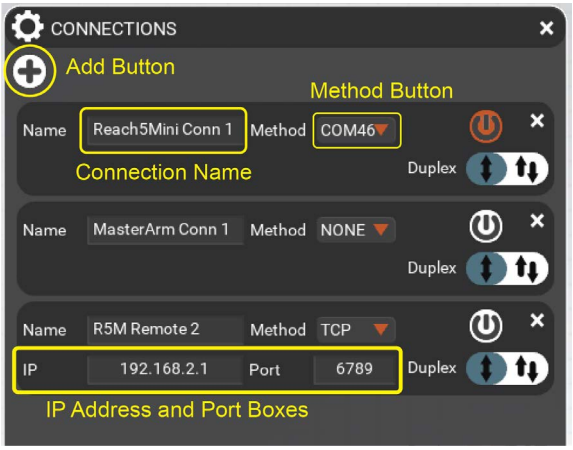
This step connects the control PC or Laptop to the manipulator. To access the CONNECTIONS setup tool, see Figure 12.

Figure 12. Connection Setup



1. Reach Control creates a single connection by default if no other connections were already setup.
2. Connections can be added by clicking on the "Add" button in the top left of the CONNECTIONS panel. See Figure 13.
3. Set a connection name by typing into the "Name" textbox.
4. Set a connection method by clicking on the orange arrow on the "Method" Button. This will bring up a list of the serial COM ports and the option to set UDP or TCP (IPv4) connections. Click on the COM port name or the UDP/TCP options to set those connection methods.
5. TIP: One way to quickly determine the COM port number for a device is to compare the list of COM ports with the serial connection plugged in and unplugged. The relevant COM port will be the one that appears/disappears.

Figure 13. CONNECTIONS options

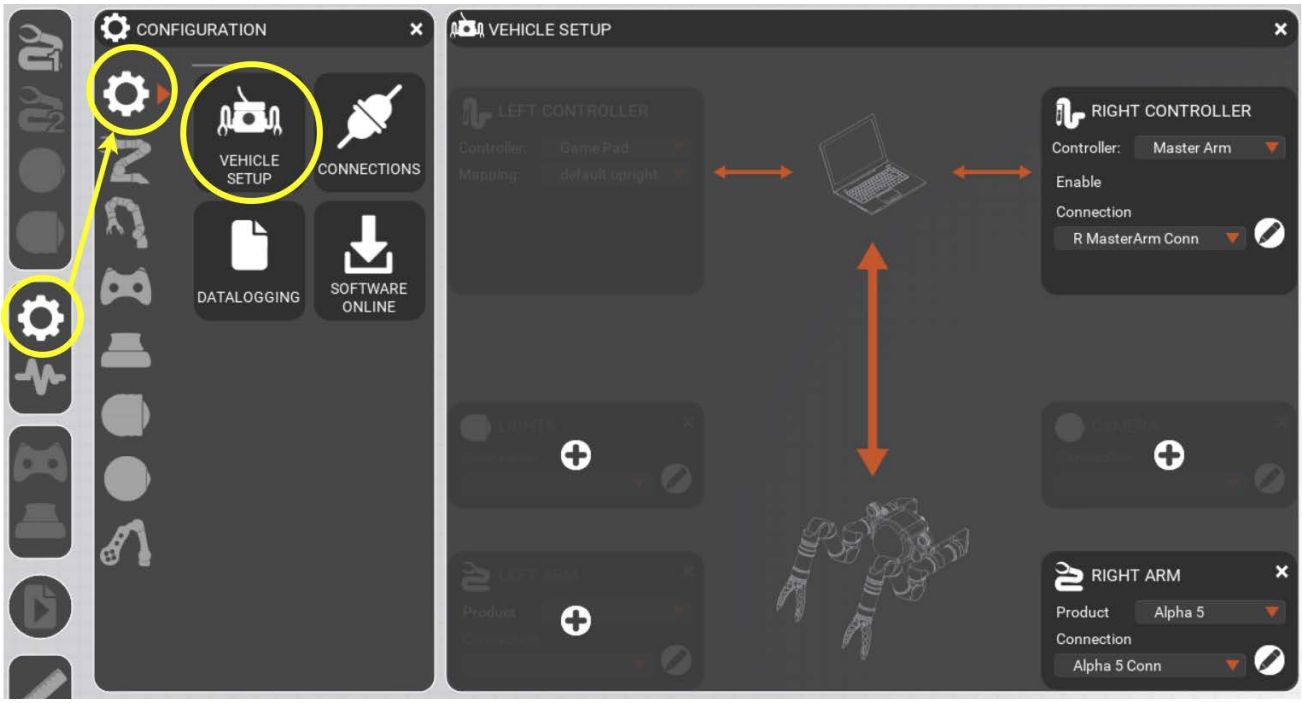


6. If a UDP or TCP connection is required, the IP Address and Port boxes will appear where you can type in the IPv4 IP Address and Port numbers.
   NOTE: *Reach Control can only act as a UDP or TCP client, not as a host.*
7. If you are connecting via the RS232 bus on the manipulator, set the connection to full duplex by clicking on the 2 reversed direction parallel arrows in the "Duplex" selector. If you are connecting via the RS485 bus on the manipulator, set the connection to half duplex by clicking on the double-ended arrow in the "Duplex" selector. The connection will assume it is half-duplex by default.
8. To the right of each Method button is the power icon. If the power icon is orange, then the connection is active and connected. You can toggle the connection on and off by clicking the power icon.
9. Close the CONNECTIONS panel after configuration.

Step 7 - Vehicle Setup

This step configures the vehicle system (or bench setup) according to the manipulators, controllers, and any other devices in use. To access the VEHICLE SETUP tool, see Figure 14.

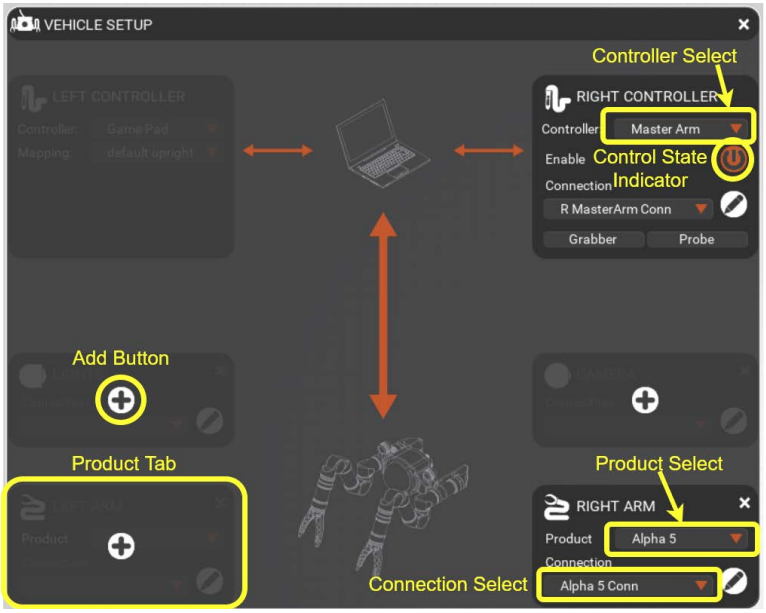
Figure 14. VEHICLE SETUP access and tool



1. The VEHICLE SETUP panel will show a list of products and controllers that are bound to the product. The RIGHT ARM tab will be shown as default, along with its RIGHT CONTROLLER tab.
2. Click on the "Add" button for each product you need. See Figure 15.

   For example: : If you have one Alpha 5 and one Master Arm, click on the "Add" button on the bottom right product tab (RIGHT ARM). If not already set, select the product type you have (Alpha 5) via the Product Select dropdown list. On the top right, select the Controller Select dropdown and click 'Master Arm'.

Figure 15. VEHICLE SETUP options

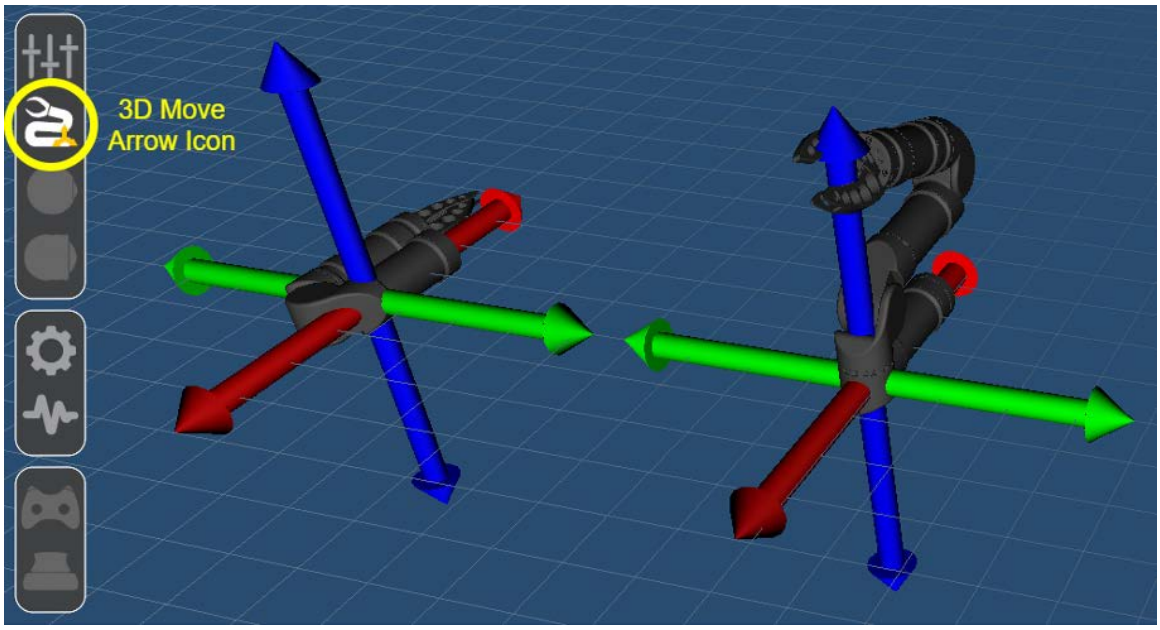


3. Set the product type you have, such as Alpha 5 or Alpha Dual Bend, by selecting it via the "Product Select" dropdown.
4. Set your chosen products to their respective connections by via selecting it via the "Connection Select" dropdown.
5. Select the controller method you wish to use via the "Controller Select" dropdown list. The "RIGHT CONTROLLER" will be used to control the "RIGHT ARM", and the "LEFT CONTROLLER" will be used to control the "LEFT ARM".
6. If you are using a Master Arm in the "LEFT CONTROLLER" or "RIGHT CONTROLLER" slots: The 'Control State Indicator' will appear if the master arm has been successfully connected. If the master arm is in control, then the indicator will be orange. On-screen controls can be used if the master arm is paused. The indicator will turn white if on-screen controls are being used, turning orange again if the master arm is resumed.
7. If you are using a 7 function Master Arm and you are controlling an Alpha 5 in either the grabber or probe configurations, you can configure the Master Arm's control axis by clicking on the 'Probe' and 'Grabber' buttons.

Step 8 - 3D Manipulator Model Positioning

If you added more than manipulator, you may wish to move the 3D models representing the manipulators in the background. To bring up the 3d model move arrows, click on the "3D Move Arrow" icon in Figure 16. Holding down and dragging the arrows will move the model along the axis of the arrow. Clicking the "3D Move Arrow" icon again will remove the 3d model move.

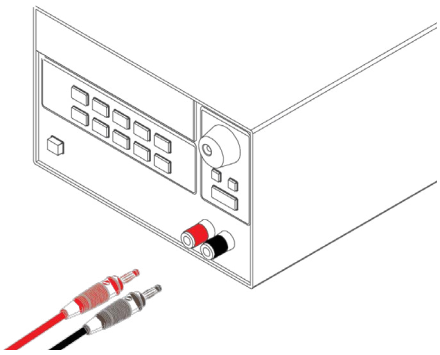
Figure 16. 3D Manipulator Model Positioning



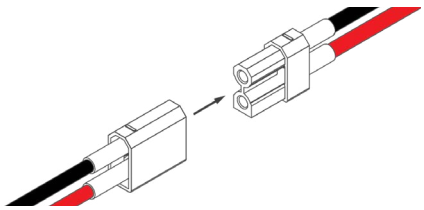
Step 9 - Power Supply

Connect power to the Break-out-board via the supplied power adaptor.

In the case of a bench top power supply, connect the ground lead from the Alpha 5 to the GND of the power supply. If you have made your own cable, ensure the Ground (GND) on the serial connector is connected to the ground on the power supply. Connect the positive (PWR+) of the Alpha 5 to the positive terminal of the power supply and turn on the power supply.



If you are using a wall adapter connect the XT30 Connector as shown and then plug the adapter into the wall.

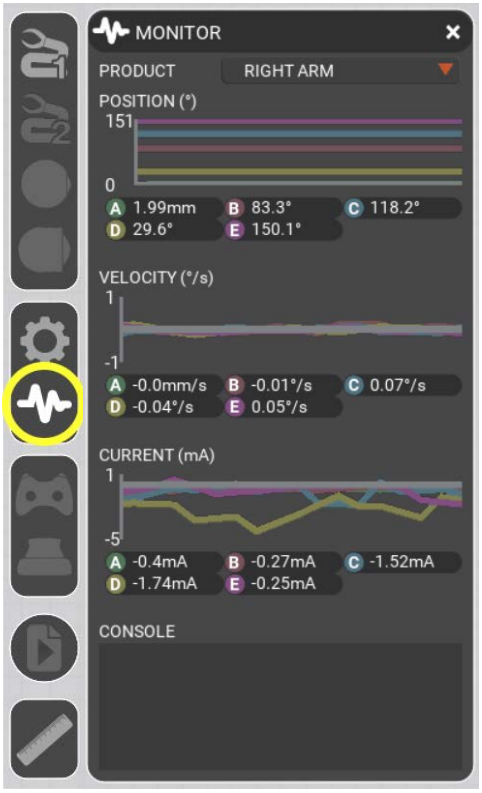


Step 10 - Power On and Condition Check

Turn the power supply on.

Five seconds after powering the manipulator the MONITOR panel will begin to show data readings for all joints on the manipulator. To access the MONITOR panel, see Figure 13.

Figure 17. Monitor Panel



If there is no update to the graphs in the MONITOR panel, ensure the manipulator is connected and communicating with Reach Control

Step 11 - Control Check

The final step in the bench test is to ensure that all joints are active, receiving commands, and responding in the expected manner. Using a control method of your choice as detailed in Section 4 (we recommend the software control panel), actuate each joint of the manipulator and ensure that the joint responds and moves correctly.

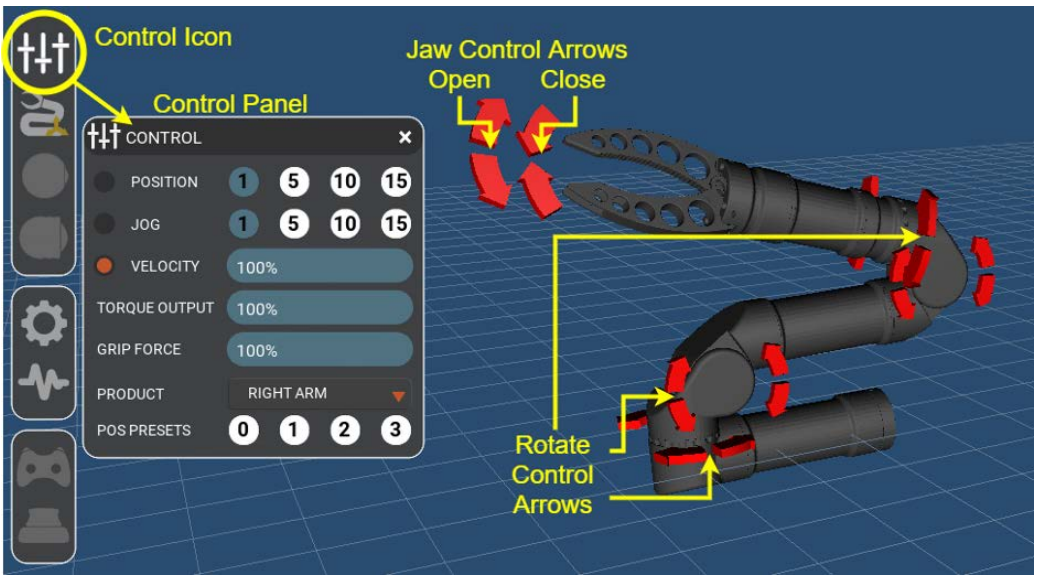
This is the end of the bench test. You are now ready to further integrate and test the manipulator for your specific application.

5 Control

5.1 Control Panel

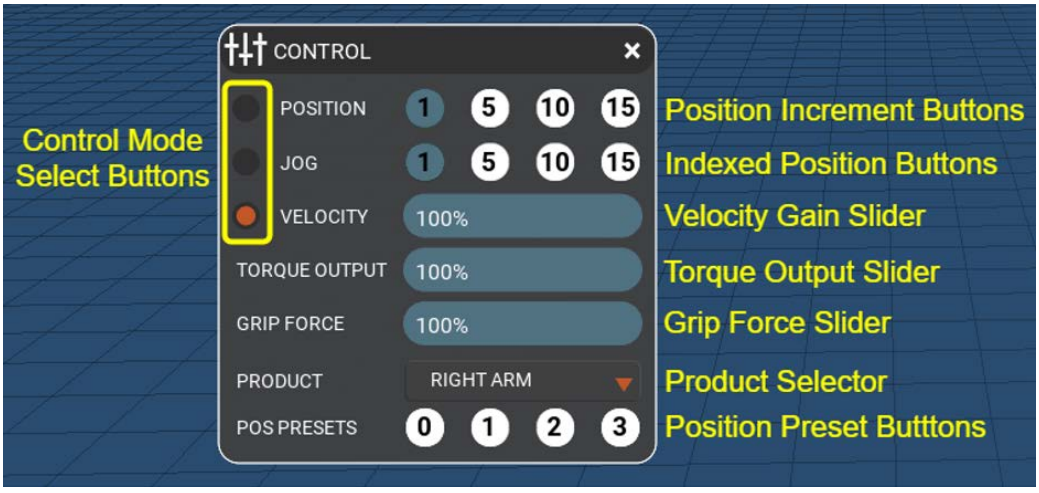
The joints of the manipulator can be manually controlled using the CONTROL panel. A graphic display indicates the settings used to control joints, and sliders are available for changing the primary parameters. To access the CONTROL panel, see Figure 18.

Figure 18. Control Panel access



Dependant on the selected manipulator, different control arrows will appear around the 3D model of the manipulator. On opening of the CONTROL panel, arrows will appear around each joint, where clicking and/or holding on them will perform the selected action (see Figure 19). For rotate joints, clicking on the arrows will rotate the joint in the direction of the arrow. Similarly, clicking on the jaw arrows will either open or close the jaws.

Figure 19. Control Panel features



The selected action is determined by the active control mode, which is selected by the "Control Mode Select" buttons (see Figure 19). The active control mode is determined by the orange "Control Mode Select" button. The selectable control modes are:

1. Position Increment (POSITION): Click and releasing on the control arrows will increment the current position of the joint by the determined "Position Increment" button number, in degrees.
2. Indexed Position Increment (JOG): Click and releasing on the control arrows will increment the indexed position of the joint by the determined "Indexed Position" button number, in degrees. This will only work if the manipulator is a kinematics device.
3. Velocity control (VELOCITY): Click and holding the control arrows will control the joint velocity, with a value dependant on the value of the "Velocity Gain" slider (0-100%). Releasing the control arrows will stop all movement of the manipulator.

The settings in the CONTROL panel (see Figure 19) are described below:

1. Position Increment Buttons: Pressing the control arrows while in "POSITION" mode will increment the position by the value of the selected "Position Increment" button (in degrees).
2. Indexed Position Buttons: Pressing the control arrows while in "JOG" mode will increment the indexed position value by the value of the selected "Indexed Position" button (in degrees). This will only work if the manipulator is a kinematics device.
3. Velocity Gain Slider: Sets the speed of the joint when the control arrows are pressed.
4. Torque Output Slider: Set the percentage torque output of all the joints besides the jaw open and close and inline rotate of all manipulators. It is recommended this remains at 50% when bench testing.
5. Grip Force Slider: Sets the amount of force applied by the jaws.
6. Product Selector: Dropdown box to select which product is the target of the Control Panel.
7. Position Preset Buttons: Click and holding the buttons will command the manipulator selected by the "Product Selector" to move to the position preset with index given by the button's number. Releasing the button will stop the manipulator moving. These can be set in the Installation panel.

5.2 Human Machine Interface (HMI)

Reach Control can take controller demands from a 3D Mouse or Gamepad. (For Master Arm users, please see Section 4.4)

When connecting either a 3D Mouse (Figure 20) or a Gamepad (Figure 21), the appropriate window will appear and display feedback and control options. Moving the HMI in their respective axes will simulate the movement on the manipulator simulation as well as highlight the controller input.

Figure 20. 3D Mouse Panel

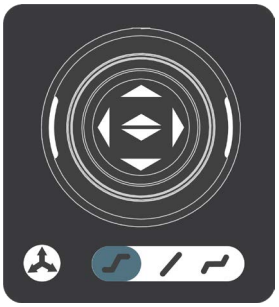


Figure 21. Gamepad Input

Depending on the task being performed, the HMI panels offer the ability to quickly change the responsiveness of the controller using the exponential settings.

- Slider to the left provides a small output demands for most of the controller input. Useful for fine-tuned, slower control.

- The Slider in the centre is a linear mapping where 50% input will provide a 50% output. This is standard mode.

- Slider to the right provides a large output demand for a small controller demand. Useful for fast, responsive movements.

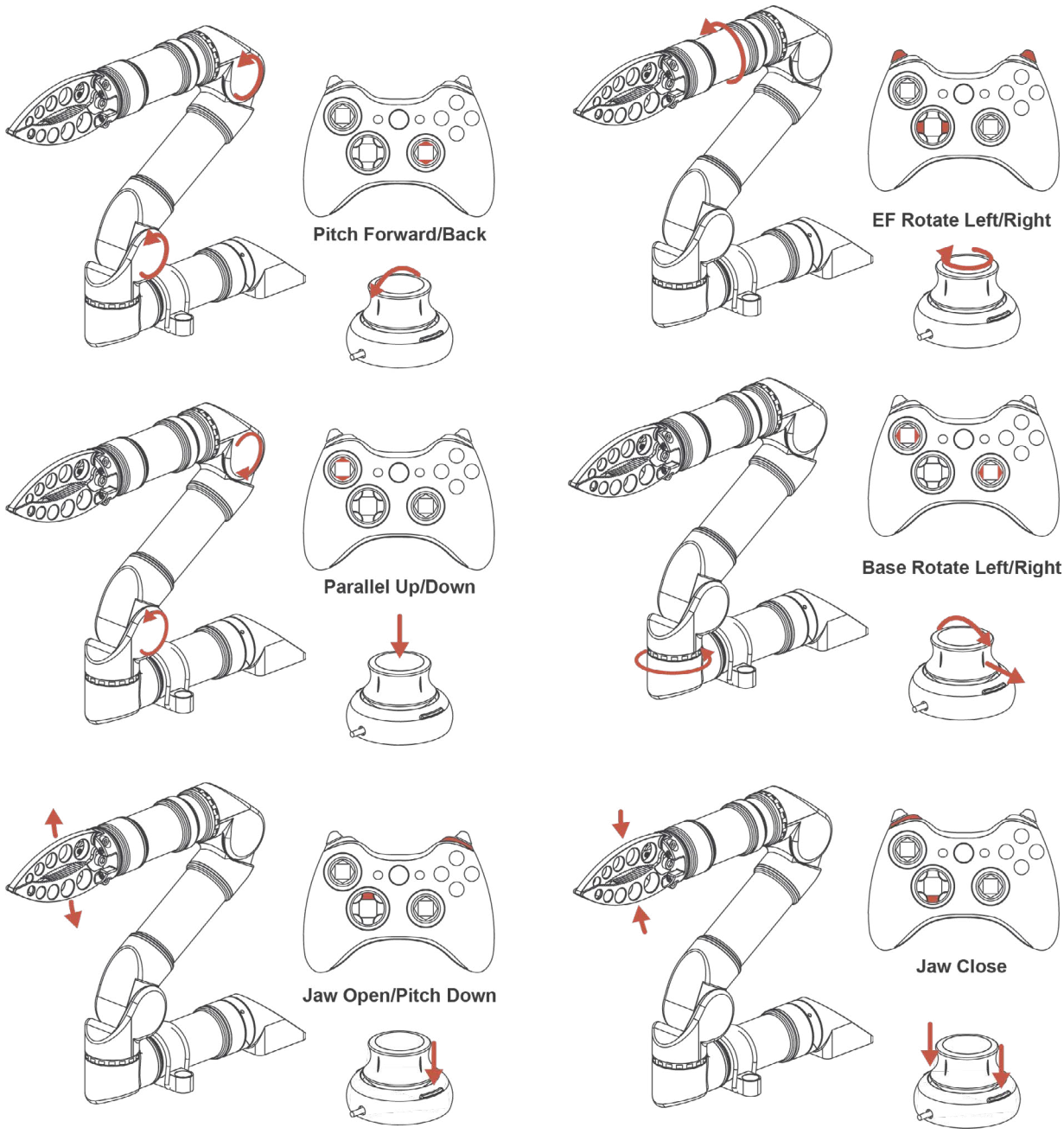
5.2.1 Manual Mode

In manual mode the joints are controlled independently, and commands do not make use of the kinematics engine. By default, the controls of the 3D Mouse and Gamepad are pre-mapped to specific functions. These can be changed in the settings panel. The mounting orientation selected during the installation setup will dictate the direction of rotation (see Section 5).

- When the Kinematics Icon (Reach Control Pro feature) is white the controller is being used in Manual Mode.

5.2.2 Controller Mapping in Manual Mode

Figure 22. Controller Mapping in Manual Mode

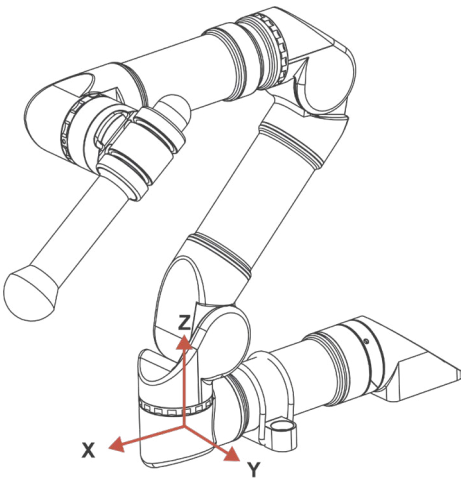


5.2.3 Kinematics Mode (Global Coordinates) (Pro Only)

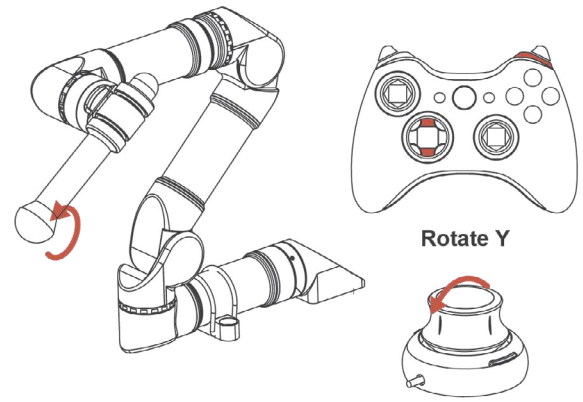
In Kinematics mode the movements are performed in the world frame in accordance with the orientation of the base given in Figure 23. This mode is useful when trying to track a straight line with respect to the base where manually combining joint movements may prove difficult.

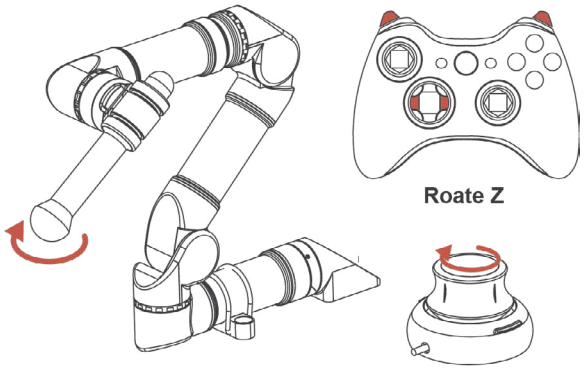
- When the Kinematics Icon is orange the controller is being used in Kinematics Mode

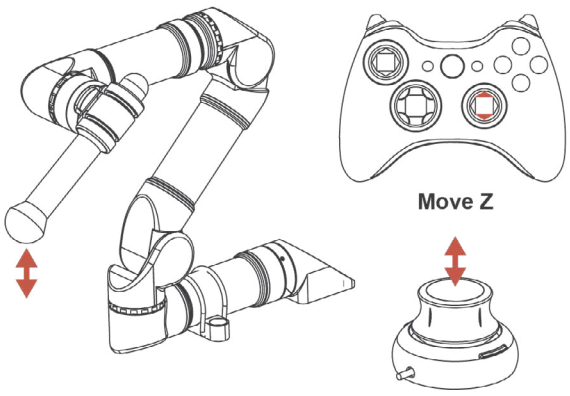
Figure 23. Kinematics Coordinate Reference Frame (Global Mode)

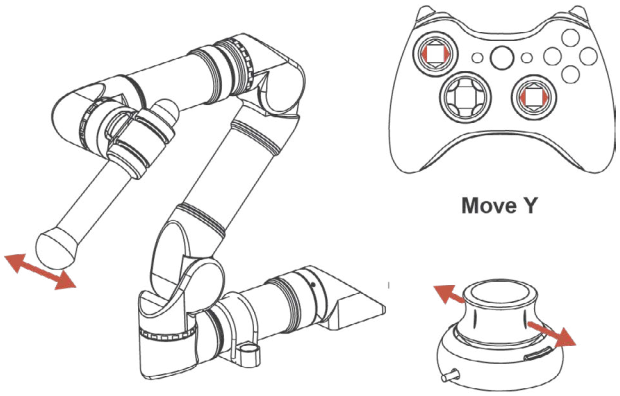


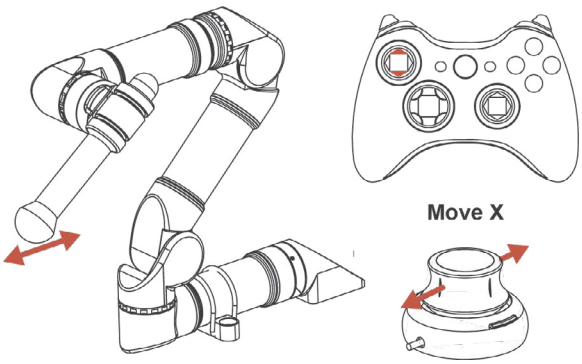
5.2.4 Controller Mapping in Kinematics (Global) Mode (Pro Only)







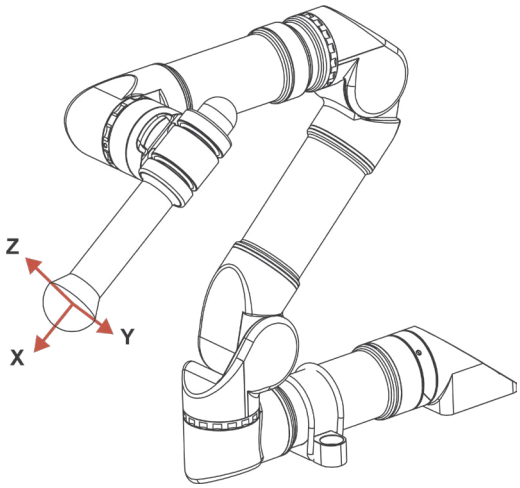




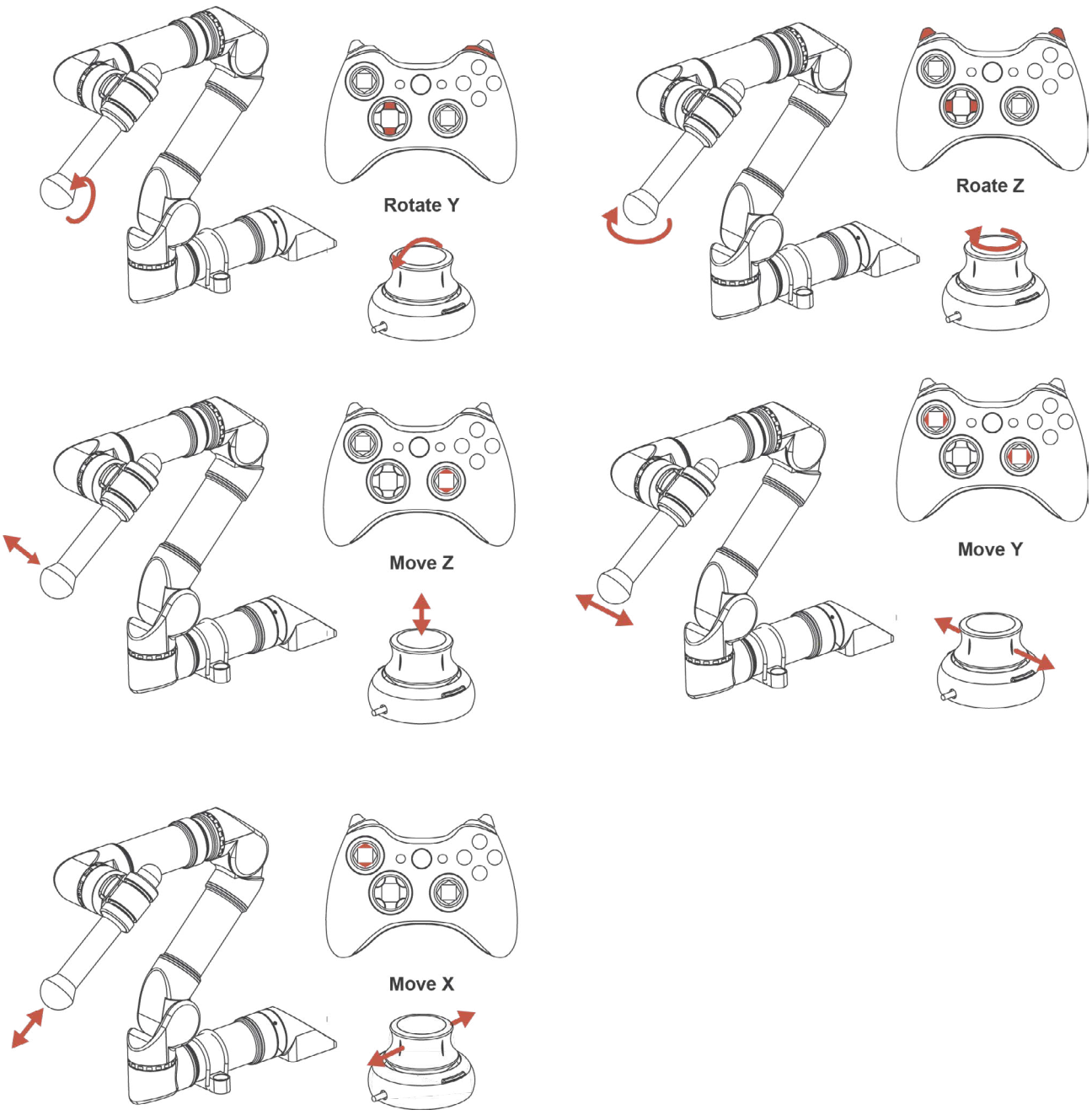
5.2.5 Kinematics Mode (End Effector Coordinates) (Pro Only)

When used in End Effector Coordinate mode, the manipulator moves in the frame of the end-effector (Figure 24). This is useful when following lines that are not at right angles with the base. Set the end-effector (probe) orthogonal to the object you are trying to follow and then control in end-effector kinematics mode.

Figure 24. Kinematics Coordinate Reference Frame (End-Effector Mode)



5.2.6 Controller Mapping in Kinematics (End-Effector) Mode (Pro Only)



5.3 HMI Advanced Setup

Reach Control provides a way of setting custom mappings for the Gamepad and 3D Mouse.

5.3.1 Gamepad Advanced Setup

The user can set custom mappings for Gamepads (e.g. Xbox Controller). There are multiple axes that can be edited, allowing for multiple commands. To access the Gamepad customisation menu, see Figure 25.

Figure 25. HMI Gamepad Advanced Setup

- **Map Select:** Dropdown box that allows you to choose from a list of Gamepad mappings, including your own custom saved settings. The mapping chosen gets set and can be used immediately.
- **Delete:** Deletes the currently set mapping from the saved list.
- **Save as:** Saves the current mapping given the name in the Map Name box. This is required to use the custom mapping for future operations of Reach Control.
- **Map Name:** Editable text box allowing you to write your own name for your custom mapping.

To create a custom axis mapping, edit the information in each axis list. The buttons are described below.

- **Mode:** Set the mode for the mapping: E.g. Velocity or position for an axis, or kinematics control.
- **Product:** Dropdown menu to select the product you want to associate the control axis with.
- **ID:** The joint axis to associate with a manual control axis, or the kinematics direction if the mode was set to kinematics.
- **Alt:** Toggles a dropdown list of custom options to edit, such as sensitivity.
- **DBL:** Sets the axis control direction for the button. The button on the left sets the direction of control.
- **DBR:** Alternative for setting the axis control direction for the associated button. The button on the left sets the direction of control. For example, if you want to have a button control a joint in the positive direction and another button for controlling in the negative direction.

5.3.2 3D Mouse Advanced Setup

The user can set a custom mapping for the 3DConnexion Spacemouse There are multiple axes that can be edited, allowing for multiple commands. To access the Spacemouse customisation menu, see Figure 26.

Figure 26. HMI 3D Mouse Advanced Setup

- **Mapping buttons 'Default' and 'Custom':** Sets whether you are using the default mapping or your custom mapping. ***NOTE:*** *You cannot have more than one custom mapping.*
- **Product:** Dropdown menu to select the product you want to associate with the 3D Mouse. Only one product can use the 3D Mouse at a time.

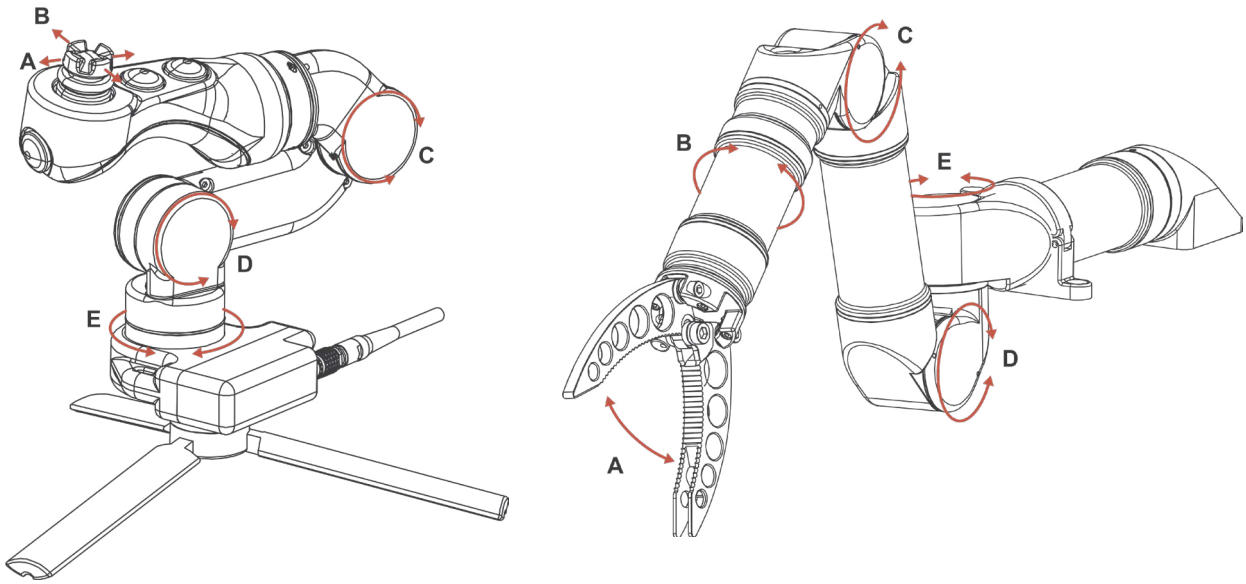
To create a custom axis mapping, edit the information in the mapping section. The buttons are described below.

- **Mode:** Set the mode for the mapping: E.g. velocity or position for an axis, or kinematics control.
- **ID:** The joint axis to associate with a manual control axis, or the kinematics direction if the mode was set to kinematics.
- **Alt:** Toggles a dropdown list of custom options to edit, such as sensitivity.
- **DBL:** Sets the axis control direction for the button. The button on the left sets the direction of control
- **DBR:** Alternative for setting the axis control direction for the associated button. The button on the left sets the direction of control. For example, if you want to have a button control a joint in the positive direction and another button for controlling in the negative direction.

5.4 Master Arm Control

Information regarding control of Alpha 5 manipulators with the Master Arm control can be found in the Master Arm Operator's Manual available from Blueprint Lab (info@blueprintlab.com).

Figure 27. Master Arm Control Mapping for the Alpha 5



6 Platform Installation

The manipulator is designed to be integrated onto different vehicle platforms. The following steps will ensure a safe and reliable installation on most unmanned vehicles. For information regarding the installation on common ROV platforms specific instructions may be available. Please contact Blueprint Lab regarding your vehicle integration requirements for more information.

6.1 Hardware Mounting Setup

Step 1

Select whether the manipulator is to be mounted upright or inverted. The mounting kit can rotate through 360 degrees to allow for attachment to surfaces at different orientations.

Figure 28. Inverted

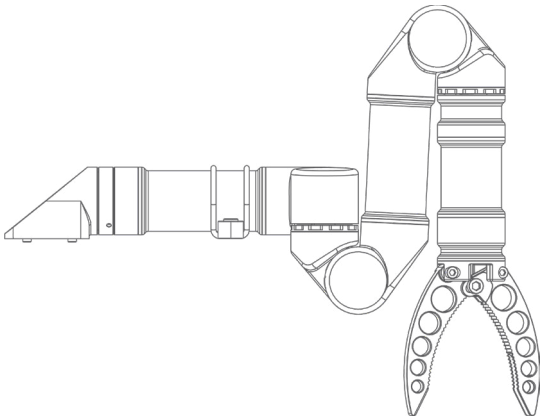
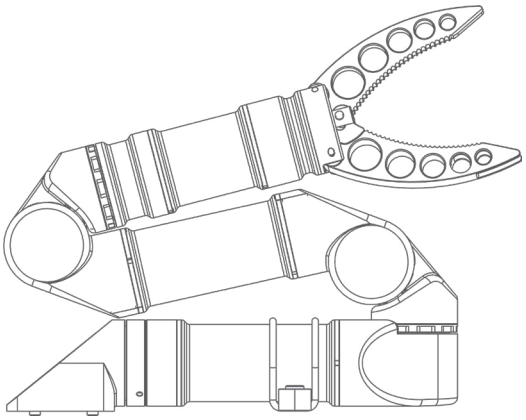


Figure 29. Upright



Step 2

Using the mounting kit hole dimensions (see mounting kit diagram on Page 7), secure the rear mounting bracket and the forward mounting bracket to the host platform surface. The rear mounting bracket can either be secured with 2 x M5 bolts from the top or with 4 x M4 bolts into the tapped holes on the bottom.

Figure 30. M5 from Top

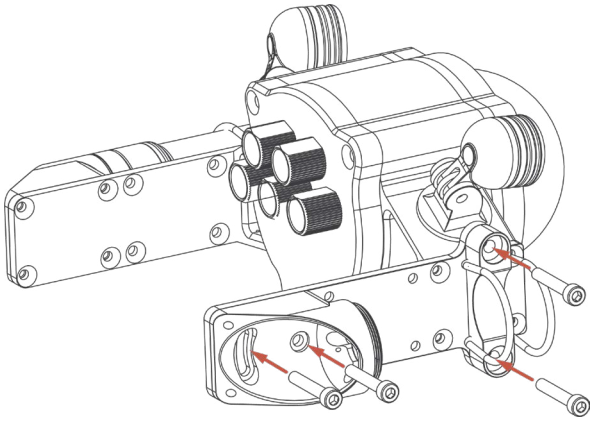
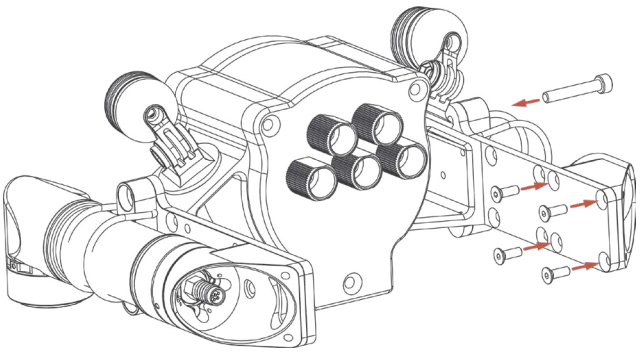


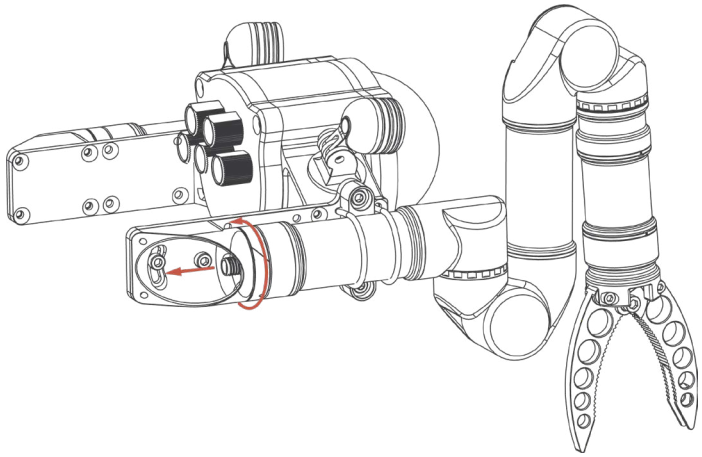
Figure 31. M4 from bottom



Step 3

Attach the manipulator by feeding the base through the O-ring and securing it with locking nut at the desired orientation.

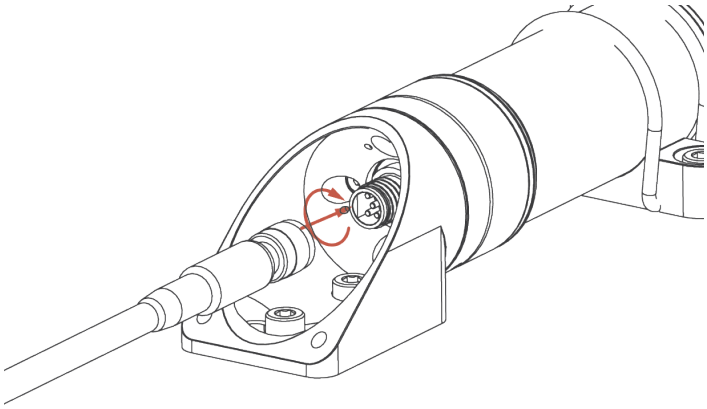
Figure 32. Insert through O-ring and Tighten Locking Nut



Step 4

Connect the manipulator cable by inserting the female Impulse connector and rotating the locking nut. Connect the manipulator to the host PC running Reach Control using the same steps given in Section 3, per your specific communication and power setup.

Figure 33. Insert Connector and Rotate Nut

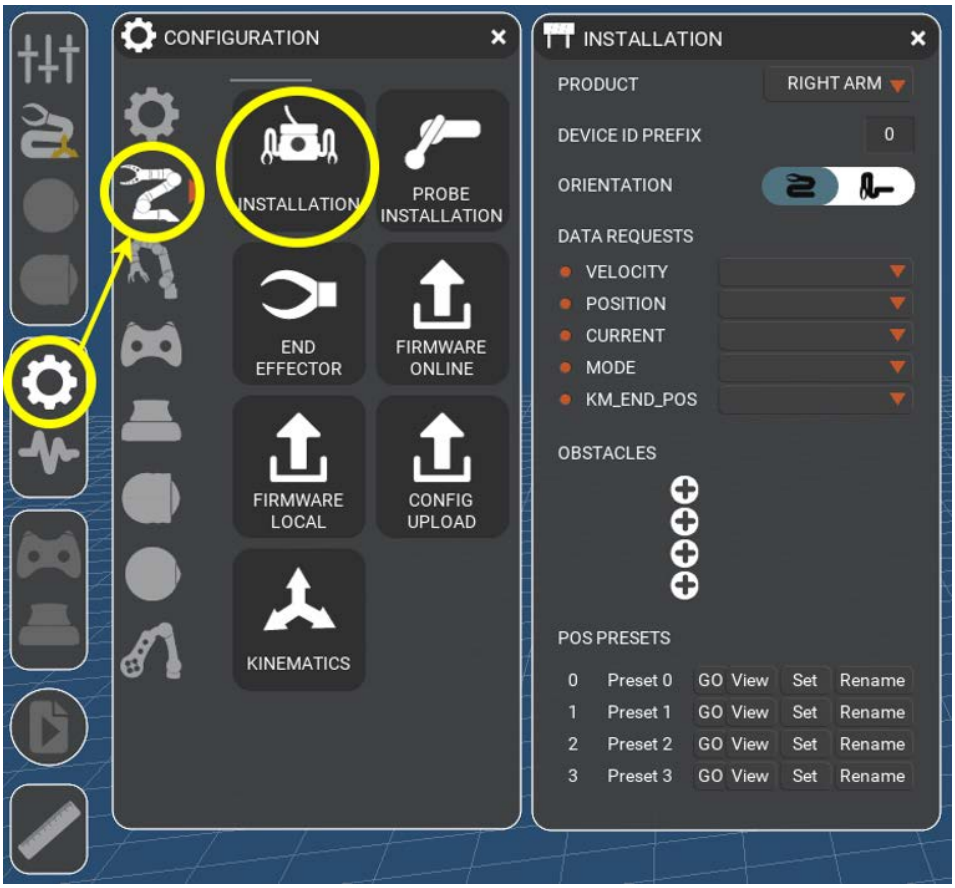


6.2 Software Setup for Hardware Constraints and Requirements via Reach Control

Step 1

To access the INSTALLATION tool, see Figure 34.

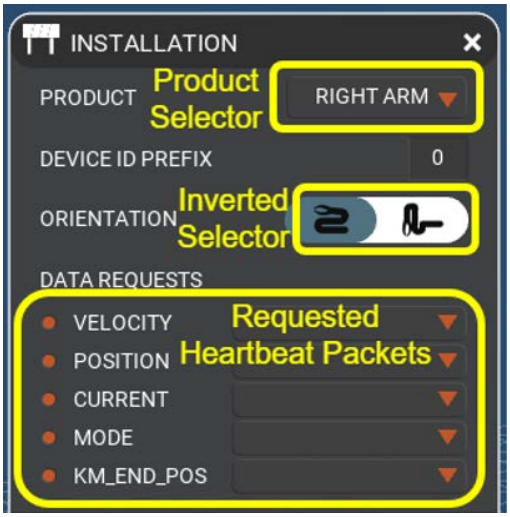
Figure 34. Installation panel and access



Step 2

Select the product to configure via the "Product Selector" dropdown. See Figure 35.

Figure 35: Product selection, device prefix, product inversion, and heartbeat requests editor



Step 3

If you require more than one manipulator on the same RS232 or RS485 communications bus, then follow the steps below.

1. Ensure you know which manipulators are required and which are designated the first and second.
2. Connect both manipulators to Reach Control.
3. Set up both manipulators using the VEHICLE SETUP. Set up the second manipulator in the LEFT ARM slot.
4. Select the second manipulator via the "Product Selector" dropdown in the INSTALLATION panel. This should be set to the LEFT ARM.
5. In the "PRODUCT DEVICES PREFIX" textbox, type in the manipulator's device index. For example, the first manipulator (RIGHT ARM) should be set to '0', and the second (LEFT ARM) on the same communication bus it should set to '1'.
6. Both manipulators should now operate independently.

Step 4

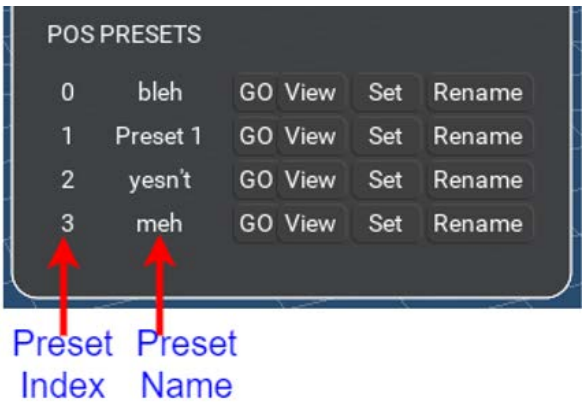
If you require a different set of requested heartbeat packets as recommended by Blueprint Lab, you can select them in the "Requested Heartbeat Packets" area (see Figure 35).
NOTE: *These should in normal operation not be modified.*

1. To toggle the default requested heartbeat packets (VELOCITY, POSITION, CURRENT, MODE, KM_END_POS), click on the radio buttons on the left. If the radio button is orange, then the packet will be requested on the heartbeat.
   NOTE*: During normal operations these should remain on to use Reach Control fully.*
2. If you require additional heartbeat packets, you can request them by clicking on the dropdown boxes and selecting the packet. If you click the blank option, no packet will be selected.

Step 5

You can control which position pre-sets are stored on the manipulator and their names via the INSTALLATION panel. Each manipulator can store up to four position pre-sets. The 'Pos Presets' section at the bottom left of the INSTALLATION panel allows you to set these settings (see Figure 36).

Figure 36. Position Preset Options



To set the preset's position:

1. Move the arm to the desired position.
2. Click on the "Set" button for the position preset required, then click 'Set' on the popup box that will appear.Click on the "Set" button, then click 'Set' on the popup box that will appear.

To set the preset's name:

1. Click on the "Rename" button for the position preset required.
2. Type in the name your wish to set in the popup box that will appear.
   NOTE: *the name can only be up to 8 characters, including spaces.*
3. Click 'Rename'.
4. If successful, the "Preset Name" related to the preset number will change to reflect the new name.

You can view the position preset's by:

1. Click on the View button for the position preset required.
2. The current position preset will be shown on the 3D visualisation for a few seconds.

You can command the arm to go to its position preset via pressing and holding down on the GO button next the relevant position preset. Releasing the GO button will stop the arm moving.

Step 6

Within the INSTALLATION settings window select the appropriate mounting orientation according to your setup. This will affect both control input and workspace restrictions.

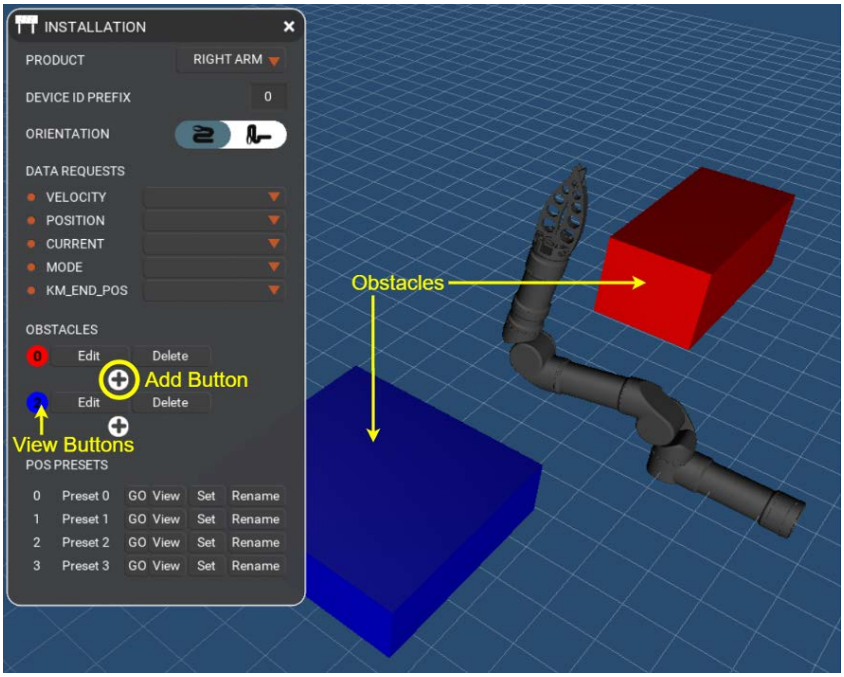
- In this configuration the Alpha 5 is mounted upright with its base joint pointing upwards

- In this configuration, with the slider to the right, the Alpha 5 is mounted inverted with the base joint pointing downwards. Note that this is independent of the installation of the mounting kit.

Step 7

Workspace restrictions provide a means of dictating 'keep out' areas for the manipulator. For a given installation there could be any number of obstacles limiting the available movement. By adding obstacles to the workspace restrictions, the manipulator will ensure that it does not enter those areas preventing damage to itself and the vehicle. Use the 3D Visualisation Tool to set workplace restrictions. To edit these obstacles, see Figure 37.

Figure 37. Installation obstacles setup

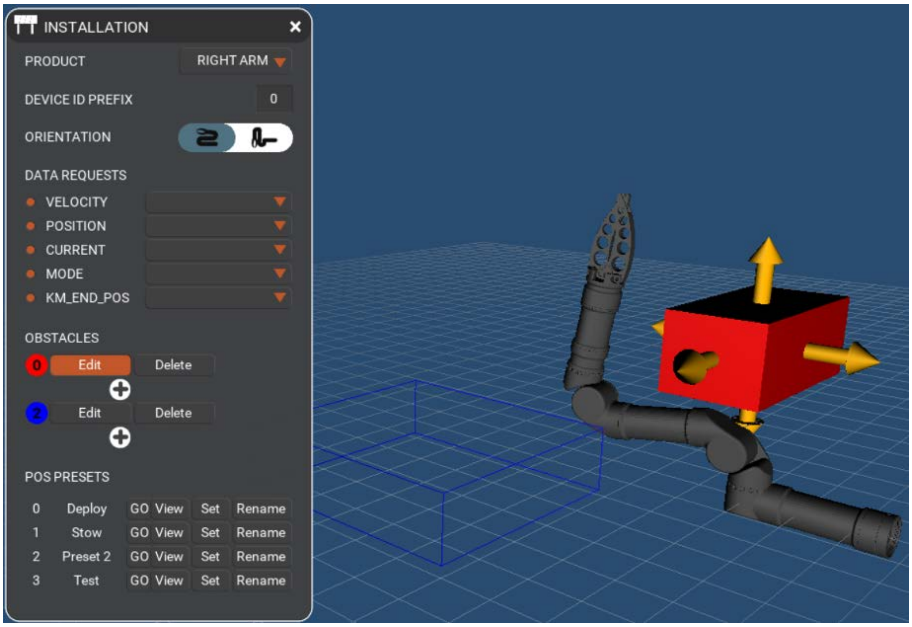


You can set workspace restrictions via the 'Obstacles' section.

To add an obstacle to the workspace restrictions:

1. Ensure the Alpha 5 is connected and communicating with Reach Control.
2. Ensure the installation tab has the Alpha 5 selected.
3. Click on one of the "Add" buttons (see Figure 38). Adding in list order is not required.
4. If successfully added, the obstacle will show in the 3D visualisation, with the colour of the obstacle matching the "View" button colour.

Figure 38. Editing of obstacles in the Installation panel



To edit the boundaries of the obstacle:

1. Ensure the obstacle has been added.
2. Press the "Edit" button for the obstacle requiring modification (colour coded).
3. If edit mode select has been successful, arrows will be drawn around the obstacle and the edit button will become orange (see Figure 38).
4. Click and drag the arrows along their axis to set the obstacles for the workspace restriction.
5. Releasing the mouse will set the current obstacles position and size and attempt to save it on the arm.
6. If unsuccessful in setting the obstacle, such as when the arm is disconnected, the obstacles will revert to their original states.
7. Clicking on the highlighted "Edit" button will reset the view of the visualisation.
8. Pressing the "Delete" button will remove the obstacle.

You can toggle wireframe mode for the obstacle in which the obstacle becomes nearly invisible, by clicking on the View Button representing the obstacle (colour-coded). If the View Button is white, then it will show the obstacle in wireframe mode.

Step 8

To access the END EFFECTOR panel, see Figure 39.

1. Select which manipulator you wish to calibrate, via the dropdown box above the 'AUTO LIMIT' button.
2. Calibrate the product by clicking the 'AUTO LIMIT' button.

This will actuate the push rod to self-determine its limits based on the attached tool.

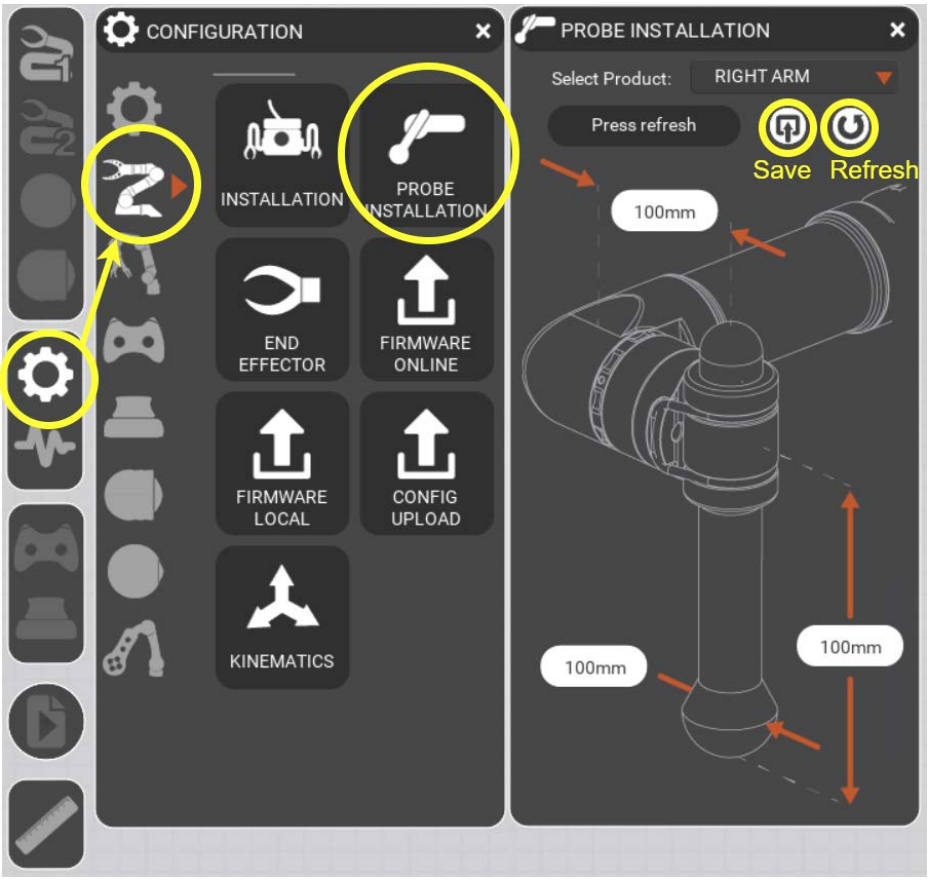
Figure 39. END EFFECTOR panel

Step 9

If you have the probe holder version of the manipulator, then you must set your probe parameters. To access the PROBE INSTALLATION panel, see Figure 40.

1. Ensure the manipulator is connected and communicating with Reach Control,
2. Press the "Refresh" button to get the current probe parameters.
3. Replace the measurements in the white boxes per your particular probe measurements.
   NOTE: *The entered measurement must be in millimetres.*
4. Press the "Save" button when done.
5. If successful, the message box will state "Saved" for a short period of time before going blank.

Figure 40. PROBE INSTALLATION panel

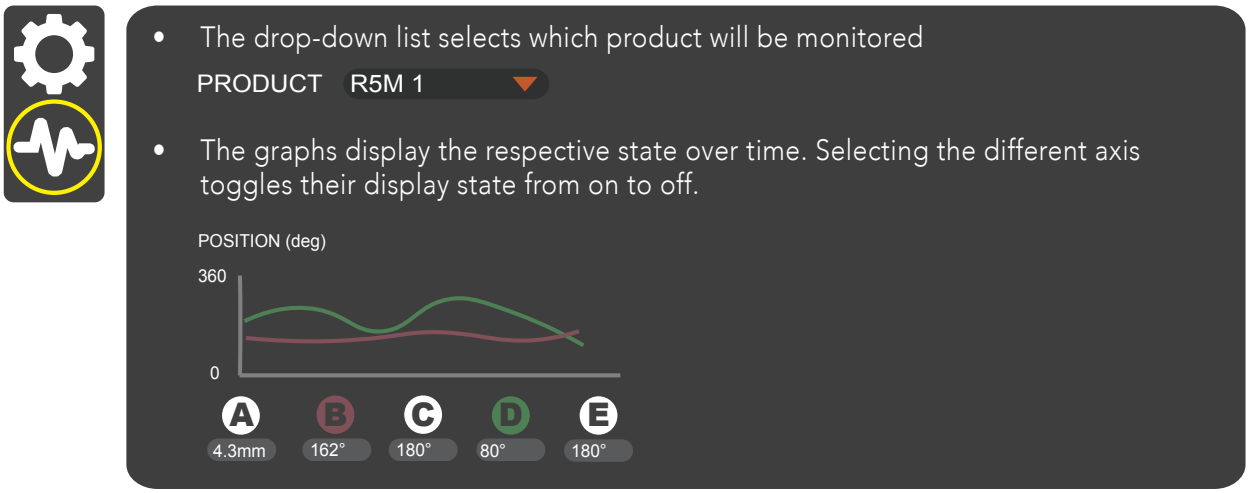


7 Additional Reach Control Widgets

7.1 Monitor Panel

The MONITOR PANEL is useful for diagnostics and to observe the state of each joint during operation. The MONITOR PANEL is accessed via the heartbeat icon and allows for the position, velocity and current of each joint to be displayed on a graph. To access the MONITOR panel, see Figure 41.

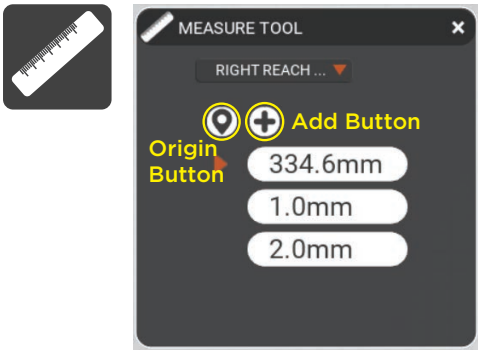
Figure 41. MONITOR PANEL icon on the main screen (Left) and MONITOR PANEL functionality (Right)



7.2 Measure Tool (full version only)

The MEASURE TOOL provides a means of measuring the distance between one end-effector position and another. The distance is the straight-line distance and is useful for determining the size of an object or measuring defects when conducting an inspection task. . To access the MEASURE TOOL, see Figure 42.

Figure 42. MEASURE TOOL icon on the main screen (Left) and Measure Tool (Right)



The distance measurement is updated in real time and displayed in the topmost readout indicated by the orange pointer.

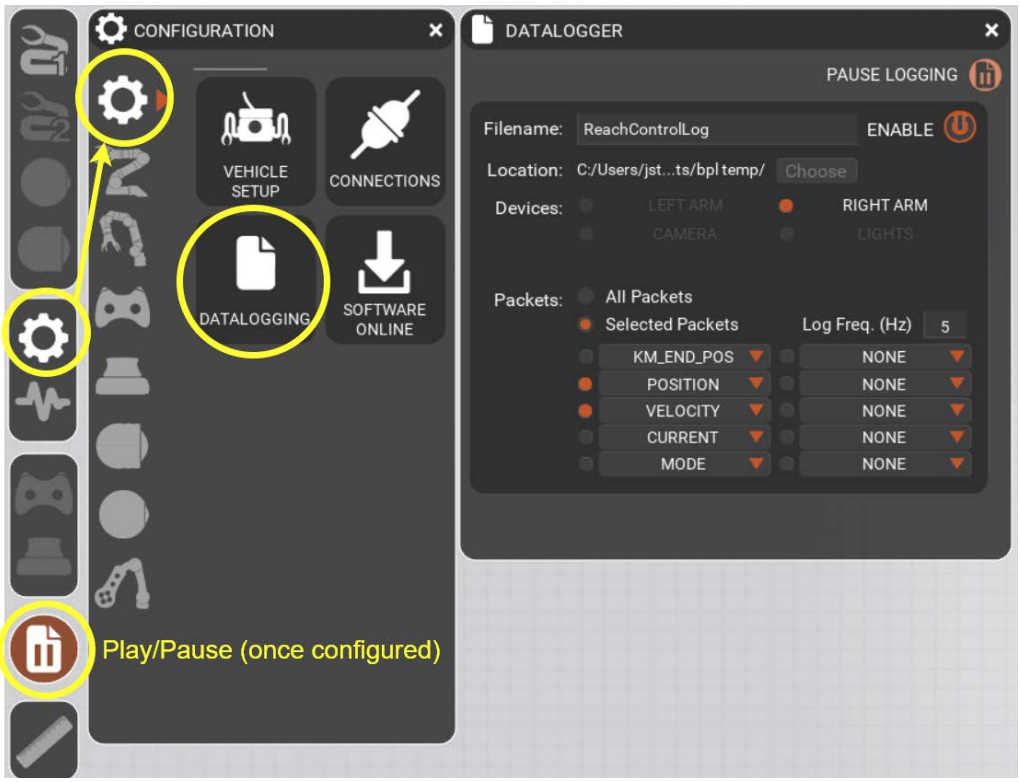
- The pin icon sets the origin to the current end effector location and zeros the measurement readout.

- The plus icon saves the measurement and adds it to the list. It also resets the origin to start a new measurement from the current position.

7.3 Data Logger (full version only)

The data logger tool provides a means to log data from your manipulator. This is recorded in the comma-separated value (.csv) format, which is compatible with most spreadsheet document editors (e.g. Microsoft Excel, LibreOffice). The data logger remembers the latest settings and are loaded on start of Reach Control. To access the DATALOGGER panel, see Figure 43.

Figure 43. Data Logger Panel



7.3.1 First Time Setup or Editing of Data Logger Settings

The first time you require datalogging or you need to edit its settings, refer to this section.

Step 1

Select a file name you wish to log data as (saved in the comma-separated value '.csv' format) by typing the preferred name in the "Filename" textbox. The output file name will be written in the format: '<chosen_file_name>_<YYYYMMDD>_<HHMMSS>.csv'. For example, if the chosen name is 'ReachControlLog', the date is 13/01/2020, and the time of clicking the ENABLE button is 12:22:26 pm, then the saved file will be named 'ReachControlLog_20200113_122226.csv'.

NOTE: *The ENABLE button must be off (white), otherwise you will not be able to edit the name.*

Step 2

Select the folder that you need to record the log files to. The current save folder will be shown by the "Location" text. To select a folder, click on the "Choose" button and follow the prompts.

NOTE: *The "ENABLE" button must be off (white), otherwise you will not be able to edit the folder location.*

Step 3

Select the products that you wish the log file to record from. This is done via the 'Devices:' section. Clicking the radio button will toggle recording of the specific product. If the radio button is orange, then it will be recording data from the product when the logger is started. If the product is greyed-out and unable to be selected, then you must enable the product (see Section 3).

Step 4

Select which method that the datalogger uses for recording. Choose either the "All Packets" or "Selected Packets" method. The method with the orange radio button is be the selected method:

- 'All Packets': This mode records all incoming packets from the selected products.
- 'Selected Packets': This mode will record the selected packets and the frequency in the "Log Freq. (Hz)" textbox. This frequency can be edited by the user by typing in the box, with a range from 0-5Hz (if you choose a value outside this range, it will default back to 5).

Step 5

If you chose the 'Selected Packets' mode, then you must select which packets you need to record. To select the packets, click on the orange arrows on each of the boxes below the 'Selected Packets' text, and select the packet from the generated list. 'NONE' represent no packet. However, the packet will not be set to record unless the small button to the left of the packet selection box is orange (representing 'on'). This can be toggled on and off by clicking on the small button.

Step 6

To enable the data logger (not record, but prepare to record), click on the "ENABLE" button. The data logger is enabled when the "ENABLE" button is orange. This will create the file using the chosen filename in the location that you have chosen. The "ENABLE" button will not turn on if you have not chosen a filename and location. If the" ENABLE" button is on, then you also will not be able to change the filename and location.

Step 7

To start the data logger and log data to the specified file, you must toggle one of the two "Log Data" buttons. One of the "Log Data" buttons is on the main screen, while another is in the top of the DATALOGGING panel (see Figure 38). These buttons will flash orange when the data logger is running and recording data.

7.3.2 Running the Data Logger

After setting up the data logger for the first time or after editing the data logger settings, you can run the data logger with the auto-saved previous settings without having to open the DATALOGGING panel. This auto-saved setting remembers whether the "ENABLE" button was pressed, meaning you do not have to re-enable it via the DATA LOGGER panel on start.

Running the data logger can be done via toggling the "Log Data" button ("Play/Pause") at the bottom left of Reach Control's main screen. This button will flash orange when logging data. Toggling it off will pause the logging. See Figure 43.

NOTE: *If the Data logger is disabled (ENABLE button is off) or there is an error, the 'Log Data' buttons will not flash and recording will not happen.*

- ENABLE button: Used to set the datalogger's settings and create the file. This must be turned on to record data. The datalogger is enabled when ENABLE button is orange, and off when it is white.

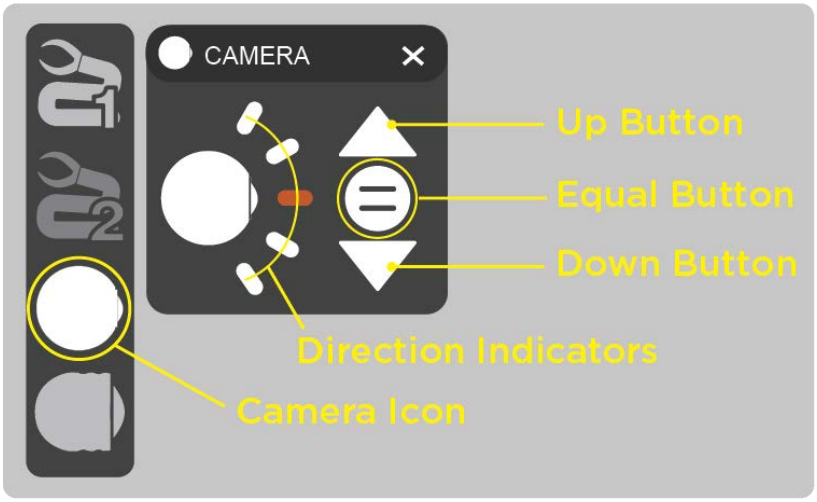
- Log Data buttons: These are used to start/stop logging data. The datalogger must be enabled before this button records data. These flash orange when logging data.

  'Log Data' icon in DATALOGGING panel and on Reach Control main screen.

7.4 Camera

For operators making use of Blueprint Lab cameras, the CAMERA tool provides a simple means of operating these. To access the CAMERA control tool, see Figure 44.

Figure 44. CAMERA TOOL Functionality



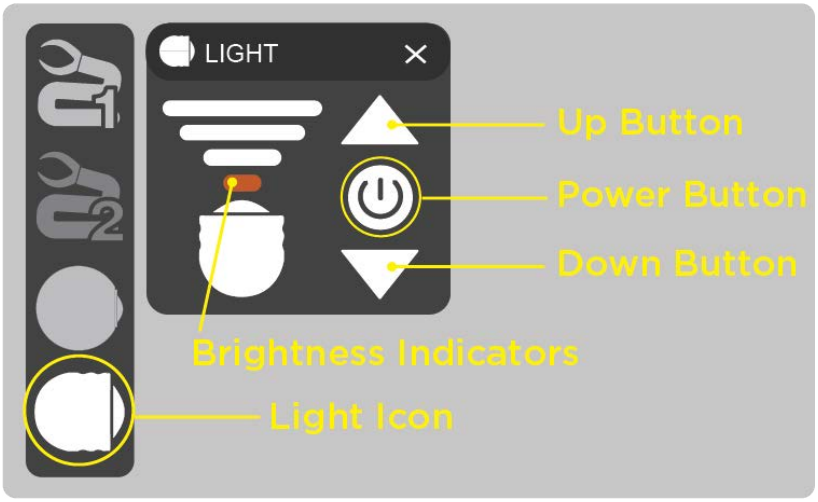
To set up and control the Camera , follow these steps:

1. Set up the camera via the VEHICLE SETUP panel and its connection via the CONNECTIONS panel. See Section 3.
2. Once the camera is set up, the Camera icon on Reach Control's main screen becomes available to click. Click on the Camera icon to bring up the CAMERA panel.
3. If the camera and its connection is setup correctly, then the "Direction Indicators" will display the camera's current orientation. The "Direction Indicator" that corresponds to its direction will become orange.
4. Pressing the "Equal" button will centre the camera's direction.
5. Pressing the "Up" button will move the camera angle up, while pressing the "Down" button will move the camera angle down.

7.5 Light

For operators making use of Blueprint Lab subsea-rated lights, the LIGHT tool provides a simple means of operating the output brightness. To access the LIGHT control tool, see Figure 45.

Figure 45. LIGHT panel



To set up and control the Reach Lights, follow these steps:

1. Set up the Reach Lights via the VEHICLE SETUP panel and its connection via the CONNECTIONS panel. See Section 3.
2. Once the lights are set up, the Light icon on Reach Control's main screen become available to click. Click on the Light icon to bring up the LIGHT panel.
3. If the camera and its connection is setup correctly, then the "Brightness Indicators" will display the lights current brightness setting. The more orange bars in the "Brightness Indicators", the brighter the lights are.
4. The "Power" button will display whether the lights are on or not. If the power button is orange, then the lights are on. Clicking this button will toggle the lights on or off.
5. Pressing the "Up" button will increase the brightness, while clicking the "Down" button will decrease the brightness.

8 Maintenance

The three main software and firmware maintenance tools can be access via the CONFIGURATION panel. These tools are the SOFTWARE UPDATE tool, FIRMWARE ONLINE tool, FIRMWARE LOCAL tool.

- The SOFTWARE UPDATE tool is used to update Reach Control to the latest version via the internet.
- The FIRMWARE ONLINE and FIRMWARE LOCAL tools are designed to update the firmware on the various manipulators including the Alpha 5.

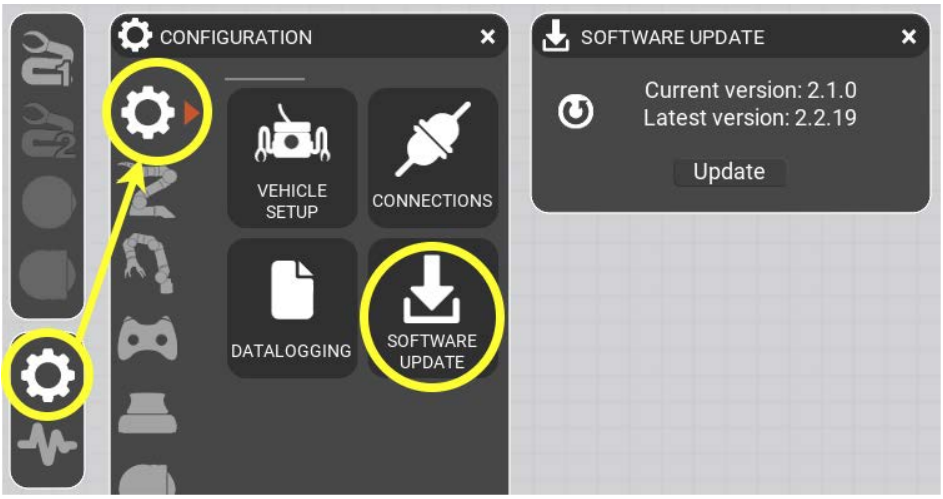
Using these software maintenance tools comes at a risk. Please ensure that updates are recommended by Blueprint Lab (info@blueprintlab.com) before proceeding.

Figure 46. CONFIGURATION panel tabs for software/firmware updates. General tab (left) and Reach Alpha tab (right).

8.1 Reach Control - Software Update

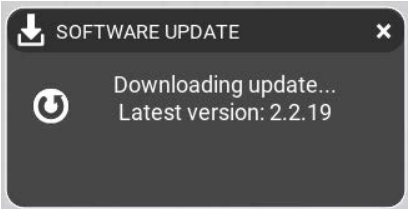
Reach Control updates are designed to provide extra features and/or stability fixes. It may be necessary to install the updates to gain the extra functionality. To access the SOFTWARE UPDATE tool, see Figure 47.

Figure 47. SOFTWARE UPDATE tool and access



1. Ensure that you have an internet connection and that Reach Control can download a file of approximately 75MB in size.
2. Click the "Update" button.
   NOTE: *The update button will only appear if your current Reach Control version is less than the online version, and that you have an internet connection.*

Figure 48. Reach Control update downloading

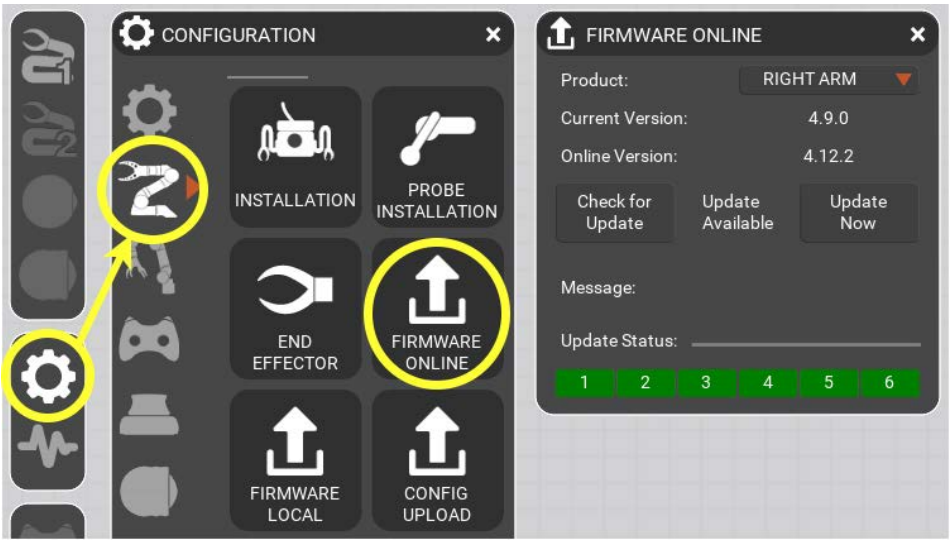


3. Reach Control will now attempt to download the update. This may take a few minutes depending on your internet connection.
4. Once the download completes, Reach Control will close and run the downloaded Reach Control installer.
5. If the software update process completes with errors, make sure you have an internet connection and restart the process beginning at Step 1. If errors persist please contact Blueprint Lab (info@blueprintlab.com).

8.2 Firmware - Online Update

It may be necessary to update the firmware on your Alpha 5 to allow additional features, bugfixes, and compatibility with Reach Control releases. The FIRMWARE ONLINE tool can be used to download the standard firmware files used on the Alpha 5. If you require specialised firmware, please refer to the FIRMWARE LOCAL tool (see Section 7.3).
To access the FIRMWARE ONLINE tool used to upload firmware directly from a file, see Figure 49.

Figure 49. FIRMWARE ONLINE tool and access

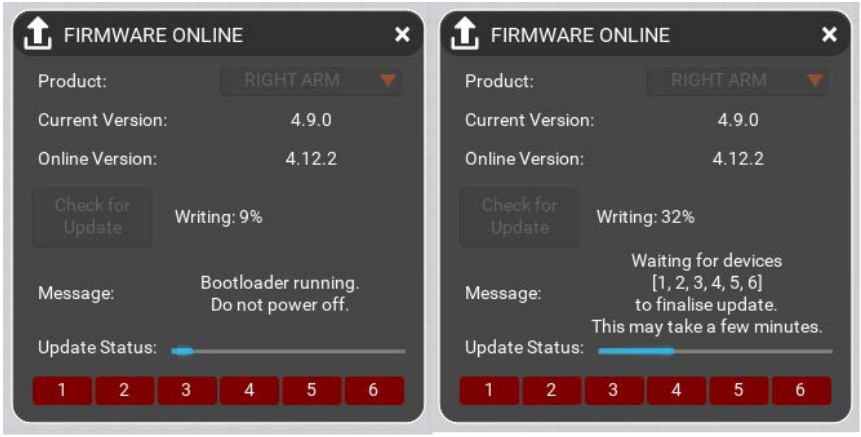


1. Ensure you are connected to the internet.
2. Ensure that the Alpha 5 is setup via the VEHICLE CONNECTION panel (see Section 3).
3. Ensure that the Alpha 5 is connected and communicating with Reach Control (see Section 3).
4. In the "Product" dropdown, select the Alpha 5 you wish to update.
5. Click the "Check for Update" button. This will check online for the latest firmware file, while requesting for the firmware version on the manipulator.
6. The online firmware file version will be displayed by the "Online Version", while the manipulators

current firmware version will be displayed by the "Current Version".

7. If the "Online Version" or the "Current Version" text states "Unknown", check to ensure that the Alpha 5 is connected and communicating with Reach Control, and you have an internet connection. Re-click the "Check for Update" to confirm.
8. Click the "Update Now" button. ***NOTE:*** *The "Upload Now" button will only appear if both the current and online versions are displayed. This means that the Alpha 5 is connected and communicating with Reach Control, and you have an internet connection.*
9. Once you click on the "Update Now" button, Reach Control will ask if you wish to power cycle or not. Pressing 'CANCEL' will stop the update.
10. If you wish to power cycle: Turn off the manipulator's power source, click 'YES', then power on the manipulator. This will then start the update.
11. If you choose 'NO', the update will begin as it is.

Figure 50. Firmware update stages 1 and 2



12. The 'Update Status' bar and the 'Message' text will display the update's progress. See Figure 50.

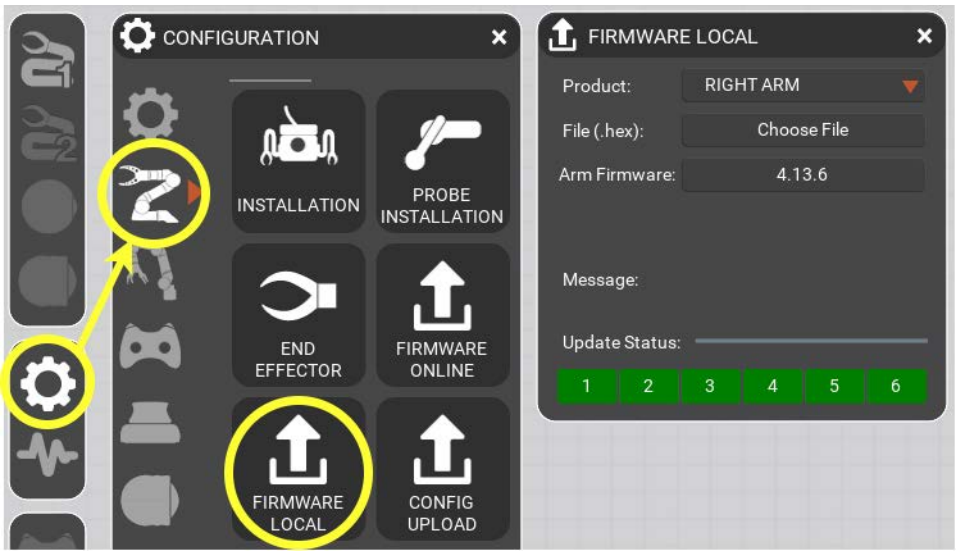
Figure 51. Firmware update complete

13. Once the update is complete, if all the of the boxes at the bottom of the tool are green, then the product is online. See Figure 51.
14. If the firmware update process completes with errors, power cycle the Alpha 5 and restart the process beginning at Step 1. If errors persist please contact Blueprint Lab (info@blueprintlab.com).

8.3 Firmware - Local Update

It may be necessary to update the firmware on your Alpha 5 to allow additional features, bugfixes, and compatibility with Reach Control releases. However, the default version online may not be suitable and that you require specialised firmware.
To access the FIRMWARE LOCAL tool used to upload firmware directly from a file, see Figure 52.

Figure 52. FIRMWARE LOCAL tool and access

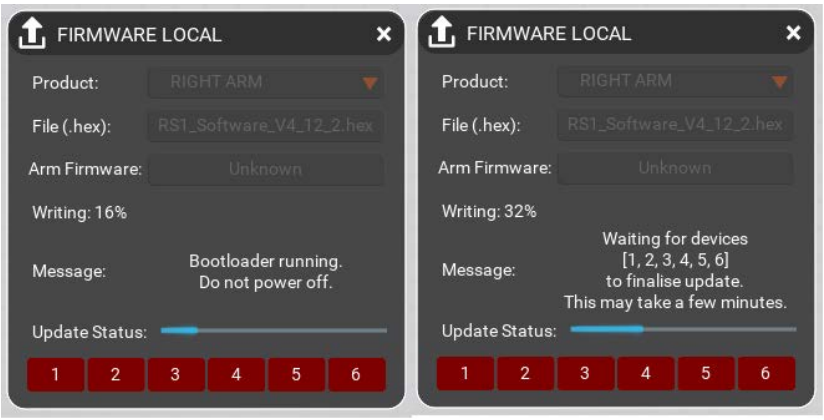


1. Download the firmware update file supplied by Blueprint Lab. Save it to the Desktop.
2. Ensure that the Alpha 5 is setup via the VEHICLE CONNECTION panel (see Section 3).
3. Ensure that the Alpha 5 is connected and communicating with Reach Control (see Section 3).
4. In the "Product" dropdown, select the Alpha 5 you wish to update.
5. Click the "Choose File" button and select the firmware file. The file name of the firmware file will then be displayed on the button (see Figure 53).

Figure 53. Firmware update ready

6. Click the "Upload Update?" button. ***NOTE:*** *The "Upload Update?" button will only appear when the Alpha 5 is connected and the firmware file has been selected.*
7. Once you click on the update button, Reach Control will ask if you wish to power cycle or not. Pressing 'CANCEL' will stop the update.
8. If you wish to power cycle: Turn off the manipulator's power source, click 'YES', then power on the manipulator. This will then start the update.
9. If you choose 'NO', the update will begin as it is.

Figure 54. Firmware update stages 1 and 2



10. The 'Update Status' bar and the 'Message' text will display the update's progress. See Figure 54.

Figure 55. Firmware update complete

11. Once the update is complete, if all the of the boxes at the bottom of the tool are green, then the product is online. See Figure 55.
12. If the firmware update process completes with errors, power cycle the Alpha 5 and restart the process beginning at Step 1. If errors persist please contact Blueprint Lab (info@blueprintlab.com).

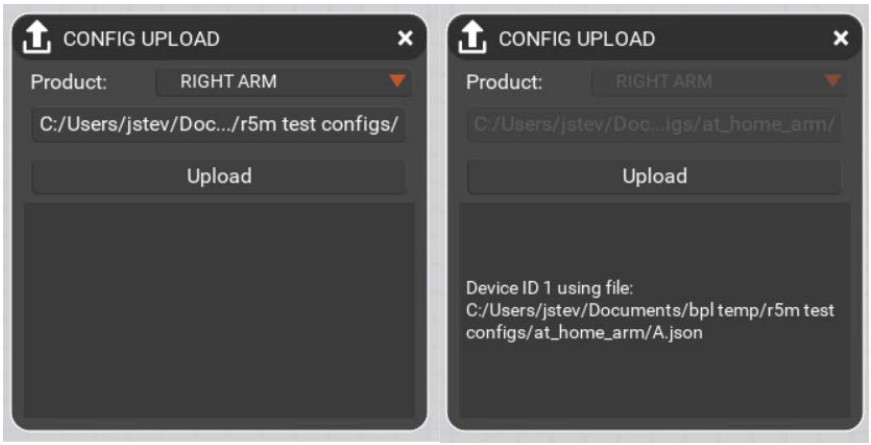
8.4 Configuration File Upload

Config Files are used to update parameters on your Alpha 5. This may be necessary during firmware updates. To access the CONFIG UPLOAD tool, see Figure 56.

Figure 56. Configuration File Upload Tool

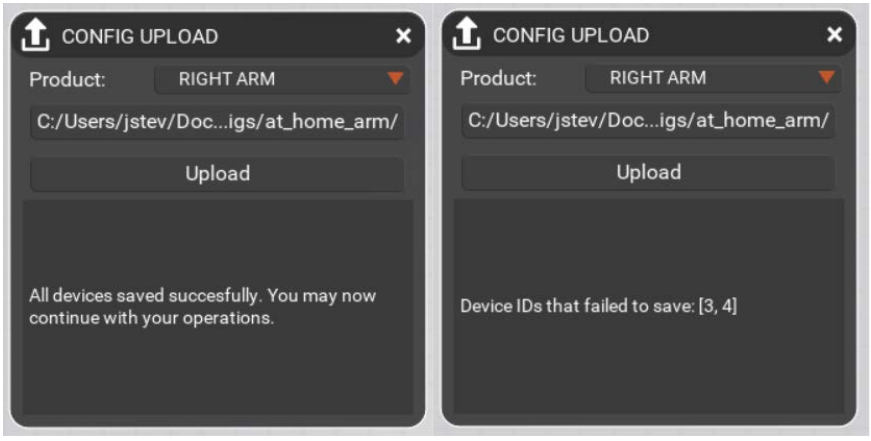
1. Download the config files supplied by The Blueprint Lab.
2. Ensure that the Alpha 5 is setup via the VEHICLE CONNECTION panel (see Section 3).
3. Ensure that the Alpha 5 is connected and communicating with Reach Control (see Section 3).
4. In the "Product" dropdown, select the Alpha 5 you wish to update.
5. Click the "Choose Folder" button and select the folder containing your config files. The folder path with your configuration files will then be displayed on the button. See Figure 57.

Figure 57. Config Upload Ready (Left) and Config Upload Running (Right)



6. Click the 'Upload' button.
   NOTE: *The 'Upload' button will only appear when the Alpha 5 is connected and the configuration folder has been selected.*
7. During the upload, the grey box at the bottom of the CONFIG UPLOAD tool will display current progress and status. See Figure 57.

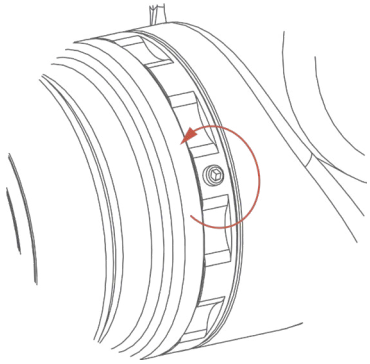
Figure 58. Config Update Successful (Left) and Config Update Failed (Right)



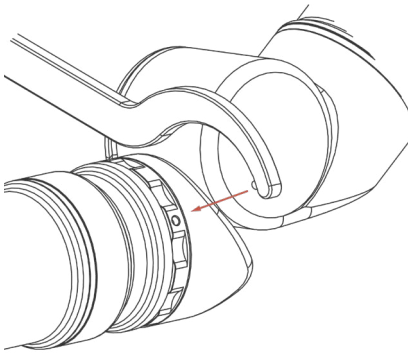
8. If the upload process completes with errors, power cycle the Alpha 5 and restart the process beginning at Step 1. If errors persist please contact Blueprint Lab (info@blueprintlab.com).

8.5 Module Replacement

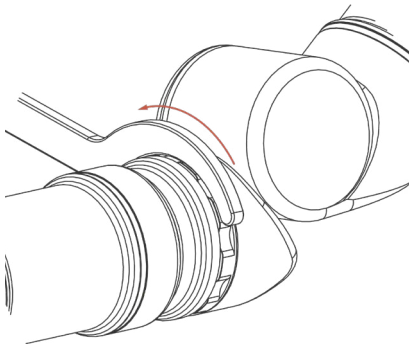
In the instance a module needs to be replaced (such as swapping an end-effector between a grabber and a pan-tilt unit), please carefully follow the steps laid out below. It is recommended that you contact your supplier prior to performing this procedure if it is your first time.



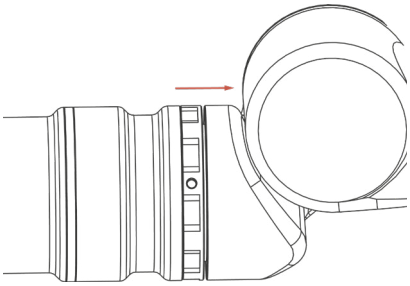
1. Loosen the M2.5 Grubscrew securing the locking nut at the base of the module you are replacing.



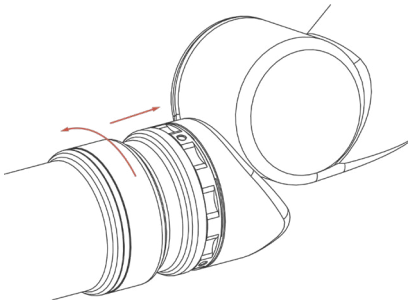
2. Insert the supplied spanner into one of the holes on the locking nut at the base of the module you are replacing.



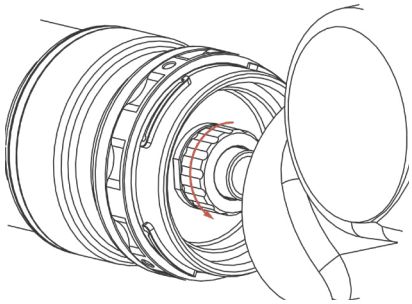
3. Rotate the spanner to loosen the nut.



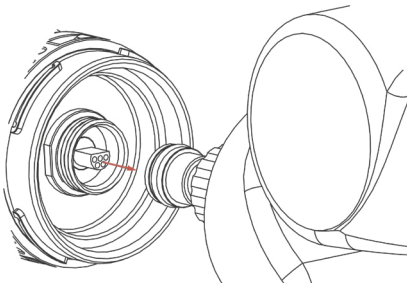
4. Push the male module into the female.



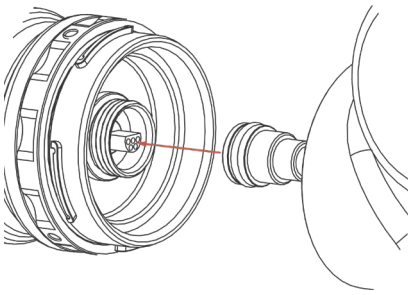
5. While pushing rotate 45 degrees. At 45 degrees carefully pull to remove.



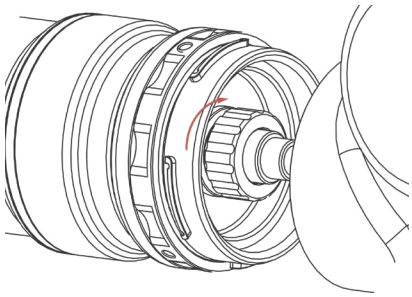
6. Loosen nut securing connector.



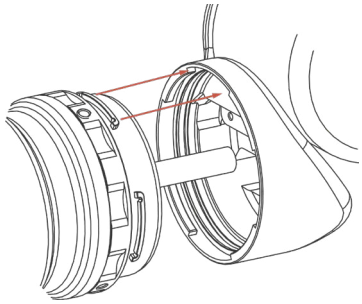
7. Remove connector plug by gently pulling on the cable.



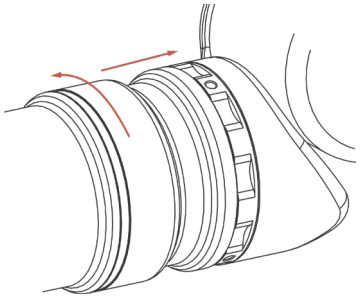
8. Apply grease to internal O-ring and male insert. Insert connector into new module by lining up the flat and pushing.



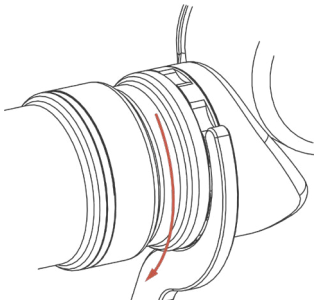
9. Tighten nut with fingers.



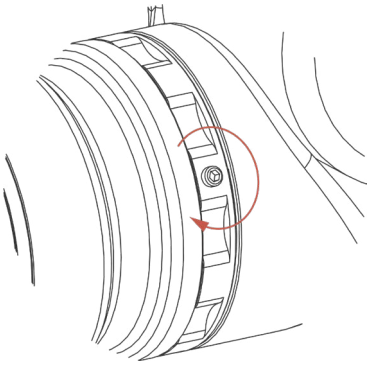
10. Line up bayonet teeth with female. Ensure the Red dots are offset by 45 degrees and not their direction. Insert male module into female. Ensure grease is applied to both surfaces.



11. Rotate module to 45 degrees to align the red dots. Pull apart to feel teeth engage.



12. Tighten looking nut.



13. Tighten Grubscrew.

CONTACT US

For more information please contact Blueprint Lab:

info@blueprintlab.com

+61 (2) 9519 7651

3 Applebee St, St Peters, NSW 2044, Australia