

Reach Bravo Integration Manual

V8.0

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Table of Contents

1 Introduction 4
2 Safety Information 5
2.1 Hazard Classification 5
2.2 Target Group 5
2.3 Personal Safety 5
2.4 Product Safety 6
Leak Detection 6
Obstacle Setup 7
Electrical Installation 7
Physical Installation 8
Operating Environment 8
3 Product Overview 9
4 Bench Setup and Acceptance Test 9
4.1 Bench Setup 10
4.2 Software Communication 12
4.3 Acceptance Test 14
5 Interfacing and Integration 15
5.1 Mechanical 15
Jaw Installation 16
Base Mounting 20
5.2 Electrical 21
7/5-function 21
3/2-function 23
Grounding with Serial Comms 24
5.3 Communication 24
Changing IP Address 25
6 Control Options 25
6.1 Software 25
Reach Control 25
Software Development Kit 26
6.2 Master Arm 26
6.3 Third-Party Controllers 27
7 Accessories 27
7.1 Wrist Camera (RB-1057) 27
7.2 Accessory Port (RB-1006) 28
7.3 Payload Interface (RB-1054) 29
8 Specifications 29
8.1 Mechanical 29
Bravo 7 31
Bravo 5 32
Bravo 3 33
Bravo 2 33
8.2 Electrical 34
8.3 Communication 34
8.4 Environmental 34

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9 Maintenance 35
9.1 Firmware Updates 35
9.2 General Product Care 37
9.3 Repairs 37
10 Compliance with EC Directives 38
10.1 CE Marking 39
10.2 Applicable Directives and Standards 39
10.3 Installation of External Safety Circuits 39
10.4 Use of the Supplied Break-Out Board 39
10.5 Cautions Regarding Official Language of EU Countries 39
11 Revision History 40

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1 Introduction

This manual is designed to help users of the Reach Bravo 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If anything in our manuals, FAQs or knowledge articles is out-of-date, poorly explained, or erroneous, please don't hesitate to let us know.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.

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2 Safety Information

This section describes the necessary safety information and precautions relevant to the setup and operation of the Reach Bravo. 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 judgements on safety procedures during operation.

2.1 Hazard Classification

DANGER	Denotes a hazard with a **high** degree of risk that may result in death or serious injury if not mitigated or avoided.
WARNING	Denotes a hazard with a **medium** degree of risk that may 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 may 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

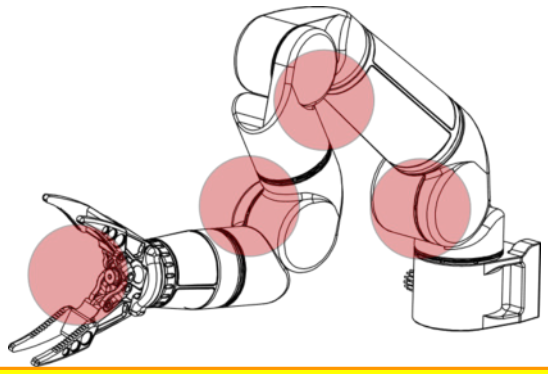
Any employee who does not have the relevant training must be given appropriate training and instruction. The instruction is to be given by authorised personnel with the appropriate training.

2.3 Personal Safety

This section describes the necessary safety information and precautions relevant to the setup and operation of the Reach Bravo 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.

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Reach Bravo 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 Bravo 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 Bravo 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 and/or compromising the integrity of the watertight seals, which may require repair at the Reach Robotics facility.
WARNING	The Reach Bravo 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 Bravo 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 Bravo 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.

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2.4.2 Obstacle Setup

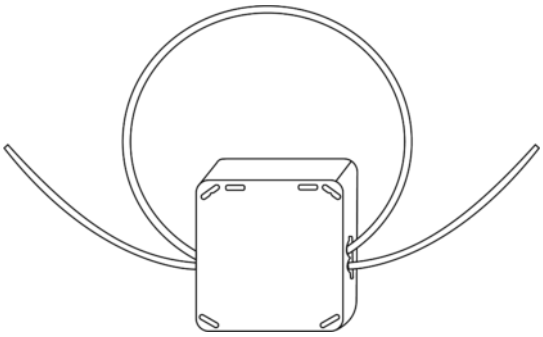
Virtual obstacles can be defined within the manipulator workspace to reduce the risk of collision between the Reach Bravo and other equipment. Care should be taken to ensure that any obstacles configured are defined correctly to cover all potential collision points. Configuring obstacles does not completely 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 appropriate software manual for more information.

INFO

All standalone Reach Bravo 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

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- 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 Bravo 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 (see Applicable Directives and Standards). 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 Bravo 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 Bravo 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 Bravo is specified for operation in water between 5°C-30°C and storage between -10°C-80°C.
INFO	The Reach Bravo is depth-rated to operate at the equivalent of 450 MSW (Metres below Sea Level).

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3 Product Overview

The Reach Bravo is an advanced electric manipulator system designed for subsea use by militaries, service providers, researchers, and other operators. Please discuss your requirements with our Sales team prior to purchase to ensure that the Reach Bravo is the correct manipulator for you.

The Reach Bravo is a modular robot, available in configurations ranging from a single-function rotate actuator up to a 7-function manipulator. Multiple tooling options are available from Reach Robotics, though the manipulator also features an end-effector interface that can accept custom tooling.



It can be controlled using a Reach Robotics Master Arm, a Gamepad or SpaceMouse, or commands sent using the RR Software Development Kit (SDK). For more information, please see the appropriate manuals for each control method.

4 Bench Setup and Acceptance Test

CAUTION	The bench setup and acceptance test are not regarded as an “integration”, and as such does not account for EMC directive standards. Please refer to Compliance with EC Directives and Product Safety for more information.
CAUTION	The provided power supply and E-stop are intended for bench testing only and should not be used in the full integrated system. The power supply provides 260 W and thus is not suitable for intensive usage.

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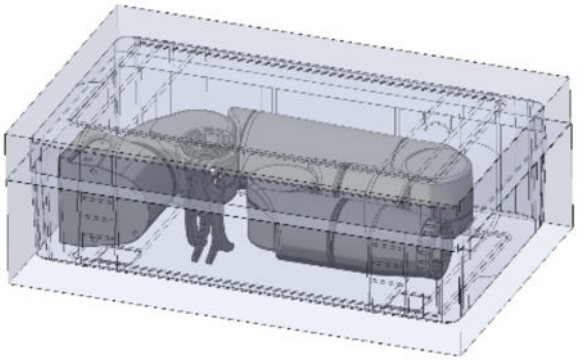
4.1 Bench Setup

This section outlines the basic setup and testing procedure users should complete to ensure their arm is fully operational. The following example is demonstrated with a Bravo 7. If you experience any issues in following these steps, please contact Support for help.

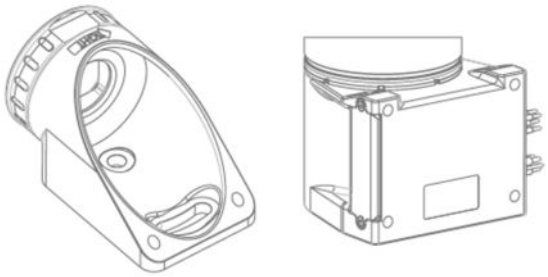
Materials required:

- Reach Bravo manipulator
- Power and comms cable(s)
- Reach Breakout Board
- Power supply
- USB or Ethernet cable
- PC with Reach Control
- 4 x M8 bolts
- 5 mm Allen key
- Marine grease

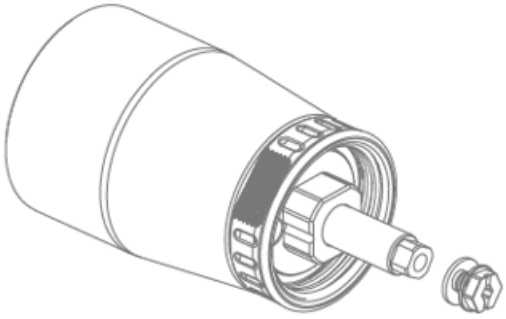
1. Unpack all Bravo components from the flight case and verify that you have all required parts.



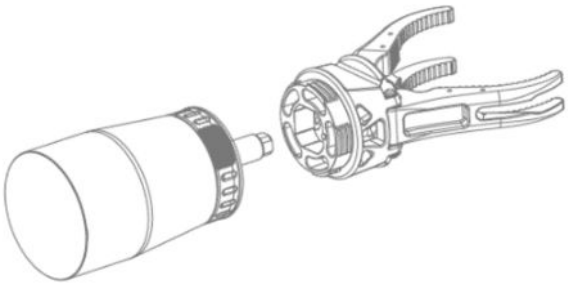
2. Use the provided 4 x M8 bolts to fix the Bravo base in position onto your mounting surface.



3. Using the 5 mm Allen key, remove the screw and washer from the end-effector pushrod.

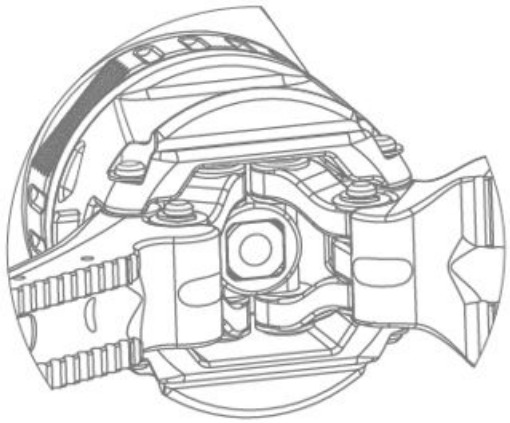


4. Fit your chosen jaws onto the arm, ensuring the dowel pin is correctly aligned. Apply marine grease to the thread at the base of the jaws.

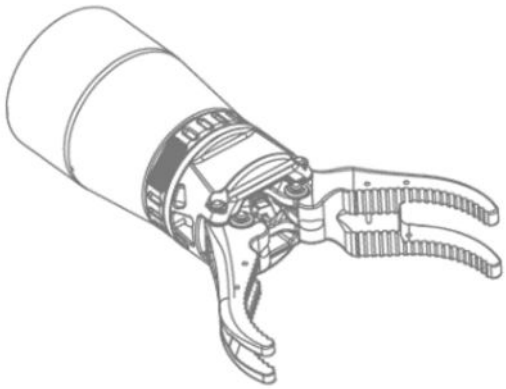


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5. Ensure the central sheath is fitted over the pushrod. You can rotate the pushrod gently by hand if necessary.



6. Screw the collar on the end-effector interface to tighten. Fasten the screw in the centre of the jaws with the 5 mm Allen key to secure (with a torque of ~3 Nm).



7. Ensure the included power and communication cable(s) are securely connected to the Reach Breakout Board (BOB).



8. Plug the power and communication cable(s) into the base of the arm.



9. Connect the power supply to the BOB. Plug the other end into a wall socket and turn on. Ensure the red E-stop button is released and a red LED is lit in the centre.



10. Use an Ethernet or microUSB cable to connect the BOB to your PC.



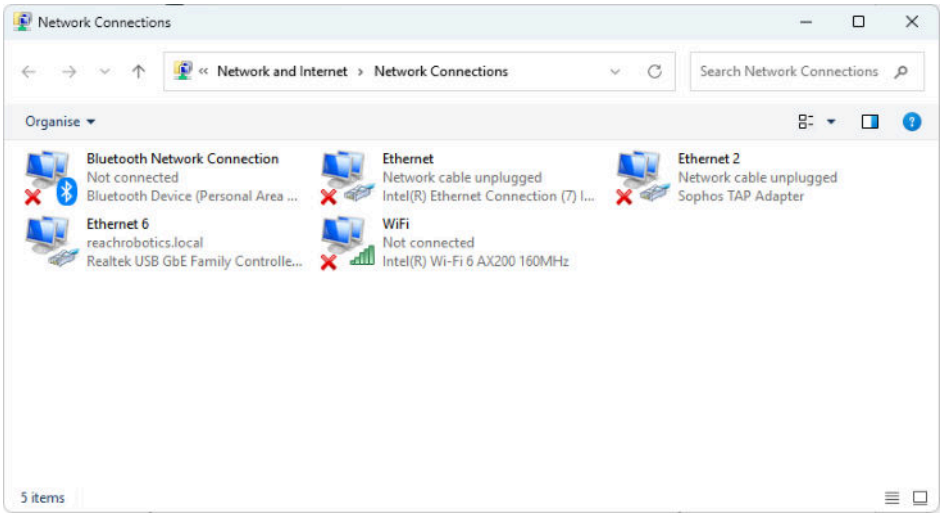
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4.2 Software Communication

Ethernet comms

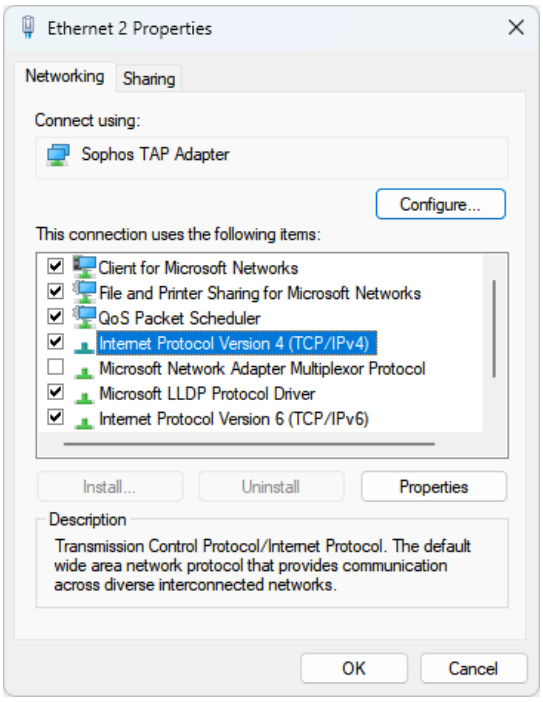
For Ethernet communication with the Bravo, you must configure the Ethernet connection to the PC before attempting to connect through Reach Control.

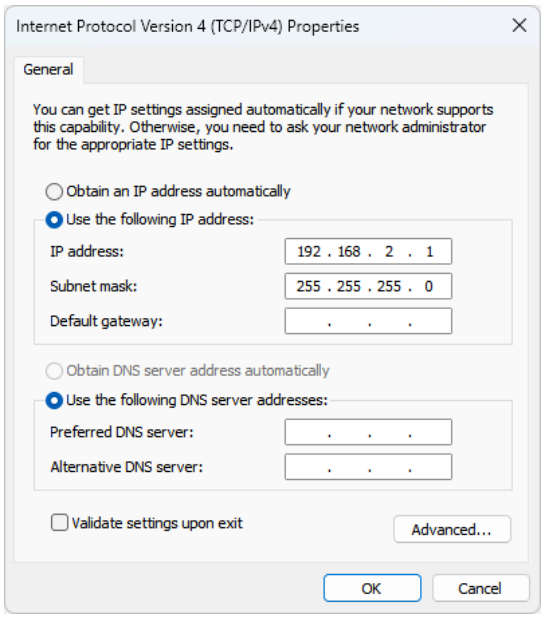
1. On your Windows PC, go to **Start > Control Panel > Network and Internet > Network and Sharing Centre > Change Adapter Settings**.



2. Double-click the Ethernet connection to the Reach Bravo arm to open the **Properties** window. (To check if you have the correct Ethernet connection, you can unplug and re-plug the cable. The connection should disappear and reappear.)

3. Highlight **Internet Protocol Version 4 (TCP/IPv4)** and click **Properties**. Select **Use the following IP address**, then set the IP address to **192.168.2.1** and the subnet mask to **255.255.255.0**.





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4. Click **OK** then close all windows.

Serial comms

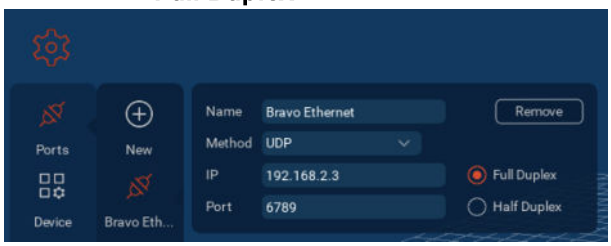
There are no initial setup requirements for serial communication with the Reach Bravo.

Reach Control

1. Install the latest version of Reach Control for either Windows or Linux from our website.

2. Open the software and go to **Settings (cog icon) > Ports > Add**. Click the new port and give it a suitable name, or use the default **Connection 1**.
   a. Ethernet:
      - Select **UDP** as the communication method
      - Set the IP address to **192.168.2.3** for Bravo 5/7, or **192.168.2.4** for the Bravo 2/3
      - Set the port to **6789**
      - Select **Full Duplex**

   b. Serial:
      - Select correct COM port (unplug and replug the connector to verify)
      - Select **Full Duplex** for RS232
      - Select **Half Duplex** for RS485





INFO

The Reach Bravo operating system can take up to **60 seconds** to come online when powered on.

3. Go to **Settings > Device** and select the existing **RIGHT ARM** device (add a new device if one doesn't already exist using the **New** button).

4. Select the port just created, then select the correct product line and type. If the Bravo has been set up correctly, the 3D model in the background will update to reflect the physical position of the manipulator and you will see data in the feedback graphs.

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5. Navigate the 3D model with the following mouse operations:
   - Rotate view – left-click and drag
   - Translate view – right-click and drag
   - Zoom – scroll wheel

4.3 Acceptance Test

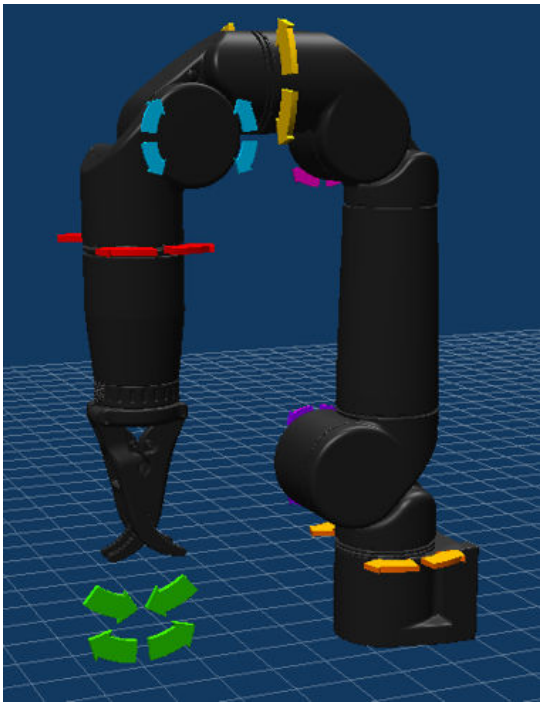
WARNING

Before carrying out the acceptance test, ensure the Reach Bravo is securely mounted and clear of all potential obstacles within its range of motion.

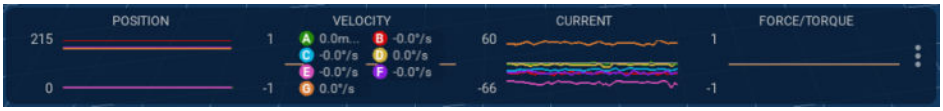
1. On the control panel in the bottom right of Reach Control, select **Velocity**. Directional arrows will appear on the 3D model.



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2. **Making sure it is safe to do so**, use the directional arrows on the 3D model of the arm to move each joint for a few seconds in each direction. Ensure the movement is as expected and corresponds with the control input. Watch the feedback graphs at the bottom to check that the position, velocity and current values are as expected (left-click each graph once to show values for each joint).



3. If using a handheld controller, connect it to Reach Control following the instructions in the relevant manual then perform a range of motion test.

5 Interfacing and Integration

This section covers the mechanical and electrical requirements for integrating the Reach Bravo into a full system. Please contact Support if you require 3D CAD files or any additional information to assist with integration.

INFO	Since the Reach Bravo is designated as partially completed equipment, the integrator must ensure that the integration of the manipulator into a complete robotics system complies with local regulations and standards. Please refer to Product Safety and Compliance with EC Directives for more information.

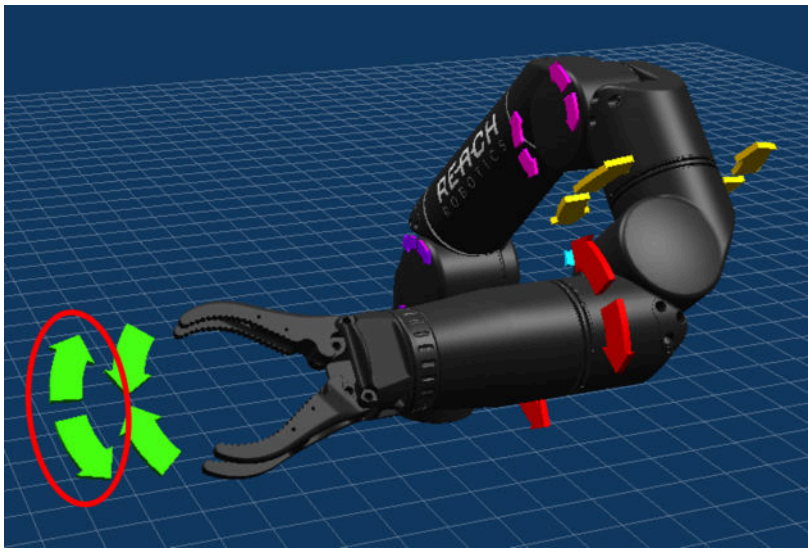
5.1 Mechanical

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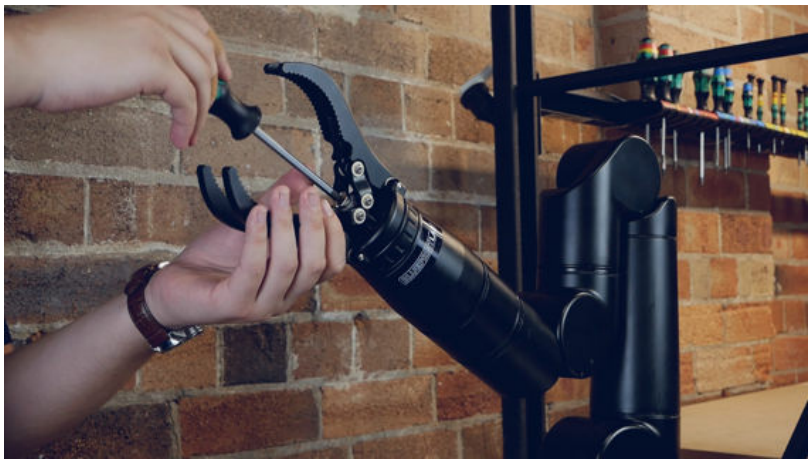
5.1.1 Jaw Installation

Whenever you change between jaw types on a Reach Robotics manipulator, you must “zero” the jaws. This is because each jaw type has a different range of motion, and so must be calibrated in the control software prior to use to ensure correct functionality.

1. With the manipulator connected to Reach Control, open the jaws using the velocity arrows.



2. Unscrew the bolt on top of the pushrod.



3. Loosen the screw-collar and remove the jaws.

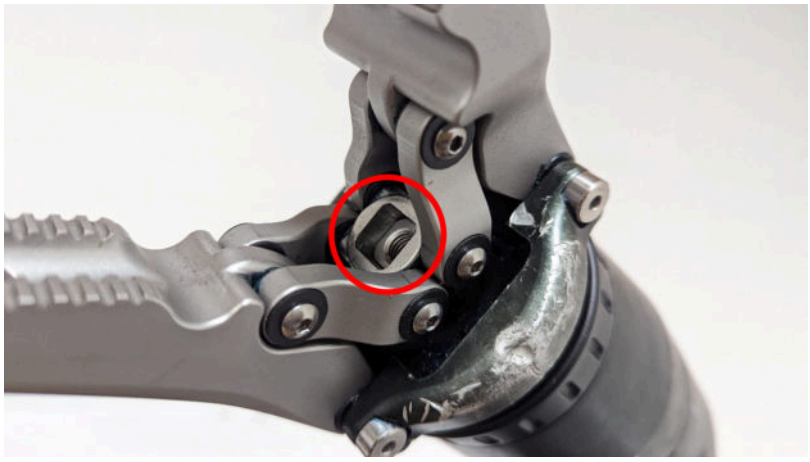
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4. Manually unscrew the pushrod one full turn from where it is flush with the pushrod block. Align the new jaws with the pushrod, ensuring that the metal pin on the jaws lines up with the groove in the pushrod block.



a. **Non-cutter jaws**
Tighten up the screw collar. You may need to move the jaws so the central square hole lines up with the pushrod as the collar tightens. Replace the pushrod bolt and washer and tighten the bolt.

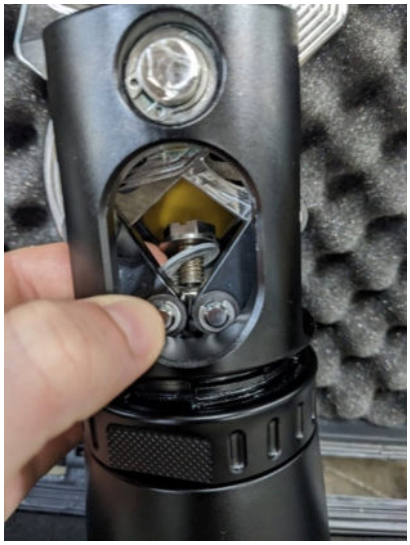


b. **Cutter jaws**
Ensure the central square hole in the jaws is lined up with the pushrod. Open the jaws slightly until the square

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hole is flush to the pushrod and the thread on the screw collar can catch on the base of the jaws. Tighten the screw collar fully – this will open the jaws further.

Replace the pushrod bolt and washer. If you are able to tighten the bolt with your fingers, do so as far as possible before tightening fully with the double-ended cutter jaw Allen key. If not, use the Allen key to tighten the bolt fully. Note: you may have to flip the Allen key to use the other end between each turn, due to the angle of the hex drive.

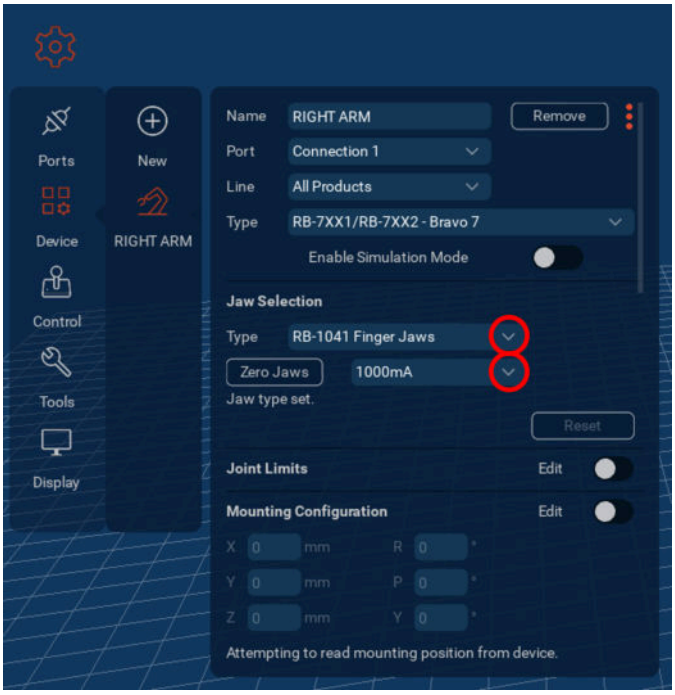




5. In Reach Control, go to **Device > RIGHT ARM** and click the three dots to expand the menu. “RIGHT ARM” is the default manipulator name; you may have named your device differently.



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6. Select the jaws you have just installed, and select **1000mA** current.
   Note: all jaws should be capable of zeroing at 800mA, but we provide a buffer to ensure that the calibration completes successfully. If you find that the jaws do not zero properly, try again using 1200mA.



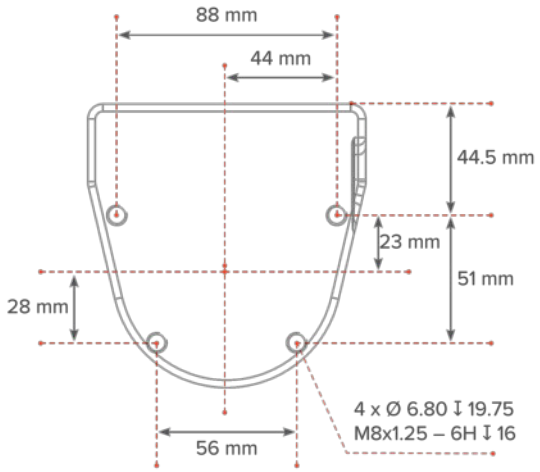
7. The jaws will open and close a couple of times. Once this is complete and you have seen a success message on the screen, your jaws are zeroed and you may begin using them.

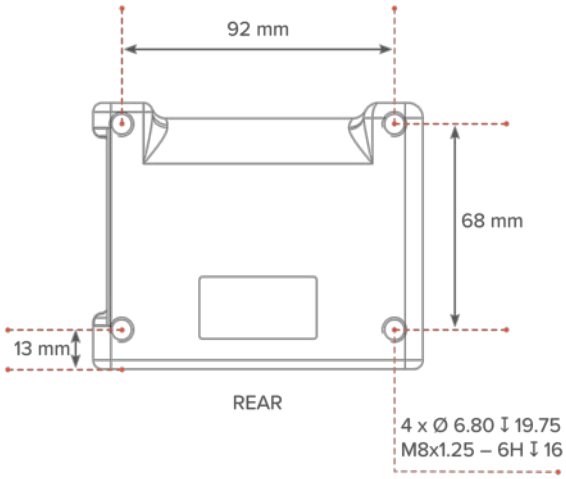
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5.1.2 Base Mounting

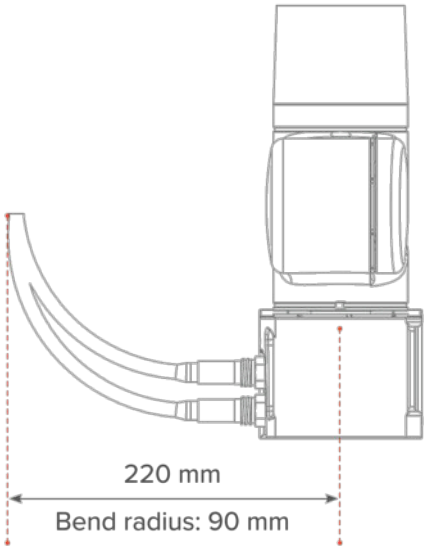
5.1.2.17/5-function

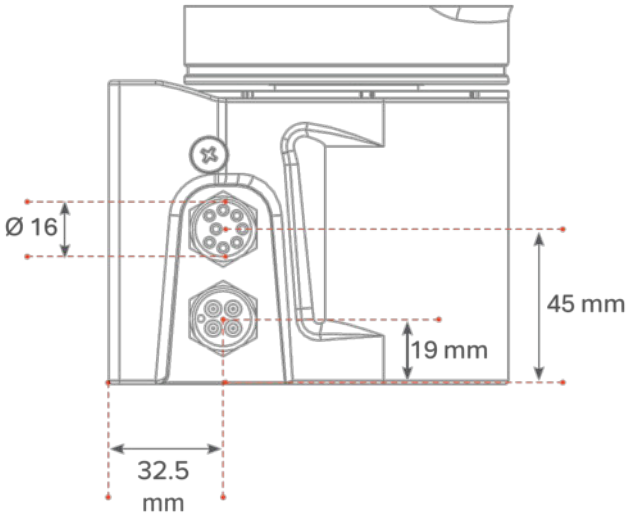
Base dimensions:





Connector clearance:

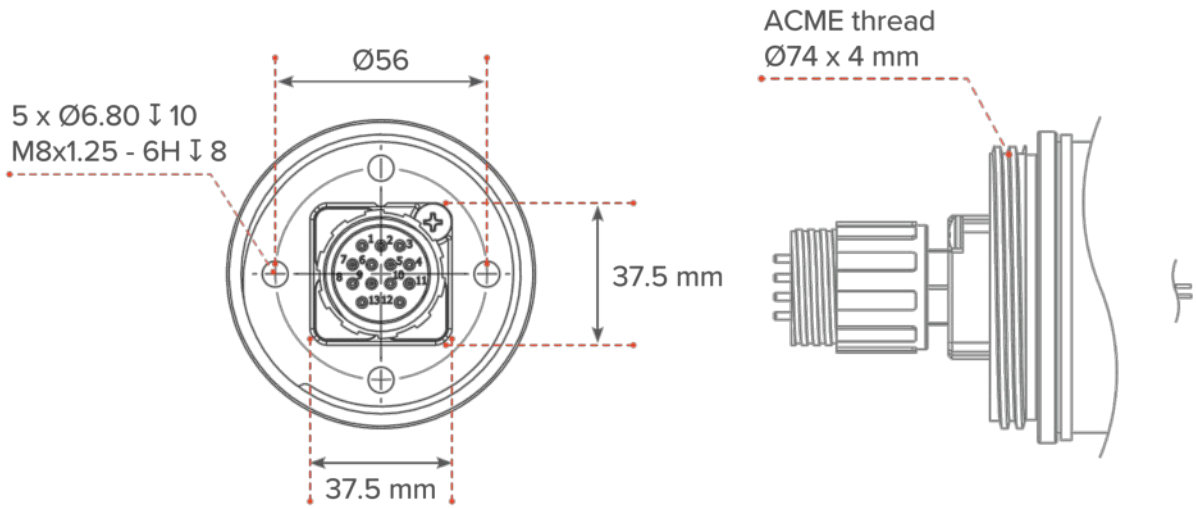




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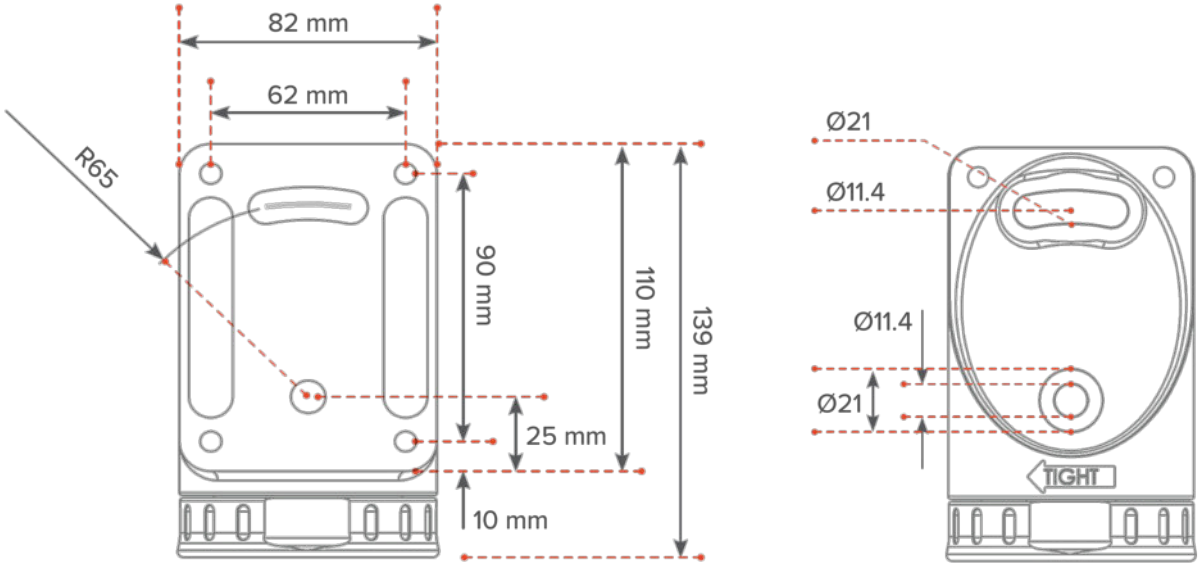
5.1.2.23/2-function

Base dimensions:



Note: the bend radius for the 13-pin Bravo cable is 90 mm.

Mounting kit:



5.2 Electrical

5.2.1 7/5-function

CAUTION	The Reach Bravo experiences a **high inrush current** that can trigger over-voltage protection in certain power supplies. This is due to the components used in the arm to prevent backdrive damage and arm drop under load. If you find that the Reach Bravo does not power on correctly when applying power, it is recommended to implement a soft start with a slew rate of ~0.5V/ms.

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INFO

TX in the tables below refers to **data to the vehicle**.
RX in the tables below refers to **data from the vehicle**.

Bulkhead power connector (MCBH4M)

Interface cable (supplied): MCIL4F (MC inline, 4C female to unterminated ends, 100cm)



Pin #	Description	Colour
1	GND	Black
2	PWR	White
3	PWR	Red
4	GND	Green

Bulkhead communication connector (MCBH8ME)

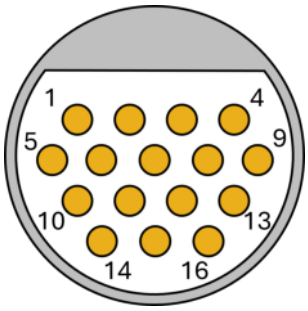
Interface cable (supplied): MCIL8FE10 (MC ethernet inline, 8C female to unterminated ends, 100cm)



Pin #	Description	Colour	Pairs
1	RS485 A	Brown	Twisted pair
2	RS485 B	Light brown	
3	RS232 TX	Blue	Twisted pair
4	RS232 RX	Light blue	
5	ETH RX-	Orange	Twisted pair
6	ETH RX+	Light orange	
7	ETH TX-	Green	Twisted pair
8	ETH TX+	Light green	

Accessory port connector (MCP16WD)

The Bravo 5 and 7 include an accessory port connector on the “elbow” joint to provide power and comms to either a Bravo Wrist Camera or Bravo Accessory Port. The port is accessible beneath the sacrificial anode.



Pin #	Description	Pin #	Description
1	RX-	9	TX+
2	CAN L	10	GND
3	CAN H	11	PWR
4	TX-	12	PWR
5	RX+	13	GND
6	GND	14	PWR
7	GND	15	PWR
8	GND	16	PWR

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CAUTION

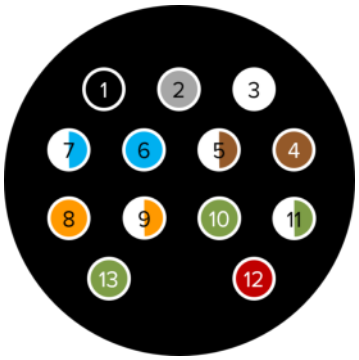
When you remove the anode or blanking cap from the Joint C accessory port connector, ensure you either replace it or install a wrist camera/accessory port. Leaving the accessory port connector open to the air can result in loss of vacuum from Joint C.

5.2.2 3/2-function

INFO

TX in the tables below refers to **data to the vehicle**.
RX in the tables below refers to **data from the vehicle**.

Bulkhead power and comms connector (DBH13M)
Interface cable (supplied): DIL13F (MC ethernet inline, 13C female to unterminated ends, 100cm)



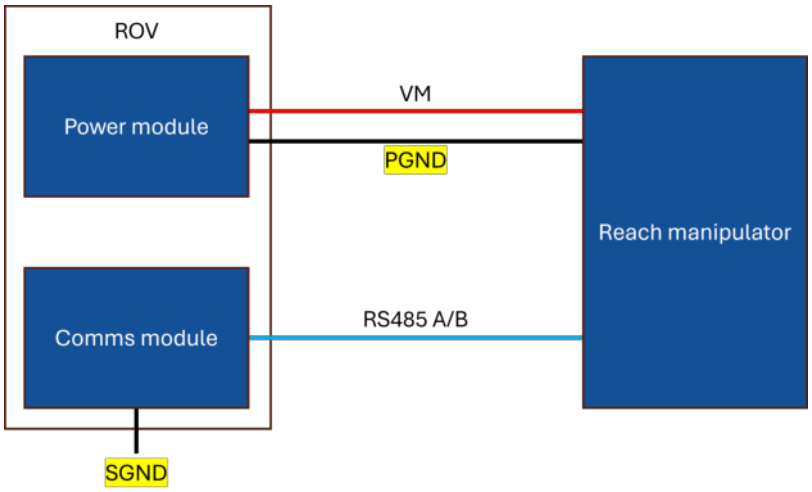
Pin #	Description	Colour	Pairs
1	GND	Black	
2	NC	(screen)	
3	PWR	White	
4	RS485 A	Brown	Twisted pair
5	RS485 B	Brown/white	
6	RS232 TX	Blue	Twisted pair
7	RS232 RX	Blue/white	
8	ETH RX-	Orange	Twisted pair
9	ETH RX+	Orange/white	
10	ETH TX-	Green	Twisted pair
11	ETH TX+	Green/white	
12	PWR	Red	
13	GND	Green	

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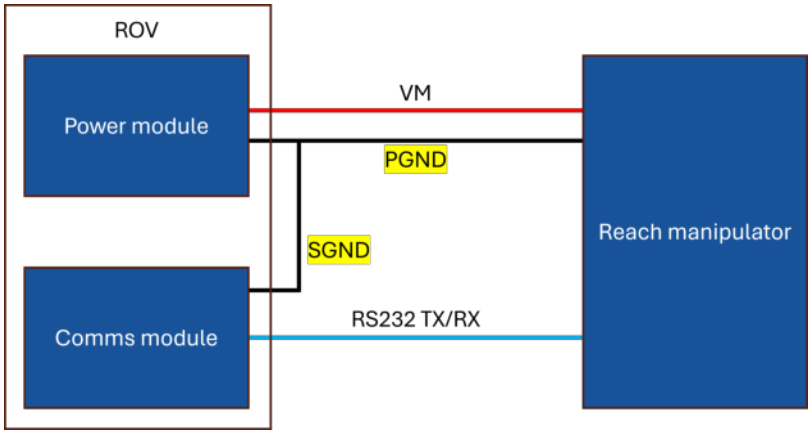
5.2.3 Grounding with Serial Comms

Ensure that the Reach Bravo is grounded correctly when using serial communications to avoid a ground loop, which can introduce interference or damage the device. This is detailed in the diagram below, using a Remotely Operated Vehicle (ROV) power and comms module as an example.

- When using **RS485**, ensure that PGND and SGND in the diagram below have a **maximum voltage difference of +5V or -7V**.



- When using **RS232**, ensure that PGND and SGND in the diagram below are **tied directly together**.



5.3 Communication

Every variant of the Reach Bravo can use both Ethernet and serial for communication. The 5- and 7-function variants have two usable IP addresses along with RS485 and RS232, while the 2- and 3-function variants have one IP address plus RS485 and RS232.

- Bravo 5/7 defaults: 192.168.2.3 (Compute), 192.168.2.4 (Base)
- Bravo 2/3 default: 192.168.2.4 (Base)

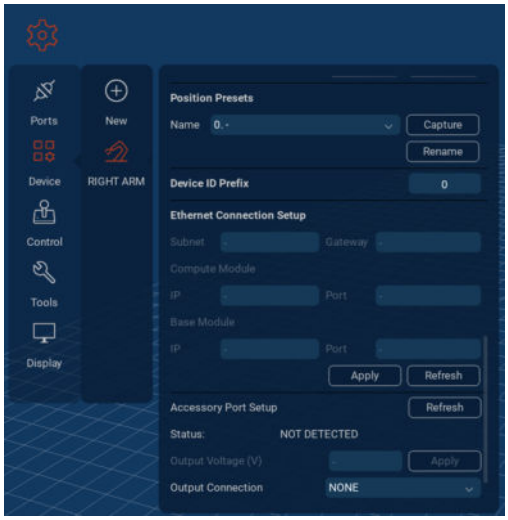
The Bravo runs a UDP server, and so UDP should be selected when creating a port in Reach Control. The TCP option in Reach Control is intended for customers who have their own TCP server, which forwards the data to the manipulator.

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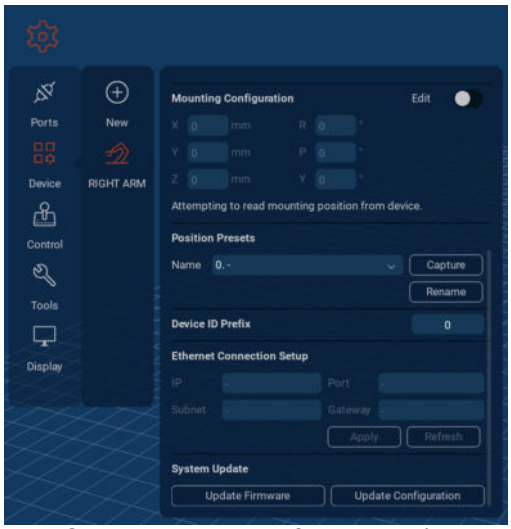
5.3.1 Changing IP Address

You can change the IP address of the Bravo manipulator to integrate it into an existing Ethernet system.

Connect the Bravo over serial comms to Reach Control. Go to **Settings (cog icon) > Device > RIGHT ARM**. Click the ellipsis [...] in the top right corner of the device panel, then scroll down to **Ethernet Connection Setup**. Change the IP address, port, subnet and gateway as required. Powercycle the unit to apply the new settings, then connect over Ethernet using the new details.



Change IP address for Bravo 5/7



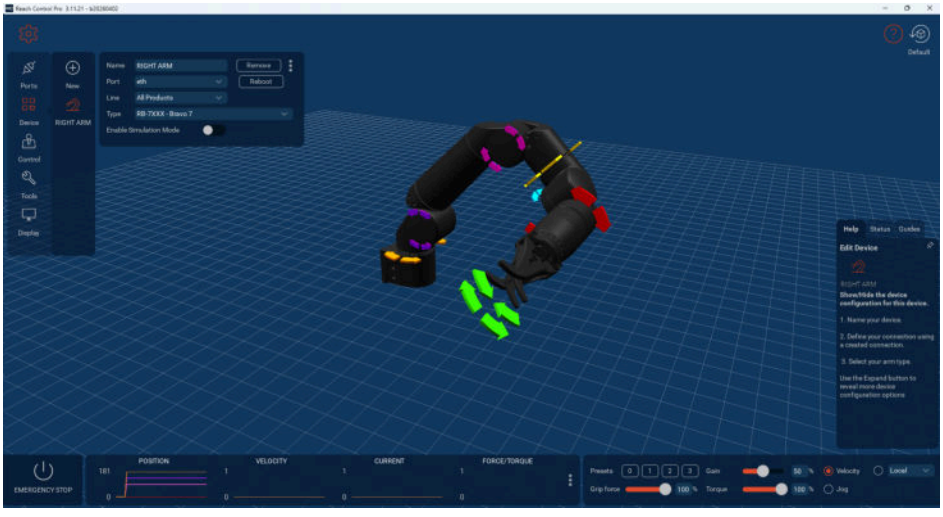
Change IP address for Bravo 2/3

6 Control Options

6.1 Software

6.1.1 Reach Control

Reach Control is the main software used to control and configure the Reach Bravo. It provides a graphical means to control each joint of the connected manipulator(s) in position, velocity or kinematics mode, as well as monitoring climate data and performing configuration, firmware and control updates. The software is free to download from our website along with the Reach Control manual.



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6.1.2 Software Development Kit

The Reach Robotics Software Development Kit (SDK) facilitates custom control of Reach Robotics products. It includes examples in Python, C and C++ for all products, and limited ROS2 node examples for Alpha 5, Bravo 5 and Bravo 7 manipulators.

INFO	ROS Noetic is reaching End Of Life (EOL) in 2025, and will no longer be supported in the SDK.
INFO	BPL Protocol will be depreciated in 2025 and replaced with Reach System Protocol. The ROS2 packages provided in this SDK are for the convenience of the user and are not currently supported by the Reach Robotics team. If you need support with your ROS2 integration, please contact Sales.

The SDK is made up of two parts: the GitHub repository that contains all the files and examples required to start communicating with your Reach Robotics product, and the Communications Protocol document that describes the commands that can be used. The SDK documentation and GitHub repository contain multiple examples in Python, C/C++, and ROS2 for common tasks.

- SDK documentation
- Github repository

The SDK is intended as a resource for users of Reach Robotics products that want to build their own custom control protocols. Use of the SDK assumes a certain amount of prior knowledge when it comes to custom control, and customer implementations vary wildly, so support must be somewhat limited. For example, while the SDK provides the means to communicate with a Reach manipulator, any control options are the user's responsibility to develop.

Reach Robotics provides the following support options for the SDK:

- Python/C/C++ - 1 hour of engineering support included if a support package is purchased
- ROS2 Foxy - paid-for support only for Alpha 5, Bravo 5 and Bravo 7, price dependent upon scope of request and availability (contact Sales)

The SDK is presented as-is and may not be updated regularly. We encourage users to let us know if they find any bugs in supported code by getting in touch with Support.

6.2 Master Arm

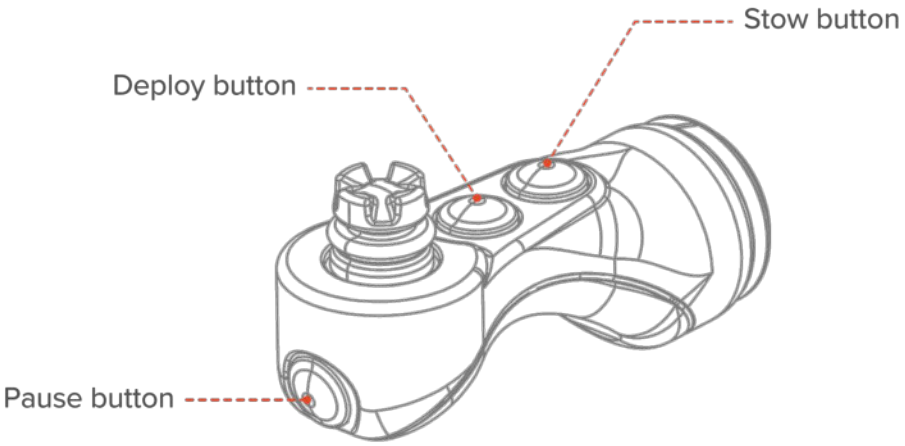
The Reach Robotics Master Arm system is a topside controller that maps the human operator control inputs to the movement of the manipulator's joints in a corresponding manner. In this way, the Master Arm controller allows the manipulator to "mimic" the movement of the operator. The Reach Bravo 7 and Reach Bravo 5 can be controlled by the 7-function and 5-function Master Arms respectively.

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.
- **Deploy position:** hold down to move the manipulator to the deploy position (Preset 1).
- **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.

The full Master Arm manual can be downloaded from our website.

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6.3 Third-Party Controllers

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.

For controlling the manipulator in end-effector Cartesian (XYZ) mode, a SpaceMouse can also be used. This translates 3D motion on the controller into kinematic control of the manipulator end-effector relative to its current position.

A standard keyboard can also be used to control the manipulator using joint velocity.

Please contact Support for access to the Third-Party Controllers manual.

7 Accessories

The datasheets and manuals for all Bravo accessories can be downloaded from our website.

7.1 Wrist Camera (RB-1057)



The Bravo wrist camera is a 2MP IP camera that connects to the accessory port connector in Joint C of the Bravo 5 and 7 to provide a video feed of the end-effector area for the Bravo operator. The Bravo must be connected via Ethernet for the wrist camera to connect, and we recommend having a connection bandwidth of 100 Mbps or higher. It can only be accessed over the default IP address if the Bravo is on the same subnet, so if unit IP addresses must be changed, it is recommended to set up the camera first before changing its or the Bravo's IP settings. The pinout for the Omnetics connector on the camera is shown in this section.

CAUTION	When you remove the anode or blanking cap from the Joint C accessory port connector, ensure you either replace it or install a wrist camera/accessory port. Leaving the accessory port connector open to the air can result in loss of vacuum from Joint C.
CAUTION	Ensure the camera connector has a clean greased O-ring installed and that the seal screw is not tampered with. These can lead to water ingress and damage if not adhered to carefully.

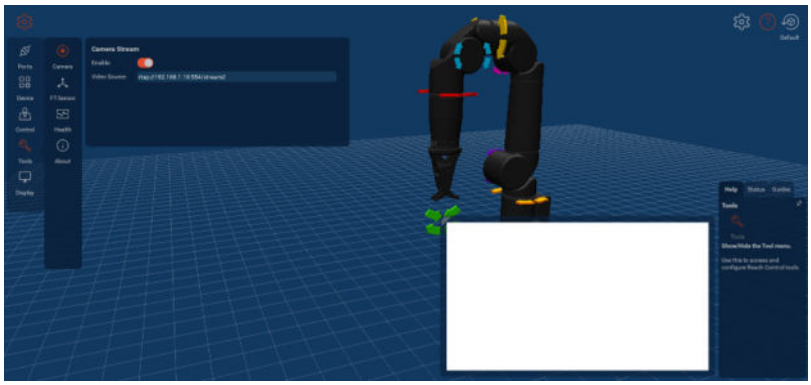
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The IP camera has a default IP address of **192.168.2.10**. To view the camera stream in Reach Control, open the software and go to **Settings > Tools > Camera**. Note that the Video Source field should read **rtsp://192.168.1.10:554/stream2**.

INFO

Older versions of the IP camera may use a different camera module. In this case, the Video Source field should be **rtsp://admin:@192.168.2.10:554/stream=1**.

Toggle the **Enable** switch below Camera Stream to open the camera feed. If the camera is connected correctly, the feed should appear in the white window. This window can be resized by dragging the top left corner.



Download the Micro IP User Manual for more information on accessing and configuring the camera stream.

7.2 Accessory Port (RB-1006)

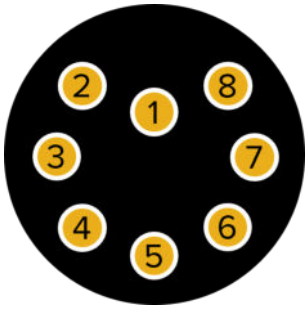
The accessory port allows integration of third-party instruments (e.g. probes and cameras) onto the Bravo. It provides an 8-pin female connector (MCBH8F) with 12-24 VDC of power and communications over either 100Mbps Ethernet or RS485.



CAUTION

When you remove the anode or blanking cap from the Joint C accessory port connector, ensure you either replace it or install a wrist camera/accessory port. Leaving the accessory port connector open to the air can result in loss of vacuum from Joint C.

To physically connect the accessory port, remove the anode or blanking cap from Joint C to reveal the wrist connector. Ensure the O-ring on the accessory port connector is greased and free of dust or debris, then mate the two connectors. Secure the accessory port with **2x M4x8mm** bolts. Tighten to **4.5 Nm** torque.

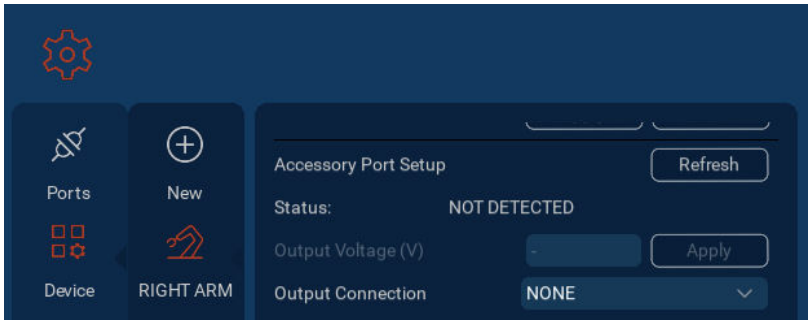


Pin #	Description
1	RS485 A
2	RS485 B
3	GND
4	PWR
5	ETH TX-
6	ETH TX+

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7	ETH RX-
8	ETH RX+

To connect an accessory port in Reach Control, first ensure no serial ports are connected. Then go to **Settings (cog icon) > Device** and expand with the ellipsis [...]. Scroll down to **Accessory Port Setup**. If the accessory port is connected correctly, the status should read **DETECTED**. Enter an output voltage between 12-24 in the box and click **Apply**. Choose the output connection that corresponds to the port on which the Bravo is connected.



The accessory port also has four additional M3 mounting holes that can be used to secure an external accessory.

7.3 Payload Interface (RB-1054)

The Payload Interface add-on allows attachment of external sensors and tools to Reach Bravo manipulators. Replacing the jaws at the end-effector, the plate design makes it easy for developers to securely integrate their own payloads to the manipulator system.



8 Specifications

8.1 Mechanical

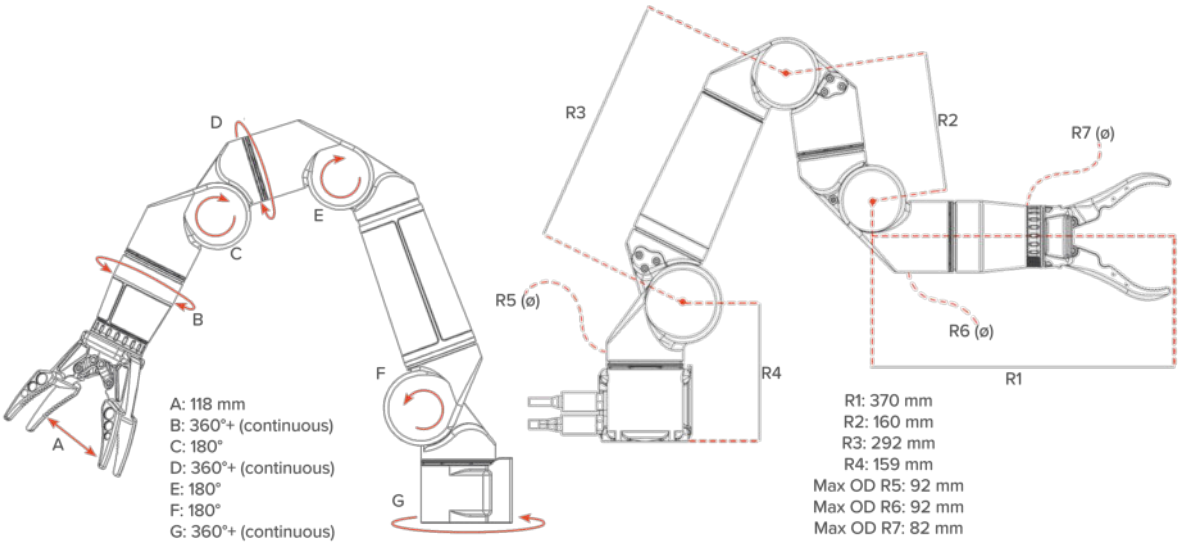
	Reach Bravo 7 RB-700X	Reach Bravo 5 RB-500X	Reach Bravo 3 RB-3001	Reach Bravo 2 RB-2130
Functions	7	5	3	2
Full extension reach	905 mm	755 mm	415 mm	325 mm (static)
Wrist rotation torque	20 Nm			
Grab force	80 kg (800 N)			
Base joint torque	110 Nm		50 Nm	N/A
Joint speed (24-48 V)	30-80 °/s			
Dynamic full-extension lift	10 kg	12 kg	15 kg	N/A
Max axial load	100 kg		200 kg	
Weight (in air)	9.5 kg	7.5 kg	4.0 kg	2.8 kg
Weight (in water)	4.5 kg	4.0 kg	2.6 kg	1.6 kg

All specifications are for Bravo V013 and higher. Please contact Reach Robotics Support for older version specifications.

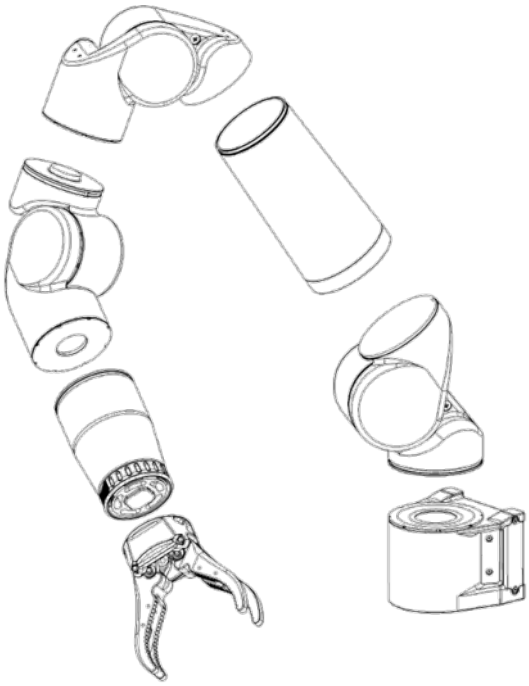
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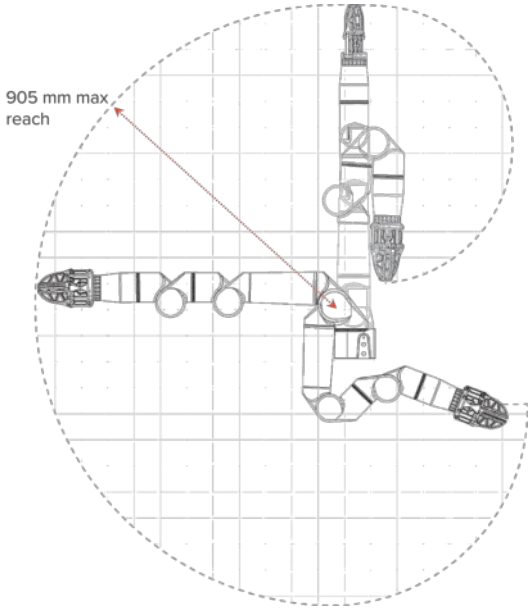
8.1.1 Bravo 7



Bravo 7 - dimensions and rotational capacity



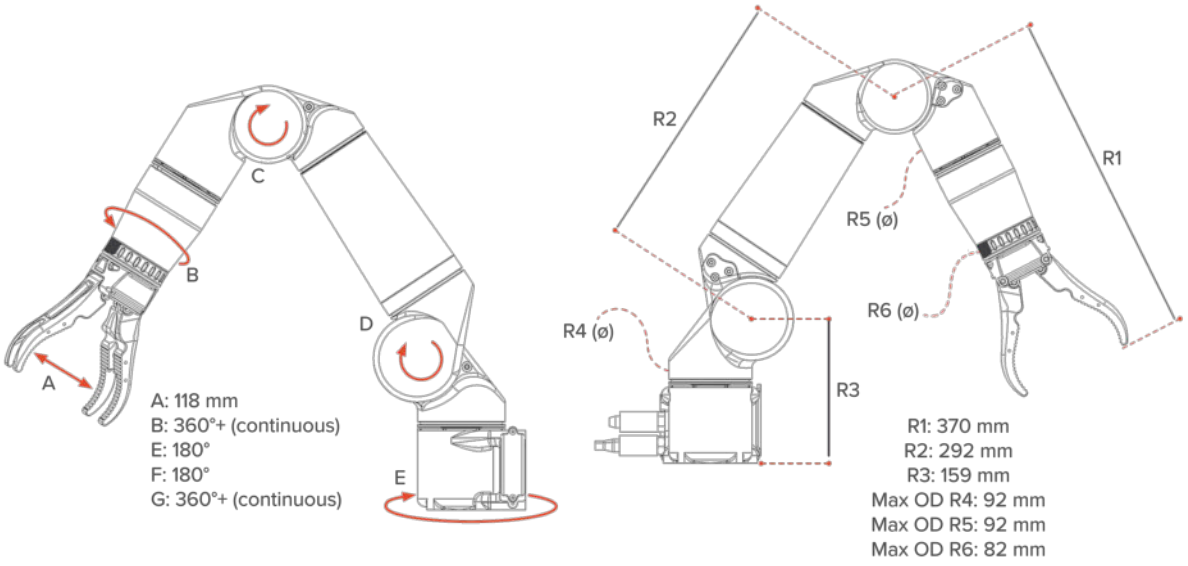
Bravo 7 - module breakdown



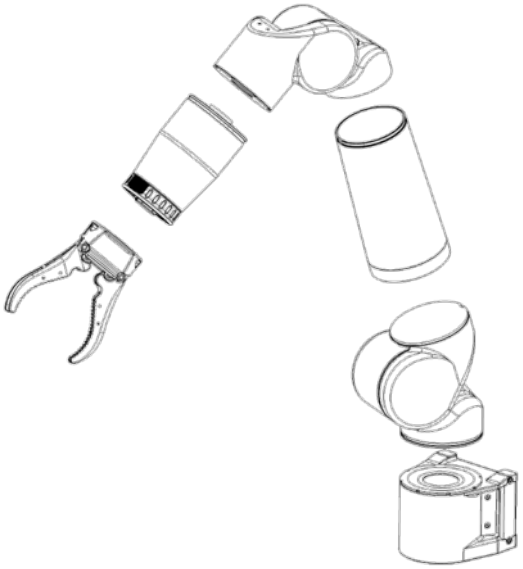
Bravo 7 - range of motion side view

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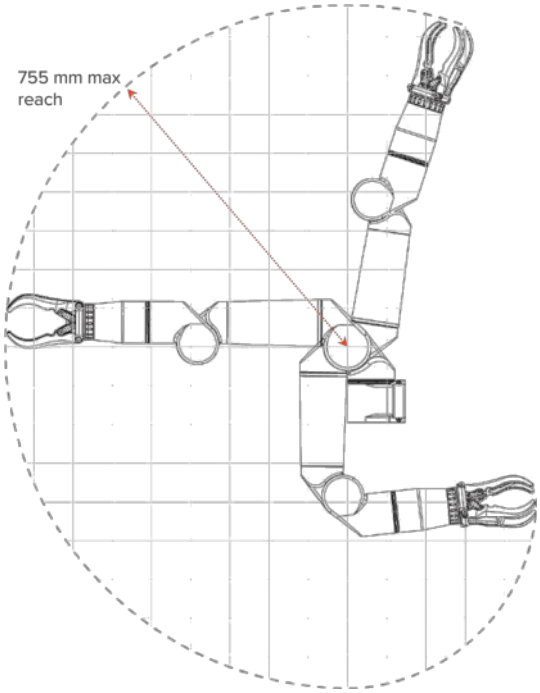
8.1.2 Bravo 5



Bravo 5 - dimensions and rotational capacity



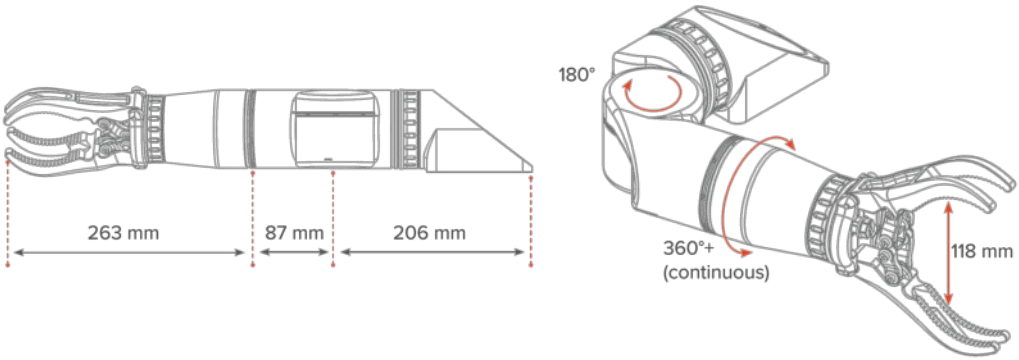
Bravo 5 - module breakdown



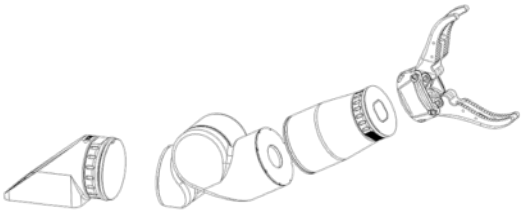
Bravo 5 - range of motion side view

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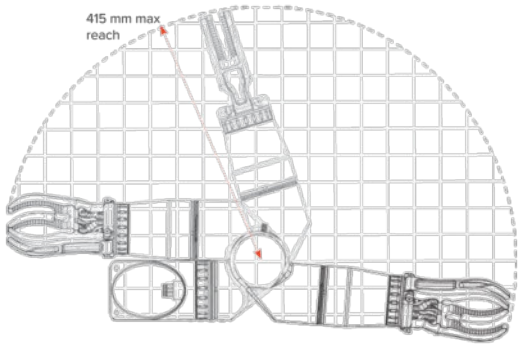
8.1.3 Bravo 3



Bravo 3 - dimensions and rotational capacity

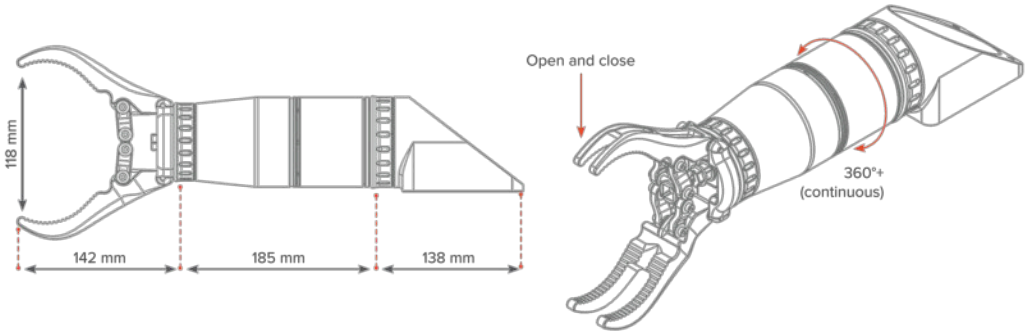


Bravo 3 - module breakdown

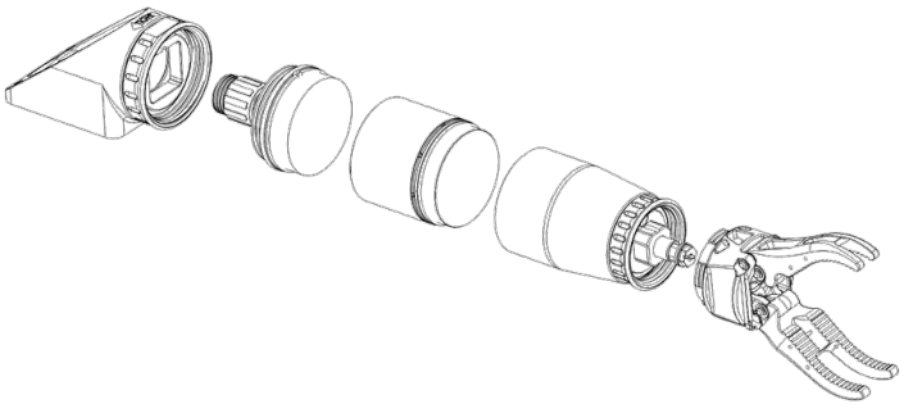


Bravo 3 - range of motion side view

8.1.4 Bravo 2



Bravo 2 - dimensions and rotational capacity



Bravo 2 - module breakdown

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8.2 Electrical

	Reach Bravo 7 RB-700X	Reach Bravo 5 RB-500X	Reach Bravo 3 RB-3001	Reach Bravo 2 RB-2130
Input voltage	24-48 V DC			
Power draw (nominal)	400 W	200 W	100 W	75 W
Power draw (standby)	500 W	300 W	200 W	150 W



For systems with strict power requirements, the velocity can be limited to reduce power draw. Please contact Support for assistance.

8.3 Communication

	Reach Bravo 7 RB-700X	Reach Bravo 5 RB-500X	Reach Bravo 3 RB-3001	Reach Bravo 2 RB-2130
Processor	NVIDIA TX2		N/A	
Interface low-level protocol	Ethernet, RS232, RS485			
Proprietary communication protocol	Reach Robotics Reach System Communication Protocol			

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

8.4 Environmental

	All Reach Bravo manipulators
Operating temperature range	5-35°C
Storage temperature range	-10-80°C
Depth rating	450 MSW
Housing material	Hard Anodised AL7075

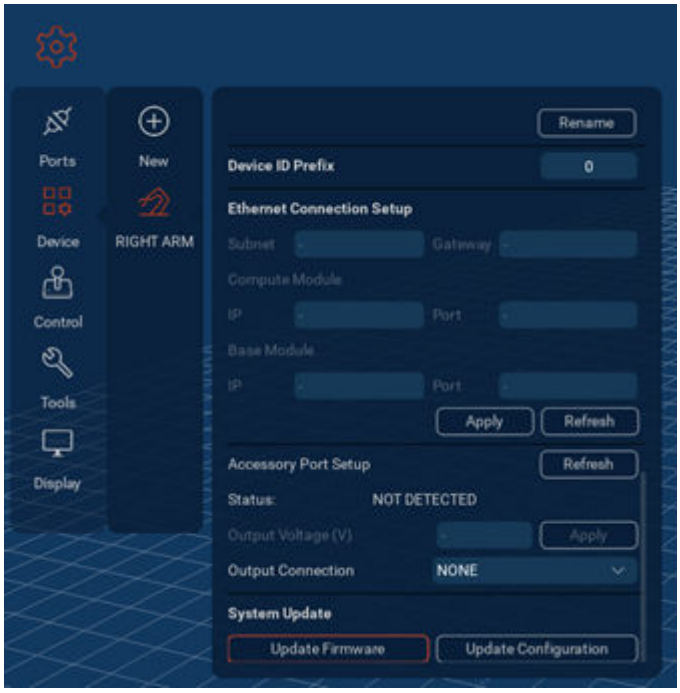
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9 Maintenance

9.1 Firmware Updates

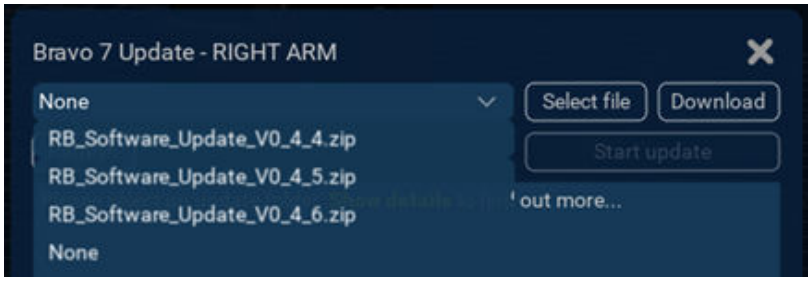
We recommend regularly checking for firmware updates using Reach Control to gain access to upgrades and bug fixes.

With the manipulator is connected, go to Settings > Device > RIGHT ARM, click the ellipsis […] in the top right corner to expand the panel, then scroll down to “Update Firmware”.



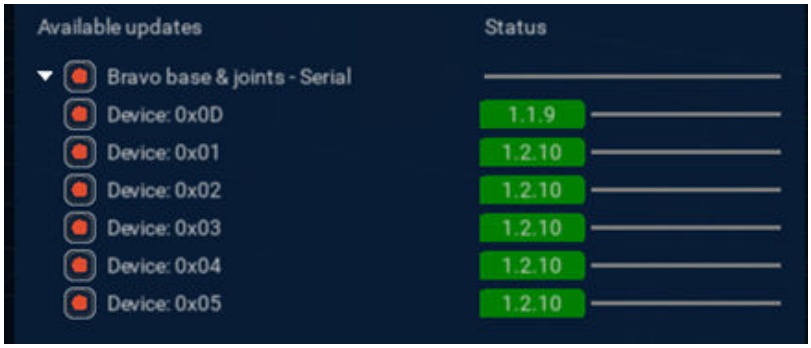
There are three ways to update the firmware from the panel that opens:

- Click “Download” to retrieve the latest software from the Reach Robotics server. Your PC must be connected to the internet.
- Click “Select file” to choose a .zip file containing the firmware you want to upload.
- Select an existing .zip file from the drop-down menu.

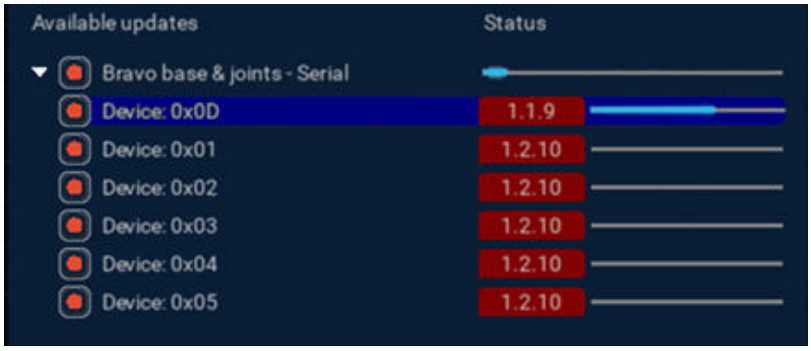


Once you have selected the correct firmware file, ensure that all the joints are selected under the available updates.

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Click “Start update”. **Do not disconnect the manipulator during the update.** The joints will now update one-by-one.



When all the joints have updated and you get a success message, you can close the Firmware Update panel.

Errors

When updating the firmware, you may encounter the following errors:

Error/warning message	Solution
Error: Connections of type […] are not supported.	The device port has not been selected. Check that the connection is secure and try again.
Error: Bad zip file.	The .zip file selected is empty or corrupted. Download again or contact Support for assistance.
Error: Unable to get software version from device 0x1, 0x2, 0x3, 0x4,…	Check that the device is powered. If the device is powered correctly, contact Support for assistance.
Error: Unable to Update. Select Refresh to try again.	The update cannot go through. Click Refresh to try again. If unsuccessful, contact Support.
Warning: No valid software files found.	The .zip file selected doesn’t have valid software files inside it. Check that the file is complete and uncorrupted.

Firmware erased and not reinstalled

In rare cases, the firmware may be successfully erased from the unit but the installation of the new firmware fails. If this happens, it will appear that the manipulator cannot be connected via any communication method.

To fix this, connect the manipulator via RS232 or RS485, leaving it unpowered. Start the update again, then apply power to the manipulator **1 second after starting the update**. The update will then proceed. Once it is complete, the joints should come back online.

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Bravo only: the Compute module cannot be updated over serial. Once the update has successfully been completed, connect the manipulator via Ethernet to the Compute IP address then go to the update panel (keep the arm powered on). **Deselect** the Base & Joints, then proceed with the update.

9.2 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.

Seal screws
- Do not remove any seal screws from the unit without access to a vacuum kit. Vacuum will be lost and the unit will be unfit for immersion.

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 (bulkheads, cables, blanking plugs)
- Keep connectors protected at all times when not in use to avoid mechanical damage and corrosion.
- Do not expose connectors to heat or direct sunlight for extended periods.
- 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.

9.3 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.

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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 CPT. 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.

10 Compliance with EC Directives

According to 2006-42-EC - Machinery directive, the Reach Bravo manipulator system is not, by itself, a complete robot system. Instead, the Reach Bravo manipulator is a component of a larger system which comprises additional power, safety, and control devices. As such, the Reach Bravo conforms to the applicable EC Directives within the scope of this framework. The customer who incorporates the Reach Bravo 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.

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10.1 CE Marking

As the Reach Bravo 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 Bravo series products (robots and controllers) and robot systems.
The Reach Bravo 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 this manual.

10.2 Applicable Directives and Standards

The applicable directives and standards are available in the "Reach Bravo – declaration of incorporation of partial machinery". As per 2006-42-EC, this document is available on request. The prescribed procedures carried out may vary according to the mechanical revision of the product.

10.3 Installation of External Safety Circuits

To comply with EC directives, customers using the Reach Bravo 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.

10.4 Use of the Supplied Break-Out Board

The Reach Bravo is commonly supplied with an external Printed Circuit Board (PCB) for interfacing between a USB Serial/Ethernet 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.

10.5 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 Bravo manipulator.

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11 Revision History

Version	Date	Author	Notes
V001	26/05/2020	Anders Ridley-Smith	Initial version
V002	25/08/2020	James Spinks	Inclusion of Bravo 2 and 3 Electrical diagrams Setup and integration information Acceptance testing
V003	15/04/2021	James Spinks	Bravo 2/3 module breakdown and mounting kit diagrams Stainless steel jaws added Servicing schedule and Support program
V004	03/08/2022	James Spinks Ethan Grenot	Integrated Bravo V010 changes Updated formatting
V005	23/08/2023	James Spinks Ellie Best	Branding/diagram/software updates Serial connection details Master Arm acceptance tests
V006	27/06/2024	Ellie Best Kyle McLean	Layout change Updated safety information Reach Control V3 screenshot updates Servicing schedule update Manipulator maintenance Additional information regarding EU compliance Information merged from existing Reach Bravo Safety Manual Added page numbering for user reference
V007	24/07/2024	Ellie Best Kyle McLean	Clarification of risk from magnetic fields How to change IP address
V8.0	22/09/2026	Ellie Best	Layout change Changing and calibrating jaws Bravo V013 information

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