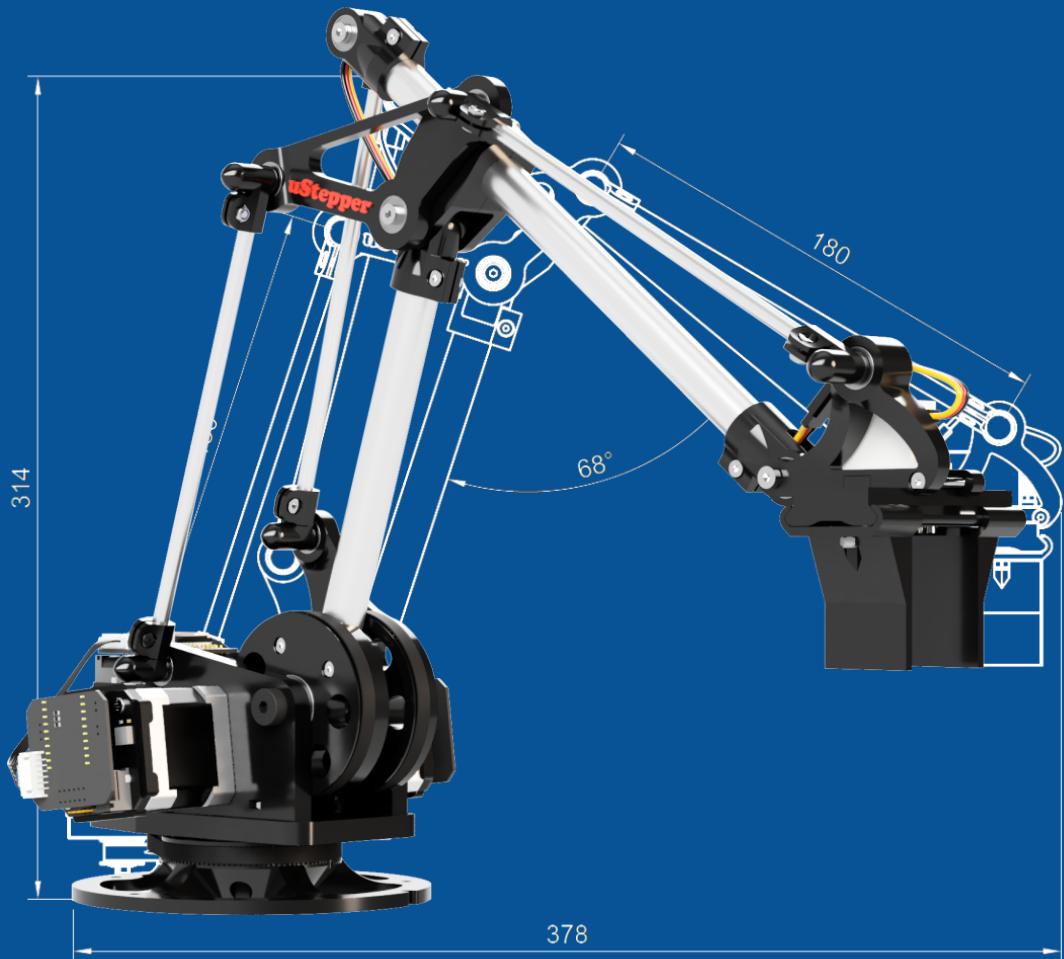


uStepper Robot Arm 4

Complete kit



Introduction

This document describes the assembly and use of uStepper Robot Arm 4 complete kit.

Product: uStepper Robot Arm 4 - Complete kit

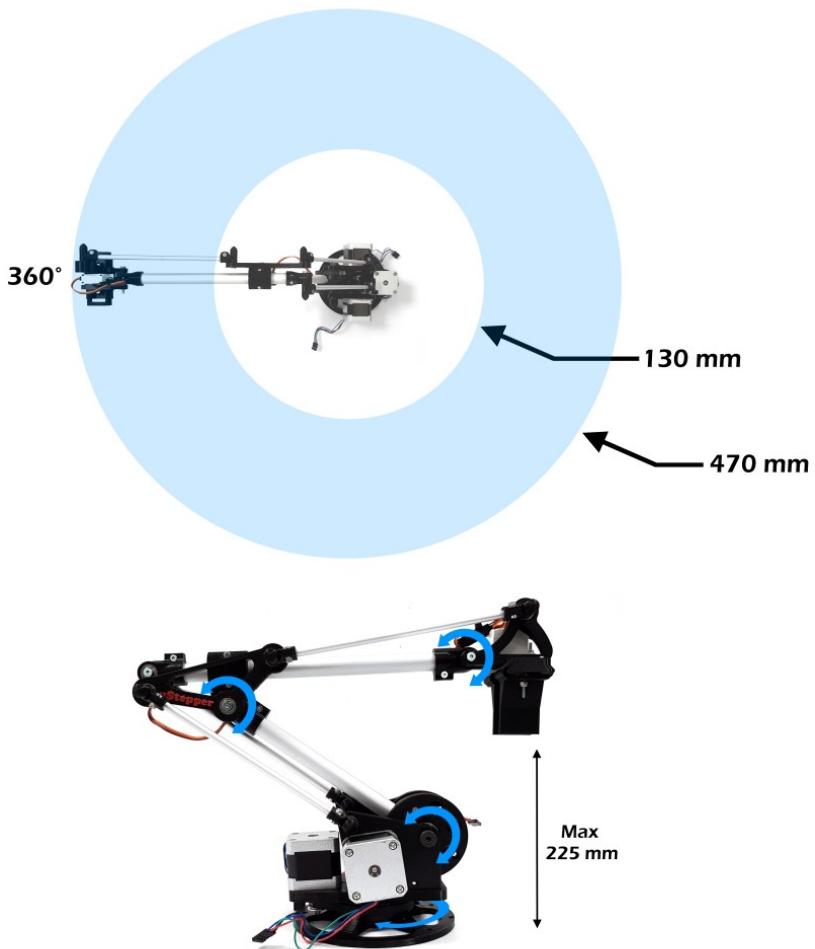
Document revision: 1.2

Author: MGN

Approved by: THO

Approval date: October 28 2020

Specifications

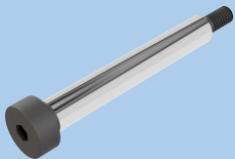


Weight (including stepper motors)	1460 g
Material	PLA plastic and Aluminum (tubes)
No. of axes	3
Maximum lift (close to base / furthest from base)	500 g / 250 g
Gear ratios (all axes)	5.1:1
Stepper motor torque	0.42 Nm
Mini servo torque	0.25 Nm @ 5 V

Bill Of Materials



Bill Of Materials



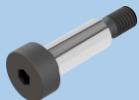
1 x shoulder bolt 7379-8-M6-55



1 x Tube 15 mm x 225 mm



3 x M4 x 35 mm



1 x shoulder bolt 7379-8-M6-20



1 x Tube 15 mm x 155 mm



7 x M3 nut



5 x 608ZZ Bearing



12 x 624ZZ Bearing



1 x 51105 Bearing



1 x F8-16M Bearing



3 x GT2 20T motor gear



3 x Belt GT2 228



2 x Tube 6 mm x 170 mm
1 x Tube 6 mm x 180 mm



8 x M4 SL nut



2 x M6 SL nut



2 x M3 x 6 mm



26 x M3 x 10 mm



7 x M3 x 20 mm



3 x M3 x 25 mm



5 x M4 x 20 mm



5 x M4 washer



1 x M6 washer



1 x M8 washer

Bill Of Materials



1 x HK15148B Digital MG Servo



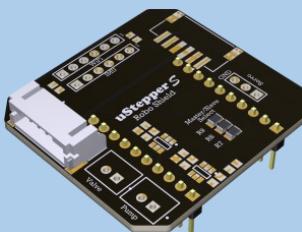
1 x Robot Shield Master w. WiFi



2 x JST cable



1 x 60 cm Servo Cable



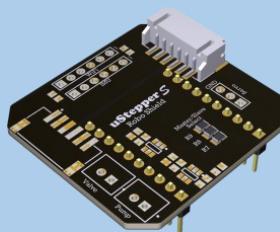
1 x Robot Shield Slave 1



1 x 25T x 20 mm Servo Horn Set



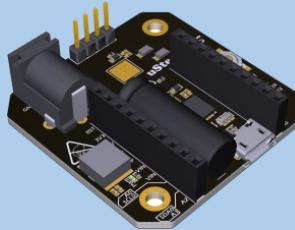
3 x NEMA 17 Stepper Motor



1 x Robot Shield Slave 2



3 x uStepper Permanent Mount



3 x uStepper S DC-jack w. accessories

1:1 Nuts & Bolts

M3 x 6 mm



M3 x 10 mm



M3 x 20 mm



M3 x 25 mm



M4 x 20 mm



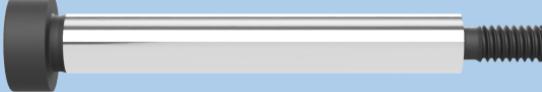
M4 x 35 mm



M6 x 20 mm



M6 x 55 mm



M3 nut



M4 nut

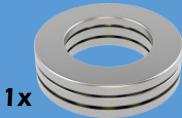


M6 nut



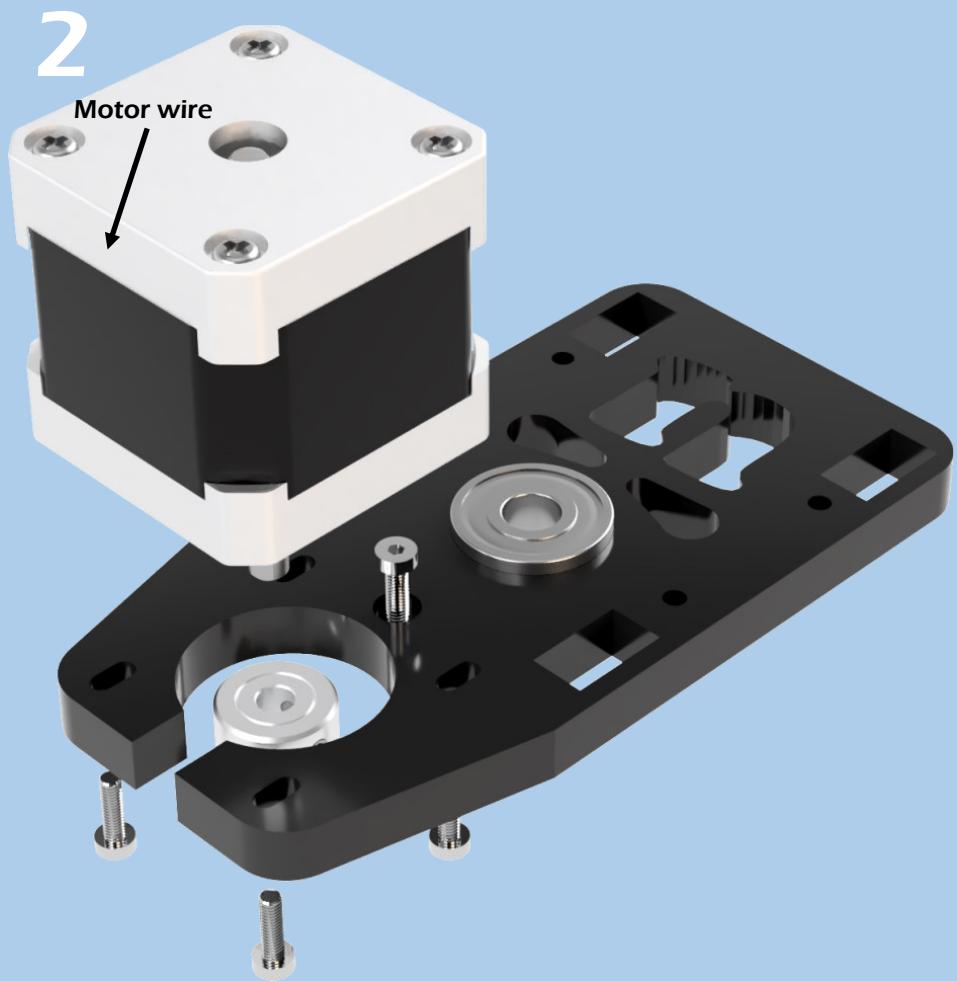
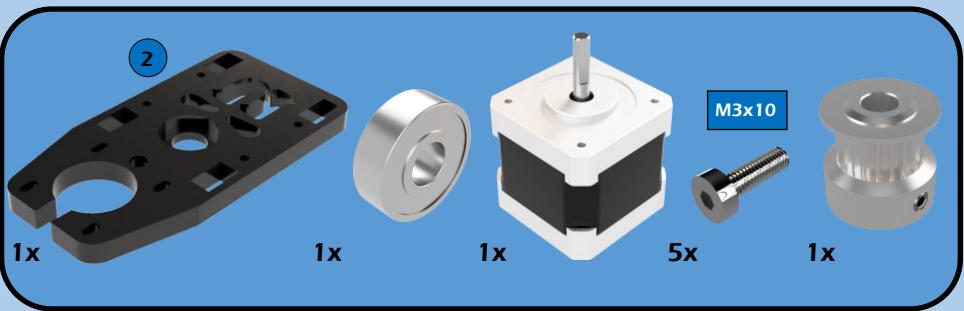
Robot Arm Assembly

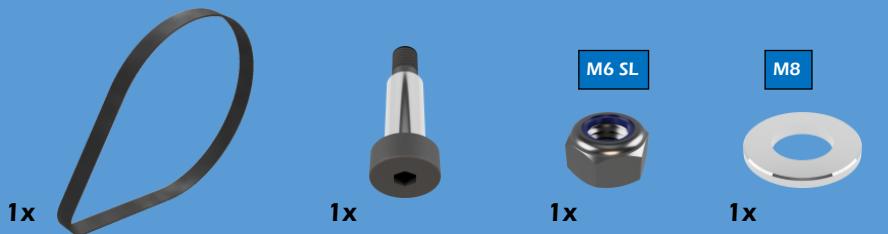
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1



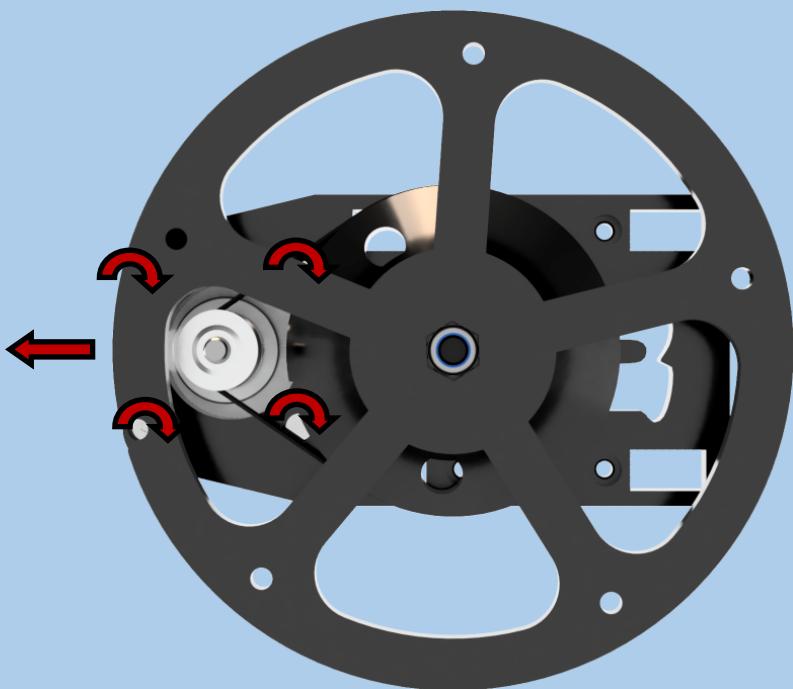
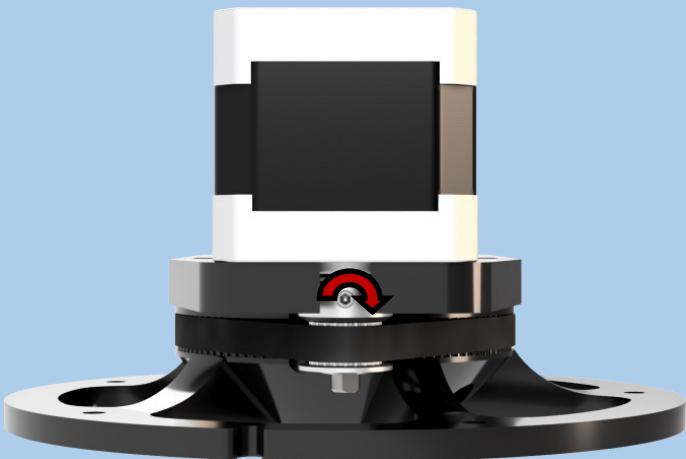




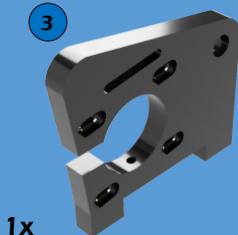
3



4



3



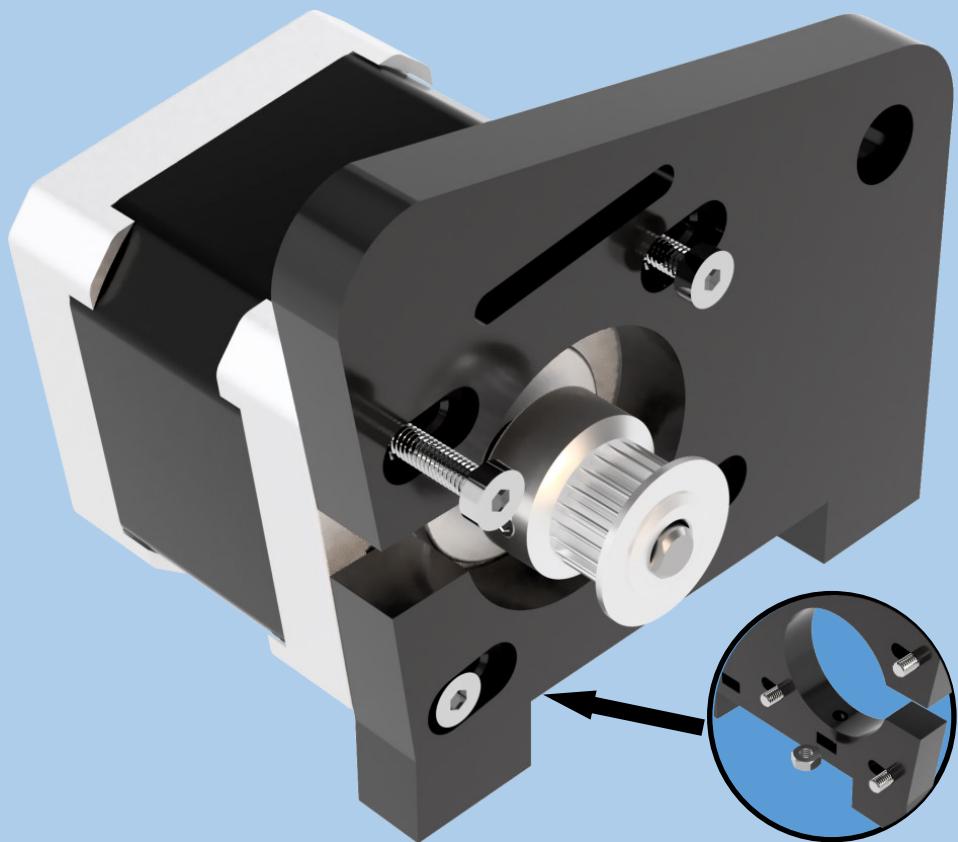
M3x10



M3



5



5



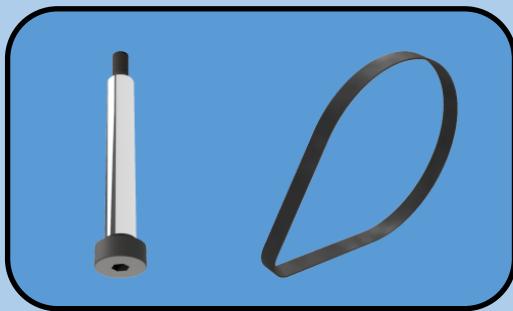
1x

2x

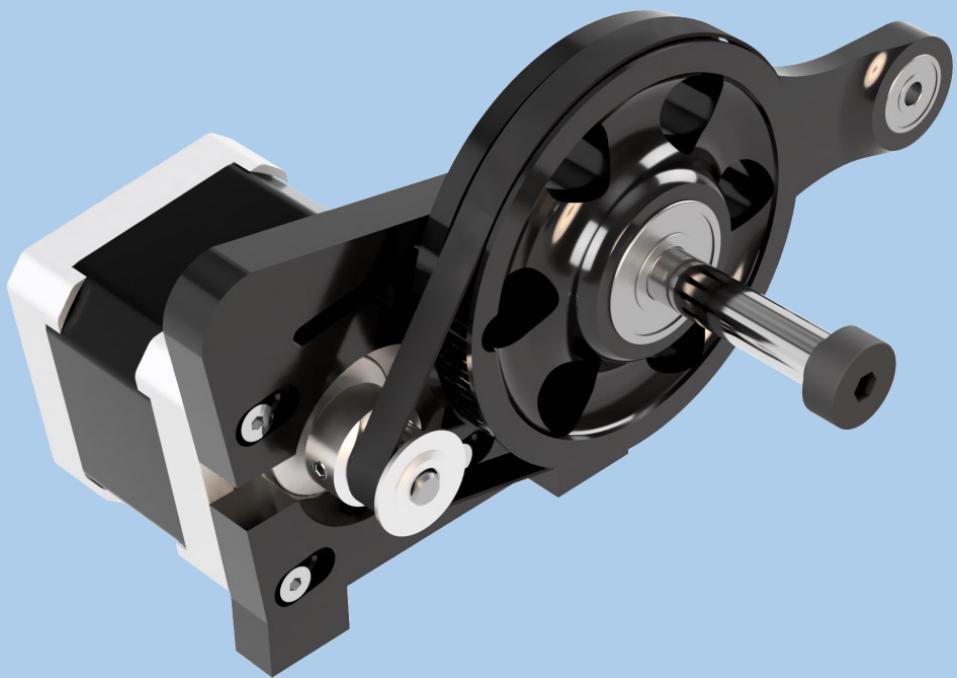
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6

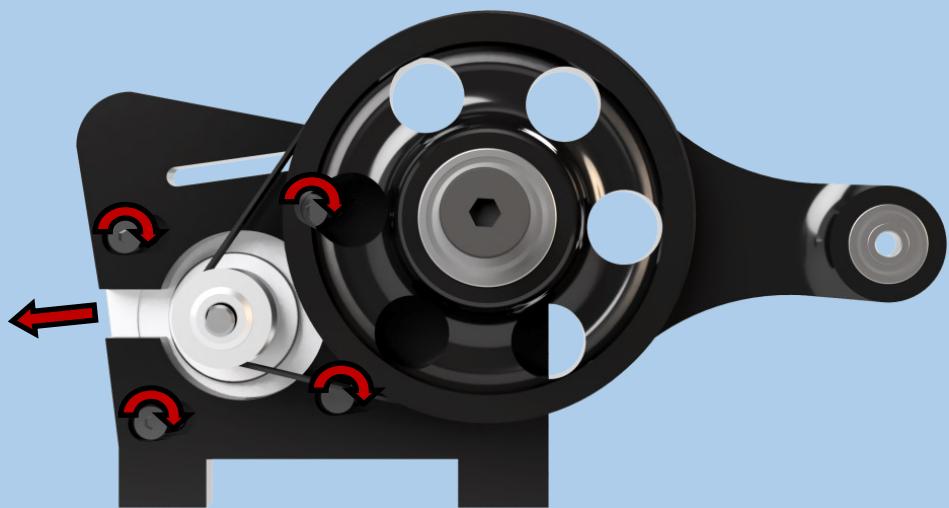
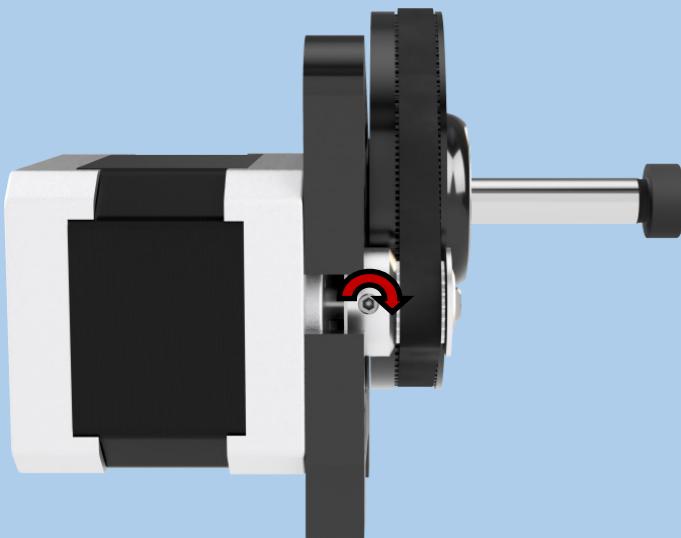


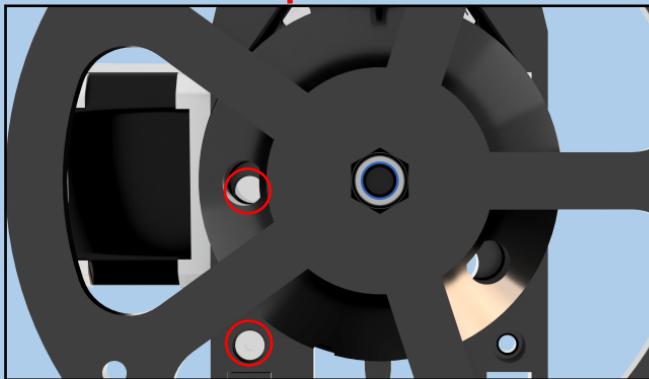
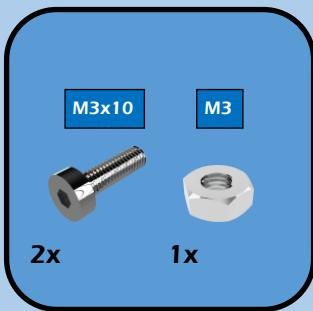


7

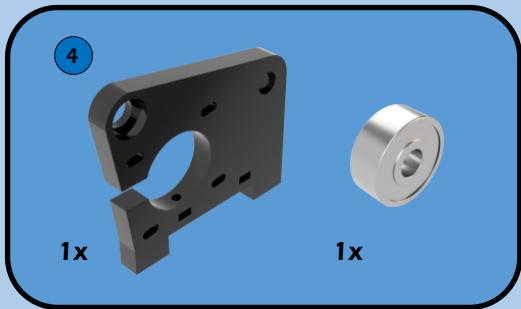


8

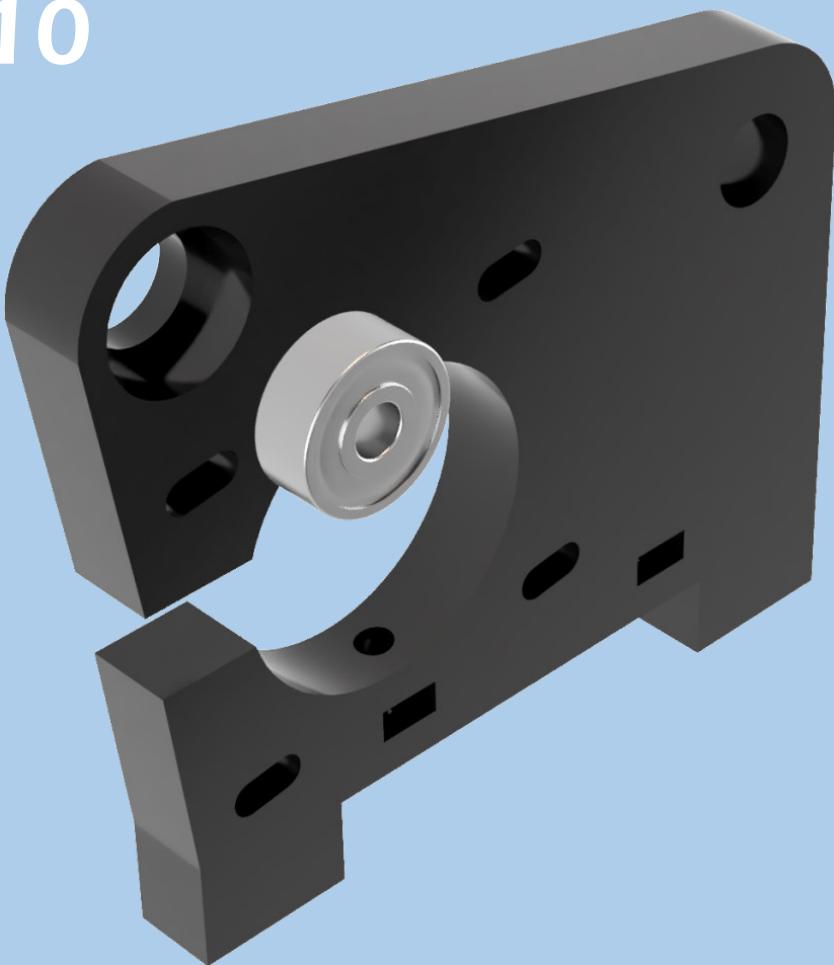




Bottom View



10





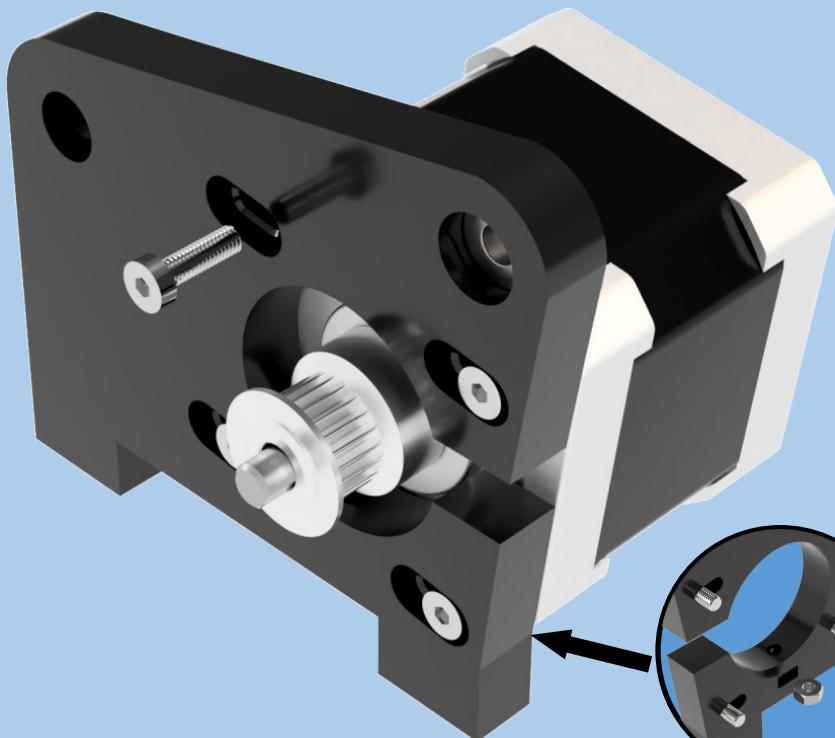
M3x10

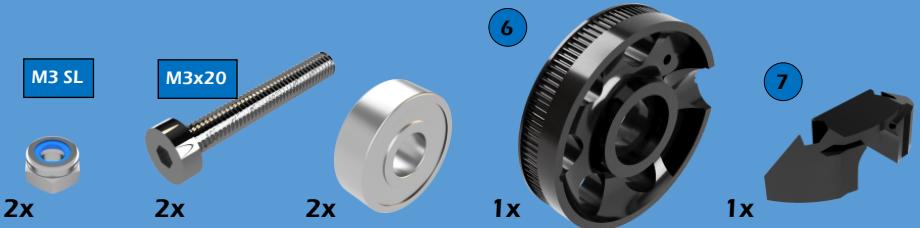


M3

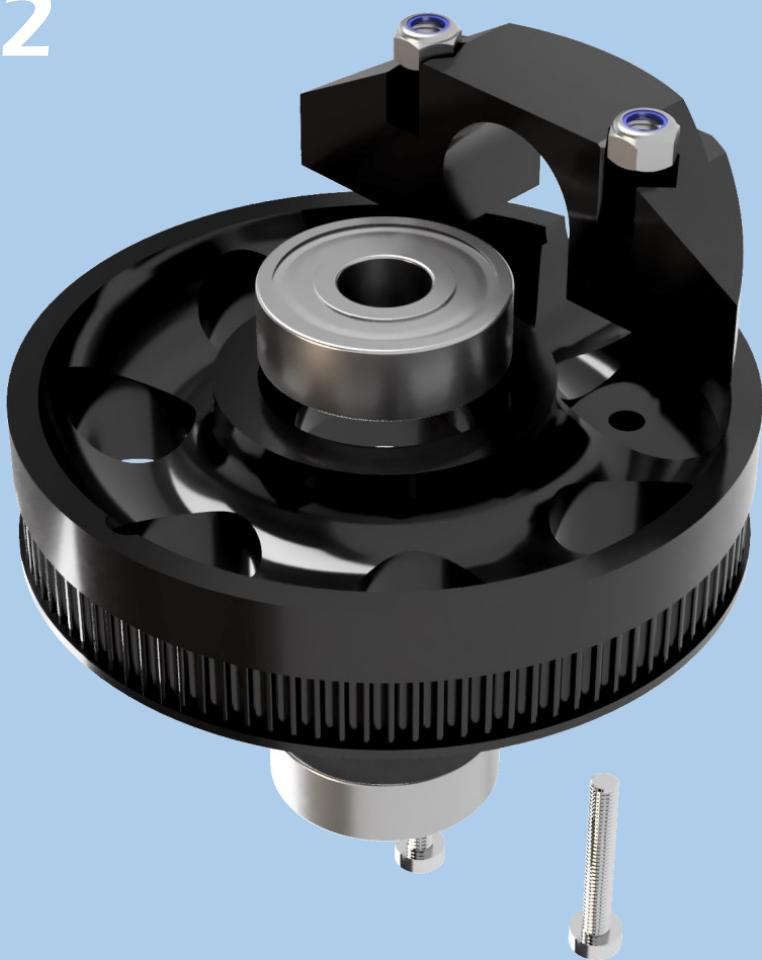


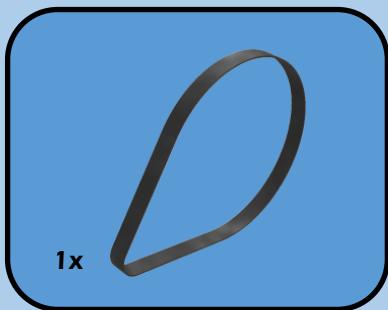
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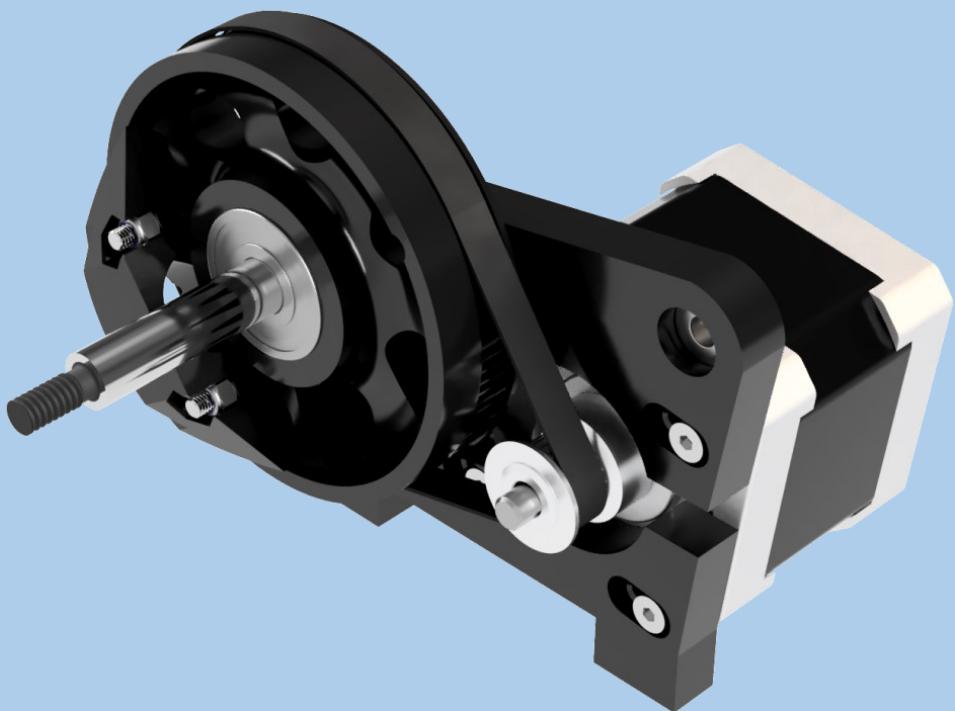
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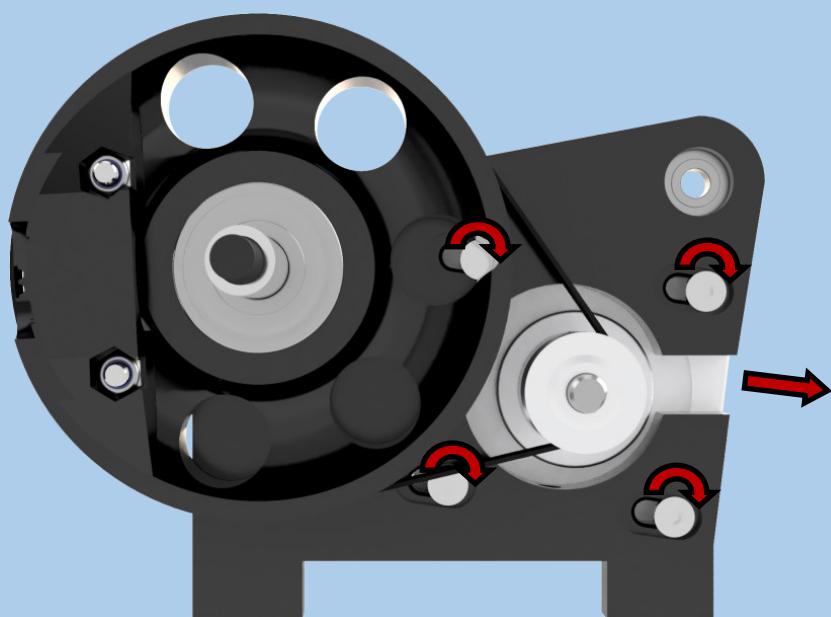
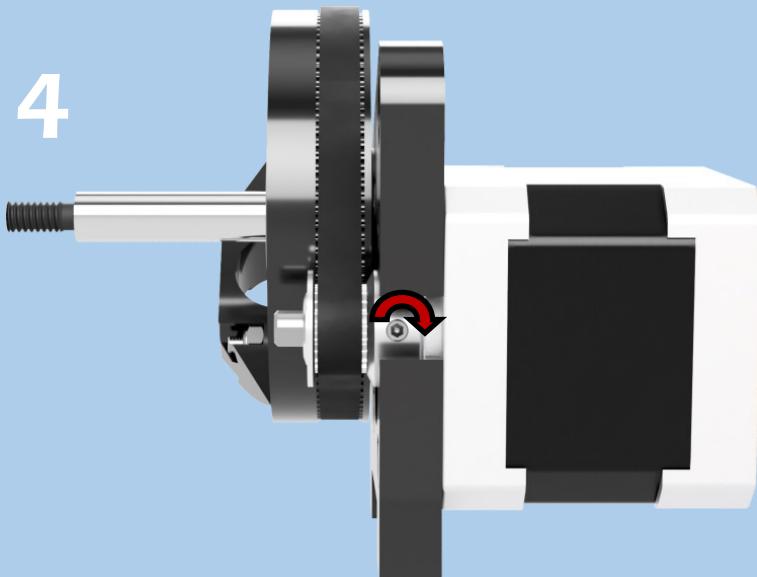


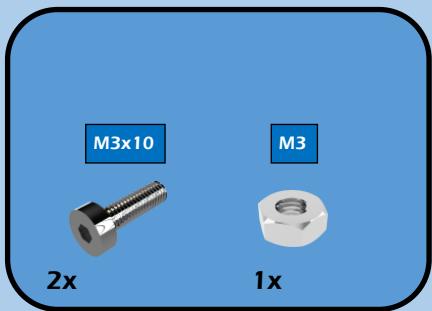
1x

13

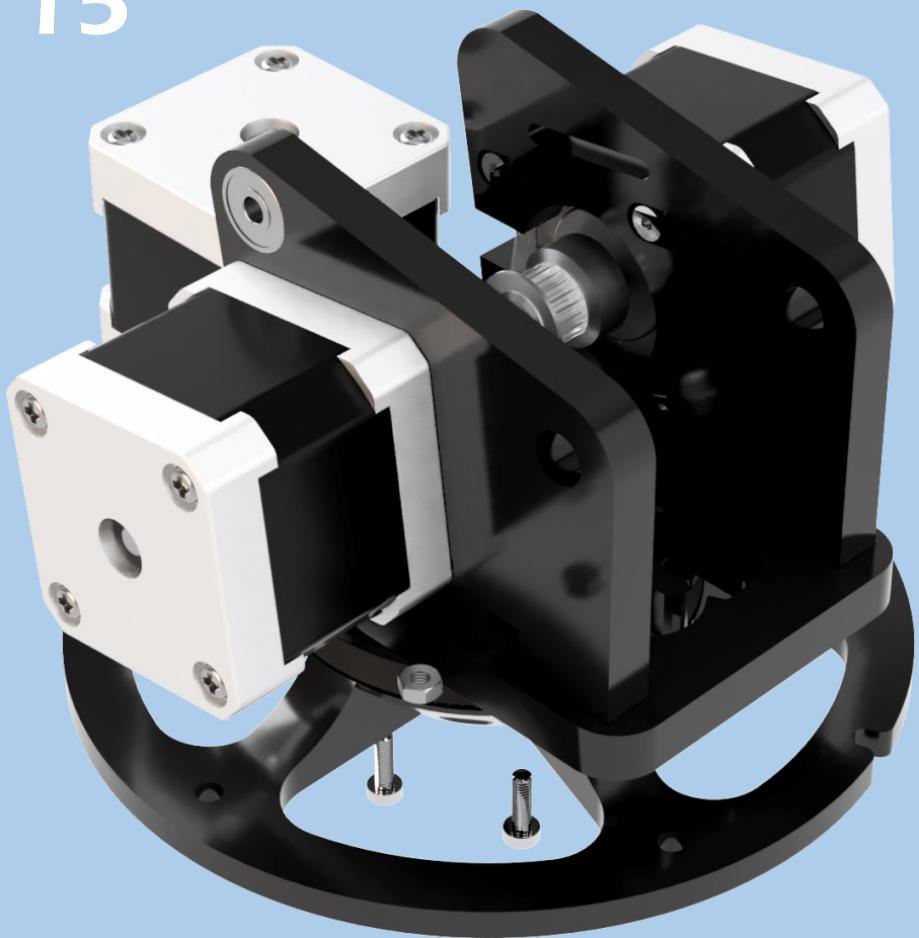


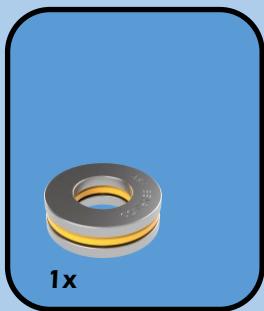
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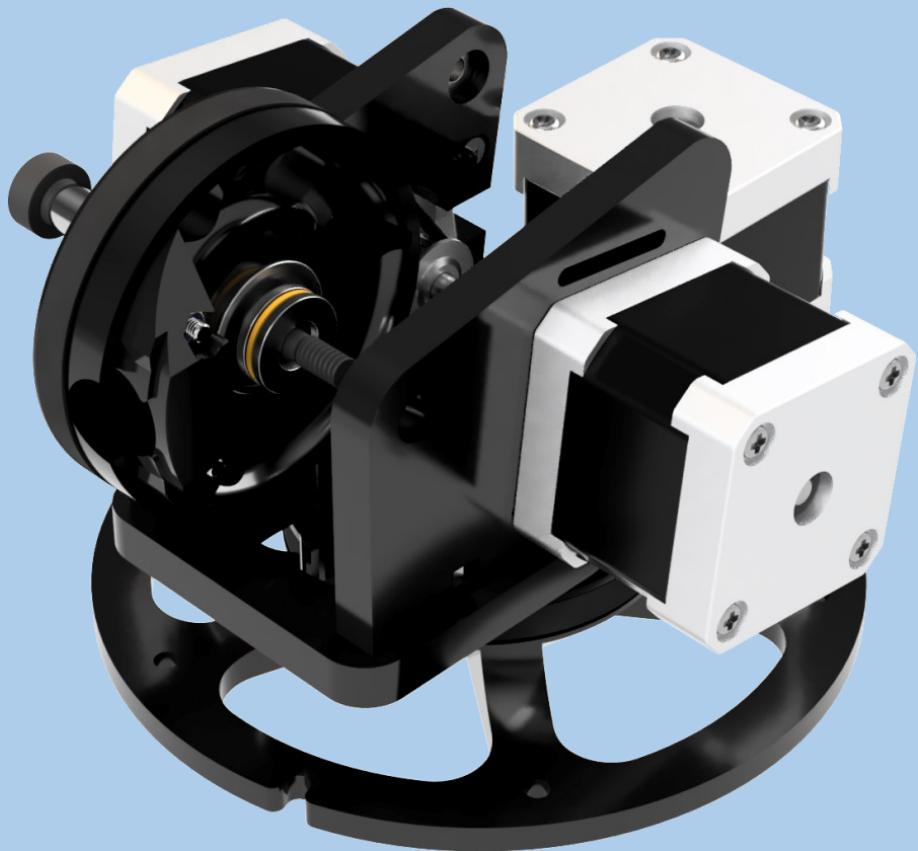


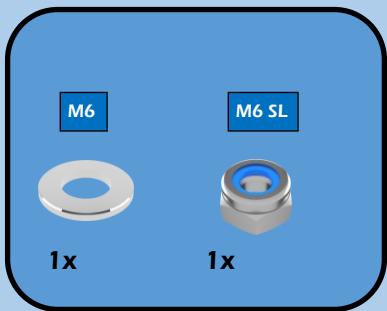
15



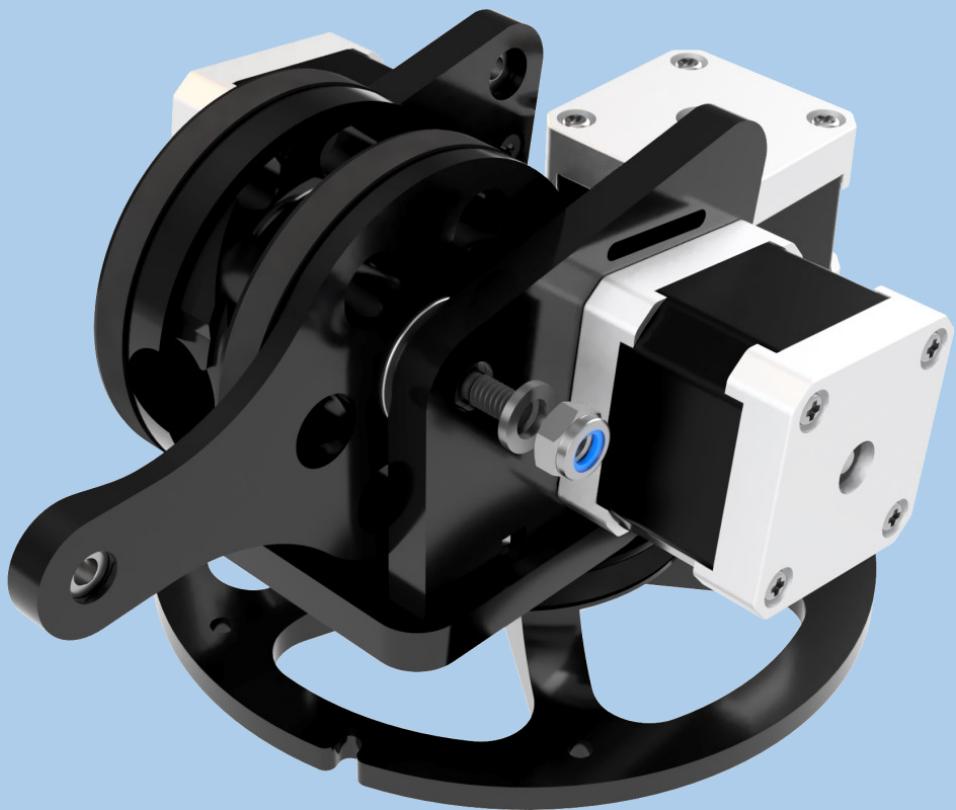


16





17



(10)



3x



3x



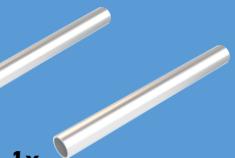
3x



6x



1x

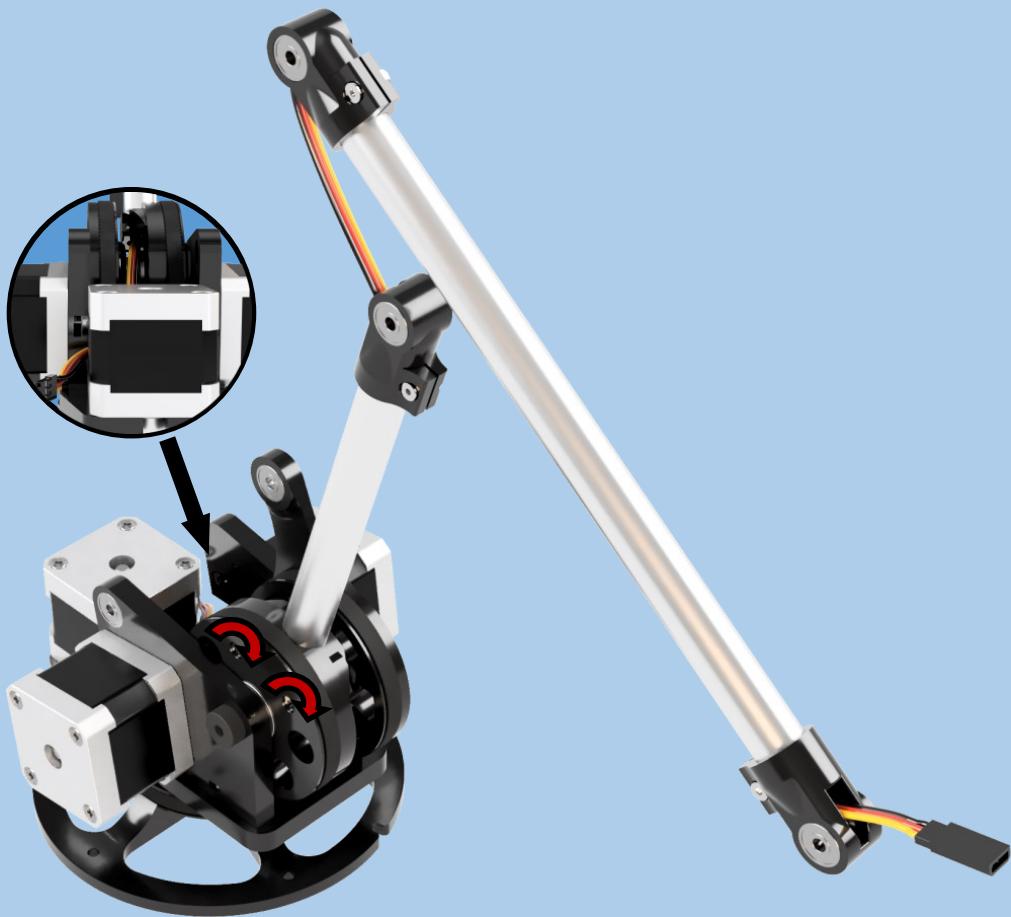


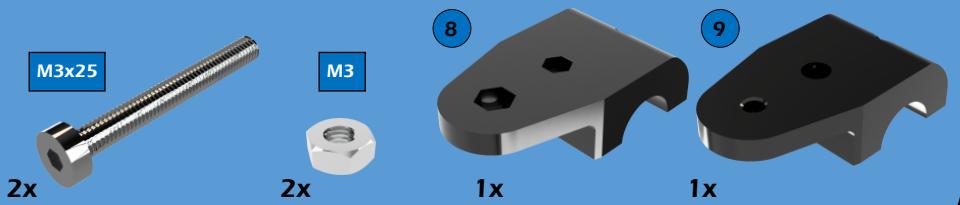
1x

18



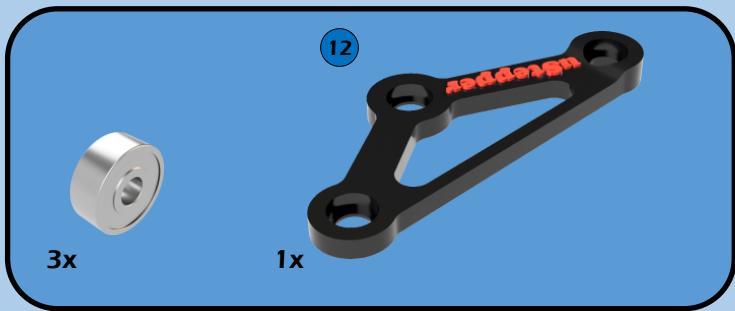
19





20





21



M4x35



1x

M4 SL



1x

M4



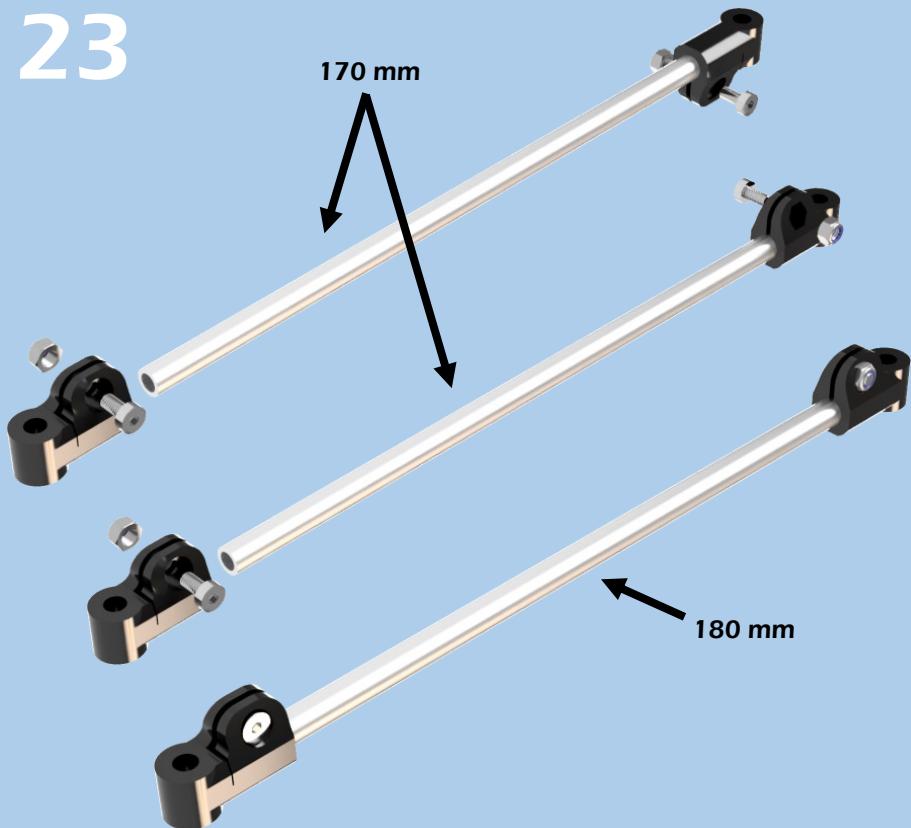
3x

22

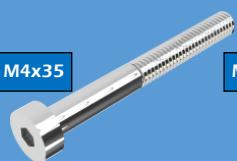




23



M4x35



1x

M4x20



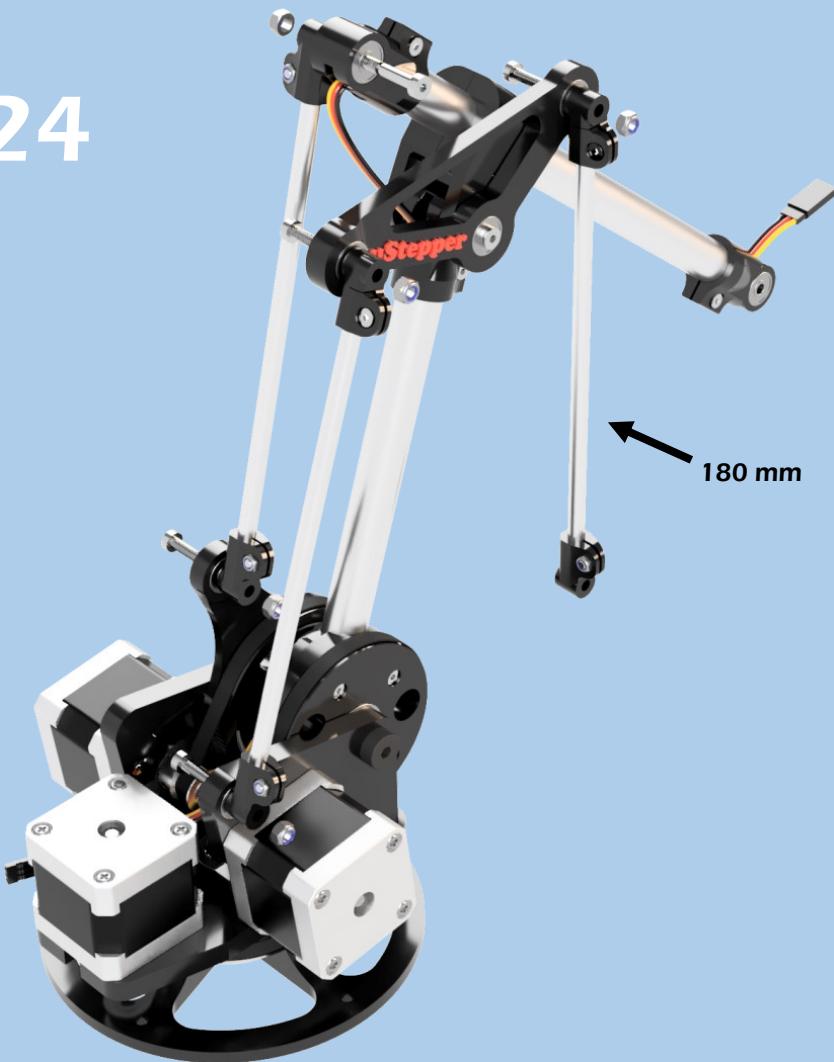
4x

M4 SL



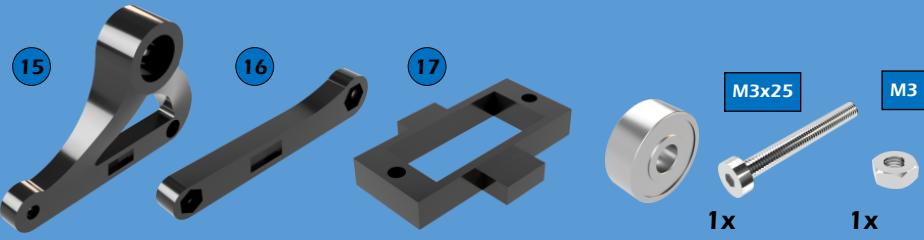
5x

24

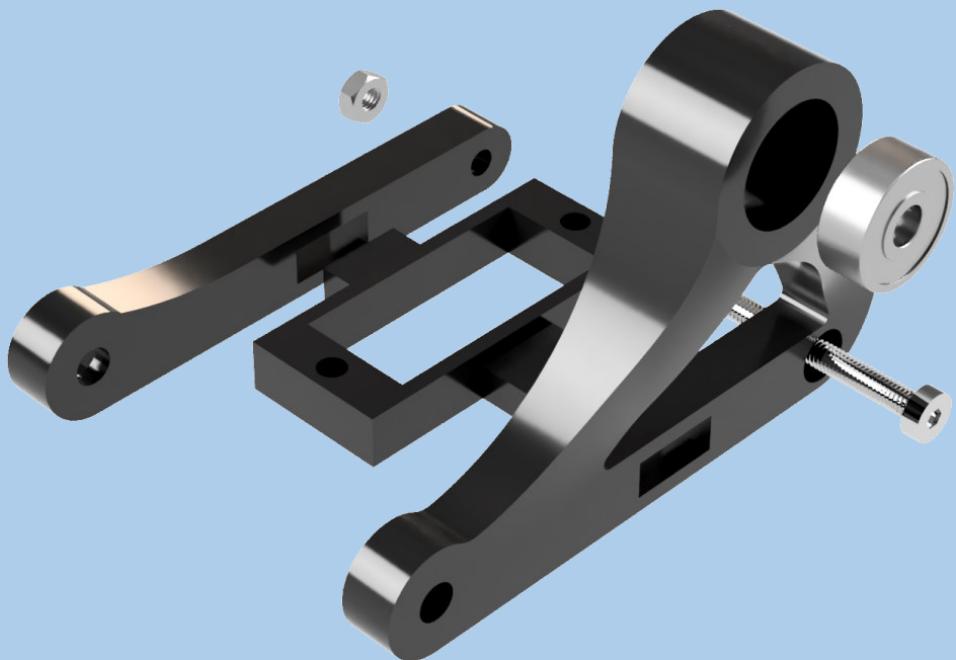




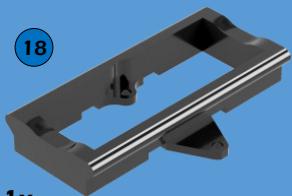
Robot Arm Gripper Assembly



25



18



1x

M3x20



2x

M3 SL

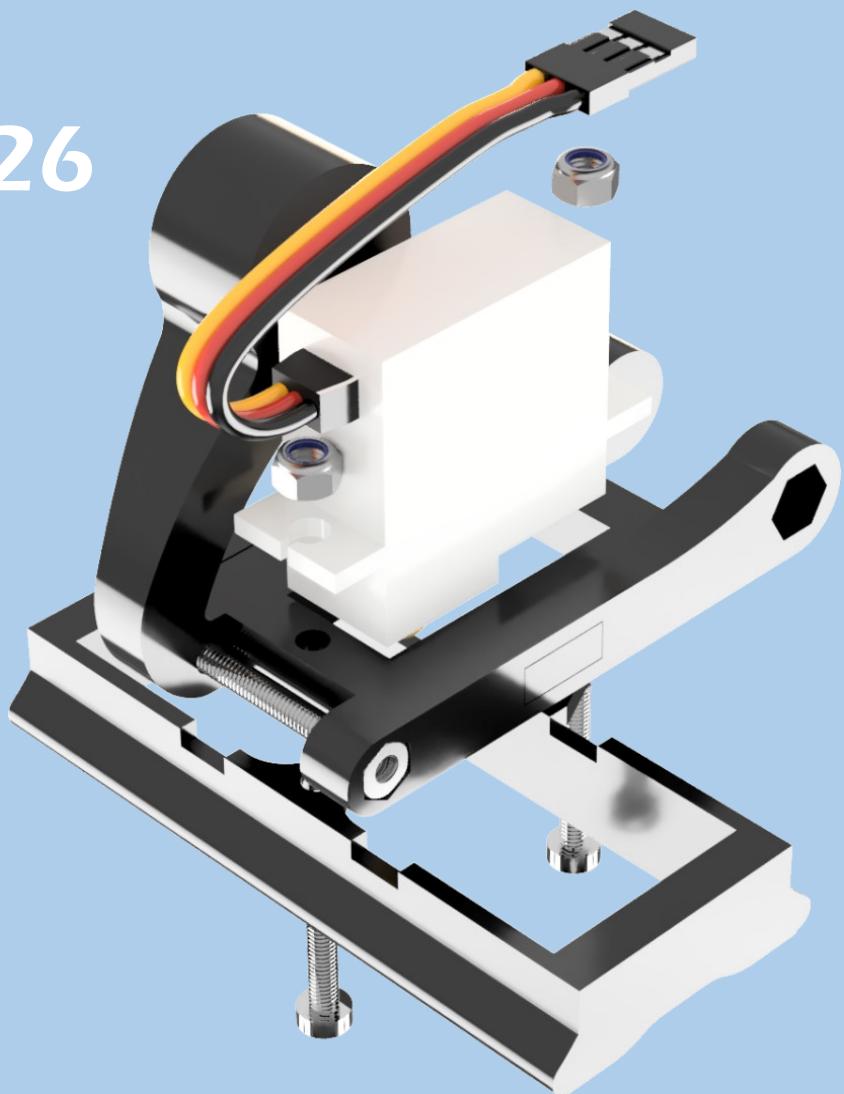


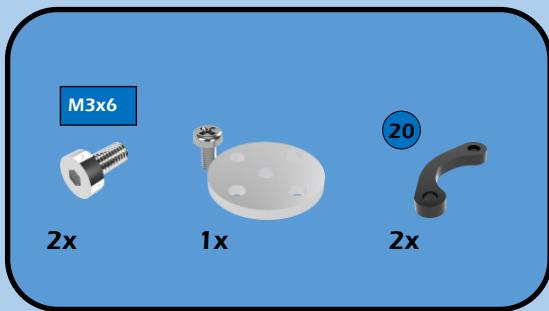
2x



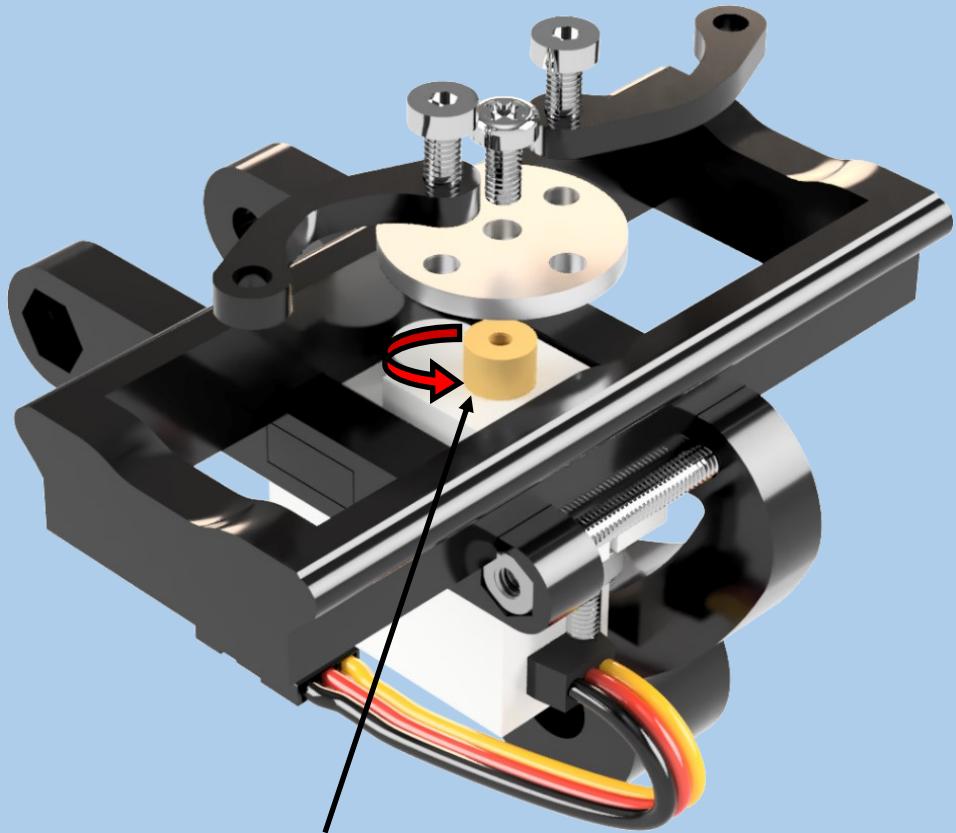
1x

26





27

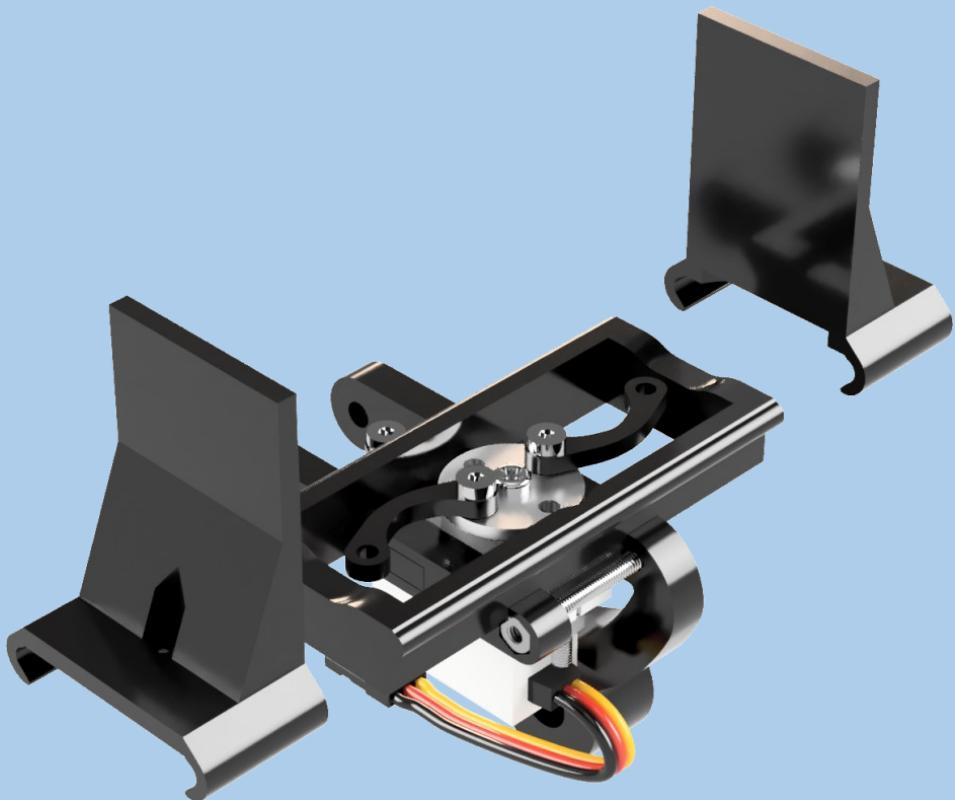


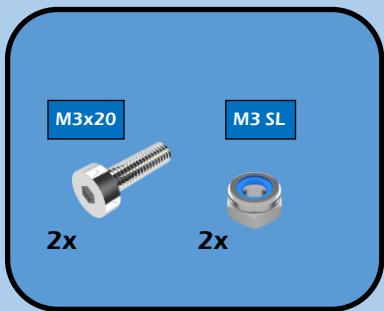
Make sure that the servo is at the furthest counter clockwise position

19

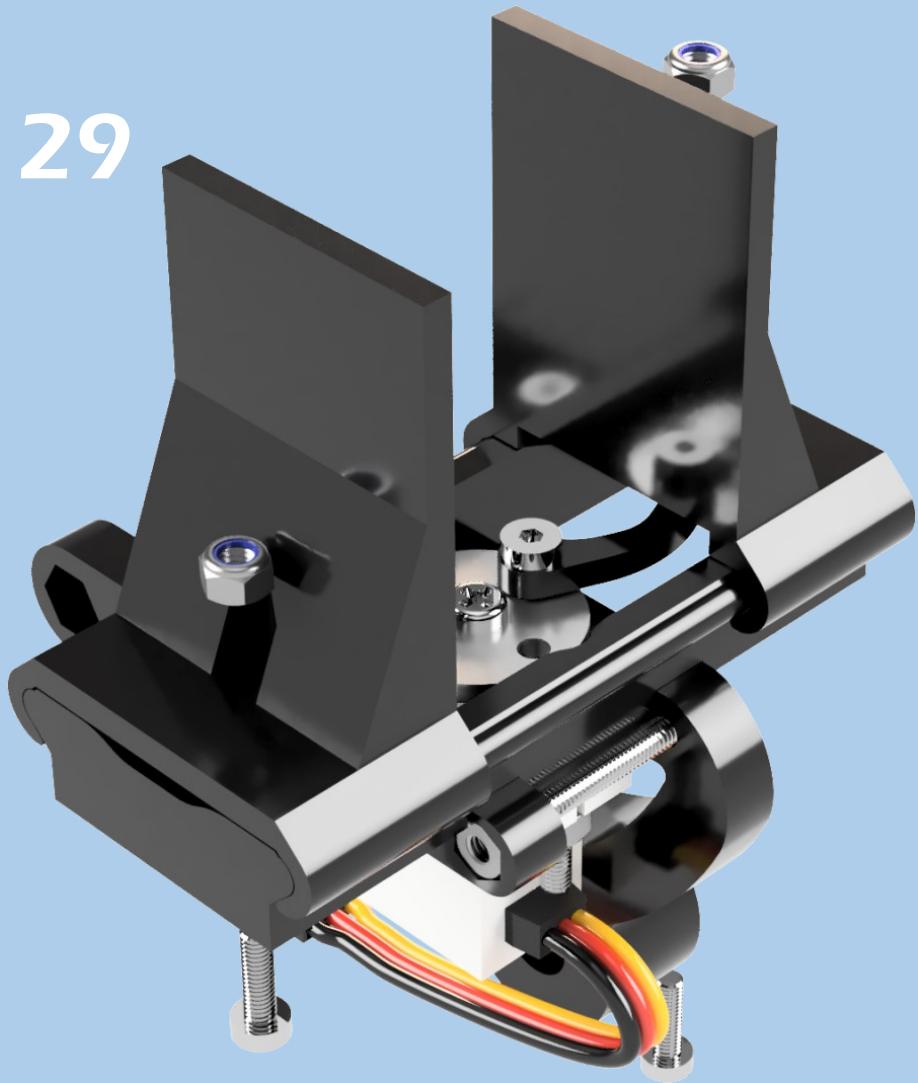
2x

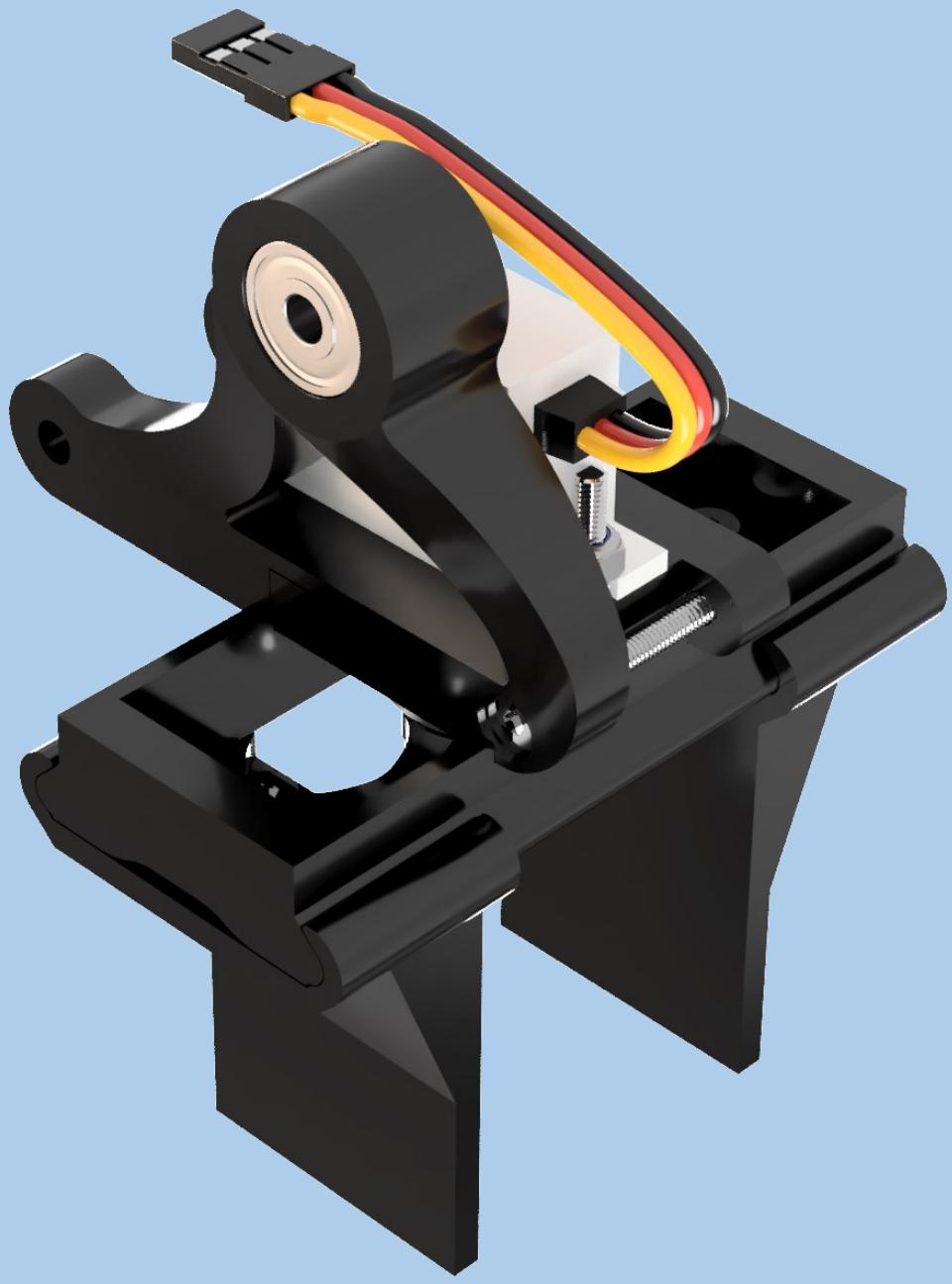
28





29





Robot Arm Gripper Mounting

M4x35



1x

M4x20



1x

M4 SL



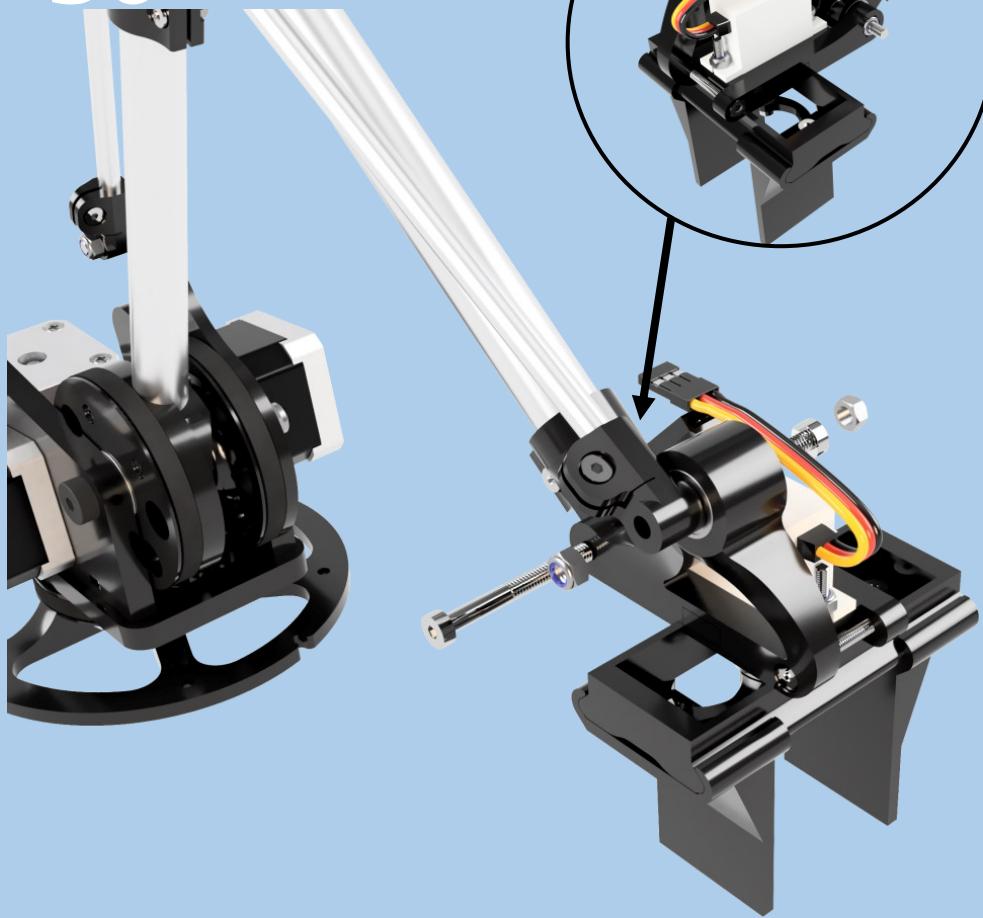
2x

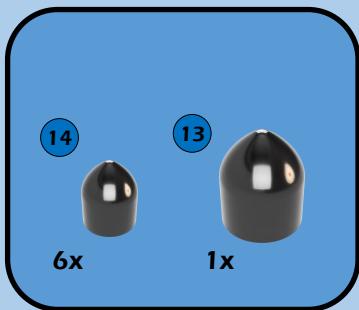
M4



2x

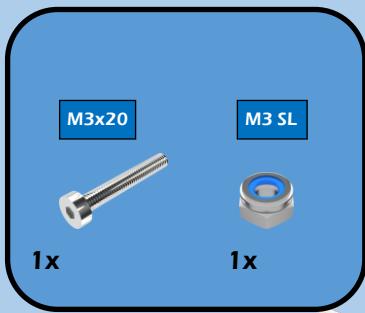
30





31



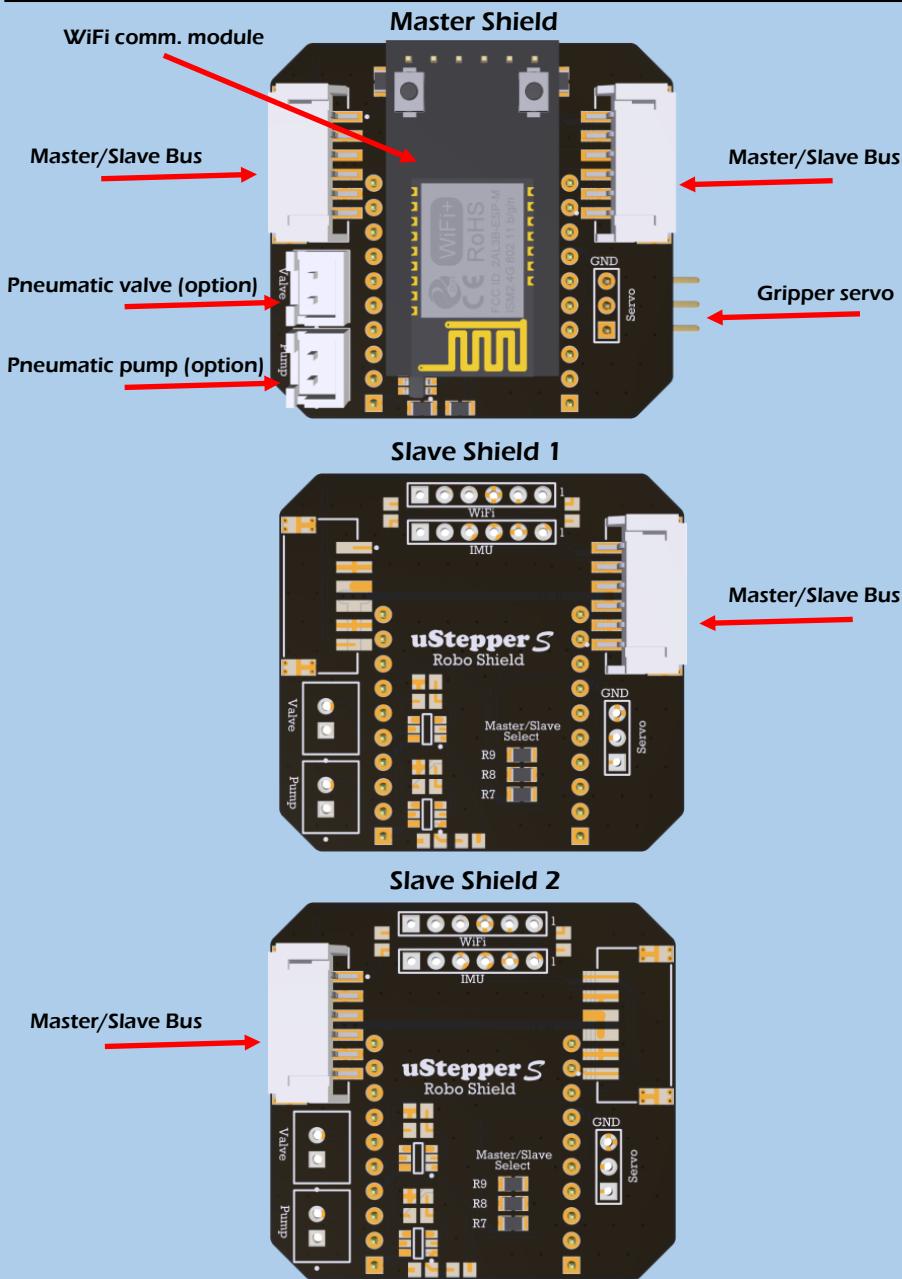


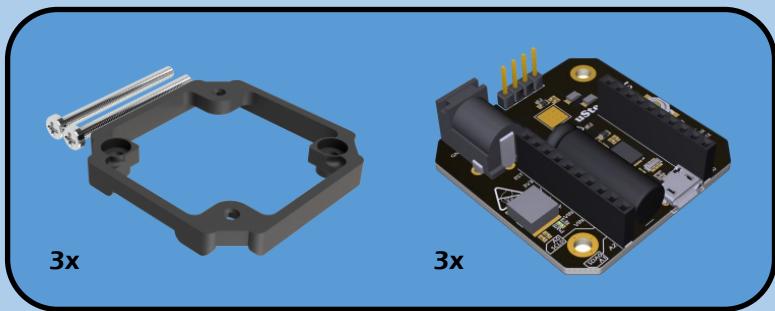
32



Robot Arm Electronics

Robot Shield Overview

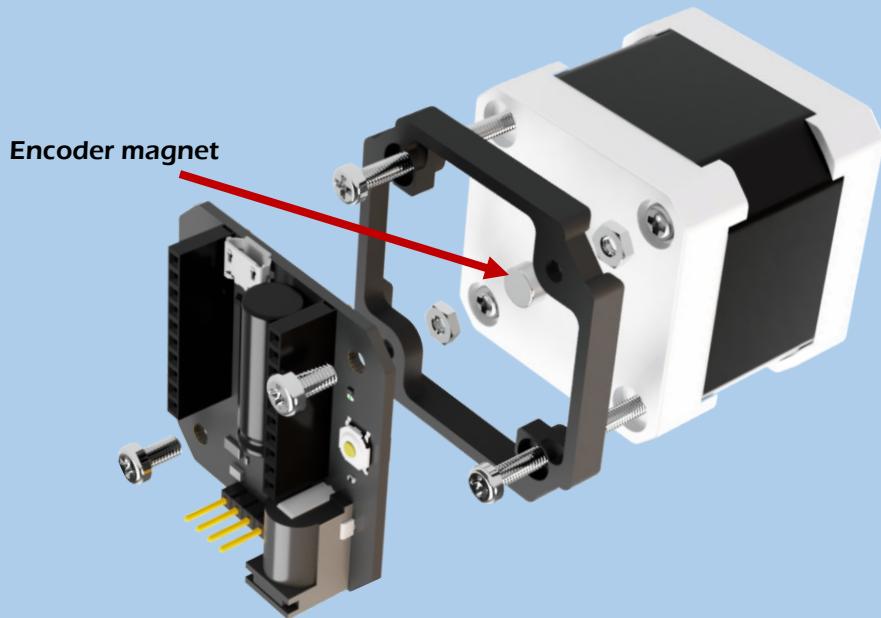


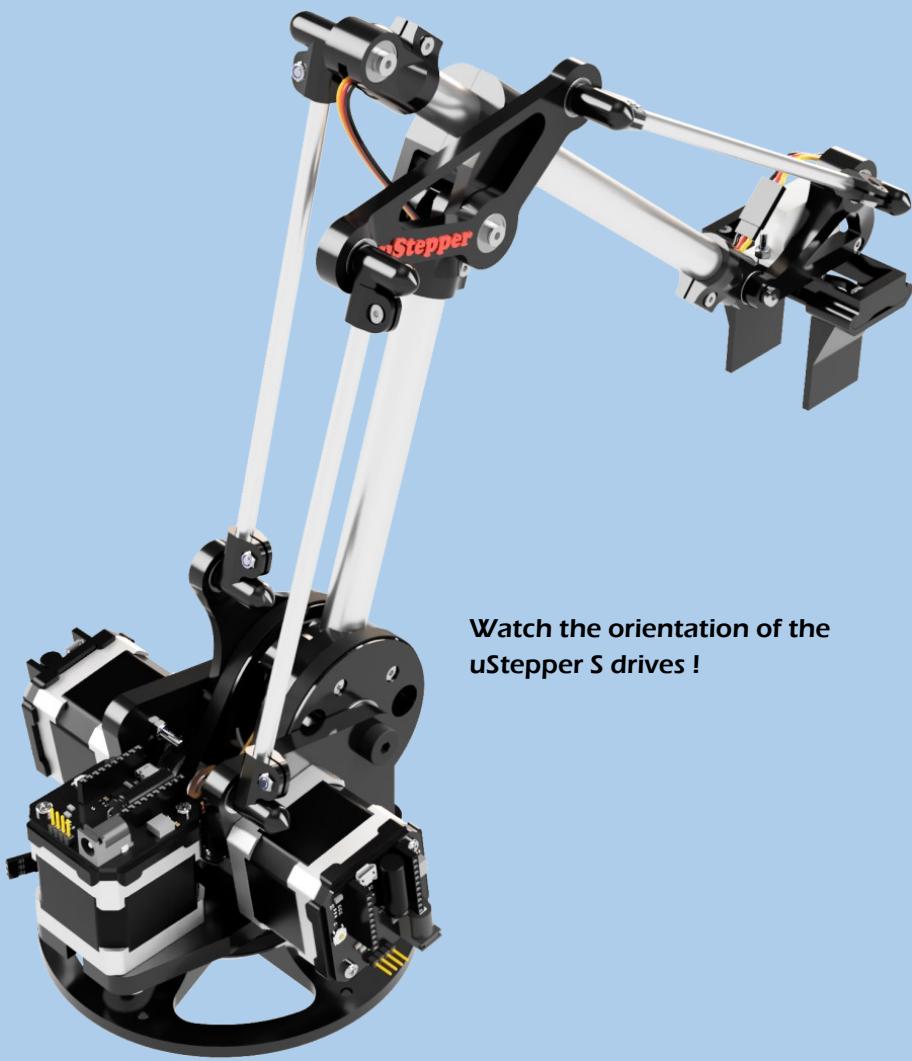


33

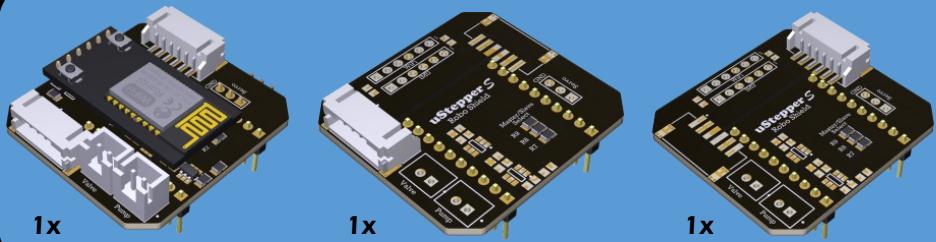
Mount uStepper S using the permanent bracket provided:

1. Remove two motor screws
2. Place encoder magnet on motor shaft
3. Insert nuts into bracket and mount bracket to motor w. two long screws
4. Secure uStepper S to the bracket with screws



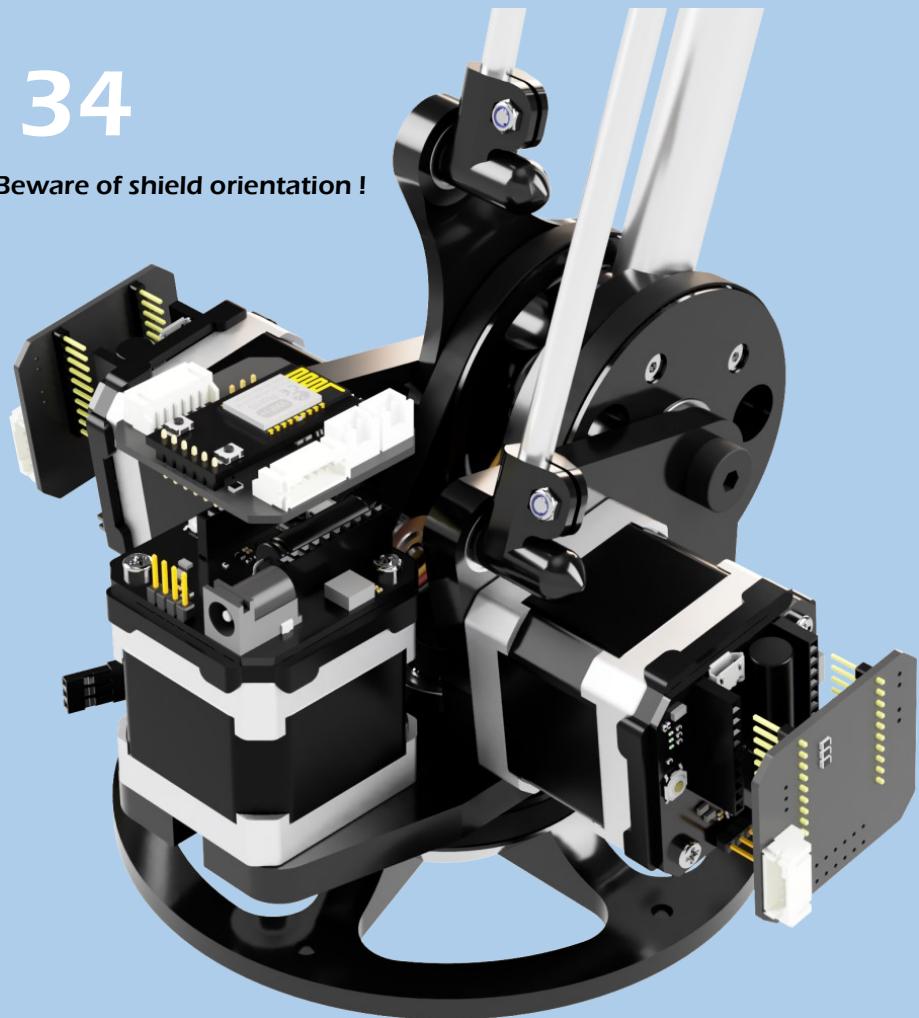


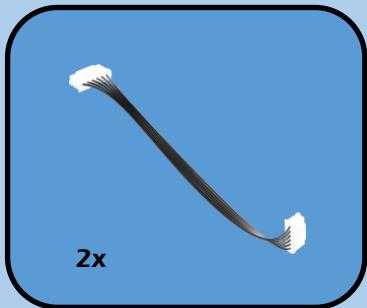
**Watch the orientation of the
uStepper S drives !**



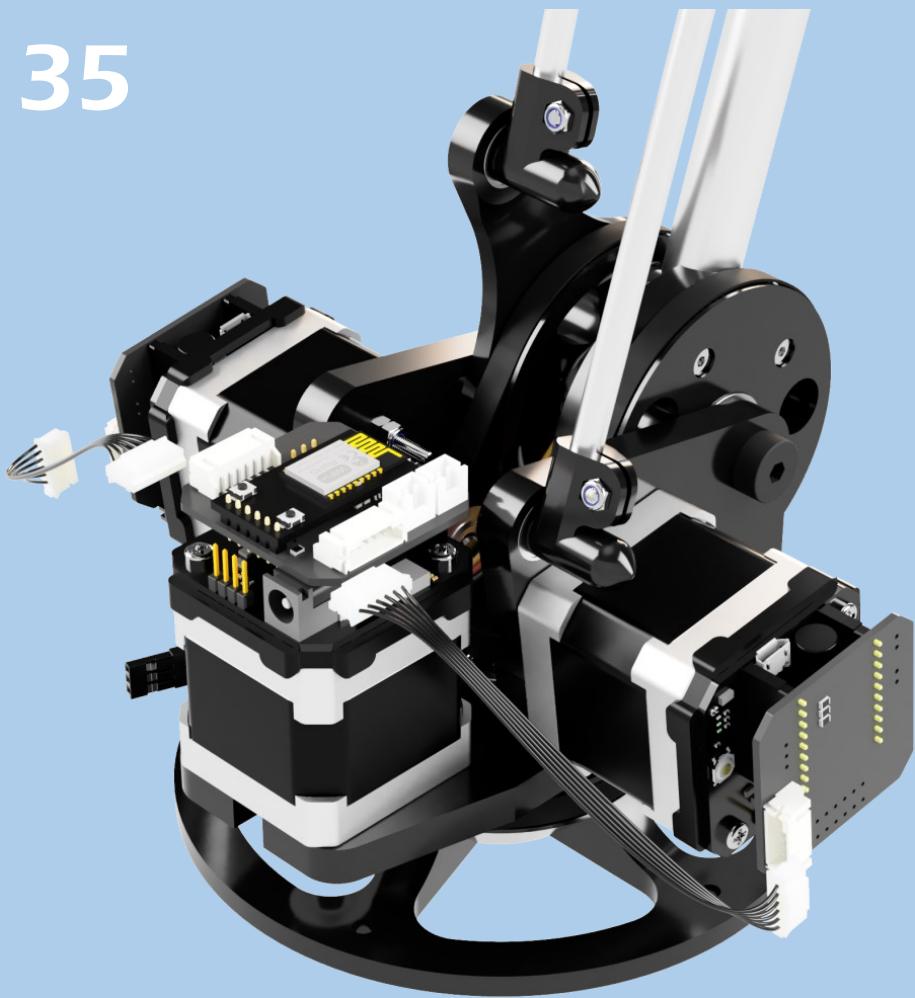
34

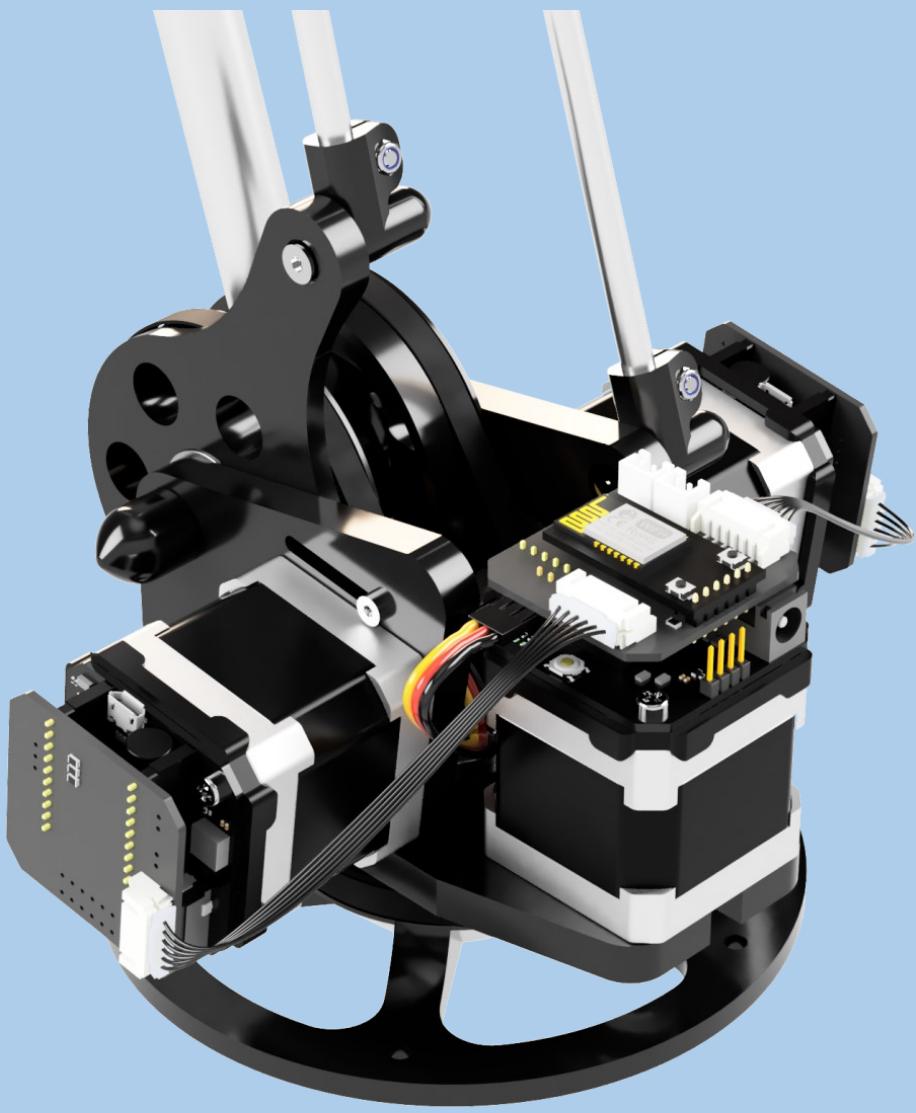
Beware of shield orientation !





35







Robot Arm Programming

The uStepper Robot Arm complete kit is designed to work with the uStepper Robot Arm Arduino library which manages the communication between the Master controller (with WiFi module) and the two Slaves using the uStepper Robot Shields. Power is provided for the Master uStepper S which distributes power and signals to the two Slaves and thus only one power cord is needed.

With the uStepper Robot Arm 4 complete kit the code comes pre-loaded on both the WiFi module and the uStepper S boards. While it is important to install the boards as depicted in the prior the boards automatically detects if it is a Slave or a Master and thus no programming should be required.

If for some reason there is a need to re-upload the code e.g. because of a new library version, please go to our GitHub and read the instructions on how to do this. You can get to the GitHub page by pressing [HERE](#) or scanning the QR code below !



Connecting to the Robot Arm UI

The uStepper Robot Arm WiFi module contains a webserver hosting a graphical user interface which enables you to control the arm as well as read status on e.g. the encoders.

To connect with the uStepper Robot Arm you'll need a device with WiFi and connect to "uStepper-GUI" as shown below:



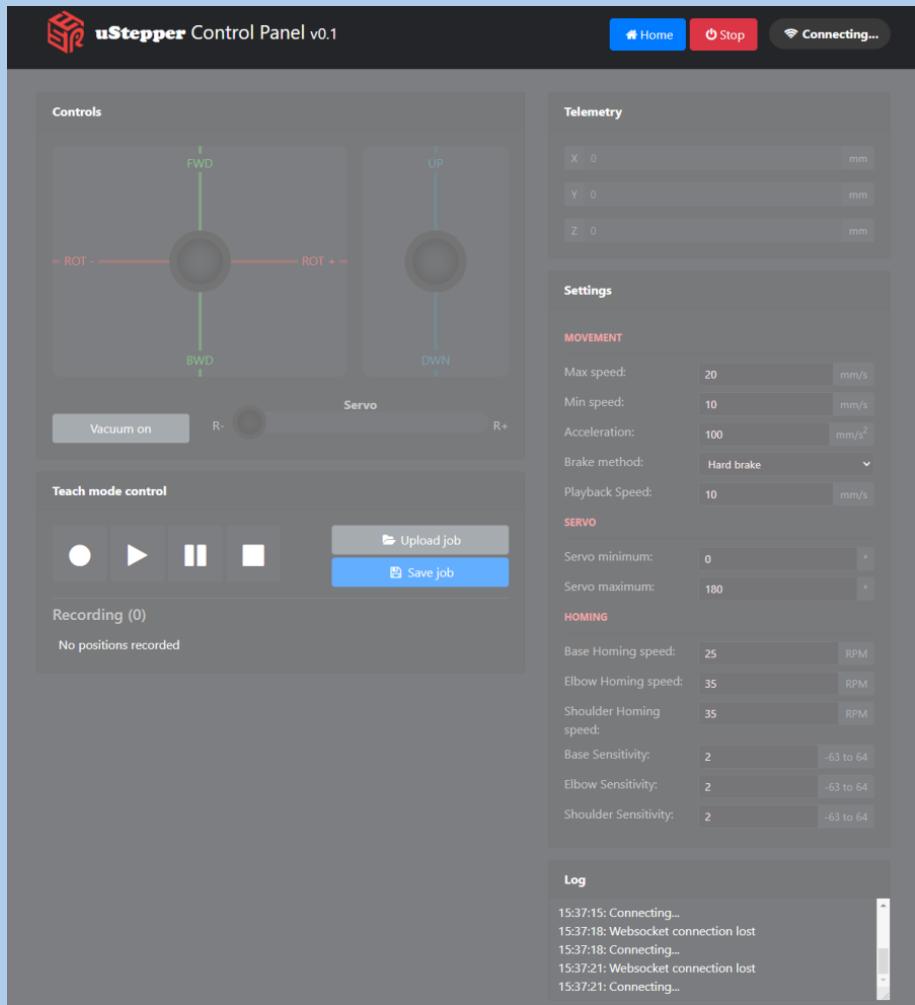
Password is "12345679"

When connected simply open up a browser window, type "192.168.4.1" and hit enter to get to the uStepper Robot Arm user interface:

A screenshot of the "uStepper Control Panel v0.1" software interface. The top navigation bar includes "Home", "Stop", and a "Connecting..." button. The main area is divided into several sections: "Controls" (with FWD, ROT -, BWD, ROT +, UP, DWN buttons), "Telemetry" (X: 0 mm, Y: 0 mm, Z: 0 mm), "Settings" (Movement: Max speed 20 mm/s, Min speed 10 mm/s, Acceleration 100 mm/s², Brake method Hard brake; Servo: Servo minimum 0, Servo maximum 180; Homing: Base Homing speed 25 RPM, Elbow Homing speed 35 RPM, Shoulder Homing 35 RPM), and "Teach mode control" (with playback controls like play, pause, stop, and a "Save job" button). A message at the bottom states "Recording (0) No positions recorded".

Controlling the Robot Arm

The user interface has a top bar where connection status is shown as well as a homing button for homing the Robot and a stop button for stopping it.



Controlling the Robot Arm

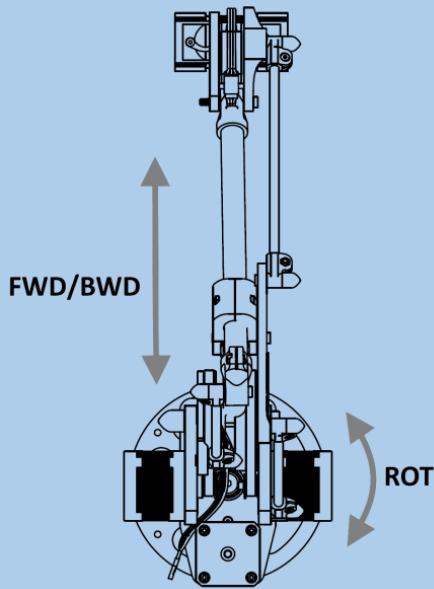
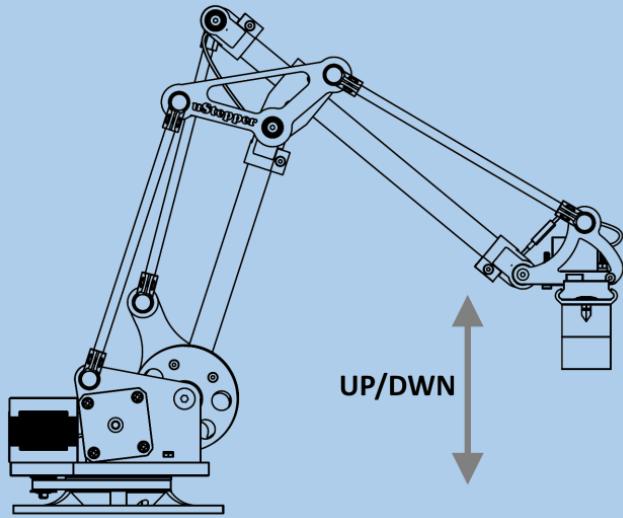
The Controls section provides two joystick style controls for moving the robot Forward/Backwards, Rotate and Up/Down (see next page). Below this is a button for activating and de-activating vacuum suction (optional part) and a slider for rotating the end effector servo.

The screenshot shows the uStepper Control Panel v0.1 interface. At the top, there is a logo and the text "uStepper Control Panel v0.1". On the right side, there are three buttons: "Home" (blue), "Stop" (red), and "Connecting..." (grey).

The main area is divided into several sections:

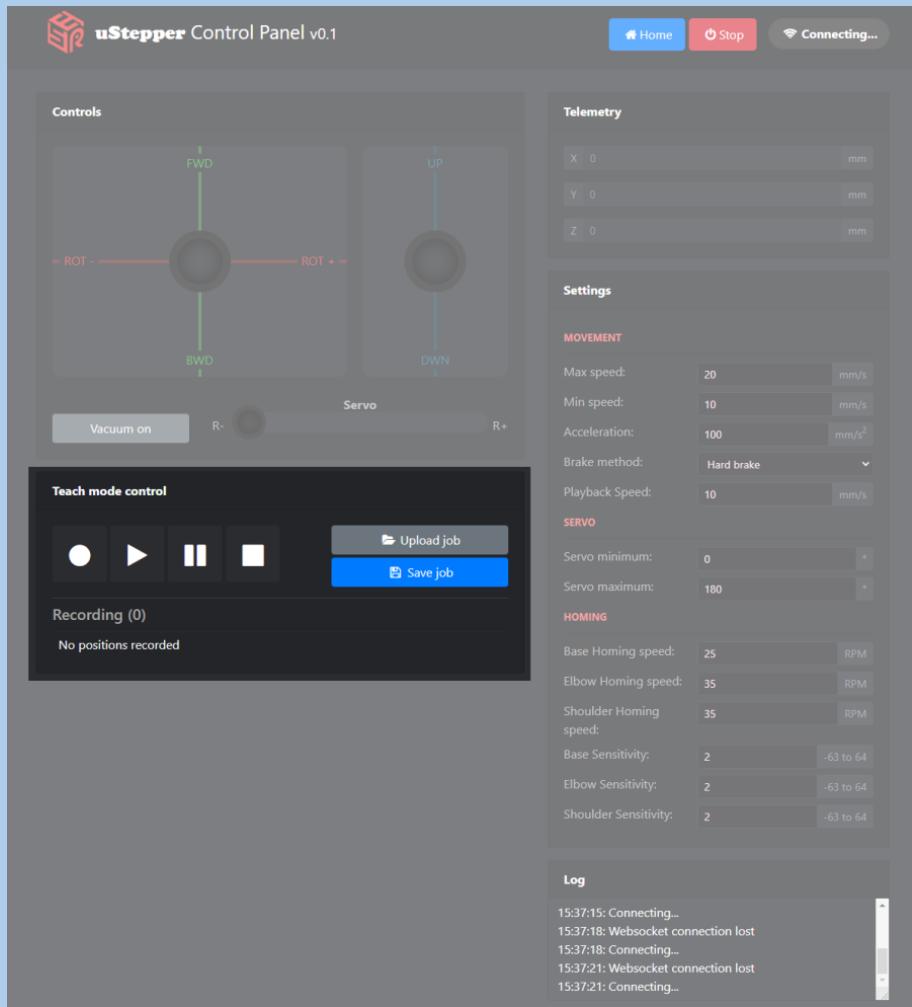
- Controls:** Contains two joysticks. The left joystick has arrows pointing FWD, ROT -, ROT +, and BWD. The right joystick has arrows pointing UP, DWN, and DWN. Below the joysticks are buttons for "Vacuum on" and "Servo" with R- and R+ sliders.
- Telemetry:** Displays current position values for X (0 mm), Y (0 mm), and Z (0 mm).
- Settings:** Contains sections for MOVEMENT, SERVO, and HOMING, each with various configuration parameters.
- Teach mode control:** Includes buttons for recording, playback, and pausing, along with "Upload job" and "Save job" buttons.
- Recording (0):** Displays the message "No positions recorded".
- Log:** Shows a list of log entries:
 - 15:37:15: Connecting...
 - 15:37:18: Websocket connection lost
 - 15:37:18: Connecting...
 - 15:37:21: Websocket connection lost
 - 15:37:21: Connecting...

Controlling the Robot Arm



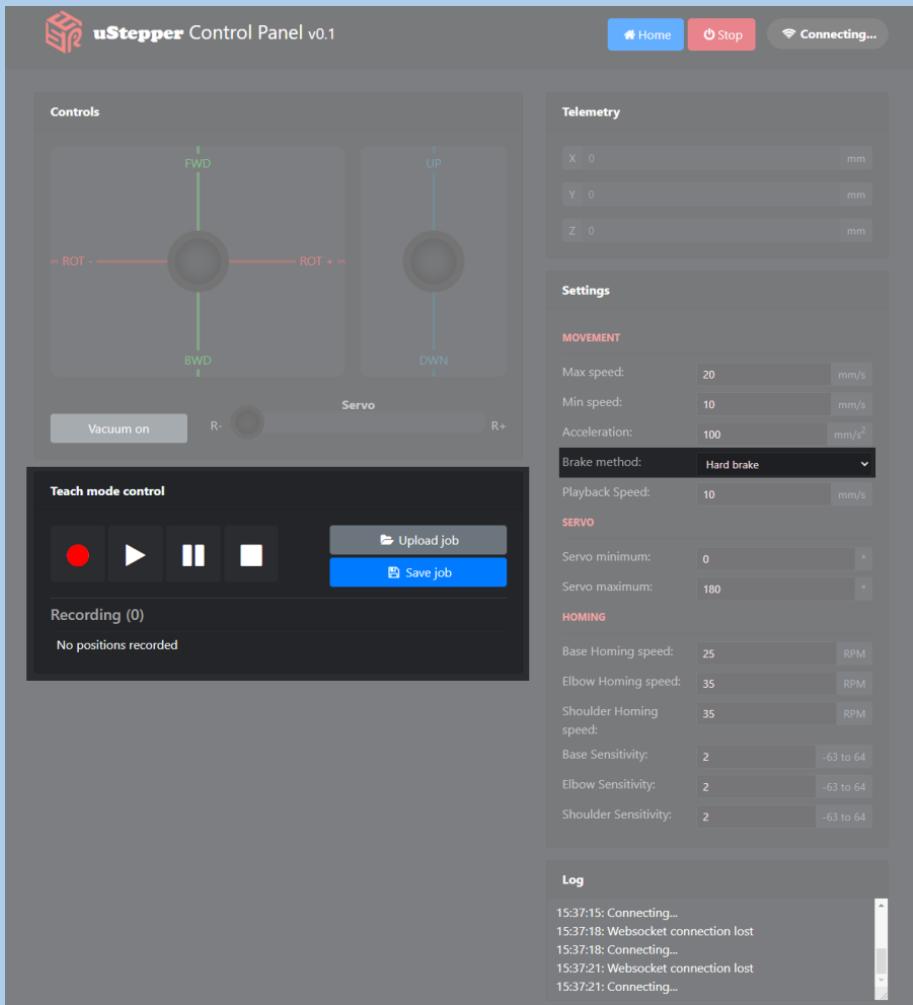
Controlling the Robot Arm

The Teach mode controls section provides buttons for recording sequences and playing them back. The recording of a sequence is started by pressing the record button—see next page for details on how to do the recordings.



Controlling the Robot Arm

After pressing record it lights up red and it is now possible to add positions as needed. Gripper position changes from one position to another is also recorded, i.e. pressing record, closing the gripper and pressing record again will record closing of the gripper. Jobs can be saved to and loaded from an external source by using the save and upload buttons. To move the robot by hand—set the brake to Freewheel or CoolBrake.



Controlling the Robot Arm

In the right corner a telemetry section is found. The current position read from the uStepper controllers is displayed here.

The screenshot shows the uStepper Control Panel v0.1 interface. It includes:

- Controls:** Buttons for FWD, BWD, ROT +, ROT -, UP, DWN, Vacuum on, R-, Servo, and R+.
- Telemetry:** Displays current positions X: 0 mm, Y: 0 mm, Z: 0 mm.
- Settings:**
 - MOVEMENT:** Max speed: 20 mm/s, Min speed: 10 mm/s, Acceleration: 100 mm/s², Brake method: Hard brake, Playback Speed: 10 mm/s.
 - SERVO:** Servo minimum: 0, Servo maximum: 180.
 - HOMING:** Base Homing speed: 25 RPM, Elbow Homing speed: 35 RPM, Shoulder Homing speed: 35 RPM, Base Sensitivity: 2 (-63 to 64), Elbow Sensitivity: 2 (-63 to 64), Shoulder Sensitivity: 2 (-63 to 64).
- Log:** A list of log entries including: 15:37:15: Connecting..., 15:37:18: WebSocket connection lost, 15:37:18: Connecting..., 15:37:21: WebSocket connection lost, 15:37:21: Connecting... .

Controlling the Robot Arm

The settings section gives the ability to set max and min speed of the drives, speed of recording playback, the min and max angle of the servo (the gripper will not use the full range on all objects) and finally the homing settings - where the settings shown are usually suitable for a 19V supply voltage.

The screenshot shows the uStepper Control Panel v0.1 interface. At the top, there is a logo and the text "uStepper Control Panel v0.1". On the right side, there are three buttons: "Home" (blue), "Stop" (red), and "Connecting..." (grey).

The main area is divided into several sections:

- Controls:** Contains two circular joysticks. The left joystick has arrows labeled "FWD" (top), "BWD" (bottom), "ROT -" (left), and "ROT +" (right). The right joystick has arrows labeled "UP" (top), "DWN" (bottom), and "ROT +" (right). Below the joysticks are buttons for "Vacuum on" (grey), "R-" (grey), "Servo" (grey), and "R+" (grey).
- Telemetry:** Displays current position values for X (0 mm), Y (0 mm), and Z (0 mm).
- Settings:** A large panel containing movement and servo settings.
 - MOVEMENT:** Max speed: 20 mm/s, Min speed: 10 mm/s, Acceleration: 100 mm/s², Brake method: Hard brake, Playback Speed: 10 mm/s.
 - SERVO:** Servo minimum: 0, Servo maximum: 180.
 - HOMING:** Base Homing speed: 25 RPM, Elbow Homing speed: 35 RPM, Shoulder Homing speed: 35 RPM, Base Sensitivity: 2 (-63 to 64), Elbow Sensitivity: 2 (-63 to 64), Shoulder Sensitivity: 2 (-63 to 64).
- Log:** A scrollable list of log entries:
 - 15:37:15: Connecting...
 - 15:37:18: WebSocket connection lost
 - 15:37:18: Connecting...
 - 15:37:21: WebSocket connection lost
 - 15:37:21: Connecting...

Controlling the Robot Arm

In the lower right corner a Log is constantly providing feedback from the system - making it possible to e.g. see the Robot Arm connection status like shown here.

The screenshot shows the uStepper Control Panel v0.1 interface. At the top, there is a logo and the text "uStepper Control Panel v0.1". On the right side, there are three buttons: "Home" (blue), "Stop" (red), and "Connecting..." (grey).

Controls: This section contains two circular joysticks. The left joystick has "FWD" at the top and "BWD" at the bottom. The right joystick has "UP" at the top and "DWN" at the bottom. Below the joysticks are buttons for "Vacuum on", "R-", "Servo", and "R+".

Telemetry: Displays current position values for X (0 mm), Y (0 mm), and Z (0 mm).

Settings:

- MOVEMENT:** Max speed: 20 mm/s, Min speed: 10 mm/s, Acceleration: 100 mm/s², Brake method: Hard brake, Playback Speed: 10 mm/s.
- SERVO:** Servo minimum: 0, Servo maximum: 180.
- HOMING:** Base Homing speed: 25 RPM, Elbow Homing speed: 35 RPM, Shoulder Homing speed: 35 RPM, Base Sensitivity: 2 (-63 to 64), Elbow Sensitivity: 2 (-63 to 64), Shoulder Sensitivity: 2 (-63 to 64).

Teach mode control: Includes buttons for play/pause, stop, and record, along with "Upload job" and "Save job" buttons.

Recording (0): Displays the message "No positions recorded".

Log: A scrollable list of log entries:

- 15:37:15: Connecting...
- 15:37:18: WebSocket connection lost
- 15:37:18: Connecting...
- 15:37:21: WebSocket connection lost
- 15:37:21: Connecting...

Additional information

The uStepper Robot Arm uses our own developed Arduino library and is based on a technical document written by us.

The technical document describes the math behind controlling the Robot i.e. the kinematics. The documentation is done thoroughly and with focus on simplicity using trigonometry. The aim is to provide the math on a level where it is accessible to both hobbyists and students.

Also 3D printable spare parts, parts for grippers and a full 3D Step model is found on our Git repo.



[Kinematics Calculations](#)



[Git repo](#)

Video Tutorials

A row of video tutorials showing the assembly of the robot as well as a walkthrough of the GUI control, teach control demos and more can be found on our YouTube channel.



[YouTube Channel](#)

Disclaimer

1 Disclaimers and Limitation of Liability

1.1 uStepper ApS and/or ON Development ApS (or any individuals affiliated with either of the two companies) can not be held responsible for any damage inflicted upon mounting or interfacing with uStepper products. This also includes damage to stepper motors (both electrical and mechanical) or any other 3rd party hardware connected to or interfacing with any uStepper products. Most stepper motor cases are made of aluminum, and care must be taken when preparing the mountings for uStepper.

1.2 uStepper ApS and/or ON Development APS (or any individuals affiliated with either of the two companies) can not be held responsible for any damage inflicted upon assembly of the uStepper Robot Arm. This includes damage to 3D printed parts, which must be considered to be of prototyping quality compared to injection moulded parts. Care must be taken while assembling 3D printed parts, and use of excessive force may lead to damage of the parts.

1.3 By using the uStepper products (including, but not limited to, hardware and software) you acknowledge that uStepper ApS and/or ON Development APS (or any individuals affiliated with either of the two companies) can not be held responsible for any personal injuries and/or damage to any 3rd party hardware that may occur when using the uStepper products.

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2.1 You agree to indemnify and hold uStepper ApS and/or ON Development APS and its employees and agents harmless from and against all liabilities, legal fees, damages, losses, costs and other expenses in relation to any claims or actions brought against uStepper ApS and/or ON Development APS arising out of any breach by you of these Terms and Conditions or other liabilities arising out of your use of this Website.

2.2 You agree to indemnify and hold uStepper ApS and/or ON Development APS and its employees and agents harmless from and against all liabilities, legal fees, damages, losses, costs and other expenses in relation to any claims or actions brought against uStepper ApS and/or ON Development APS arising out of any breach by you of these Terms and Conditions or other liabilities arising out of your use of products (including, but not limited to, hardware and software) developed, produced or sold by uStepper ApS and/or ON Development APS (or any individuals affiliated with either of the two companies).

3 Severance

If any of these Terms and Conditions should be determined to be invalid, illegal or unenforceable for any reason by any court of competent jurisdiction then such Term or Condition shall be severed and the remaining Terms and Conditions shall survive and remain in full force and effect and continue to be binding and enforceable.

