

ASSEMBLY MANUAL



LANL Human Robotic Arm Attachment

5DoF - LANL - Robotic Arm Assembly Manual

Introduction

Welcome to the assembly manual for the LANL robotic arm. This guide will walk you through the step-by-step process of assembling the robotic arm safely and efficiently. Please read all instructions carefully before beginning assembly.

Safety Precautions

- Ensure all power sources are disconnected before assembly.
 - Wear safety gloves and goggles when handling sharp components.
 - Follow proper wiring guidelines to avoid electrical hazards.
 - The robotic arm is nearly 30 lbs when fully assembled. Ensure proper ergonomic handling to prevent injury. Use the help of another person to move and transport the fully assembled robotic arm.
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Robot Base Assembly

Assembly Steps

Step 1: Base Installation

Purpose: This base is intended for mounting our 5-DoF manipulator for ease of transportation and usage.

Materials:

- Two (2) 4040 T-Slot Aluminum Extrusions
- Twelve (12) M6-22mm Black Flathead Bolts
- Twelve (12) 4040 T-Slot Sliding Nuts M6
- One (1) 3D-PLA Base Plate [Dimensions: Length: 30 mm , Width: 23 mm, Thickness: 12.7 mm, Number of Holes: 12, Hole Diameter: 6 mm]

Tools Required:

- Allen Wrench - M6
- Allen Wrench M4

Pre-Assembly Check:

1. Verify that all components listed above are present and match the specifications.
2. Inspect the 3D-PLA base plate for any defects or damage.

Assembly Steps:

1. **Prepare the Extrusions:** Place both 4040 T-Slot Aluminum extrusions on a flat, stable work surface.
2. Make sure the Correct side of the base is facing the ground. Figure 1 below should face the ground.

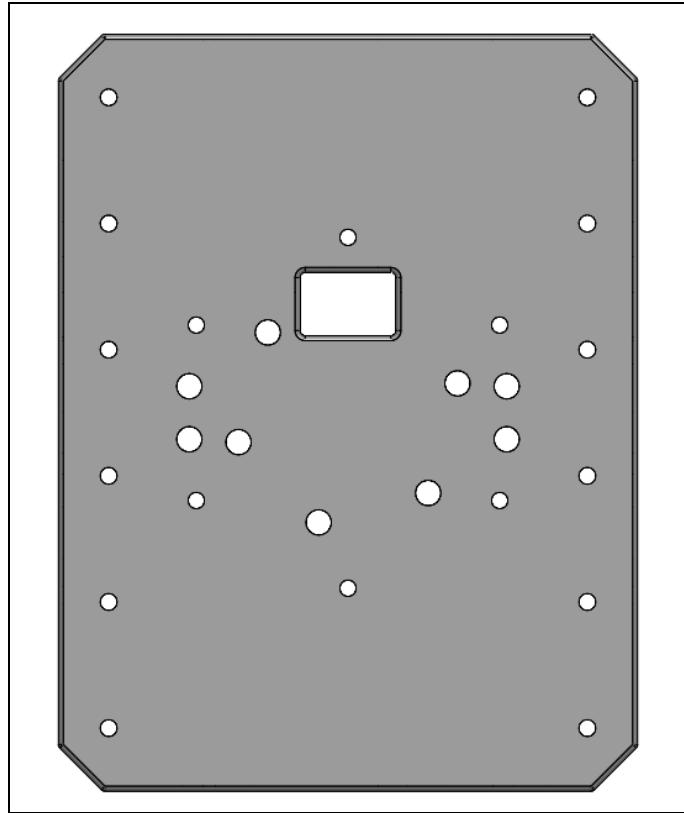


Figure 1: SolidWorks model of Base

3. **Insert T-Nuts:** Slide six (6) T-slot sliding nuts into each of the aluminum extrusions.
4. **Position T-Nuts:** Position the nuts within each extrusion so that the *centers* of the nuts are 5 mm apart. This distance *must* match the center-to-center spacing of the holes on your 3D-PLA base plate.

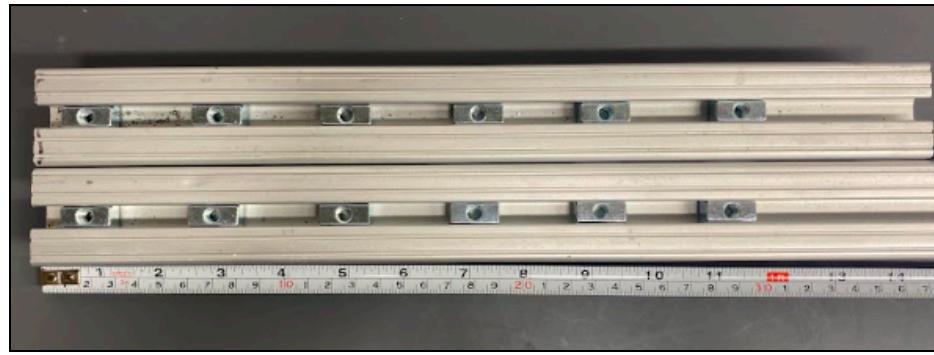


Figure 1: Extrusion with T-Slot Nuts and 5 mm spacing

5. **Position Base Plate:** Carefully place the 3D-PLA base plate on top of the aluminum extrusions. Align the holes in the base plate with the T-slot sliding nuts in the extrusions.

Ensure that all twelve holes align correctly. As mentioned above, the orientation of the base is *extremely* important, before you fasten the aluminum extrusions to the base. If you are looking at Figure 1 straight on, that side should be facing the floor (aka touching/fastened to the aluminum extrusions). See Figure 2 for reference.



Figure 2: Base orientation with aluminum extrusions.

6. **Attach Base Plate:** Gently insert an M6-22mm bolt through each hole in the base plate. Thread the bolts into the corresponding T-slot sliding nuts with a M4-Allen Wrench.
7. **Secure Fasteners:** Using the appropriate tool, M4-Allen Wrench , tighten each bolt gradually and evenly. Avoid over-tightening, especially with the 3D-PLA base plate, as this can cause damage. Tighten until the bolts are snug and the base plate is securely attached to the extrusions. Do not overtighten.
8. **Verification:** Visually inspect all fasteners to ensure they are fully engaged and tightened. Gently shake the assembled base to confirm stability. If any movement is detected, re-tighten the appropriate bolts. See Figure 3 for the assembled Base.

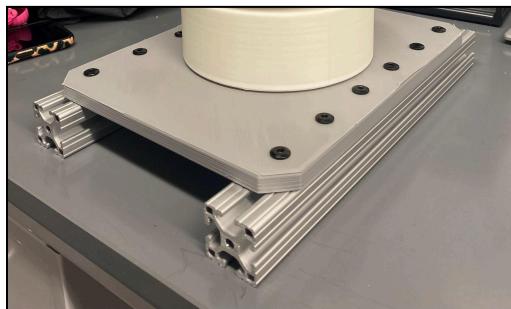


Figure 3: Final Base Assembly

Important Notes:

- The spacing of the T-nuts is *critical* for proper assembly. Double-check the measurement against the hole spacing on your base plate.
- PLA is more susceptible to damage from over-tightening than metal. Exercise caution when tightening the bolts.

Joint 1 Assembly (Shoulder Rotation Joint)

Step 2: J1 Assembly Instructions

Purpose: This section details the assembly of the J1 housing, including the motor, bearing, and attachment to the base.

Parts List:

- J1 Motor Holder (Quantity: 1)
- J1 Motor Cover (Quantity: 1)
- J1 Mushroom Cap (Quantity: 1)
- J1 Motor: [Motor Name and Model Number] (Quantity: 1)
- J1 Cross Roller Bearing: [Bearing Type and Size] (Quantity: 1)
- Robot Base: Manufactured in Step 1 (Quantity: 1)

Hardware:

- 18 M6 Brass Tapered Heat Set Inserts
- 10 M5 Brass Tapered Heat Set Inserts
- 5 M4x15mm screws
- 10 M5x30mm screws
- 10 M5x22 screws
- 4 M6x18mm screws
- 6 M6x20mm screws
- 6 M4x10mm screws

Tools Required:

- Soldering Iron
- M5 and M6 Heat Set Insert tip for Soldering Iron
- M4, M5, and M6 Allen Wrenches

1. Heat Set Insert Installation:

- **Caution:** Work in a well-ventilated area. PLA can release fumes when heated. THE PLA PARTS WILL BE HOT TO THE TOUCH (for about 5-10 minutes) BE CAREFUL. If soldering a material like ASA or PETG, you will have to use a higher temperature.
- Before turning the soldering iron, ensure you have the correct size soldering tip to match the heat set insert size.
- Using the soldering iron heated to approximately 200°F (start lower and adjust as needed), carefully install the **M6 heat set inserts** into the designated holes on the underside of J1 Motor Cover as follows:
 - 6 inserts into the holes that will fasten J1 Motor Cover to the Robot Base.

- 4 inserts into the holes that will fasten the J1 Motor Cover to the J1 Motor Holder.
- 8 inserts into the holes on the J1 Mushroom Cap that will fasten to the J2 Circle Base Joint.
- Using the soldering iron heated to approximately 200°F, carefully install the **M5 heat set inserts into the designated holes on the J1 Mushroom Cap as follows:**
 - 10 inserts into holes on J1 Mushroom Cap that will allow for fastening to the outer ring of the bearing.
 - 8 inserts into the 8 M6 sized holes on the J1 Mushroom cap that will allow for fastening to the J2 Motor Holder.
- Allow the parts and the soldering iron to cool completely before proceeding.

2. J1 Motor to the J1 Motor Holder:

- Using 5 M4x15mm screws , attach the J1 Motor (Cube Mars AK10-9) to the J1 Motor Holder as seen in Figure 4. Ensure that the motor's electrical wiring is not pinched or obstructed by the PLA part.

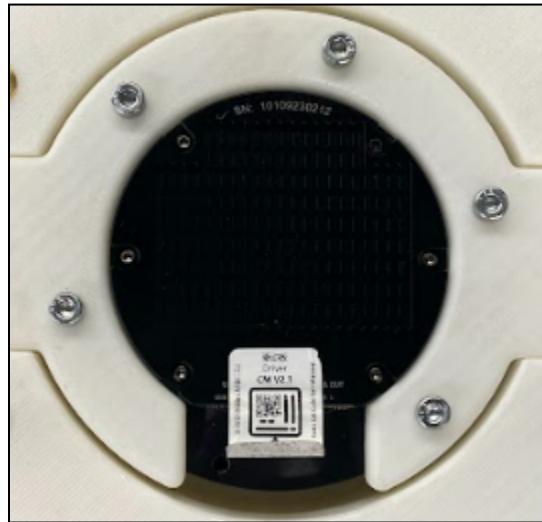


Figure 4: J1 Motor attached to J1 Motor Holder

3. J1 Mushroom Cap to J1 Cross Roller Bearing:

- Align the holes on the outer ring of the bearing with the M5 heat set inserts in the J1 Mushroom Cap. **Please ensure that the orientation of the bearing is so that the counter bored parts are where the fasteners go in first.** See Figure 5.
- Using 10 M5x22 screws, fasten the J1 Mushroom Cap to the bearing by screwing through the bottom of the bearing into the heat set inserts in the J1 Mushroom Cap. Ensure these screws are counterbored into the bearing correctly so they do not interfere with rotation.

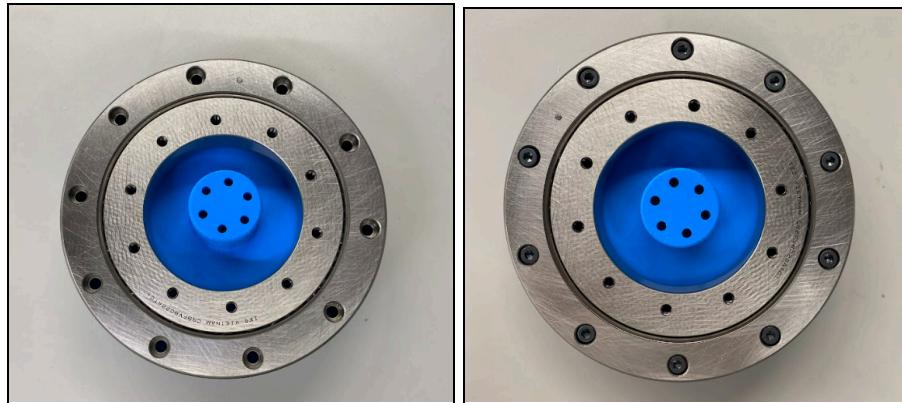


Figure 5: J1 Mushroom Cap to J1 Cross Roller Bearing

4. J1 Cross Roller Bearing assembly to the J1 Motor Cover:

- Place the J1 Cross Roller Bearing (2010N16) on top of the center hole in the J1 Motor Cover. **Please ensure that the orientation of the bearing is so that the counter sunk parts are closest to the J1 Motor Cover, you do not want them facing outwards.** See Figure 5.
- Flip over so that the bearing is on a flat surface. From the inside of the J1 Motor Cover, attach the J1 Cross Roller Bearing to the J1 Motor Cover using 10 M5x30mm screws.



Figure 6: J1 Cross Roller Bearing assembly to the J1 Motor Cover

6. Assembling J1 Motor Holder and the J1 Motor Cover:

- The bearing should be on a flat surface so J1 will appear upside down.

- Carefully position the J1 Motor Cover (with the J1 Cross Roller Bearing and J1 Mushroom Cap attached) over J1 Motor Holder (with the motor attached). Align the holes in the J1 Motor Holder with the heat set inserts in the J1 Motor Cover.
- Using 4 M6x18mm screws , fasten the J1 Motor Holder to the J1 Motor Cover by screwing from the bottom of the J1 Motor Holder into the heat set inserts in the J1 Motor Cover. See Figure 7.

Important: The use of socket head screws here might create an uneven surface for mounting to the Robot Base. Consider using different fasteners and counterboring the holes in the J1 Motor Holder, or redesigning it to have a flat mounting surface. The holes in the Robot Base align perfectly with the J1 Housing so everything will fit snug.

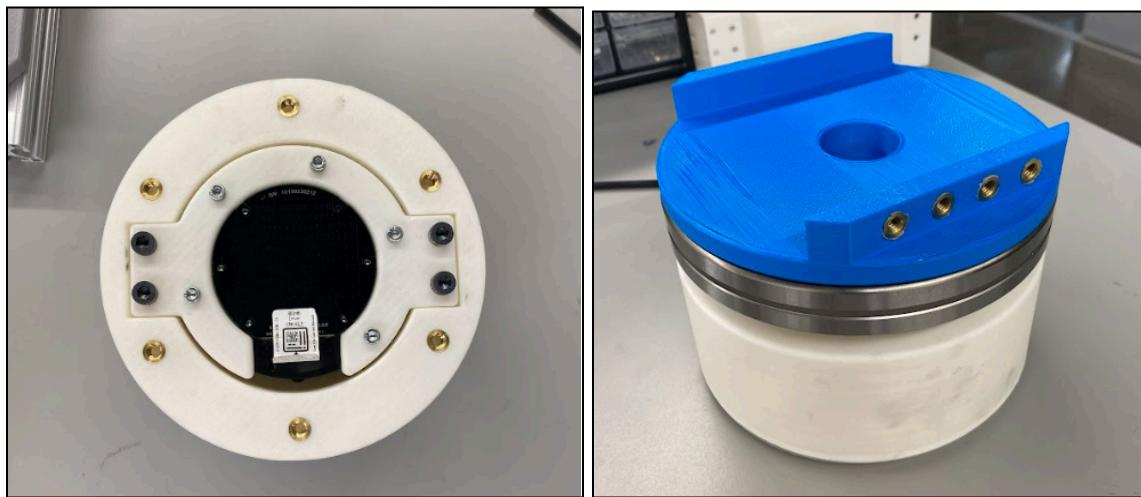


Figure 7: Assembling J1 Motor Holder and the J1 Motor Cover

5. Securing J1 Mushroom Cap to J1 Motor Shaft:

- The J1 Motor Cover and Bearing should already be fastened tightly together.
- Carefully manipulate (rotate) the J1 Mushroom cap to align with the 6 holes on the J1 Motor Shaft.
- Using 6 M4x10mm screws , fasten the J1 Mushroom Cap to the motor shaft by screwing through the inner ring of holes on the J1 Mushroom Cap into the motor shaft (See Figure 8). For the best results fasten the screws in opposite holes rather than in one clockwise/counterclockwise motion. As this can cause alignment issues. If you are having issues placing the fasteners into the holes. Utilize needle nose pliers for assistance.

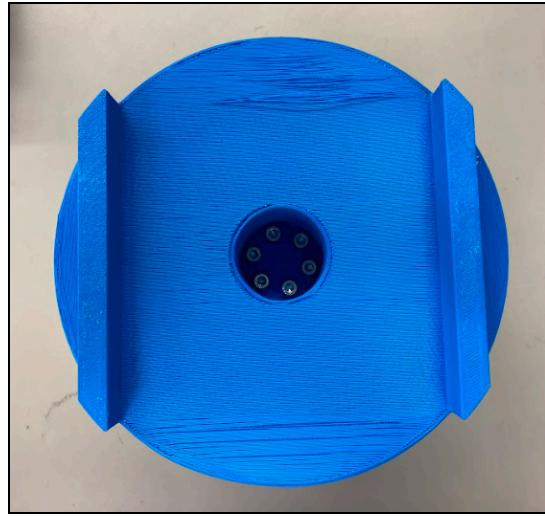


Figure 8: Securing J1 Mushroom Cap to J1 Motor Shaft

7. Attaching J1 Housing to Robot Base:

- Position the assembled Robot Base (with aluminum extrusions fastened already) onto the J1 housing (the bearing should be on a flat surface - so it will appear upside down). Align the mounting holes on the Robot Base with the heat set inserts in the J1 Motor Cover.
- Using 6 M6x20mm screws fasten the J1 housing to the Robot Base by screwing from the bottom of the Robot Base into the heat set inserts in the J1 Motor Cover. See Figure 9.



Figure 9: Attaching J1 Housing to Robot Base

8. Verification:

- Visually inspect all fasteners to ensure they are fully engaged and tightened. Gently shake the assembled unit to confirm stability. If any movement is detected, re-tighten the appropriate bolts. See Figure 10.

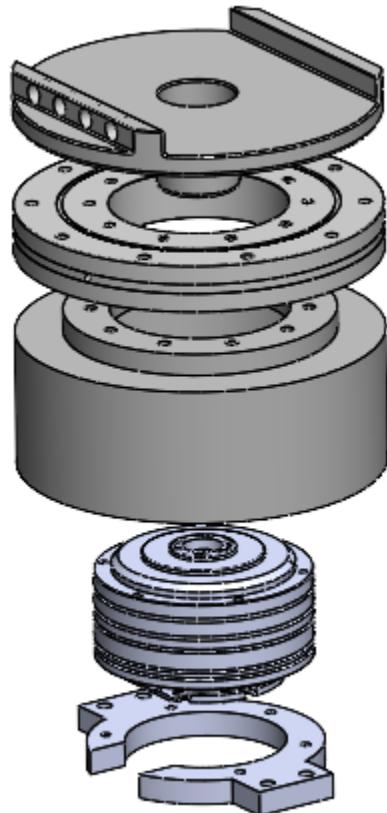


Figure 10: Exploded CAD view of J1 Assembly

Joint 2 Assembly (Shoulder Flexion Joint)

Step 3: J2 Assembly Instructions

Purpose: This section details the assembly of the J2 housing, including the motor bearing and attachment to J1 and the Bicep.

Parts List:

- J2 Motor Holder (Quantity: 1)
- J2 Motor (AK10-9 V2-0) (Quantity: 1)
- J2 Ball Bearing (K972K3) (Quantity: 1)
- J2 Bearing Holder (Quantity: 1)
- J2 Cylinder (Quantity: 1)
- Bicep (Quantity: 1)

Hardware:

- 16 M5 Brass Tapered Heat Set Inserts
- 6 M4 x 6 mm screws
- 6 M4 x 10 mm screws
- 8 M6 x 10 mm screws
- 20 M5 x 8 mm screws

Tools Required:

- Soldering Iron
- M5 Heat set insert tip for Soldering Iron
- M4 Allen wrench
- M5 Allen wrench
- M6 Allen wrench

1. Heat Set Insert Installation (J2 Cylinder and J2 Motor Holder) :

- **Caution:** Work in a well-ventilated area. PLA can release fumes when heated. THE PLA PARTS WILL BE HOT TO THE TOUCH (for about 5-10 minutes) BE CAREFUL.
- Before turning the soldering iron, ensure you have the correct size soldering tip to match the heat set insert size.
- Using the soldering iron heated to approximately 200°F (start lower and adjust as needed), carefully install the **M5 heat set inserts** into the designated holes on the underside of J1 Motor Cover as follows:
 - 16 inserts into the holes that will fasten J2 Cylinder to the Bicep.
 - 4 inserts into the holes that will fasten J2 Bearing Holder to J2 Motor Holder

- Using the soldering iron heated to approximately 200°F, carefully install the **M5 heat set inserts into the designated holes on the J2 Cylinder**
- Allow the parts and the soldering iron to cool completely before proceeding.
- The soldered heat set inserts for the J2 cylinder and J2 Motor Holder can be seen below in Figure 11 (it won't be fully assembled yet).



Figure 11: Heat set insert locations for J2

2. J2 Motor to J2 Motor Holder:

- Align the holes on the outer ring of the J2 Motor Holder to the outer ring of the bottom side of the J2 Motor.
- Using six M4 x 6mm screws, fasten the J2 motor holder to the J2 Motor. See Figure 12 below.

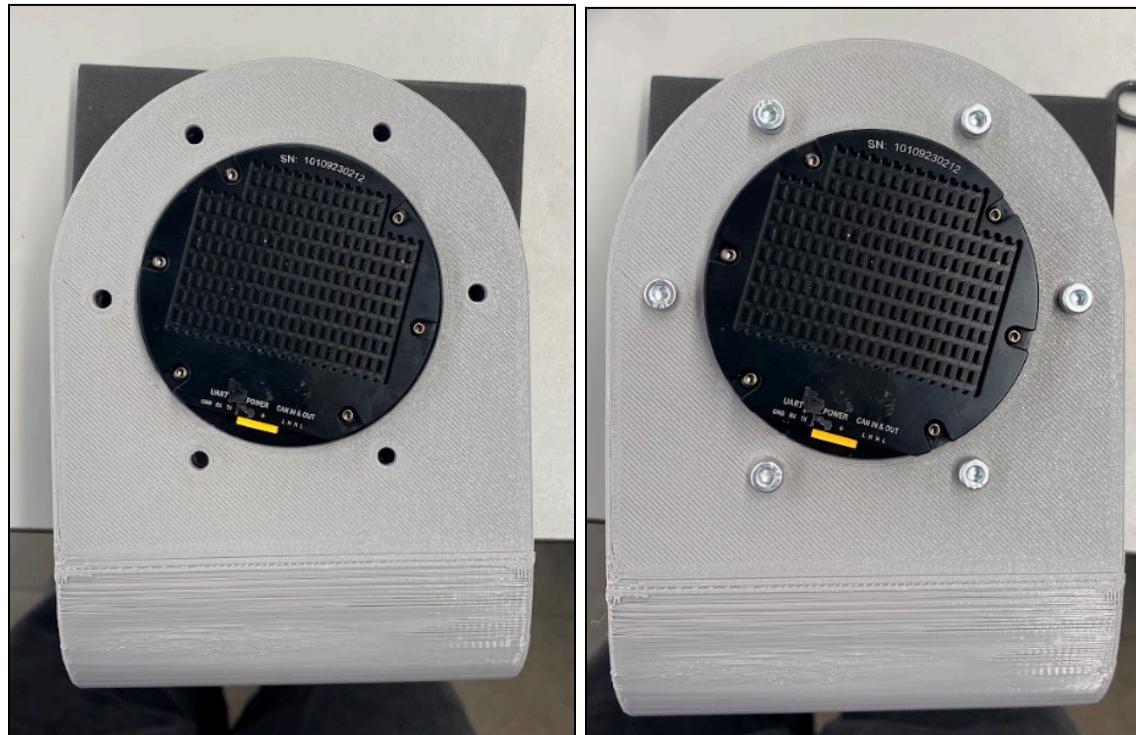


Figure 12: J2 Motor to J2 Motor Holder assembly

3. J2 Cylinder to J2 Motor Shaft

- Prep 6 M4x10 mm screws, a long M4 allen wrench, the J2 cylinder, and the J2 Motor. See Figure 13 below.



Figure 13: J2 Cylinder to J2 Motor Shaft

- Align the holes on the inside of the J2 Cylinder to the J2 Motor Shaft with the holes that have threads.
- Using a long M4 size allen wrench, fasten 6 M4x10 mm screws into the J2 Motor Shaft holes. Due to the size of the cylinder this step tends to be quite tedious.
- By the end of this step the J2 Motor Holder should be connected to the J2 motor which should be connected to the J2 Cylinder (Figure 13).

4. J2 Motor Holder to J1 Mushroom Cap

- For the start of this step, the J2 Motor Holder should be connected to the J2 motor which should be connected to the J2 Cylinder. See Figure 13.
- Align the holes of the J2 Motor Holder to the holes of the J1 Mushroom Cap. There are four on each side. Refer to Figure 14.

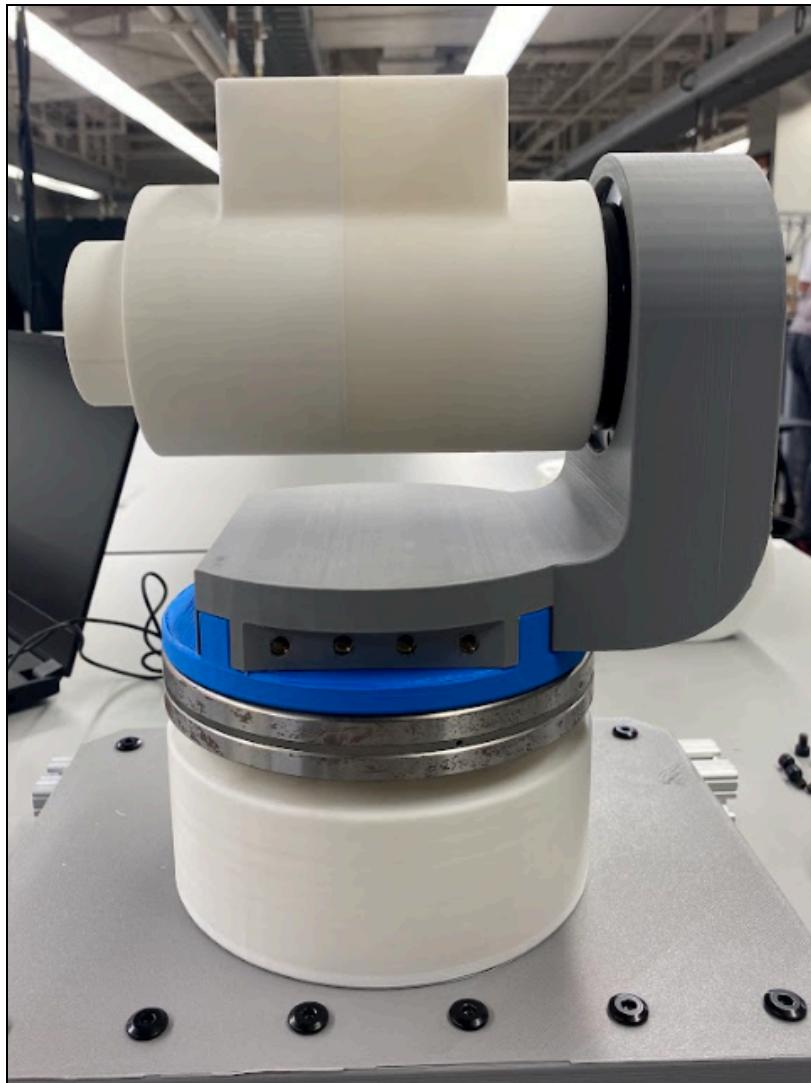


Figure 14: J2 Motor Holder to J1 Mushroom Cap

- Using 8 M6 x 10 mm screws, fasten the J2 Motor Holder to the 8 holes in the J1 Mushroom Cap (heat set inserts). There are four holes on each side of the mushroom cap. See Figure 15 below.



Figure 15: J2 Motor Holder to J1 Mushroom Cap Fasteners

5. J2 Bearing to J2 Bearing Holder

- Locate the J2 Bearing and J2 Bearing Holder. Press fit the bearing into the J2 Bearing holder hole. It should be a relatively tight fit. The inner ring of the bearing should move freely when touched after this step. Refer to Figure 16.



Figure 16: J2 Bearing to J2 Bearing Holder

6. J2 Bearing Holder to J2 Motor Holder

- The Robotic arm should look like Figure 17 below.

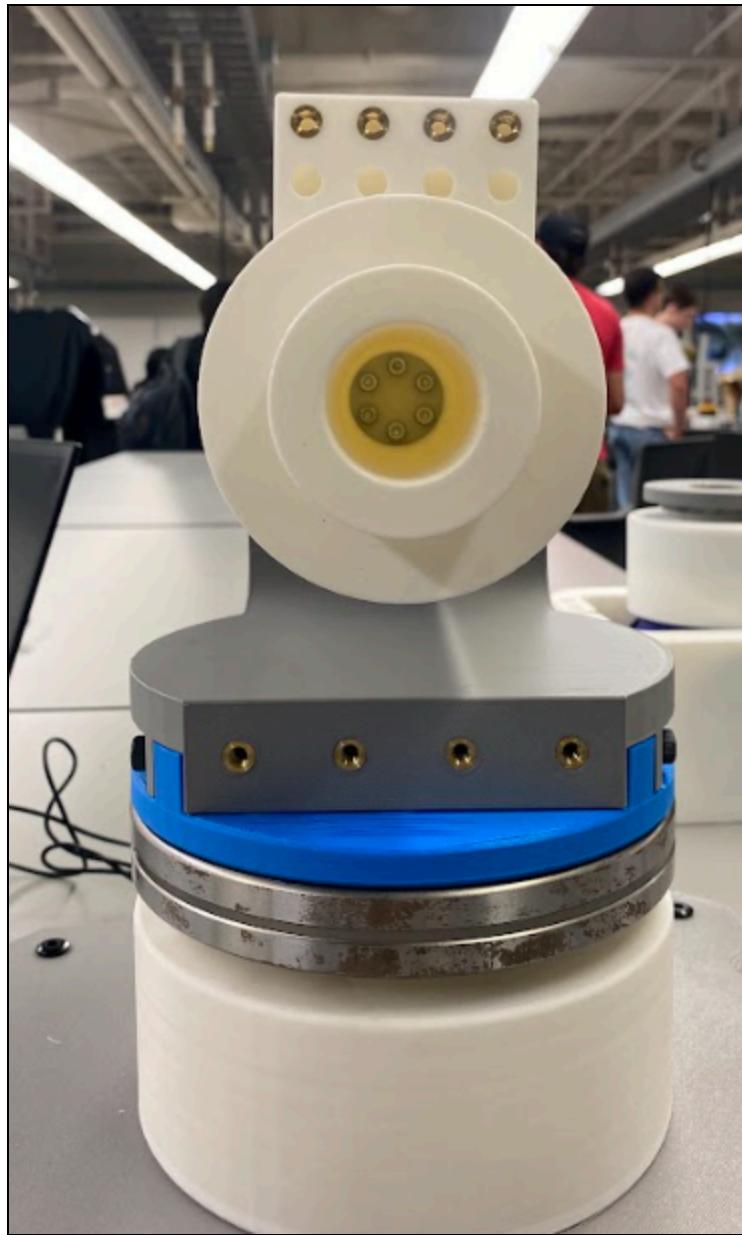


Figure 17: Fully assembled J2 up until J2 Bearing Holder

- Prepare the J2 Bearing holder and match the hole pattern to match the heat set inserts seen in Figure 17 above.
- Insert the mini cylinder protrusion from the J2 Cylinder into the J2 Bearing.
- Align the holes of the J2 Bearing Holder to the Holes of the J2 Motor Holder (where heat set inserts are).



Figure 18: J2 Bearing Holder to J2 Motor Holder

- Using 4 M5 x 8 mm screws, fasten the J2 Bearing Holder to the J2 Motor Holder. See Figures 18 & 19.



Figure 19: J2 Bearing Holder to J2 Motor Holder

7. Bicep to J2 Cylinder

- Prepare the Bicep and 16 M5x8 mm screws. Ensure that the Bicep is in the same orientation as seen below in Figure 20.



Figure 20: Bicep and associated fasteners

- Place the bicep onto the J2 Cylinder rectangular protrusion. Refer to Figure 21.

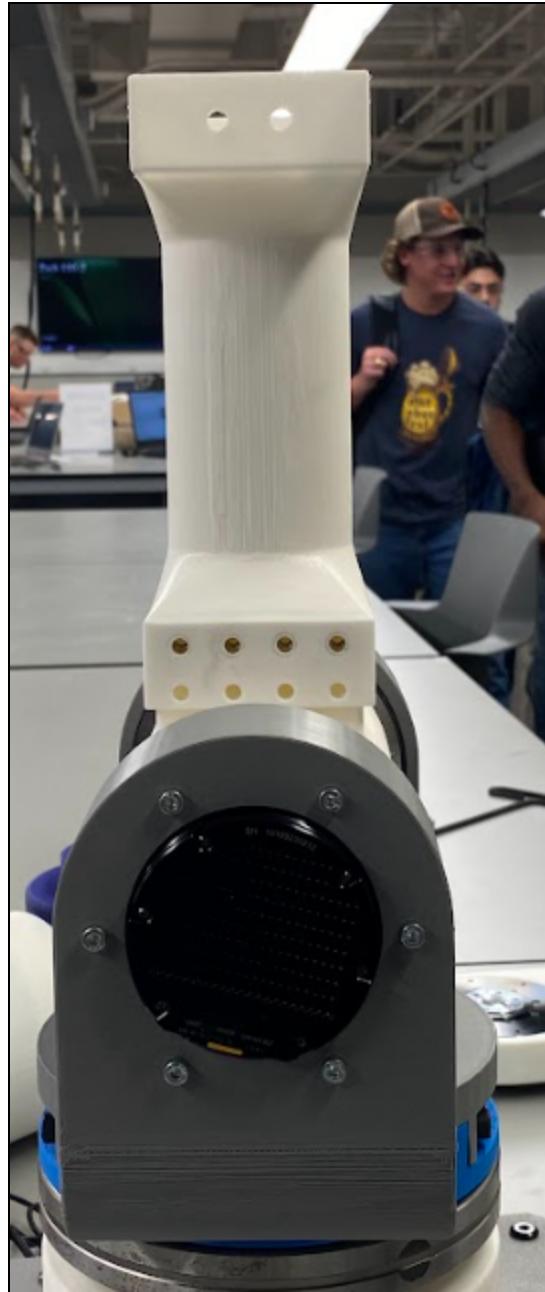


Figure 21: Bicep on J2 Cylinder

- Using 16 M5 x 8 mm screws, fasten the Bicep to the J2 Cylinder. We only used 8 total as we reduced the amount of heat set inserts we had to solder into the J2 cylinder. See Figure 22 below.



Figure 22: J2 Bicep Fastened to J2 Cylinder

Joint 3 Assembly

(Elbow Flexion Joint)

Step 4: J3 Assembly Instructions

Purpose: This section details the assembly of the J3 housing, including the motor, bearing, and attachment to J4 and the Bicep.

Parts List:

- J3 Bearing Holder (Quantity: 1)
- J3 Ball Bearing (5972K113) (Quantity: 1)
- J3 Motor (AK80-6 & AK80-9) (Quantity:1)
- J3 Motor Holder (Quantity: 1)
- J3 Cylinder (Quantity: 1)

Hardware:

- 8 M3 x 4 mm screws
- 6 M4 x 8 mm screws
- 12 M6 x 20 mm screws
- 12 M6 washers
- 12 M6 hex nuts

Tools Required:

- Soldering Iron
- M4 Soldering Iron tips
- Long M4 Allen wrench
- M5 Allen wrench
- M6 Allen wrench

1. Heat Set Insert Installation:

- **Caution:** Work in a well-ventilated area. PLA can release fumes when heated. THE PLA PARTS WILL BE HOT TO THE TOUCH (for about 5-10 minutes) BE CAREFUL.
- Before turning the soldering iron, ensure you have the correct size soldering tip to match the heat set insert size.
- Using the soldering iron heated to approximately 200°F (start lower and adjust as needed), carefully install six **M4 heat set inserts** on the top of the J3 cylinder. Use your hands or Needle Nose pliers to assist holding the Heat set insert in place.
- One of the M4 Heat set inserts fully installed can be seen below in Figure 23.

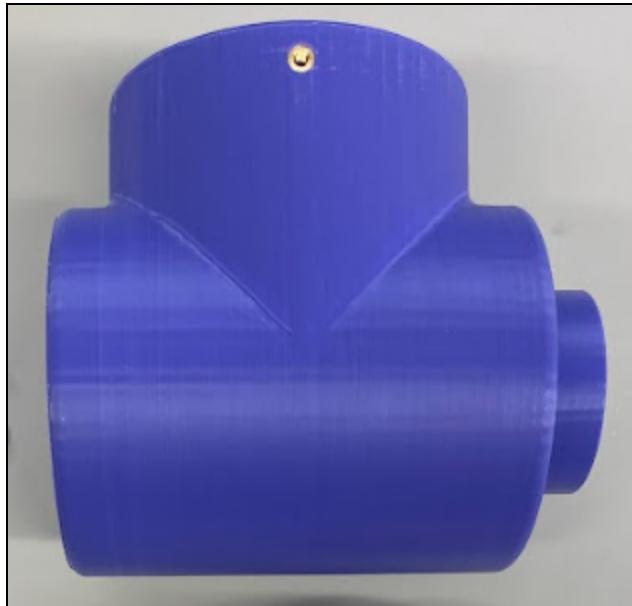


Figure 23: Heat set inserts for J3 Cylinder

1. J3 Motor to J3 Motor Holder:

- Align the holes on the outer ring of the J3 Motor Holder to the outer ring of the bottom side of the J3 Motor.
- Using eight M3x4mm, fasten the J3 motor holder to the J3 Motor. See Figure 24 below.



Figure 24: J3 Motor to J3 Motor Holder

2. J3 Cylinder to J3 Motor Shaft

- Align the holes on the inside of the J3 Cylinder to the J3 Motor Shaft with the holes that have threads.
- Using a long M4 size allen wrench, fasten six M4 x 8 Socket Head Screws into the J3 Motor Shaft holes. Due to the size of the cylinder this step tends to be quite tedious. See Figures 25 and 26 below.
- By the end of this step the J3 Motor Holder should be connected to the J3 motor which should be connected to the J3 Cylinder.

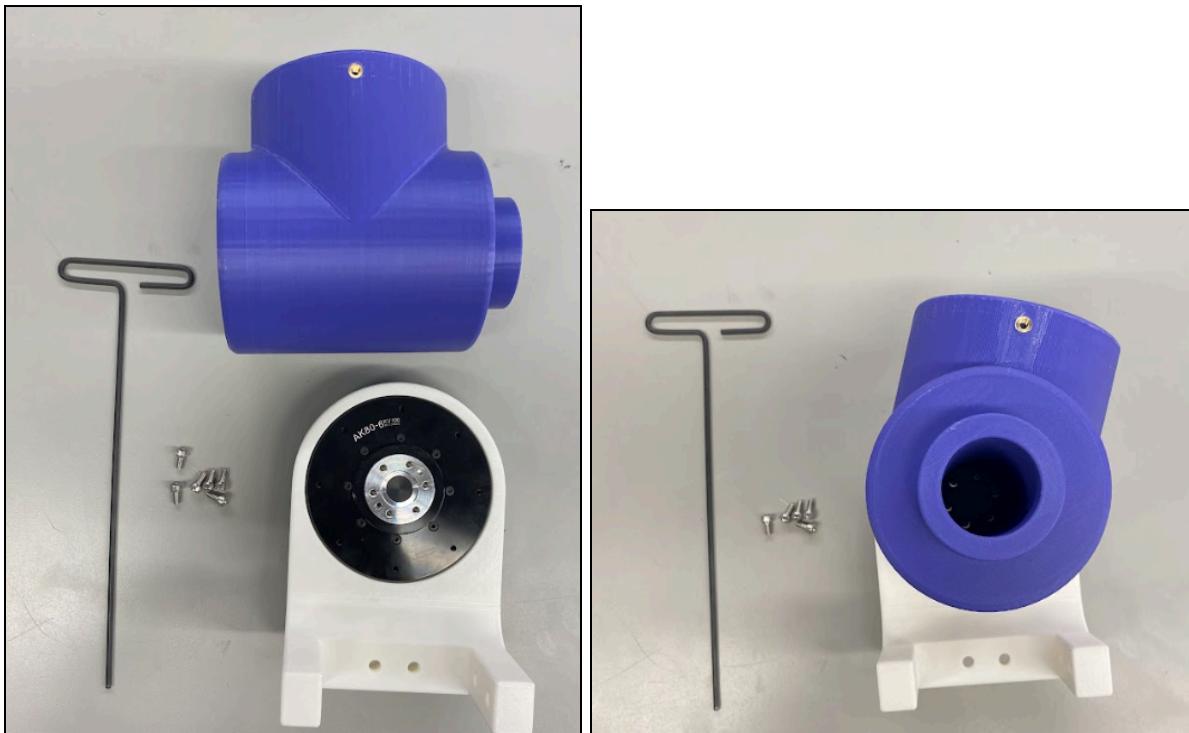


Figure 25: J3 Cylinder to J3 Motor Shaft

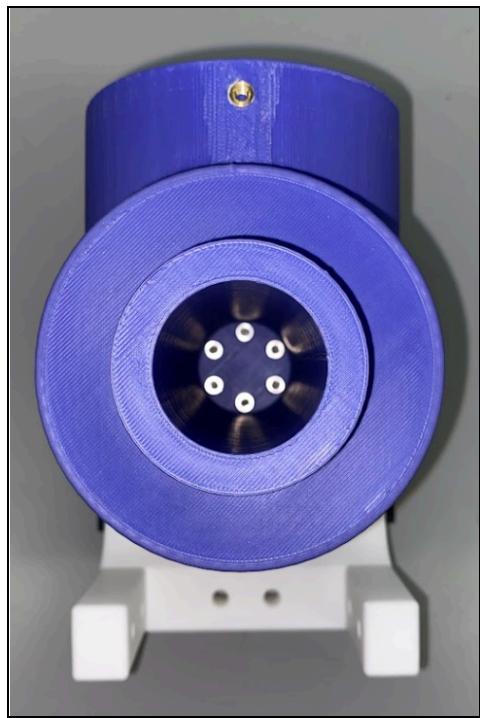


Figure 26: J3 Cylinder to J3 Motor Shaft

3. J3 Bearing to J3 Bearing Holder

- Locate the J3 Bearing and J3 Bearing Holder. Press fit the bearing into the J3 Bearing holder hole. It should be a relatively tight fit. The inner ring of the bearing should move freely when touched after this step. Refer to Figure 27.



Figure 27: J3 Bearing to J3 Bearing Holder

4. J3 Bearing Holder to Bicep

- Gather 6 M6x20 Screws, 6 M6 washers, and 6 M6 hex nuts

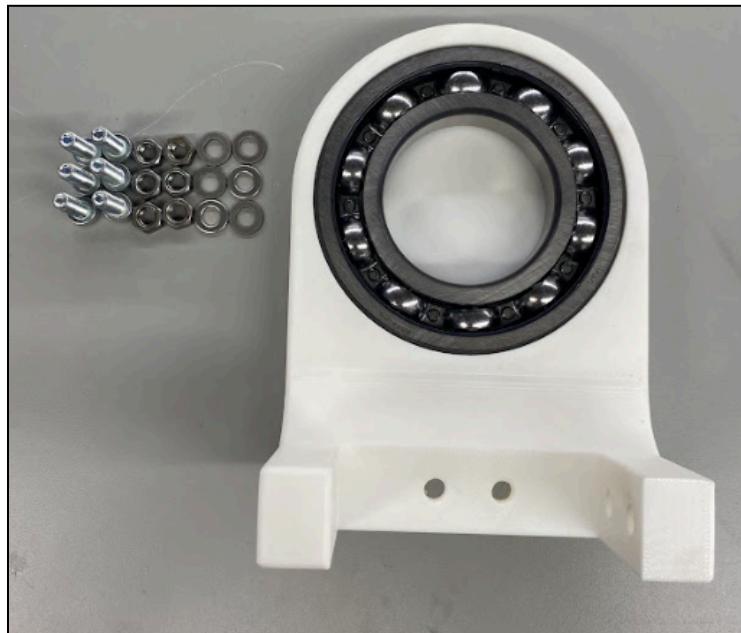


Figure 28: J3 Bearing Holder to Bicep

- Place the J3 Bearing Holder onto the top of the bicep and line the holes up accordingly
- The J3 Bearing Holder should be on the same side of the robotic arm as the J2 Bearing Holder
- With the help of another person, place each fastener in the holes, if you prefer to do one fastener at a time with the washer and nut. That order works as well.



Figure 29: J3 Bearing Holder to Bicep Fastener orientation

- Below is the placement of the fasteners with the washer and nut in place. If the nut is difficult to tighten, use needle nose pliers for assistance. See Figure 30.

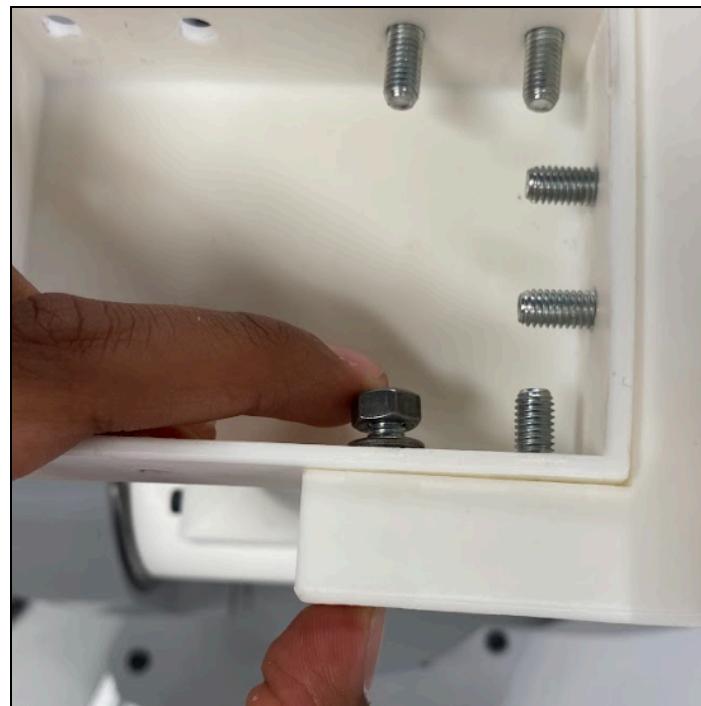


Figure 30: J3 Bearing Holder to Bicep Fastener orientation

- After each fastener has been fastened in with the M6 Hex Nut, it should look like the Figure 31 below.



Figure 31: J3 Bearing Holder to Bicep Fastener orientation

5. J3 Motor Holder to Bicep

- Align the holes of the J3 Bearing Holder to the Holes of the Bicep arm.
- Insert the mini cylinder protrusion from the J3 Cylinder into the inner hole of the J3 Bearing.

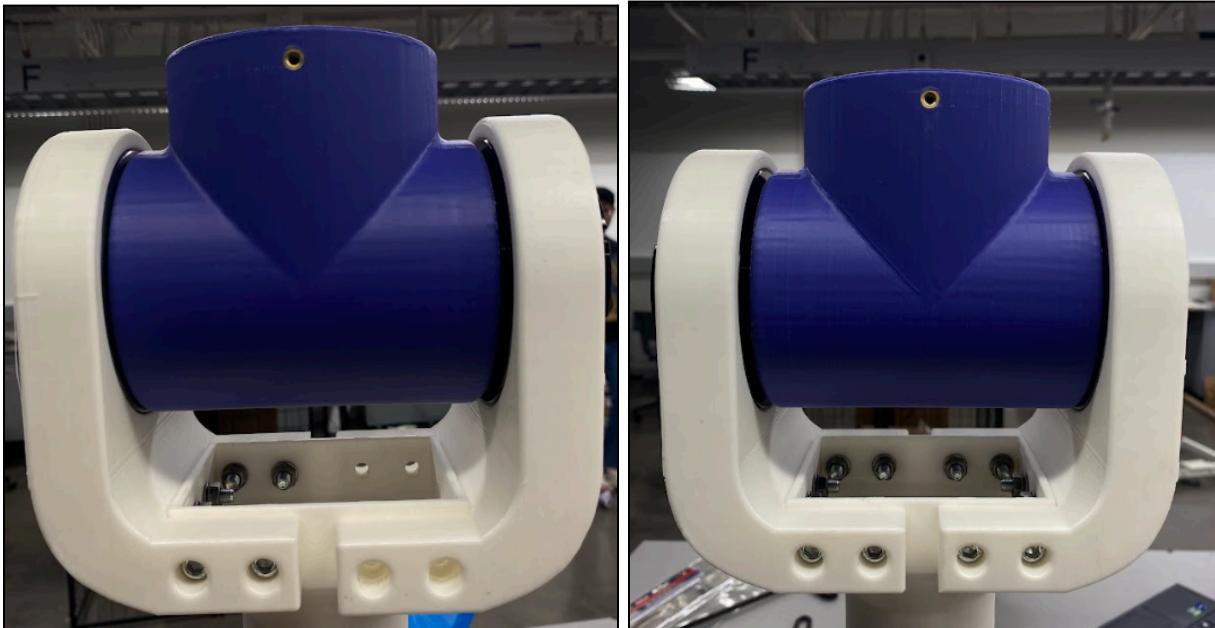


Figure 32: J3 Motor Holder to Bicep

- Gather 6 M6x20 Screws, 6 M6 washers, and 6 M6 hex nuts.
- Ensure that each fastener is pushed flush to the plastic before adding the washer and hex nut.
- Perform the same procedure for fastening the J3 Bearing holder into the Bicep, see Figure 32.
- The angle of this may prove to be more difficult than the J3 Bearing Holder (Since the cylinder is present now) so two people would be helpful for this step.

Joint 4 Assembly (Elbow Rotation Joint)

Step 5: J4 Assembly Instructions

Parts List:

- J4 Motor Assembly (AK80-6 Kv 100 Motor)
- J4 Motor Holder
- J4 Motor Cover
- J4 Cross Roller Bearing
- J4 Mushroom Cap

Hardware:

- 6 M4 Heat set inserts
- 8 M2.5 Heat set inserts
- 16 M2.5 x 6mm screws
- 6 M4 x 6mm screws
- 4 M4 x 6mm screws
- 2 M3 x 5 mm screws

Tools Required:

- Soldering iron
- M2.5 and M4 Soldering Iron tips
- Phillips head screwdriver for M2.5 screws
- M3 Allen Wrench
- M4 Allen Wrench

1. Heat Set Insert Installation:

- **Caution:** Work in a well-ventilated area. PLA can release fumes when heated. THE PLA PARTS WILL BE HOT TO THE TOUCH (for about 5-10 minutes) BE CAREFUL.
- Before turning the soldering iron, ensure you have the correct size soldering tip to match the heat set insert size.
- Using the soldering iron heated to approximately 200°F (start lower and adjust as needed), carefully install six **M4 heat set inserts** on the top of the J4 Mushroom cap and eight **M2.5 heat set inserts** into the designated holes on the bottom of the J4 Mushroom Cap. Use **M3 heat set inserts** on the J4 Motor Holder. Use Needle Nose pliers to assist holding the Heat set insert in place.
- The M4 Heat set inserts fully installed can be seen below in Figure 33.

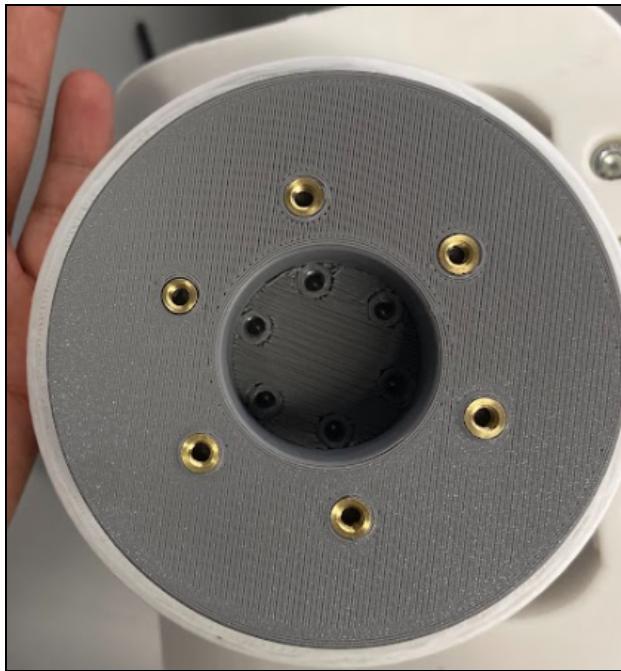


Figure 33: J4 Mushroom Cap Heat set inserts

- The M2.5 Heat set inserts fully installed can be seen below in Figure 34.



Figure 34: J4 Mushroom Cap Heat set inserts M2.5

- Allow the parts and the soldering iron to cool completely before proceeding.

2. J4 Motor Holder to J4 Motor Assembly

- Obtain the AK80-6 Kv 100 motor and six M3 x 4mm screws, which will be used to secure the back of the motor to the J4 Motor Holder. See Figure 35.



Figure 35: J4 Motor Holder to J4 Motor Assembly

3. J4 Material Acquisition

- Gather the J4 Motor Cover, J4 Cross Roller Bearing, and J4 Mushroom Cap, along with eight M4 x 6mm screws, twelve M2.5 x 6mm screws, and a screwdriver compatible with M2.5 screws. See Figure 36.

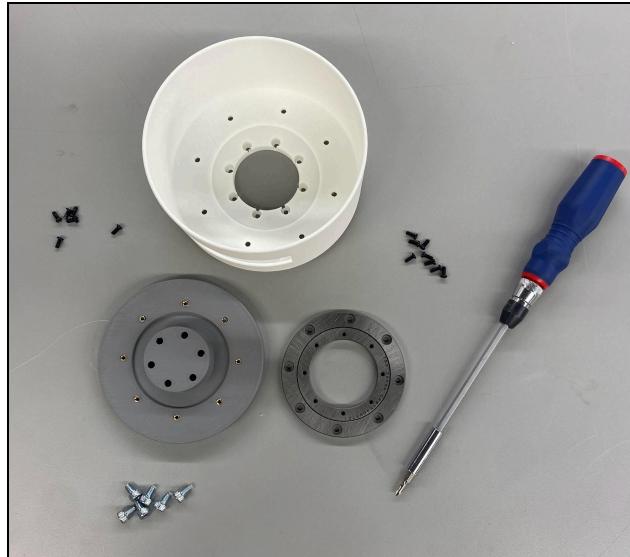


Figure 36: J4 Materials

4. J4 Mushroom Cap to J4 Bearing

- Using the materials allocated in Step 2, start by positioning the J4 Cross Roller Bearing on top of the J4 Mushroom Cap, ensuring the countersunk holes face upward.
- Secure the bearing by inserting eight M2.5 x 6mm screws into the counterbored holes, fastening them into the heat-set inserts within the J4 Mushroom Cap. See Figure 37.

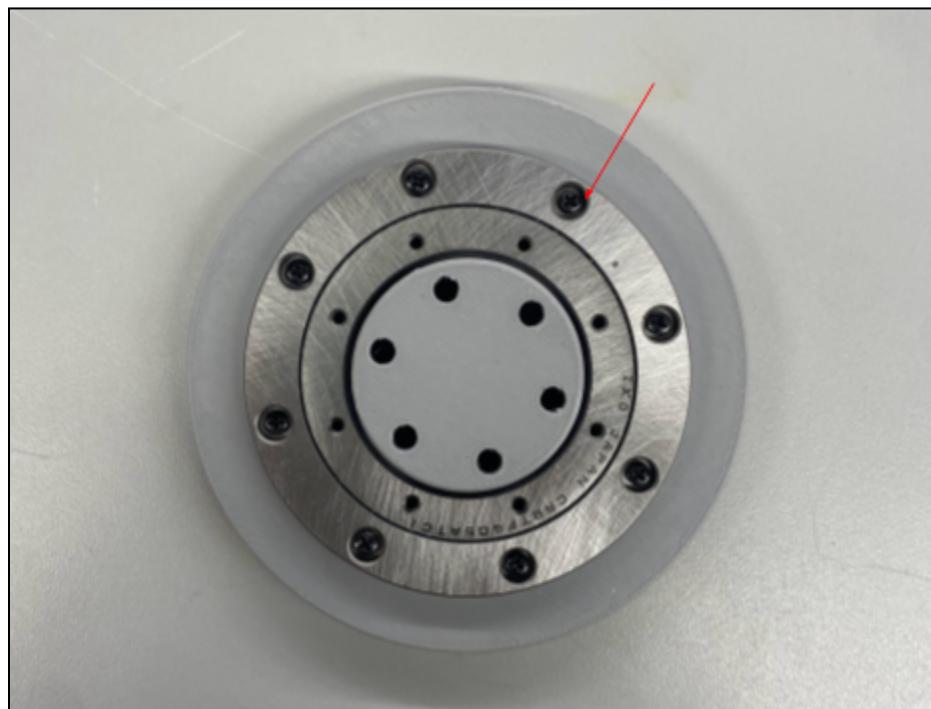


Figure 37: J4 Mushroom Cap to J4 Bearing

5. J4 Motor Cover to J4 Mushroom Cap

- After securing the Cross Roller Bearing to the Mushroom Cap, retrieve the J4 Motor Cover and position it on top of the assembly from Step 3.
- Using eight M2.5 x 6mm screws, fasten the innermost hole of the cap to the inner ring of the Cross Roller Bearing and J4 Mushroom Cap assembly, as indicated by the red arrow in Figure 38.

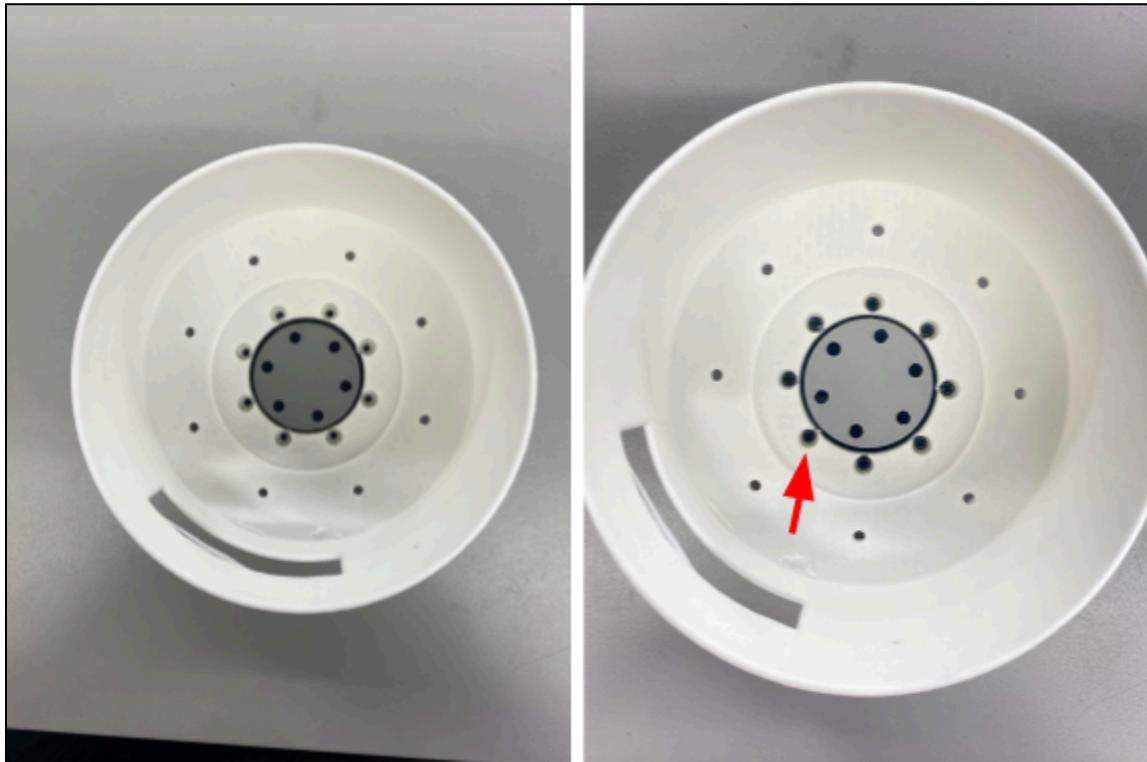


Figure 38: J4 Motor Cover to J4 Mushroom Cap

6. J4 Motor assembly to J3 Cylinder

- Now, shifting to the J4 Motor and J4 Motor Holder assembly, place it on top of the J3 Cylinder, ensuring that the designated holes on the J4 Motor Holder align with the heat-set inserts on the J3 Cylinder.
- Obtain four M4 x 6mm Allen wrench screws and use them to securely fasten the J4 Motor Holder to the J3 Cylinder. See Figure 39.

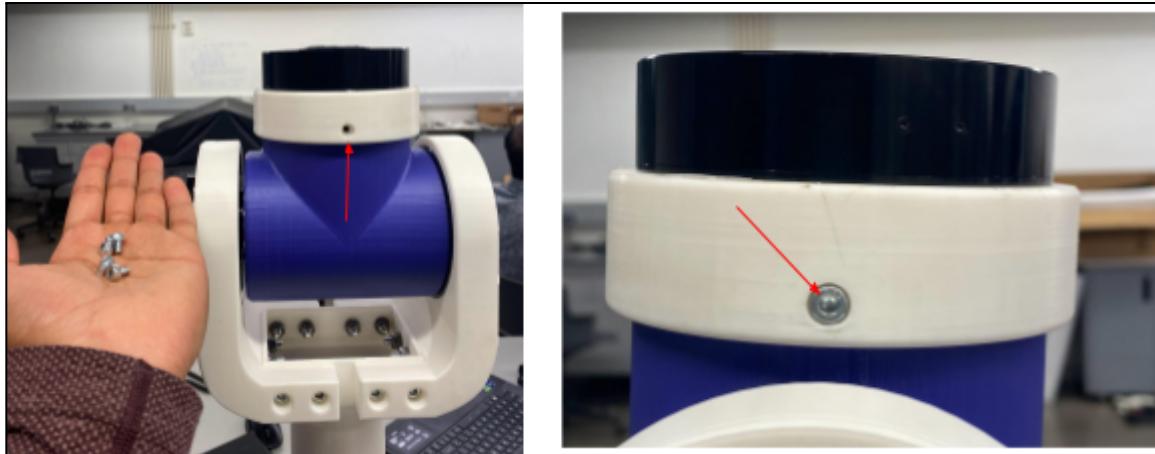


Figure 39: J4 Motor Assembly to J3 Cylinder

**** NOTE: IT IS CRITICAL TO NOTE THAT THE ELECTRICAL BOX ON THE J4 MOTOR SHOULD BE ON THE SAME SIDE AS THE J3 MOTOR AND J2 MOTOR ****

7. J4 Mushroom Cap securing to J4 Motor Shaft

- Now, take the subassembly from Step 4, consisting of the J4 Mushroom Cap, J4 Cross Roller Bearing, and J4 Motor Cover, and place it over the J4 Motor and Motor Holder assembly from Step 5.
- Now, view the assembly from the top and align the holes of the J4 Mushroom Cap with the J4 Motor shaft, ensuring free rotation of the J4 linkage.
- To secure the alignment, obtain six M4 x 6mm screws.
- Once aligned, fasten the screws into the designated holes to secure the assembly.

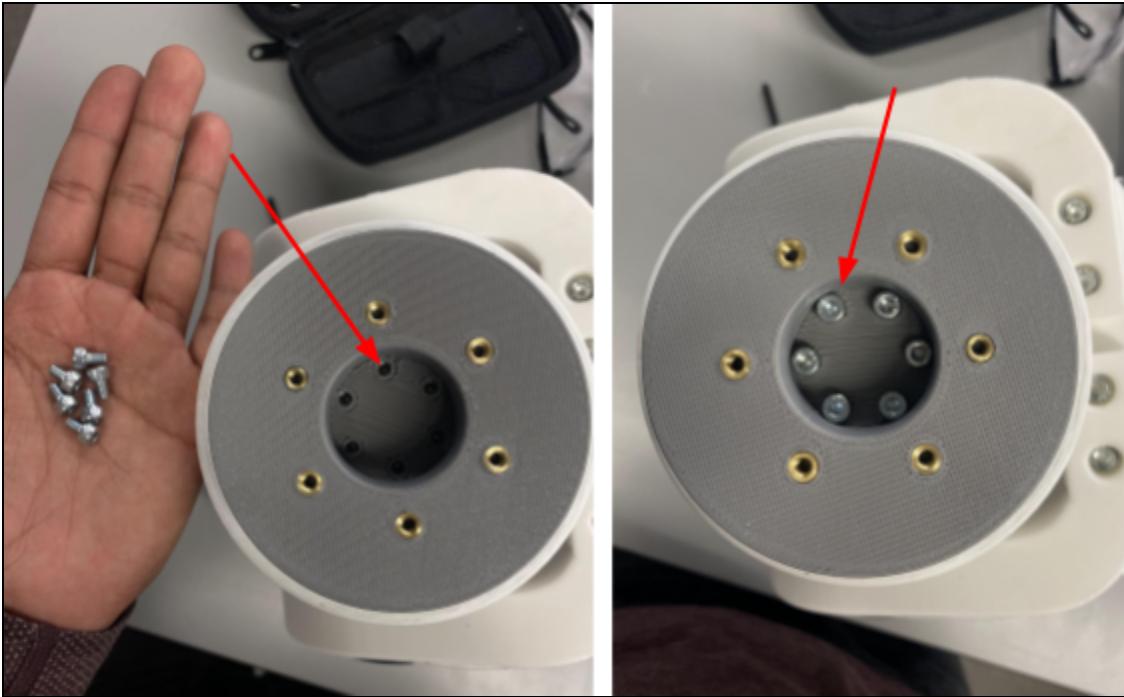


Figure 40: J4 Mushroom Cap to J4 Motor Shaft

6. J4 Motor Cap to J4 Motor Holder

- Ensure that the heat set inserts of the J4 Motor Holder line up with the J4 Motor Cap. The Large hole in the Motor Cap should align with the Electrical hole in the J4 Motor Holder. You may have to adjust the motor cap around till it lines up with the brass heat set inserts
- Fasten two M3x5 screws in the holes of the J4 Motor Cap that line up with the J4 Motor Holder Heat set inserts. See Figure 41. *We only fastened one because we drilled these holes ourselves. If you skip this step the Motor Cover will move when you test J4.

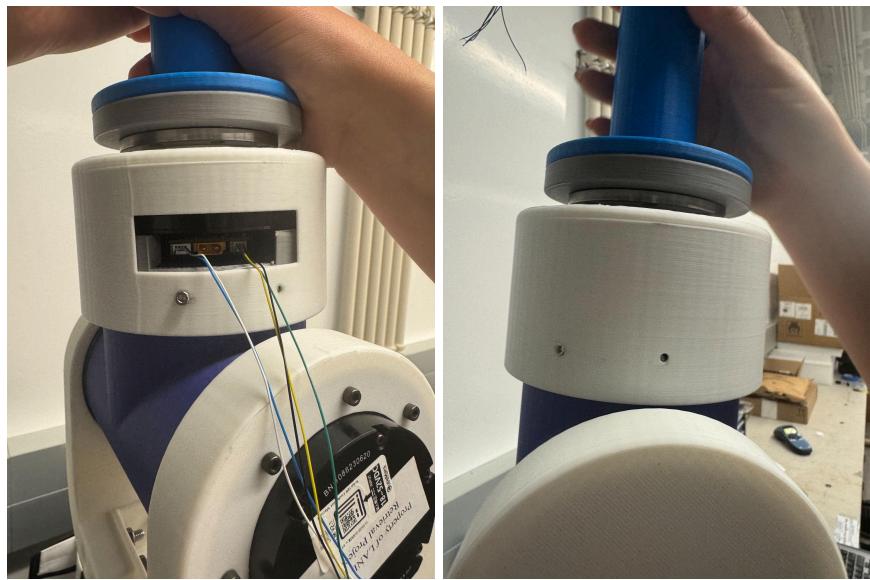


Figure 41: J4 Motor Cap to J4 Motor Holder

7. J4 Assembly Verification

- The J4 assembly is now complete and should appear as shown in Figure 42.



Figure 42: Fully Assembled arm to up J4

Joint 5 Assembly (Wrist Joint)

Step 6: J5 Assembly Instructions

Purpose: This section details the assembly of the J5 housing, including the motor, bearing, and attachment to J4 and the Forearm.

Parts List:

- Forearm (Quantity: 1)
- J5 Motor Holder (Quantity: 1)
- J5 Bearing Holder (Quantity: 1)
- J5 Cylinder (Quantity: 1)
- J5 Cylinder Cap (Quantity: 1)
- J5 Motor (GL40) (Quantity: 1)
- J5 Bearing (5972K105)

Hardware:

- 4 M2.5x5 mm screws
- 4 M2.5 heat set inserts
- 8 M3x5 mm screws
- 14 M4x10 mm screws
- 8 M4 washers
- 8 M4 nuts

Tools Required:

- Soldering Iron
- M2.5 Soldering Iron Tip
- M2.5 Allen Wrench
- Long M3 Allen Wrench
- M4 Allen Wrench

1. Heat Set Insert Installation:

- **Caution:** Work in a well-ventilated area. PLA can release fumes when heated. THE PLA PARTS WILL BE HOT TO THE TOUCH (for about 5-10 minutes) BE CAREFUL.
- Before turning the soldering iron, ensure you have the correct size soldering tip to match the heat set insert size.
- Using the soldering iron heated to approximately 200°F (start lower and adjust as needed), carefully install four **M2.5 heat set inserts** into the designated holes near the opening of the J5 Cylinder. Use Needle Nose pliers to assist holding the Heat set insert in place.

- Allow the parts and the soldering iron to cool completely before proceeding.

2. J5 Bearing to J5 Bearing Holder

- Prepare the J5 Bearing Holder and J5 Bearing.
- Press fit the Bearing into the holder. It should be a snug fit. See Figure 43.

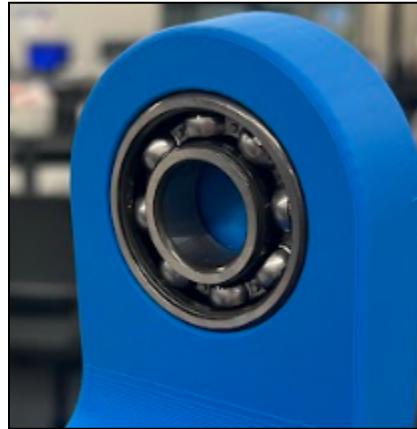


Figure 43: J5 Bearing to J5 Bearing Holder

3. J5 Bearing Holder to Forearm

- Prepare J5 Bearing holder, Forearm (the forearm should have the J5 Motor Holder already attached), 4 M4x10 mm screws, 4 M4 washers, and 4 M4 nuts
- Ensure that the holes of the J5 Bearing Holder match the holes of the top of the Forearm
- Place the 6 M4x10 mm screws into the holes
- Using your hands or needle nose pliers, place the washer on each fastener and fasten the M4 Hex nuts onto the end of each screw. See Figure 44 below.



Figure 45: J5 Bearing Holder to Forearm

4. J5 Motor to J5 Motor Holder:

- Prepare J5 Motor, J5 Motor Holder, 4 M3x 5 mm screws, and a long M3 allen wrench. See Figure 46 below.

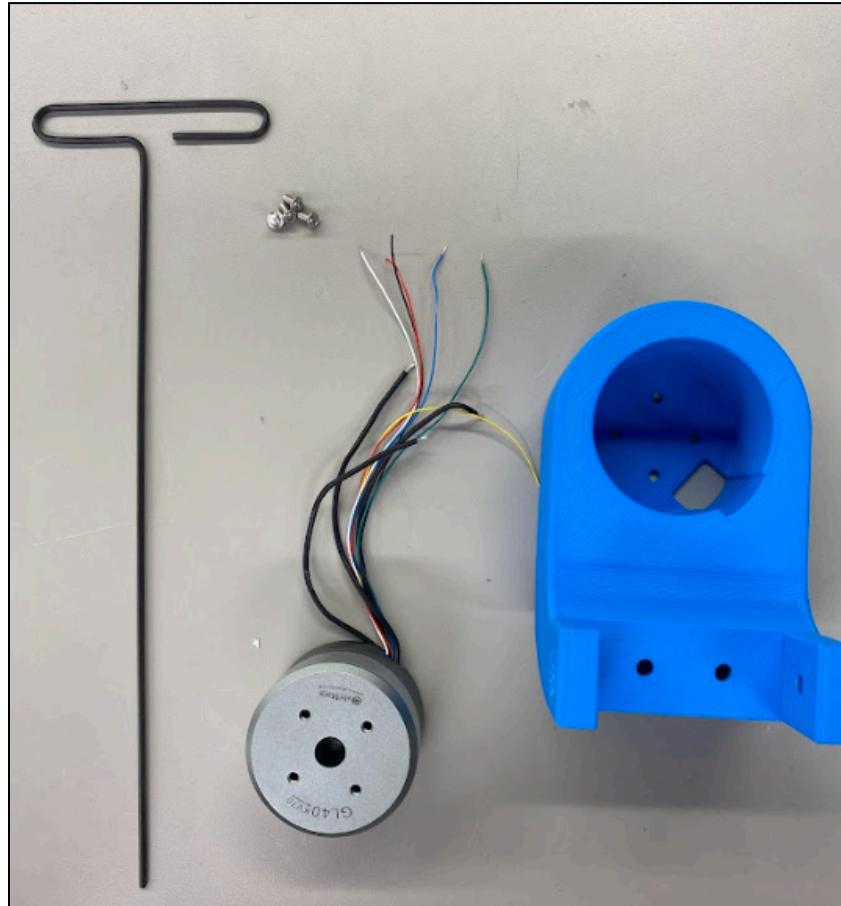


Figure 46: J5 Motor to J5 Motor Holder

- Place the wire in the J5 Motor Holder
- Carefully pull the wires through, line up the holes of the J4 Motor Holder and the J4 Motor

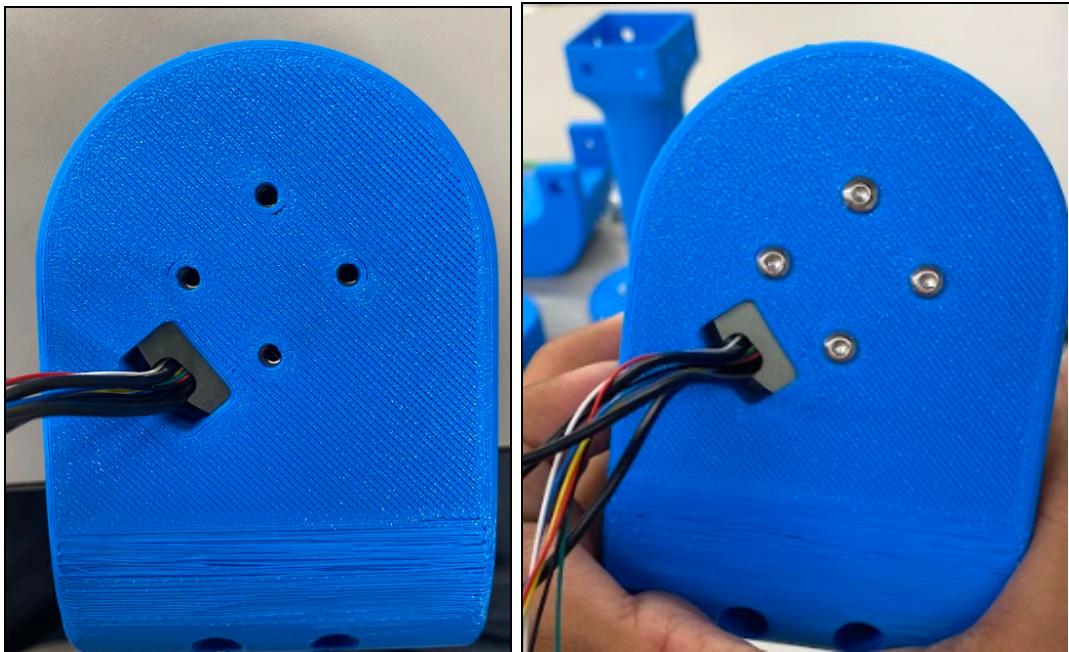


Figure 47: J5 Motor to J5 Motor Holder

- Fasten each of the 4 M3x 5 mm screws into the back to fasten the motor into place.
- The front of the J4 Motor Holder should look like Figure 48.



Figure 48: J5 Motor to J5 Motor Holder

5. J5 Cylinder to J5 Motor

- Prepare the J5 Motor Holder (with J5 motor intact), 4 M3x5 mm screws, and a long M2.5 allen wrench. See Figure 49.

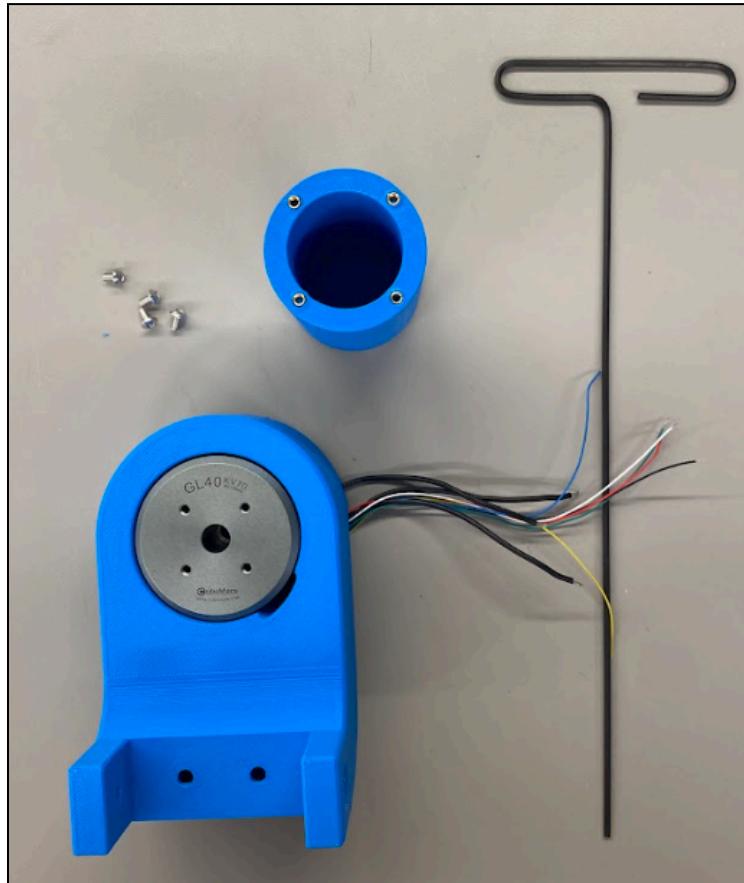


Figure 49: J5 Cylinder to J5 Motor

- There will be 4 holes in the cylinder that will match with the front face of the J5 Motor
- Place the J5 Cylinder on the J5 Motor Face
- Use 4 M3x5 mm screws and fasten the cylinder onto the face of this motor. See Figure 50.

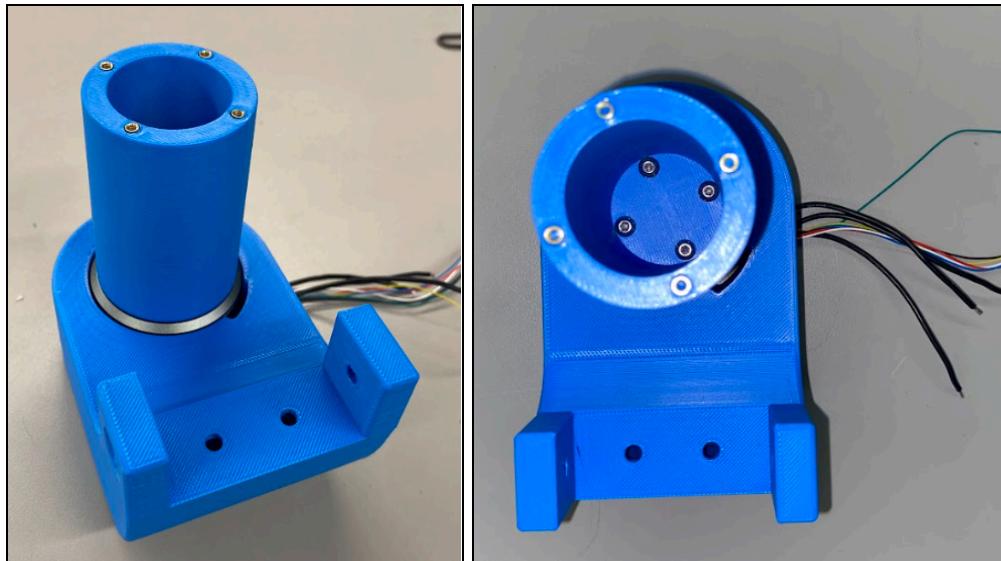


Figure 50: J5 Cylinder to J5 Motor

6. J5 Cylinder cap to J5 Cylinder

- Prepare 4 M2.5x5 mm screws, a phillips head screwdriver, the J5 cylinder cap and the assembled J5 Motor Holder with the cylinder included. See Figure 51.



Figure 51: J5 Cylinder Cap to J5 Cylinder

- Place the cylinder cap on top of the cylinder and align the holes with the heat set inserts in the cylinder. Ensure that the protrusion on the cylinder cap is facing outwards. Refer to Figure 52.
- Fasten the 4 M2.5x5 mm screws through the cylinder cap into the cylinder heat set inserts. Refer to Figure 52.

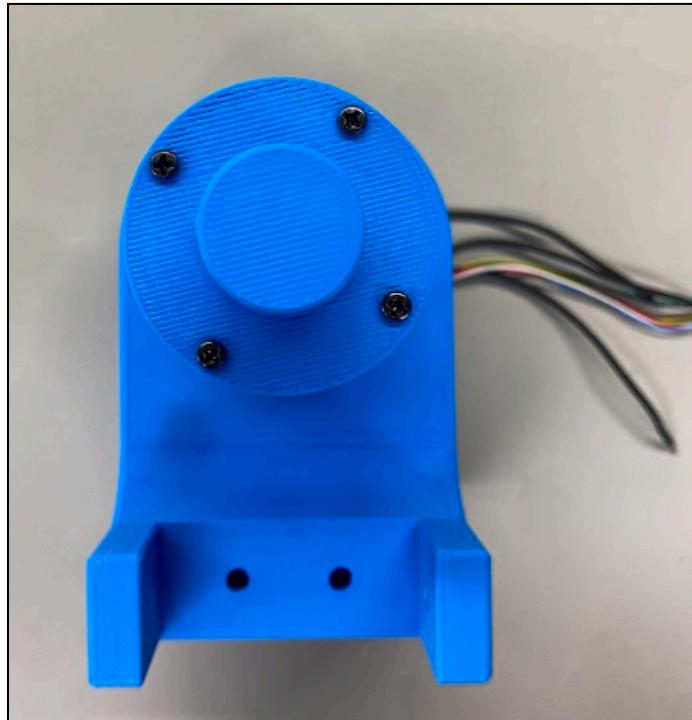


Figure 52: J5 Cylinder to J5 Cylinder

7. J5 Motor Holder to Forearm

- Gather J5 Motor Holder (With J5 cylinder and J5 Motor attached), 6 M4x10 mm screws, 6 M4 washers, and 6 M4 nuts.
- The J5 Bearing Holder should already be on the Forearm.



Figure 53: J5 Motor Holder to Forearm

- Similar to the J5 joint, start by placing the J5 Motor Holder onto the top of the Forearm. The holes only align in a certain position so ensure that all the holes align perfectly.
- Insert the mini cylinder protrusion from the J5 Cylinder/Cylinder cap (should be connected to the J5 Motor) into the inner ring of the bearing. Remember the bearing holder should already be attached to the Forearm.
- With the help of one person holding the J5 Motor Holder and the Forearm, place each fastener (6 M4x10 mm long screws) into the hole securing the pieces together. Ensure that the screw is flush on the surface as you might need to push it.
- Place the washer and then screw on the nuts using your hands or needle nose pliers to help. See Figure 54.



Figure 54: J5 Motor Holder to Forearm

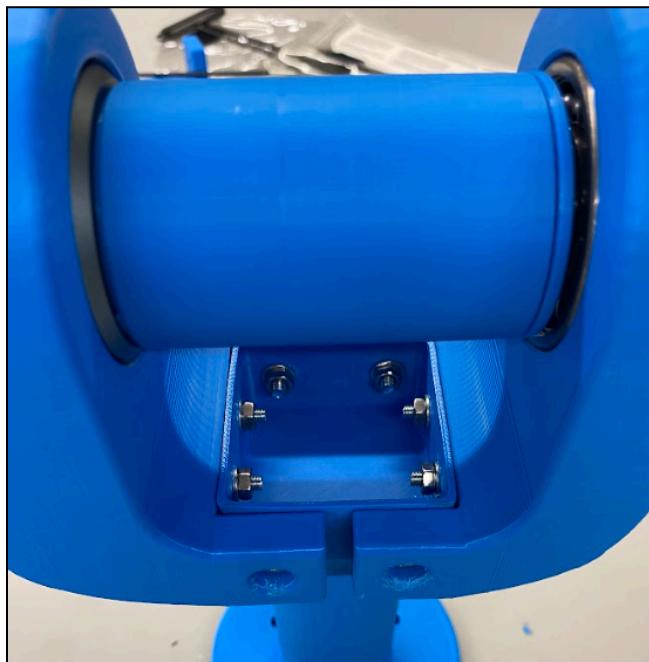


Figure 55: J5 Motor Holder to Forearm

8. J5 Assembly to J4 Assembly

- Gather the complete J5 assembly and 6 M4x10 mm long screws
- Place the J5 assembly Forearm onto the J4 mushroom cap. Match the holes of the mushroom cap to the Forearm.



Figure 56: J5 Assembly to J4 Assembly

- Using 6 M4x10 mm long screws, fasten the Forearm to the J4 Mushroom Cap. See Figure 57 Below.

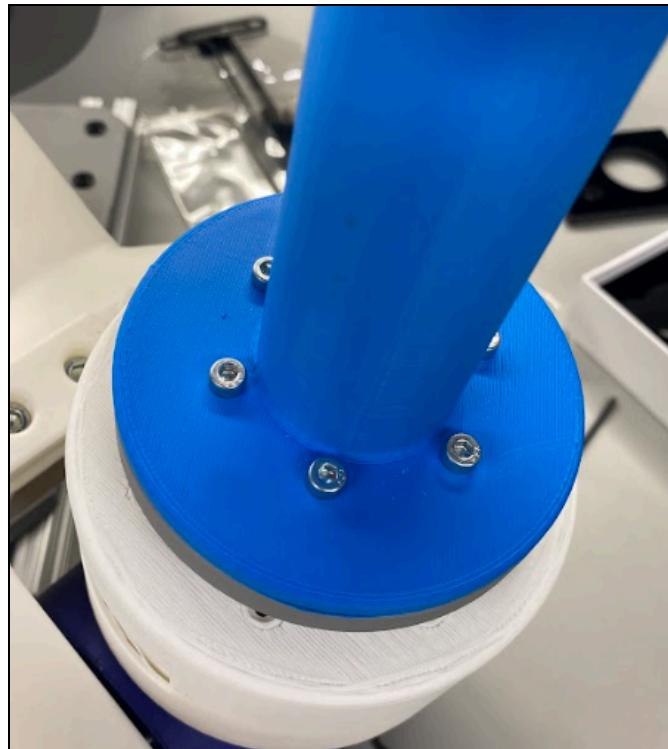


Figure 57: J5 Cylinder to J5 Motor

Congratulations. The Arm should be fully assembled! See Figure 58 below for reference.



Figure 58: Fully Assembled Arm