

# Model AR2 Assembly Manual

## **NOTE:**

This manual shows the construction of the AR2 robot using aluminum for the primary structural components, and plastic for the belt covers and spacer components. Use Loctite on all screws during assembly process.

This robot can also be constructed using 3D printed components. The .stl print files for all components can be found on the project page. The construction illustrated in this manual is the same using either aluminum or 3D printed components - note the following details if using 3D printed components:

- 3D printed components require all threaded holes to be cleared with appropriate drill size and then tapped.
- All printed components were printed at minimum 50% solid with the exception of any drive spindles and tension rings which were printed at 90%+ solid. Parts were printed at 2mm layer height and thick shells.
- The J1 baseplate, J1 baseplate spacer and J2 arm larger than most 3D printer beds and therefore are printed in 2 pieces and require being epoxied together.
- The printed design calls for additional reinforcements to be epoxide in place around the J1 base and at the base of the J2 arm (see details at the end of this manual)
- You will need to cut and drill aluminum tubing as shown in BOM section of this manual.

# **BILL OF MATERIALS**

# Aluminum Components



J1 BASE PLATE



J1 TURRET HOUSING



J1 SPINDLE



J1 PLATFORM



J2 TURRET HOUSING



J2 ARM



J2 DRIVE SPINDE



J2 TENSION RING



J1 & J3 MOTOR MOUNT



J2 MOTOR SUPPORT



J3 BEARING CUP



J3 SPINDLE



J3 SPINDLE RETAINER



J4 TURRET HOUSING



J4 MAIN SHAFT



J5 MOTOR MOUNT





J4 TIMING HUB



J4 MOTOR MOUNT



J5 HOUSING



J5 BELT CARRIER & J5 BELT CARRIER CLAMP



J5 BEARING POST



J5 IDLER TENSION BLOCK



J6 MAIN BEARING ARM



J6 HOUSING SINGLE PIECE

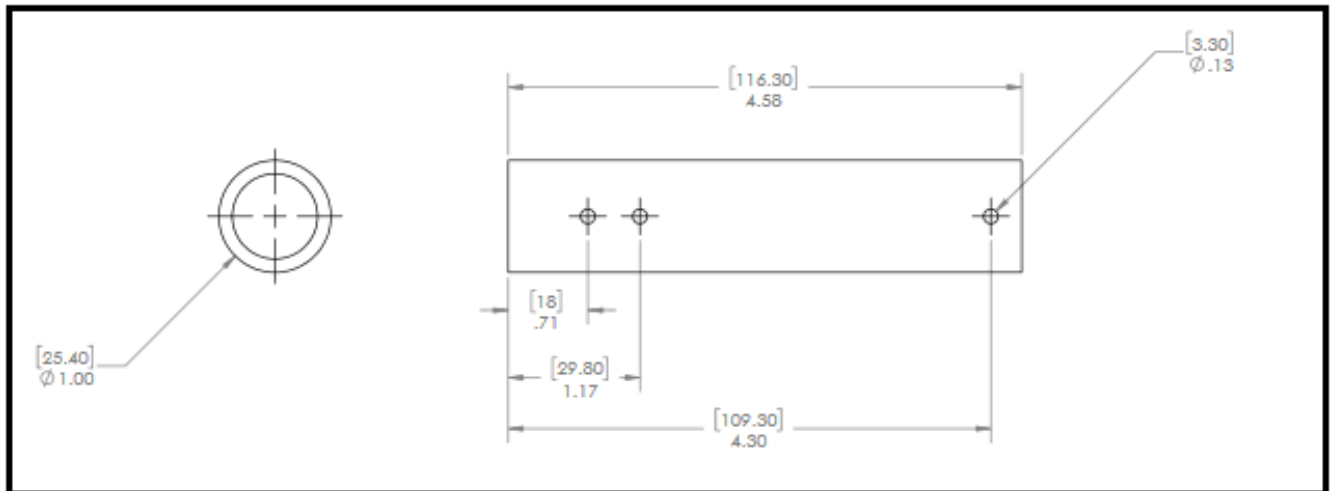


J6 BEARING CAP



J6 GRIPPER MOUNT

Note: If you are building a 3D printed robot and do not have aluminum parts you will need to purchase a length of aluminum tubing, cut and drill as shown in this drawing.



### High-Strength 2024 Aluminum Tube

0.035" Wall Thickness, 1" OD



Length, ft.  
✓ 1

☐ Each

**ADD TO ORDER**

In stock  
\$10.53 Each  
1968T17

# Plastic Components



J1 BASE SUPPORT SPACER PART 1



J1 BASE SUPPORT SPACER PART 2



J2 ARM COVER SPACER (x2)



J2 SIDE COVER (x2)



J5 SIDE COVER CAP



J5 SIDE COVER



J5 SIDE COVER SPACER (x2)



J6 LIMIT SWITCH TIP

# Stepper Motors

Geared and linear stepper motors as well as stepper drivers are available from Stepper Online

<http://www.omc-stepperonline.com/>



## Nema 17 Stepper Motor L=39mm Gear Ratio 20:1 High Precision Planetary Gearbox

★★★★★ 0 reviews | Write a review

SKU: 17HS15-1684S-HG20

**\$60.18**

Bulk quantity price break:

Qty	3	10	30	100
Price	\$58.93	\$55.17	\$53.91	\$50.15
Save	2.08%	8.33%	10.42%	16.67%

Availability: 67

\* Ship from

China

- 1 + **ADD TO CART**

[Report error](#) / [Notify inventory](#) / [Request bulk price](#)

Like 10 Tweet Post Share

J1 motor

SKU: 17HS15-1684S-HG20



## Nema 23 Stepper Motor L=56mm Gear Ratio 50:1 High Precision Planetary Gearbox

★★★★★ 0 reviews | Write a review

SKU: 23HS22-2804S-HG50

**\$90.27**

Bulk quantity price break:

Qty	3	10	30	100
Price	\$88.39	\$82.75	\$80.87	\$75.23
Save	2.08%	8.33%	10.42%	16.67%

Availability: -1

\* Ship from

China

- 1 + **ADD TO CART**

[Report error](#) / [Notify inventory](#) / [Request bulk price](#)

Like 0 Tweet Post Share

J2 motor

SKU: 23HS22-2804S-HG50





## Nema 17 Stepper Motor L=39mm Gear Ratio 50:1 High Precisi Planetary Gearbox

★★★★★ 0 reviews | Write a review

SKU: 17HS15-1684S-HG50

**\$60.18**

Bulk quantity price break:

Qty	3	10	30	100
Price	\$58.93	\$55.17	\$53.91	\$50.15
Save	2.08%	8.33%	10.42%	16.67%

Availability: 46

\* Ship from

China

- 1 + **ADD TO CART**

[Report error](#) / [Notify inventory](#) / [Request bulk price](#)

Like 0 Tweet Face Reddit

J3 motor

SKU: 17HS15-1684S-HG50



## Nema 11 Stepper Motor Bipolar L=51mm w/ Gear Ratio 14: Planetary Gearbox

★★★★★ 0 reviews | Write a review

SKU: 11HS20-0674S-PG14

**\$37.49**

Bulk quantity price break:

Qty	3	10	30	100
Price	\$36.77	\$34.60	\$33.88	\$31.72
Save	1.92%	7.69%	9.62%	15.38%

Availability: 0

\* Ship from

China

United States

Germany

United Kingdom

Australia

Russian Federation

- 1 + **ADD TO CART**

[Report error](#) / [Notify inventory](#) / [Request bulk price](#)

Like 0 Tweet Face Reddit

J4 motor

SKU: 11HS20-0674S-PG14



## Nema 17 External 48mm Stack 1.68A Lead 8mm/0.31496" Len, 200mm

★★★★★ 0 reviews | Write a review

SKU: 17LS19-1684E-200G

**\$44.86**

Bulk quantity price break:

Qty	3	10	30	100
Price	\$43.88	\$40.96	\$39.98	\$37.06
Save	2.18%	8.69%	10.88%	17.39%

Availability: 1

\* Ship from

[China](#) [United States](#)

- 1 + [ADD TO CART](#) [♡](#)

[Report error](#) / [Notify inventory](#) / [Request bulk price](#)

[Like](#) [Twitter](#) [Facebook](#) [Share](#)

J5 motor

SKU: 17LS19-1684E-200G



## Nema 14 Stepper Motor Bipolar L=33mm w/ Gear Ratio 19:1 Planetary Gearbox

★★★★★ 1 reviews | Write a review

SKU: 14HS13-0804S-PG19

**\$34.95**

Bulk quantity price break:

Qty	3	10	30	100
Price	\$34.28	\$32.26	\$31.59	\$29.58
Save	1.92%	7.65%	9.62%	15.38%

Availability: 198

\* Ship from

[China](#) [United States](#) [Germany](#) [United Kingdom](#) [Australia](#)

- 1 + [ADD TO CART](#) [♡](#)

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J6 motor

SKU: 14HS13-0804S-PG19



## Nema 11 Bracket for Stepper Motor and Geared Stepper Motor , Steel Bracket

★★★★★ 0 reviews | Write a review

SKU: ST-M3

**\$1.96**

Bulk quantity price break:

Qty	3	10	30	100
Price	\$1.83	\$1.70	\$1.56	\$1.43
Save	6.67%	13.33%	20%	26.67%

Availability: 131

\* Ship from

China

United States

Germany

-

1

+

ADD TO CART



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Like 0



Tweet



Post



Share

J4 bracket

SKU: ST-M3

# Bearings



uxcell  
uxcell 45mmx73mmx15mm 32009 Single Row Tapered F  
Rolling Wheel Bearing

[Be the first to review this item](#)

Price: **\$12.77** & FREE Shipping

Note: Not eligible for Amazon Prime

Only 6 left in stock - order soon.

Get it as soon as Feb. 13 - 16 when you choose Expedited Shipping at checkout.

Ships from and sold by uxcell.

Now (1) from \$12.77 & FREE shipping.

Specifications for this item

Bore Diameter	1.77 inches inches
Brand Name	uxcell
Number of Items	1

Qty. (2) for J1 bearings - Amazon



30206 Taper Wheel Bearing 30x62x17.2

[Be the first to review this item](#)

Price: **\$11.97** Prime

Note: Available at a lower price from other sellers, potentially with

In Stock.

Want it Friday, Feb. 10? Order within 15 hrs 48 mins and choose Details

Ships from and sold by Amazon.com.

New (2) from \$9.95 & FREE shipping.

Specifications for this item

Qty. (2) for J2 bearings - Amazon



Uxcell 30204 Single Row 47mm  
Outside Diameter 14mm Thick Tapered  
Roller Bearing

[Be the first to review this item](#)

Price: **\$8.30** & FREE Shipping

Note: Not eligible for Amazon Prime. Available with free shipping from other sellers on Amazon.

Only 3 left in stock.

Get it as soon as Feb. 27 - March 2 when you choose Expedited Shipping at checkout.

Qty. (1) for J3 bearing - Amazon



VXB  
Thrust Needle Roller Bearing 35x52x4 Thrust Bearing

[Be the first to review this item](#)

Price: **\$7.64** Prime

Note: Available at a lower price from other sellers, potentially without free Prime shipping.

Only 6 left in stock (more on the way).

Want it Thursday, Feb. 23? Order within 15 hrs 29 mins and choose One-Day Shipping Details

Ships from and sold by Amazon.com.

New (2) from \$5.77 & FREE shipping.

Specifications for this item

Part Number	K88675
Brand Name	VXB
Inside Diameter	35 millimeters

Qty. (1) 35mm thrust bearing and washer set for J3 - Amazon

### Thrust Needle-Roller Bearing

for 1" Shaft Diameter, 1-9/16" OD



☐ Each In stock  
\$3.17 Each  
5909K36

**ADD TO ORDER**

You ordered 4 each on 01/28/17.

Qty.(3) 1" thrust bearings (2 for J4 and 1 for J6) –McMaster Carr

### 0.032" Thick Washer for 1" Shaft Diameter Thrust Needle-Roller Bearing



☐ Each In stock  
\$1.15 Each  
5909K49

**ADD TO ORDER**

You ordered 6 each on 01/28/17.

RoHS Not Compliant

Qty.(4) (3 for J4 and 1 for J6) –McMaster Carr

## 0.126" Thick Washer for 1" Shaft Diameter Thrust



Each

In stock  
\$5.00 Each  
5909K63

ADD TO ORDER

You ordered 2 each on 01/28/17.

RoHS Not Compliant

Qty.(2) (1 for J4 and 1 for J6) –McMaster Carr



SKF HK 1612 Needle Roller Bearing, Caged Drawn C Ring and Roller, Open, 16mm Bore, 22mm OD, 12mm

Price: \$10.59 Prime

Only 1 left in stock (more on the way).

Want it Monday, Feb. 20? Order within 11 hrs 48 mins and choose One-Day Shipping

Details

Ships from and sold by Amazon.com.

Bore Diameter String:

16 mm

Item Diameter String:

22 mm

Item Width String: 12 mm

Qty. (1) for J5 belt idler - Amazon



by Koyo

Koyo B-1616 Needle Roller Bearing, Full Complement Cup, Open, Inch, 1" ID, 1-1/4" OD, 1" Width, 4300rpm Rotational Speed, 16700lbf Static Load Capacity, 7600lbf Dynamic Load Capacity

★★★★★ 4 customer reviews

Price: \$9.71 Prime

Note: Available at a lower price from other sellers, potentially without free Prime shipping.

In Stock.

Want it Tuesday, Feb. 28? Order within 4 hrs 19 mins and choose Two-Day Shipping

Details

Ships from and sold by Amazon.com.

New (5) from \$1.71 + \$6.15 shipping

Qty.(2) for J4 bearings - Amazon

uxcell

10Pcs 150 x 3mm Stainless Steel Cylinder Linear F Rod Shaft

★★★★★ 4 customer reviews

Price: \$7.50 Prime

In Stock.

Want it Thursday, March 9? Order within 2 hrs 23 mins and choose Two-Day Shipping

checkout. Details

Sold by uxcell and Fulfilled by Amazon. Gift-wrap available.

- Product Name : Round Rod, Size : 150x 3mm / 5.9"x 0.12"(L"D)
- Material : Stainless Steel
- Color : Silver Tone
- Weight : 83g

Qty.(1) set of 10 shafts (you only need 2) - Amazon



CNC INC

8pcs LM3UU 3mm linear bushing linear bearing

Be the first to review this item

Price: \$11.76 (\$1.47 / Item) & FREE Shipping

Note: Not eligible for Amazon Prime.

In Stock.

Get it as soon as March 13 - 16 when you choose Expedited Shipping at checkout

Ships from and sold by Ogry.

New (1) from \$11.76 & FREE shipping.

Specifications for this item

Part Number CNC000001-8

Qty.(1) set of 8 bearings (you only need 2) - Amazon



uxcell

10 Pcs 688Z Metal Sealed Deep Groove Radial Ball Bearings, 16 x 5mm

★★★★★ 4 customer reviews

Price: \$8.91 Prime

Only 15 left in stock.

Want it Thursday, March 9? Order within 13 hrs 23 mins and choose One-Day Shipping

Details

Sold by uxcell and Fulfilled by Amazon. Gift-wrap available.

New (2) from \$7.79 & FREE shipping.

Specifications for this item

Qty.(1) set of 10 8x16x5mm bearings (you only need 1) - Amazon



**30203 Taper Roller Wheel Bearing:  
17x40x12 VXB Brand**

[Be the first to review this item](#)

Price: **\$6.55**

**Note:** Not eligible for Amazon Prime.

**In Stock.**

Get it as soon as **March 27 - 30** when you choose **Exp** checkout.

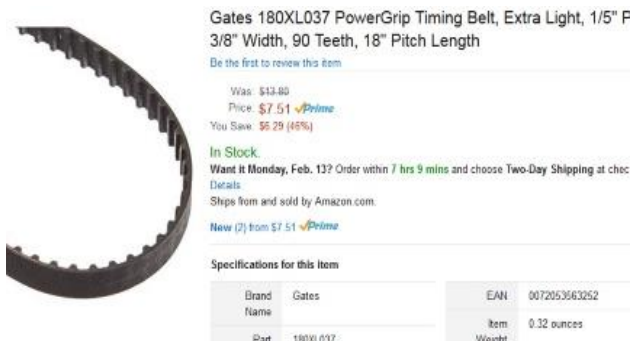
Ships from and sold by [VXB Bearing](#).

\*\*\* [View all product details](#) \*\*\*

Qty.(1) for J6 bearing - Amazon

# Belts - Sprockets





Qty. (1) J1 belt - Amazon



(2' length) J3 chain – McMaster Carr

## Connecting Link for ISO Number 04B Me



Qty.(1) link for J3 – McMaster Carr



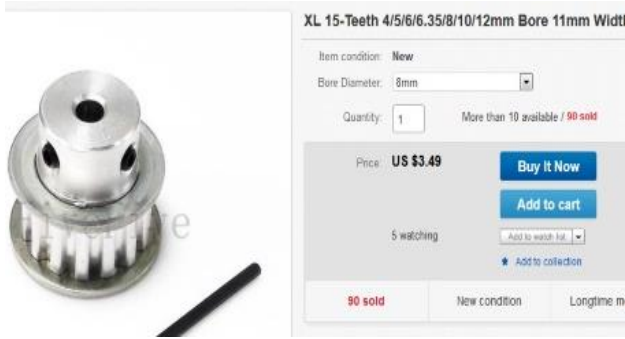
Qty.(1) J4 belt – Amazon



Qty.(1) J5 belt – Amazon



Qty.(1) driven pulley for J1 – Amazon



Qty.(2) 15 tooth 8mm bore sprocket (1 for J1 and 1 for J6) - Ebay



Qty.(1) for J4 - Ebay

### Machinable-Bore Sprocket

for ISO #04B Roller Chain, 6mm Pitch, 13 Teeth



☐ Each

In stock  
\$12.45 Each  
2302K72

**ADD TO ORDER**

2 each added to your order.  
Ships in the morning (from our  
Chicago warehouse)


Qty.(2) for J3 chain – McMaster Carr



# Hardware

Metric Key Stock

Undersized, Steel, 2mm x 2mm, 12" Length



Each

In stock  
\$1.87 Each  
92288A710

ADD TO ORDER

You ordered 1 each on 01/20/17.

Material	Steel
Size	2 x 2 mm
Length	12"

Qty.(1) – McMaster Carr

Metric Key Stock

Oversized, Zinc-Plated Steel, 4mm x 4mm, 12" Long



Each

In stock  
\$3.81 Each  
92288A110


ADD TO ORDER

You ordered 1 each on 02/09/17.

Qty.(1) – McMaster Carr

Keyed Rotary Shaft

1045 Carbon Steel, 8 mm Diameter, 300 mm Long



Each

In stock  
\$20.27 Each  
1439K211

ADD TO ORDER

You ordered 1 each on 01/20/17.

Material	1045 Carbon Steel
Diameter	8 mm
Length	300 mm

Qty.(1) McMaster Carr

High-Strength 2024 Aluminum Tube

0.035" Wall Thickness, 1" OD



Each

In stock  
\$10.53 Each  
1968T17


ADD TO ORDER

Length, ft.  
✓ 1

Qty.(1) McMaster Carr

Square Head Extended Point Set Screw

Alloy Steel, M8 x 1.25 Thread, 25mm Long



Packs of 5

In stock  
\$5.52 per pack  
92635A314

ADD TO ORDER

Qty.(1) – McMaster Carr

# Screws

M3x20 FLAT HEAD SCREWS	6
M3x25 SOCKET HEAD SCREWS	16
M3x3 SET SCREW	4
M3x4 SET SCREW	1
M3x5 SOCKET HEAD CAP SCREW	1
M3x6 SET SCREW	4
M3x8 SOCKET HEAD CAP SCREW	6
M4x10 FLAT HEAD SCREWS	16
M4x10 SET SCREWS	9
M4x10 SOCKET HEAD CAP SCREWS	18
M4x14 FLAT HEAD SCREW	2
M4x18 FLAT HEAD SCREW	6
M4x20 SOCKET HEAD CAP SCREWS	8
M4x35 SOCKET HEAD CAP SCREWS (fully threaded)	4
M4x5 SET SCREWS	22
M6x14 SOCKET HEAD CAP SCREWS	13
M6x18 FLAT HEAD SCREWS	9
M6x20 SOCKET HEAD CAP SCREWS	3
M8x25 SQUARE HEAD	1
M4 washers	16
M4 nuts	4

# Gripper & Switches



Pneumatic Gripper – Ebay (used)



Baomain

**Baomain Pneumatic Air Control Solenoid Valve 4V210-08 DC24V 5 Way 2 Position PT1/4" Internally Piloted Acting Type Single Electrical Control**

[Be the first to review this item](#)

Price: **\$12.79** ✓prime

**In Stock.**

24vdc Solenoid to actuate gripper – Amazon

NOTE: solenoid valves tend to interrupt the serial connection to the Arduino if located too close. If you find Arduino losing connection when valve actuates install a flyover diode across solenoid terminals (reverse bias).







SV-166-1C25 Limit Switch Long Hinge Roller A  
Action 3-16A 250VAC (10 pieces)

Be the first to review this item

Price: \$7.56 (\$0.76 / item) + \$4.49 shipping

Note: Not eligible for Amazon Prime

Only 2 left in stock - order soon.

Get it as soon as Feb. 14 - 17 when you choose Expedited Shipping at  
Ships from and sold by Standard Supply Co.

New (1) from \$7.56 + \$4.49 shipping

Specifications for this item

Brand Name	Yuejing Saigo Electronics
------------	---------------------------



OdiySurveil

OdiySurveil (TM) XV-152-1C25 Hinge Lever  
Micro Switch(Pack of 5)



15 customer reviews | 4 answered questions

Price: \$8.29 Prime

In Stock.

Want it Friday, April 21? Order within 3 hrs 24 mins and choose Two-Day Shipping

Sold by Overseasymall and Fulfilled by Amazon. Gift-wrap available.

- Product Name : Micro Switch;Model No. : XV-152-1C25;
- Actuator Type : Straight Hinge Lever;

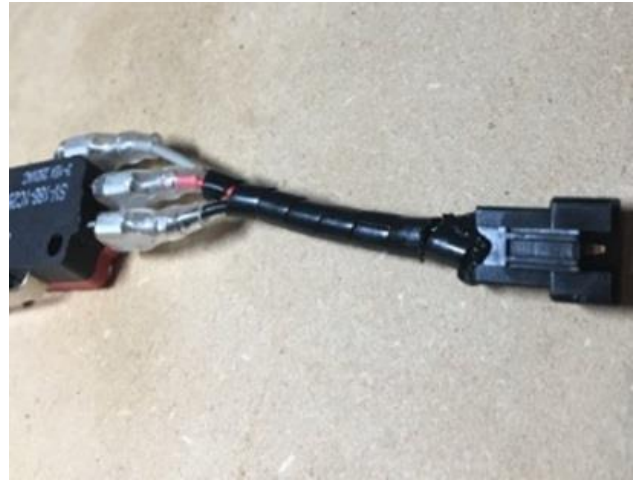
Qty.(5 switches) – Amazon

Qty.(1 switch) – Amazon

# **ASSEMBLY**



Cut motor pigtails and attach JST connectors to each of the 6 motors as shown in section 4 of the wiring harness manual.



Fabricate 6 limit switch pigtails with JST connectors as shown in section 3 of the wiring harness manual.



Press (x2) #32009 bearing races into the J1 turret housing. If you do not have access to a press place turret housing in oven @ 350° and bearing races in freezer for 60 minutes, quickly remove housing from oven – the cold races will drop into the expanded housing. (you will need to do this for both races one at a time)



Install #32009 bearing on J1 spindle as shown.



Insert J1 spindle into turret housing then install the other #32009 bearing on top side of spindle. (note location of flat on housing)



Press (x2) #30206 bearing races into the J2 turret housing. If you do not have access to a press place turret housing in oven @ 350° and bearing races in freezer for 60 minutes, quickly remove housing from oven – the cold races will drop into the expanded housing. (you will need to do this for both races one at a time)



Use abrasive saw to cut square M8 screw down as shown leaving approx 8mm of threads remaining.



Install square head M8 screw into J1 turret platform as shown – make sure square head is tangent to center bolt circle as indicated by dashed line in picture.



Secure J2 turret housing to J1 platform using (x6) M8x18 flat head screws.



Install (x2) M6 x 20 socket head screws in front of J2 turret housing going into the J1 platform.



Install platform assembly onto J1 spindle assembly and secure with (x8) M6 X 14 socket head cap screws.



Install (4) M4 x 10 set screws in the 4 perimeter holes in the platform. These place tension on the upper bearing. Snug the 4 set screws down evenly until there is no play in the bearings.





Mount J2 limit switch to J2 housing using (x2) M3x14 socket head cap screws.



Install the J1 assembly onto the J1 base as shown. Make sure the flat surface with 2 holes is facing toward the back.



Secure J1 assembly from the bottom using (x8) M4x10 socket head cap screws.



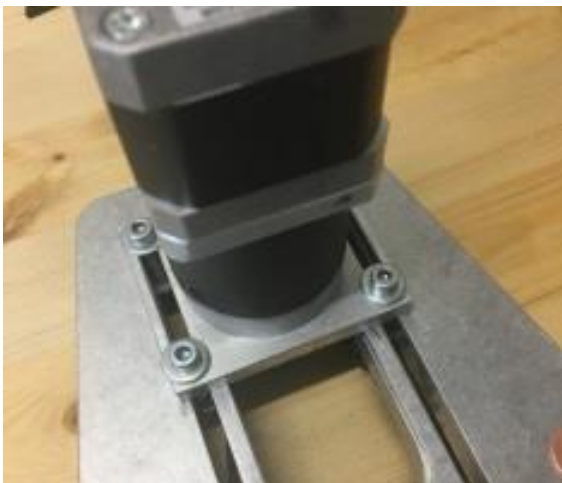
Mount J1 limit switch to J1 housing using (x2) M3x14 socket head cap screws.



Install the J1 driven sprocket onto the J1 spindle and secure with (x4) M6x14 socket head cap screws.



Install J1 motor mount onto J1 motor using (x4) M4x10 flat head screws and then Install XL15 tooth 8mm bore drive sprocket on J1 gear motor shaft.



Install motor assembly onto base and secure with (4) 4mm X 20 socket head cap screws and (4) 4mm washers. (note this picture was taken with a prototype slotted J1 baseplate – print files and future parts will have fixed mounting holes in J1 baseplate – new pictures will be taken)



Tension J1 belt using (x2) M4x10 set screws in rear of motor mount slots. (note this picture was taken with a prototype slotted J1 baseplate – print files and future parts will have fixed mounting holes in J1 baseplate – new pictures will be taken)



Place J1 baseplate on top of plastic spacer (*they are aligned with 4mm dowel pins*) then use 4 screws or bolts to mount robot to benchtop or surface of your choosing.



Install J2 spindle into J2 arm and secure using (x8) M4x10 flat head screws. Make sure keyway is aligned in the up position.



NOTE: when installing the J2 spindle the 2 mounting holes for the J3 limit switch should be on right side as shown.



Install #30206 bearing onto J2 spindle as shown.





Install M3x10 set screw into J2 spindle as shown but do not thread through to keyway yet.



Install J2 arm assembly into J2 turret housing and then install the other #30206 bearing from opposite side as shown.



Install the J2 tension ring and secure with (6) M3 x 10 flat head screws. Note orientation – tension ring is 90° to the J2 arm.



Install and snug (x4) M4x5 screws until there is no play in J2 bearings.



Remove (x4) M4 cap screws from the J2 motor gearbox as shown.



Remove the top of the gearbox as shown.



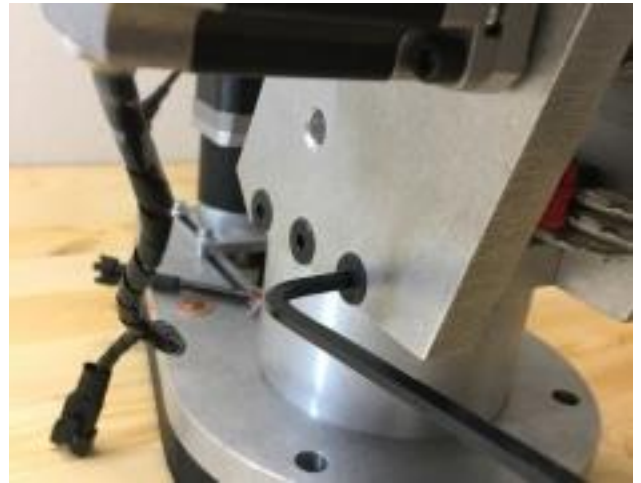
Install the J2 motor support plate over the gearbox housing as shown.



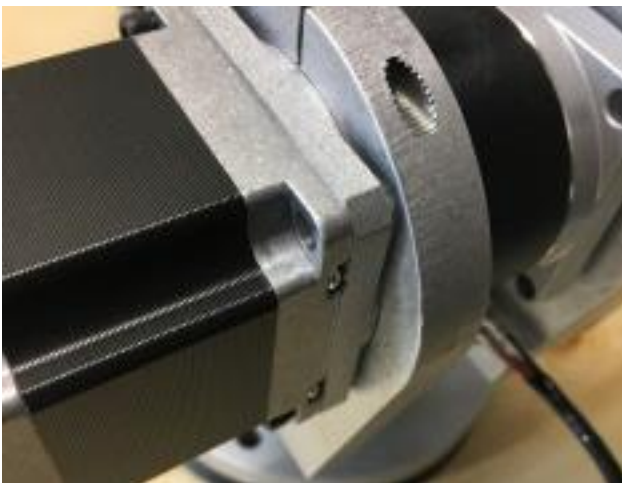
Reinstall the top of the J2 gearbox and re-secure with M4 cap screws. (make sure the key is in the up position as shown)



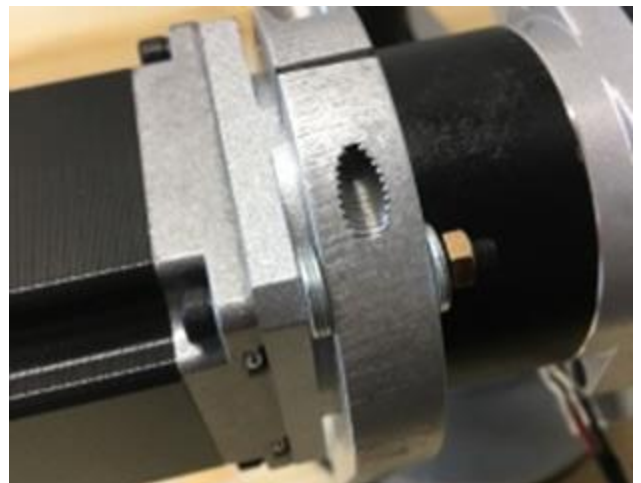
Insert J2 motor shaft into the J2 spindle as shown.



Secure J2 motor support to J1 platform using (x3) M6x18 flat head screws.



One at a time remove the factory M4x10 cap screws from J2 motor mount.



Replace factory screw with M4x35 fully threaded cap screw. Place (x3) 4mm washers between gearbox and J2 motor support then secure with 4mm washer and nut as shown. (repeat this process for all 4 motor screws)





Install and tighten M6x20 cap screw in J2 motor support plate.



Tighten M3x10 set screw through access hole in J2 turret housing as shown.



Install J3 motor mount onto J3 motor using (x4) M4x10 flat head screws.



The 13 tooth 8mm bore sprockets must be drilled and tapped to accept a 4mm set screw. Use a 3.3mm (#29) drill to drill 2 holes in each sprocket. (holes should be 90 from each other)



Use 4mm tap to thread (2) holes in each sprocket (total 4 holes)



Install sprocket on to J3 motor shaft and tighten (x2) M4x5 set screws.



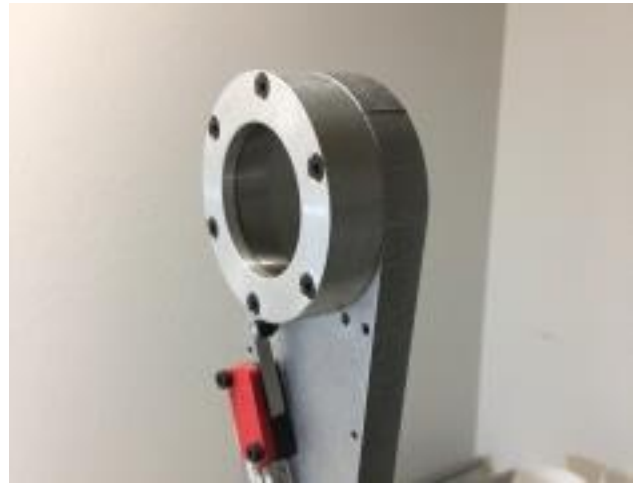
Install J3 motor onto J2 arm and secure with (x4) M4x20 socket head cap screws.



Mount J3 limit switch to J2 arm using (x2) M3x14 socket head cap screws.



Press (1) #30204 bearing race into the J3 bearing cup.



Secure J3 bearing cup and race to end of J2 arm using (6) M3 x 25 flat head screws.



Use abrasive saw to cut length of 8mm keyed shaft to 53mm long.



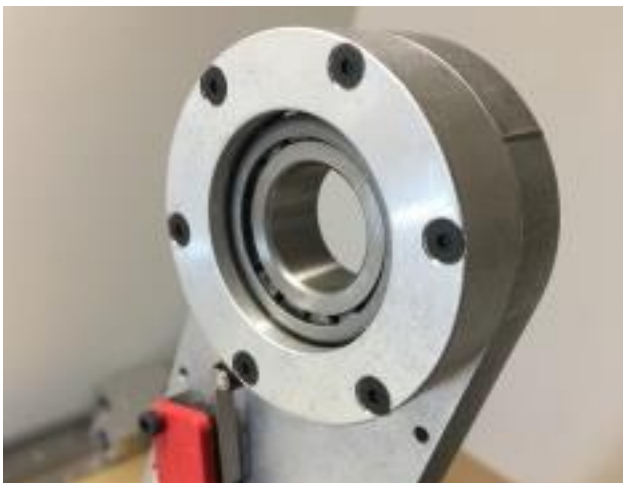
Use abrasive saw to cut length of 2mm keyed stock to 25mm long.



Install 8mm shaft into J3 spindle. Install 2mm key stock into shaft and spindle slot and secure with 3mm x 4 set screw.



Install 35x52x4 thrust bearing and washers onto J3 spindle.



Install #30204 bearing as shown.



Install J3 spindle and shaft into J2 arm – slide spindle into #30204 bearing.





Install J3 spindle retainer. Secure with (4) M3 x 10 flat head screws. Tension screws so there is no play in bearings.



Install one sprocket on the J3 spindle Shaft and secure with (x2) M4x5 set screws.



Cut length of 04B roller chain down to 20-3/4" long (52.7 cm). It should have 43 links.



Install master link in 04B roller chain.





Install chain around J3 and motor sprockets.



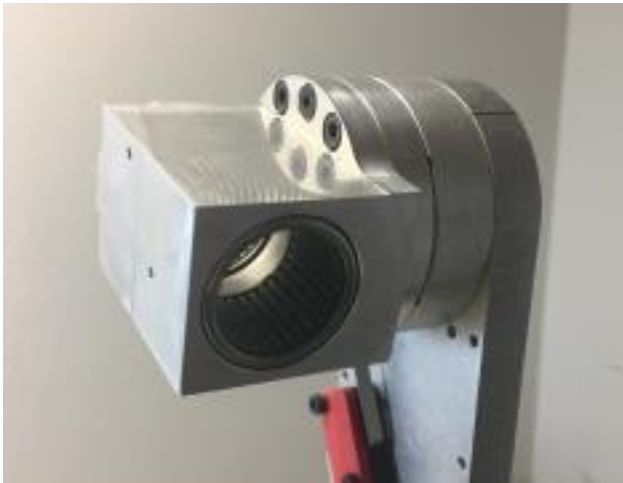
Leave J3 motor mount screws barely snug so motor can still slide and then install (x2) M3x14 cap screws into lower holes on motor mount and then tighten to tension the chain. (*these M3 screws will push against the lower motor mount screws*)



Once chain has good tension tighten all 4 of the J3 motor mount cap screws.



Press (2) B-1616 (1" ID) needle roller bearings into the J3 turret housing (install one each side).



Secure turret housing to J3 spindle using (x2) M4x14 flat head screws (center) And (x4) M4x10 cap screws (outer).



Install (1) M3x5 socket head cap screw into motor housing.

*Note: this screw serves as a timing lug for J4.*



Secure J5 linear screw motor to J5 motor mount using (4) M3 x14 socket head cap screws.



Insert J4 main shaft as shown. Note the single hole in end of shaft must align with set screw hole in J5 motor mount near the M3 timing lug.



Install M4x10 set screw as shown – make sure set screw aligns and screws into hole in shaft – note when looking down tube you should be able to see the head of set screw just poking through tube.



Install and snug one more M4 set screw in housing in next hole 90° to the set screw in the previous step.



Install (x1) .032" thick bearing washer over tube and into motor mount as shown.



Install (x1) 1" ID needle bearing over tube and into motor mount as shown.



Install (1) .032" bearing washer over tube and on top of needle bearing as shown.



Insert J5 Motor shaft assembly into J3 turret housing as shown.



Pre install (x4) M4x5 set screws in back side of J4 timing hub.



Install (x1) .032" bearing washer into timing hub as shown.





Install (x1) 1" ID needle bearing into timing hub.



Install (1) .126" thick bearing washer on top of thrust bearing as shown.



Install J4 timing hub and bearings into J4 shaft. Make sure M4 threaded hole in timing hub aligns with 2<sup>nd</sup> hole in shaft.



Install (x4) M4x5 set screws around perimeter of timing hub. Make sure set screws on 2 sides seat into 2 holes in J4 shaft. You should be able to see head of set screw slightly protrude on inside of shaft.



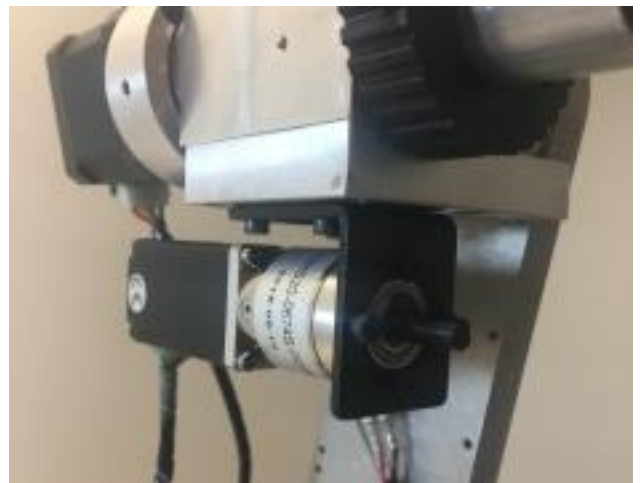
Tighten (x4) M4x5 set screws in face of timing hub to set tension on J4 bearings.



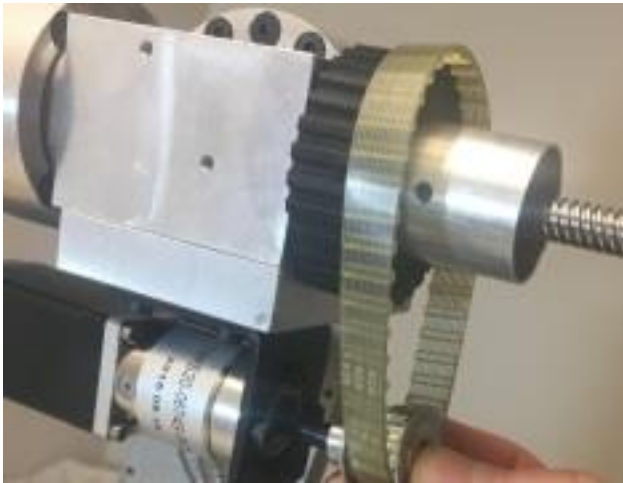
Install J4 motor mount / limit switch contact block as shown and secure with (x3) M4x10 socket head cap screws.



Install Nema11 motor mount bracket and secure with (x4) M3x14 socket head cap screws.



Install J4 motor into bracket and secure with (4) M3x8 socket head cap screws.



Slide XL 10 tooth 6mm bore drive pulley onto motor shaft along with 84XL037 timing belt simultaneously over J4 driven sprocket.

*(the belt in these instructions happens to be clear but depending on source will likely be black)*



When belt and pulley are fully seated tighten set screw on pulley making sure set screw is aligned with flat on motor shaft.



Countersink the 3 holes in POM nut (supplied with linear motor) .



Install POM nut into the J5 carrier. secure with (3) M3x10 flat head screws.



Install (x4) LM3UU 3mm linear bearings into J5 carrier. Note: I left them protruding by 2mm to increase overall support width (the carrier will experience significant side load) If building a 3D printed version I would advise using epoxy to also secure bearing into carrier.



Secure bearings with (x4) M3x4 set screws.



Use abrasive saw to cut (2) 3mm linear rods down to 85mm length.



Install (2) 3mm liner rods into J5 housing and through the J5 carrier bearings as shown.





Temporarily install M4x20 cap screw fully threaded into hole as shown (this will prevent 3mm rod from going too deep and blocking hole) then finish sliding 3mm rods into place.



Secure both 3mm rods using (x2) M3x6 set screws – one from the top and one from the bottom. Then remove the M4 cap screw. *(Don't forget to apply grease to 3mm rods and bearings)*



Install J5 idler tension block and secure with (2) M3x8 socket head cap screws.



Install HK1612 bearing over the J5 bearing post as shown.



Then install J5 bearing and post into tension block and secure with (x1) M4x10 socket head cap screw.



Press 688Z 8x16x5mm bearing in end of J5 housing.



secure with (x2) M3x6 set screws from each side.



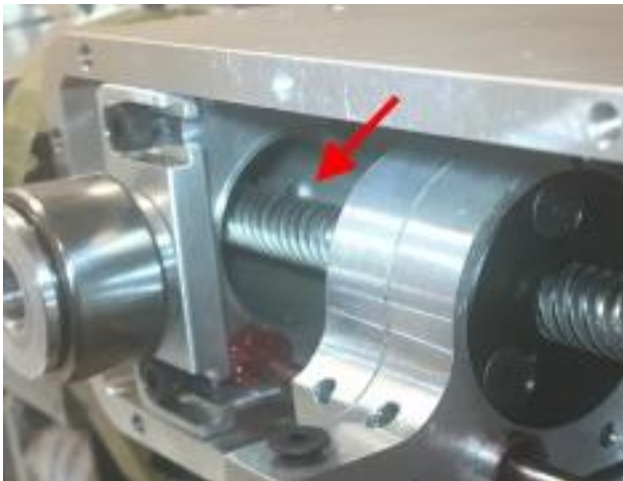
Spin J5 housing assembly onto J5 drive screw as shown.



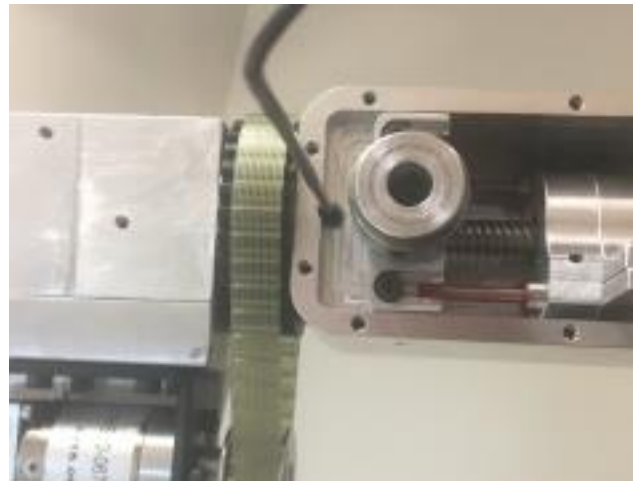
Slide J5 housing assembly forward onto J4 main tube.



Make sure hole in J5 housing and J4 main tube are perfectly aligned and then install M3x6 set screw.



Make sure set screw slightly protrudes inside J4 main tube.



Install one more M3x6 set screw on opposite side.



Secure limit switch to J3 turret housing using (x2) M3x14 socket head cap screws.



Press #30203 taper roller bearing race into J5 main bearing support arm.

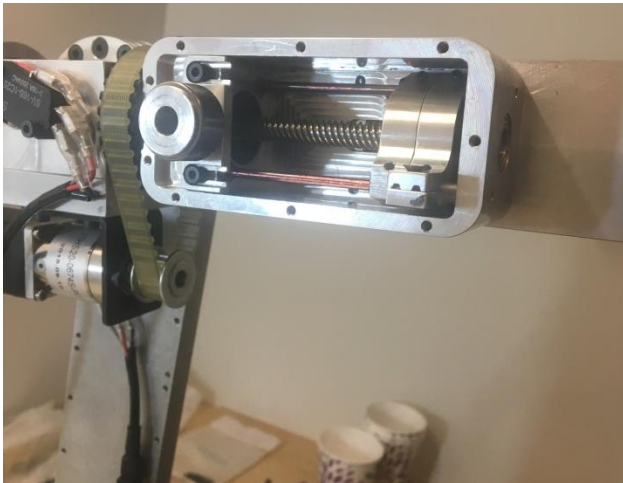


Secure J6 main bearing arm to J5 housing using (x6) M4x18 flat head screws.



Install J5 limit switch into slot on J6 bearing support arm as shown.





Manually rotate the screw shaft on the J5 motor until the J5 belt carrier is all the way to the end of its stroke as shown.



With carrier at the end of its stroke carefully adjust limit switch so that switch wheel contacts carrier clicks when carrier is forward.



Install and snug (x2) M4x10 set screws to secure switch in place-be careful not to overtighten (do not damage switch). Rotate J5 motor shaft forward back to make sure limit switch clicks when carrier is in the forward position and adjust switch position as necessary.



Install #30203 taper bearing onto J6 housing side post.

*Note: If building 3D printed robot Use epoxy to secure J6 drive post to J6 housing as they are printed in 2 pieces.*



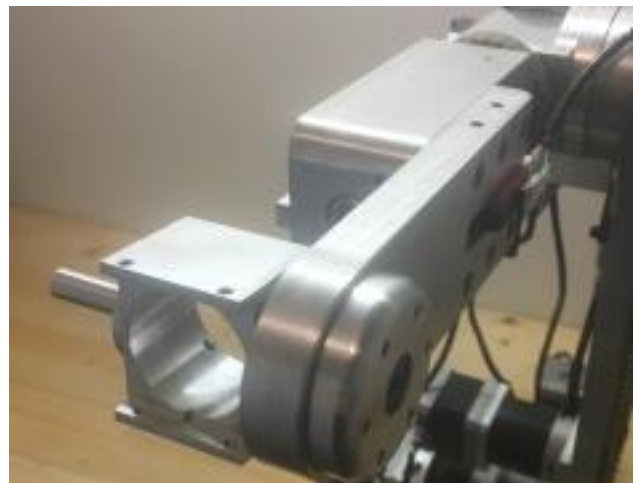
Install (x1) .126" thick bearing washer into J6 bearing cap.



Install (1) 1" ID needle bearing into J6 bearing cap.



Install (1) .032" bearing washer into J6 bearing cap on top of bearings.



Install J6 motor bearing assembly into bearing support arm with J6 cap assembly on opposite side and secure with (x1) M6x14 socket head cap screw.



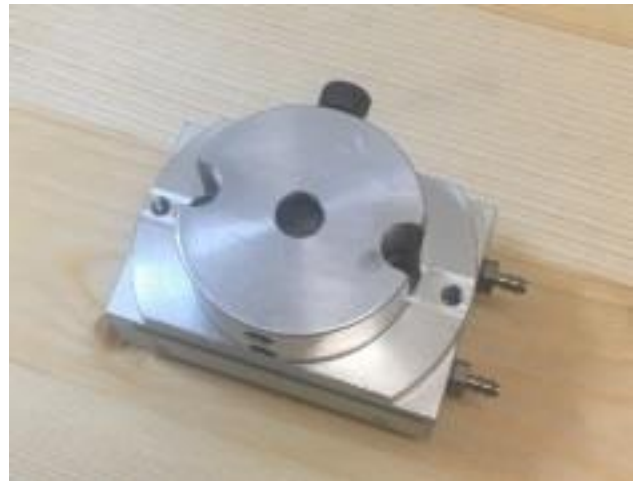
Install (x6) M4x5 set screws in perimeter of bearing cap and set tension against needle bearings so there is no play in J6 motor assembly.



Install J6 motor into J6 housing as shown and secure with (4) M3x3 set screws. You may need to grind down the upper left screw so it doesn't keep the J6 limit switch from sitting flat. Note that motor pigtail is in the up position.



Insert (x1) M4x10 socket head cap screw into shoulder of gripper mount. (this will be the contact for the J6 limit switch)



Secure J6 gripper mount to SMC MFH2-8D1 gripper using (x2) M4x10 socket head cap screws.



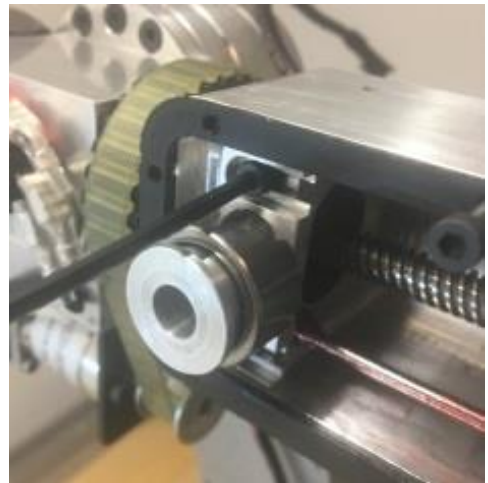
Install gripper mount over J6 motor shaft and secure with (x2) M4x10 set screws.



Install plastic J5 side cover and Install (1) XL15 tooth –8mm bore drive sprocket on J6 spindle shaft as shown but do not tighten set screws yet.



Use 3mm drill to create small hole in center of 150XL037 belt,



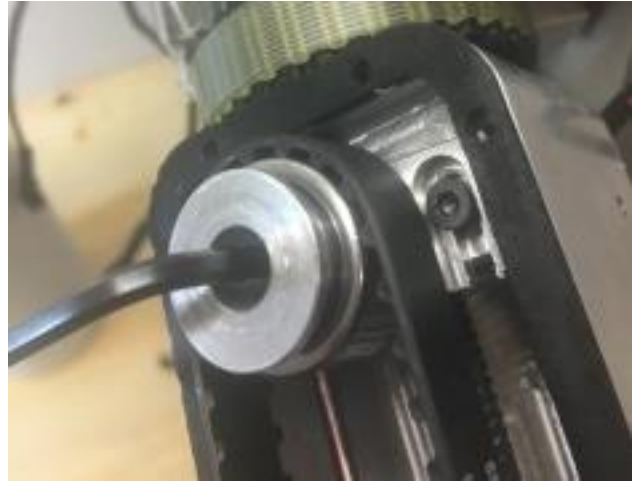
Adjust J5 idler tension block so that belt just barely too tight to fit and tighten mounting screws.





Belt should be just barely too tight so that you cant slip it over the idler bearing.

*Note: when using 3D printed components you may not be able to get the belt this tight.*



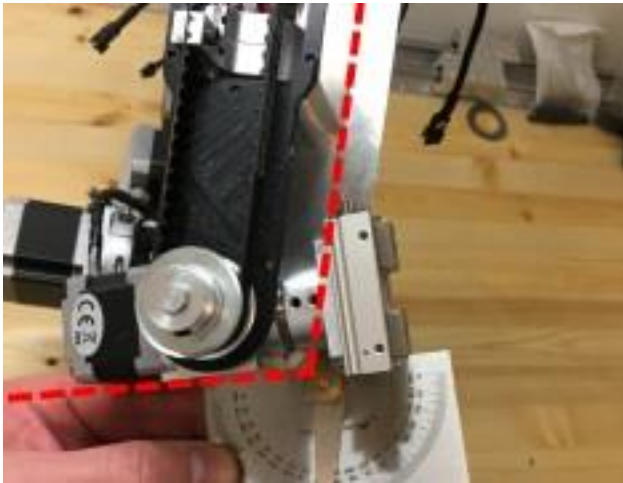
Loosed bearing post mounting screw so that post tips back and belt can now slide onto bearing. Now tighten post mounting screw – this should now result in a very tight belt adjustment.



When using 3D printed components the M4 screws do not have the holding force to keep tension on the belt under load. Place a small drop of super glue around the heads of the M4 screws securing the head of the screw to the tension block. (if disassembled or tension needs to be reset bond will need to be broken and a new tension block installed)



Install (x1) M3x8 set screw through belt and J5 carrier clamp as shown and tighten to clamp belt to carrier.



Rotate J5 motor shaft until belt carrier is to the top of its stroke and you can feel the J5 limit switch click or make contact. Use angle gauge and rotate J6 housing until housing is at 105°



Once J5 limit switch is clicked and housing is at 105° tighten the pulley set screws as shown.



Install J5 side spacers and cover cap as shown. Secure to J5 housing with (8) M3x25 flat head screws.(these go through the cap, spacer and side plate and then thread into the J5 housing)



Secure the cover & spacer to the side plate on the front using (6) M3x20 flat head screws. (these thread into shallow threads on the plastic side plate)



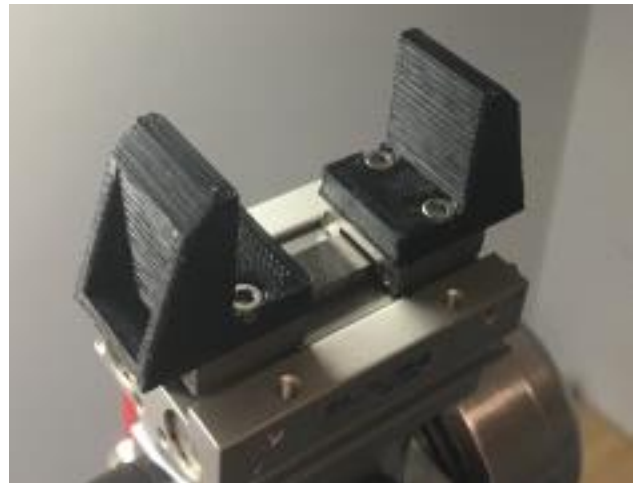
Apply grease to chain and then Install the J2 side cover spacers and caps using (x16) M3x25 socket head cap screws.



Epoxy J6 limit switch arm tip to J6 limit switch as shown. (make sure it remains flat and fully seated while epoxy cures)



Install J6 limit switch onto J6 housing as shown using (x2) M3x14 socket head cap screws.



Install jaws of your own design/choosing – the jaws pictures were 3D printed but jaws can be made of any material.



If you are building a 3D printed version use epoxy to attach (x6) auxiliary support braces evenly spaced around J1 turret for added rigidity.



If you are building a 3D printed version use epoxy to attach J2 auxiliary support brace as shown for added rigidity.

Mechanical assembly of the robot is now complete. Please review the wiring harness, electrical enclosure and startup manuals to complete robot build.