



REV 1" LIFT BUILD GUIDE

January 7, 2019

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1 1" LIFT BUILD OVERVIEW

The REV 1" Lift kits meet a variety of team needs from basic two-stage lifts to cascading multistage lifts. One kit is available: The 1" Extrusion Lift Kit (REV-25-1290). The 1" Extrusion Lift Kit (REV-25-1290) can be added to the 1" Extrusion Lift Kit (REV-25-1290) to create a three-stage lift. It is possible to add more 1" Extrusion Lift Kit (REV-25-1290), but we do not recommend lifts beyond four stages. To build multistage lifts efficiently, prior planning is required to avoid interferences and ensure correct placing of all the components. To help teams expedite this process, REV provides individual and subassembly step files.

This guide is a step-by-step walk through for the assembly of two 1" Extrusion Lift Kits (REV-25-1290) with suggestions at the end of the guide for building a carriage (parts not included).

This guide also includes recommended motor and gearbox combinations.

1.1 HOW TO USE THIS GUIDE

Read this guide through before attempting to build the lift. Before assembling the lift, plan how to mount the lift to the drive train and decide which motor and gearbox combination to use. The top and bottom three inches of the first stage as well as the cross members of the first stage are optimal locations to mount the lift to the drive train.

REV recommends two individuals participate in assembling the lift on a large work surface in a room with 10+ foot ceilings. Dividing tasks and working in parallel between the two individuals will also help build the lift more quickly.

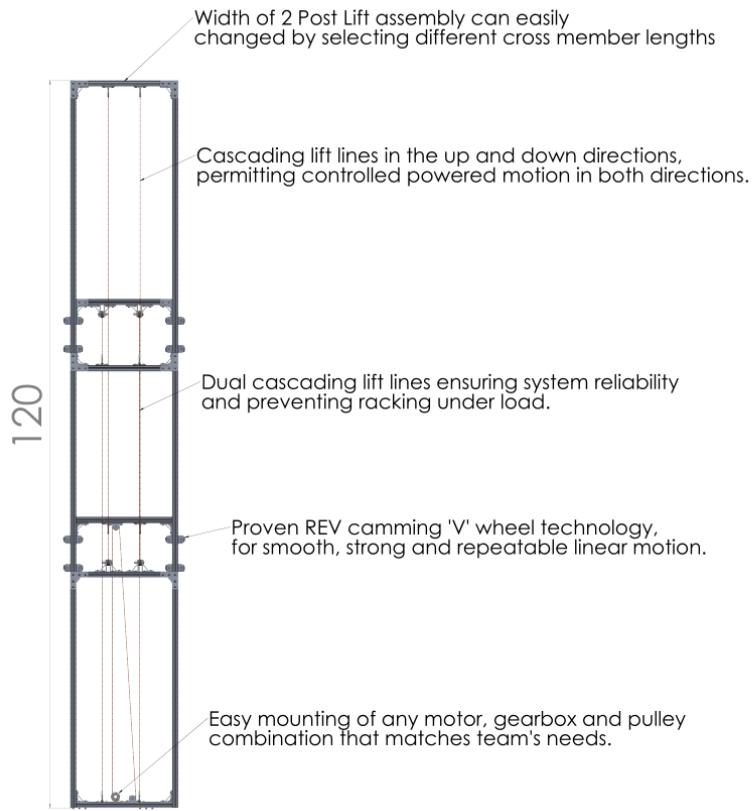
1.2 HOW THE REV LIFT WORKS

In order to drive the 2nd stage upwards the REV recommends using string and a pully with the string being wound up on half of the pully and wound out on the other half. This allows one motor/gearbox to be used to give powered extension and retraction for the lift. The only major issue teams need to look out for is ensuring the lift lines are completely vertical in both the XZ and YZ planes. If the lift lines are not completely vertical the sine/cosine error of the sting as it approaches and moves away from the mounting point causes the line to become slack

The REV 1" Lift Kits allow teams to have a powered extension and retraction of the lift by using two sets cascading lift lines. The extension set of cascading lift lines is mounted to bottom of the 1st stage of the lift, run up to the pulley at the top of the 2nd stage then back down to the bottom of the 3rd stage. This configuration is almost universally standard for cascading lifts. On the REV Lift a second set of cascading lift lines are run from the top of the 1st stage of the lift, down to pulley on the bottom of the 2nd stage then up to the top of the 3rd stage. This set of lift lines works the same way as the extension lines with the fixed points and bearing point inverted. The easiest way to think about the retraction set of lift lines is to imagine flipping the whole lift over making the 3rd stage the 1st and so on. The retraction lines then become the extension lines and vice versa. It is important to ensure the cascading lift lines are in the same ZY plane. This prevents sine/cosine error from becoming a problem on the cascading lift lines.

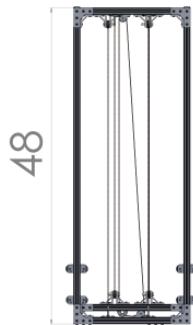
The cascading and regular lift lines will likely stretch out over time and require re-tensioning for this reason it is important to have a solid understanding of how the lift works and be able to restring it rapidly.

1.3 FEATURES



Extremely compact cross section enabling teams to dedicate valuable robot real estate to drivetrain and manipulator.

Lift displacement of up to 36 inches per additional stage.
For a total displacement of 72 inches with recommended 3 stage lift.



1.3

Each additional stage adds only 1.3 inches to lift assembly



Overall collapsed height of lift assembly and additional displacement remains constant regardless the the number of stages added.

1.4 KIT CONTENTS

1" Extrusion Lift Kit (REV-25-1290) comes with the following:

PRODUCT DESCRIPTION	PART NUMBER	QUANTITY
1" EXTRUSION-4FT	REV-21-1000	6
1" LINEAR MOTION KIT	REV-15-1189	4
1" EXTRUSION ENDCAP SLIDE-4 PACK	REV-21-1202	1
90 DEGREE BRACKET	REV-21-1580	14
PILLOW BLOCK	REV-21-1031	2
1" INSIDE CORNER BRACKET	REV-21-1203	12
V-GROOVE BEARING	REV-29-1014	4
2200 LB UHMWPE CORD-25FT	REV-29-1244	1
M4 EYE-TO-EYE TURNBUCKLE	REV-29-1241	2
1/4"-20, 3/8" SHOULDER SCREW	REV-29-1237	2
10-32 3/8" LONG BUTTON HEAD SCREW-100 PACK	REV-29-1221	1
10-32 1/2" LONG BUTTON HEAD SCREW-100 PACK	REV-29-1222	1
10-32 1 1/2" LONG COUNTER SUNK SCREW-25 PACK	REV-29-1223	1
10-32 LOW PROFILE NYLOC NUT-100 PACK	REV-29-1016	2
3/8" SPLIT LOCK WASHER-25 PACK	REV-29-1240	1
1/8" BALL END BONDHUS SCREW DRIVER	REV-29-1225	1
10-32 1-1/2" LONG BUTTON HEAD SCREW-5 PACK	REV-29-1220	1
1" UNIVERSAL MOTOR BRACKET FLAT	REV-21-1579	1
10-32 TO 3/8" SPACER-10 PACK	REV-29-1243	1
TIE-DOWN D-RING	REV-29-1242	8

21" SINGLE STAGE ASSEMBLY

Step-by-step guide to assemble the REV 1" Extrusion Lift Kit (REV-25-1290) as a single stage. Plan motor mounting and drive train mounting before assembling the kit.

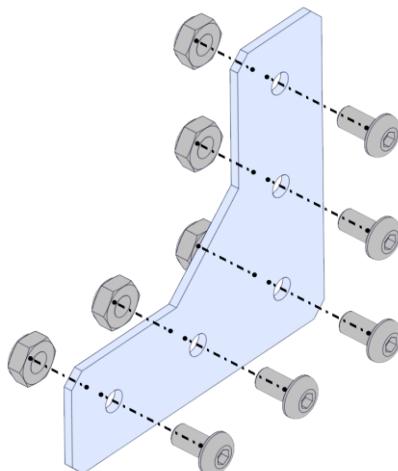
2.1 ADDITIONAL TOOLS AND SUPPLIES NEEDED

Table 2-1: Not Included in Kit

ITEM	NUMBER
5/32" HEX L KEY	1
3/16" HEX L KEY	1
3/8" WRENCH OR ADJUSTABLE WRENCH	1
1/2" WRENCH OR ADJUSTABLE WRENCH	1
ALUMINUM CUTTING HACKSAW	1
BASTARD FILE OR SANDING BLOCK	1
FINE TIP PERMANENT MARKER	1
CARPENTER'S OR ADJUSTABLE SQUARE	1
YARD STICK OR TAPE MEASURE	1
BLUE LOCTITE OR MEDIUM STRENGTH THREAD LOCKER	1
10-32 TAP AND TAP HANDLE	1
OUTPUT SHAFT COLLARS	3
MOTOR AND GEARBOX	1
MOTOR MOUNT	1

2.2 REV 1" EXTRUSION LIFT KIT SINGLE STAGE ASSEMBLY INSTRUCTIONS

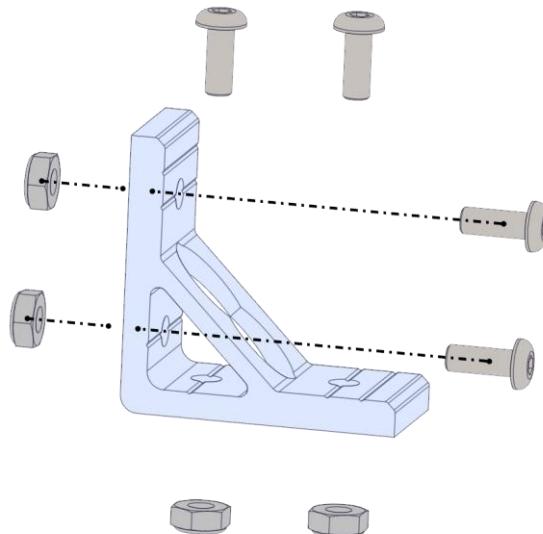
1



Assemble 90° Brackets

Preload all **14** 90° Brackets with 10-32 3/8" Button Head screws and 10-32 Low Profile Nylock Nuts.

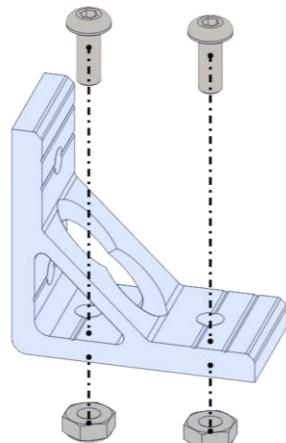
2



Assemble Inside Corner Brackets

Preload **8** Inside Corner Brackets with 10-32 1/2" Button Head screws and 10-32 Low Profile Nylock Nuts. **In all 4 holes.**

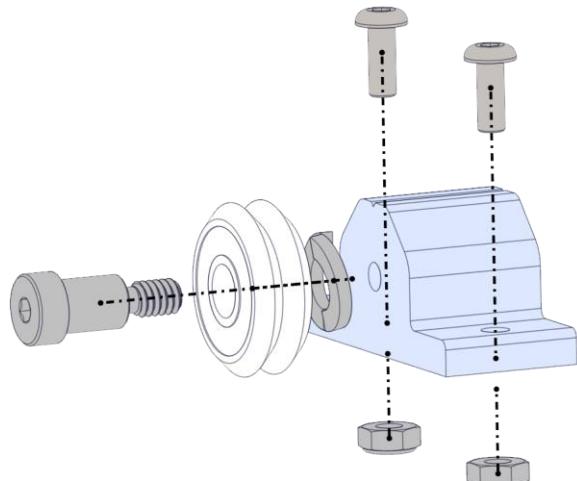
3



Assemble 2 Screw Inside Corner Bracket

Preload **1** Inside Corner Brackets with 10-32 1/2" Button Head screws and 10-32 Low Profile Nylock Nuts. **In 2 holes.**

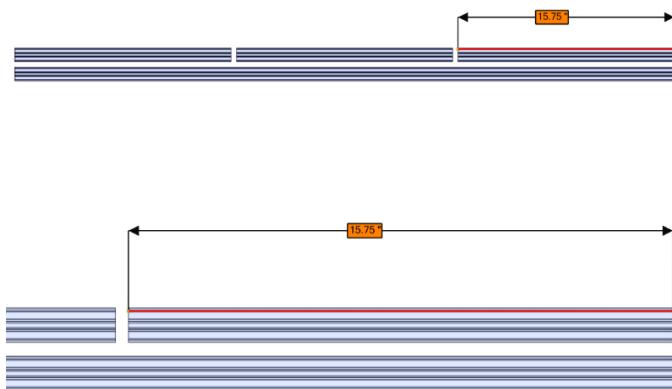
4



Assemble V-Grove Bearing Pillow Blocks

Preload **2** Pillow Blocks with 1/4-20 3/8" diameter Shoulder Screw, 1" V-Groove Bearing, 3/8" Split Washer, 10-32 1/2" Button Head screws and 10-32 Low Profile Nylock Nuts.

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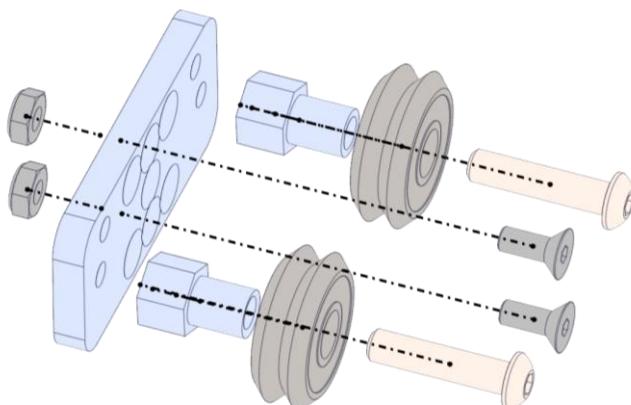


Cut Lift Cross Members

Cut **2** REV 1" Extrusion 48* long pieces into **4** 15.75" segments. The specific length is not critical, but all the Cross Members need to be the same. Deburr and remove sharp edges on the ends using the file. You will be left with one piece approximately 32" long. Save the 32" long piece as it may be useful for mounting the motor.

**The length of the Lift Cross Members can be customized to meet the needs of different applications, however shorter than 15.75" is not recommended as interferences become tricky to avoid.*

6



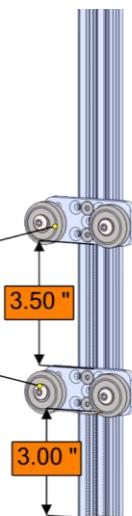
Assemble 1" Linear Motion Kits

Assemble all **4** of the 1" Linear Motion Kit bearing blocks. Use one Concentric Bushing and one Eccentric Bushing to mount the V-Groove Bearings. Add Blue Loctite or equivalent to the 1/4-20 1.125" long cap head screw and thread though the Bushings with V-Groove Bearings into the Dual Bearing Plate. Then preload the Dual Bearing Plate with two 10-32 1/2" Countersunk Flat Head screws and 10-32 Low Profile Nylock Nuts.

7

Assemble Vertical Lift 'A'

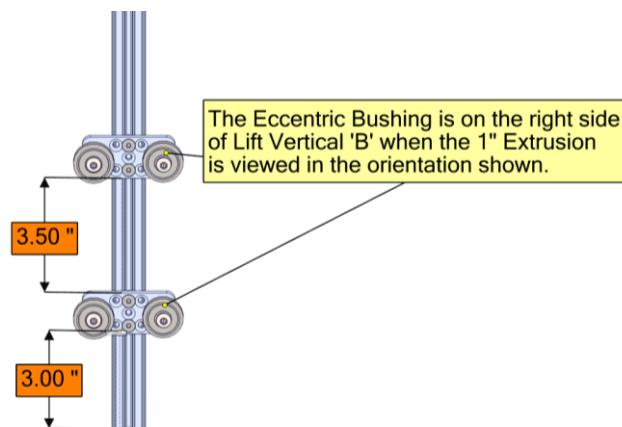
The Eccentric Bushing is on the left side of Lift Vertical 'A' when the 1" Extrusion is viewed in the orientation shown.



Slide 2 of the assembled 1" Linear Motion Kits onto a 48" long piece of the 1" REV Extrusion such that the Eccentric Bushing is on the **left side** when viewed from the orientation shown. The lower Dual Bearing Plate should be 3" above the bottom of the 1" REV Extrusion. The upper Dual Bearing Plate should be a minimum of 3.5" above the lower Dual Bearing Plate.

The 1" Linear Motion Kits must be square to the 1" REV Extrusion using the Carpenters Square or Adjustable Square.

8



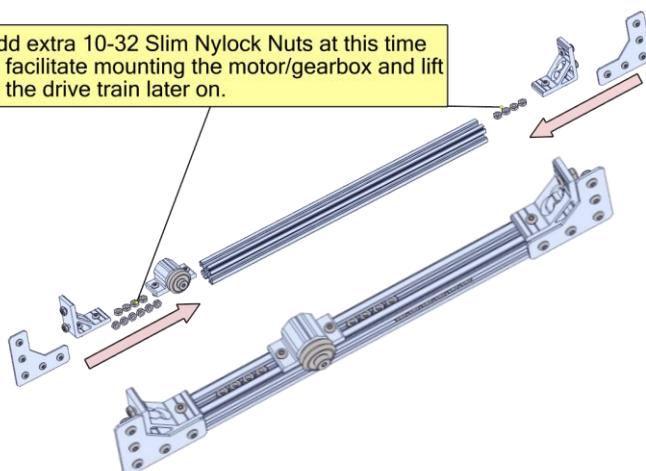
Assemble Vertical Lift 'B'

Reference the assembly of Lift 'A', but note that the eccentric bushings are on the **right side** of the carriage. **This should be a mirrored, NOT duplicated, version of Lift 'A'.**

The 1" Linear Motion Kits must be square to the 1" REV Extrusion using the Carpenters Square or Adjustable Square.

9

Add extra 10-32 Slim Nylock Nuts at this time to facilitate mounting the motor/gearbox and lift to the drive train later on.



Assemble 1st Stage Cross Members

Construct **2**, 1st Stage Cross members. Slide the assembled V-Grove Bearing Pillow Block onto the top of the Lift Cross Member, add extra 10-32 Low Profile Nylock Nuts. Add a preloaded Inside Corner Bracket to each end of the Lift Cross Member such that the Inside Corner Bracket is flush with the ends of the Lift Cross Member. Add a 90° Bracket to each end of the Lift Cross Member such that the 90° Bracket is protruding 1" from the ends of the Lift Cross Member. This is to allow another 1" REV Extrusion to slide onto the 90° Bracket. Loosely tighten the screws that go into the Lift Cross Member so that the parts do not fall off but can slide around if needed.

10 Add extra 10-32 Slim Nylock Nuts at this time to facilitate mounting the manipulator and other modifications.

Assemble 2nd Stage Lower Cross Member

1, 2nd Stage Lower Cross member needs to be constructed. Slide the assembled 2 Screw Inside Corner Bracket onto the front of the Cross Member, add extra 10-32 Low Profile Nylock Nuts. Add two 90° Bracket to each end of the Lift Cross Member such that the 90° Bracket is protruding 1" from the ends of the Lift Cross Member.

Loosely tighten the screws that go into the Lift Cross Member so that the parts do not fall off but can slide around if needed.

11 Add extra 10-32 Slim Nylock Nuts at this time to facilitate mounting the manipulator and other modifications.

Assemble 2nd Stage Upper Cross Member

1, 2nd Stage Upper Cross member needs to be constructed. Slide extra 10-32 Low Profile Nylock Nuts into the Cross Member. Add a preloaded Inside Corner Bracket to each end of the Lift Cross Member such that the Inside Corner Bracket is flush with the ends of the Lift Cross Member. Add a 90° Bracket to each end of the Lift Cross Member such that the 90° Bracket is protruding 1" from the ends of the Lift Cross Member.

Loosely tighten the screws that go into the Lift Cross Member so that the parts do not fall off but can slide around if needed.

12

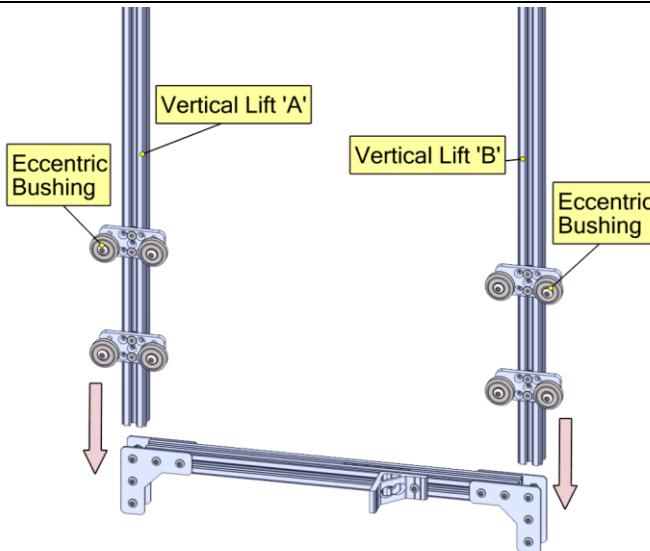
Begin Assembling the 1st Stage

Slide 2 48" Long 1" REV Extrusions into the 'L' created by the 90° Brackets and the Inside Corner Brackets. Lower the 48" Long 1" REV Extrusions until they are flush with the bottom of the 1st Stage Cross Member.

Tighten the screws that go into the Lift Cross Member and 48" Long 1" REV Extrusions so that the parts do not move, but you can loosen the screws can easily be loosened if needed.

Set partially completed 1st Stage aside.

13



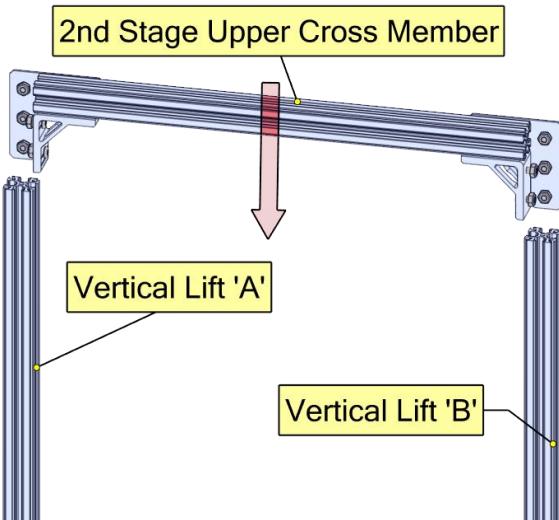
Begin Assembling the 2nd Stage

Slide Vertical Lift 'A' into the pocket between the 90° Brackets on the left side. Slide Vertical Lift 'B' into the pocket between the 90° Brackets on the right side. Lower the Vertical Lifts until they are flush with the bottom of the 90° Brackets.

Tighten the screws that go into the Lift Cross Member and Vertical Lifts so that the parts do not move but the screws can easily be loosened if needed.

Set partially completed 2nd Stage aside.

14



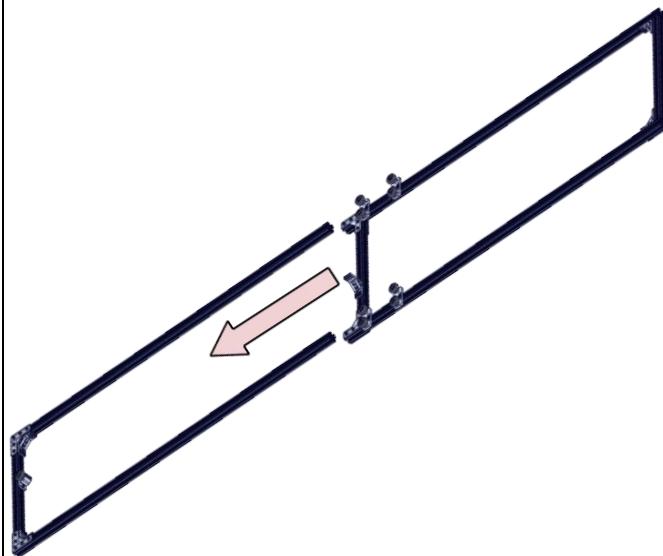
Complete Assembling the 2nd Stage

Slide the 2nd Stage Upper Cross Member onto Lift 'A' and 'B' such that they go into the 'L' created by the 90° Brackets and the Inside Corner Brackets. Lower the Upper Cross member until it is flush with the top of the Lifts.

Tighten the screws that go into the Lift Cross Member and Vertical Lifts so that the parts do not move but the screws can easily be loosened if needed.

2nd Stage is completed.

15

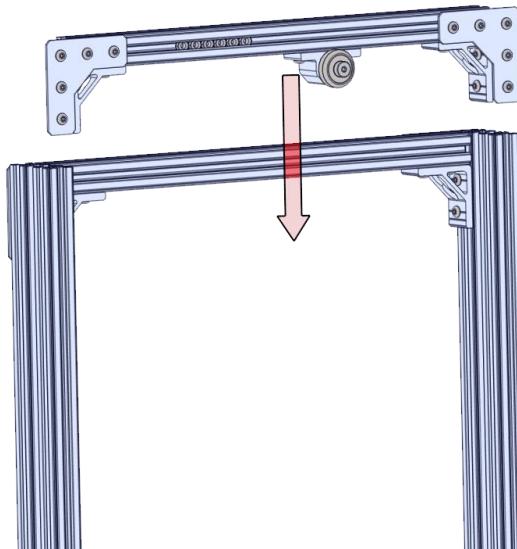


Combine 1st and 2nd Lift Stage

Using the 1/2" wrench rotate the Eccentric Bushings to their fully open position. Slide the 2nd Lift Stage onto the 48" Long 1" REV Extrusions on the partially completed 1st Stage. The 1st Stage Lift should be oriented with the Lower Cross Member at the bottom and the 2 Screw Inside Corner Bracket pointing in the same direction as the V-Grove Bearing Pillow Block. The V-Grove Bearings on the 1" Linear Motion Kit should slide on the matching V channels in the 48" Long 1" REV Extrusions on the partially completed 1st Stage.

Lower the 2nd Lift Stage such that the tops and bottoms of both Lift Stages are flush.

16



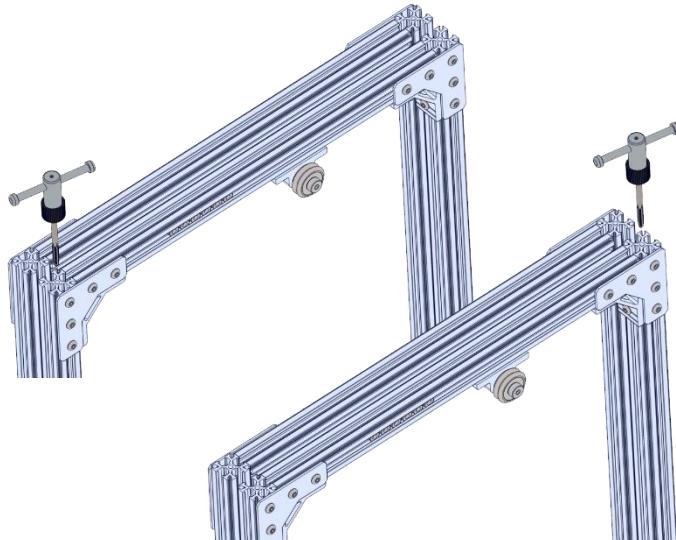
Complete Assembling the 1st Stage

Slide the 1st Stage Cross Member onto the 48" Long 1" REV Extrusions on the partially completed 1st Stage such that 48" Long 1" REV Extrusions go into the 'L' created by the 90° Brackets and the Inside Corner Brackets. Lower the Cross member until it is flush with the top of the 48" Long 1" REV Extrusions.

Tighten the screws that go into the Lift Cross Member and 48" Long 1" REV Extrusions so that the parts do not move but the screws can easily be loosened if needed.

1st Stage is completed.

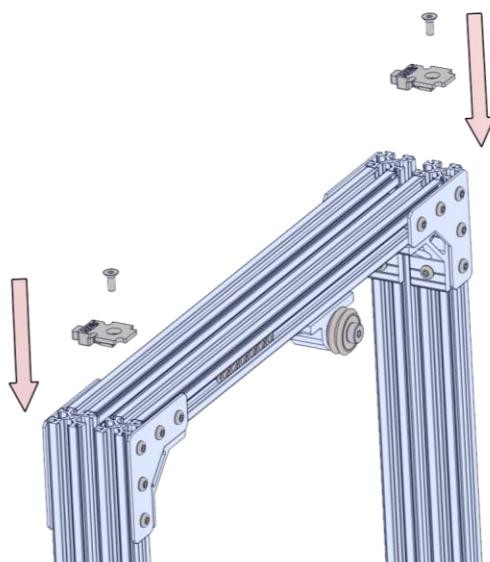
17



Thread the top of the 1st Stage

Using the 10-32 tap thread the hole in the center of the 48" Long 1" REV Extrusions at the top of the 1st Stage. The threads need to extend ~0.5" into the Extrusion.

18

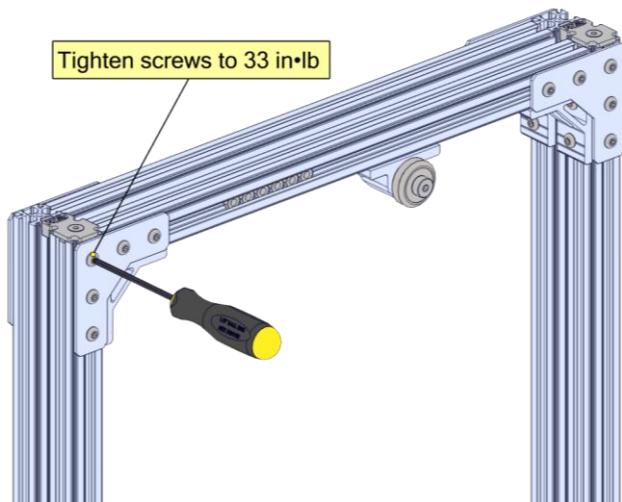


Adding the 1" Extrusion Endcap Slide (REV-21-1202) the top of 1st Stage

Place the 1" Extrusion Endcap Sliders on the left and right 48" Long 1" REV Extrusions at the top of the 1st Stage.

Thread the 10-32 1/2" Countersunk Flat Head screws into place leaving the screws loose enough to allow the endcap to freely wiggle.

19



Tighten 1st Stage Screws

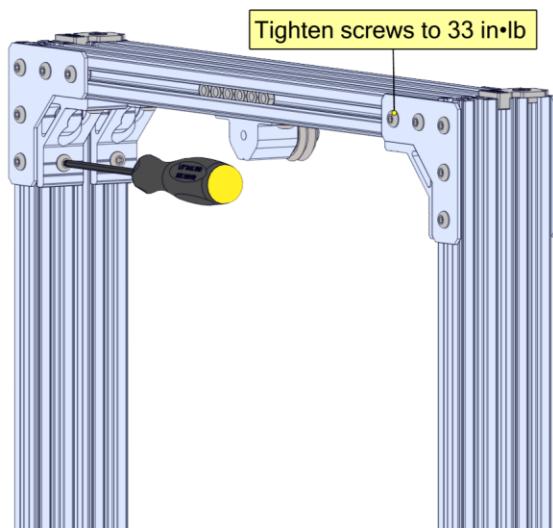
Tighten* the screws starting with the 1st Stage screws. Be sure to confirm that the Cross Members are in the correct locations and square with the vertical 48" Long 1" REV Extrusions.

Rotate the eccentric bushing with the 1/2" wrench until the bearing comes into contact with the vertical 48" Long 1" REV Extrusions.

Leave the V-Grove Bearing Pillow block screws loose.

**33 in-lb is the recommended torque for these screws, but it is not required to be exact*

20



Tighten 2nd Stage Screws

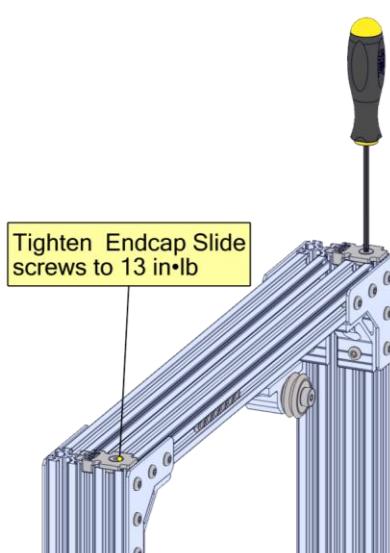
Tighten* the screws on the 2nd Stage. Confirm that the Cross Members are in the correct locations and square with the vertical 48" Long 1" REV Extrusions.

Extend 2nd Stage to maximum height to confirm smooth motion. If lift is binding, loose 2nd Stage screws, extend 2nd Stage and retighten.

Leave the 2 Screw Inside Corner Bracket screws loose.

**33 in-lb is the recommended torque for these screws, but it is not required to be exact*

21



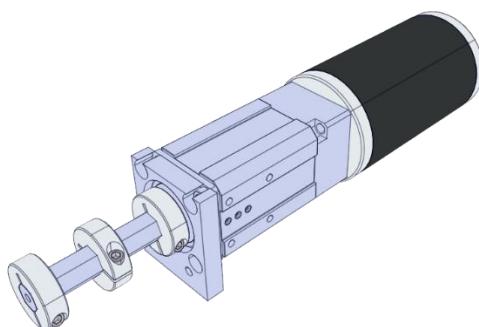
Tighten 1" Extrusion Endcap Slide Screws

Extend 2nd Stage to maximum height then tighten* the screws on the 1" Extrusion Endcap Sliders

Extend 2nd Stage to maximum height to confirm smooth motion. If lift is binding, loose the screws on the 1" Extrusion Endcap Sliders and find the "sweet spot" so that the sliders allow smooth motion during the full travel of the lift, then retighten.

**13 in-lb is the recommended torque for these screws, but it is not required to be exact. Overtightening these screws will deform the plastic slider.*

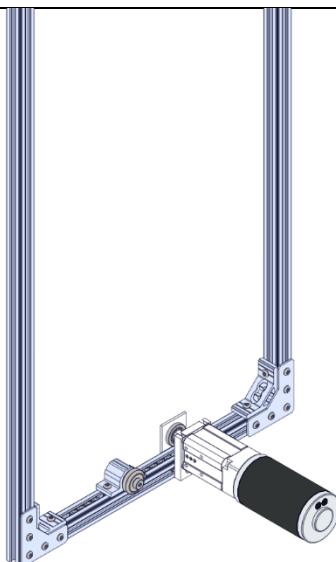
22



Motor Spindle (Optional)

Attach 3 shaft collars (not included) to the output shaft of the motor with enough space in between them to be able to coil all the line required to lift the elevator.

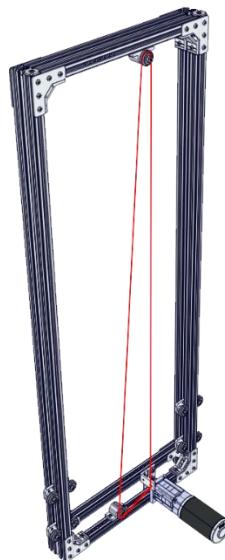
23



Mount Motor and Gearbox

Mount Motor and Gearbox to lift with a mounting plate (not included) to the bottom of the first stage. Make sure to support the output shaft at both ends for added rigidity. See Motor and Gearbox recommendation section (4) for potential Motor and Gearbox mounting solutions.
(36:1 CIM Sport and CIM pictured here)

24

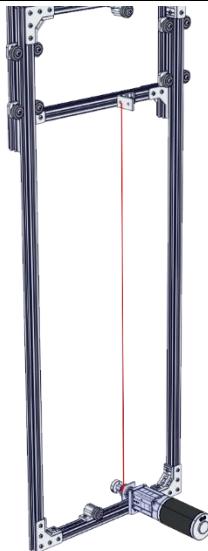


String the Up Line of the Lift

Securely attach the bottom of the High Strength Line to your pulley such that it is not able to rotate. Wrap the pulley 2 or 3 times in the **Clock Wise** direction.

Slide the lower the V-Grove Bearing Pillow block as close as possible to the pulley and tighten down. Lower the 2nd stage to the most compact height, then run the string under lower V-Grove Bearing and then over the top of the upper V-Grove Bearing. Tie the High Strength Line to the outside hole in 2 Screw Inside Corner Bracket using a turnbuckle. Slide the upper the V-Grove Bearing Pillow block so the string is perfectly vertical, then tighten down the Pillow block.

25



String the Down Line of the Lift

Securely attach the bottom of the High Strength Line to your pulley such that it is not able to rotate. Wrap the pulley 2 or 3 times in the **Counter Clock Wise** direction.

Extend 2nd Stage to maximum height. Then tie the High Strength Line to the inside hole in 2 Screw Inside Corner Bracket making the line as tight as possible.

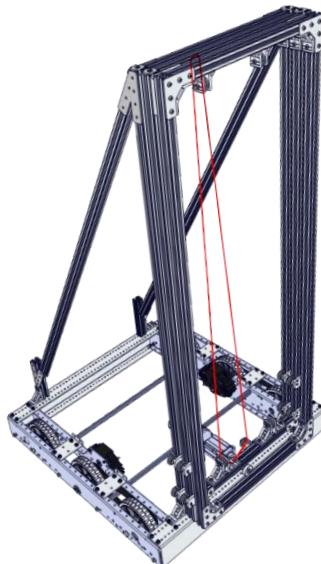
26



Tension the Up Line of the Lift

Lower 2nd Stage to 50% of its maximum height. Add tension to the Up Line using the Turn Buckle such that both the Up Line and the Down line are tighten. If the Turn Buckle does not have enough travel, un-tension the line and slide the lower Bearing Pillow block away from your pulley, then re-tension.

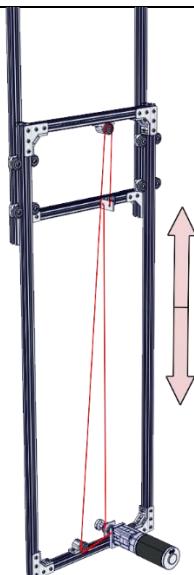
27



Mount the lift to the Drive Train

This is mostly up to the particulars of the team's implementation. Mount securely the top as well as the bottom of the 1st Stage to the drive train.

28



Test the Lift

Run the lift to maximum and minimum heights ensuring the Up and Down lines reliable spool onto the pulley and remain tight throughout travel.

29

CAUTION

There are multiple pinch points on this lift mechanism which can cause injury. Make sure the lift is fully supported on the robot, and nobody's hands nearby, before running the lift on the motor.

30

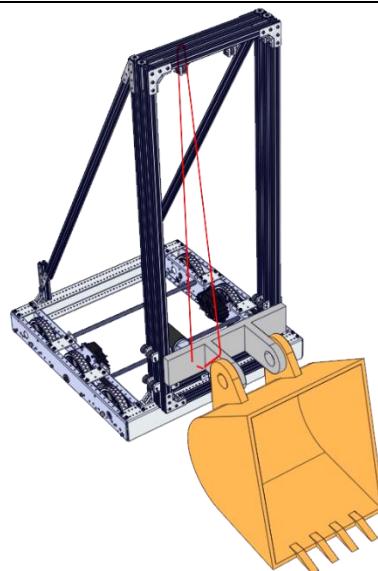


Add Sensors

This is mostly up to the particulars of the team's implementation; however, adding sensors to detect when the lift is at its maximum and minimum height is highly recommended.

REV recommends the Magnetic Limit Switch (REV-31-1462).

31



Attach Manipulator

Mount the team's manipulator to the 2nd Stage of the Lift.

32

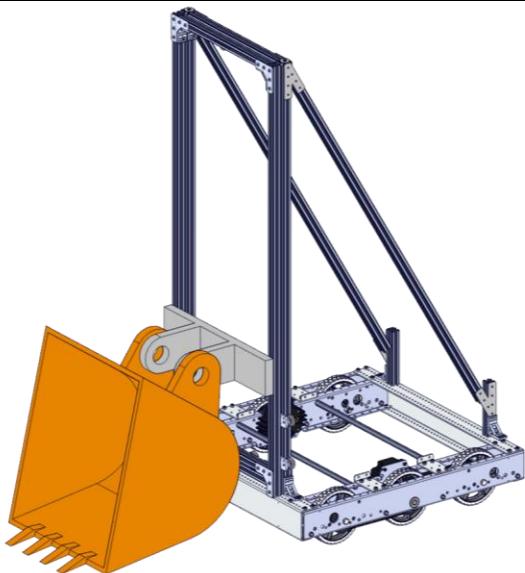


Cable and Pneumatic runs

The Cable and Pneumatic runs to the manipulator need to conformably reach the manipulator without binding. The runs must also be routed in such a way as to not get caught on anything as the lift travels up and down.

Teams should strongly consider using Cable Carrier Drag Chain to assist in achieving this goal.

33



REV 1" Extrusion Lift Kit Lift Done!!

Modify, tune and tweak as needed.

3 1" MULTISTAGE LIFT ASSEMBLY

Step-by-step guide to assemble the REV 1" Extrusion Lift Kit (REV-25-1290) and one additional 1" Extrusion Lift Kit (REV-25-1290). Plan motor mounting and drive train mounting before assembling the Lift Kit.

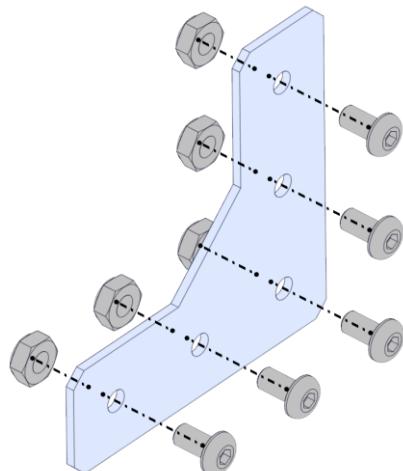
3.1 MINIMUM SUPPLIES NEEDED

Table 3-1: Not Included in Kit

ITEM	NUMBER
5/32" HEX L KEY	1
3/16" HEX L KEY	1
3/8" WRENCH OR ADJUSTABLE WRENCH	1
1/2" WRENCH OR ADJUSTABLE WRENCH	1
ALUMINUM CUTTING HACKSAW	1
BASTARD FILE OR SANDING BLOCK	1
FINE TIP PERMANENT MARKER	1
CARPENTER'S OR ADJUSTABLE SQUARE	1
YARD STICK OR TAPE MEASURE	1
BLUE LOCTITE OR MEDIUM STRENGTH THREAD LOCKER	1
10-32 TAP AND TAP HANDLE	1
OUTPUT SHAFT COLLARS	3
MOTOR AND GEARBOX	1
MOTOR MOUNT	1

3.2 REV 1" MULTISTAGE LIFT ASSEMBLY INSTRUCTIONS

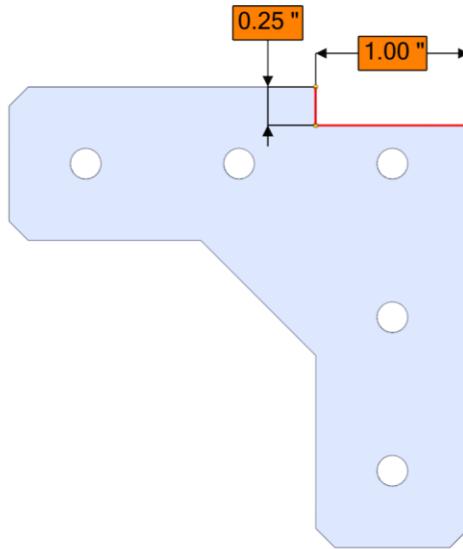
1



Assemble 90° Brackets

Preload **18** 90° Brackets with 10-32 3/8" Button Head screws and 10-32 Low Profile Nylock Nuts.

2

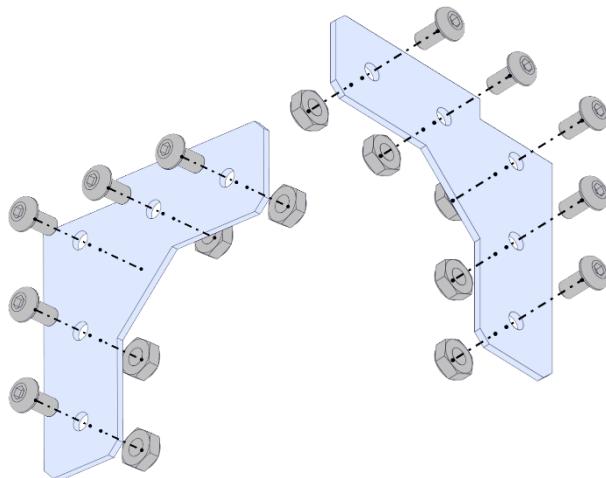


Notch out two 90° Brackets

Cut a 1" x 0.25" notch out of the corner of the 90° Bracket. Deburr sharp edges with the file or sand paper.

See the drawing in the Documentation and Resources section of Add-on Stage Lift Kit web page for detailed dimensions. The file can be scaled and printed on a 1:1 scale and glued to the bracket as a guide.

3

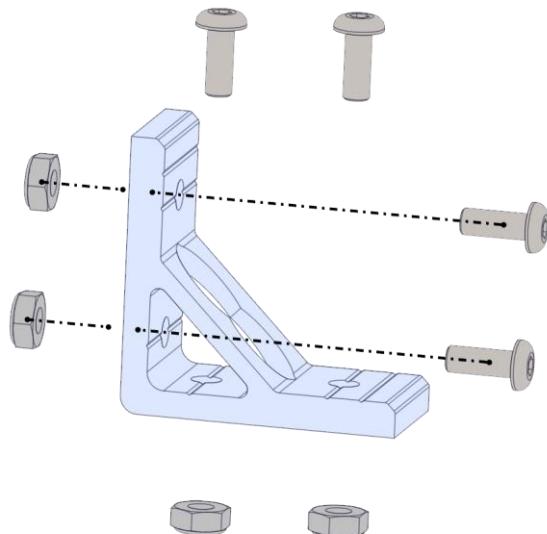


Assemble Notched 90° Brackets

Preload the **2** Notched 90° Brackets with 10-32 3/8" Button Head screws and 10-32 Low Profile Nylock Nuts.

The two 90° Brackets should be mirrored.

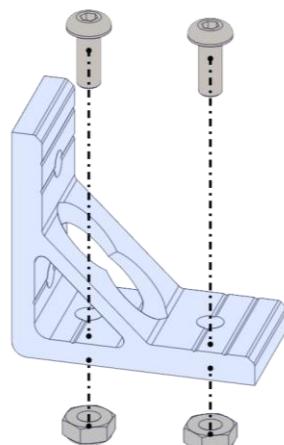
4



Assemble Inside Corner Brackets

Preload **12** Inside Corner Brackets with 10-32 1/2" Button Head screws and 10-32 Low Profile Nylock Nuts. **In all 4 holes.**

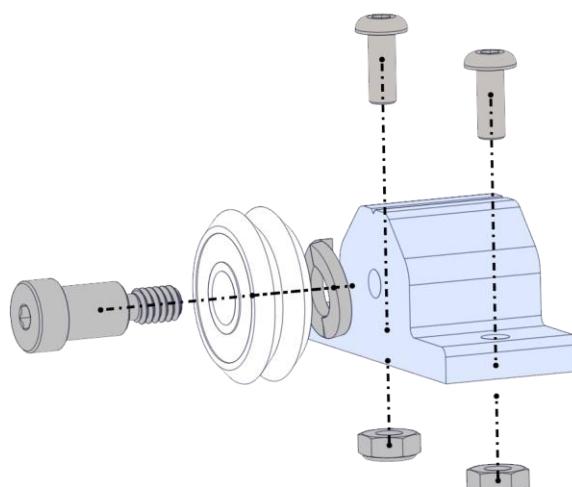
5



Assemble 2 Screw Inside Corner Bracket

Preload **9** Inside Corner Brackets with 10-32 1/2" Button Head screws and 10-32 Low Profile Nylock Nuts. **In 2 holes.**

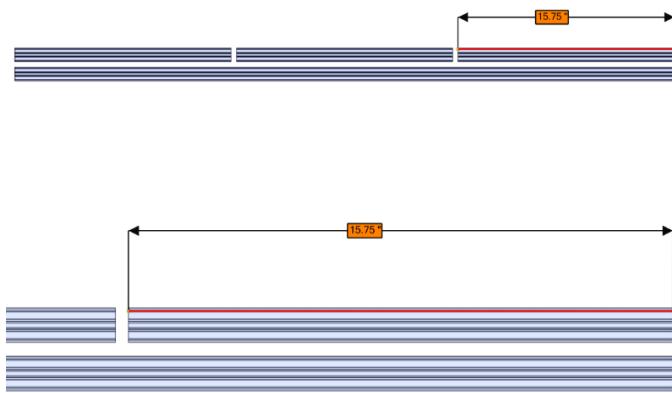
6



Assemble V-Grove Bearing Pillow Blocks

Preload **2** Pillow Blocks with 1/4-20 3/8" diameter Shoulder Screw, 1" V-Groove Bearing, 3/8" Split Washer, 10-32 1/2" Button Head screws and 10-32 Low Profile Nylock Nuts.

7

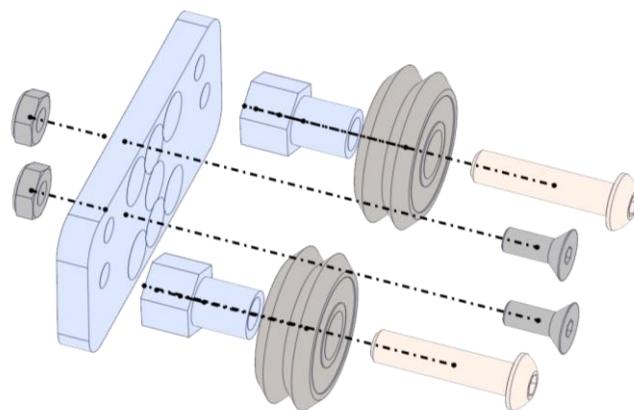


Cut Lift Cross Members

Cut **2** REV 1" Extrusion 48" long pieces into **6** 15.75" segments with the hacksaw. The specific length is not highly critical, but all the Cross Members just need to be the same. Deburr and break the edges on the ends using the file.

**The length of the Lift Cross Members can be customized to meet the needs of different applications, however shorter than 15.75" is not recommended as interferences become tricky to avoid.*

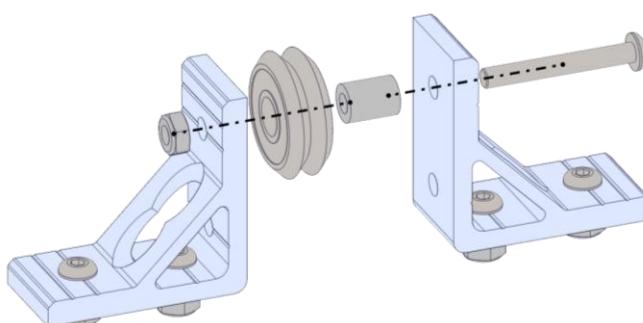
8



Assemble 1" Linear Motion Kits

Assemble all **8** of the 1" Linear Motion Kit bearing blocks. Use one Concentric Bushing and one Eccentric Bushing to mount the V-Grove Bearings. Add Blue Loctite or equivalent to the 1/4-20 1.125" long cap head screw and thread through the Bushings with V-Grove Bearings into the Dual Bearing Plate. Then preload the Dual Bearing Plate with two 10-32 1/2" Countersunk Flat Head screws and 10-32 Low Profile Nylock Nuts.

9

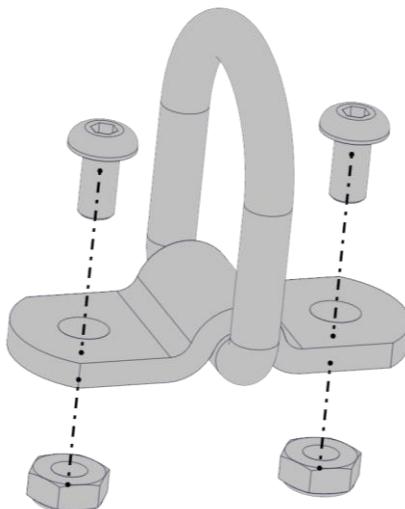


Assemble V-Grove Bearing Inside Corner Bracket Mounts

Place the 3/8 inch #10 screw spacer inside of the V-Grove Bearing, then sandwich with two Inside Corner Brackets. Thread the 10-32 1.5" Button Head screw through the upper hole in the Inside Corner Brackets and the spacer. Tighten down the 10-32 nut onto the 10-32 1.5" Button Head screw.

Repeat 3 times to construct a total of 4 bearing assemblies.

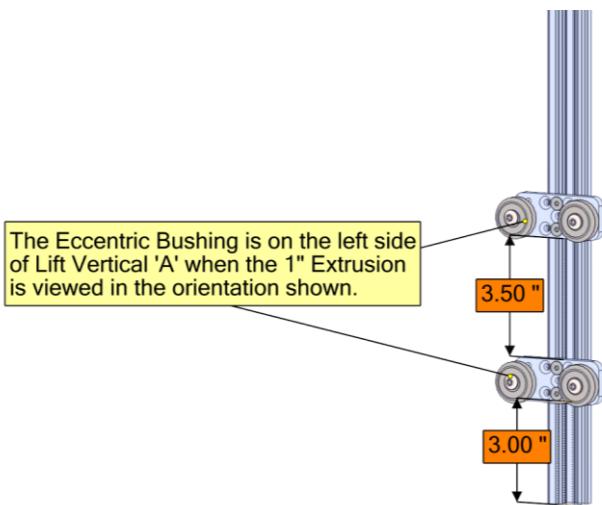
10



Assemble Tie Down D-Ring

Preload **all 8** Tie Down D-Rings with 10-32 1/2" Button Head screws and 10-32 Low Profile Nylock Nuts.

11



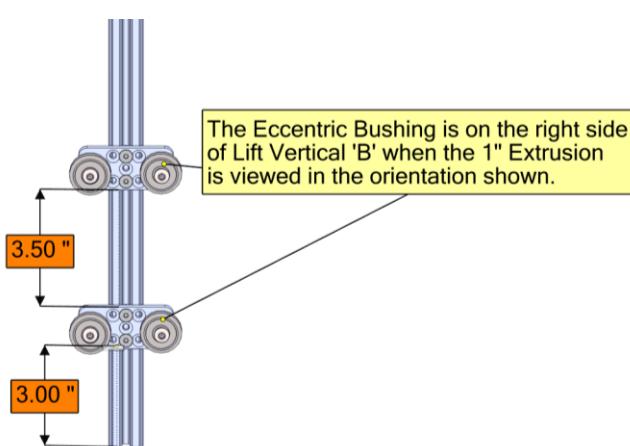
Assemble Vertical Lift 'A'

Slide 2 of the assembled 1" Linear Motion Kits onto a 48" long piece of the 1" REV Extrusion such that the Eccentric Bushing is on the **left side** when viewed from the orientation shown. The lower Dual Bearing Plate should be 3" above the bottom of the 1" REV Extrusion. The upper Dual Bearing Plate should be a minimum of 3.5" above the lower Dual Bearing Plate.

The 1" Linear Motion Kits must be square to the 1" REV Extrusion using the Carpenters Square or Adjustable Square.

Repeat 1 times to construct 2 Vertical Lift 'A' assemblies.

12

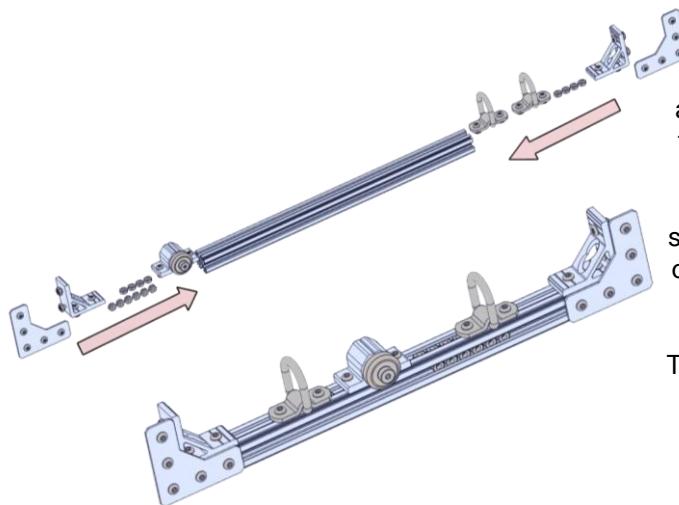


Assemble Vertical Lift 'B'

Reference the assembly of Lift "A", but note that the eccentric bushings are on the **right side** of the carriage. **This should be a mirrored, NOT duplicated, version of Lift 'A'.**

Repeat 1 time to construct a total of 2 Vertical Lift 'B' assemblies.

13

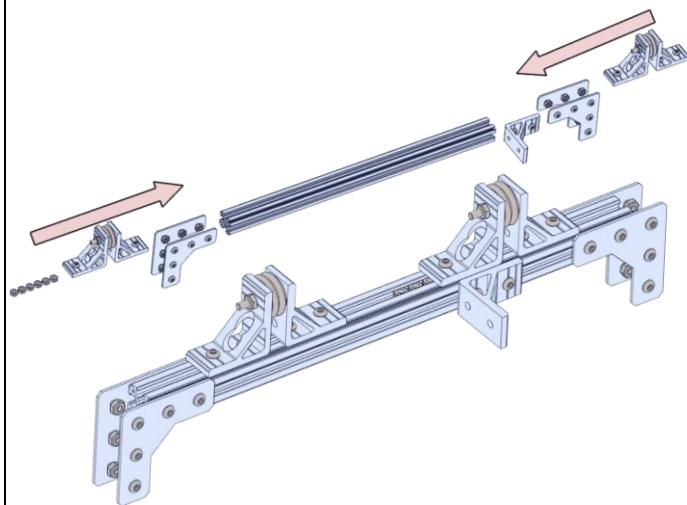


Assemble 1st Stage Cross Members

Construct **2**, 1st Stage Cross members. Slide the assembled V-Grove Bearing Pillow Block onto the top of the Lift Cross Member, Tie Down D-Rings and add extra 10-32 Low Profile Nyloc Nuts. Add a preloaded Inside Corner Bracket to each end of the Lift Cross Member such that the Inside Corner Bracket is flush with the ends of the Lift Cross Member. Add a 90° Bracket to each end of the Lift Cross Member such that the 90° Bracket is protruding 1" from the ends of the Lift Cross Member. This is to allow another 1" REV Extrusion to slide onto the 90° Bracket.

Loosely tighten the screws that go into the Lift Cross Member so that the parts do not fall off but can slide around if needed.

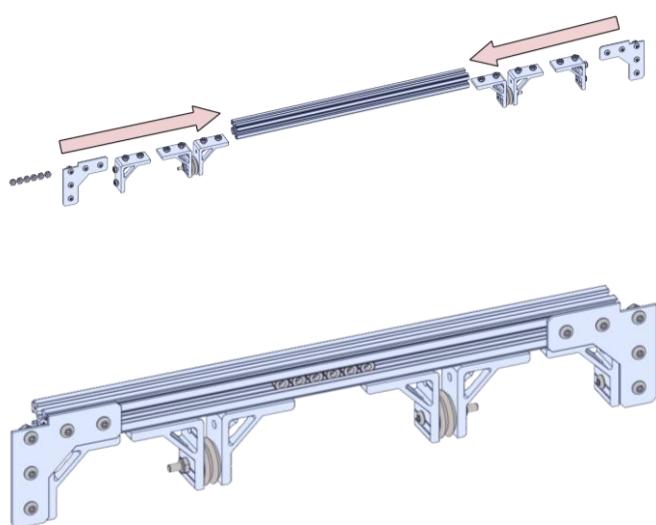
14



Assemble 2nd Stage Lower Cross Member

1, 2nd Stage Lower Cross member needs to be constructed. Slide the assembled 2 Screw Inside Corner Bracket onto the front of the Cross Member, add extra 10-32 Low Profile Nylock Nuts. Slide 2 V-Grove Bearing Inside Corner Bracket Mounts into the top of the Lower Cross Member. Add two 90° Bracket to each end of the Lift Cross Member such that the 90° Bracket is protruding 1" from the ends of the Lift Cross Member. Loosely tighten the screws that go into the Lift Cross Member so that the parts do not fall off but can slide around if needed.

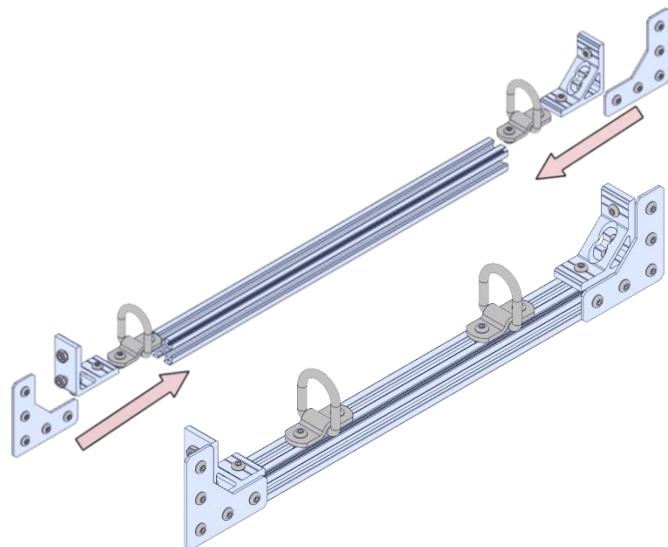
15



Assemble 2nd Stage Upper Cross Member

1, 2nd Stage Upper Cross member needs to be constructed. Slide extra 10-32 Low Profile Nylock Nuts into the Cross Member. Slide 2 V-Grove Bearing Inside Corner Bracket Mounts into the Lower Cross Member. Add a preloaded Inside Corner Bracket to each end of the Lift Cross Member such that the Inside Corner Bracket is flush with the ends of the Lift Cross Member. Add the notched 90° Brackets to each end of the Lift Cross Member such that the 90° Bracket is protruding 1" from the ends of the Lift Cross Member. Loosely tighten the screws that go into the Lift Cross Member so that the parts do not fall off but can slide around if needed.

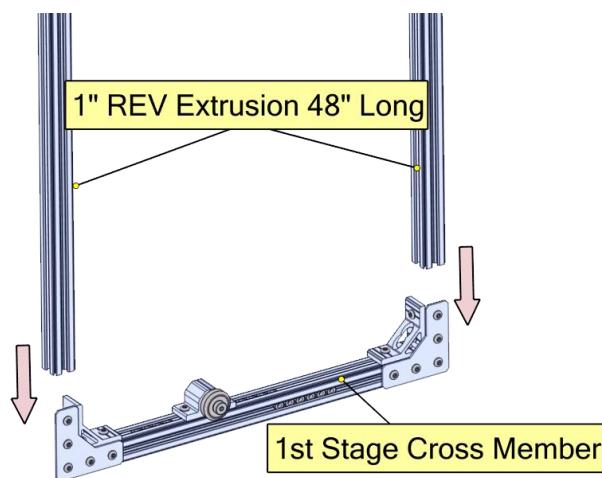
16



Assemble 3rd Stage Cross Members

Construct **2**, 3rd Stage Cross members.
Slide on 2 Tie Down D-Rings and extra 10-32 Low Profile Nylock Nuts. Add a preloaded Inside Corner Bracket to each end of the Lift Cross Member such that the Inside Corner Bracket is flush with the ends of the Lift Cross Member. Add a 90° Bracket to each end of the Lift Cross Member such that the 90° Bracket is protruding 1" from the ends of the Lift Cross Member. This is to allow another 1" REV Extrusion to slide onto the 90° Bracket. Loosely tighten the screws that go into the Lift Cross Member so that the parts do not fall off but can slide around if needed.

17



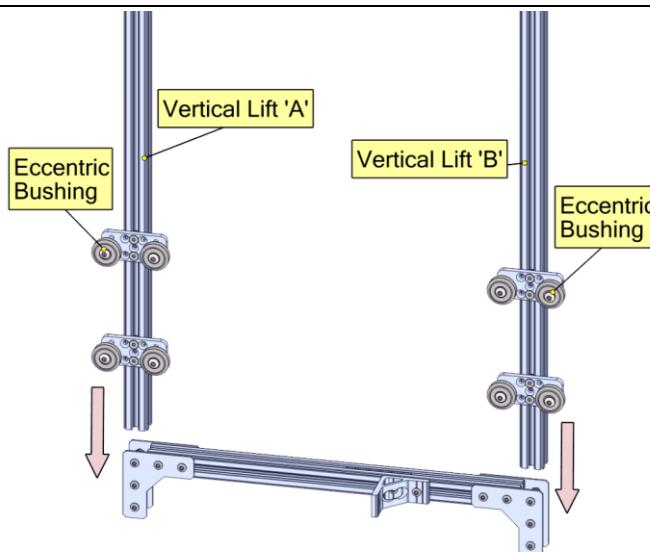
Begin Assembling the 1st Stage

Slide **2** 48" Long 1" REV Extrusions into the 'L' created by the 90° Brackets and the Inside Corner Brackets. Lower the 48" Long 1" REV Extrusions until they are flush with the bottom of the 1st Stage Cross Member.

Tighten the screws that go into the Lift Cross Member and 48" Long 1" REV Extrusions so that the parts do not move but the screws can easily be loosened if needed.

Set partially completed 1st Stage aside.

18



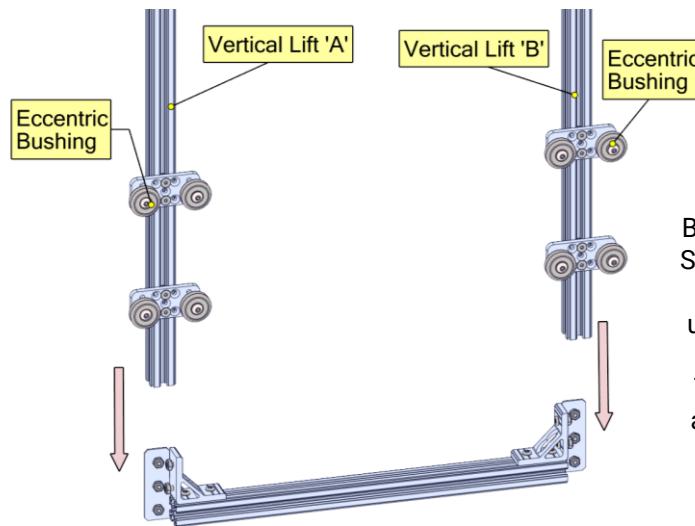
Begin Assembling the 2nd Stage

Slide Vertical Lift 'A' into the pocket between the 90° Brackets on the left side. Slide Vertical Lift 'B' into the pocket between the 90° Brackets on the right side. Lower the Vertical Lifts until they are flush with the bottom of the 90° Brackets.

Tighten the screws that go into the Lift Cross Member and Vertical Lifts so that the parts do not move but the screws can easily be loosened if needed.

Set partially completed 2nd Stage aside.

19

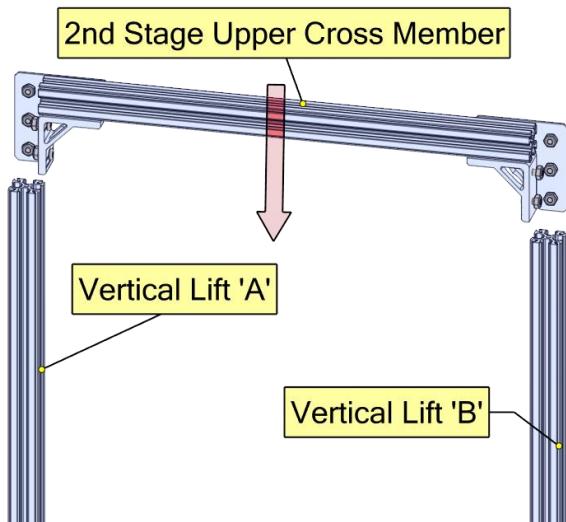


Begin Assembling the 3rd Stage

Slide Vertical Lift 'A' into the pocket between the 90° Brackets on the left side of the 3rd Stage Cross Member. Slide Vertical Lift 'B' into the into the pocket between the 90° Brackets on the right side. Lower the Vertical Lifts until they are flush with the bottom of the 90° Brackets.

Tighten the screws that go into the Lift Cross Member and Vertical Lifts so that the parts do not move but the screws can easily be loosened if needed.

20



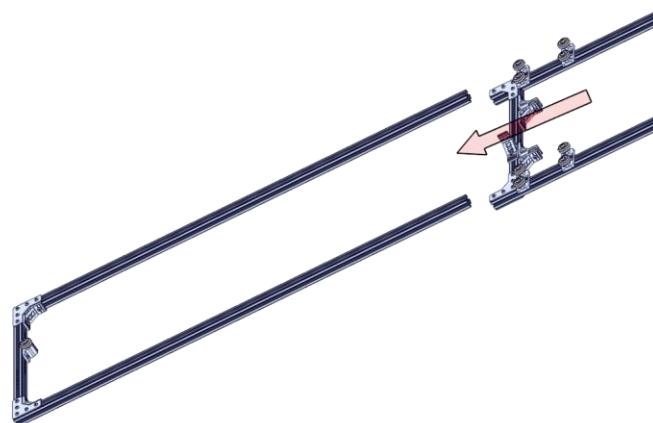
Complete Assembling the 3rd Stage

Slide the 3rd Stage Cross Member onto Lift 'A' and 'B' such that they go into the 'L' created by the 90° Brackets and the Inside Corner Brackets. Lower the Upper Cross member until it is flush with the top of the Lifts.

Tighten the screws that go into the Lift Cross Member and Vertical Lifts so that the parts do not move but the screws can easily be loosened if needed.

3rd Stage is completed.

21



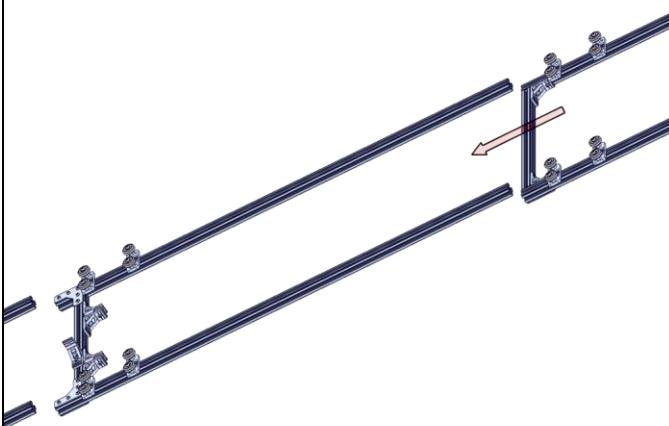
Combine 1st and 2nd Lift Stage

Using the 1/2" wrench rotate the Eccentric Bushings to their fully open position. Slide the 2nd Lift Stage onto the 48" Long 1" REV Extrusions on the partially completed 1st Stage. The 1st Stage Lift should be oriented with the Lower Cross Member at the bottom and the 2 Screw Inside Corner Bracket pointing in the same direction as the V-Grove Bearing Pillow Block. The V-Grove Bearings on the 1" Linear Motion Kit should slide on the matching V channels in the 48" Long 1" REV Extrusions on the partially completed 1st Stage.

Lower the 2nd Lift Stage such that the tops and bottoms of both Lift Stages are flush.

22

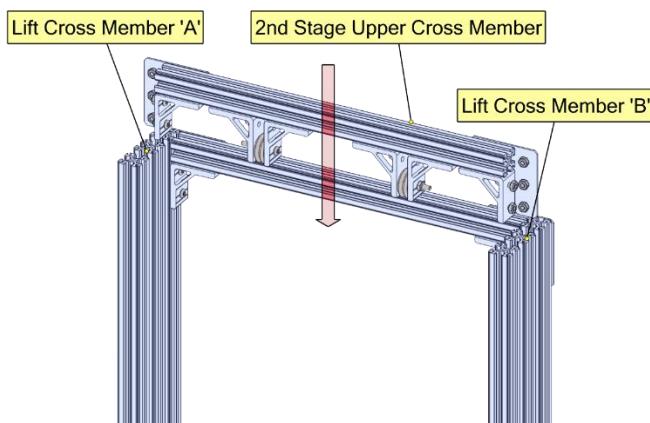
Add 3rd Lift Stage



Using the 1/2" wrench rotate the Eccentric Bushings to their fully open position. Slide the 3rd Lift Stage onto the Vertical Lifts 'A' and 'B' on the partially completed 2nd Stage. The 1st Stage Lift should be oriented with the Lower Cross Member at the bottom and the 2 Screw Inside Corner Bracket pointing in the same direction as the V-Grove Bearing Pillow Block. The V-Grove Bearings on the 1" Linear Motion Kit should slide on the matching V channels in the 48" Long 1" REV Extrusions on the partially completed 1st Stage.

Lower the 2nd Lift Stage such that the tops and bottoms of both Lift Stages are flush.

23



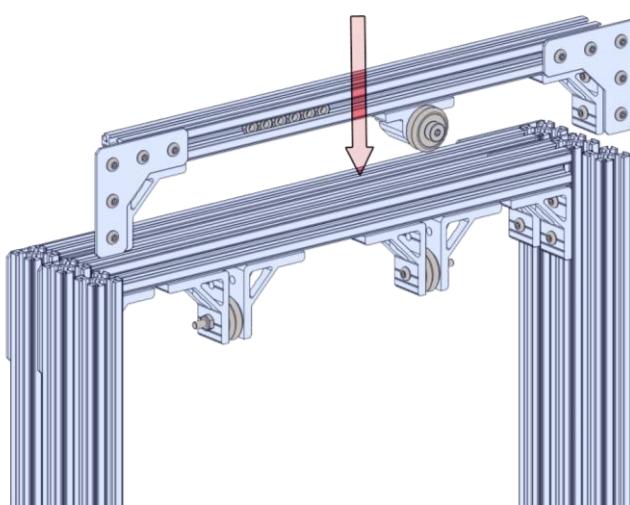
Complete Assembling the 2nd Stage

Slide the 2nd Stage Upper Cross Member onto Lift 'A' and 'B' such that they go into the 'L' created by the 90° Brackets and the Inside Corner Brackets. Lower the Upper Cross member until it is flush with the top of the Lifts.

Tighten the screws that go into the Lift Cross Member and Vertical Lifts so that the parts don't move but the screws can easily be loosened if needed.

2nd Stage is completed.

24



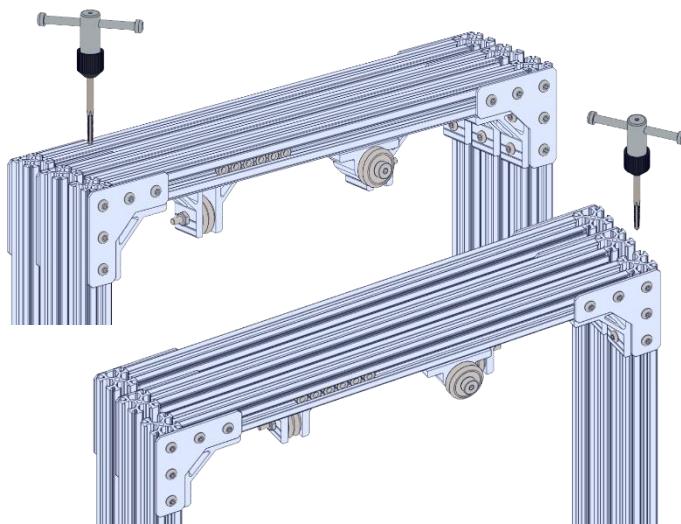
Complete Assembling the 1st Stage

Slide the 1st Stage Cross Member onto the 48" Long 1" REV Extrusions on the partially completed 1st Stage such that 48" Long 1" REV Extrusions go into the 'L' created by the 90° Brackets and the Inside Corner Brackets. Lower the Cross member until it is flush with the top of the 48" Long 1" REV Extrusions.

Tighten the screws that go into the Lift Cross Member and 48" Long 1" REV Extrusions so that the parts do not move but the screws can easily be loosened if needed.

1st Stage is completed.

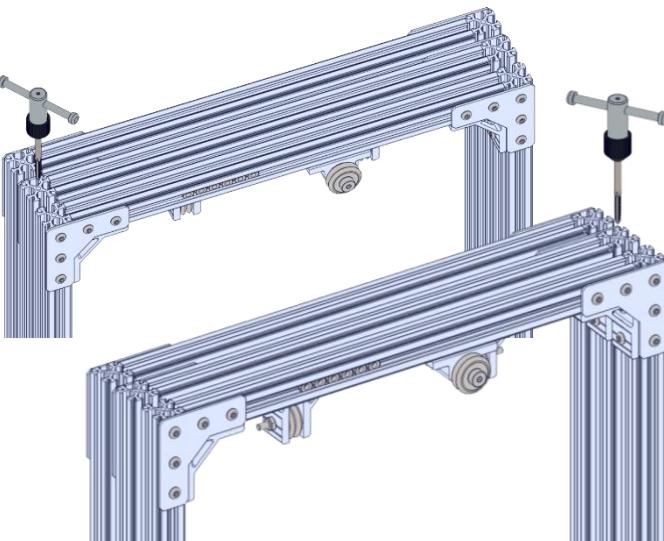
25



Thread the top of the 1st Stage

Using the 10-32 tap thread the hole in the center of the 48" Long 1" REV Extrusions at the top of the 1st Stage. The threads need to extend ~0.5" into the Extrusion.

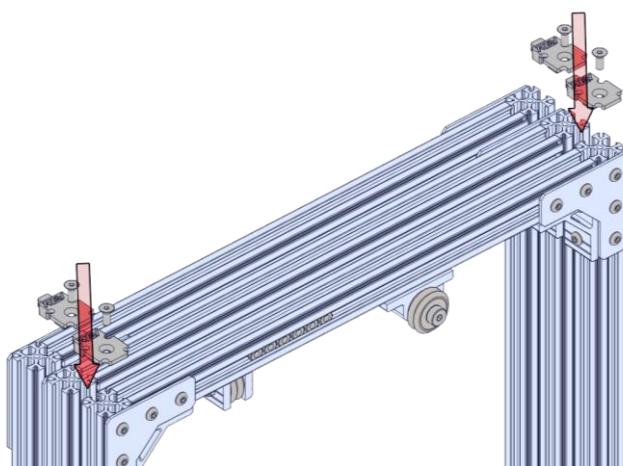
26



Thread the top of the 2nd Stage

Using the 10-32 tap thread the hole in the center of the Vertical Lifts 'A' and 'B' at the top of the 2nd Stage. The threads need to extend ~0.5" into the Extrusion.

27



Adding the 1" Extrusion Endcap Slides the top of the 1st Stage and 2nd Stage

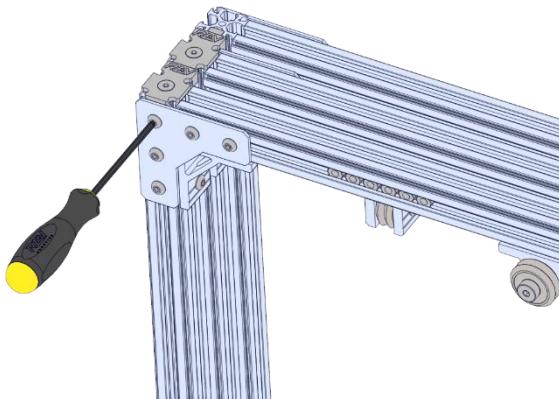
Place the 1" Extrusion Endcap Sliders on the left and right 48" Long 1" REV Extrusions at the top of the 1st Stage.

Place the 1" Extrusion Endcap Sliders on the Vertical Lifts 'A' and 'B' at the top of the 2nd Stage.

Thread the 10-32 1/2" Countersunk Flat Head screws into place leaving the screws loose enough to allow the endcap to freely wiggle.

28

Tighten 1st Stage Screws



Tighten* the screws starting with the 1st Stage screws. Be sure to confirm that the Cross Members are in the correct locations and square with the vertical 48" Long 1" REV Extrusions.

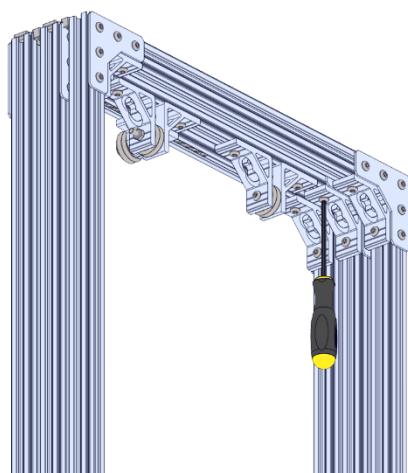
Rotate the eccentric bushing with the 1/2" wrench until the bearing comes into contact with the vertical 48" Long 1" REV Extrusions.

Leave the V-Grove Bearing Pillow block screws loose.

**33 in•lb is the recommended torque for these screws, but it is not required to be exact*

29

Tighten 2nd Stage Screws



Tighten* the screws on the 2nd Stage. Be sure to confirm that the Cross Members are in the correct locations and square with the vertical 48" Long 1" REV Extrusions.

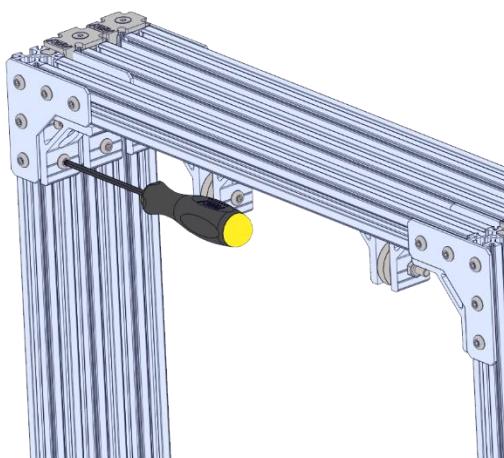
Extend 2nd Stage to maximum height to confirm smooth motion. If lift is binding loosen 2nd Stage screws extend 2nd Stage and retighten.

Leave the 2 Screw Inside Corner Bracket screws loose.

**33 in•lb is the recommended torque for these screws, but it is not required to be exact*

30

Tighten 3rd Stage Screws

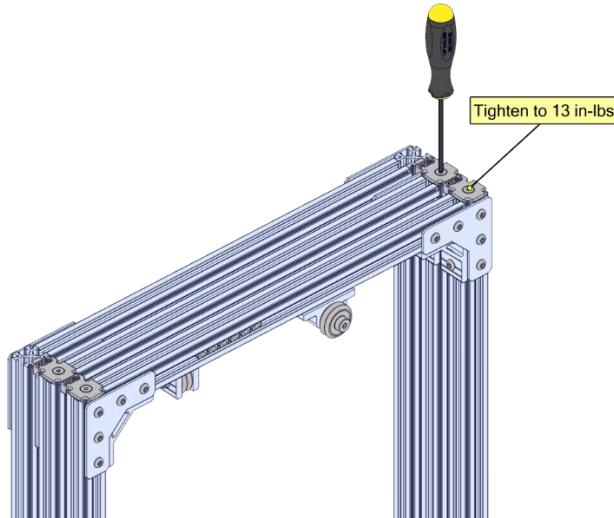


Tighten* the screws on the 3rd Stage. Be sure to confirm that the Cross Members are in the correct locations and square with the vertical 48" Long 1" REV Extrusions.

Rotate the eccentric bushing with the 1/2" wrench until the bearing comes into contact with the vertical 48" Long 1" REV Extrusions.

Leave the V-Grove Bearing Pillow block screws loose.

**33 in•lb is the recommended torque for these screws, but it is not required to be exact*

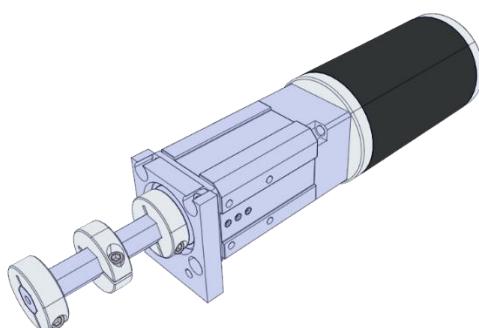
31

Tighten 1" Extrusion Endcap Slide Screws

Extend 2nd and 3rd Stages to maximum height then tighten* the screws on the 1" Extrusion Endcap Sliders.

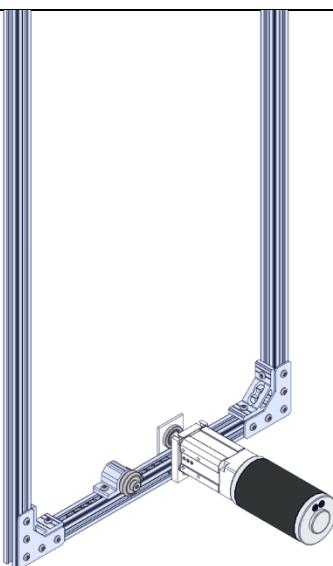
Extend 2nd and 3rd Stages to maximum height to confirm smooth motion. If lift is binding, loosen the screws on the 1" Extrusion Endcap Sliders and find the "sweet spot" so that the sliders allow smooth motion during the full travel of the lift, then retighten.

*13 in·lb is the recommended torque for these screws, but it is not required to be exact

32

Motor Spindle (Optional)

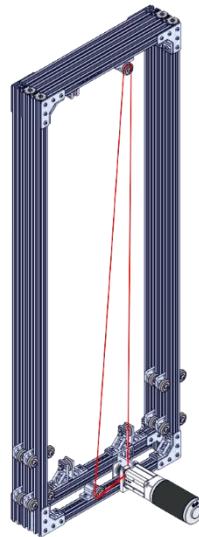
Attach 3 shaft collars (not included) to the output shaft of the motor with enough space in between them to be able to coil all the line required to lift the elevator.

33

Mount Motor and Gearbox

Mount Motor and Gearbox to lift with a mounting plate (not included) to the bottom of the first stage. Make sure to support the output shaft at both ends for added rigidity. See Motor and Gearbox recommendation section (4) for potential Motor and Gearbox mounting solutions.
(36:1 CIM Sport and CIM pictured here)

34

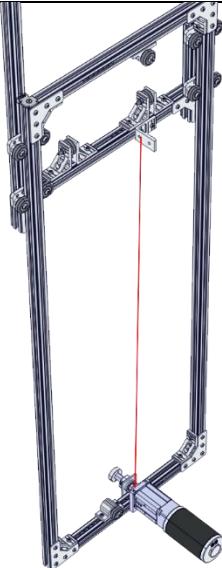


String the Up Line of the Lift

Securely attach the bottom of the High Strength Line to your pulley such that it is not able to rotate. Wrap the pulley 2 or 3 times a **Clock Wise** direction.

Slide the lower the V-Grove Bearing Pillow block as close as possible to the pulley and tighten down. Lower the 2nd stage to the most compact height, then run the string under lower V-Grove Bearing then over the top of the upper V-Grove Bearing then tie the High Strength Line to the outside hole in 2 Screw Inside Corner Bracket using a High-Tension Tuckers Hitch knot. Slide the upper V-Grove Bearing Pillow block so the string is perfectly vertical, then tighten down the Pillow block.

35

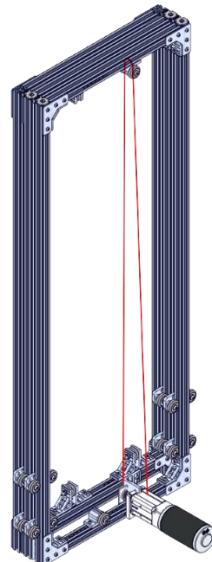


String the Down Line of the Lift

Securely attach the bottom of the High Strength Line to your pulley such that it is not able to rotate. Wrap the pulley 2 or 3 times a **Counter Clock Wise** direction.

Extend 2nd Stage to maximum height then tie the High Strength Line to the inside hole in 2 Screw Inside Corner Bracket making the line as taught as possible.

36



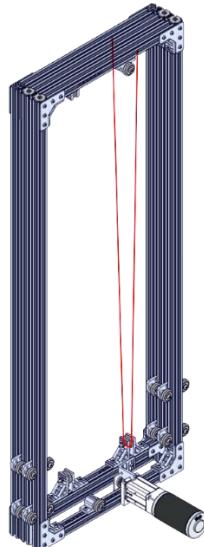
String the Up Line of the 3rd Stage

Securely attach the bottom of the High Strength Line to the 1st Stage Lower Cross Member. Then run the line up and over the Left V-Grove Bearing Inside Corner Bracket Mount on the 2nd Stage Upper Cross Member. The High Strength Line is then run down to the 3rd Stage Lower Cross Member securing the line using a High-Tension Tuckers Hitch knot.

Adjust the start and end points of the line so they are in the same plane as the V-Grove Bearing.

Repeat for the Right V-Grove Bearing Inside Corner Bracket Mount.

37



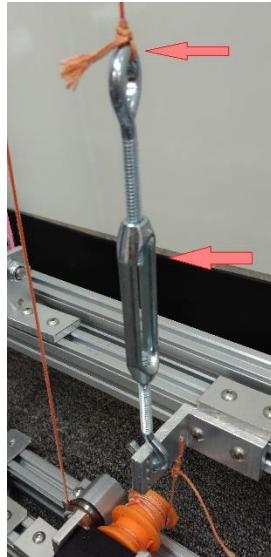
String the Down Line of the 3rd Stage

Securely attach the bottom of the High Strength Line to the 1st Stage Upper Cross Member. Then run the line down and under the Left V-Grove Bearing Inside Corner Bracket Mount on the 2nd Stage Lower Cross Member. The High Strength Line is then run up to the 3rd Stage Upper Cross Member securing the line using a High-Tension Tuckers Hitch knot.

Adjust the start and end points of the line so they are in the same plane as the V-Grove Bearing.

Repeat for the Right V-Grove Bearing Inside Corner Bracket Mount.

38

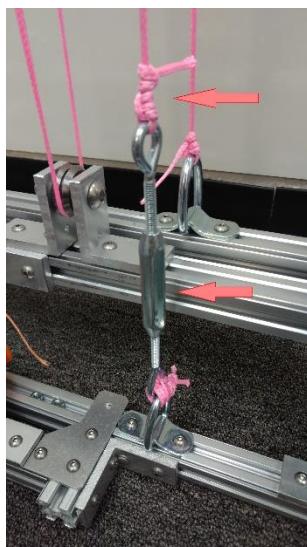


Tension the Up Line of the Lift

Lower 2nd Stage to 50% of its maximum height. Add tension to the Up Line using the High-Tension Tuckers Hitch knot (upper arrow on left) such that both the Up Line and the Down line are tightened. If the High-Tension Tuckers Hitch knot does not have enough travel, untension the line and slide the lower Bearing Pillow block away from your pulley, then re-tension.

You can also use the recommended upgrade turnbuckle (lower arrow on left) to tension as well.

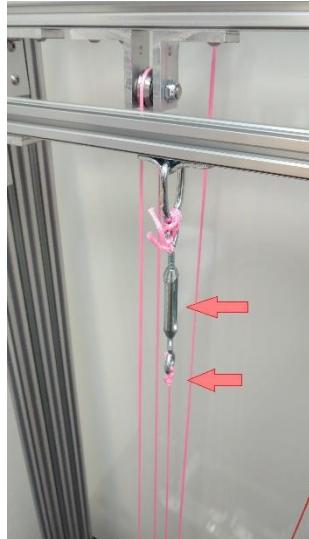
39



Tension the 3rd Stage Up Lines

Fully extend 2nd and 3rd Stages to their maximum height. Add tension to the 3rd Stage Up Lines using the High-Tension Tuckers Hitch knots (upper arrow on left) such that both 3rd Stage Up Lines are taught. Both lines must have the same tension on them this can be checked by plucking the lines. If the High-Tension Tuckers Hitch knot does not have enough travel undo the knot retie and tension.

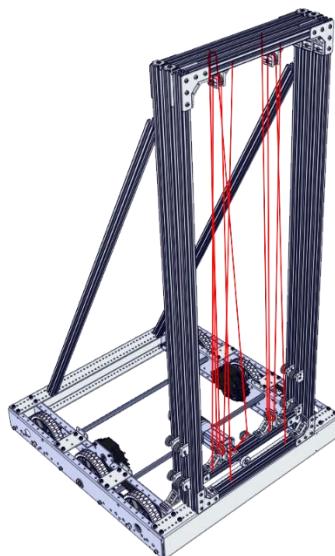
You can also use the recommended upgrade turnbuckle (lower arrow on left) to tension as well.

40

Tension the 3rd Stage Down Lines

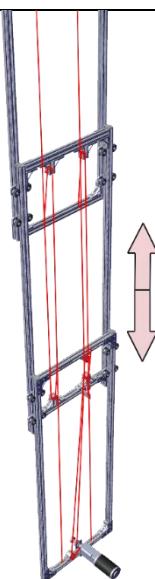
Fully lower 2nd and 3rd Stages to their minimum height. Add tension to the 3rd Stage Down Lines using the High-Tension Tuckers Hitch knots (lower arrow on left) such that both 3rd Stage Down Lines are taught. Both lines must have the same tension on them this can be checked by plucking the lines. If the High-Tension Tuckers Hitch knot does not have enough travel undo the knot retie and tension.

You can also use the recommended upgrade turnbuckle (upper arrow pictured left) to tension as well.

41

Mount the lift to the Drive Train

This is mostly up to the particulars of the team's implementation. The top as well as the bottom of the 1st Stage must be securely mounted to the drive train.

42

Test the Lift

Run the lift to maximum and minimum heights ensuring the Up and Down lines reliable spool onto the pulley and remain tight throughout travel.

43

CAUTION

There are multiple pinch points on this lift mechanism which can cause injury. Make sure the lift is fully supported on the robot, and nobody's hands nearby, before running the lift on the motor.

44

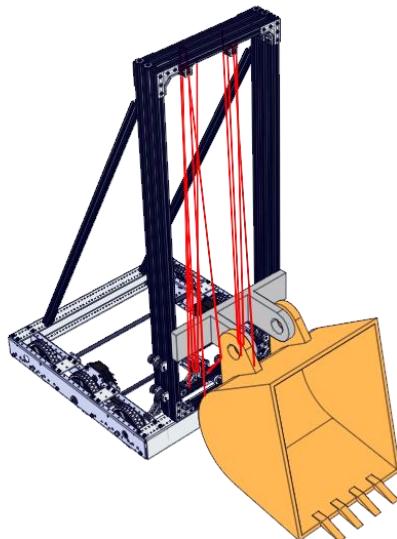


Add Sensors

This is mostly up to the particulars of the team's implementation; however, REV recommends adding sensors to detect when the lift is at its maximum and minimum height.

REV recommends the Magnetic Limit Switch (REV-31-1462).

45



Attach Manipulator

Mount the team's manipulator to the 3rd Stage of the Lift.

46

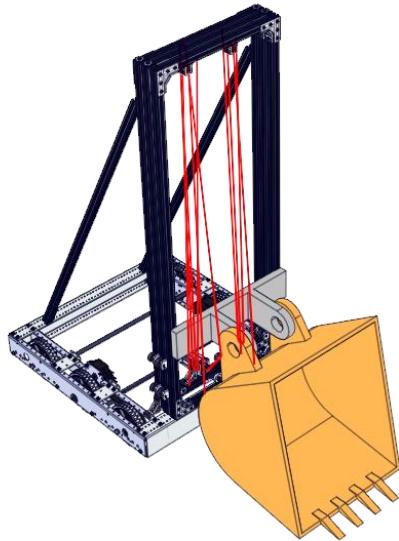


Cable and Pneumatic runs

The Cable and Pneumatic runs to the manipulator need to conformably reach the manipulator without binding. The runs must also be routed in such a way as to not get caught on anything as the lift travels up and down.

Teams should consider using Cable Carrier Drag Chain to assist in achieving this goal.

47



Lift Done!!

Modify, tune and tweak as needed.

CAUTION

There are multiple pinch points on this lift mechanism which can cause **INJURY**. Make sure the lift is fully supported on the robot, and nobody is near the lift, before powering the lift with the motor.

4 1" CARRIAGE MOD ASSEMBLY

Step-by-step guide to assemble the REV 1" Extrusion Lift Kit (REV-25-1290) and an additional 1" Extrusion Lift Kit (REV-25-1290) with the Carriage Mod. The assembling the 1" Extrusion Lift Kit (REV-25-1290) as a Carriage stage uses all the same parts as the 1" Extrusion Lift Kit (REV-25-1290) except for only one 48" long piece of REV 1" extrusion. Plan motor mounting and drive train mounting before assembling the Single Stage Lift Kit and Add-On Kit.

4.1 ADDITIONAL SUPPLIES NEEDED

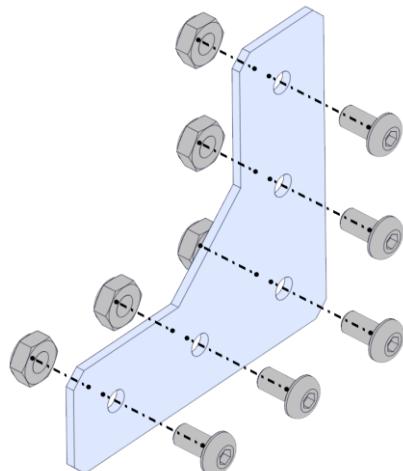
Below are not included in the 1" Extrusion Lift Kit, however you may have leftover pieces depending on the number of kits purchased to make a carriage for the lift.

PRODUCT DESCRIPTION	PART NUMBER	QUANTITY
1" EXTRUSION-4FT	REV-21-1000	1
1" LINEAR MOTION KIT	REV-15-1189	4
90 DEGREE BRACKET	REV-21-1580	4
1" INSIDE CORNER BRACKET	REV-21-1203	12
V-GROOVE BEARING	REV-29-1014	4
2200 LB UHMWPE CORD-25FT	REV-29-1244	1
M4 EYE-TO-EYE TURNBUCKLE	REV-29-1241	2
10-32 3/8" LONG BUTTON HEAD SCREW-100 PACK	REV-29-1221	1
10-32 1/2" LONG BUTTON HEAD SCREW-100 PACK	REV-29-1222	1
10-32 1/2" LONG COUNTER SUNK SCREW-25 PACK	REV-29-1223	1
10-32 LOW PROFILE NYLOC NUT-100 PACK	REV-29-1016	2
10-32 1-1/2" LONG BUTTON HEAD SCREW-5 PACK	REV-29-1220	1
10-32 TO 3/8" SPACER-10 PACK	REV-29-1243	1
TIE-DOWN D-RING	REV-29-1242	8

ITEM	NUMBER
5/32" HEX L KEY	1
3/16" HEX L KEY	1
3/8" WRENCH OR ADJUSTABLE WRENCH	1
1/2" WRENCH OR ADJUSTABLE WRENCH	1
ALUMINUM CUTTING HACKSAW	1
BASTARD FILE OR SANDING BLOCK	1
FINE TIP PERMANENT MARKER	1
CARPENTER'S OR ADJUSTABLE SQUARE	1
YARD STICK OR TAPE MEASURE	1
BLUE LOCTITE OR MEDIUM STRENGTH THREAD LOCKER	1
10-32 TAP AND TAP HANDLE	1
OUTPUT SHAFT COLLARS	3
MOTOR AND GEARBOX	1
MOTOR MOUNT	1

4.2 REV 1" CARRIAGE MOD ASSEMBLY INSTRUCTIONS

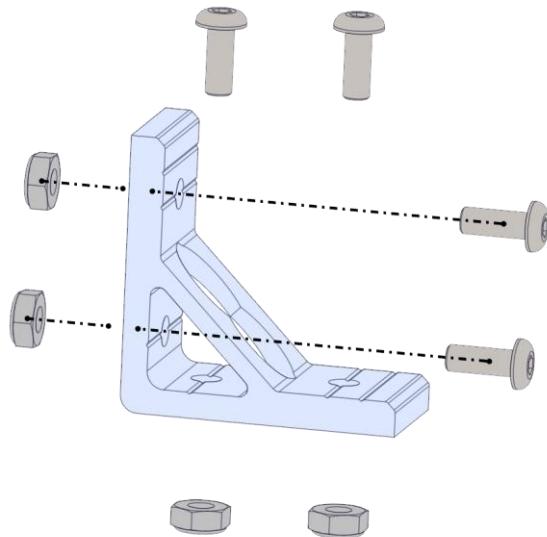
1



Assemble 90° Brackets

Preload all **20** 90° Brackets with 10-32 3/8" Button Head screws and 10-32 Low Profile Nylock Nuts.

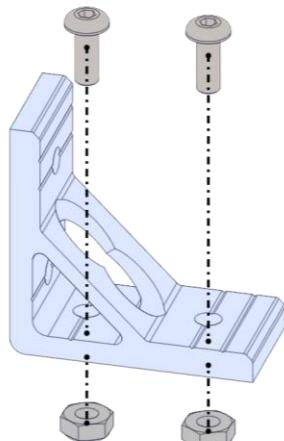
2



Assemble Inside Corner Brackets

Preload **12** Inside Corner Brackets with 10-32 1/2" Button Head screws and 10-32 Low Profile Nylock Nuts. **In all 4 holes.**

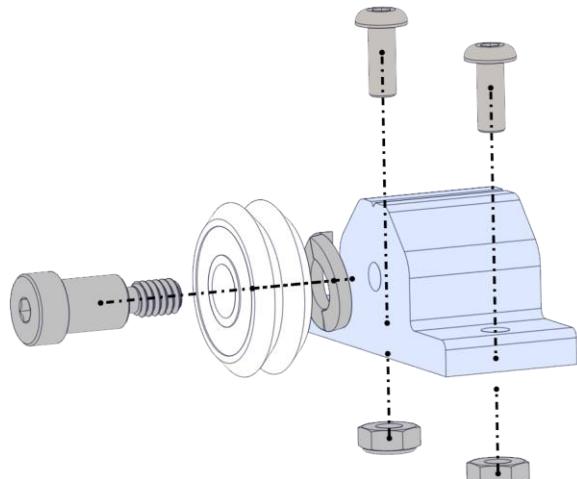
3



Assemble 2 Screw Inside Corner Bracket

Preload **9** Inside Corner Brackets with 10-32 1/2" Button Head screws and 10-32 Low Profile Nylock Nuts. **In 2 holes.**

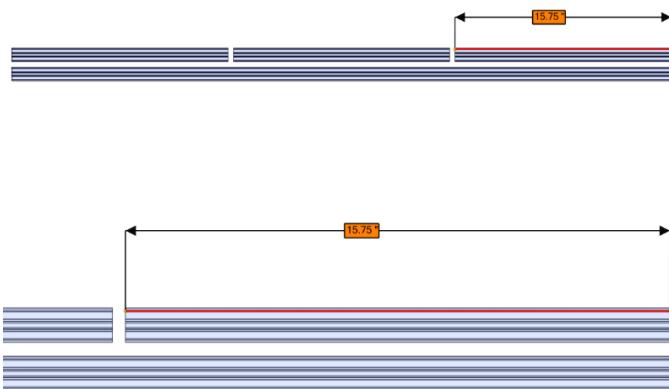
4



Assemble V-Groove Bearing Pillow Blocks

Preload **2** Pillow Blocks with 1/4-20 3/8" diameter Shoulder Screw, 1" V-Groove Bearing, 3/8" Split Washer, 10-32 1/2" Button Head screws and 10-32 Low Profile Nylock Nuts.

5

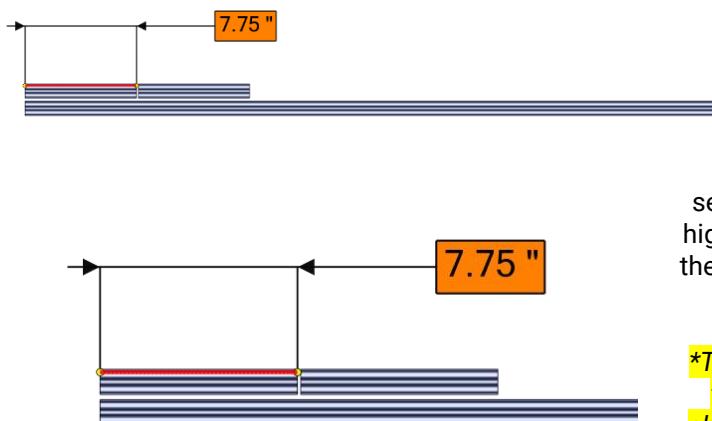


Cut Lift Cross Members

Cut **2** REV 1" Extrusion 48" long pieces into **6** 15.75" segments with the hacksaw. The specific length is not highly critical, but all the Cross Members just need to be the same. Deburr and break the edges on the ends using the file.

**The length of the Lift Cross Members can be customized to meet the needs of different applications, however shorter than 15.75" is not recommended as interferences become tricky to avoid.*

6

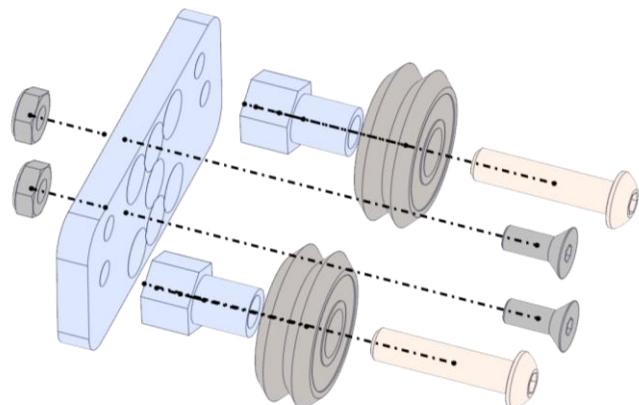


Cut Carriage Verticals

Cut **1** REV 1" Extrusion 48" long pieces into **2** 7.75" segments with the hacksaw. The specific length is not highly critical, but both the Carriage Verticals need to be the same. Deburr and break the edges on the ends using the file.

**The length of the Carriage Verticals can be customized to meet the needs of different applications, however shorter than 7.75" is not recommended as interferences become tricky to avoid.*

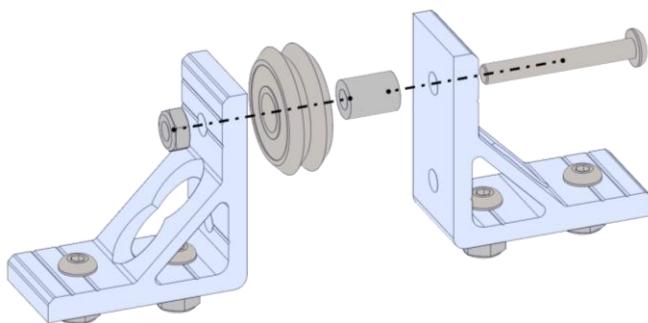
7



Assemble 1" Linear Motion Kits

Assemble all **8** of the 1" Linear Motion Kit bearing blocks. Use one Concentric Bushing and one Eccentric Bushing to mount the V-Grove Bearings. Add Blue Loctite or equivalent to the 1/4-20 1.125" long cap head screw and thread though the Bushings with V-Grove Bearings into the Dual Bearing Plate. Then preload the Dual Bearing Plate with two 10-32 1/2" Countersunk Flat Head screws and 10-32 Low Profile Nylock Nuts.

8

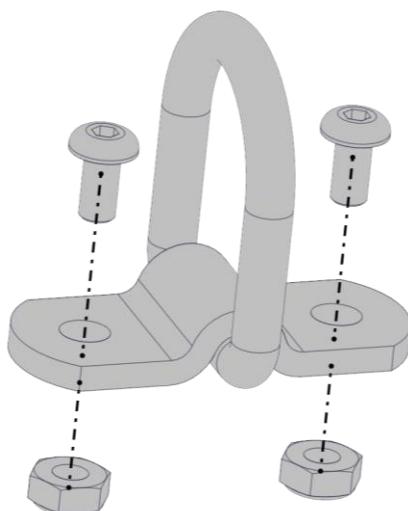


Assemble V-Grove Bearing Inside Corner Bracket Mounts

Place the 3/8 inch into #10 screw spacer inside of the V-Groove Bearing, then sandwich with two 2 Inside Corner Brackets. Thread the 10-32 1.5" Button Head screw through the upper hole in the Inside Corner Brackets and the spacer. Tighten down the 10-32 nut onto the 10-32 1.5" Button Head screw.

Repeat 3 times to construct a total of 4 bearing assemblies.

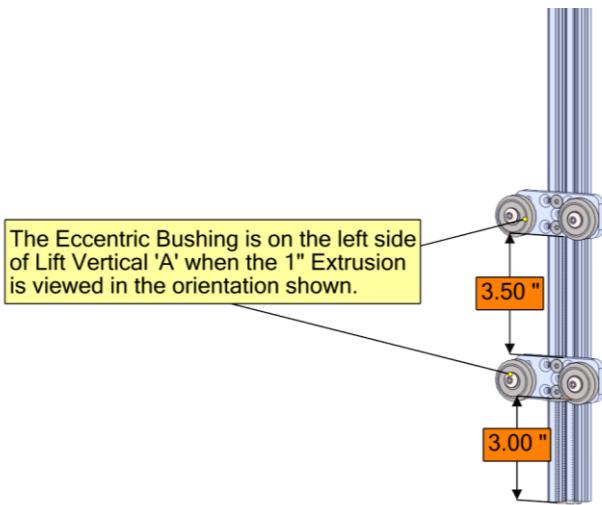
9



Assemble Tie Down D-Ring

Preload **all 8** Tie Down D-Rings with 10-32 1/2" Button Head screws and 10-32 Low Profile Nylock Nuts.

10



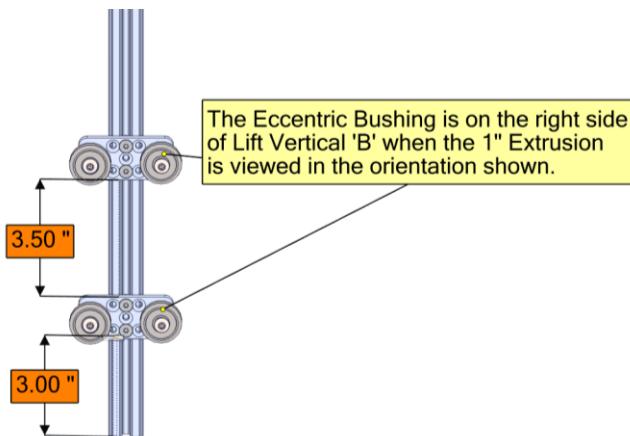
Assemble Vertical Lift 'A'

Slide 2 of the assembled 1" Linear Motion Kits onto a 48" long piece of the 1" REV Extrusion such that the Eccentric Bushing is on the **left side** when viewed from the orientation shown. The lower Dual Bearing Plate should be 3" above the bottom of the 1" REV Extrusion. The upper Dual Bearing Plate should be a minimum of 3.5" above the lower Dual Bearing Plate.

The 1" Linear Motion Kits must be square to the 1" REV Extrusion using the Carpenters Square or Adjustable Square.

Construct 1 Vertical Lift 'A' assemblies.

11

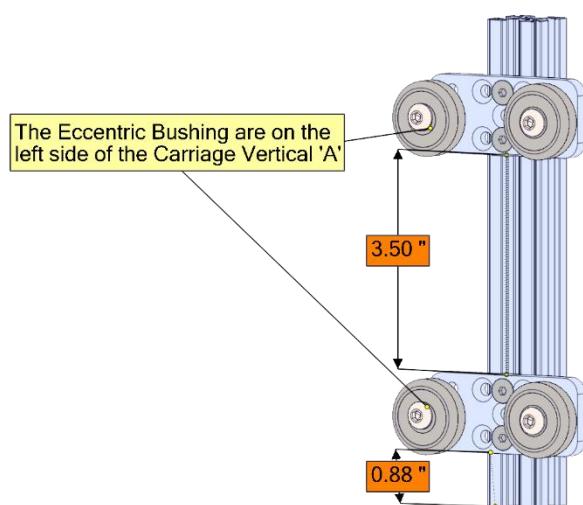


Assemble Vertical Lift 'B'

Reference the assembly of Lift "A", but note that the eccentric bushings are on the **right side** of the carriage. **This should be a mirrored, NOT duplicated, version of Lift 'A'.**

Construct 1 Vertical Lift 'B' assemblies.

12



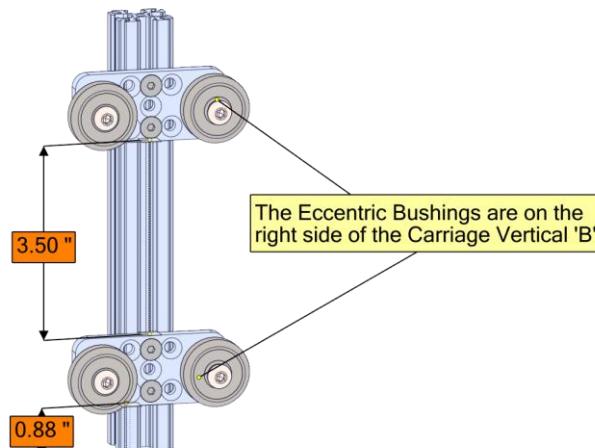
Assemble Carriage Vertical 'A'

Slide 2 of the assembled 1" Linear Motion Kits onto a precut Carriage Vertical such that the Eccentric Bushing is on the **left side** when viewed from the orientation shown. The lower Dual Bearing Plate should be 0.875" above the bottom of the 1" REV Extrusion. The upper Dual Bearing Plate should be 3.5" above the lower Dual Bearing Plate.

The 1" Linear Motion Kits must be square to the 1" REV Extrusion using the Carpenters Square or Adjustable Square.

Construct 1 Carriage Vertical 'A' assembly.

13

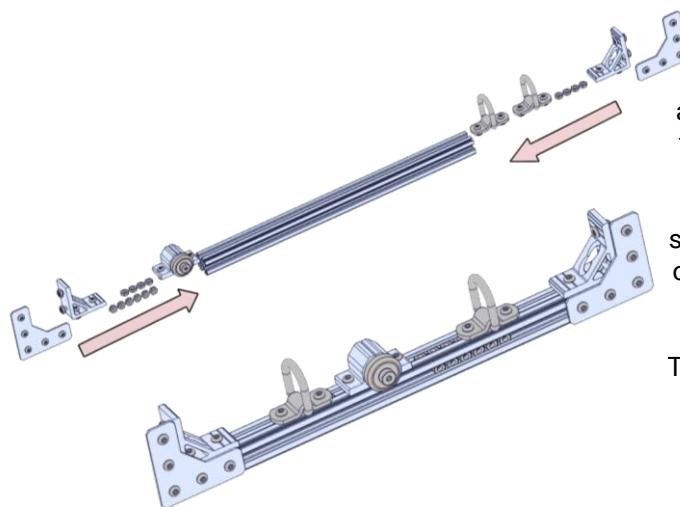


Assemble Carriage Vertical 'B'

Reference the assembly of Carriage Vertical 'A', but note that the eccentric bushings are on the **right side** of the carriage. **This should be a mirrored, NOT duplicated, version of Carriage Vertical 'A'.**

Construct 1 Carriage Vertical 'B' assembly.

14

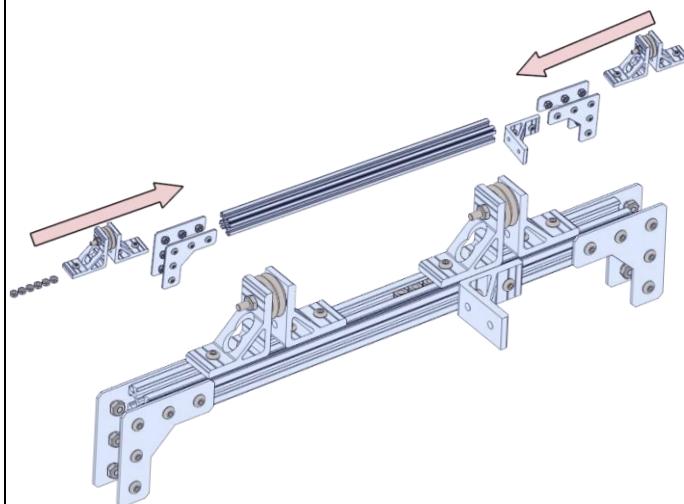


Assemble 1st Stage Cross Members

Construct 2, 1st Stage Cross members. Slide the assembled V-Grove Bearing Pillow Block onto the top of the Lift Cross Member, Tie Down D-Rings and add extra 10-32 Low Profile Nyloc Nuts. Add a preloaded Inside Corner Bracket to each end of the Lift Cross Member such that the Inside Corner Bracket is flush with the ends of the Lift Cross Member. Add a 90° Bracket to each end of the Lift Cross Member such that the 90° Bracket is protruding 1" from the ends of the Lift Cross Member. This is to allow another 1" REV Extrusion to slide onto the 90° Bracket.

Loosely tighten the screws that go into the Lift Cross Member so that the parts do not fall off but can slide around if needed.

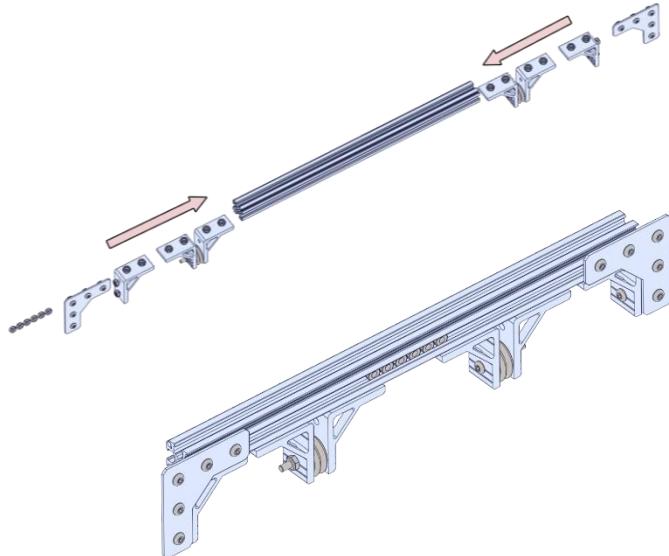
15



Assemble 2nd Stage Lower Cross Member

1, 2nd Stage Lower Cross member needs to be constructed. Slide the assembled 2 Screw Inside Corner Bracket onto the front of the Cross Member, add extra 10-32 Low Profile Nylock Nuts. Slide 2 V-Grove Bearing Inside Corner Bracket Mounts into the top of the Lower Cross Member. Add two 90° Bracket to each end of the Lift Cross Member such that the 90° Bracket is protruding 1" from the ends of the Lift Cross Member. Loosely tighten the screws that go into the Lift Cross Member so that the parts do not fall off but can slide around if needed.

16

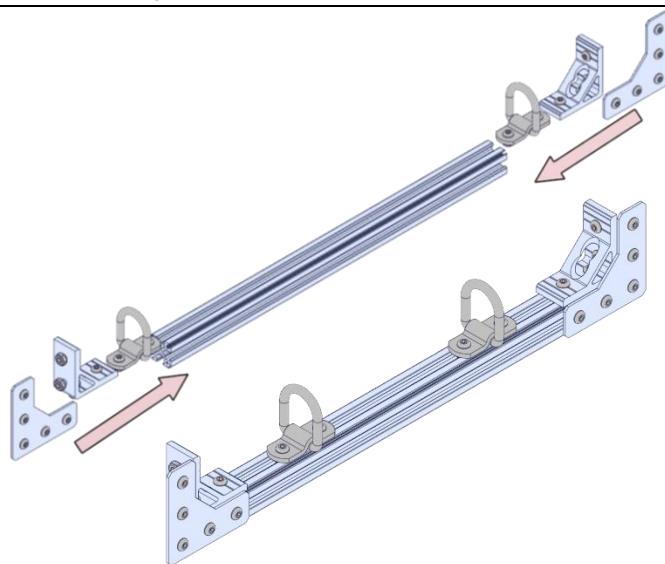


Assemble 2nd Stage Upper Cross Member

1. 2nd Stage Upper Cross member needs to be constructed. Slide extra 10-32 Low Profile Nylock Nuts into the Cross Member. Slide 2 V-Grove Bearing Inside Corner Bracket Mounts into the Lower Cross Member. Add a preloaded Inside Corner Bracket to each end of the Lift Cross Member such that the Inside Corner Bracket is flush with the ends of the Lift Cross Member. Add a 90° Bracket to each end of the Lift Cross Member such that the 90° Bracket is protruding 1" from the ends of the Lift Cross Member.

Loosely tighten the screws that go into the Lift Cross Member so that the parts do not fall off but can slide around if needed.

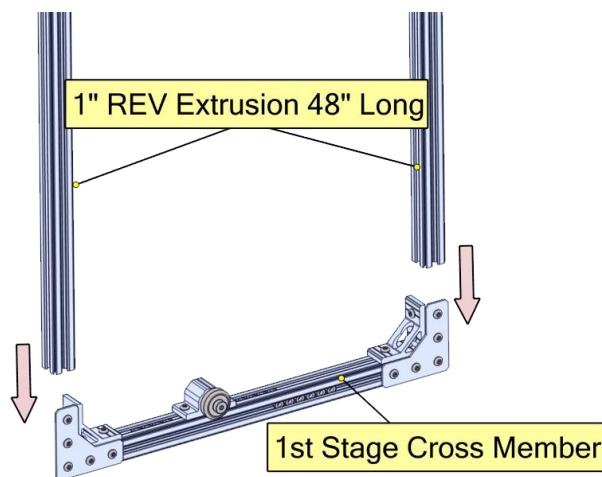
17



Assemble Carriage Stage Cross Members

Construct 2, Carriage Stage Cross members. Slide on 2 Tie Down D-Rings and extra 10-32 Low Profile Nylock Nuts. Add a preloaded Inside Corner Bracket to each end of the Lift Cross Member such that the Inside Corner Bracket is flush with the ends of the Lift Cross Member. Add a 90° Bracket to each end of the Lift Cross Member such that the 90° Bracket is protruding 1" from the ends of the Lift Cross Member. This is to allow another 1" REV Extrusion to slide onto the 90° Bracket. Loosely tighten the screws that go into the Lift Cross Member so that the parts do not fall off but can slide around if needed.

18



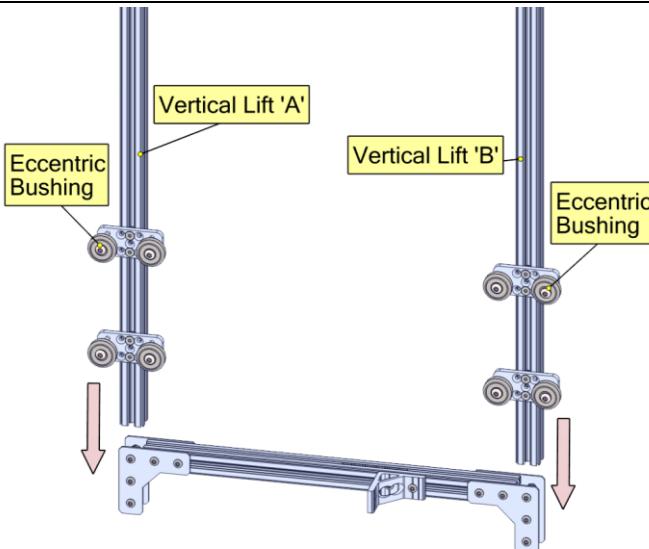
Begin Assembling the 1st Stage

Slide 2 48" Long 1" REV Extrusions into the 'L' created by the 90° Brackets and the Inside Corner Brackets. Lower the 48" Long 1" REV Extrusions until they are flush with the bottom of the 1st Stage Cross Member.

Tighten the screws that go into the Lift Cross Member and 48" Long 1" REV Extrusions so that the parts do not move but the screws can easily be loosened if needed.

Set partially completed 1st Stage aside.

19



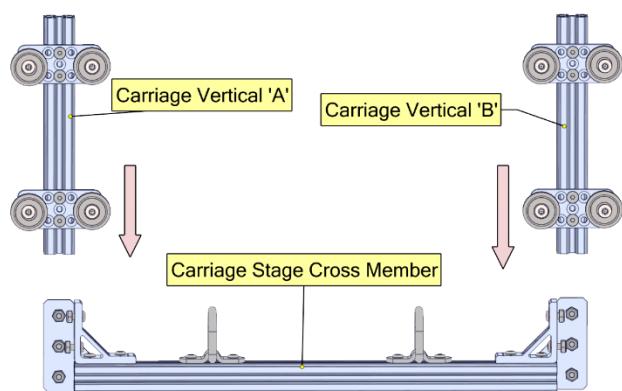
Begin Assembling the 2nd Stage

Slide Vertical Lift 'A' into the pocket between the 90° Brackets on the left side. Slide Vertical Lift 'B' into the pocket between the 90° Brackets on the right side. Lower the Vertical Lifts until they are flush with the bottom of the 90° Brackets.

Tighten the screws that go into the Lift Cross Member and Vertical Lifts so that the parts do not move but the screws can easily be loosened if needed.

Set partially completed 2nd Stage aside.

20

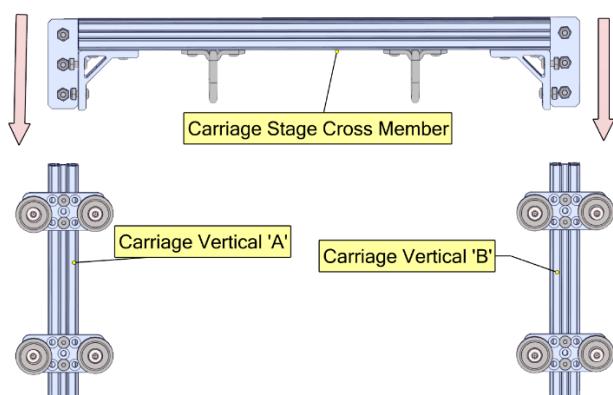


Begin Assembling the Carriage Stage

Slide Carriage Vertical 'A' into the pocket between the 90° Brackets on the left side of the Carriage Stage Cross Member. Slide Carriage Vertical 'B' into the into the pocket between the 90° Brackets on the right side. Lower the Carriage Verticals until they are flush with the bottom of the 90° Brackets.

Tighten the screws that go into the Lift Cross Member and Carriage Verticals so that the parts do not move but the screws can easily be loosened if needed.

21



Complete Assembling the Carriage Stage

Slide the Carriage Stage Cross Member onto Carriage Vertical 'A' and 'B' such that they go into the 'L' created by the 90° Brackets and the Inside Corner Brackets. Lower the Upper Cross member until it is flush with the top of the Carriage Verticals.

Tighten the screws that go into the Lift Cross Member and Carriage Verticals so that the parts do not move but the screws can easily be loosened if needed.

Carriage Stage is completed.

22

Combine 1st and 2nd Lift Stage

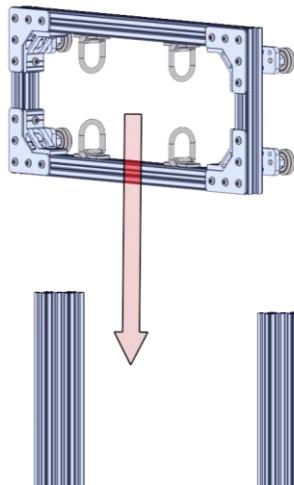


Using the 1/2" wrench rotate the Eccentric Bushings to their fully open position. Slide the 2nd Lift Stage onto the 48" Long 1" REV Extrusions on the partially completed 1st Stage. The 1st Stage Lift should be oriented with the Lower Cross Member at the bottom and the 2 Screw Inside Corner Bracket pointing in the same direction as the V-Grove Bearing Pillow Block. The V-Grove Bearings on the 1" Linear Motion Kit should slide on the matching V channels in the 48" Long 1" REV Extrusions on the partially completed 1st Stage.

Lower the 2nd Lift Stage such that the tops and bottoms of both Lift Stages are flush.

23

Add Carriage Stage

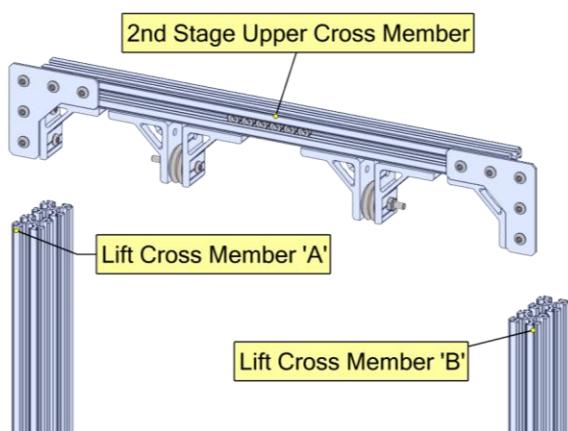


Using the 1/2" wrench rotate the Eccentric Bushings to their fully open position. Slide the Carriage Stage onto the Vertical Lifts 'A' and 'B' on the partially completed 2nd Stage. The 1st Stage Lift should be oriented with the Lower Cross Member at the bottom and the 2 Screw Inside Corner Bracket pointing in the same direction as the V-Grove Bearing Pillow Block. The V-Grove Bearings on the 1" Linear Motion Kit should slide on the matching V channels in the 48" Long 1" REV Extrusions on the partially completed 1st Stage.

Lower the 2nd Lift Stage such that the tops and bottoms of both Lift Stages are flush.

24

Complete Assembling the 2nd Stage

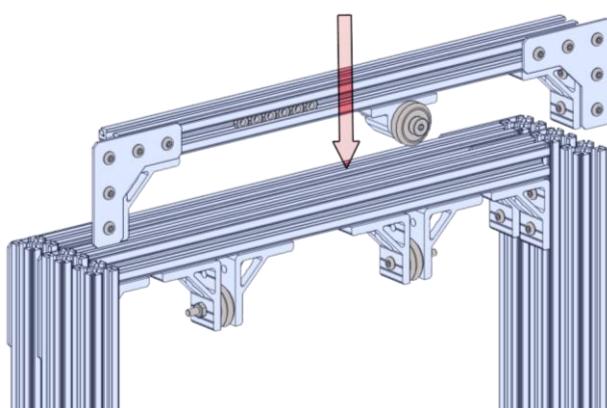


Slide the 2nd Stage Upper Cross Member onto Lift 'A' and 'B' such that they go into the 'L' created by the 90° Brackets and the Inside Corner Brackets. Lower the Upper Cross member until it is flush with the top of the Lifts.

Tighten the screws that go into the Lift Cross Member and Vertical Lifts so that the parts don't move but the screws can easily be loosened if needed.

2nd Stage is completed.

25



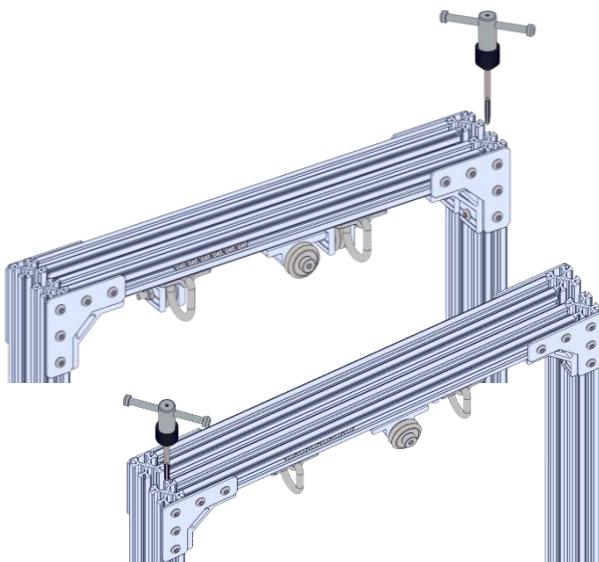
Complete Assembling the 1st Stage

Slide the 1st Stage Cross Member onto the 48" Long 1" REV Extrusions on the partially completed 1st Stage such that 48" Long 1" REV Extrusions go into the 'L' created by the 90° Brackets and the Inside Corner Brackets. Lower the Cross member until it is flush with the top of the 48" Long 1" REV Extrusions.

Tighten the screws that go into the Lift Cross Member and 48" Long 1" REV Extrusions so that the parts do not move but the screws can easily be loosened if needed.

1st Stage is completed.

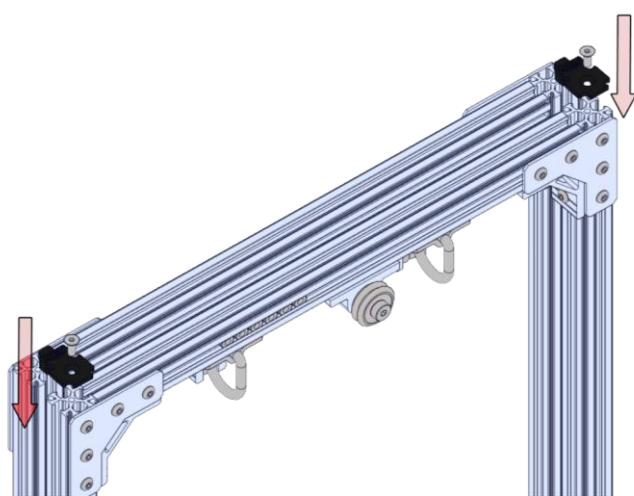
26



Thread the top of the 1st Stage

Using the 10-32 tap thread the hole in the center of the 48" Long 1" REV Extrusions at the top of the 1st Stage. The threads need to extend ~0.5" into the Extrusion.

27



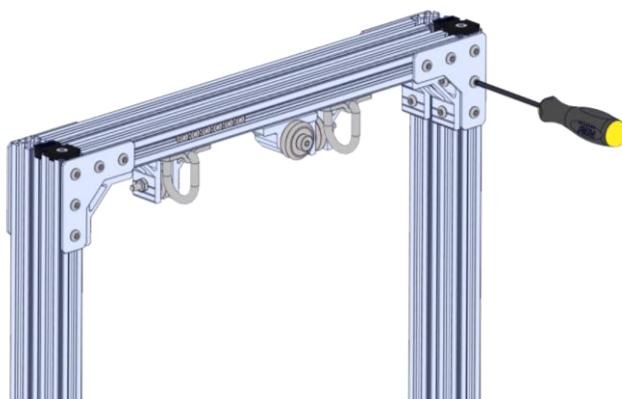
Adding the 1" Extrusion Endcap Slides the top of the 1st Stage.

Place the 1" Extrusion Endcap Sliders on the left and right 48" Long 1" REV Extrusions at the top of the 1st Stage.

Thread the 10-32 1/2" Countersunk Flat Head screws into place leaving the screws loose enough to allow the endcap to freely wiggle.

28

Tighten 1st Stage Screws



Tighten* the screws starting with the 1st Stage screws. Be sure to confirm that the Cross Members are in the correct locations and square with the vertical 48" Long 1" REV Extrusions.

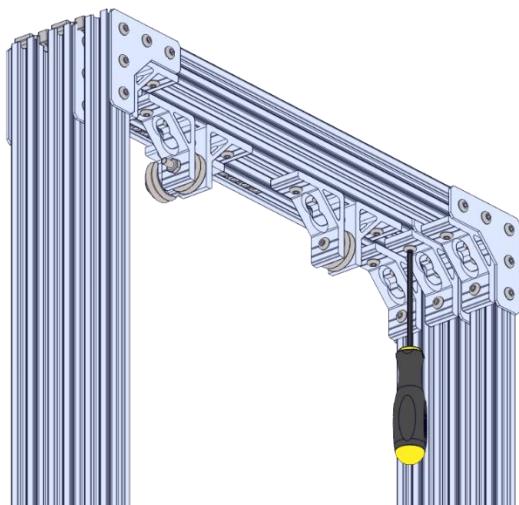
Rotate the eccentric bushing with the 1/2" wrench until the bearing comes into contact with the vertical 48" Long 1" REV Extrusions.

Leave the V-Grove Bearing Pillow block screws loose.

**33 in•lb is the recommended torque for these screws, but it is not required to be exact*

29

Tighten 2nd Stage Screws



Tighten* the screws on the 2nd Stage. Be sure to confirm that the Cross Members are in the correct locations and square with the vertical 48" Long 1" REV Extrusions.

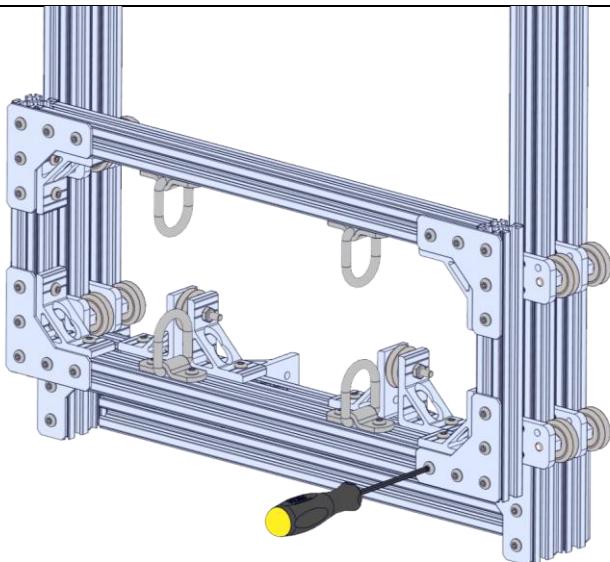
Extend 2nd Stage to maximum height to confirm smooth motion. If lift is binding loosen 2nd Stage screws extend 2nd Stage and retighten.

Leave the 2 Screw Inside Corner Bracket screws loose.

**33 in•lb is the recommended torque for these screws, but it is not required to be exact*

30

Tighten Carriage Stage Screws



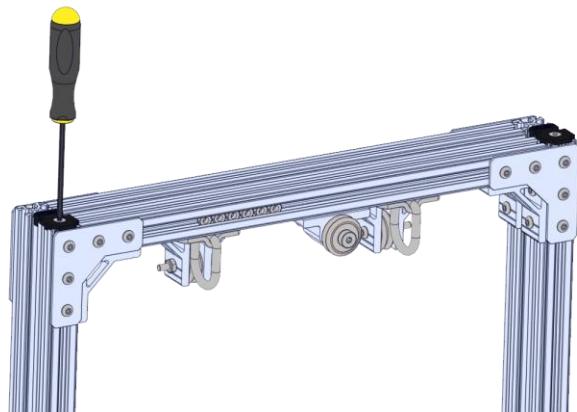
Tighten* the screws on the Carriage Stage. Be sure to confirm that the Cross Members are in the correct locations and square with the vertical 48" Long 1" REV Extrusions.

Rotate the eccentric bushing with the 1/2" wrench until the bearing comes into contact with the vertical 48" Long 1" REV Extrusions.

Leave the V-Grove Bearing Pillow block screws loose.

**33 in•lb is the recommended torque for these screws, but it is not required to be exact*

31



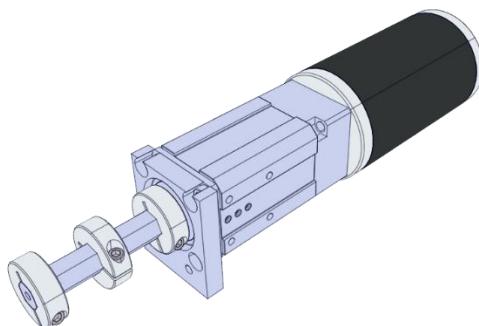
Tighten 1" Extrusion Endcap Slide Screws

Extend 2nd and Carriage Stages to maximum height then tighten* the screws on the 1" Extrusion Endcap Sliders.

Extend 2nd and 3rd Stages to maximum height to confirm smooth motion. If lift is binding, loosen the screws on the 1" Extrusion Endcap Sliders and find the "sweet spot" so that the sliders allow smooth motion during the full travel of the lift, then retighten.

*13 in·lb is the recommended torque for these screws, but it is not required to be exact

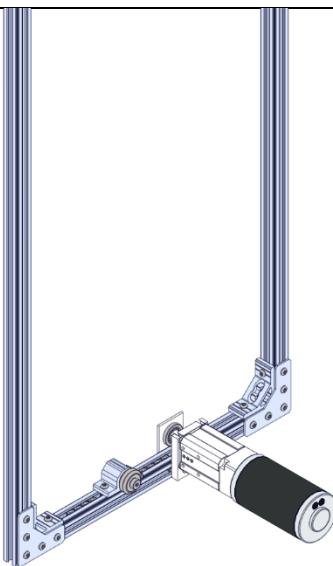
32



Motor Spindle (Optional)

Attach 3 shaft collars (not included) to the output shaft of the motor with enough space in between them to be able to coil all the line required to lift the elevator.

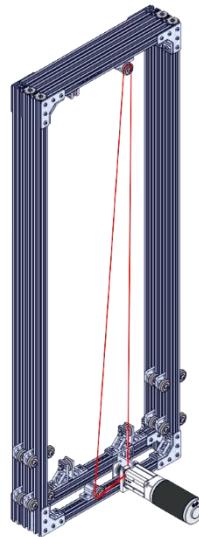
33



Mount Motor and Gearbox

Mount Motor and Gearbox to lift with a mounting plate (not included) to the bottom of the first stage. Make sure to support the output shaft at both ends for added rigidity. See Motor and Gearbox recommendation section (4) for potential Motor and Gearbox mounting solutions.
(36:1 CIM Sport and CIM pictured here)

34

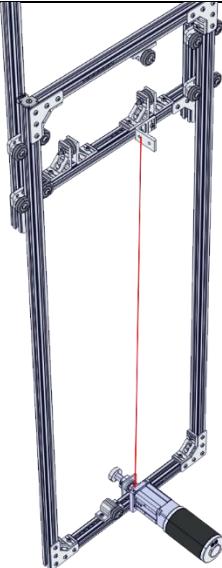


String the Up Line of the Lift

Securely attach the bottom of the High Strength Line to your pulley such that it is not able to rotate. Wrap the pulley 2 or 3 times a **Clock Wise** direction.

Slide the lower the V-Grove Bearing Pillow block as close as possible to the pulley and tighten down. Lower the 2nd stage to the most compact height, then run the string under lower V-Grove Bearing then over the top of the upper V-Grove Bearing then tie the High Strength Line to the outside hole in 2 Screw Inside Corner Bracket using a High-Tension Tuckers Hitch knot. Slide the upper V-Grove Bearing Pillow block so the string is perfectly vertical, then tighten down the Pillow block.

35

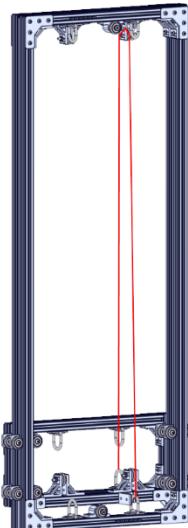


String the Down Line of the Lift

Securely attach the bottom of the High Strength Line to your pulley such that it is not able to rotate. Wrap the pulley 2 or 3 times a **Counter Clock Wise** direction.

Extend 2nd Stage to maximum height then tie the High Strength Line to the inside hole in 2 Screw Inside Corner Bracket making the line as taught as possible.

36



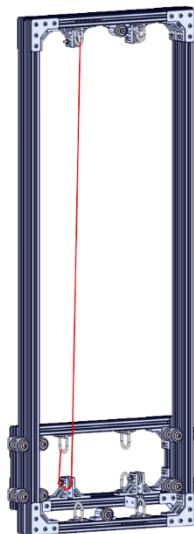
String the Up Line of the 3rd Stage

Securely attach the bottom of the High Strength Line to the 1st Stage Lower Cross Member. Then run the line up and over the Left V-Grove Bearing Inside Corner Bracket Mount on the 2nd Stage Upper Cross Member. The High Strength Line is then run down to the 3rd Stage Lower Cross Member securing the line using a High-Tension Tuckers Hitch knot.

Adjust the start and end points of the line so they are in the same plane as the V-Grove Bearing.

Repeat for the Right V-Grove Bearing Inside Corner Bracket Mount.

37



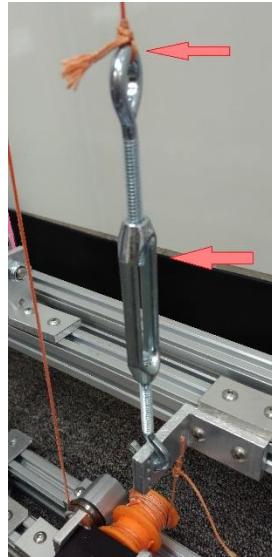
String the Down Line of the 3rd Stage

Securely attach the bottom of the High Strength Line to the 1st Stage Upper Cross Member. Then run the line down and under the Left V-Grove Bearing Inside Corner Bracket Mount on the 2nd Stage Lower Cross Member. The High Strength Line is then run up to the 3rd Stage Upper Cross Member securing the line using a High-Tension Tuckers Hitch knot.

Adjust the start and end points of the line so they are in the same plane as the V-Grove Bearing.

Repeat for the Right V-Grove Bearing Inside Corner Bracket Mount.

38



Tension the Up Line of the Lift

Lower 2nd Stage to 50% of its maximum height. Add tension to the Up Line using the High-Tension Tuckers Hitch knot (upper arrow on left) such that both the Up Line and the Down line are tightened. If the High-Tension Tuckers Hitch knot does not have enough travel, untension the line and slide the lower Bearing Pillow block away from your pulley, then re-tension.

You can also use the recommended upgrade turnbuckle (lower arrow on left) to tension as well.

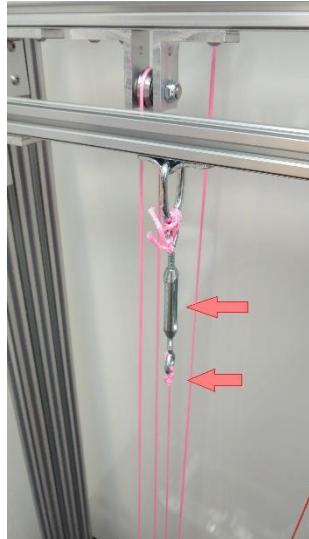
39



Tension the 3rd Stage Up Lines

Fully extend 2nd and 3rd Stages to their maximum height. Add tension to the 3rd Stage Up Lines using the High-Tension Tuckers Hitch knots (upper arrow on left) such that both 3rd Stage Up Lines are taught. Both lines must have the same tension on them this can be checked by plucking the lines. If the High-Tension Tuckers Hitch knot does not have enough travel undo the knot retie and tension.

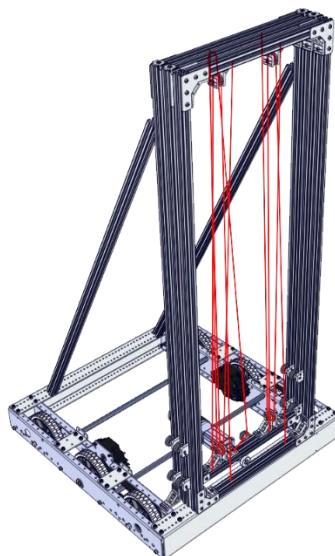
You can also use the recommended upgrade turnbuckle (lower arrow on left) to tension as well.

40

Tension the 3rd Stage Down Lines

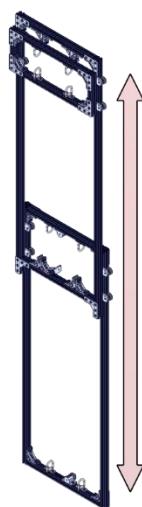
Fully lower 2nd and 3rd Stages to their minimum height. Add tension to the 3rd Stage Down Lines using the High-Tension Tuckers Hitch knots (lower arrow on left) such that both 3rd Stage Down Lines are taught. Both lines must have the same tension on them this can be checked by plucking the lines. If the High-Tension Tuckers Hitch knot does not have enough travel undo the knot retie and tension.

You can also use the recommended upgrade turnbuckle (upper arrow pictured left) to tension as well.

41

Mount the lift to the Drive Train

This is mostly up to the particulars of the team's implementation. The top as well as the bottom of the 1st Stage must be securely mounted to the drive train.

42

Test the Lift

Run the lift to maximum and minimum heights ensuring the Up and Down lines reliably spool onto the pulley and remain tight throughout travel.

43

CAUTION

There are multiple pinch points on this lift mechanism which can cause injury. Make sure the lift is fully supported on the robot, and nobody's hands nearby, before running the lift on the motor.

44

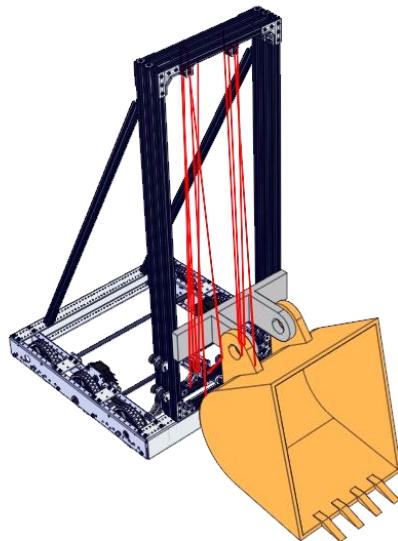


Add Sensors

This is mostly up to the particulars of the team's implementation; however, REV recommends adding sensors to detect when the lift is at its maximum and minimum height.

REV recommends the Magnetic Limit Switch (REV-31-1462).

45



Attach Manipulator

Mount the team's manipulator to the 3rd Stage of the Lift.

46

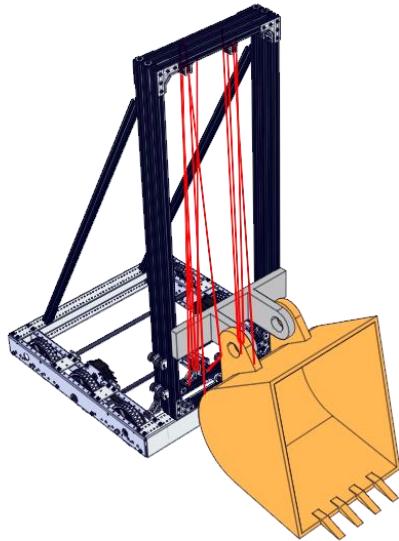


Cable and Pneumatic runs

The Cable and Pneumatic runs to the manipulator need to conformably reach the manipulator without binding. The runs must also be routed in such a way as to not get caught on anything as the lift travels up and down.

Teams should consider using Cable Carrier Drag Chain to assist in achieving this goal.

47



Lift Done!!

Modify, tune and tweak as needed.

CAUTION

There are multiple pinch points on this lift mechanism which can cause **INJURY**. Make sure the lift is fully supported on the robot, and nobody is near the lift, before powering the lift with the motor.

5MOTOR & GEARBOX SELECTION

CAUTION

These are only theoretical suggestions. REV Robotics does not sell these products and is not able to guarantee real world performance equivalency

Table 4-1: Gearbox and Motor Recommendations

Gearbox	Motor	Gearing	Pulley Dia.	Amperage Load	Rated Load Weight	Loaded Speed (36 in travel)
Andymark CIM Sport (3in shaft)	NEO	36: 1	.625in	11.71 Amps	250 lbs	7.91 Sec
Andymark CIM Sport (3in shaft)	CIM	36: 1	.625in	15.75 Amps	250 lbs	8.52 Sec
VEX VersaPlanetary (with CIM adapter)	CIM	30:1	.625in	18.96 Amps	250 lbs	7.31 Sec

The table above is a list of recommendations that are deemed robust and reliable for this mechanism. The motors and gearboxes can be bought from the following links:

REV NEO motor: <http://www.revrobotics.com/rev-21-1650/>

CIM motor: <https://www.vexrobotics.com/217-2000.html> or <http://www.andymark.com/CIM-Motor-p/am-0255.htm>

Versaplanetary Gearbox: <https://www.vexrobotics.com/vexpro/motion/gearboxes/versaplanetary.html>

CIM Sport Gearbox: <http://www.andymark.com/CIM-Sport-p/am-cimsport.htm>

CIM sport 3in Shaft: <http://www.andymark.com/product-p/am-3791.htm>

This is not a complete list of all motor and gearbox combinations that would be successful in this elevator. Other motors and gearing combinations that are powerful for this application are:

NEO Brushless – 20:1 gear reduction or larger

CIM - 20:1 gear reduction or larger

MiniCIM - 25:1 gear reduction or larger

BAG motor - 40:1 gear reduction or larger

775 Pro - 60:1 gear reduction or larger

775 Redline - 60:1 gear reduction or larger

CAUTION

If gearbox gearing is below the lower limit listed above, there is high possibility for tripping the 30A fuse on the power distribution board.