



15MM LINEAR MOTION SYSTEM

September 20, 2017

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1 INTRODUCTION

The REV Robotics 15mm Linear Motion kit is intended to be used with the REV Robotics 15mm x 15mm Aluminum Extrusion. The Linear Motion kit contains all the necessary hardware (Figure 1) to build a 2-stage lift. A 5.5mm Nut driver and 2mm Allen key are needed for assembly. Items necessary for powering the linear motion system are sold separately as part reequipments are highly implantation dependent.

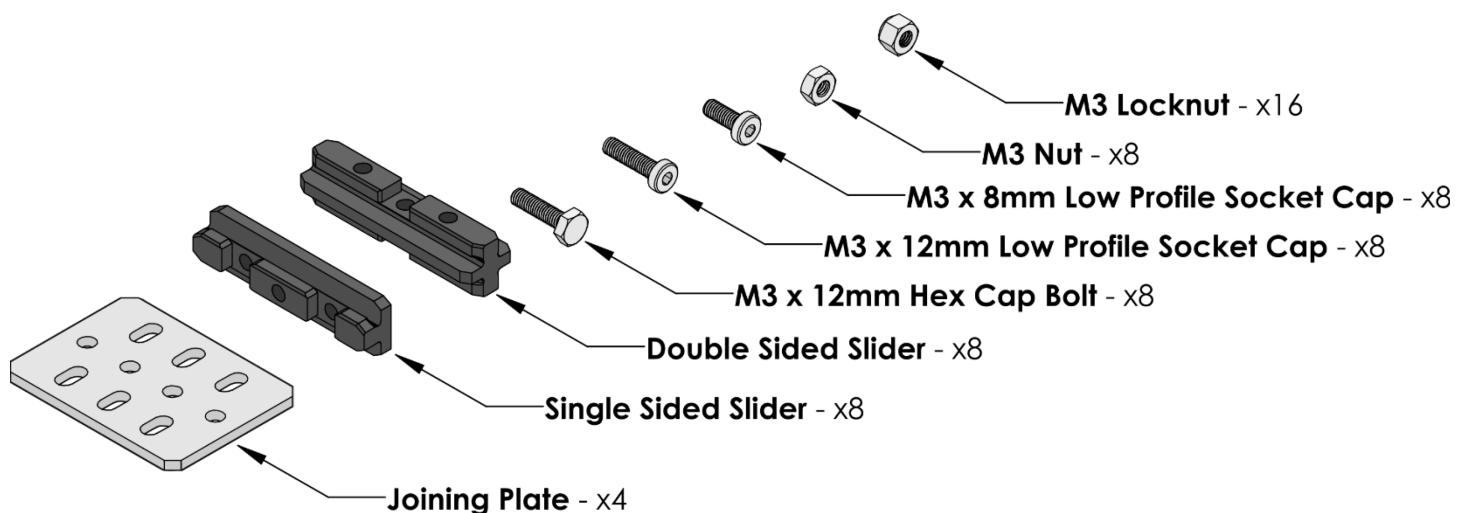


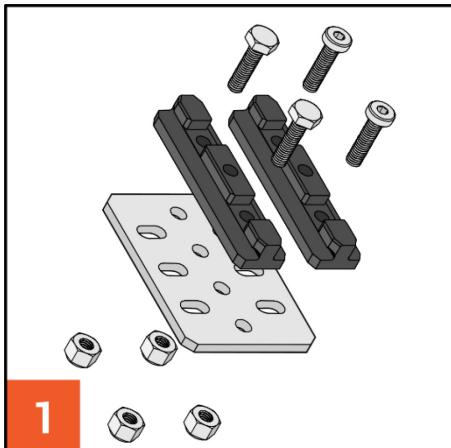
Figure 1: Linear Motion Kit Contents (REV-41-1098)

To drive the linear motion system, we recommend using:

- Small Pulley Bearings (REV-41-1368)
- M3 x 12mm or longer hex cap bolts (REV-41-1360)
- M3 Nyloc Nuts (REV-41-1361)
- M3 Plain Nuts
- Non-Stretching string such as Spectra fishing line

2 ASSEMBLY INSTRUCTIONS

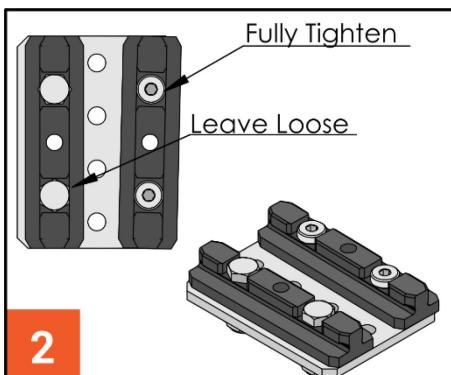
These instructions explain how to build one half of a single stage lift. Each linear motion kit contains enough hardware to create a 2-stage lift.



Step 1

Required Components:

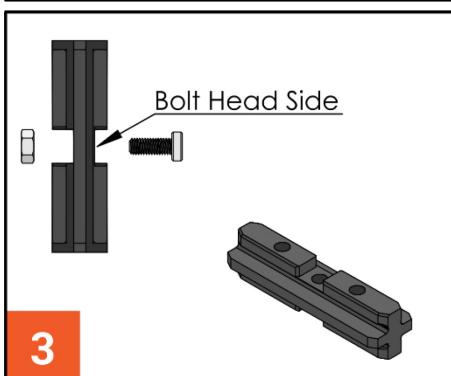
- Joining Plate – x2
- Single Sided Slider – x2
- M3 x 12mm Hex Cap Bolts – x2
- M3 x 12mm Low Profile Socket Cap Bolts – x2
- M3 Nylon Locknuts – x4



Step 2

On the single-sided slider side with the low profile socket cap bolts, fully tighten the single-sided slider onto the joining plate so that the edge of the slider and the plate are roughly parallel.

On the single-sided slider with the hex cap bolts, just start the nuts enough so they won't fall off, but leave the bolts loose.

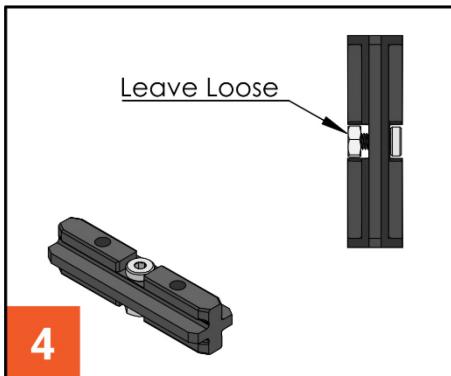


Step 3

Required Components:

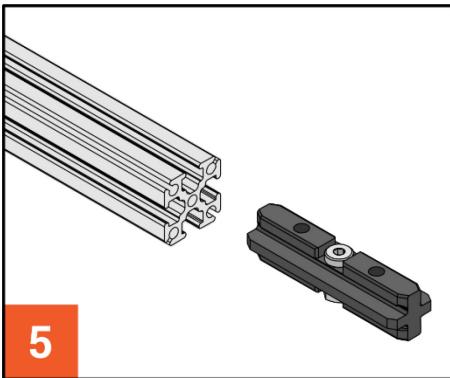
- Double Sided Slider – x1
- M3 x 8mm Low Profile Socket Cap Bolts – x1
- M3 Nut – x1

Be sure that you insert the bolt from the correct side because the double-side slider is not completely symmetric. The bolt should be on the side with the shallower cutout as shown.



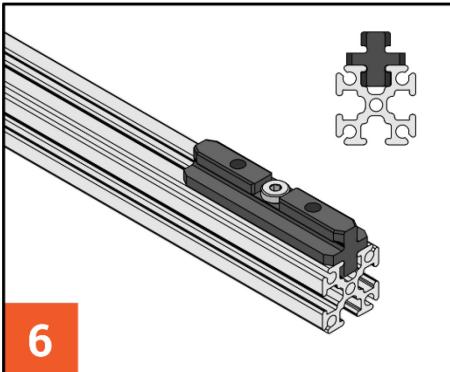
Step 4

When assembling the double-sided slider, only tighten the nut so that it is flush with the bottom of the slider when the bolt head is all the way down. There should be clearance between the top of the nut and the slider as shown.



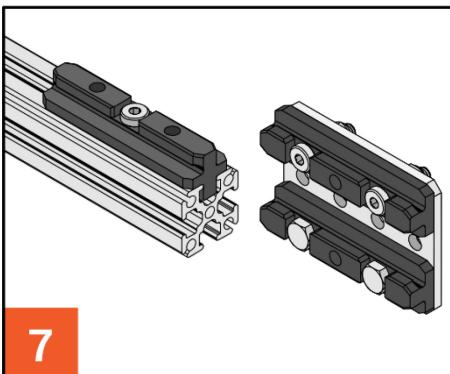
Step 5

Insert the double-sided slider into the extrusion channel. You may have to slightly loosen or tighten the nut so that it will alight with the channel.



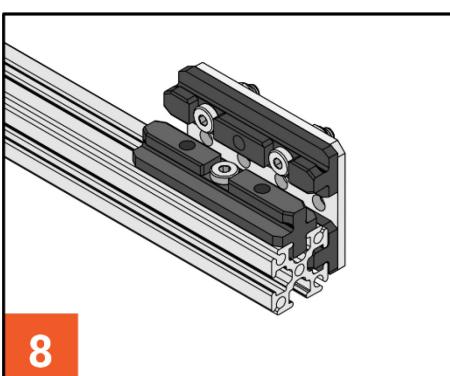
Step 6

Once the slider is fully inserted into the channel tighten the bolt until snug.



Step 7

Take the single-sided assembly from Step 2 and slide the hex cap bolt slider into the extrusion channel on the side adjacent to the double-sided slider.



Step 8

Once the slider assembly from Step 2 is fully inserted into the channel, tighten just enough so that the single-sided slider assembly does not freely slide in the channel, but is still loose enough that you can move the slider with some minimal force.

The above steps 1-8 will result in the basic building assemble for a linear motion elevator using the REV Robotics Linear Motion Kit and Extrusion (Figure 2). Repeat the steps 1-8 above for as many stages as needed, a minimum of two assemblies are needed.

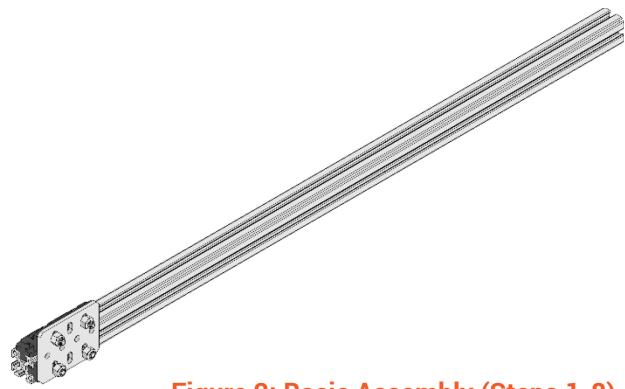
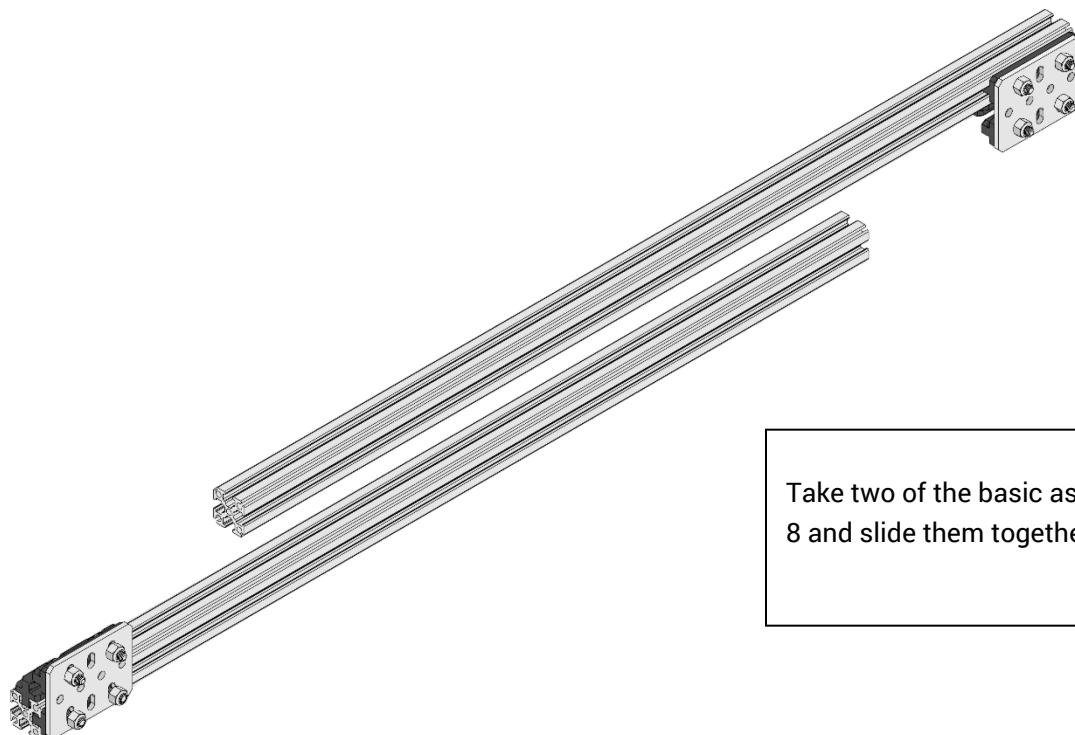
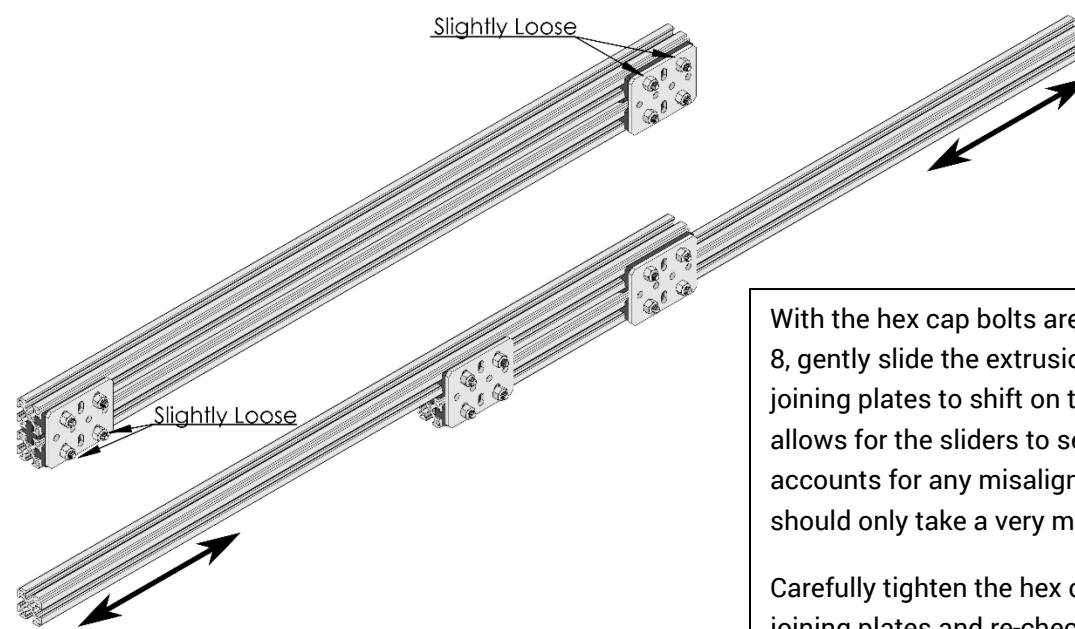


Figure 2: Basic Assembly (Steps 1-8)



Take two of the basic assemblies created in Steps 1-8 and slide them together.



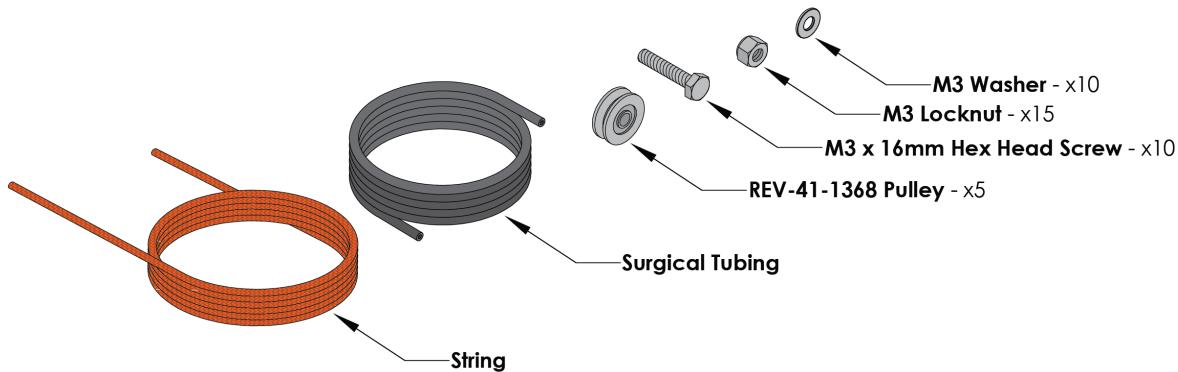
With the hex cap bolts are still slightly loose from step 8, gently slide the extrusion in and out allowing the joining plates to shift on the hex cap bolts. This allows for the sliders to self-adjust parallel and accounts for any misalignment from step 2. The slide should only take a very minimum effort to move.

Carefully tighten the hex cap bolts without shifting the joining plates and re-check the slide for any binding. Repeat as necessary.

3 How to drive Linear Motion

Linear motion stages can be driven many different ways our recommendation is to use a string wound around a pulley and segment of surgical tubing to operate as a powered return. The string and pulley arrangement is commonly set up in one of two ways: Cascading or Continuous string. In the Cascading string assembly, all the stages move up simultaneously, each one by an equal amount. In the Continuous string assembly, the position of each stage relative to each other not controlled only the position of the final stage relative to the start position is controlled. This distinction is not relevant in most applications however it is a feature that can be used to great effect in some applications and worth keep in mind during design and prototyping. The parts necessary for powering the linear motion system are sold separately as part reequipments are highly implantation dependent.

3.1 Cascading String

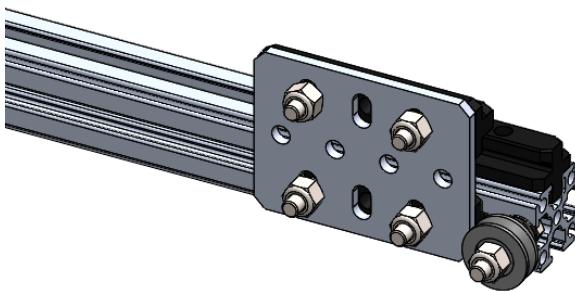


Collect parts for Cascading string assembly. This guide assumes you are building a four-stage lift with a surgical tubing return. These parts are not included in the linear motion kit.

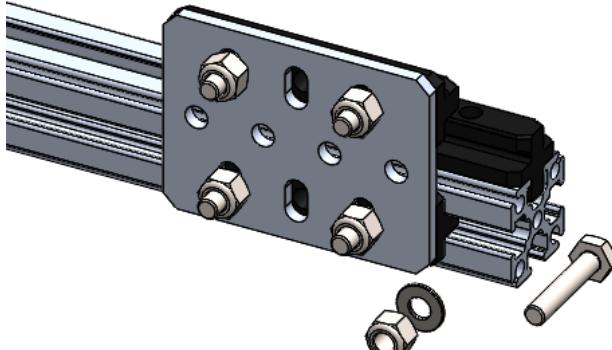
A photograph of a linear motion stage, specifically a 15mm model, mounted on a metal plate. A pulley assembly is attached to the stage, consisting of a pulley wheel, a locknut, and a washer. Below the stage, a separate set of hardware components (pulley, locknut, washer) is shown.

Collect parts:

- M3 x 16mm Hex Head Screw
- M3 Locknut x2
- M3 Washer
- REV-41-1368 Pulley

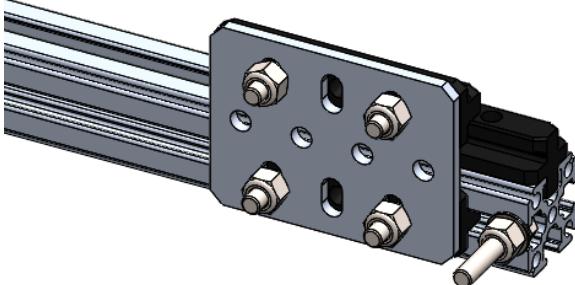


Add a pulley to the top of the first three extrusions. All pulleys must be on the same side of the assembled linear motion system.

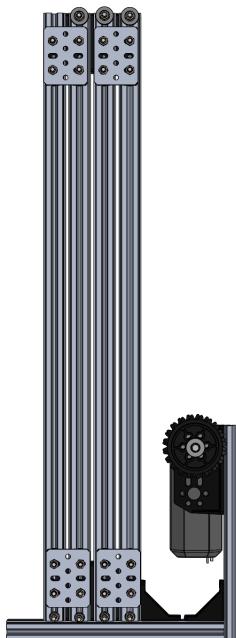


Collect parts:

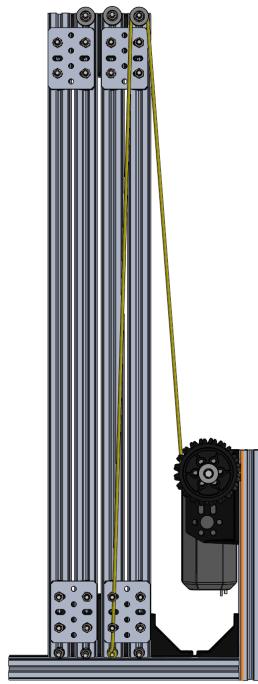
- M3 x 16mm Hex Head Screw
- M3 Locknut
- M3 Washer



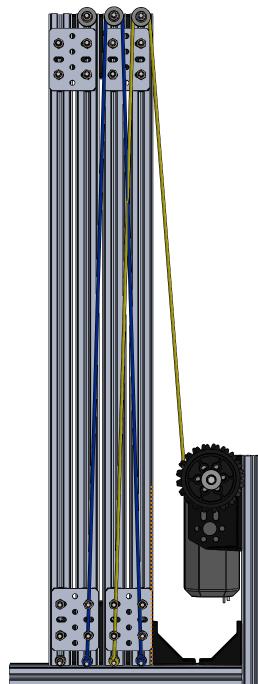
Add a screw post to the bottom of all the extrusions. All screw posts must be on the same side of the assembled linear motion system.



Assemble Lift.



Attach a length of string to the post on the bottom of second stage. Run the string over the pulley at the top of the first stage and down to the winding pulley. Secure the string onto the winding pulley.



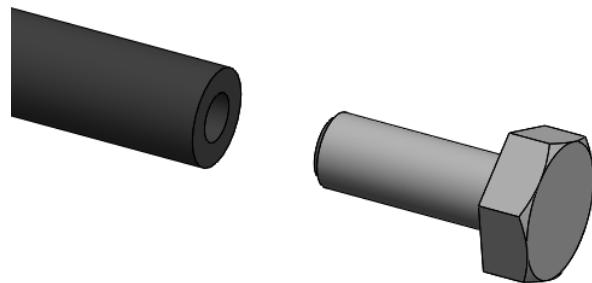
Attach a length of string to the post on the bottom of first stage. Run the string over the pulley at the top of the second stage. Attach sting to the screw post at the bottom of the third stage.



Attach a length of string to the post on the bottom of second stage. Run the string over the pulley at the top of the third stage. Attach sting to the screw post at the bottom of the fourth stage.

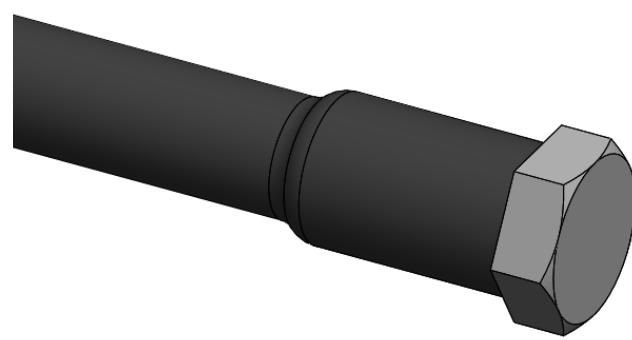


Add a pulley below the fourth stage.

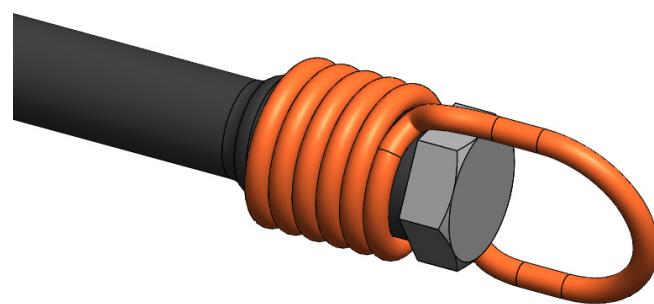


Collect parts for surgical tubing assembly

- M3 x 16mm or M3 x 8mm Hex Head Screw
- Surgical tubing
- String



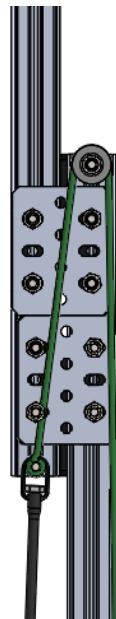
Push a screw into an end of the surgical tubing.



With string tightly wrap the surgical tubing onto the screw and tie it off. Then tie a loop of string such that the loop can be hooked over a screw post.



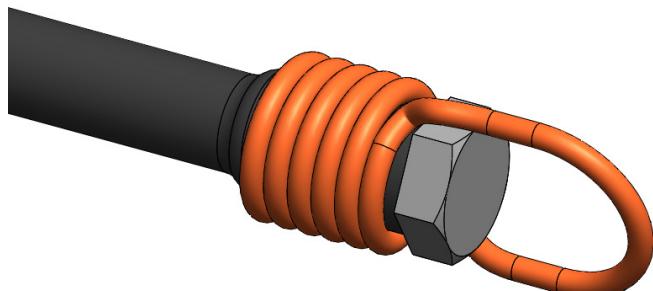
Fully extend the lift.



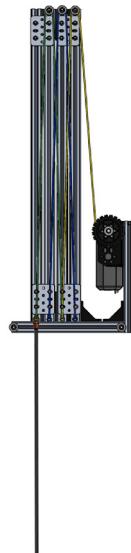
Hook the prepared end of the surgical tubing over the screw post at the bottom of the fourth stage.



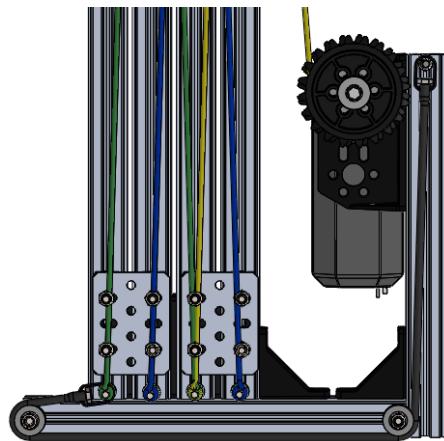
Stretch the surgical tubing such that the end of stretch out portion of the surgical tubing lines up with bottom of the lift. Cut the surgical tubing ~50 mm below this point.



Let the surgical tubing become slack. Push a screw into the freshly cut end of the surgical tubing. With string tightly wrap the surgical tubing onto the screw and tie it off. Then tie a loop of string such that the loop can be hooked over a screw post.



Lower the lift. With one end of the surgical tubing attached to the fourth stage stretch the free end the surgical tubing such that there is light pressure pulling down on the fourth stage.



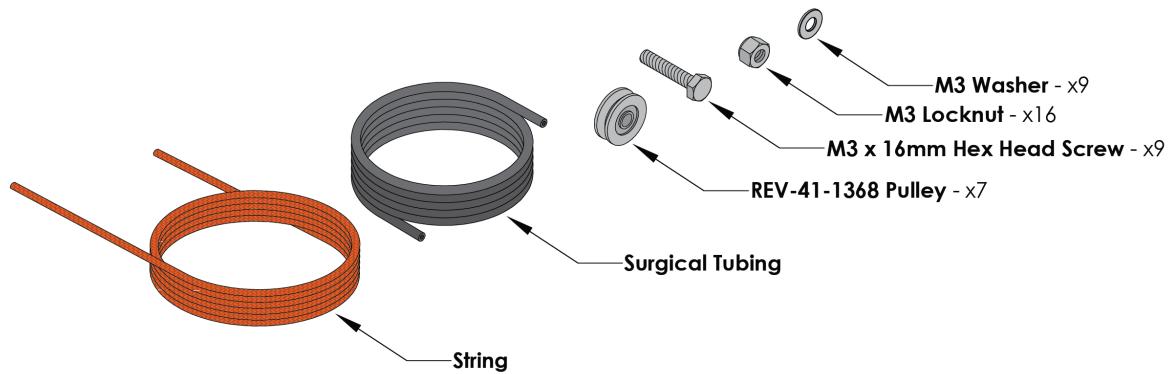
Add pulleys to guide the surgical tubing as needed.

Add a screw post at this point such that the surgical tubing can hooked onto it

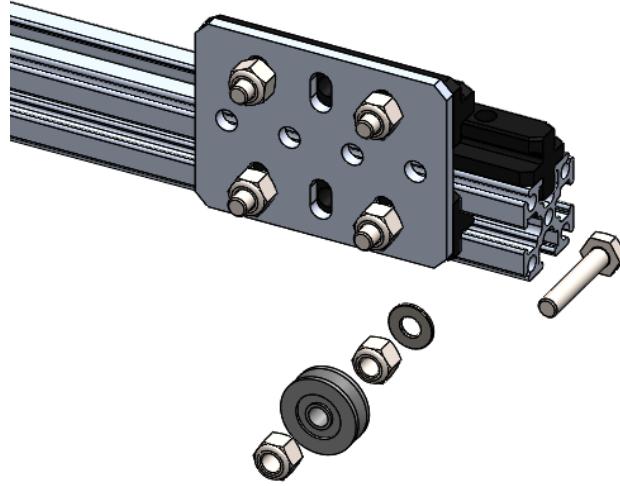
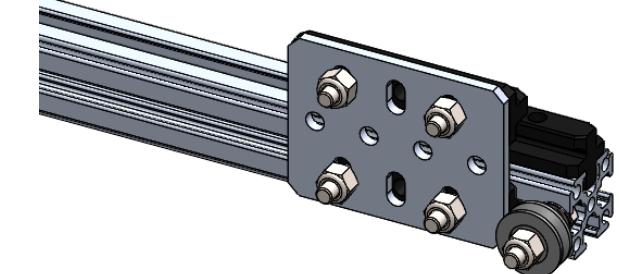


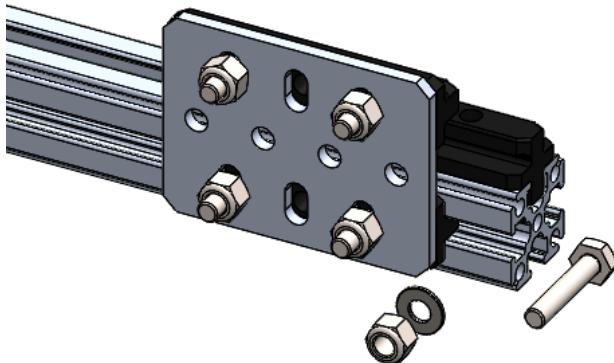
Done!

3.2 Continuous String



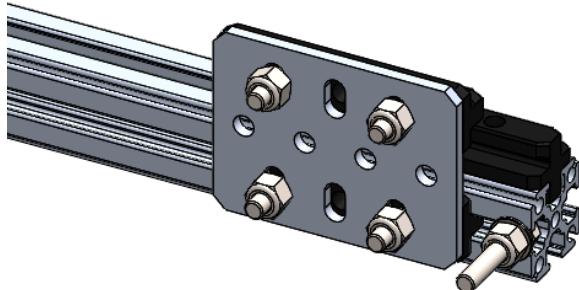
Collect parts for Cascading string assembly. This guide assumes you are building a four-stage lift with a surgical tubing return. These parts are not included in the linear motion kit.

	<p>Collect parts:</p> <ul style="list-style-type: none">• M3 x 16mm Hex Head Screw• M3 Locknut x2• M3 Washer• REV-41-1368 Pulley
	<p>Add a pulley to the top of the first three stages and the bottom of the two center stages. All pulleys must be on the same side of the assembled linear motion system.</p>

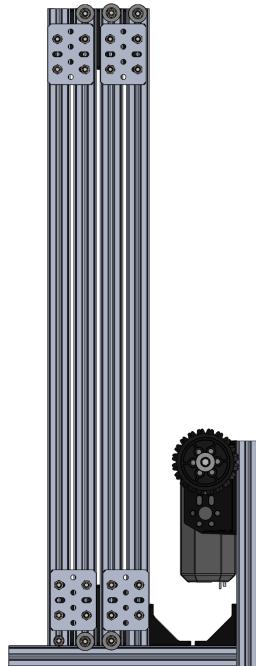


Collect parts:

- M3 x 16mm Hex Head Screw
- M3 Locknut
- M3 Washer



Add a screw post to the bottom of the last stage. The screw post must be on the same side of the assembled linear motion system as the pulley.



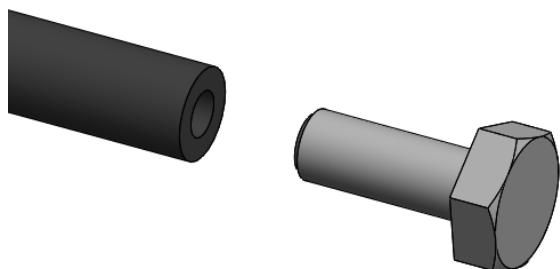
Assemble lift.



Secure the string onto the winding pulley. Run the string over the pulley at the top of the first stage and down to the pulley on second stage. Then back up to the pulley on the top of second stage. The string then goes down to the pulley on third stage. Then back up to the pulley on the top of third stage. The string then goes down to the screw post on the last stage.



Add a pulley below the fourth stage.

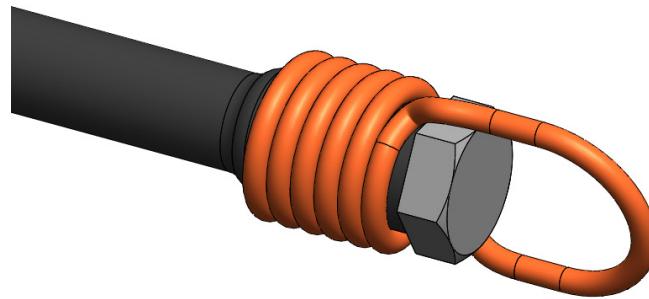


Collect parts for surgical tubing assembly

- M3 x 16mm or M3 x 8mm Hex Head Screw
- Surgical tubing
- String



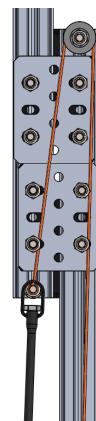
Push a screw into an end of the surgical tubing.



With string tightly wrap the surgical tubing onto the screw and tie it off. Then tie a loop of string such that the loop can be hooked over a screw post.



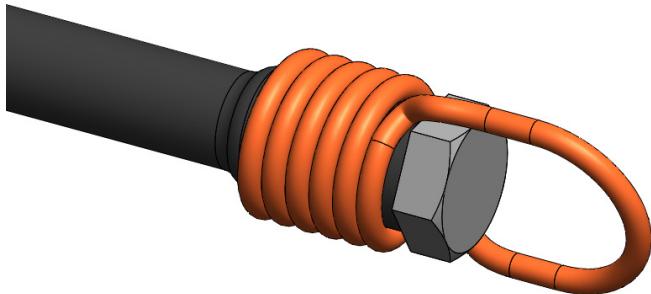
Fully extend the lift.



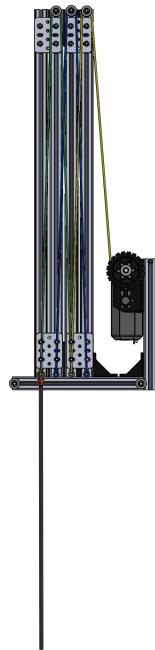
Hook the prepared end of the surgical tubing over the screw post at the bottom of the fourth stage.



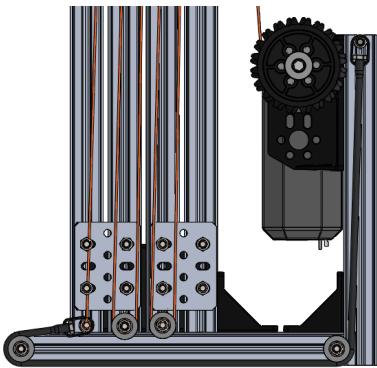
Stretch the surgical tubing such that the end of stretch out portion of the surgical tubing lines up with bottom of the lift. Cut the surgical tubing ~50 mm below this point.



Let the surgical tubing become slack. Push a screw into the freshly cut end of the surgical tubing. With string tightly wrap the surgical tubing onto the screw and tie it off. Then tie a loop of string such that the loop can be hooked over a screw post.



Lower the lift. With one end of the surgical tubing attached to the fourth stage stretch the free end the surgical tubing such that there is light pressure pulling down on the fourth stage.



Add pulleys to guide the surgical tubing as needed.

Add a screw post at this point such that the surgical tubing can hooked onto it



Done!

3.3 Chain lift (Advanced)

Chain based lifts are conceptually the same as the continues string lift. The chain loops back and forth along the stages of the lift and fixed to the final stage of the lift. The remainder of the chain then loops back to the drive sprocket completing the loop. Interferences and miss alignments that a string based lift is able to tolerate cannot generally be tolerated by chain based lift. It should be noted that in order to properly tension a chain drive lift a spring loaded chain tensioner should be used. If a spring loaded chain tensioner cannot be used the chain must remain vertical or horizontal during operation minimizing sine/cosine error stack ups. Given these complexities of implementation a Chain lift should only be used if a team has the expertise and time to properly execute and debug the lift.

4 KIT COMPONENTS (1:1 Scale)



M3 Locknut - x16



M3 Nut - x8



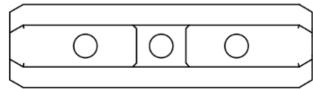
M3 x 8mm Low Profile Socket Cap - x8



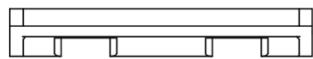
M3 x 12mm Low Profile Socket Cap - x8



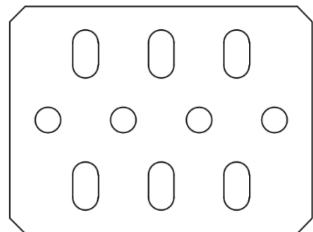
M3 x 12mm Hex Cap Bolt - x8



Double Sided Slider - x8



Single Sided Slider - x8



Joining Plate - x4