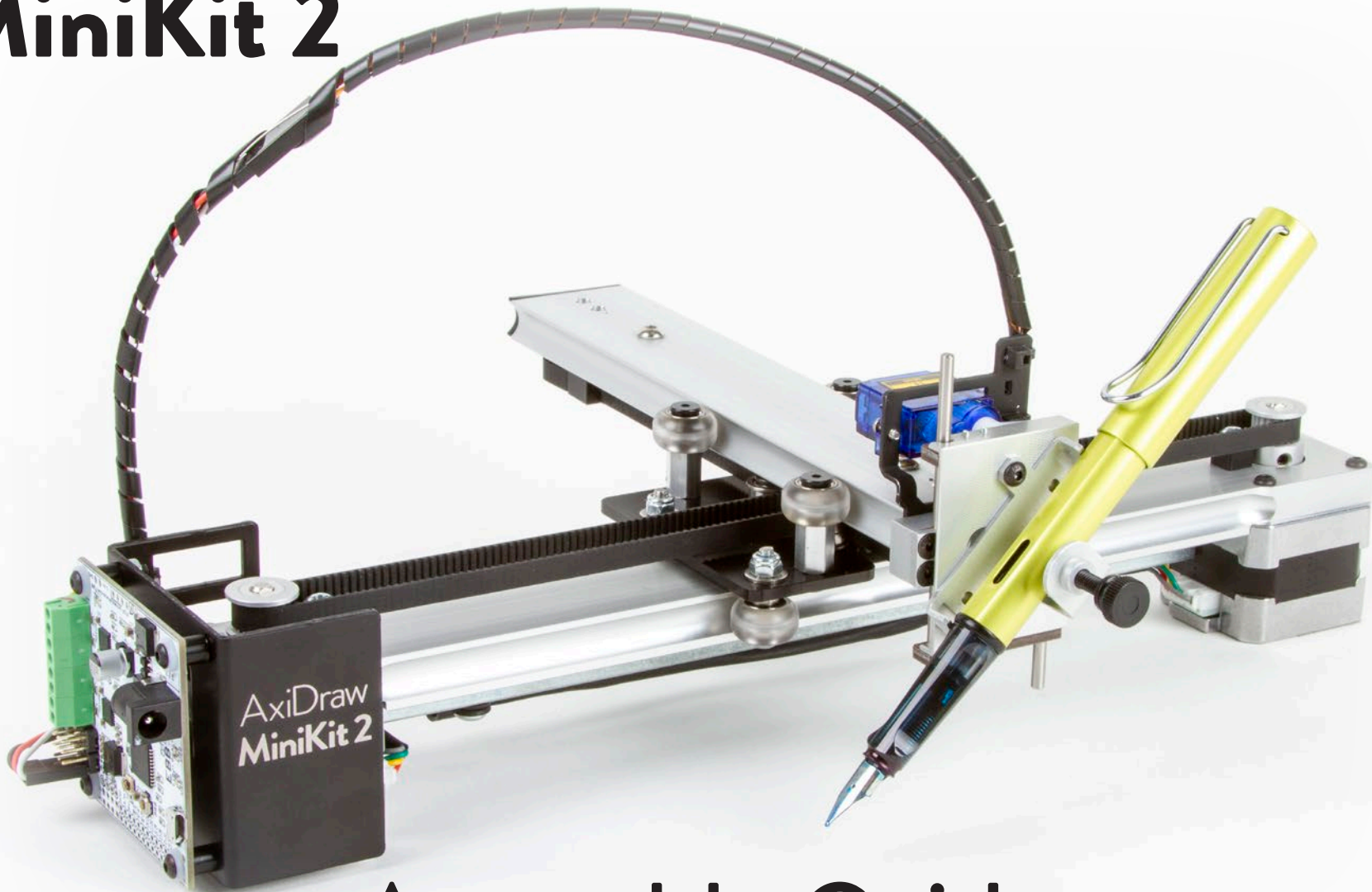


AxiDraw MiniKit 2



Assembly Guide

AxiDraw MiniKit 2 Assembly guide v 2.5
Last updated: May 8, 2021

Model 2542
<https://emsl.us/924>

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Introduction

About this guide and this kit

This is the assembly guide for **AxiDraw MiniKit 2**, a compact “DIY kit” version of the AxiDraw writing and drawing machine.

This guide covers steps needed to build the MiniKit 2, from opening the box to a working machine. It also covers model-specific usage information about the MiniKit, as a supplement to the main AxiDraw User Guide.

This guide is provided as a PDF download, with the intent that it can be viewed on-screen (desktop, laptop, tablet or phone) while you assemble your kit. The latest version is available at: wiki.evilmadscientist.com/minikit

Note: These instructions *do not* cover the previous generation AxiDraw MiniKit – without the 2 – model 2540. If you have that model, see the separate assembly instructions for it, available at the same link.

Getting help

If you should need any kind of assistance while building your AxiDraw MiniKit, please do not hesitate to contact us: shop.evilmadscientist.com/contact

Whether you need help with an assembly step, parts support, assistance troubleshooting an issue, or reassurance that you’re building something correctly, please feel welcome to drop us a line. *We are here to help.*

Software

Towards the end of this guide, you will need AxiDraw software on your computer. Get started at: axidraw.com/sw

Warning: Small parts

This kit is not a toy. It contains a great number of small parts that should be kept out of reach of children.

Warning: Sharp edges and points

While the finished kit should not present any excessively sharp edges, some components within this kit may have edges and points that are razor sharp. Exercise appropriate care when handling, and keep away from children.

After assembly

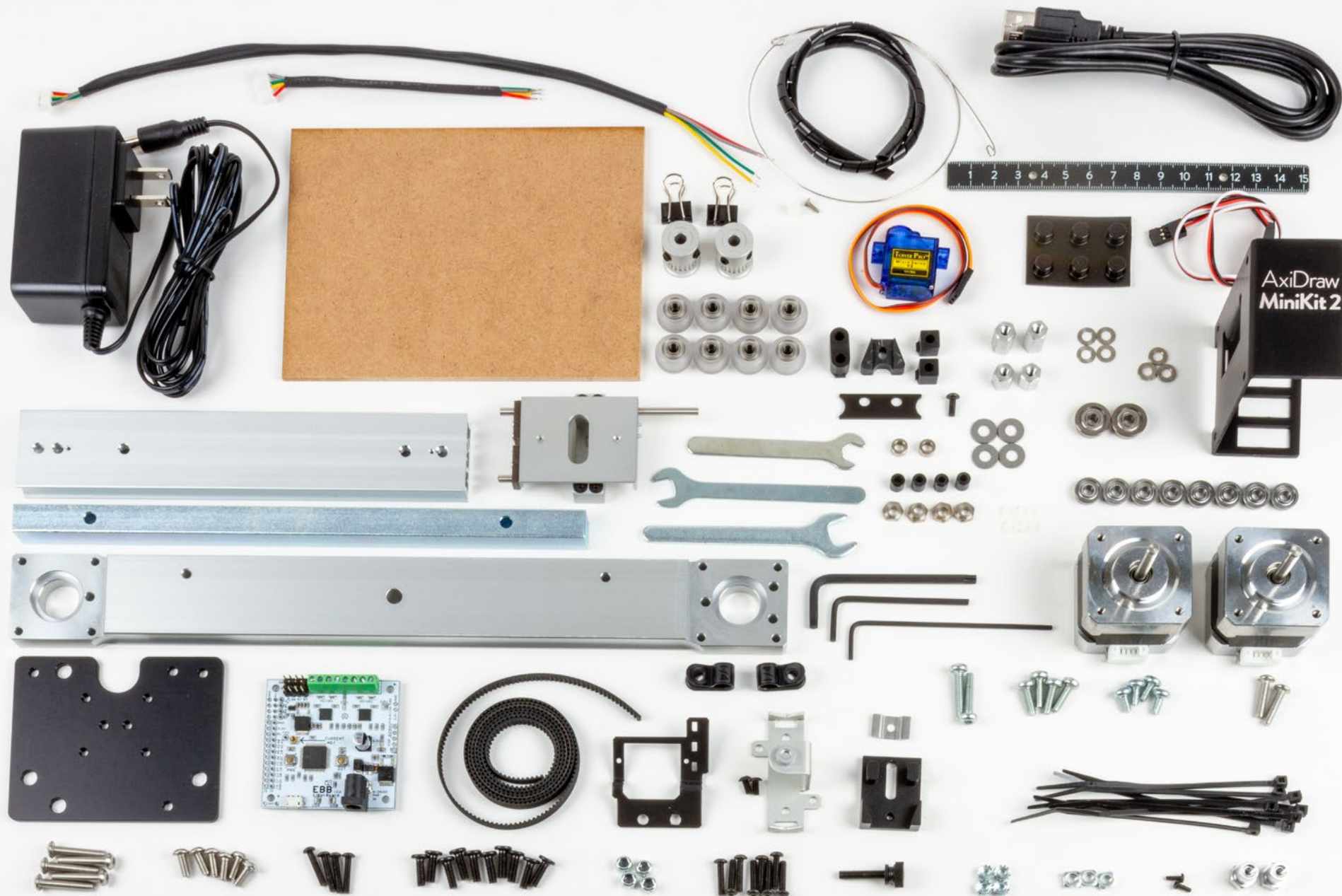
After assembling your AxiDraw MiniKit, you will want to review the usage information in the AxiDraw user guide, available at: axidraw.com/guide

More about AxiDraw and MiniKit

To learn more about AxiDraw in general please visit its main site: AxiDraw.com

To learn more about the AxiDraw MiniKit, please visit its product page: emsl.us/924

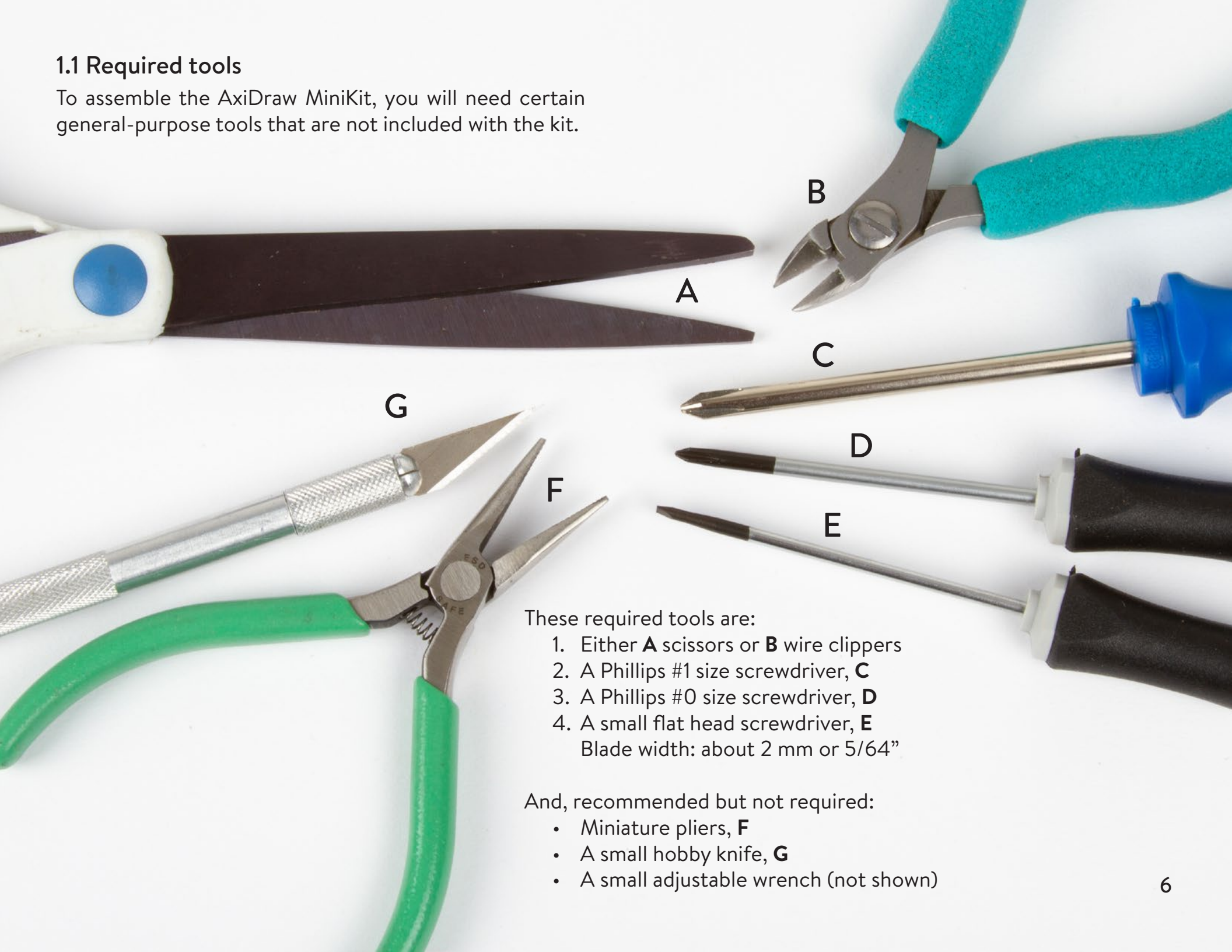
The main documentation site for AxiDraw can be found on our wiki, at axidraw.com/docs



Part 1: Tools

1.1 Required tools

To assemble the AxiDraw MiniKit, you will need certain general-purpose tools that are not included with the kit.



These required tools are:

1. Either **A** scissors or **B** wire clippers
2. A Phillips #1 size screwdriver, **C**
3. A Phillips #0 size screwdriver, **D**
4. A small flat head screwdriver, **E**
Blade width: about 2 mm or 5/64"

And, recommended but not required:

- Miniature pliers, **F**
- A small hobby knife, **G**
- A small adjustable wrench (not shown)

1.2 Included tools

Several specific tools are included with the kit.

We will refer to these, and other parts included with the kit, by part numbers.



The included tools are:

- #1, 15 cm / 6 inch Ruler
- #2, T20-size Torx L-wrench
- #3, 2 mm Ball-end Hex L-wrench
- #4, 2.5 mm Hex L-wrench
- #5, 10 mm Low-profile Wrench
- #6, 8 mm Low-profile Wrench
- #7, 7 mm Low-profile Wrench

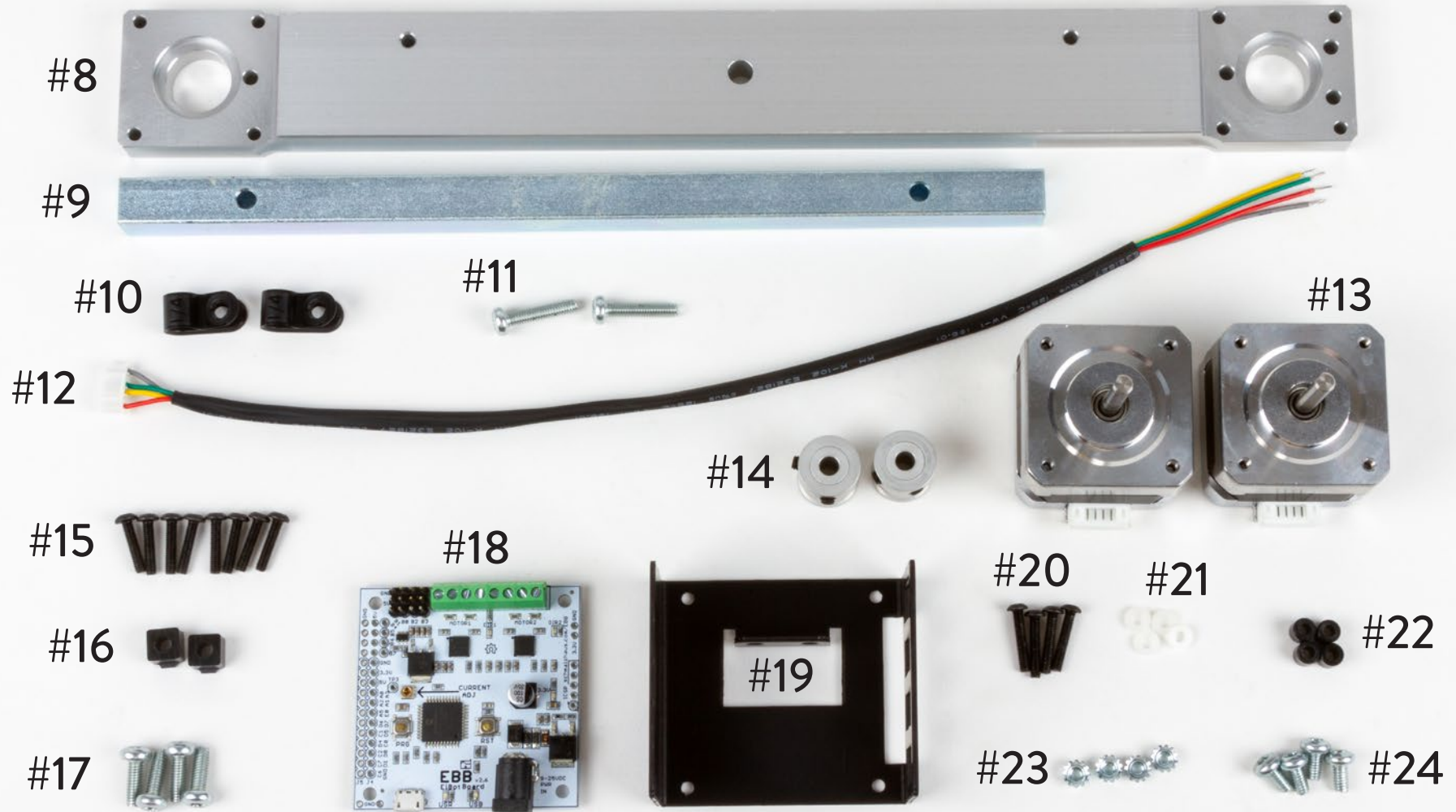
The three L-wrenches are distinctive. Only #2 is a Torx (star-shaped) wrench. And the only one with a ball end is the 2 mm L-wrench, #3. However, the three Low-profile Wrenches are very similar in appearance; you may want to label them with a marker.

Most of the wrenches are only needed during assembly. However #3, the ball-end wrench, will continue to be useful in regular everyday operation of the MiniKit after assembly.



Part 2: The Base

2.1 Parts in the base assembly



#8, MiniKit Base Rail (1)

#9, Ballast Weight (1)

#10, Nylon Loop Clamp (2)

#11, M4×20 Torx Tapping Screw (2)

#12, Motor Wire Harness, Long (1)

#13, Stepper Motor (2)

#14, Timing Belt Pulley (2)

#15, M3×14 Button-head Screw (8)

#16, X Endstop (2)

#17, M4×12 Torx Tapping Screw (4*)

#18, EBB Driver Board (1)

#19, EBB Support (1)

#20, M3×16 Button-head Screw (4)

#21, White Nylon Washer (4)

#22, Black Nylon Spacer (4)

#23, M3 Kep Nut (4)

#24, M4×8 Torx Tapping Screw (4*)

**Note: Some of the screws counted here will not be used until a later step.*

2.2 Ballast Weight

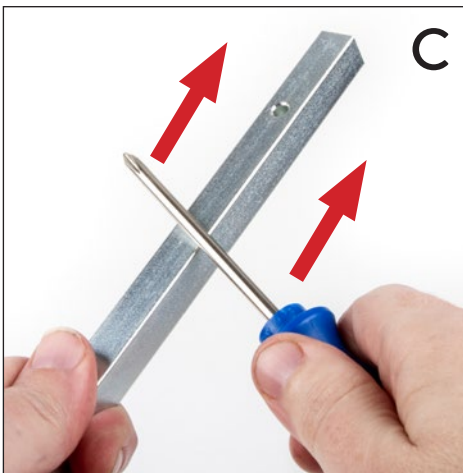
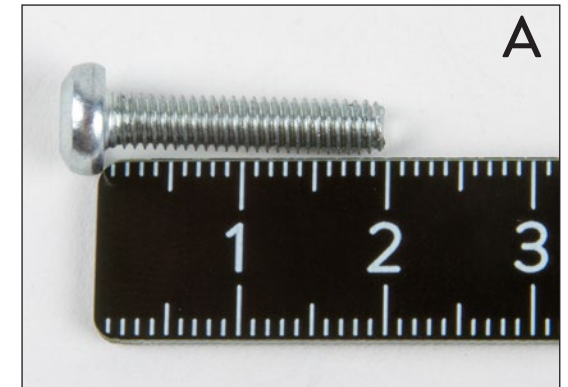


The ballast weight may have sharp edges;
Handle with appropriate care.

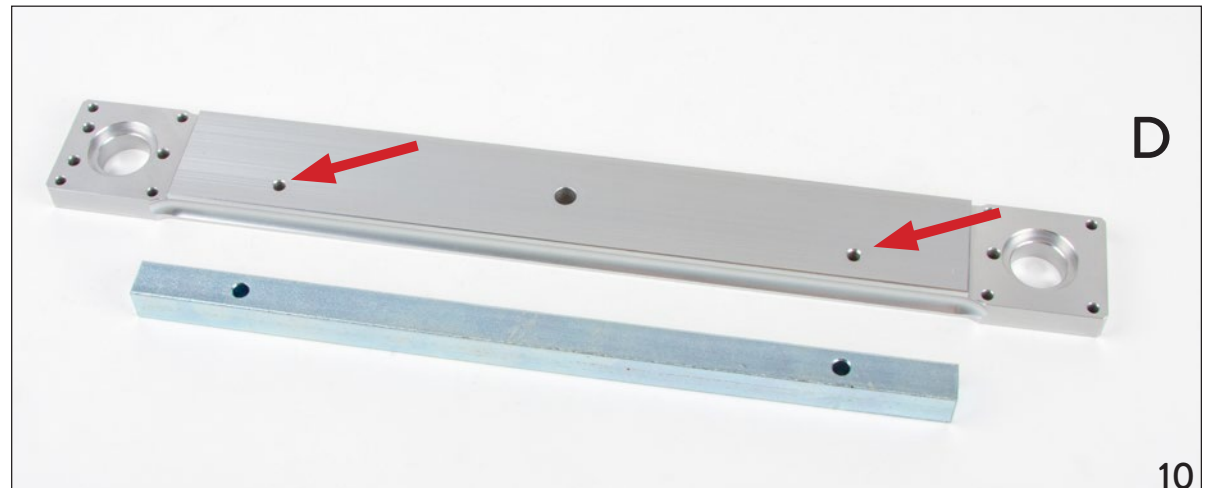
1. Identify the Base Rail #8, the Ballast Weight #9, the two nylon loop clamps #10, and the M4×20 Torx tapping screws. These screws can be identified by the star-shaped socket on their heads and length of approximately 20 mm, as measured below the head (A).

Note: These are **tapping screws**, designed to create strong threads in drilled holes that are not initially threaded.

2. Press the screws through the loop clamps as shown (B).
3. Check the ballast weight for any sharp edges, and dull them if necessary using (for example) the side of a screwdriver blade (C). (The ends may be sharp as well, but they are mostly protected once installed.)
4. Orient the Base Rail as shown: With the two “middle” holes shown on the side facing up and towards you (D). These are the two holes that line up with those on the Ballast Weight.



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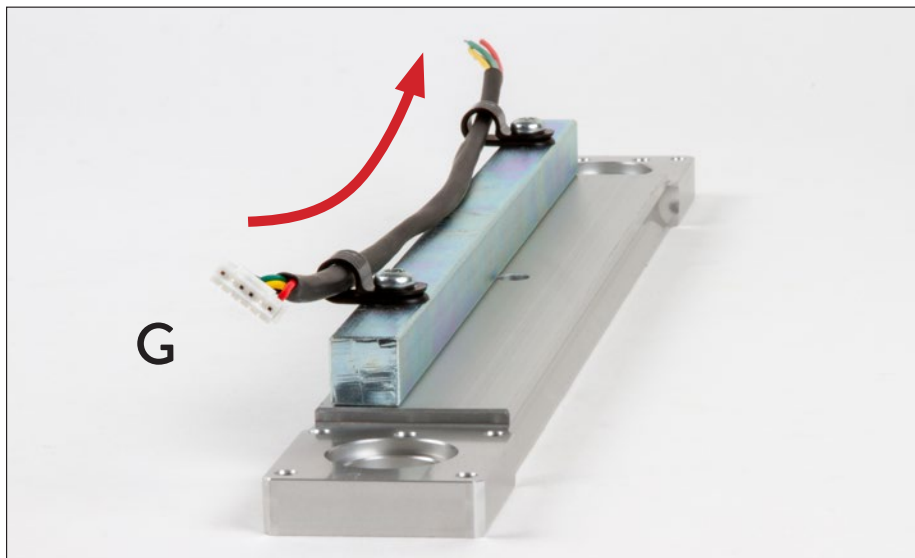
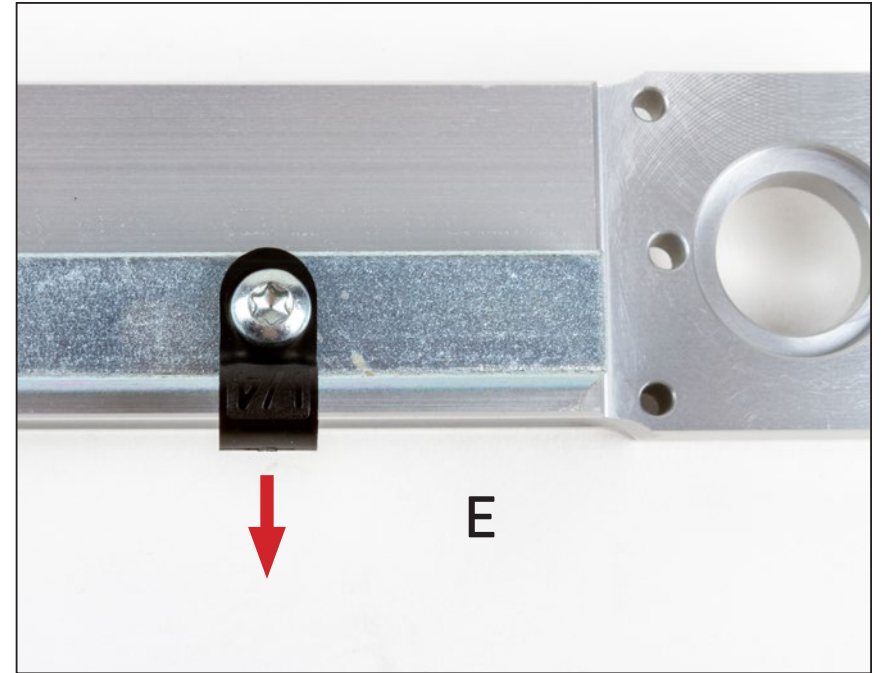


§2.2 Ballast Weight, continued

5. Place the Ballast Weight on top of the Base Rail, lining up the two pairs of holes, and insert the tips of the screws through the two pairs of holes. Orient both loop clamps so that they point “straight out” away from the Rail (**E**).
6. Turn the screws into place with **#2**, the Torx L-wrench (**F**). Alternate between the two screws until both are tight.

Tip: You may find it easiest to start the screws on the “long” end of the wrench and then tighten them with the short end (shown).

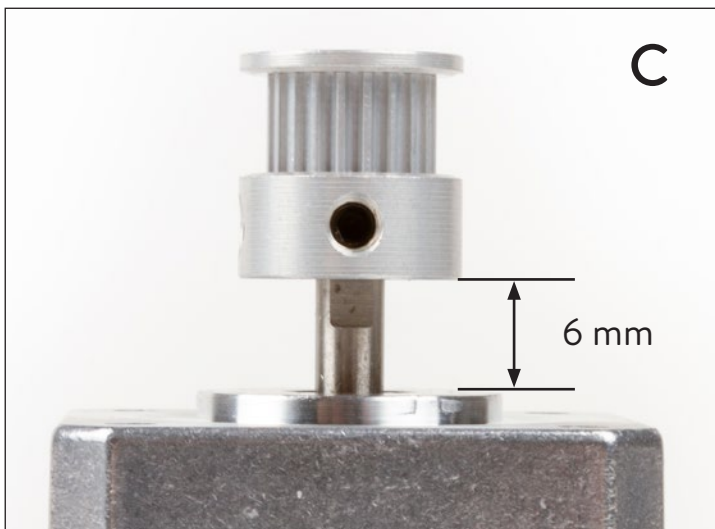
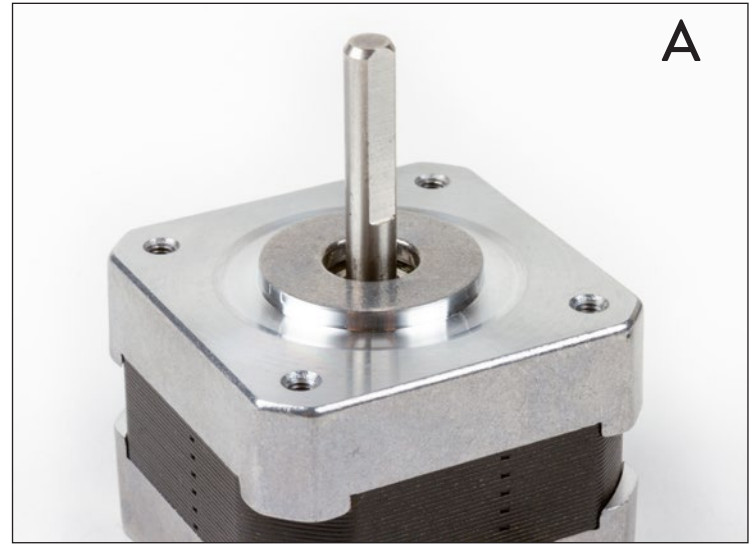
7. Slip the Long Motor Wire Harness **#12**, through both loop clamps in the direction shown (**G**). With the loop clamps pointing towards you, the connector should end up on the RIGHT end of the Base Rail.



2.3 Add pulleys to motors

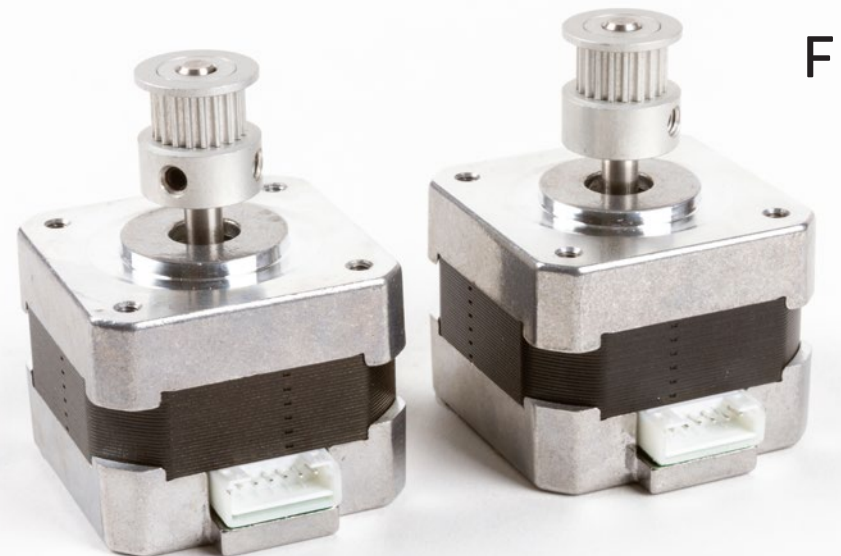
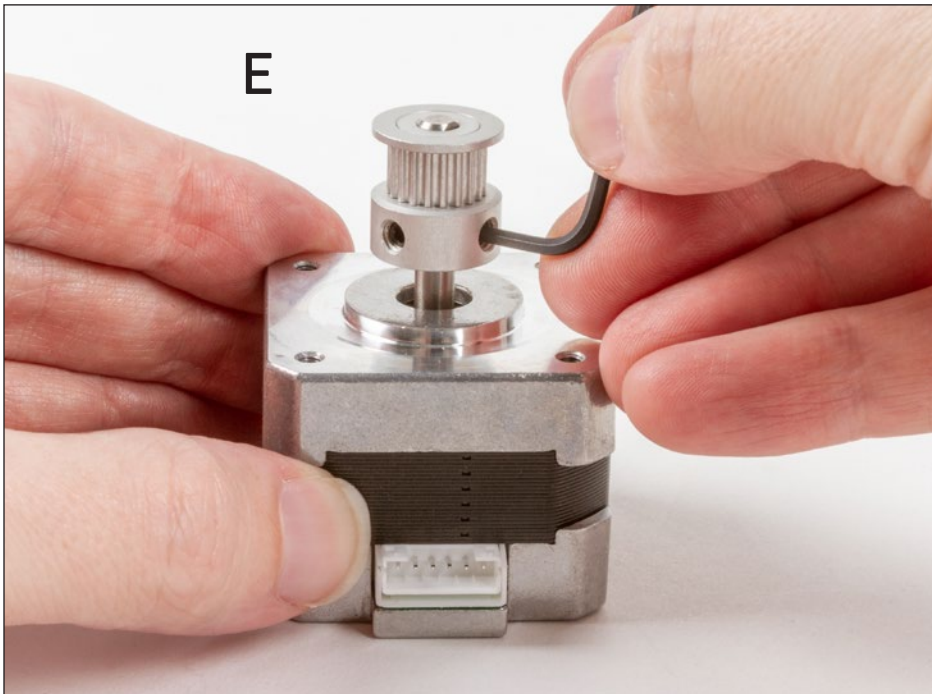
1. Locate the flat face (A) on the shafts of the stepper motors, #13.
2. Observe that the timing belt pulleys, part #14, each have two set screws (B). The wrench for these screws is the 2 mm Ball-end Hex L-wrench #3.
3. Slide a pulley onto a motor shaft, “teeth” up. You may need to loosen the set screws to do so.
4. Position the pulley with a set screw in front of the flat face, and with its bottom 6 mm above the uppermost part of the motor face (C). You can use a ruler to measure the gap or – *much better* – borrow a Black Nylon Spacer (#22) from a future step and use it as a spacer to measure the gap (D).

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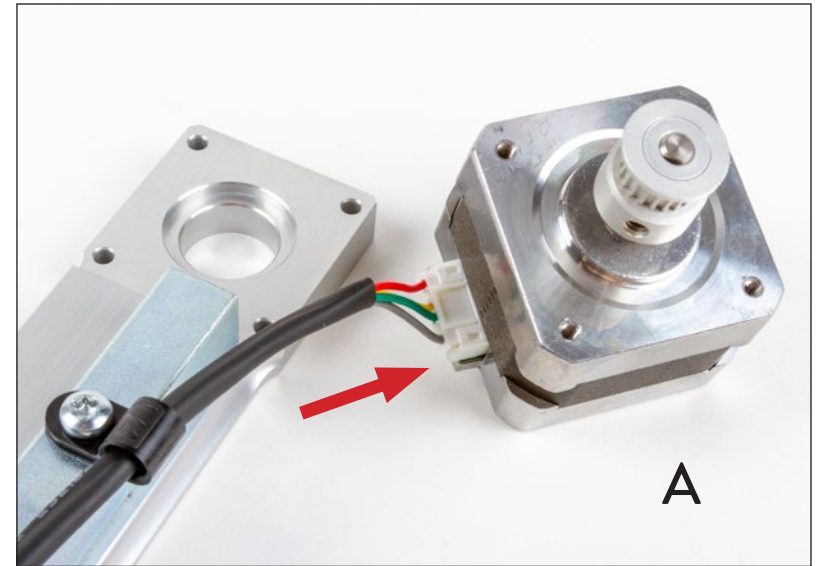
§2.3 Add pulleys to motors, continued

5. Firmly tighten the set screw against the flat face of the motor shaft, using the short end of the hex wrench (**E**).
6. Tighten the second set screw on the pulley, again using the short end of the hex wrench.
7. Use the same method to add the second pulley to the second motor (**F**).

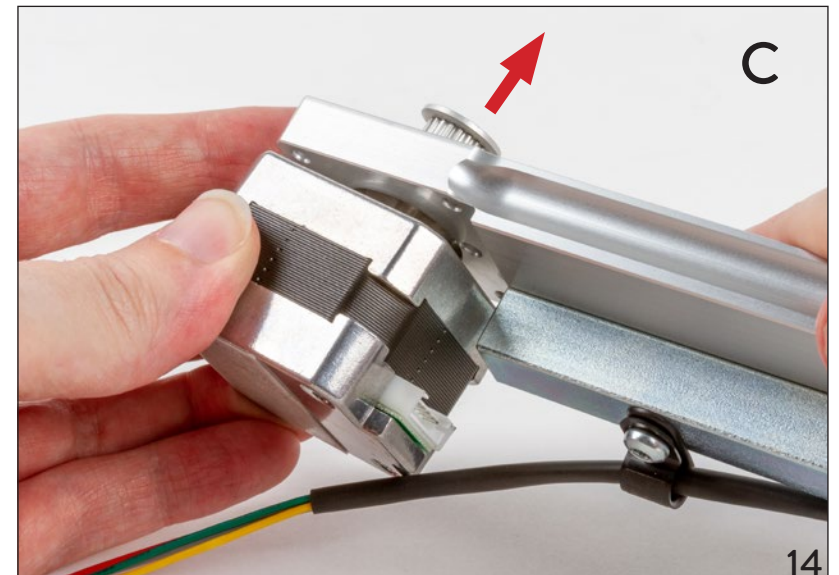
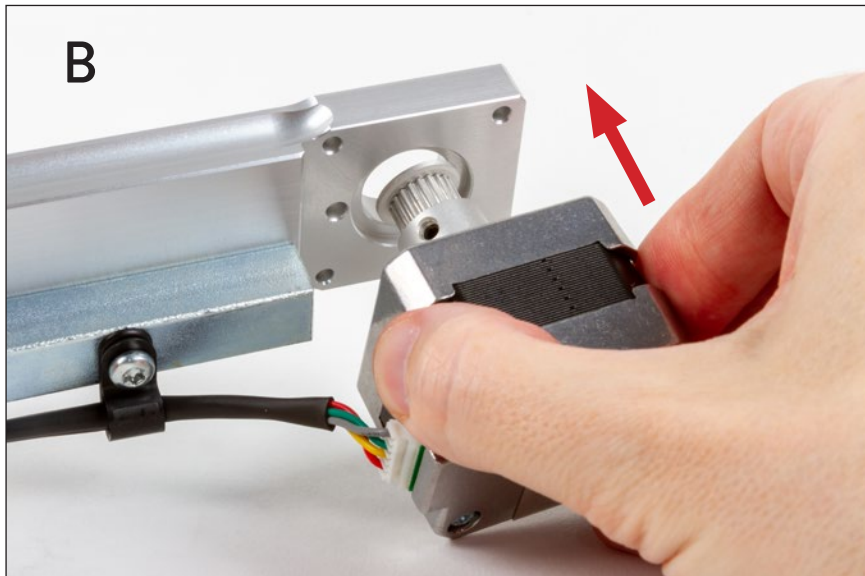


2.4 Install the motors

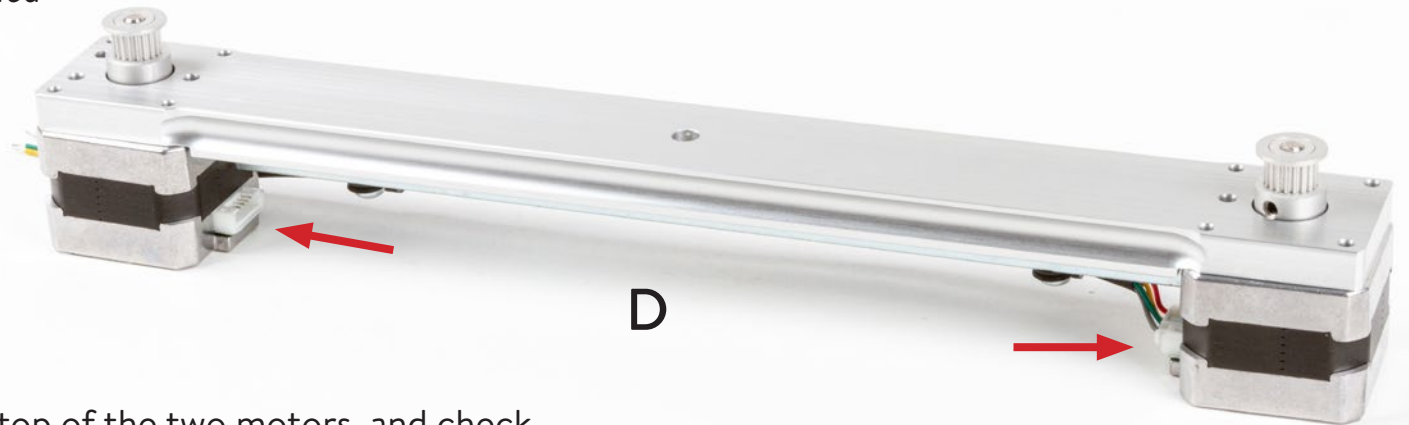
1. Attach the connector on the Long Motor Wire Harness to one of the two stepper motors (**A**).
2. Rotate the motor and feed its pulley through the large hole in the Base Rail (**B**), taking care to not pull the cable out of the loop clamps.
3. Feed the pulley on second motor through the large hole at the other end of the Base Rail (**C**). Orient the motor such that its connector faces towards the center of the Base Rail.



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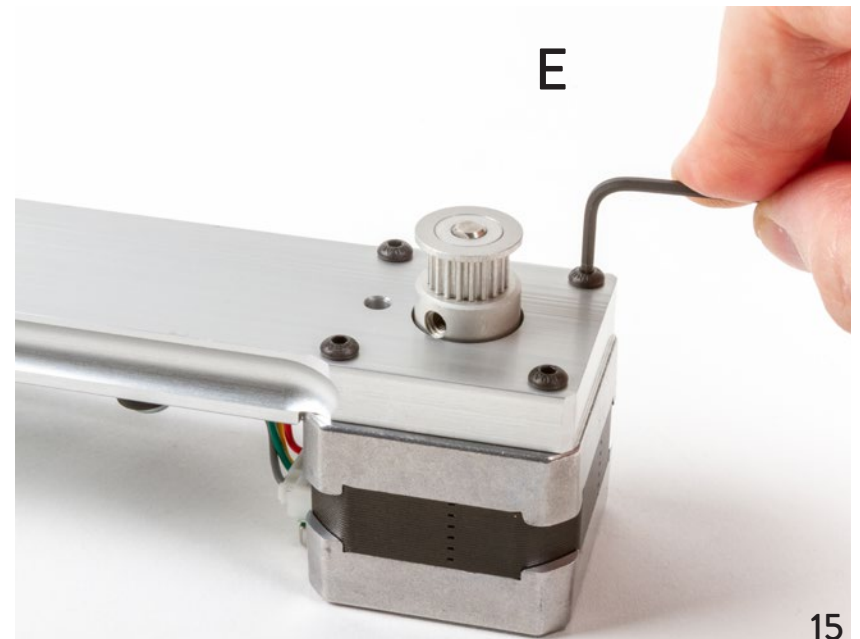


§2.4 Install the motors, continued



D

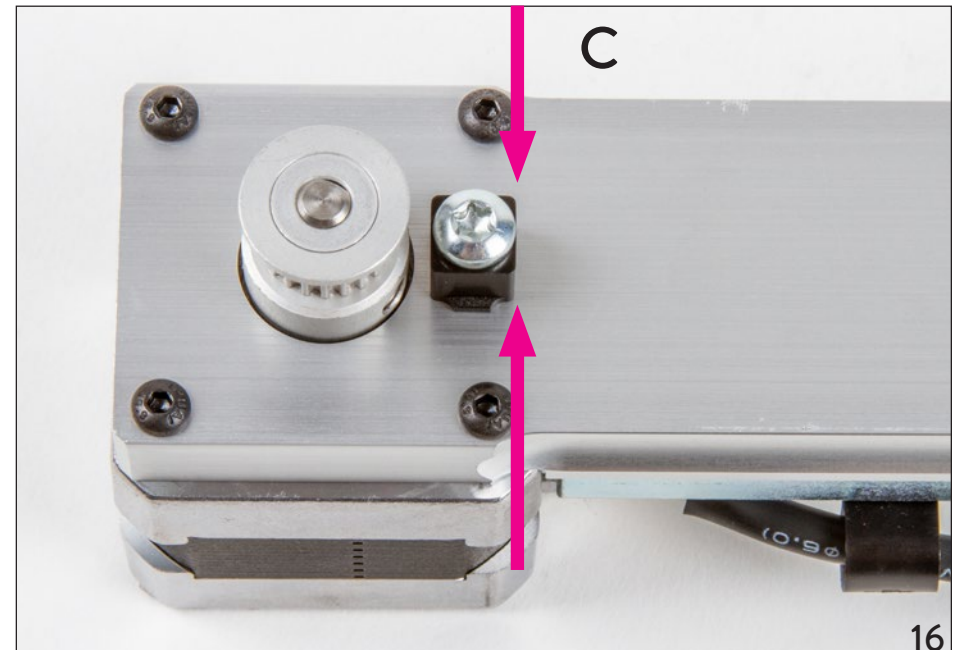
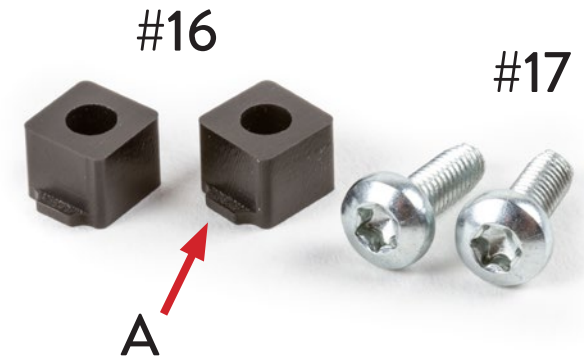
4. Set the Base Rail down on top of the two motors, and check their orientation: The connectors on both motors should face towards the center of the base rail (D).
5. Identify the M3×14 Button-head Screws, #15. These can be identified by their black color and length of approximately 14 mm, as measured below the head. Note that there are also 4 similar-looking but slightly longer M3×16 screws in the kit; *this step requires the 8 shorter ones.*
6. Slip four of the M3×14 screws through the four corner holes around one of the stepper motors, and tighten them in place (E) with the 2 mm Ball-end Hex L-wrench #3. Lightly snug all four screws, then tightening all four securely.
7. Repeat this step, adding the other four M3×14 screws to secure the other motor in place.



E

2.5 X Endstops

1. Identify the X Endstops **#16** and the M4×12 Torx Tapping Screws, **#17**. The X Endstops are black plastic blocks with a hole through the center. There may be a tab (**A**) on one side of the Endstop. The screws have silver color, a star-shaped socket on the head, and a length of approximately 12 mm, as measured below the head.
2. Slip the screw through an X Endstop, and then install it in the hole next to one of the timing belt pulleys (**B**). If there is a tab on the side of the X Endstop, orient that tab down, against the Base Rail, and pointing back towards the side with the loop clamps. Use the Torx L-wrench **#2** to thread the screw into place. Repeat for the second X Endstop.
3. Before final tightening, square up each X Endstop so that its four sides are parallel to those of the Base Rail (**C**). Once they are square, tighten them securely.



2.6 Mounting the EBB

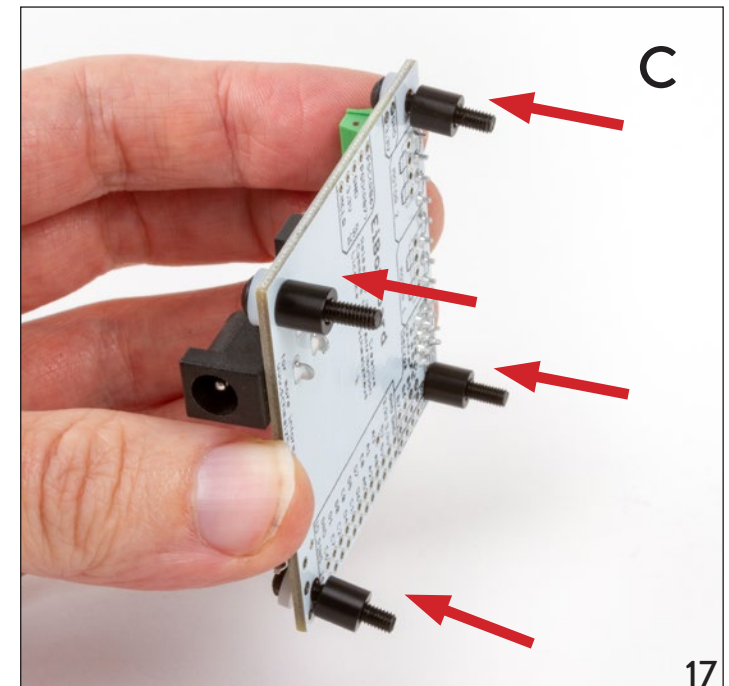
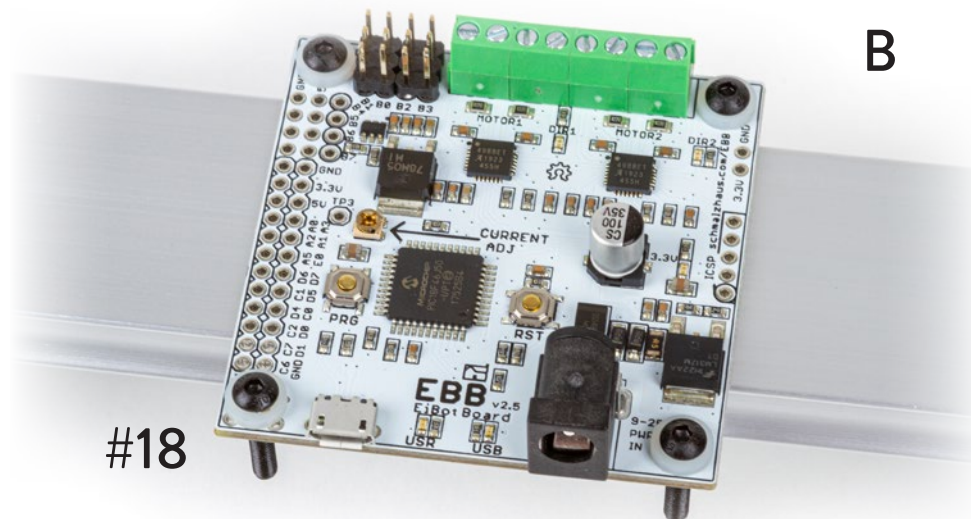
1. Identify the EBB Driver Board **#18**, and the EBB Support **#19**. You will also need the four long, black M3×16 Button-head Screws **#20**, the White Nylon Washers **#21**, the Black Nylon Spacers **#22**, and the M3 Kep Nuts **#23**. The spacers are short black plastic tubes, and the nuts are distinguished by having a built-in toothed washer.
2. Slide a white nylon washer over each screw (**A**), and then insert the screws through the four corner holes of the EBB (**B**).

Tip: Rest the EBB on top of the Base Rail for easy access.

3. Holding the EBB vertically with the power jack facing sideways as shown (**C**), slide one of the black nylon spacers over each screw. Place a finger over each screw head as you slide its spacer on, to prevent the screw from popping out of the hole.

Tip: If you have difficulty with this step, it may be helpful to put a small piece of tape over the screw heads.

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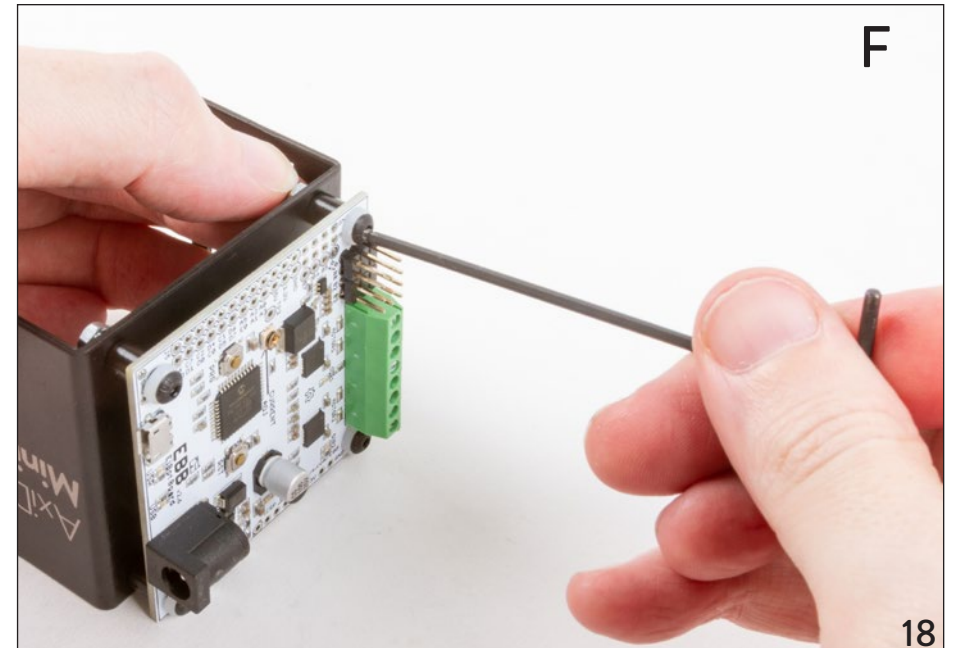
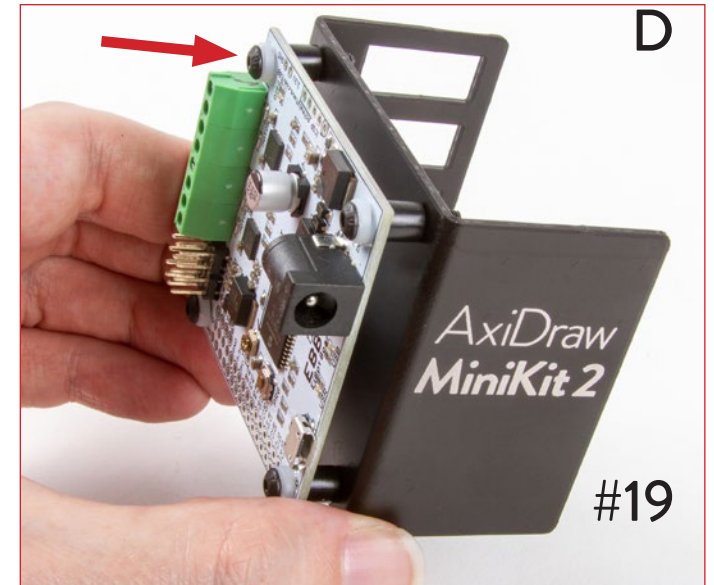
§2.6 Mounting the EBB, continued

4. Orient the EBB Support such that the power jack and USB port face towards the “AxiDraw MiniKit 2” logo. Then, two at a time, guide the four screws into the corner holes of the EBB support (**D**).
5. Thread an M3 Kep Nut onto each screw, such that the “teeth” of the nut point in towards the EBB (**E**). Then, tighten each screw with your 2 mm Ball-end Hex L-wrench **#3**, steadying the nut with a finger (**F**).

Tip: If you have difficulty with this step, it may be helpful to use a small wrench to steady the nut in place. If you do so, take special care not to over-tighten the screws.

6. Check that the EBB and all four of its screws feel securely mounted in place.

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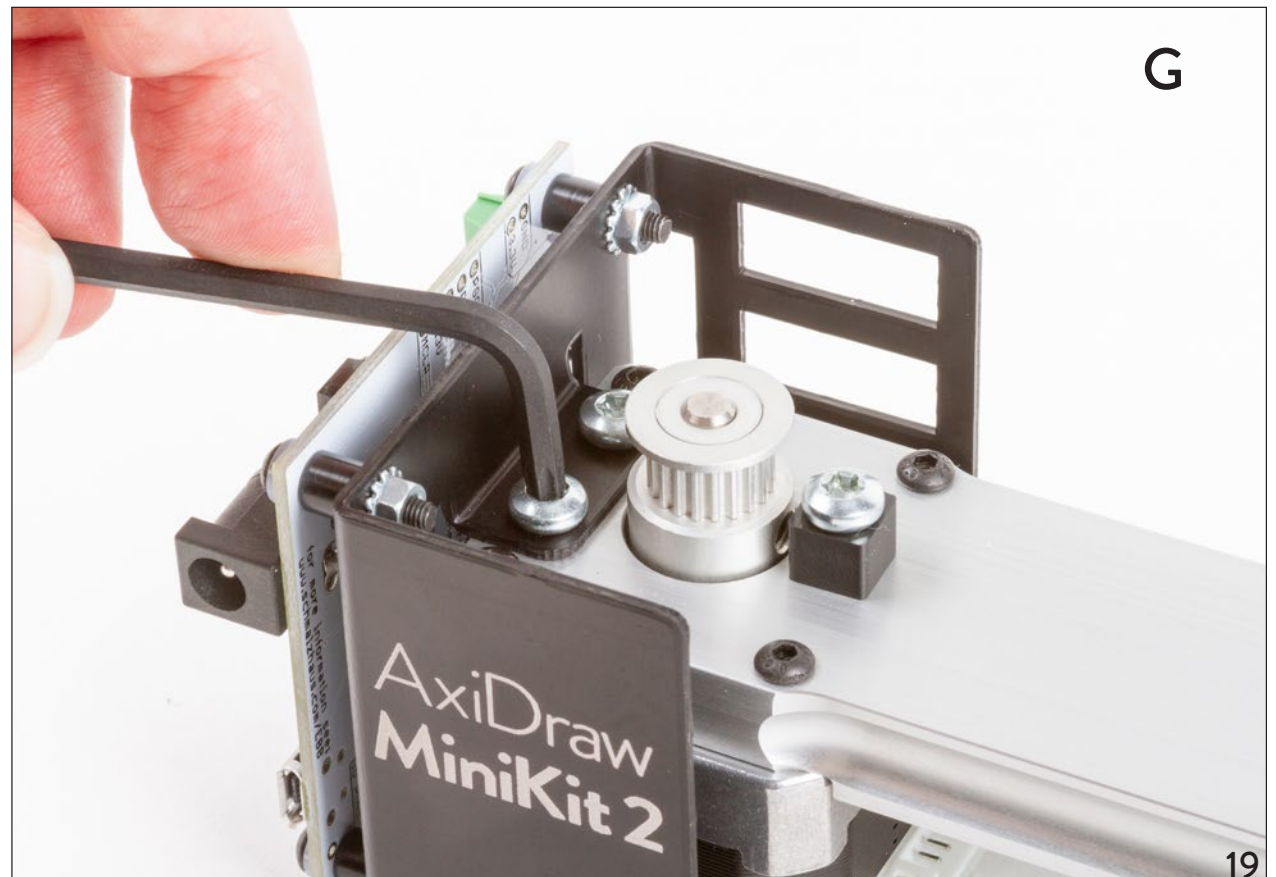


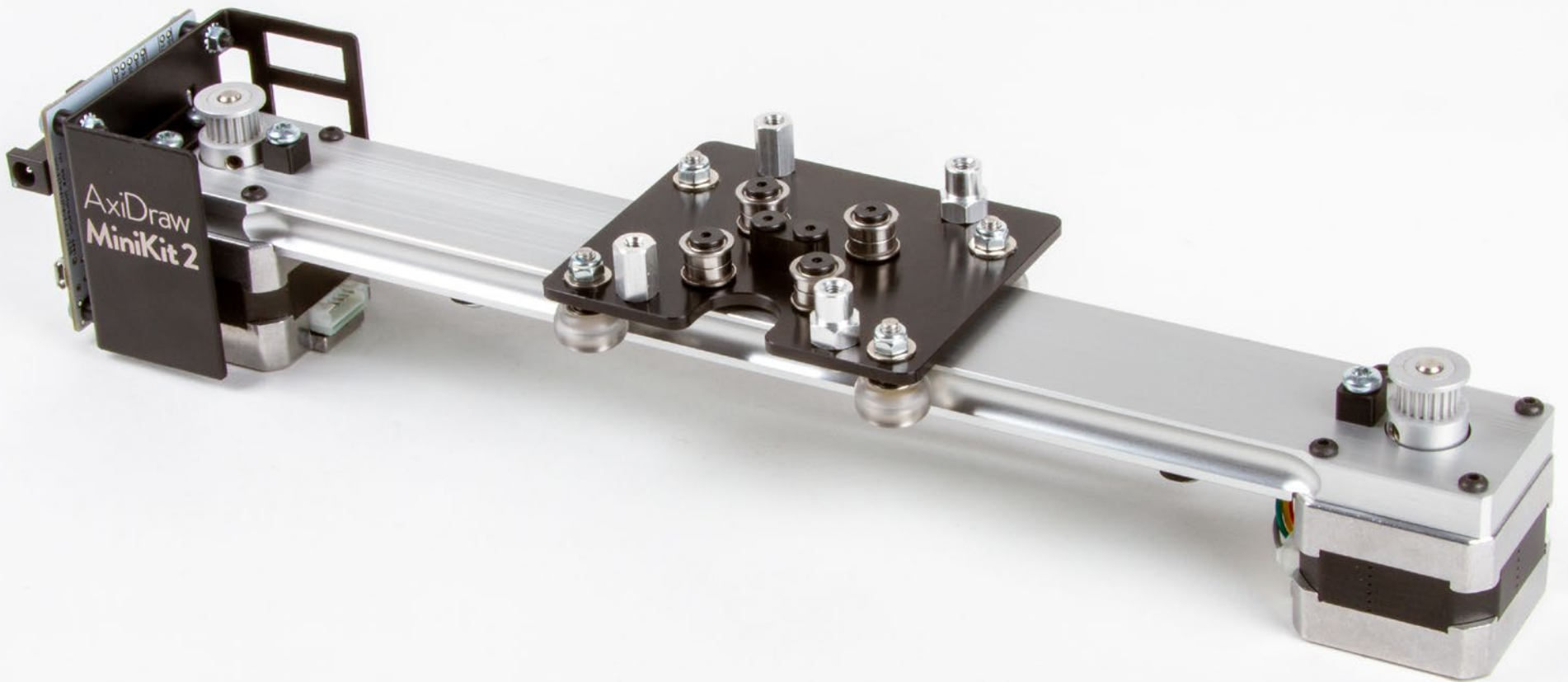
§2.6 Mounting the EBB, continued

7. Attach the EBB Support to the Base Rail, using two of the **#24** M4×8 Torx Tapping Screws. These screws have silver color, a star-shaped socket on the head, and a length of approximately 8 mm, as measured below the head.

The screws go through the flange in the EBB support and into the two remaining holes on the top of the Base Rail. Use the Torx L-wrench **#2** to thread both screws into place and then tighten both screws securely.

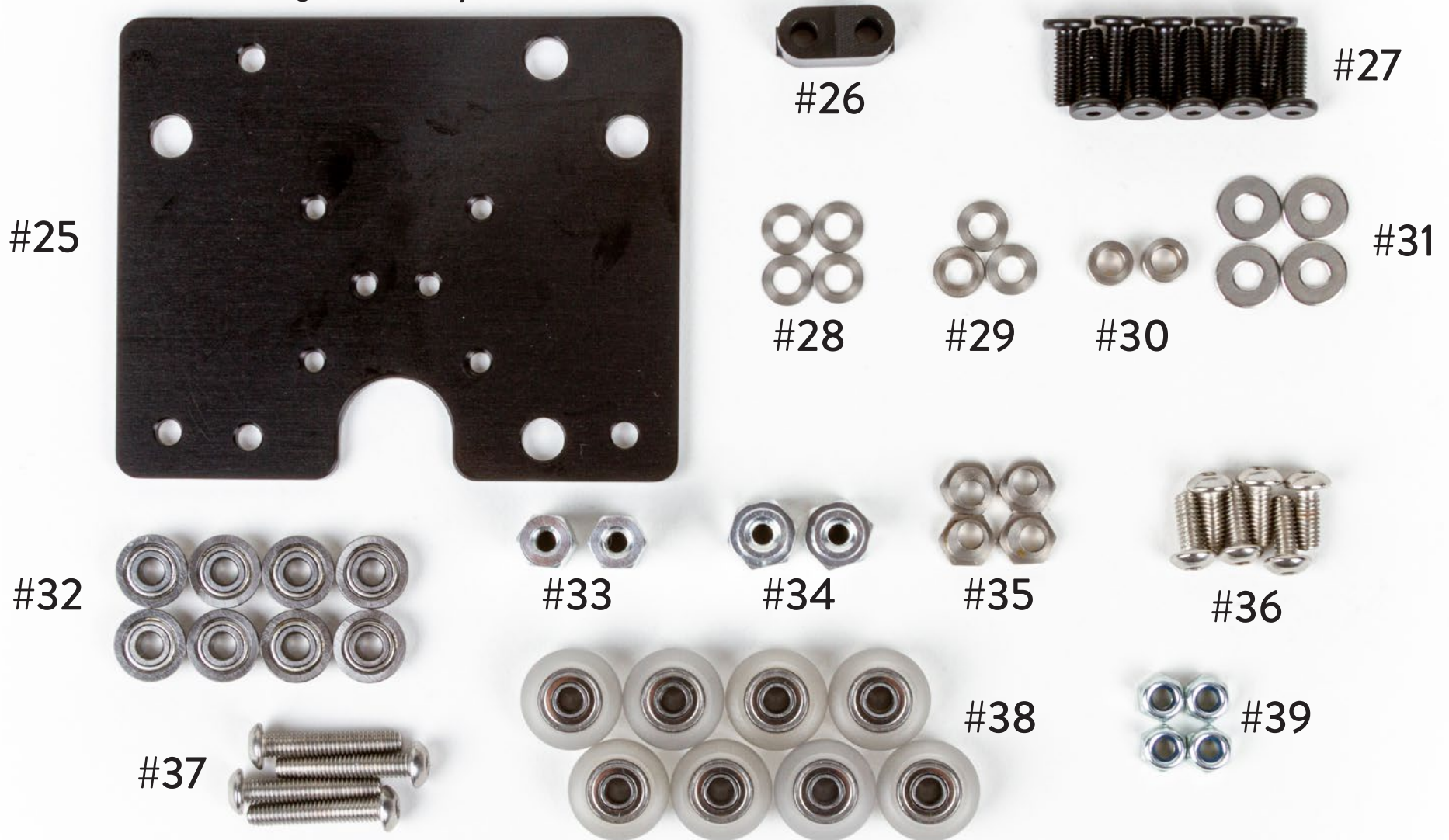
Tip: We find it easiest to use the long end of the driver to start each screw, and then the short end of the driver to tighten it in place.





Part 3: The X Carriage

3.1 Parts in the X Carriage Assembly



#25, Carriage Plate (1)

#26, Y Endstop (1)

#27, M4×12 Low Profile Screws (10*)

#28, Precision Shim, M4×8×0.5 (4)

#29, Precision Shim, M4×8×1 (3*)

#30, Spacer, M4×7×3 (2)

#31, Stamped Washer, M4×10×1 (4)

#32, MF104 Ball Bearing (8)

#33, M4×8×12 Hex Standoff (2)

#34, M4×10×12 SemiHex Standoff (2)

#35, Eccentric Spacer (4)

#36, M4×10 Button-head Screw (6*)

#37, M4×22 Button-head Screw (5*)

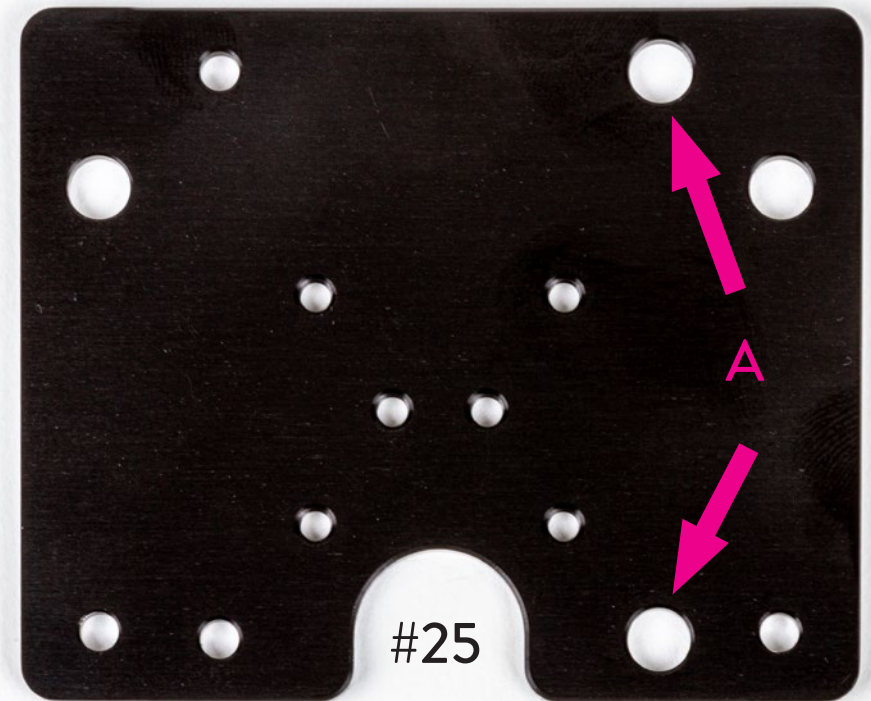
#38, Roller Wheel (8*)

#39, M4 Nylon locknut (4)

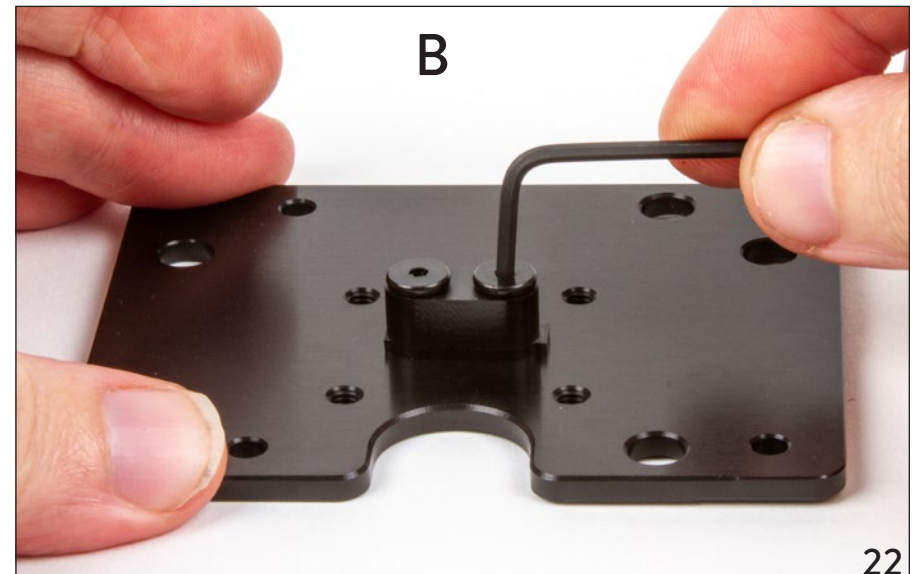
**Note: Some of the parts counted here will not be used until later steps.*

3.2 Install the Y Endstop

1. Orient the Carriage Plate #25 top-side up: With the large notch – the **front** of the plate – facing you, the two larger holes should be on the right-hand side of the part as shown (A).
2. Identify the Y Endstop #26, and the M4×12 Low Profile Screws #27. These screws can be identified by their black color, wide head, and length of approximately 12 mm, as measured below the head.



3. Align the two holes in the Y Endstop over the center two holes on the top of the Carriage Plate. Slip two Low Profile Screws through the two holes, and tighten them securely with the short end of the correct Hex L-wrench. (The correct wrench may be the 2.5 mm or 2 mm hex wrench; only one will fit correctly.)



3.3 Spacers, shims, and washers

There are several types of round spacers in the X Carriage. Since they are similar in appearance, let's take a closer look.

All four of these parts are made of stainless steel, with a 4 mm clearance hole in the center.

Precision Shims **#28** and **#29** are both 8 mm in diameter. They are precision machined washers distinguished by thickness: **#28** is 0.5 mm thick, while **#29** is 1 mm thick. Side by side, you should be able to tell them apart.

Spacer **#30** is a thicker, more like a short tube. It is 7 mm in outer diameter and 3 mm in height.

Stamped Washer **#31** has a larger diameter of 10 mm and is not as precisely flat.



#28

#29



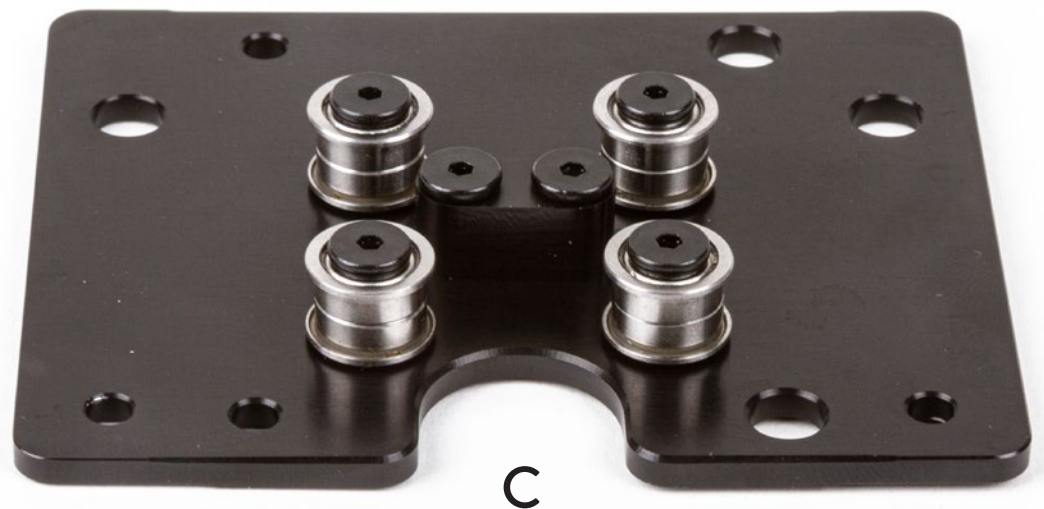
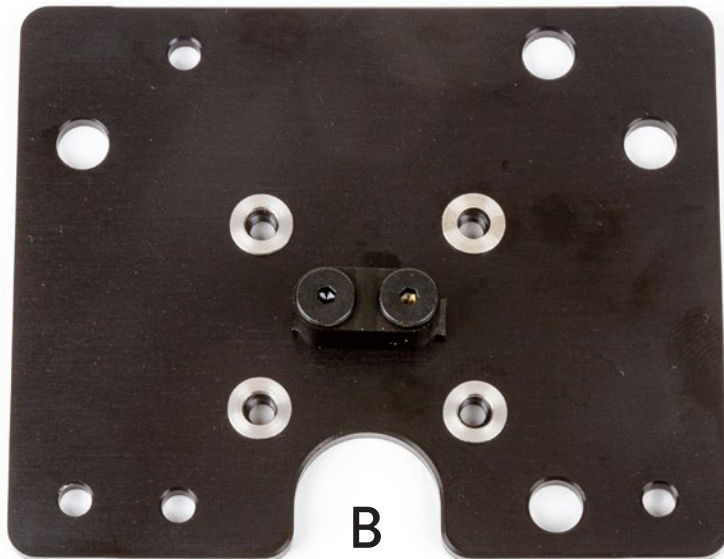
#30



#31

3.4 X Carriage Idler Pulleys

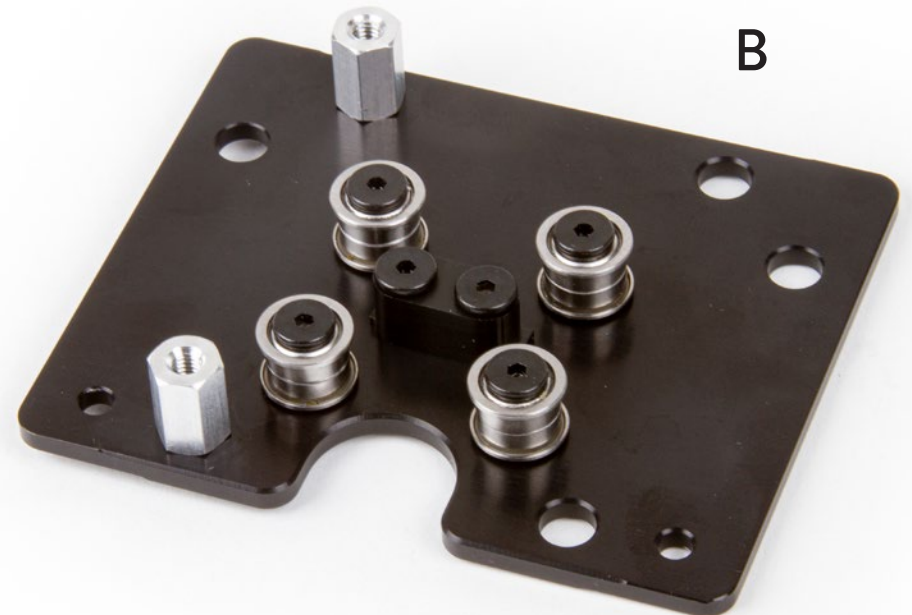
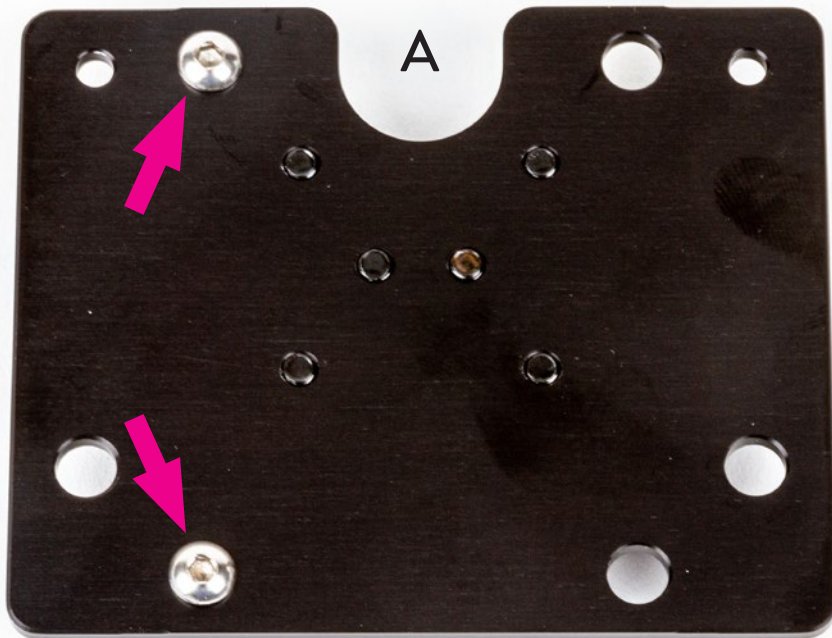
1. Identify part **#32**, the MF104 Ball Bearings. There are 8 of these, and they are smaller size of the ball bearings with flanges.
2. Assemble these bearings into four stacks of two, lined up with the flanges facing away from each other – like tiny yet inedible metal sandwiches. Slip one of the M4×12 Low Profile Screws **#27** through each pair (**A**).
3. Place the four M4×8×0.5 Precision Shims **#28** – *the thinnest ones* – over the four holes in the carriage plate nearest to the Y Endstop (**B**).
4. Insert the screw and bearing stacks through the shim washers (**C**). Tighten each screw securely with the short end of the correct Hex L-wrench **#3**.



3.5 Y Wheel Supports

1. Identify parts **#33**, and **#34**, threaded hexagonal standoffs, each 12 mm long. The straight hexagonal prisms are **#33**, the M4×8×12 Hex Standoffs. Parts **#34** are the “SemiHex” Standoffs, with a 10 mm hex section on the lower half only.
2. Also identify the eccentric spacers **#35** and the M4×10 Button-head Screws **#36**. The eccentric spacers have a hexagonal outline and an off-center hole. The screws can be identified by their silver color, hex socket on the head, and a length of approximately 10 mm below the head.
3. Turn the Carriage Plate upside down so that the bearings and Y Endstop are facing down. Slip the M4×10 screws into the two indicated holes (**A**), the small-diameter holes that are not near the corners of the Carriage Plate.
4. On the top side of the carriage, thread the two M4×8×12 hex standoffs **#33** onto the protruding screws (**B**).

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§3.5 Y-Wheel supports, continued

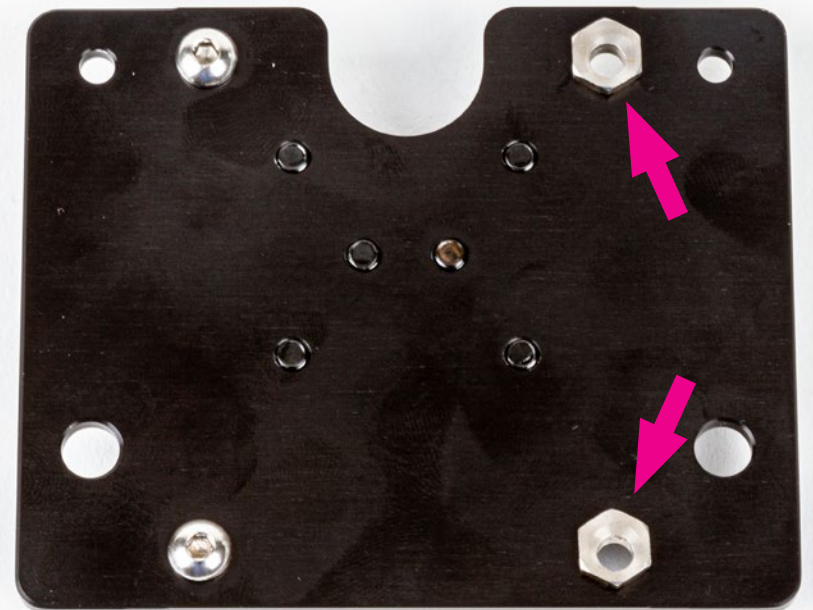
- Using the 2.5 mm Hex L-wrench #4 and the 8 mm Low-profile Wrench #6, firmly tighten the two hex standoffs into place (C).

Tip: In cases like this – more are coming – it is usually easiest hold the hex standoff (or hex nut) steady with the open-ended wrench, while you turn the screw with the hex L-wrench.

- Observe that the #35 Eccentric Spacers have an upper part that is cylindrical, above the hexagonal outline (D).
- With the Carriage Plate upside down again, slip two Eccentric Spacers into the indicated holes (E). These are the two large-diameter holes opposite the hex standoffs. The cylindrical part goes down into the hole, while the hexagonal outline sits atop the plate.



D

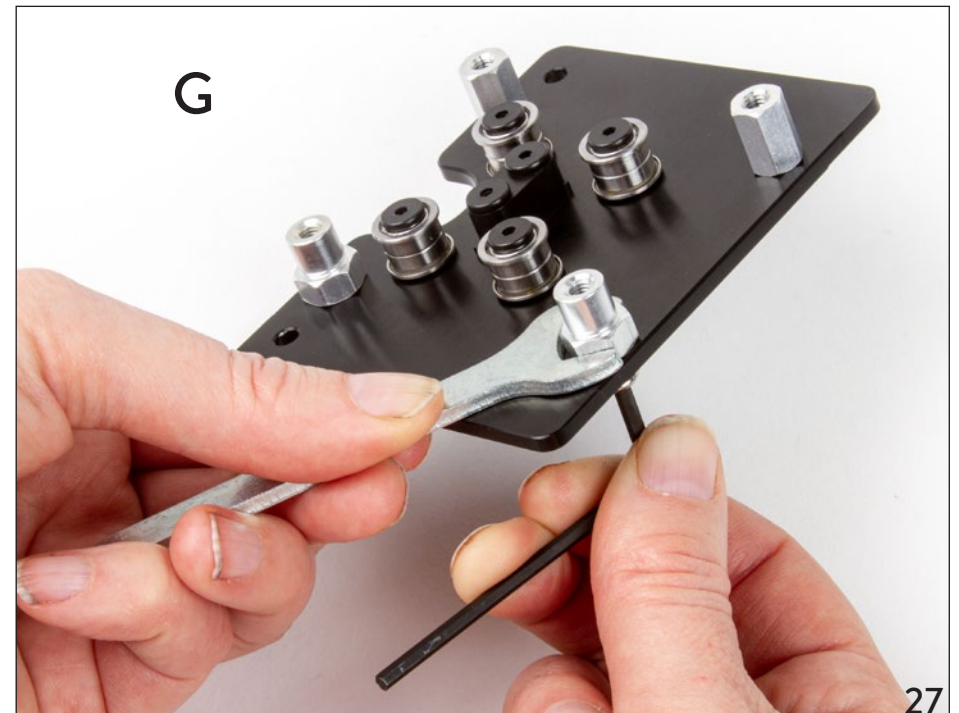
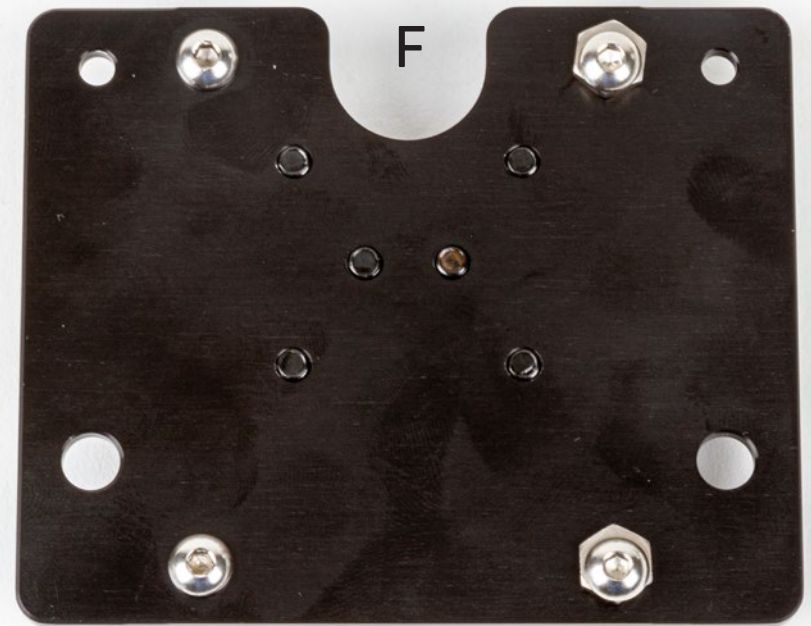


E

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§3.5 Y-Wheel supports, continued

8. Slip another M4×10 Button-head Screw through the hole in each Eccentric Spacer (**F**).
9. Thread a SemiHex Standoff #34 onto each of the protruding screws, with the wide hexagonal surface down, in contact with the Carriage Plate.
10. Tighten both SemiHex Standoffs securely in place (**G**) with the 2.5 mm Hex L-wrench and the 10 mm Low-profile Wrench #5.

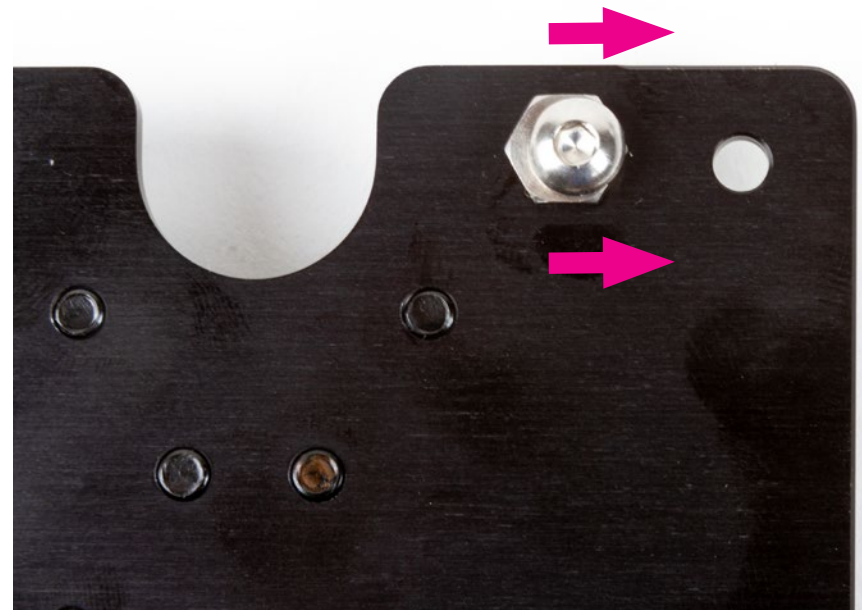
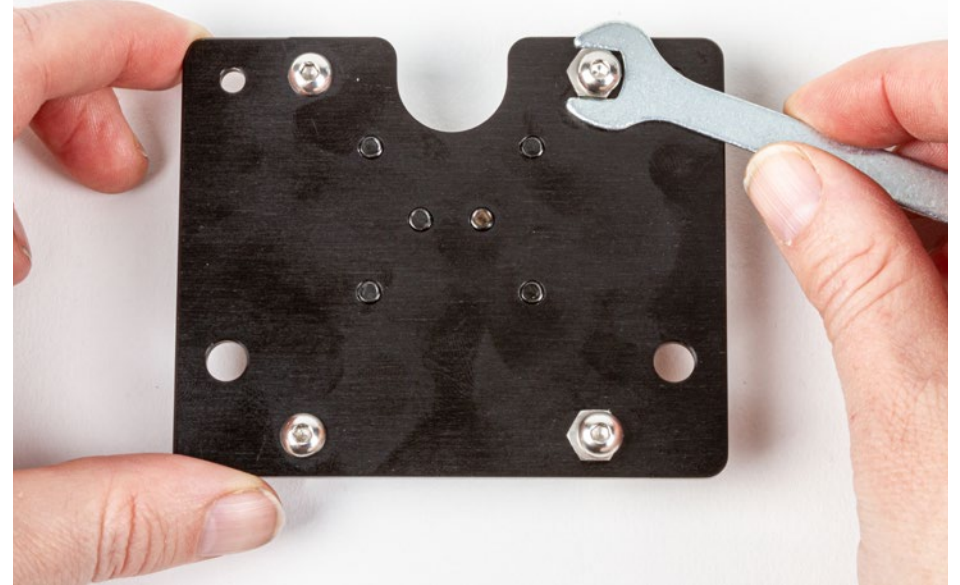


3.6 Preset Y Eccentrics

The Eccentric Spacers can be rotated to move the screw position closer to or further from the centerline of the Carriage Plate. The two that have been added thus far will be used to adjust the Y Carriage in a later step.

Rotate the two Eccentric Spacers, using the 8 mm Low-profile Wrench #6, such that the screw heads are as far as possible from the centerline of the carriage plate.

If the screws are so tight that they cannot be rotated, you may need to loosen them very slightly in order to make the adjustment.

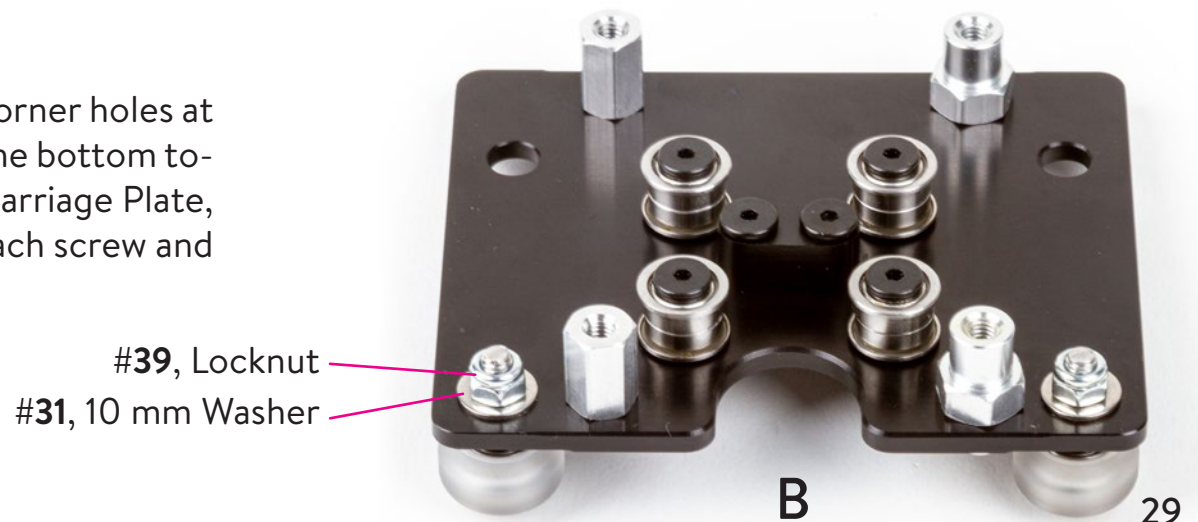
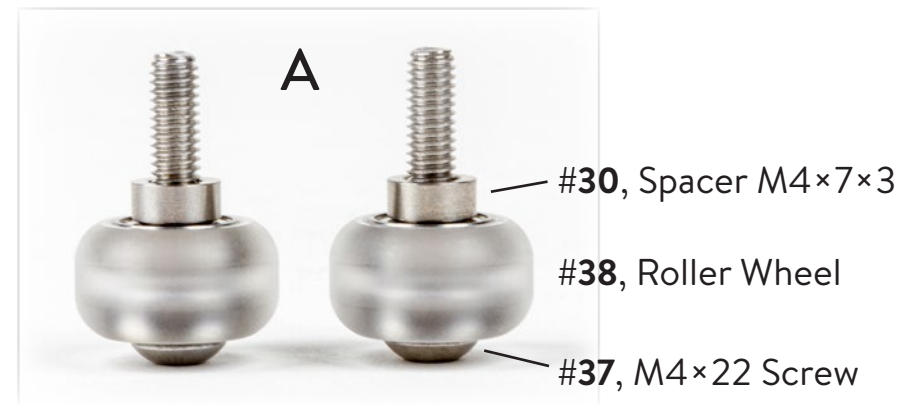


3.7 Front X Wheels

1. Identify parts **#37**, **#38**, and **#39**, the M4×22 Button-head Screw, Roller Wheels, and M4 Nylon Locknuts. The screws are the longest in the kit, 22 mm long, with a hexagonal socket on the head. The M4 Locknuts have a hexagonal outline and rounded tops.
2. Also locate the thick M4×7×3 Spacers **#30** and M4×10×1 Stamped Washers **#31** which will be used in this step. (Refer to §3.3, “Spacers, shims, and washers” on page 23 for more about identifying these parts.)
3. Slip one of the M4×22 screws through a wheel, and then through one of the thick 3 mm spacers **#30**. Repeat this to make two of these stackups (**A**).

Tip: There is a shim spacer inside each roller wheel. If the screw does not easily slip through the wheel, it is possible that the spacer is in the way. Use your 2 mm Hex L-wrench to push the shim back into position so that the screw fits through.

4. Slip the two stackups up through the two corner holes at the front side of the Carriage Plate, from the bottom towards the top (**B**). On the top side of the Carriage Plate, place a 10 mm Stamped Washer **#31** over each screw and then thread on an M4 Nylon Locknut **#39**.



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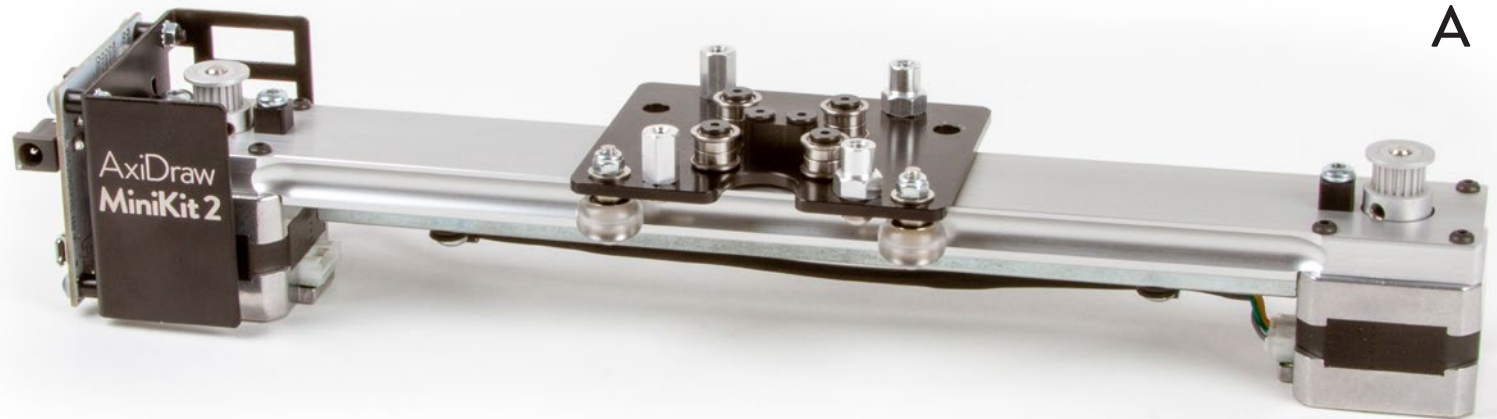
§3.7 Front X Wheels, continued

5. Tighten both wheels securely in place using the 2.5 mm Hex L-wrench #4 and, the 7 mm Low-profile Wrench #7 to steady the locknut (C). Important: *Do not overtighten the wheels.* The wheels should be secure in place but the outer clear plastic part of the wheel must be able to turn freely.

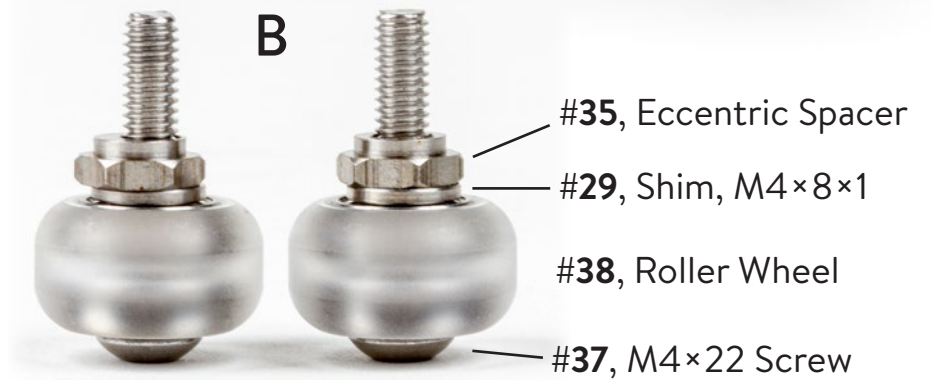
Tip: In order to grip these nuts and tighten them, you will need to keep the nut and washer pressed up against the carriage plate. Hold the Locknut against the plate with your thumb while you turn – *not press* – the screw with the 2.5 mm Hex L-wrench.



3.8 Rear X Wheels



1. Set the carriage assembly on top of the base rail, with wheels facing down and forward. That is, the front side – with the notch and two wheels – should face towards you when the EBB support (with its AxiDraw MiniKit 2 logo) is on the left and facing towards you (A).
2. Slip one M4×22 Button-head Screw #37 through a Roller Wheel #38, through M4×8×1 Precision Shim #29, and finally into the *hexagonal end* of an eccentric spacer, #35. Repeat to make two of these stackups (B).
3. Slip the two stackups up through the two remaining holes in the Carriage Plate, from the bottom towards the top. Guide the cylindrical part of each eccentric spacer to sit in the hole.
4. On the top side of the Carriage Plate, place a 10 mm Stamped Washer #31 over each protruding screw and then loosely thread on a M4 Nylon Locknut #39 (C).



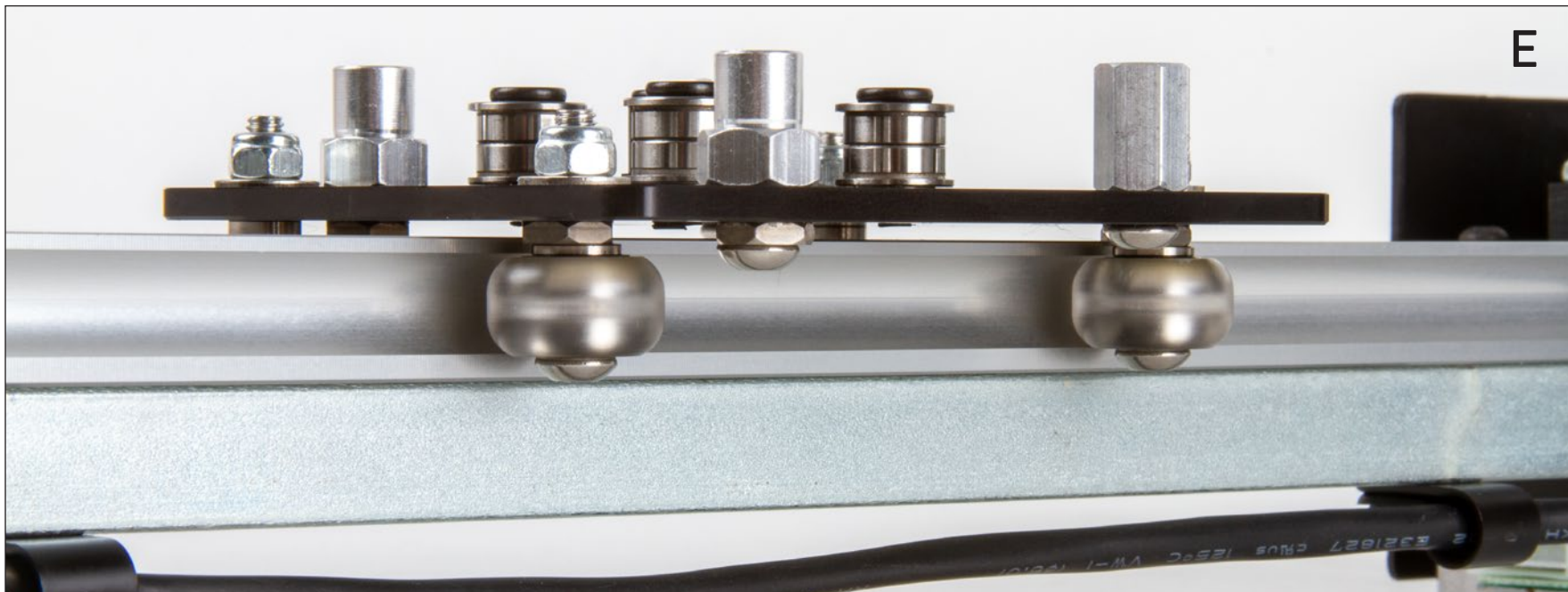
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§3.8 Rear X Wheels, continued

5. Now, tighten both wheels – *only until barely tight* – using the 2.5 mm Hex L-wrench and the 7 mm Low-profile Wrench #7 to steady the locknut. It is easiest to tilt the assembly forward while doing so (**D**). *Final tightening will be in a subsequent step.*

Tip: Once again, you will need to hold the nut against the carriage plate as you turn the hex wrench.

6. Visual inspection: Check that all four wheels are positioned in the channels on the sides of base rail, and double check that the cylindrical part of each Eccentric Spacer is inserted into its hole (**E**).



3.9 Tuning the X Carriage

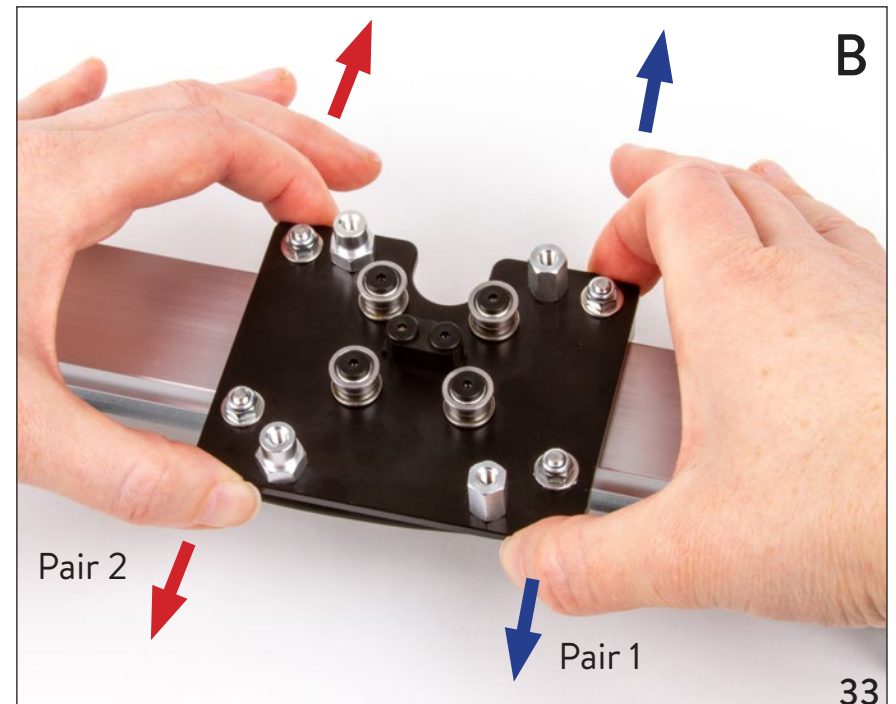
In this step we will adjust the position of the two rear wheels using the Eccentric Spacers located above them. The goal will be to tune the tension between the Roller Wheels and the Base Rail, so that the carriage moves smoothly and without slack.

The total range of adjustment on the Eccentric Spacers – from overly loose to overly tight – is very small; only one half turn total. Thus, when you do make adjustments, make very small rotations.

To rotate the Eccentric Spacer you will use tool #6, the 8 mm Low-profile Wrench, as in the previous case (§3.6 on page 28).

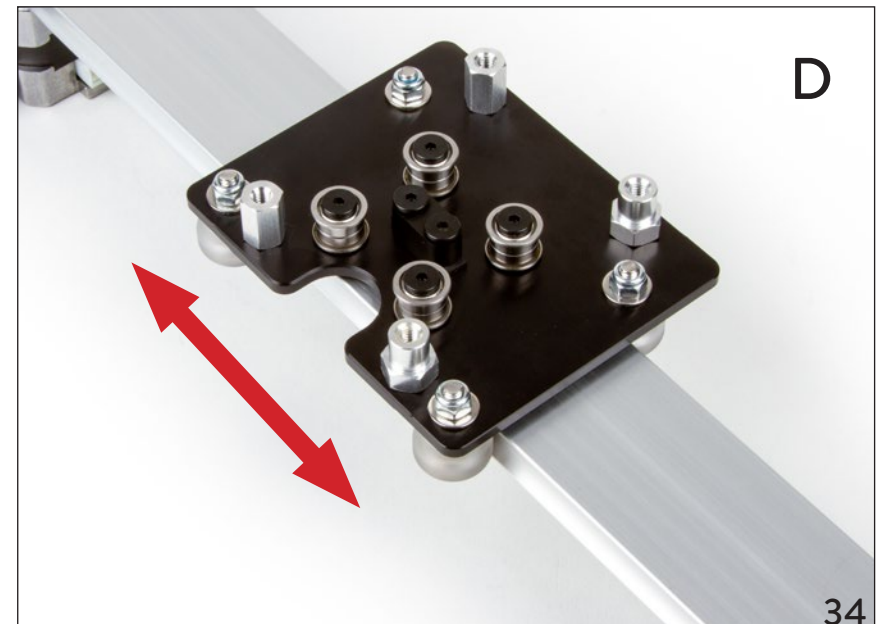
1. Check each rear wheel to make sure that it can be rotated. If it cannot, it is likely overly tight against the base rail. Rotate the eccentric (**A**) in the direction necessary to loosen it.
2. Position your hands as shown (**B**), with one hand on each side, and fingers directly in line with either the two left-side wheels or the two right-side wheels. We will call these two pairs **Pair 1** and **Pair 2** for reference in this step.
3. Keeping your hands in this position, try moving the carriage back and forth in the direction indicated, for Pair 1 alone. You will most likely feel some slack movement in line with these two wheels. Test the same way for Pair 2.

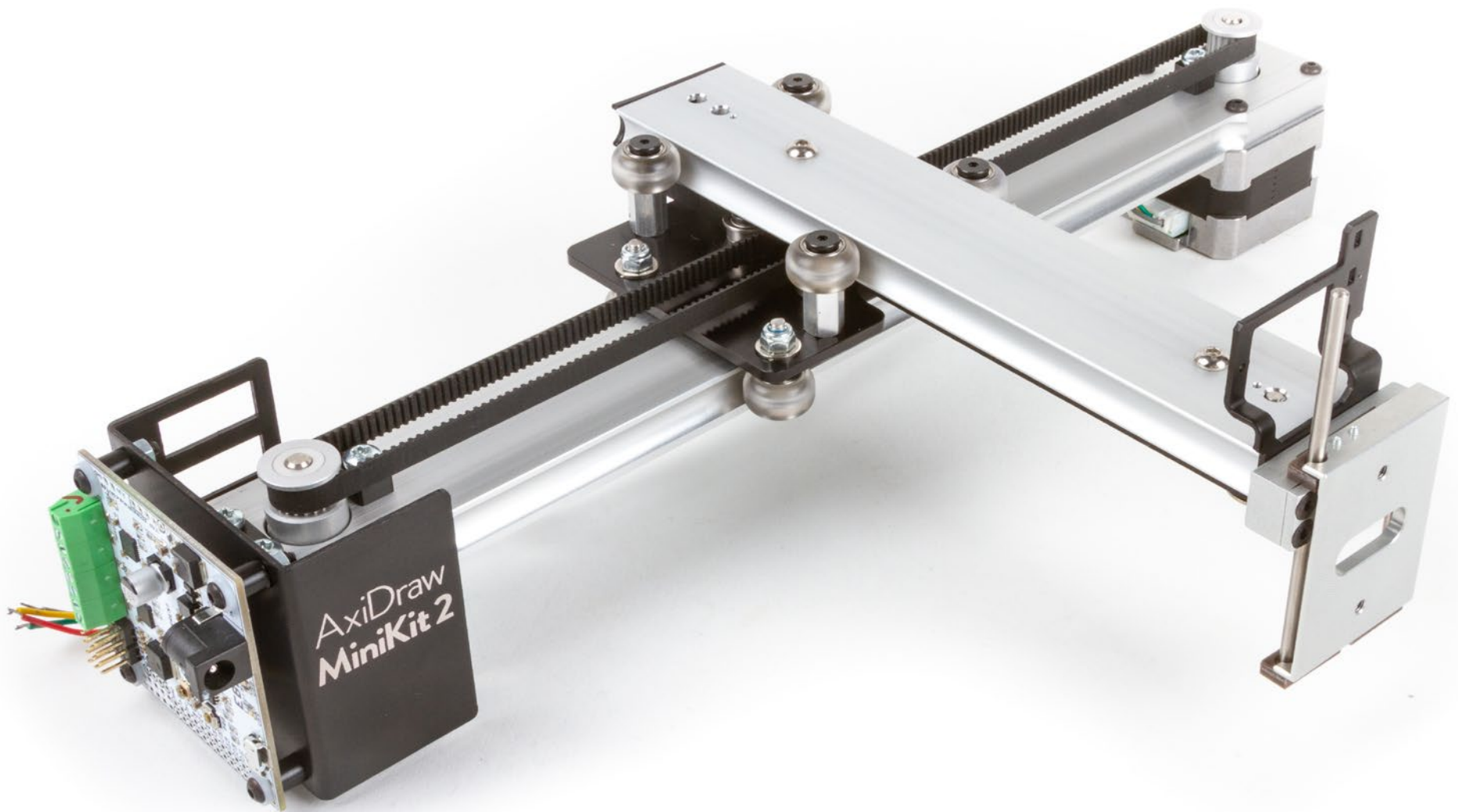
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§3.9 Tuning the X Carriage, continued

4. If you can feel any slack movement in Pair 1 alone, make a small adjustment to the eccentric position (**C**), and test again. Repeat until there is no slack movement in line with these two wheels. The pair is properly adjusted when there is no slack movement when tested as in (**B**), but the rear wheel *can* be rotated with a little effort.
5. Once Pair 1 is properly adjusted, move on to Pair 2. Do not go back and forth between the two. Again, make small angle adjustments until there is no slack movement in line with Pair 2, but the wheel can still be rotated by hand.
6. Once both wheel pairs are tuned, tighten the locknut using the 2.5 mm Hex L-wrench and the 7 mm Low-profile Wrench.
7. Test that the carriage now rolls smoothly – with little effort, and no excess slop – along the full length of the base rail, from one X Endstop to the other (**D**).





Part 4: Y, Belt, and Z

4.1 Parts in the Y, Belt, and Z assemblies

#40



#41



#42



#43



#51

#44



#45



#46



#47



#48



#49



#50



#52



#40, MiniKit Y Rail (1)
#41, M4 Square Nut (3)
#42, Tensioning Block (1)
#43, F624 Ball Bearing (2)
#44, M4x8x8 Hex Standoff (2)

#45, M4x16 Button-head Screw (2)
#46, Y EndCap (1)
#47, Timing Belt (1)
#48, Belt Spacer (1)
#49, Belt Retaining Clip (1)

#50, M3x8 Button-head Screw (1)
#51, Servo Mount (1)
#52, Z Slide Assembly (1)

4.2 Tensioning block

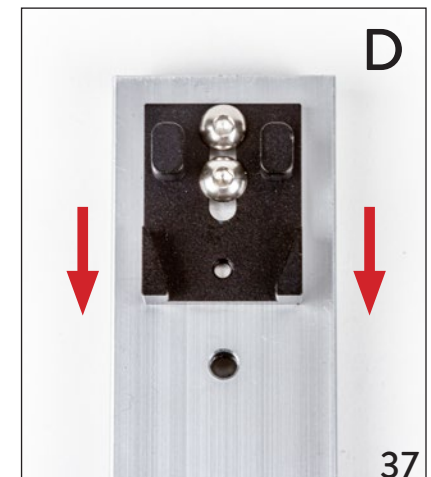
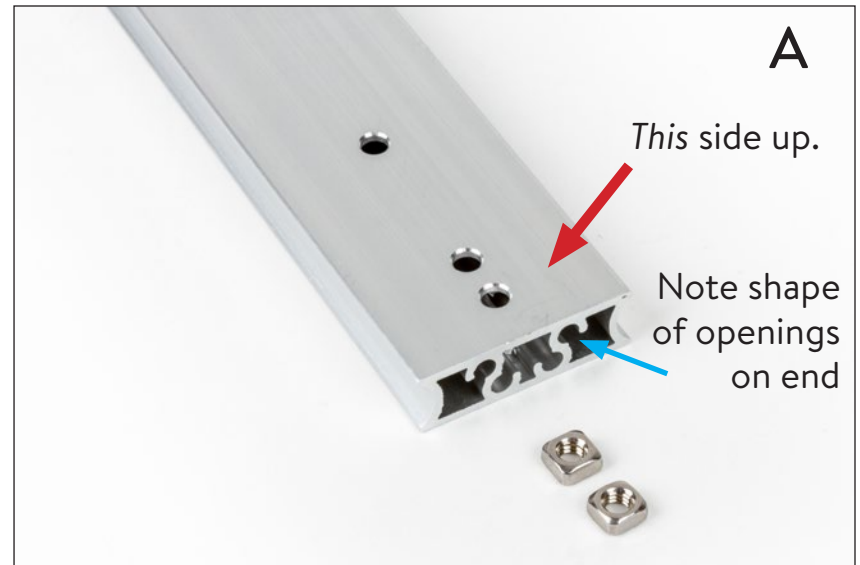


Aluminum extrusions like the Y Rail may have extremely sharp points and edges. *Handle with appropriate care.*

1. Begin with the MiniKit Y Rail #40. For this step, orient it as shown (A), with the further-apart set of openings visible on the end facing up. Locate the end that has the two drilled-through holes close together.
2. Insert two of the #41 M4 Square Nuts into the center channel of that end, and push them with the 2.5 mm Hex L-wrench until they line up with the first two holes (B).

Tip: There are tiny holes drilled in the Y rail, into which you can optionally insert a pin or toothpick that can serve as a backstop while pushing in square nuts from either end.

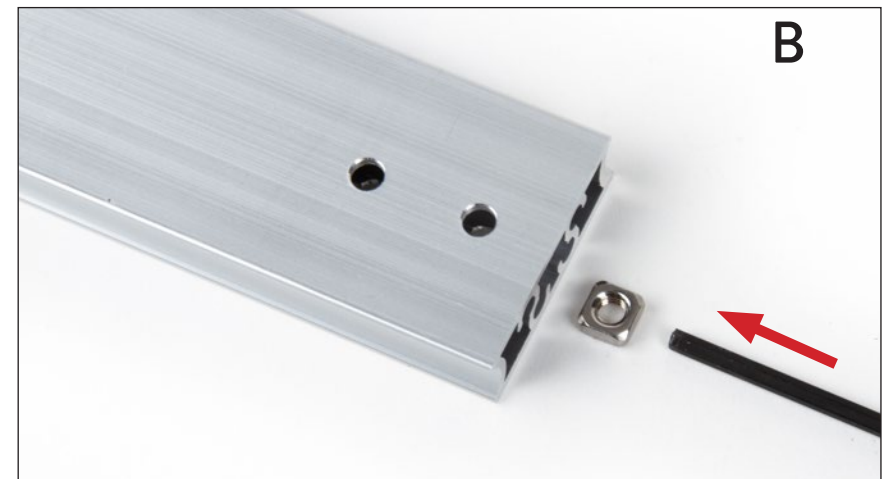
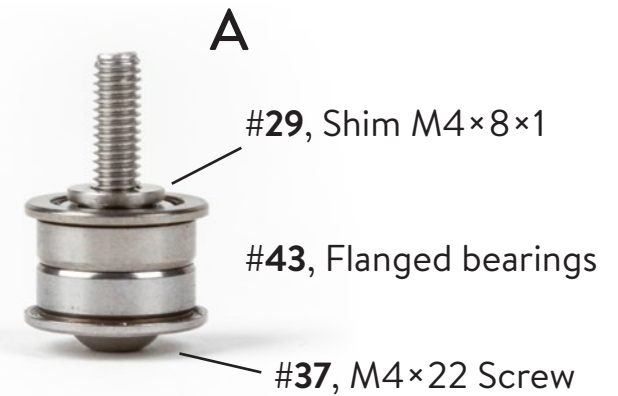
3. Place the Tensioning Block #42 over the Y Rail, flat side down, such that its slot is towards the end of the Y Rail and lies over the two holes as shown (C).
4. Insert two M4×10 button socket cap screws, #36, through the slot and into the square nuts. Thread them into the nuts with the 2.5 mm Hex L-wrench. Slide the tensioning block to the end of the slot, towards rail center (D).
5. Lightly tighten the two screws. (Final tightening will be in a subsequent step.)



4.3 Y Carriage Idler Pulley

In this step you will install the “Idler Pulley”, at the front of the Y Carriage.

1. Identify part **#43**, the 2 large flanged ball bearings, type F624.
2. Slip the remaining **#37** M4×22 Button-head Screw through the two ball bearings, with the flanges facing away from each other – once again like a tiny metal sandwich. Then, slip on the remaining **#29** M4×8×1 Precision Shim (**A**).
3. Insert the remaining M4 Square Nut **#41** into the channel on the opposite end of the Y rail (**B**), and push it in until it lines up with the first hole.
4. Insert the free end of the M4×22 screw stackup into the first hole with the square nut (**C**). Tighten it firmly in place with the short end of the 2.5 mm Hex L-wrench.

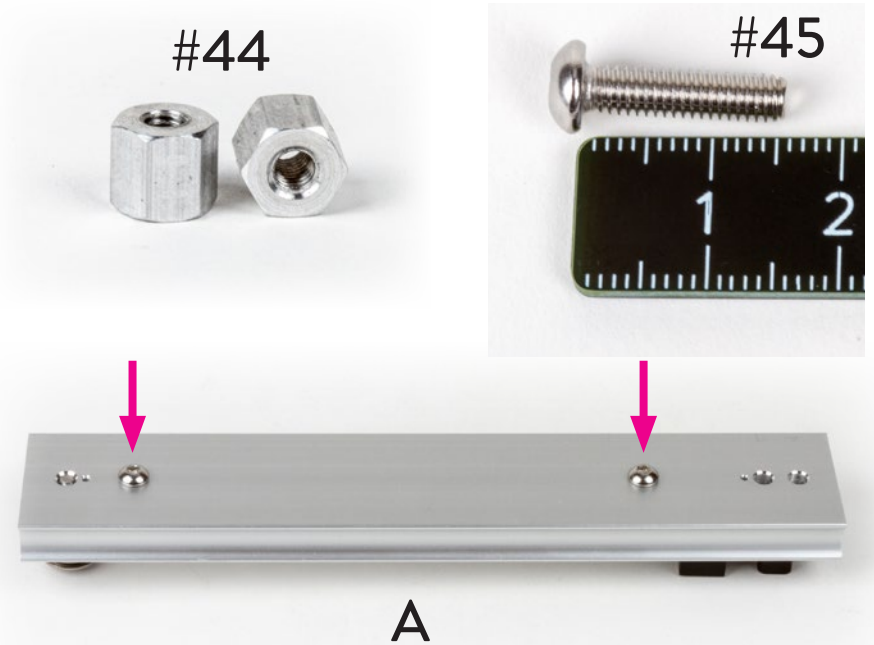


4.4 Y Carriage Travel Limits

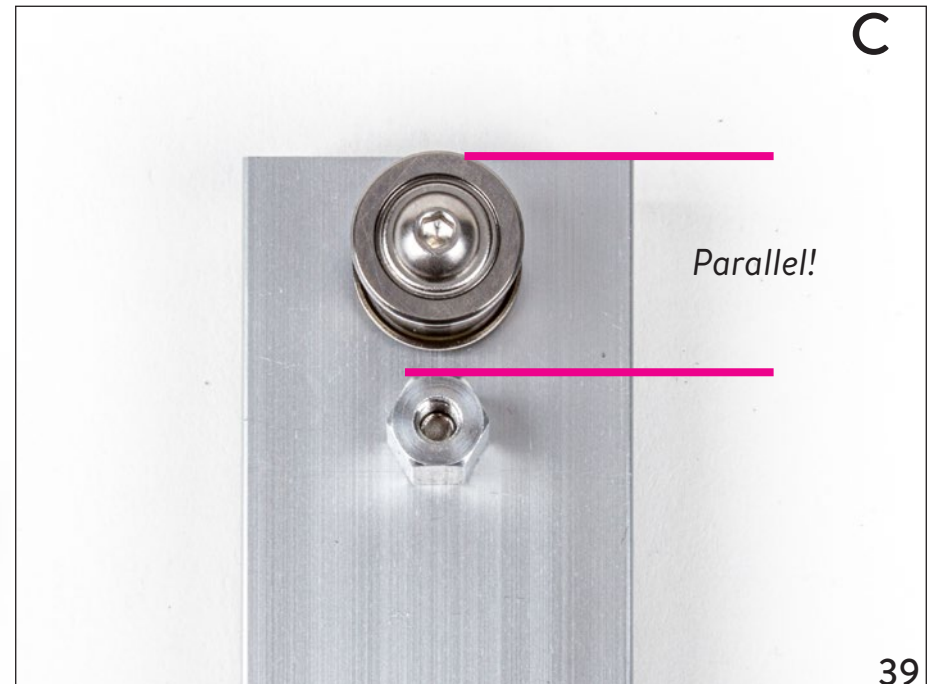
1. Identify part **#44**, the M4×8×8 Hex Standoffs. These are threaded hexagonal pieces 8 mm across and 8 mm tall.
2. Also identify M4×16 Button-head Screws **#45**, silver in color, with a hexagonal socket on the head, and a length of approximately 16 mm under the head.
3. Slip these two screws through the two empty holes in the Y rail, from the top (empty) side through to the bottom side, which has the tensioning block and bearings (**A**).
4. On the bottom side, thread the Hex Standoffs **#44** onto the screws (**B**).
5. Tighten the standoffs firmly into place with the 2.5 mm Hex L-wrench and 8 mm Low-profile Wrench **#6**. As you tighten it, line up one side of each hex standoff to be parallel to the end of the Y rail (**C**).



B



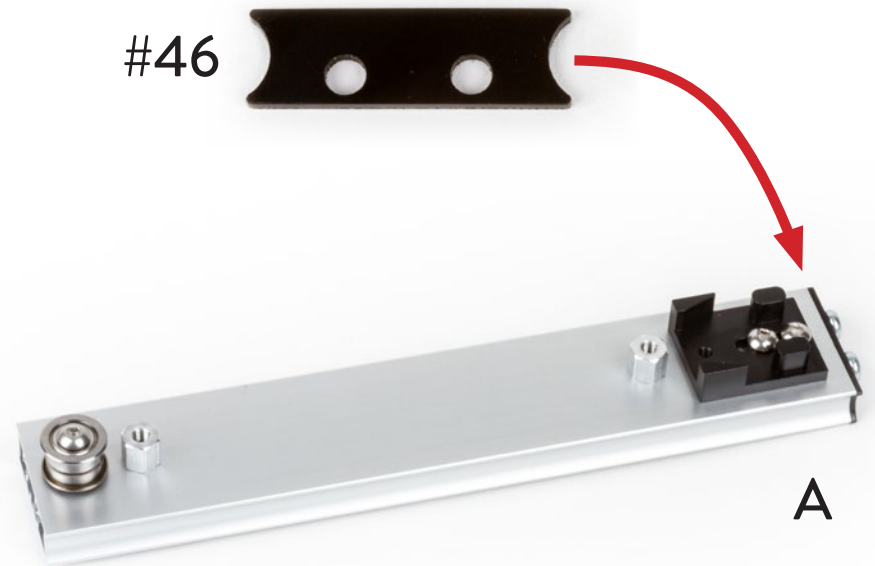
A



4.5 Y Endcap and Pre-threading

1. Identify the Y Endcap **#46** and locate the two remaining the M4×8 Torx Tapping Screws **#24**.
2. Position the endcap on the “back” end of the Y Rail, which is the end with the Tensioning Block. Align its two holes with the matching holes in the end of the Y Rail, and its outline to the shape of the Y Rail.
3. Use the Torx L-wrench, **#2**, to fasten the endcap into place with the two M4×8 Torx Tapping Screws. It may be easiest to hold the hold the Y Rail *vertically* while doing so. As you tighten it into place, keep its edges lined up with the sides of the Y Rail (**A**).
4. Locate the two remaining M4×12 Torx Tapping Screws, **#17**. Using the Torx L-wrench, thread the two screws into the further-apart (lower) pair of holes on the open end of the Y Rail. Then, fully remove the two screws – we will need them later. Again, you may find it easiest to hold the Y Rail vertically during this process.

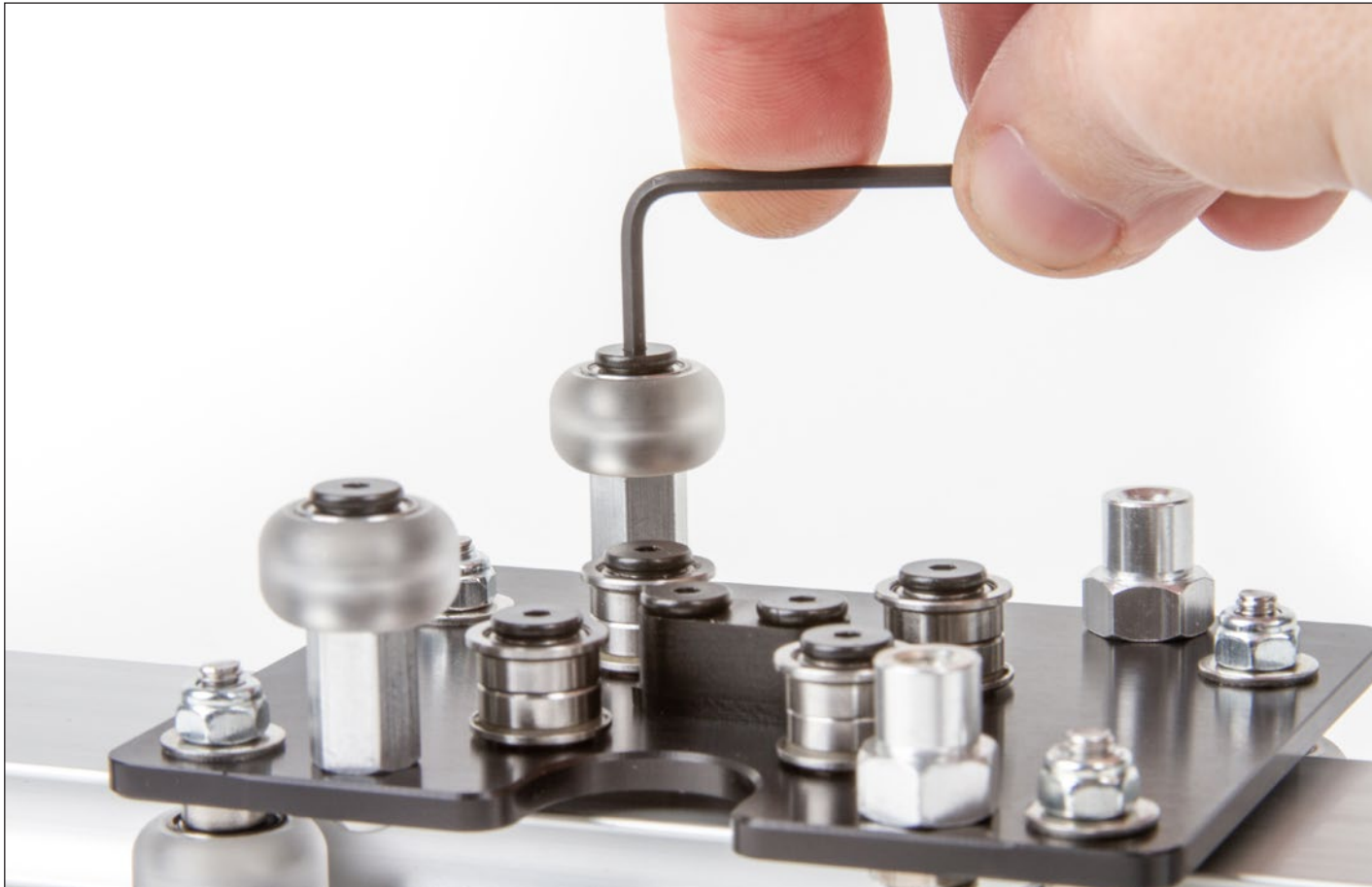
This operation adds threads to these holes, which will make a subsequent step much easier.



4.6 Fixed Y Wheels

Next, attach Roller Wheels #38 to the top of the two tall and straight M4×8×12 Hex Stand-offs #33 on the left side of the X Carriage. These are the fixed (not adjustable) wheels for the Y axis.

Use two of the M4×12 Low Profile Screws #27, and tighten them securely in place with the short side of the correct Hex L-wrench.



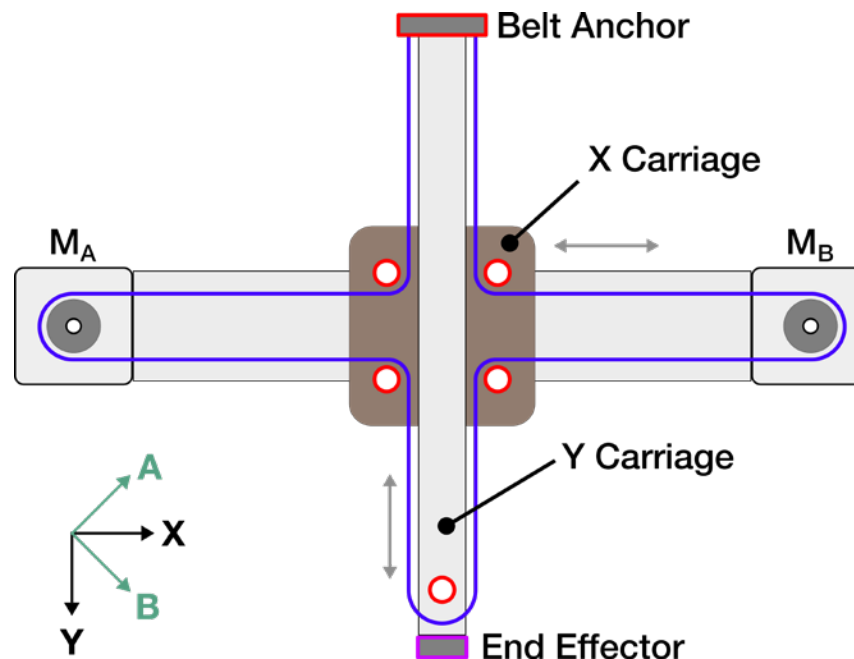
4.7 Aside: AxiDraw kinematics

In the next step we will begin adding the timing belt to the kit. It is helpful to understand how the belt is arranged – and thus how the machine works – before doing so.

The AxiDraw is driven by two stepper motors, each rigidly fixed to the base of the machine. Each motor drives a timing belt pulley that is attached directly to the motor shaft. Together, the two motors and their pulleys move a single timing belt that loops around both motors, as well as idler pulleys on the X and Y carriages.

The X carriage contains four idler pulleys, arranged essentially in a square. The Y carriage has one idler pulley at the front near the end effector (pen holder) and an anchor point (the tensioning block) for the belt at the back, farthest from the pen holder.

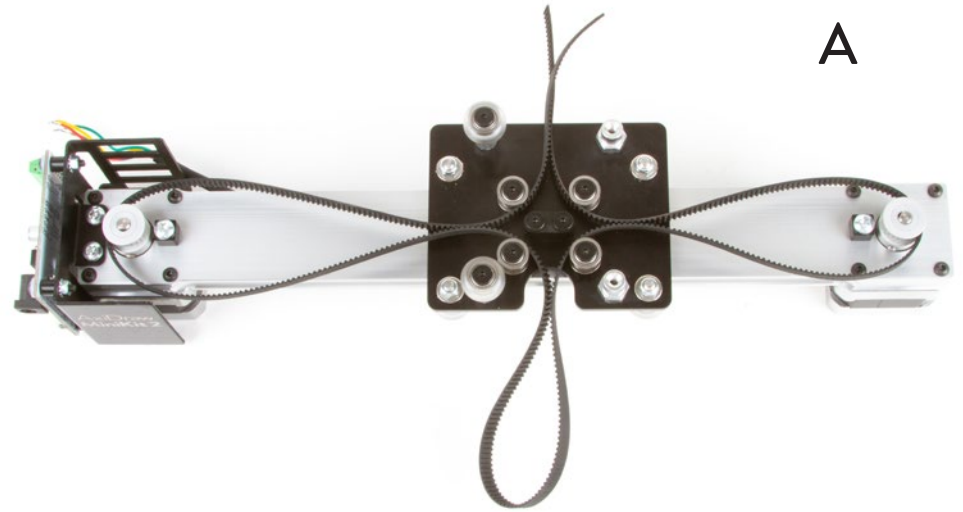
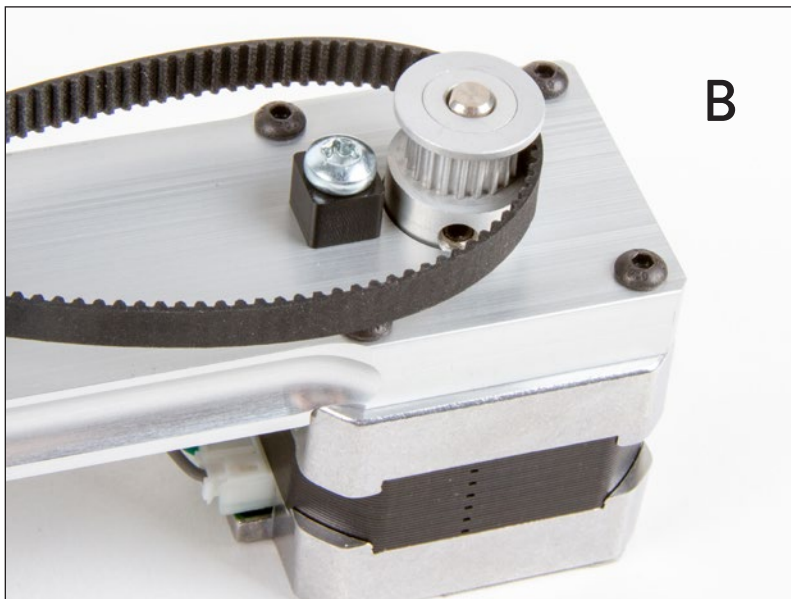
When the left-hand motor (M_A) turns but the right-hand motor (M_B) does not, it causes the end effector to move along the **A** axis. When the right-hand motor moves but the left does not, it causes the end effector to move along the perpendicular **B** axis. Controlled movements of both motors simultaneously can move the end effector along the **X** or **Y** axes or in arbitrary directions.



4.8 Belt Staging

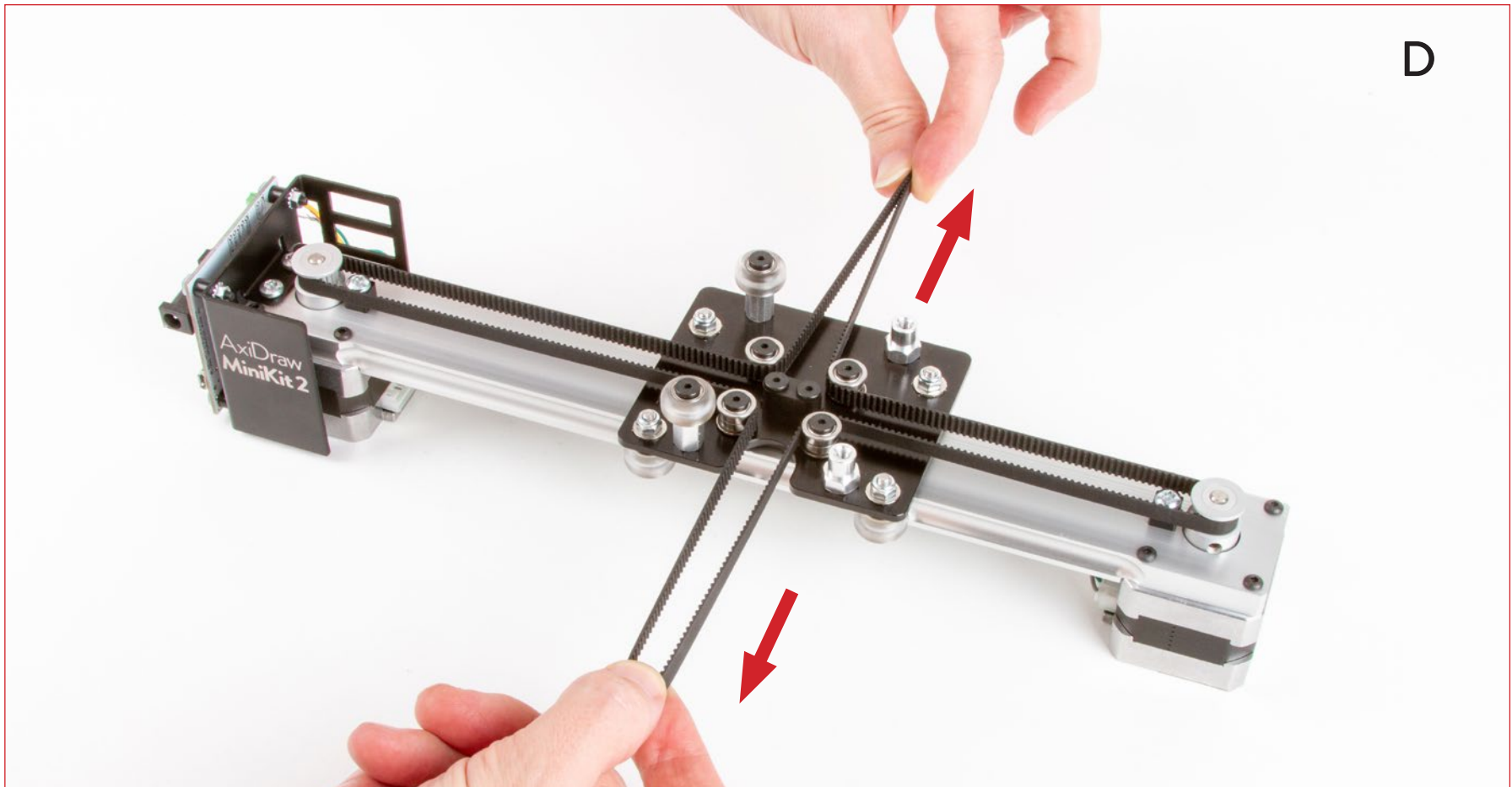
1. Set the Timing Belt #47 roughly in place. Position its loose ends out the back of the carriage and with a loose loop out the front side of the carriage (**A**).
2. Loop the belt over both timing belt pulleys, and make sure that the teeth on the belt are “pointing in” so that they engage with the motors (**B**).
3. On the X Carriage, set the belt as shown (**C**), looping around each of the four pulleys. Refer to the diagram on the previous page if necessary. Once we add the Y Carriage, the front loop will go around the Y idler pulley, and the loose ends will be anchored by the Tensioning Block.

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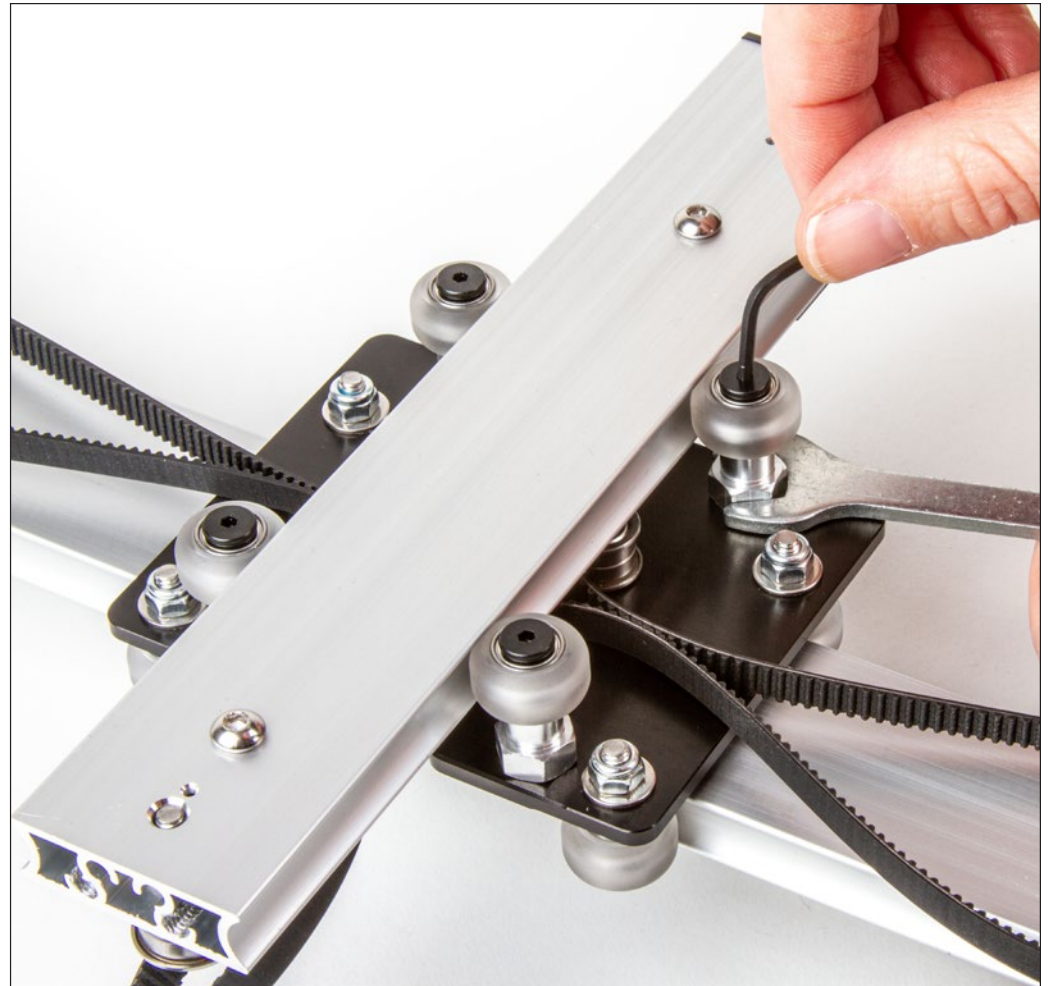
§4.8 Belt Staging, continued

4. Once the belt seems to be in the right place, test its placement by pulling the loose ends (pinched together) straight back while pulling the front loop straight forward (**D**).
5. While holding the belt in tension, make sure that it is flat and not twisted, engaged in the teeth of both motors, engaged between the flanges the four idler pulleys, and not looped around anything that it isn't supposed to be.
6. Gently release the belt, leaving it in place as best you can.

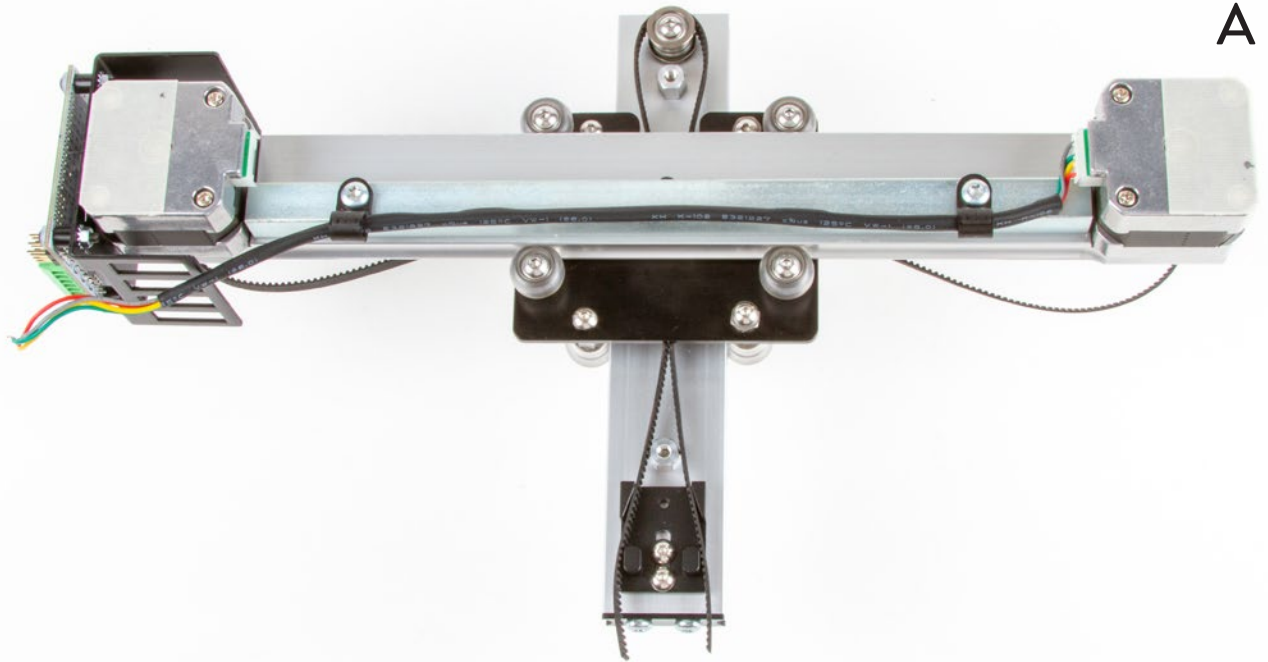


4.9 Add the Y Carriage

1. Set the Y Carriage in place atop the X Carriage, with its idler pulley pointing down and towards the front of the X carriage – towards the side with the belt loop, not the loose belt ends.
2. Set one of the M4×12 Low Profile Screws #27 through a Roller Wheel #38 and set it on top of one of the SemiHex Standoffs #34 on the right side of the X Carriage.
3. Hold the base of the SemiHex Standoff steady with the 10 mm Low-profile Wrench #5 while you tighten the wheel securely in place with the short side of the Hex L-wrench. *Take care to not rotate the stand-off.*
4. Repeat these steps to add the other roller wheel to the other SemiHex Standoff.



4.10 Belt tensioning



1. Loop the belt over the Y Carriage idler pulley.
2. Holding both X and Y carriages to prevent them from sliding, turn the full assembly upside down (**A**).

Tip: It may be helpful to rest the assembly on your lap or on a large cup or bowl while inverted.

3. Identify the parts that we will use to anchor the belt in place: The belt Spacer **#48**, the Belt Retaining Clip **#49**, and the M3×8 Button-head Screw **#50**. The screw is distinguished by its 2 mm hex socket, black color, and length of approximately 8 mm below the head.



#48



#49

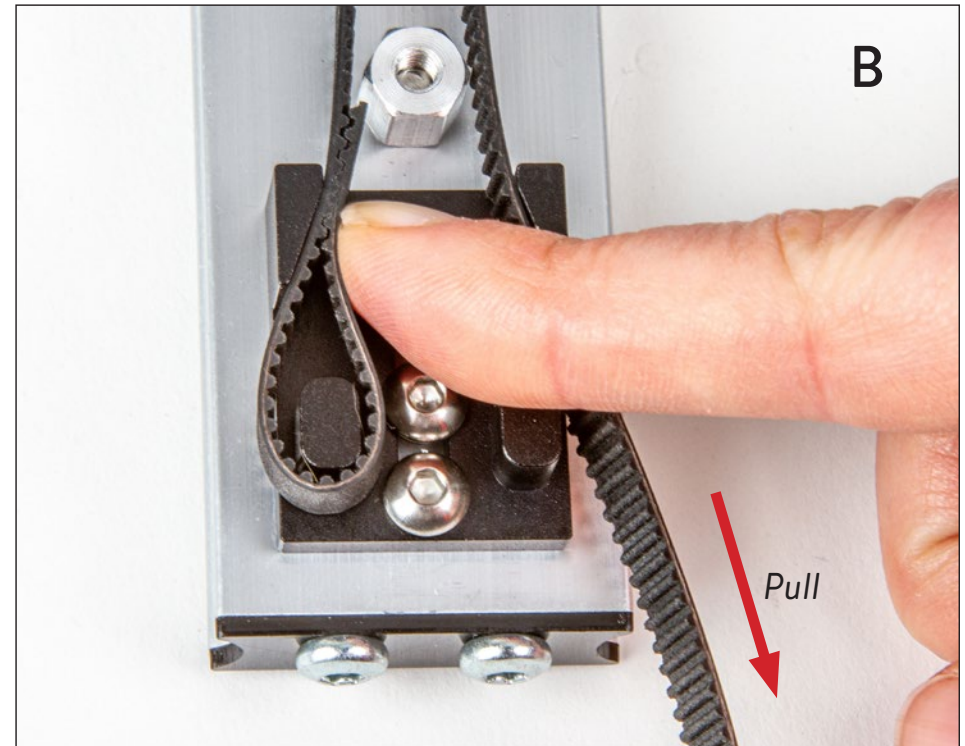


#50

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§4.10 Belt tensioning, continued

4. Loop one end of the belt around the rounded post near the end of the Tensioning Block, and fold it back up so that the belt teeth engage with each other.
5. Holding the belt steady by the engaged teeth (**B**), pull the loose end to establish a little tension and ensure that the belt is still looped around the motors and pulleys. As you do so, check to make sure that the belt is still in position, looped around the motor and idler pulleys.
6. Pull out as much slack as you can and loop the loose end of the belt around the other post (**C**).



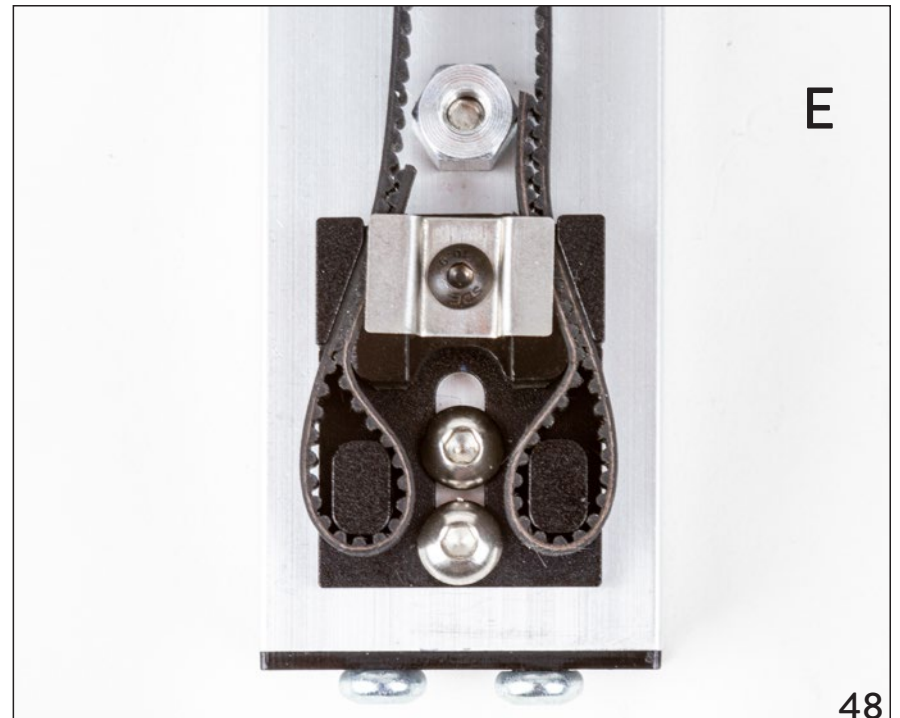
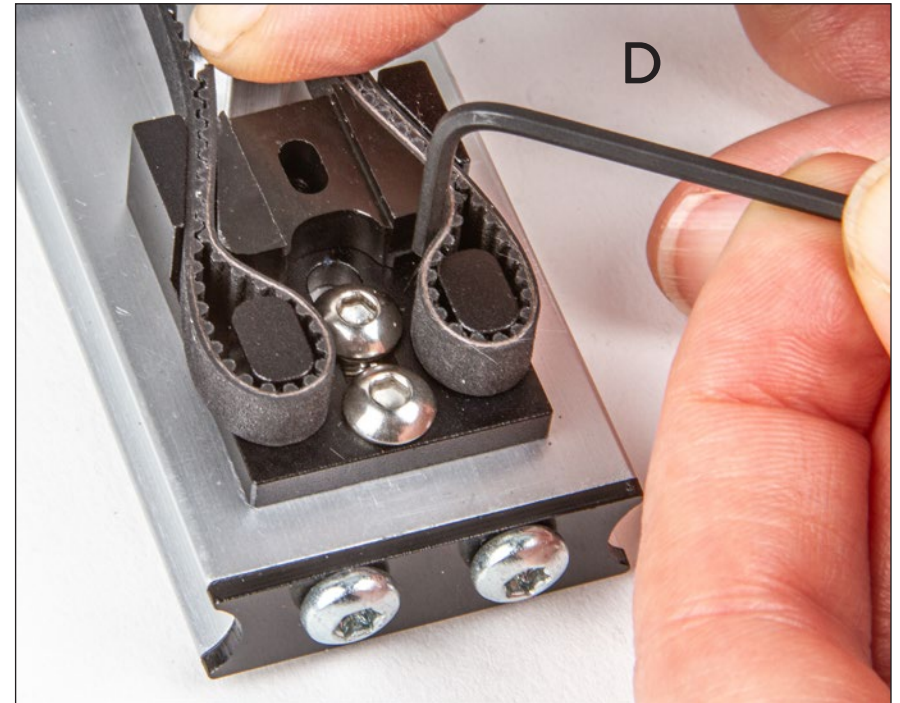
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§4.10 Belt tensioning, continued

7. Insert the Belt Spacer, with its recessed side facing up, into the gap in the middle of the Tensioning Block (**D**). Its function is to pinch the two looped ends of the belt, and thus anchor the belt.

Tip: Use your 2 mm Hex L-wrench to help pull the belt out of the way while you add the spacer.

8. The Belt Spacer is wedge shaped and adjustable. If you pull it towards the back of the Y Carriage, it will release the belt, and if you push it forward it will pinch the belt tightly in place. Keep it pushed forward, so that it pinches the belt ends together in place.
9. To fix the belt spacer in place, use the Belt Retaining Clip #49 and the M3×8 Button-head Screw #50. The retaining clip has little wings that go up and over the edges of the belt to keep it from falling out vertically. Push the belt spacer forward (towards the center of the carriage) and tighten the screw with the 2 mm Hex L-wrench (**E**).



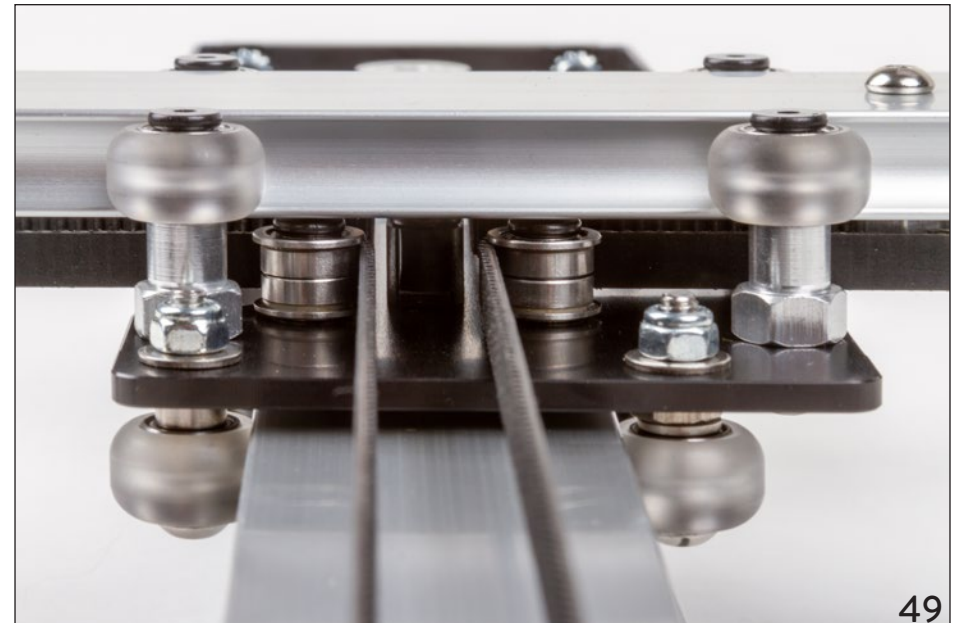
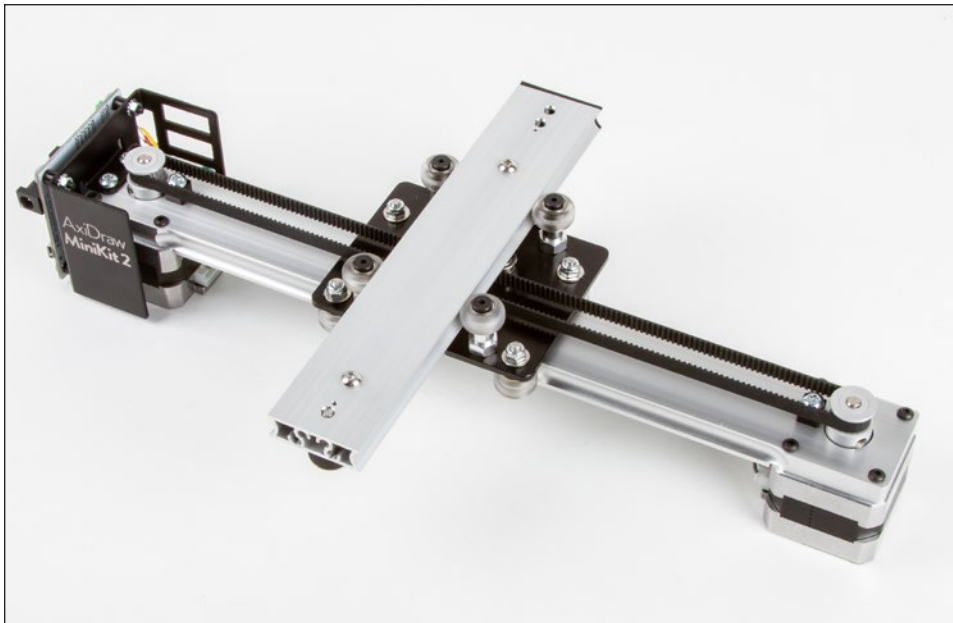
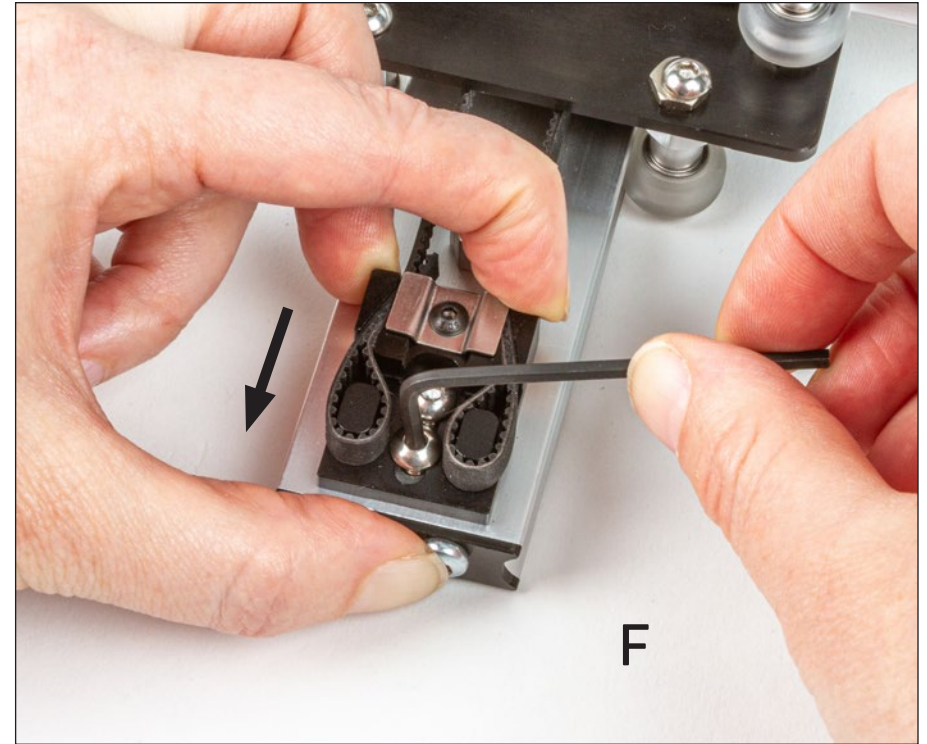
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§4.10 Belt tensioning, continued

10. Using the 2.5 mm Hex L-wrench, slightly loosen the two silver-colored M4 screws in the Tensioning Block. Pull it straight back – tight – towards the end of the carriage to tension the belt, and then tighten the two screws to lock it in place (**F**). *The belt should now be properly tensioned.*

Note that from this point forward, there will be extra friction when you move either carriage, as it is moving the belt and thus the motors.

11. Flip the machine back right side up, and double check that the belt is properly routed and feels secure. Visually inspect that it's wrapped around the teeth of both motor pulleys, in the groove of the four X Carriage pulleys, and also the Y Carriage pulley. If anything is loose or improperly routed, fix it now before proceeding to the next step.

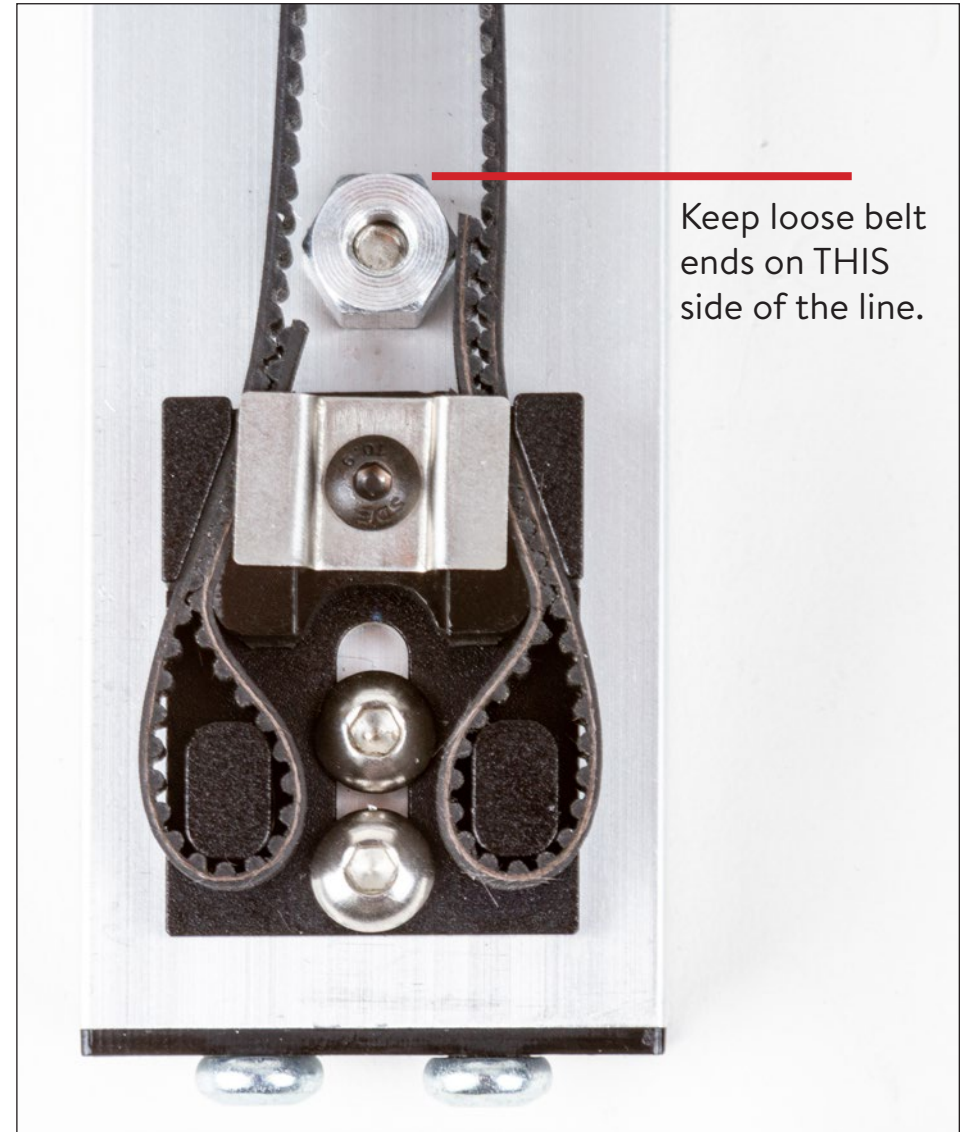


4.11 Trim the belt ends

Once the belt is tensioned and you have double-checked that it is properly routed, you can trim the belt to length.

The loose ends of the belt must not cross the “red line” shown here, which is the inner face of the hex standoff by the tensioner on the bottom of the Y carriage.

If both loose ends are already behind this line, go on to the next step. If the belt ends extend past it, trim them with scissors or wire cutters.

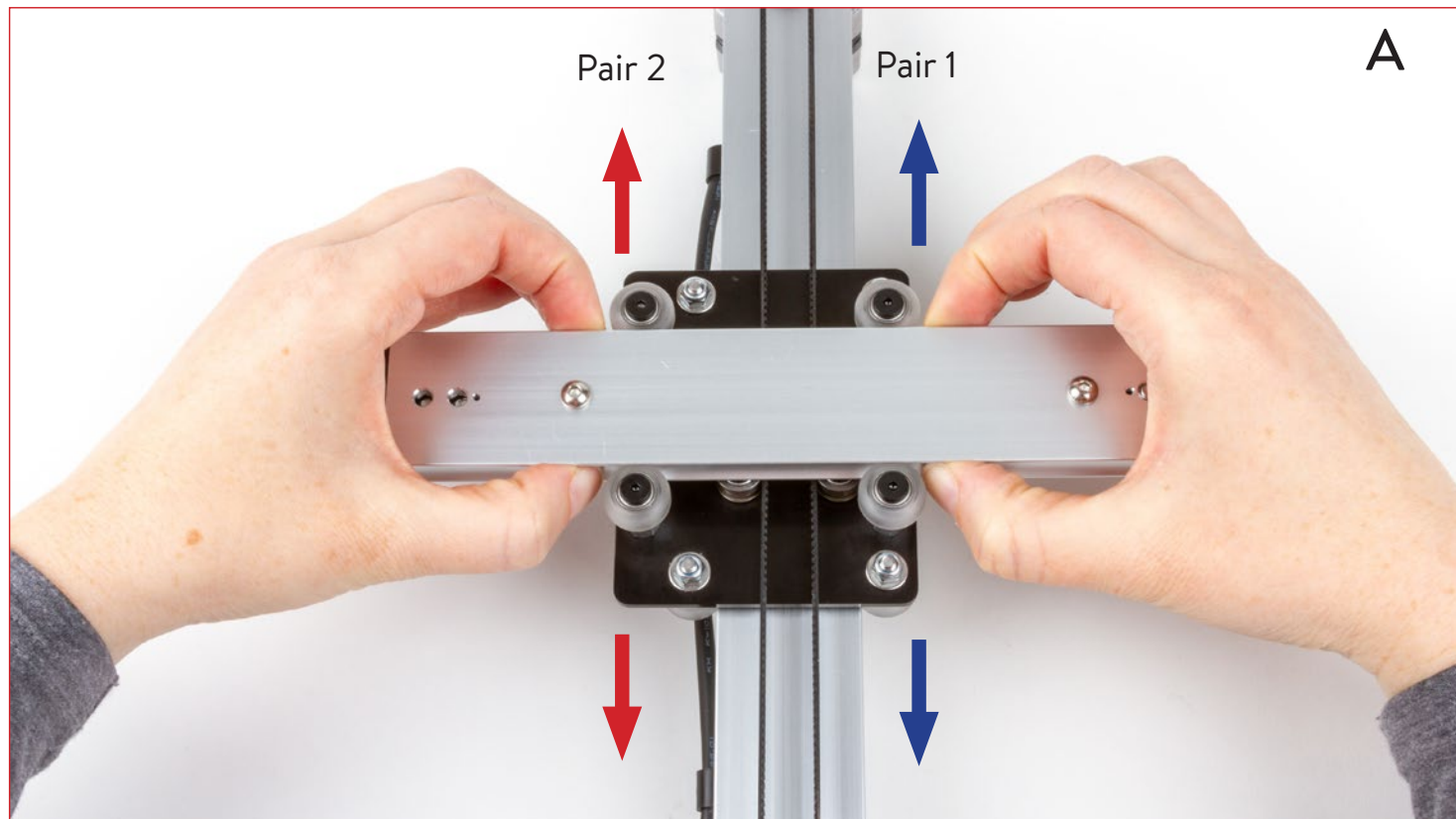


4.12 Tuning the Y Carriage

In this step we will adjust the position of the two right-hand Y-axis wheels using the eccentric spacers located below them. This is much like the previous tuning step, §3.9 “Tuning the X Carriage” on page 33.

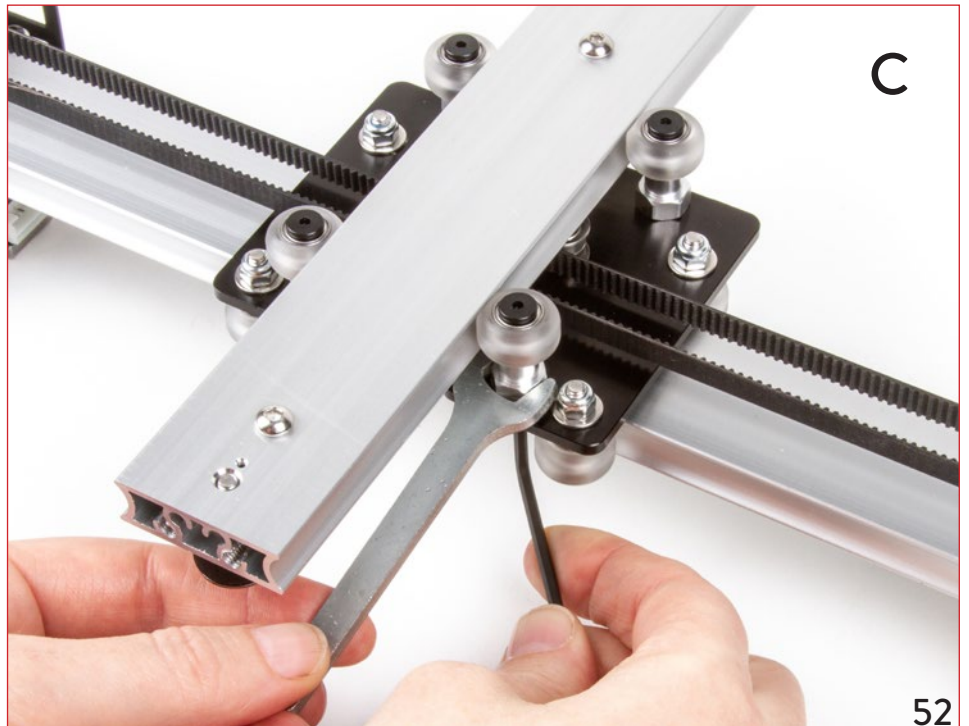
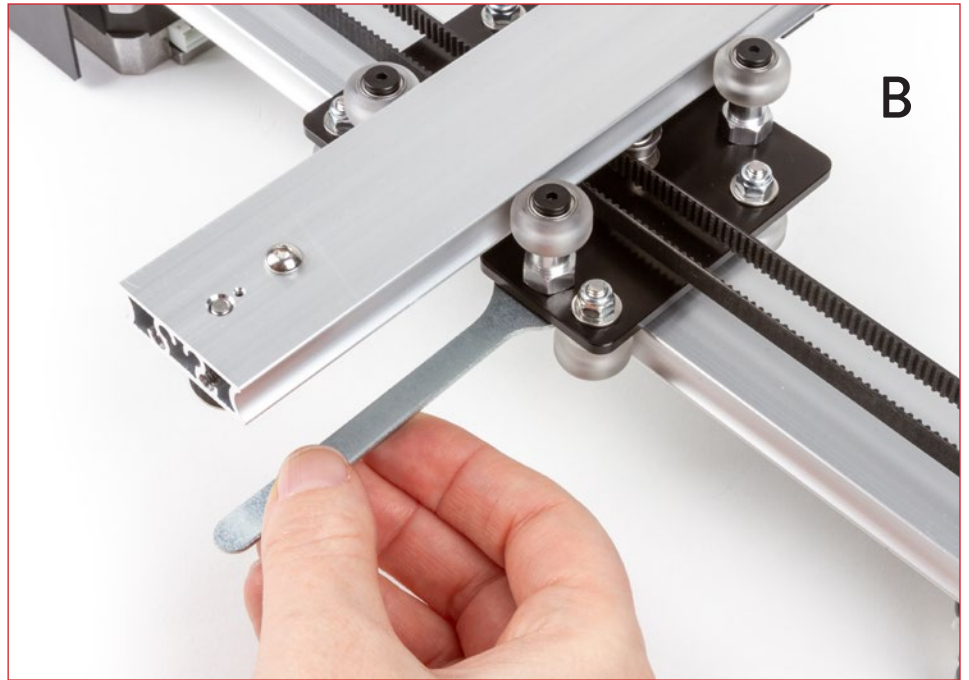
1. Position your hands as shown (**A**), with one hand on each side, and fingers almost directly in line with either the two front-side Y wheels or the two rear-side Y wheels. We will call these two pairs **Pair 1** and **Pair 2** for reference in this step. Feel for slack movement – there should be plenty at this point – along Pair 1 alone, and then along Pair 2.

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§4.12 Tuning the Y carriage, continued

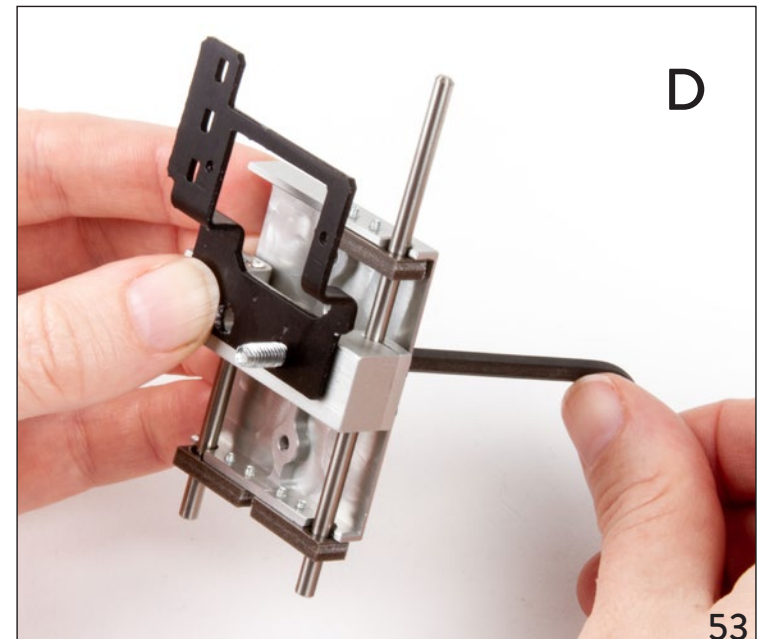
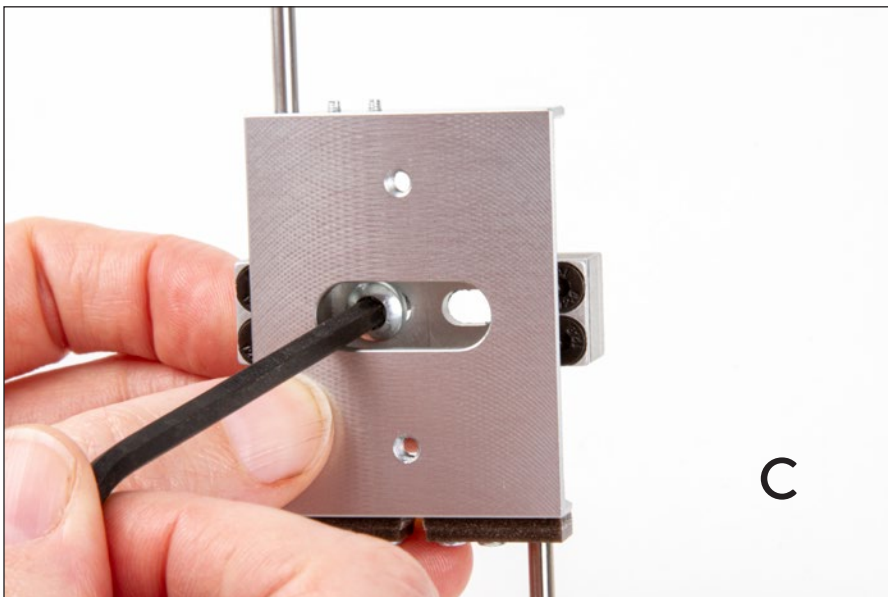
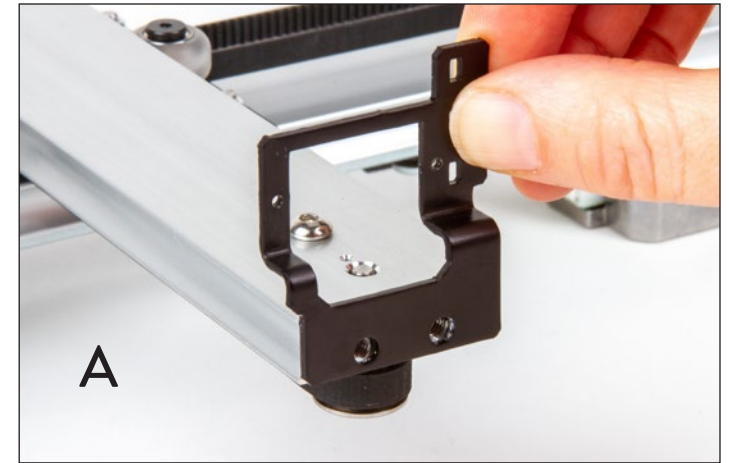
2. If you can feel any slack movement in Pair 1 alone, make a small adjustment to the position of the eccentric spacer beneath the SemiHex standoff (**B**). Repeat until there is no slack movement in line with these two wheels. The pair is properly adjusted when there is no slack movement when tested as in (**A**), but a wheel in the pair *can* be rotated with a little effort.
3. If the eccentric is difficult to turn, you may need to slightly loosen the screw below it. If it comes fully loose, tighten it versus the SemiHex Standoff.
4. Once Pair 1 is properly adjusted, repeat these steps for Pair 2.
5. Once both wheel pairs are tuned, tighten the eccentric in place. Hold the base of the SemiHex standoff steady with the 10 mm low-profile wrench #5 while you tighten the wheel securely in place with the short side of the 2.5 mm hex L-wrench from the bottom (**C**). Check again to make sure that both wheel pairs are properly adjusted.



4.13 Adding the Z Slide

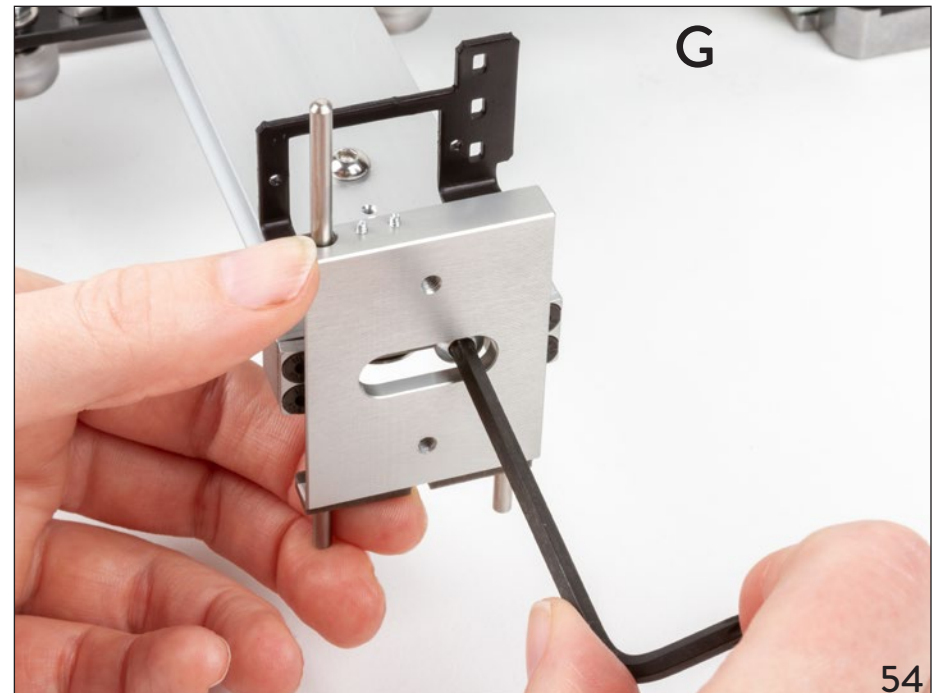
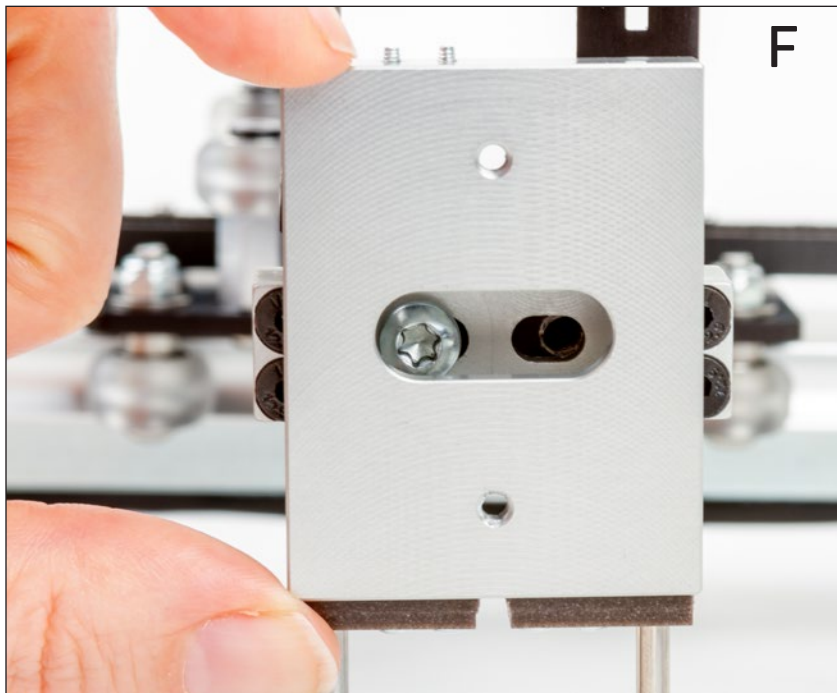
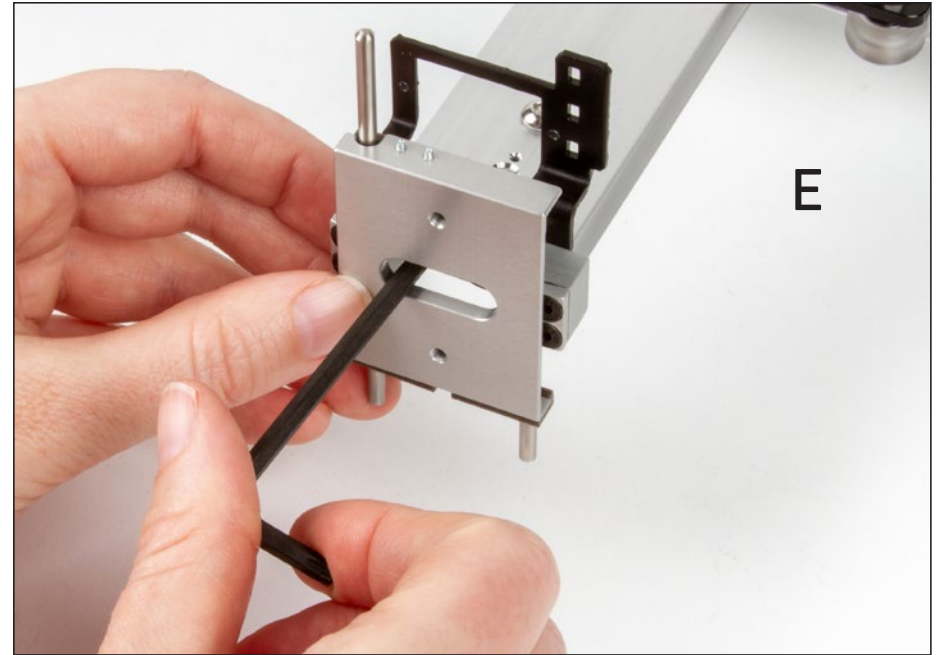
1. Identify the servo mount, #51, and test fit it over the front end of the Y carriage (A). The two holes should line up with the lower two holes, which you tapped earlier. It extends above the Y carriage, and folds back over it slightly.
2. Identify part #52, the Z slide assembly. This has two parts, a front face with two small holes and one large slot, and a smaller rear mounting bracket with two smaller slots in it. Check that the front face slides freely with respect to the mounting bracket.
3. Put one of the M4×12 Torx Tapping Screws #17 on the tip of the #2 Torx L-wrench (B), and then insert it through the mounting bracket of the Z slide (C) and the servo mount (D), matching the orientation shown. **Important:** Take care that the screw head touches only the back mounting bracket of the Z slide, *not* the front face.

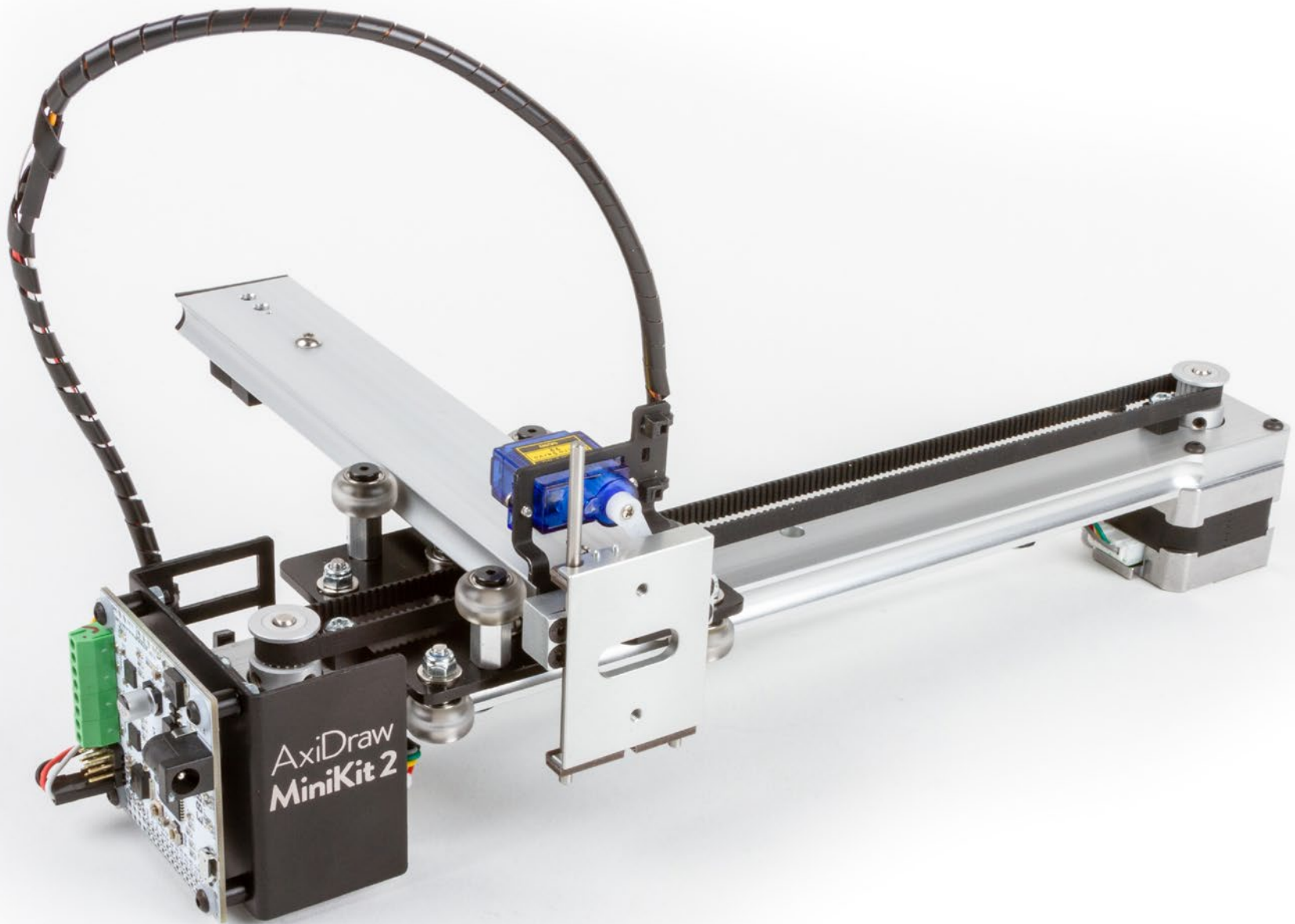
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§4.13 Adding the Z Slide, continued

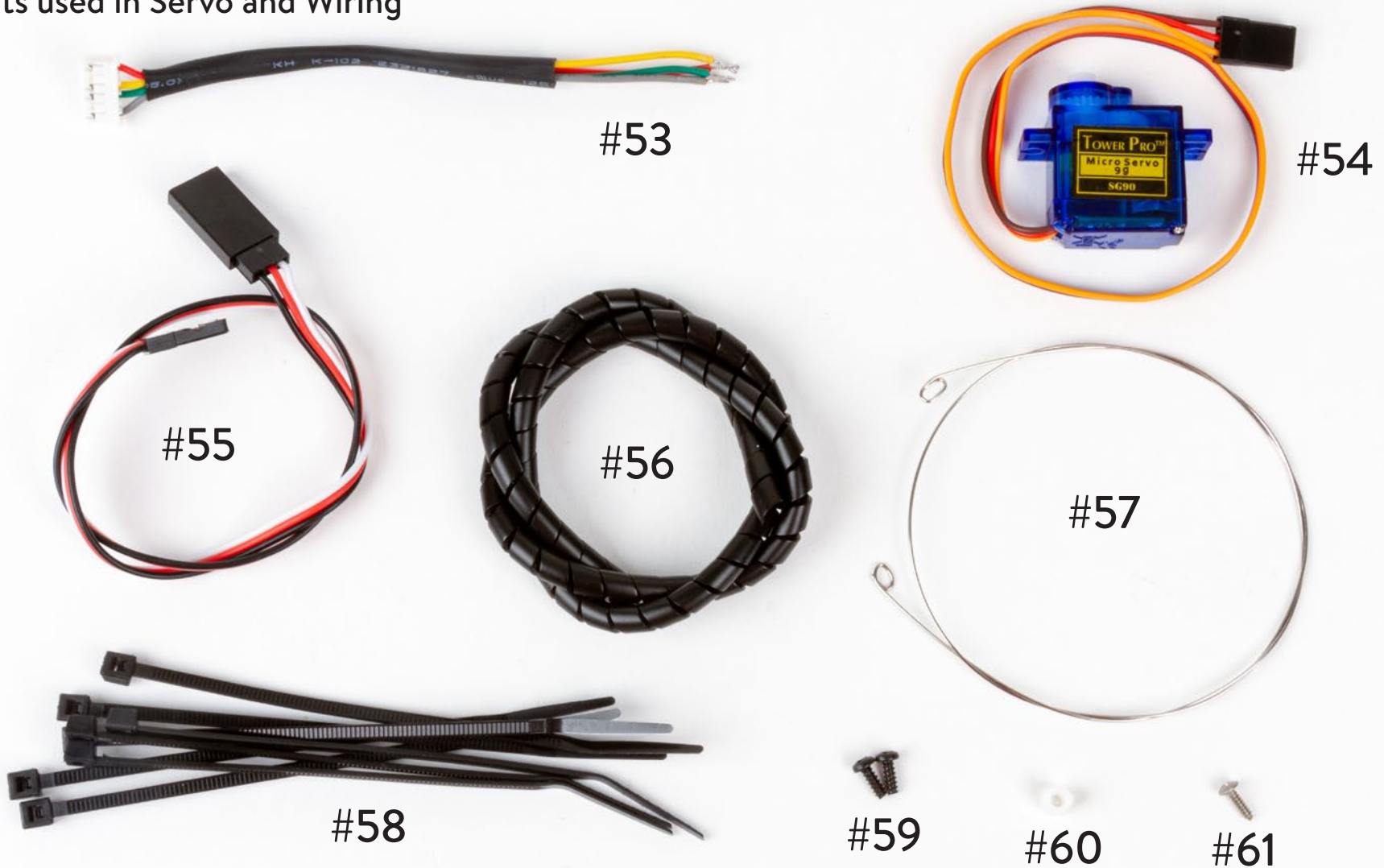
4. Engage the screw into the tapped hole in the end of the Y carriage, and bring it to *almost* tight (**E**).
5. Align the Z slide mounting bracket and servo mount such that the path is clear for the second screw (**F**).
6. Add the second screw (**G**). Again, ensure that the screw head engages with the mounting bracket of the Z slide *not* the front face of the slide.
7. Tighten both screws securely.





Part 5: Servo and wiring

5.1 Parts used in Servo and Wiring



#53, Motor Wire Harness, Short (1)

#54, Micro Servo Motor (1)

#55, Servo Extension Cable (1)

#56, Spiral Wrap Tubing (1)

#57, Support Wire (1)

#58, Cable Ties (8)

#59, No. 2 Tapping Screws (2)

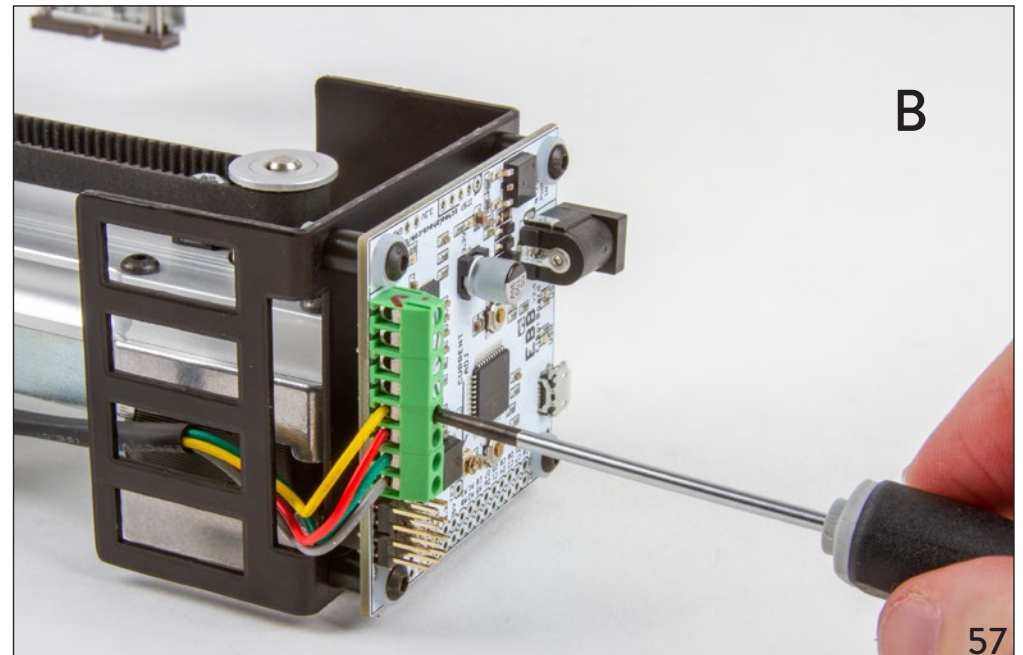
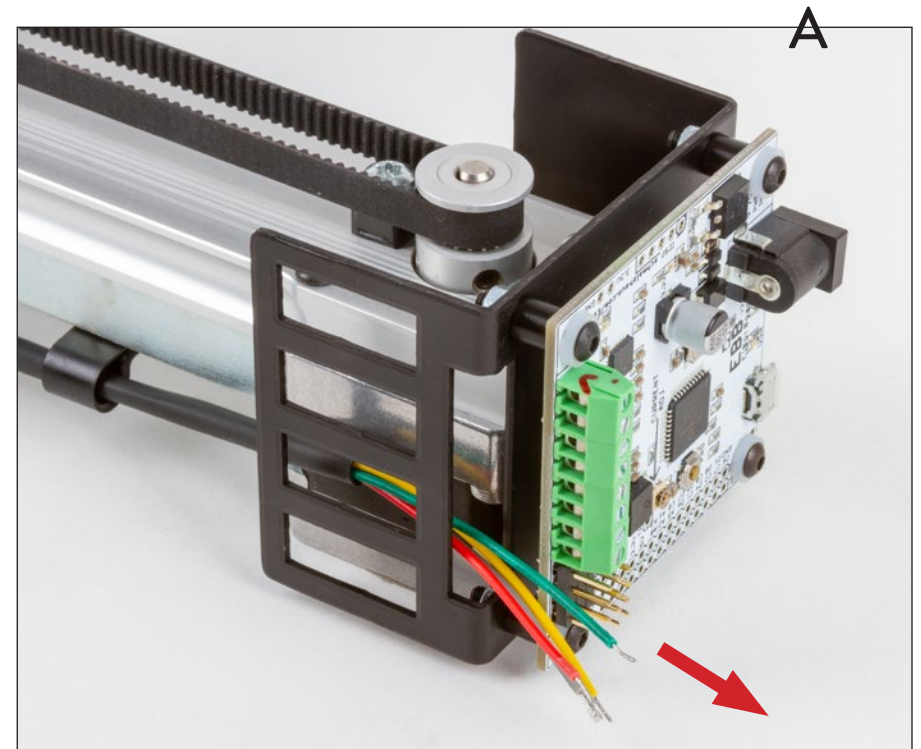
#60, White Nylon Spacer (1)

#61, No. 1 Truss-head screw (1)

5.2 Stepper wiring 1

1. Pull the wire ends from your long Motor Wire Harness through the tall vertical slot on the back of the EBB Support (**A**). These wires come out next to the tall 8-position terminal block.
2. One by one, insert the four wire ends into the terminal block and tighten them firmly with your small flat-head screwdriver. The wires go into the lowest four positions ("motor 1") on the driver board, and the wire order is, bottom to top: Gray, Green, Red, Yellow.

Tip: If you are unable to tell the wires apart by color, please contact technical support for assistance.

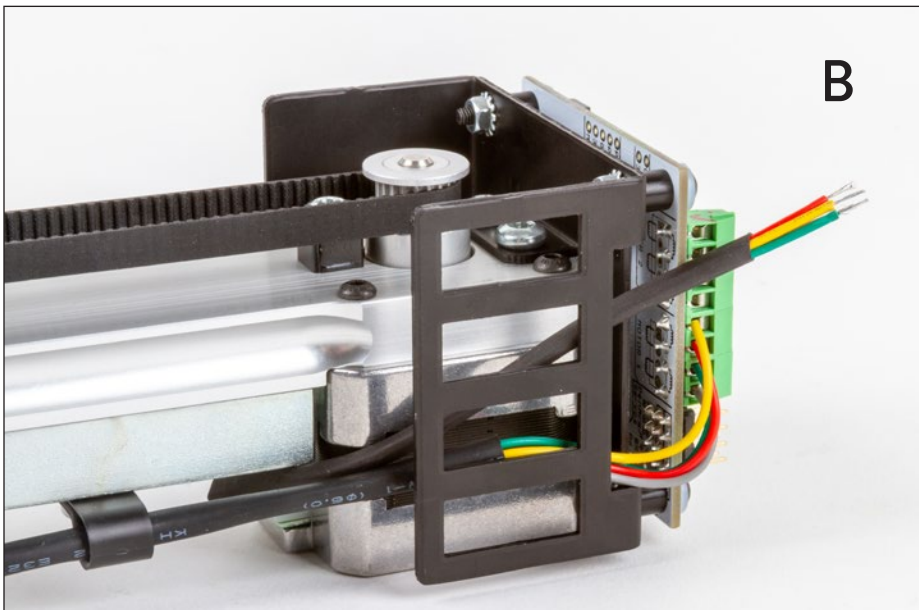
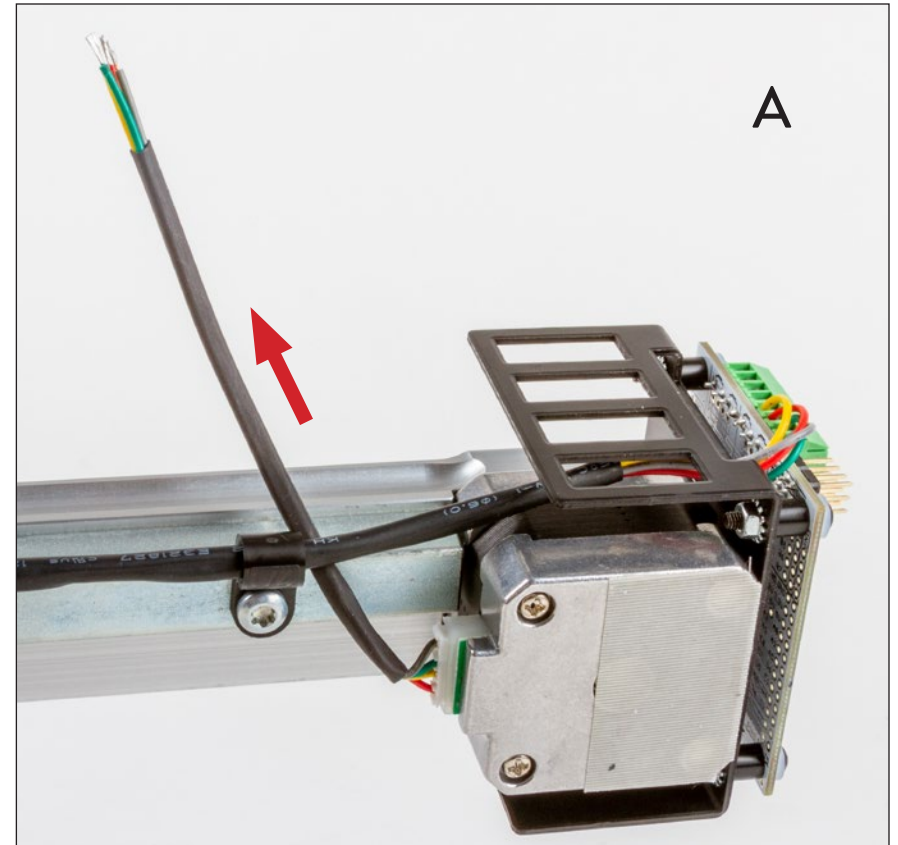


5.3 Stepper wiring 2

1. Attach the Short Motor Wire Harness #53 to the left-hand stepper motor, with its loose end guided through the gap by the motor above the Long Motor Wire Harness (A).

Tip: It may be easier to position the wiring harness through this gap first, *before* connecting it to the motor

2. Guide the wires over through the vertical slot, above the other Wire Harness (B).
3. Connect the four wire ends to the upper four positions of the EBB terminal block (C) and tighten each well. The wire order is again Gray, Green, Red, Yellow, bottom to top.



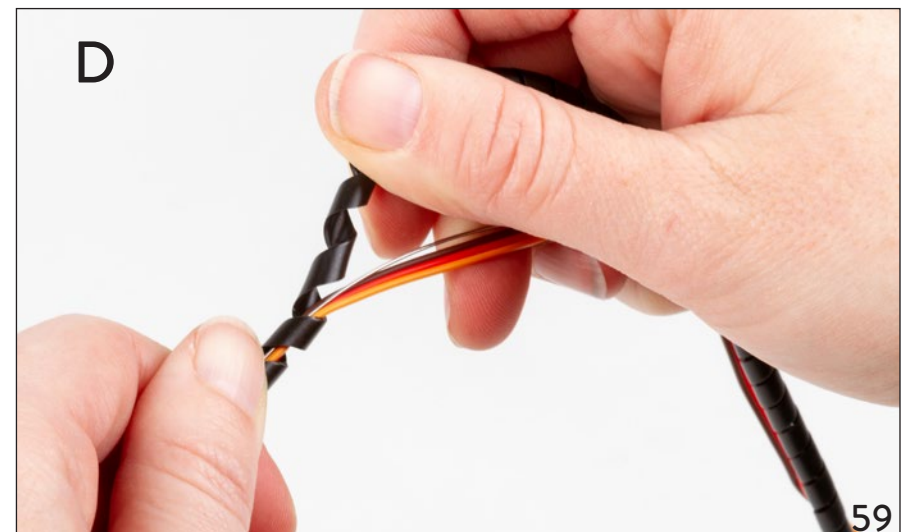
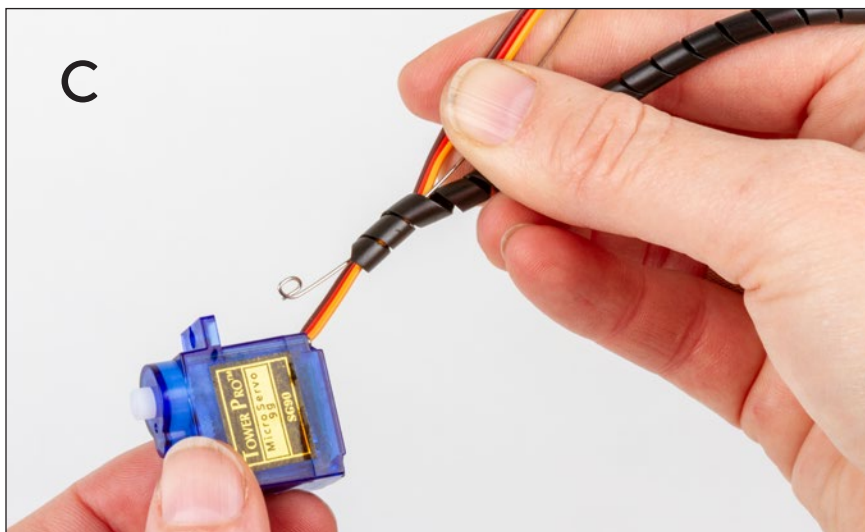
5.4 Cable guide wrapping



The Support Wire is made from spring-temper stainless steel. It is very springy and may have sharp ends that can spring at you. Handle with appropriate care.

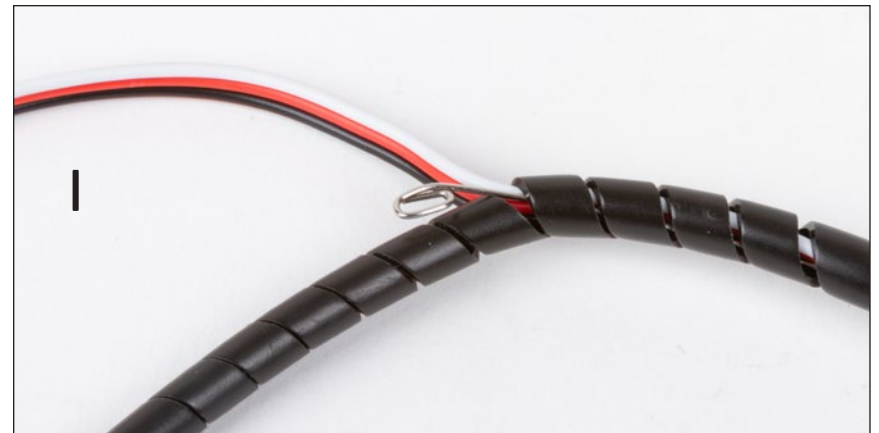
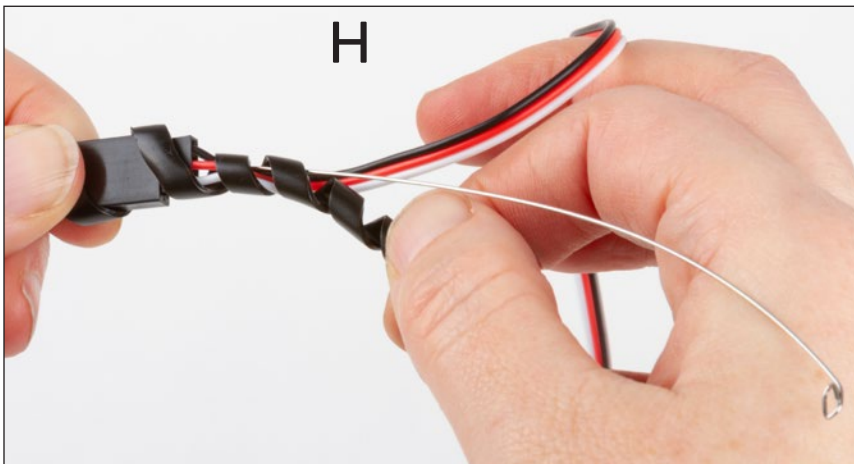
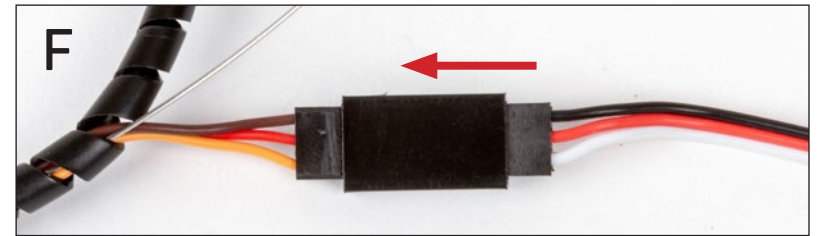
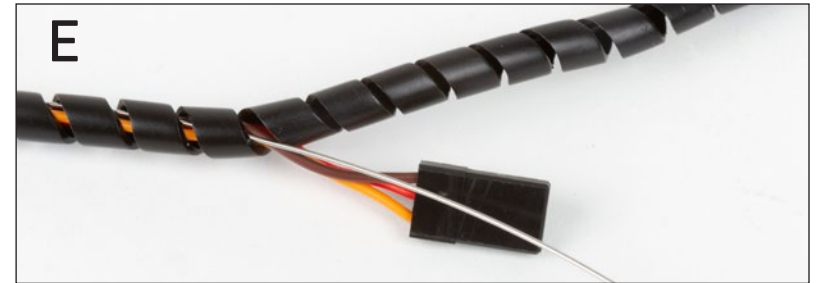
1. Get out the Micro Servo Motor #54. Set aside and keep the accessories that are packaged with it.
2. Carefully uncoil the Support Wire #57, and position one looped end of it next to the body of the servo motor (A).
3. Starting from the body of the Servo Motor, wrap the Spiral Wrap Tubing #56 around the servo cable and support wire. As you do so, keep the cable and wire together, and keep the loop end next to the servo body (B,C,D).

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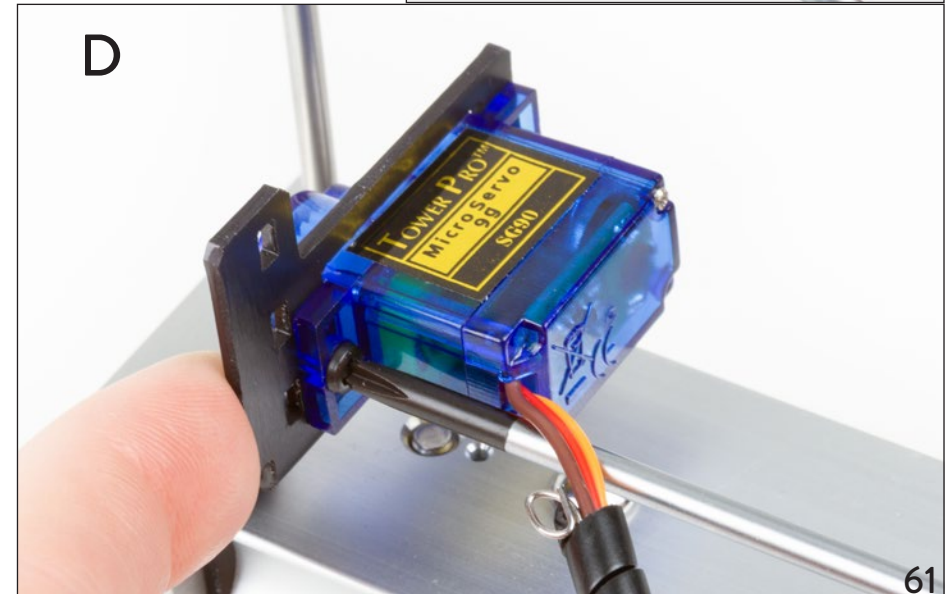
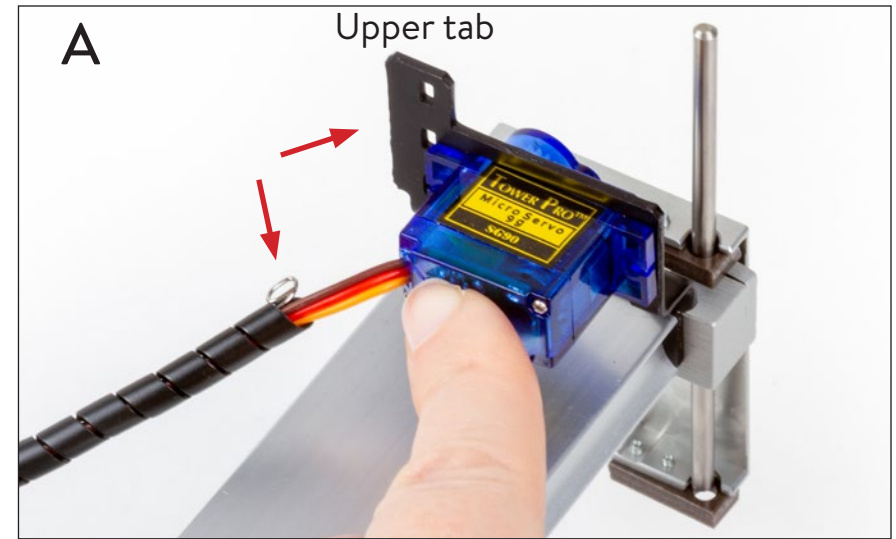
§5.4 Cable guide wrapping, continued

4. When you reach the end of the servo cable (**E**), connect the Servo Extension Cable #55 to its end (**F**). Orientation matters: The brown (darkest) wire on the servo cable connects to the black wire on the extension cable.
5. Continue wrapping the spiral wrap, including coarsely over the connection between the two cables (**G,H**).
6. When you reach the end of the support wire, you may have excess spiral wrap tubing, extending out past the end of the support wire. If so, trim it to length with scissors (**I**) and wrap the end neatly (**J**).



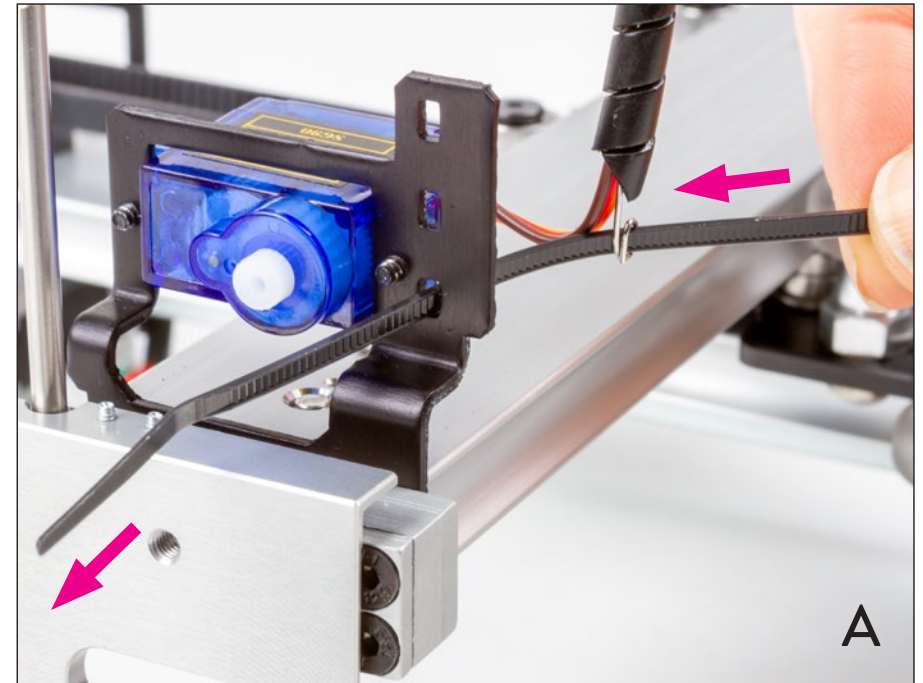
5.5 Mounting the servo

1. Test fit the servo motor. It will sit behind the servo mount, with the cable oriented towards the black upper tab of the servo mount (A).
2. Identify the two No. 2 Tapping Screws, #59. These screws are small and black, with a Phillips head and a length of about 6 mm under the head.
3. Put one of the screws on the tip of your #0 Phillips screwdriver (B) and steady it with a finger for inserting it into place.
4. Thread the screw through the servo and into the matching hole in the Servo Mount (C), and repeat for the other side (D), and then tighten both screws securely.

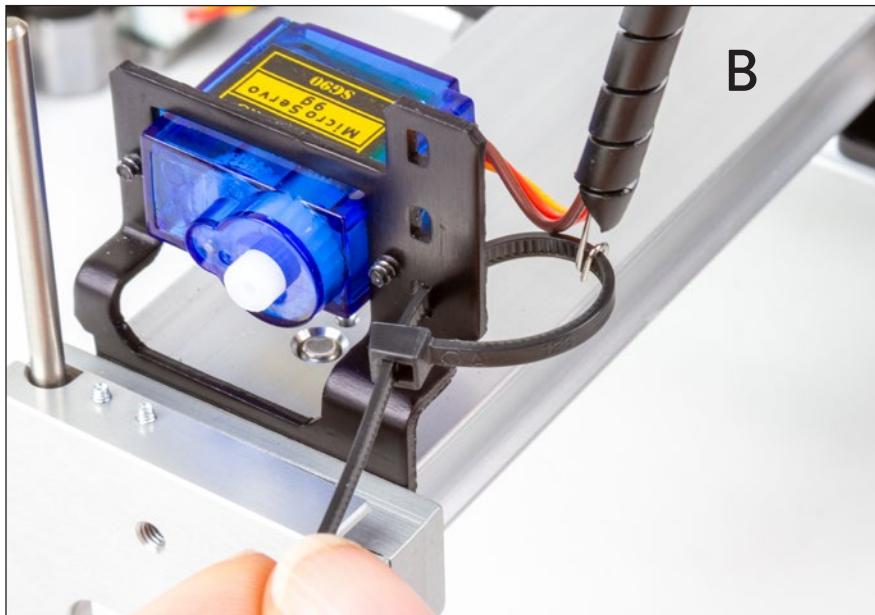


5.6 Mount the cable guide

1. Slip the narrow end of a cable tie #58, through the loop at the end of the support wire and then forward through the lowest rectangular hole in the servo mount (**A**). Then, loop the narrow end through its square locking piece to close it (**B**).
2. Pull the loose end of the cable tie to take out the slack. As you do so, guide the support wire loop behind the servo mount, and the square locking piece to sit flat against the front of the Servo Mount (**C**). Cinch the cable tie firmly.

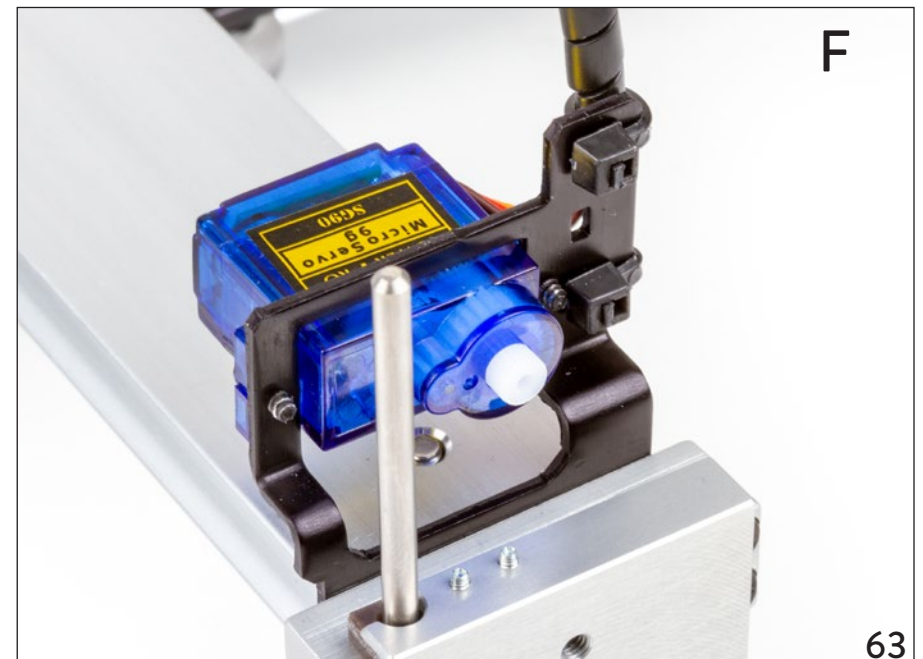
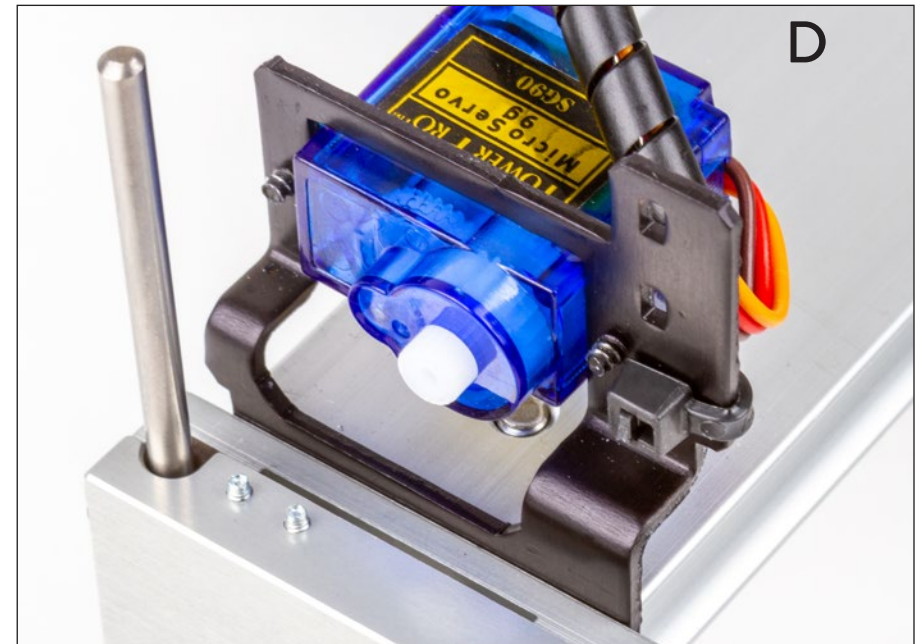


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§5.6 Mount the cable guide, continued

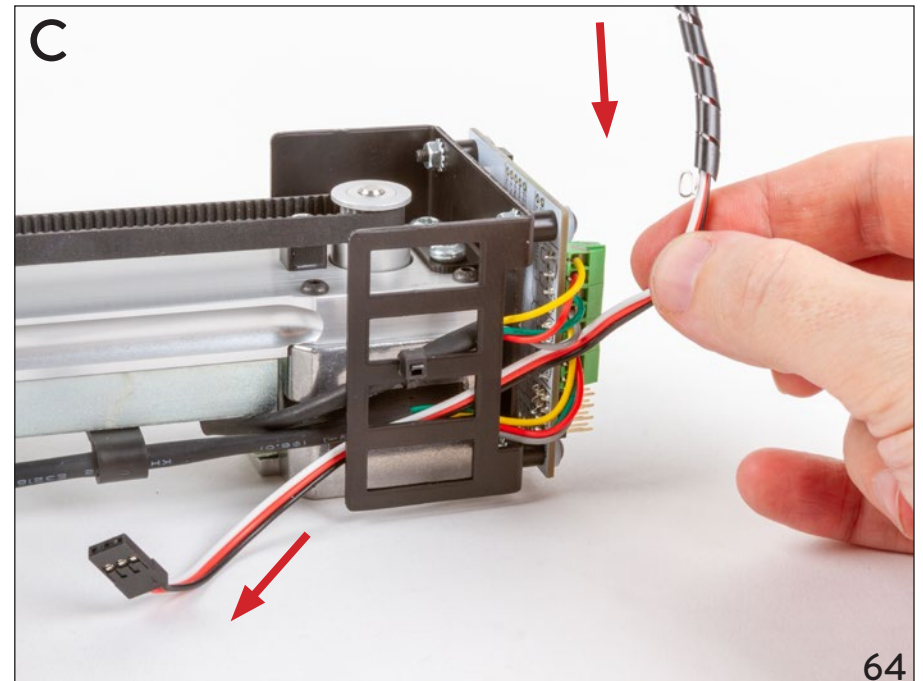
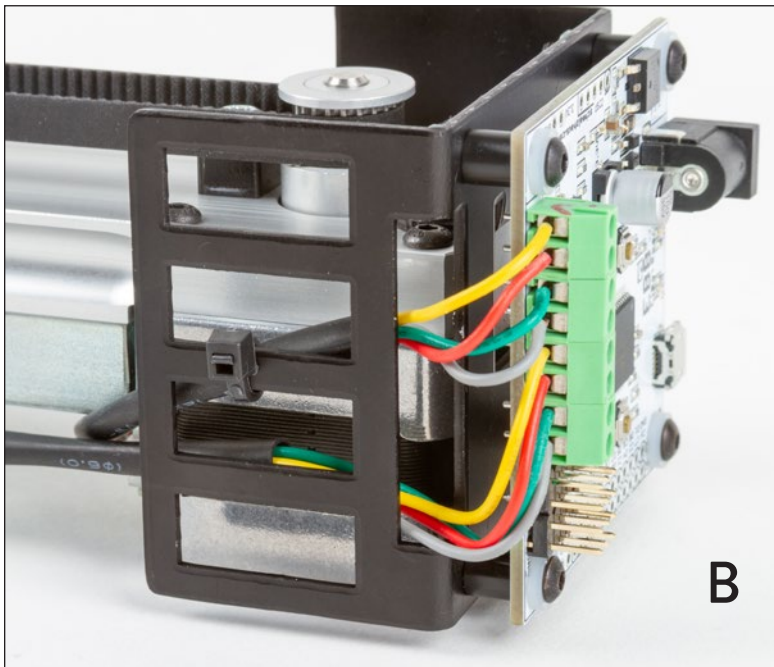
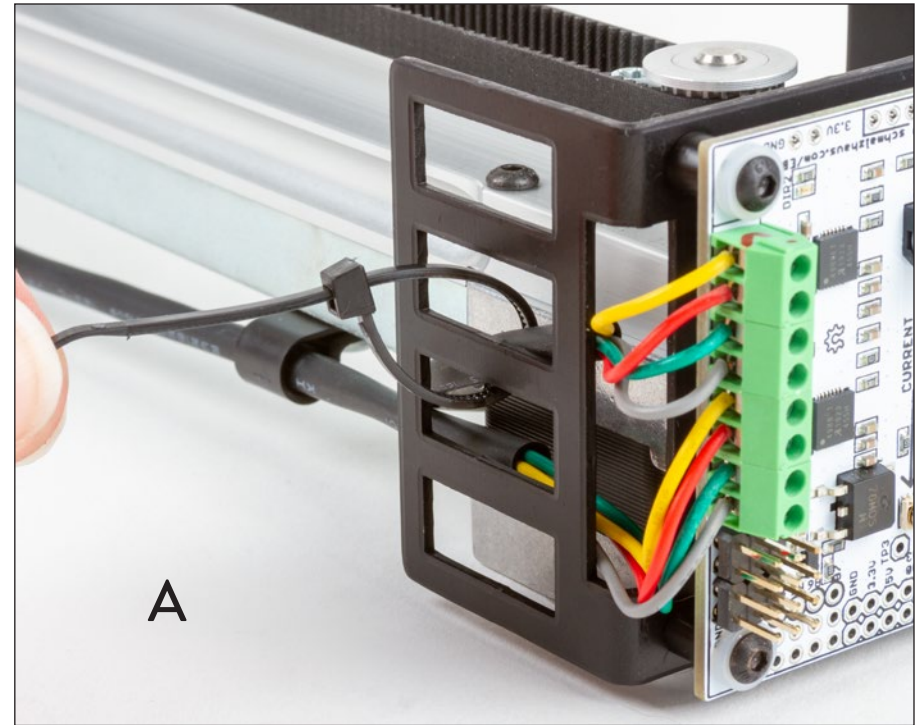
3. Cut off the excess length of the cable tie, with scissors or wire clippers (**D**).
4. Add a second cable tie, looping around the wrapped cable, forward through the uppermost rectangular hole in the servo Mount (**E**). Cinch it tight and cut off the excess length (**F**).



5.7 Complete the wiring

1. Use a cable tie to attach the Short Motor Wire Harness to the middle horizontal “beam” of the EBB support (A).
2. Cinch the cable tie tight and cut off the excess length (B).
3. Pull the free end of the servo extension cable in through the vertical slot of the EBB support, below the left-hand motor wire harness that you just tied down (C).

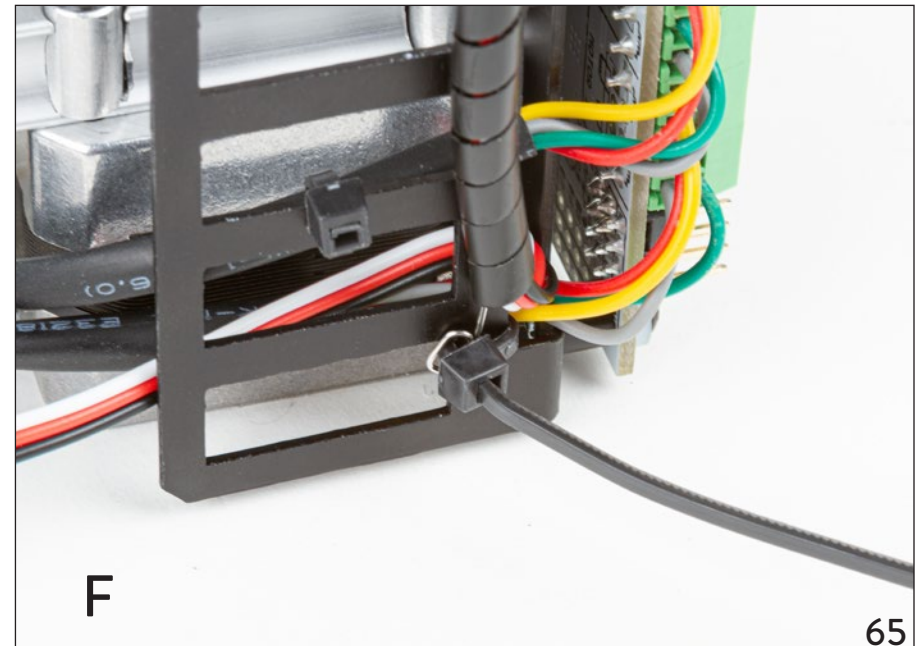
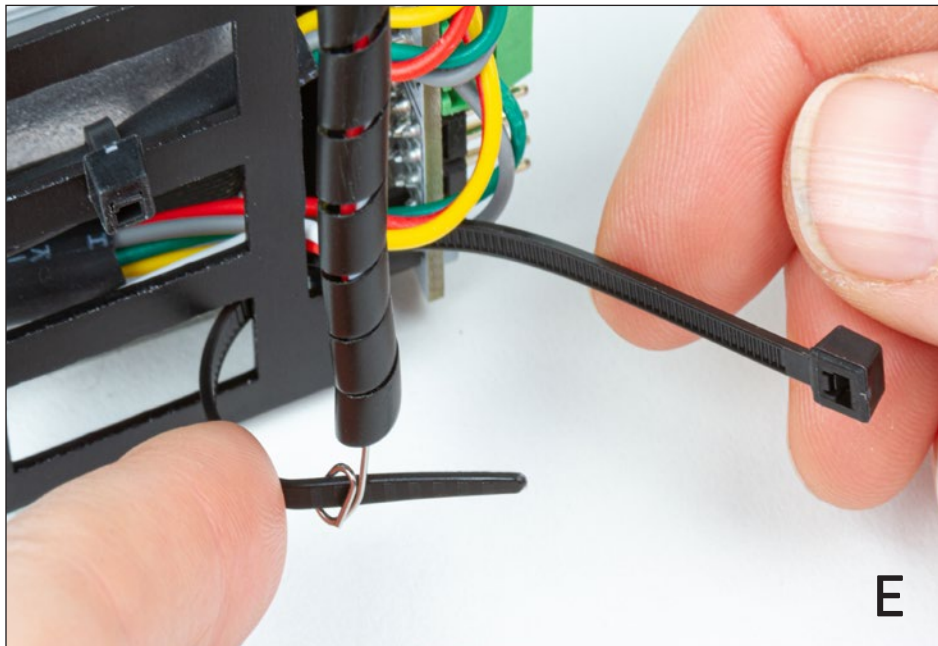
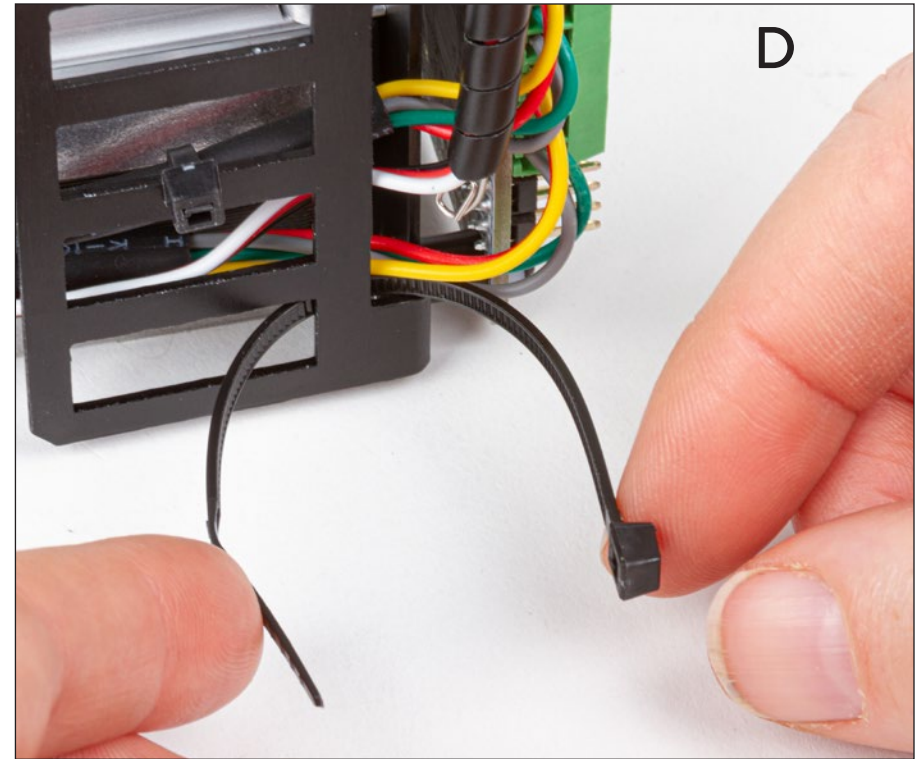
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§5.7 Complete the wiring, continued

4. Loop a cable tie into the bottom of the vertical slot in the EBB support, and out of the lowest horizontal slot (**D**).
5. Slip the end of that cable tie through the loop at the end of the support wire (**E**).
6. Close and cinch the cable tie (**F**), pull it tight, and cut off the excess length.

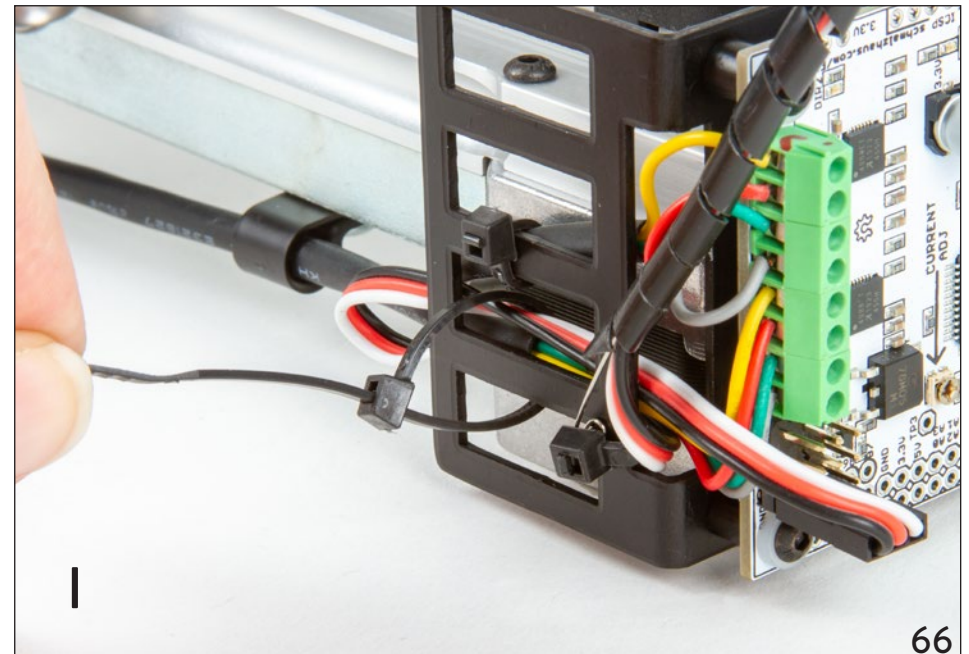
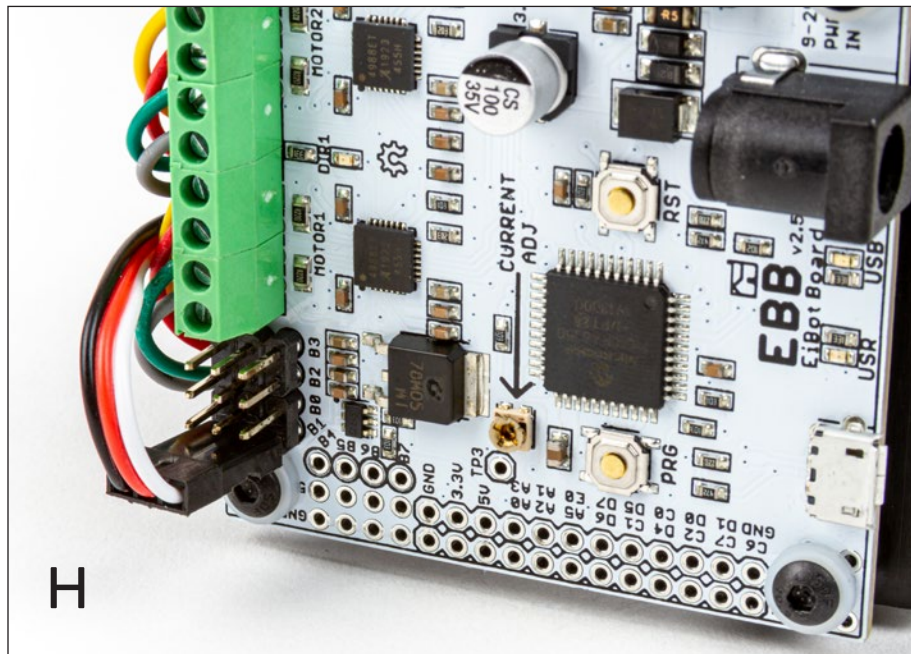
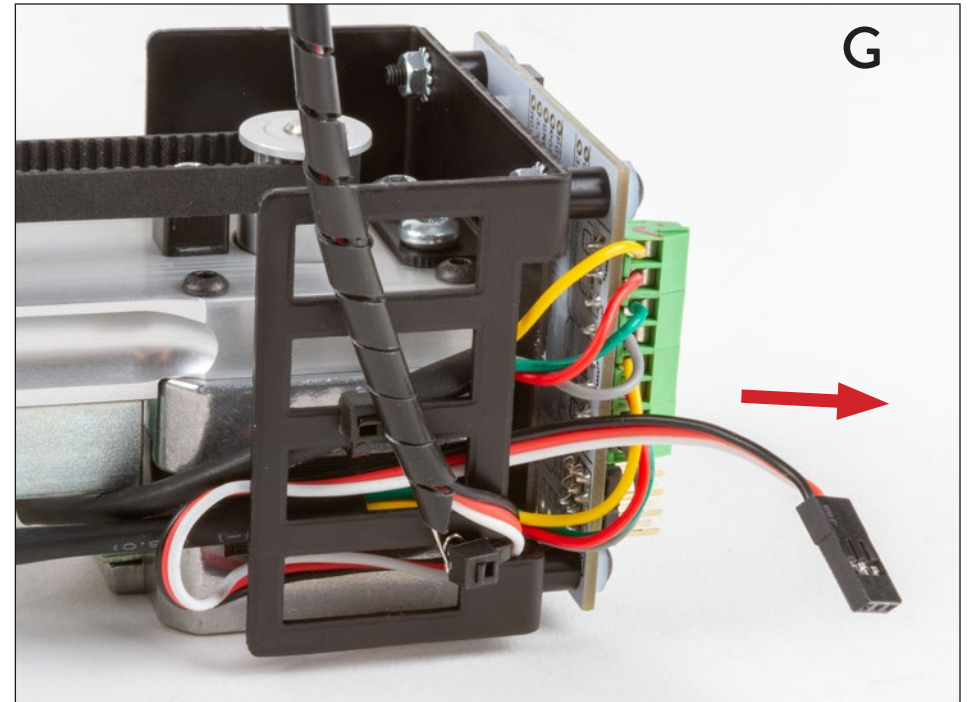
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§5.7 Complete the wiring, continued

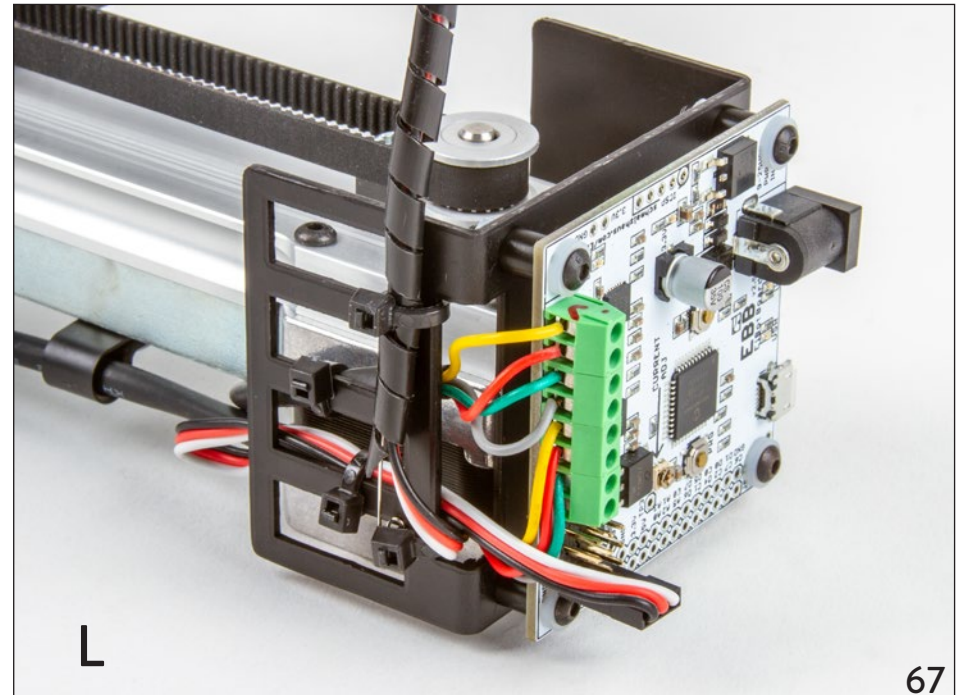
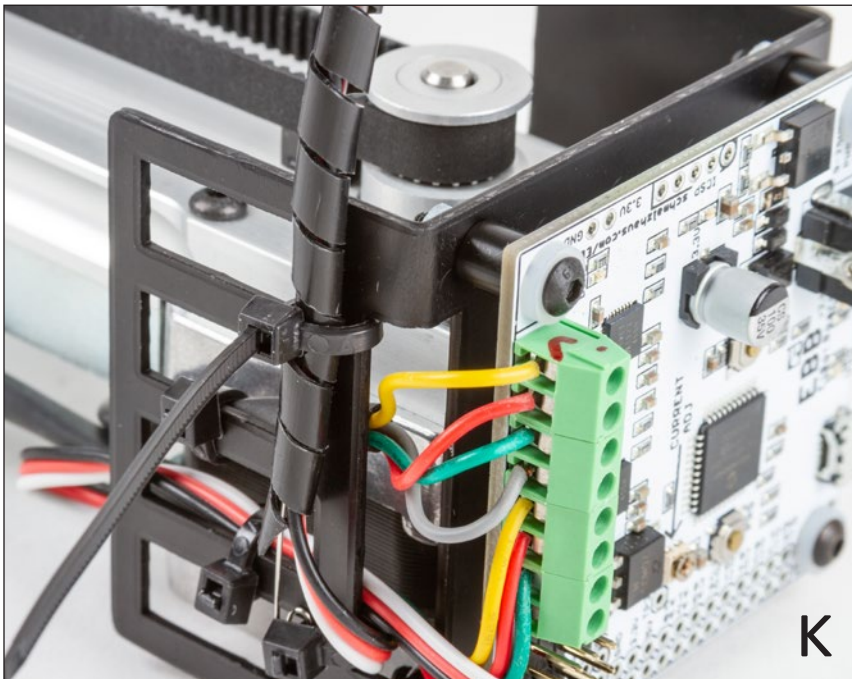
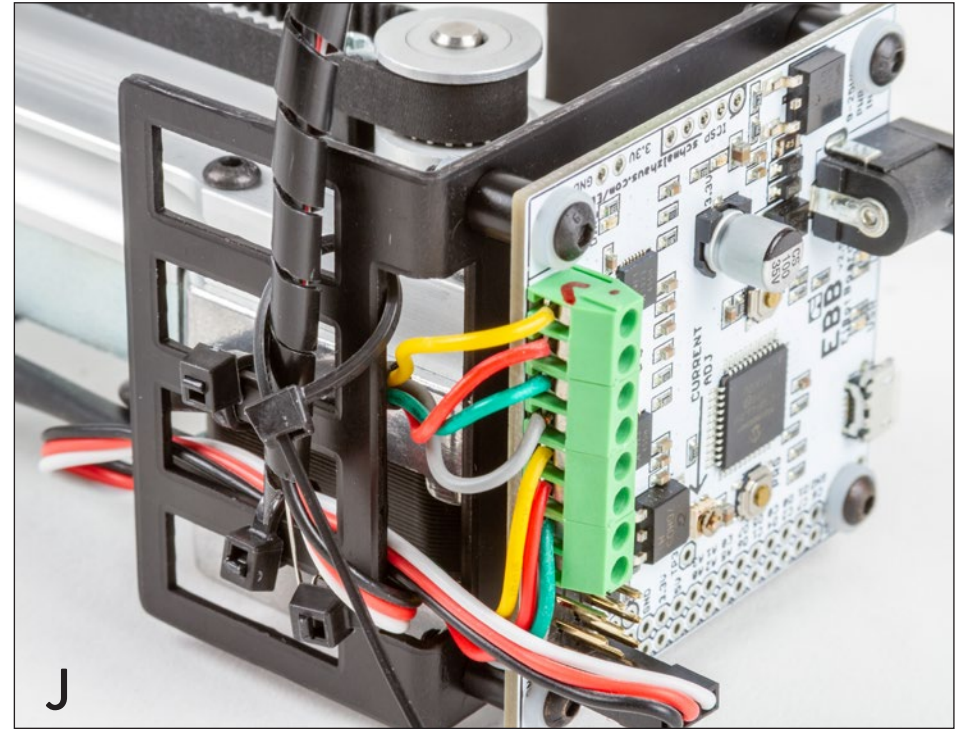
7. Pull the end – only the end – of the Servo Extension Cable out through the vertical slot in the EBB Support (G).
8. Plug in the Servo Extension Cable to the bottom three horizontal pins below the terminal block on the EBB driver board. The white wire goes forward, and the black wire back towards the edge of the board (H).
9. Loop a cable tie around the horizontal beam of the EBB Support below the middle beam, capturing the Long Motor Wire Harness and both directions of the Servo Extension Cable (I). Cinch it tight and cut off the excess length of the cable tie.

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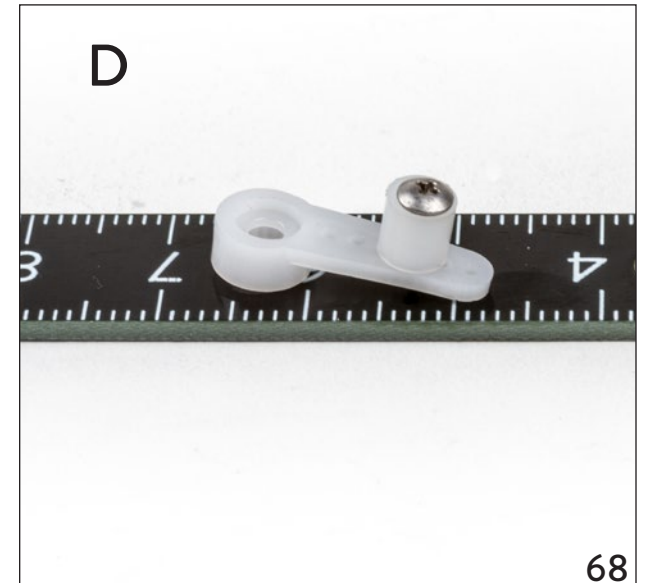
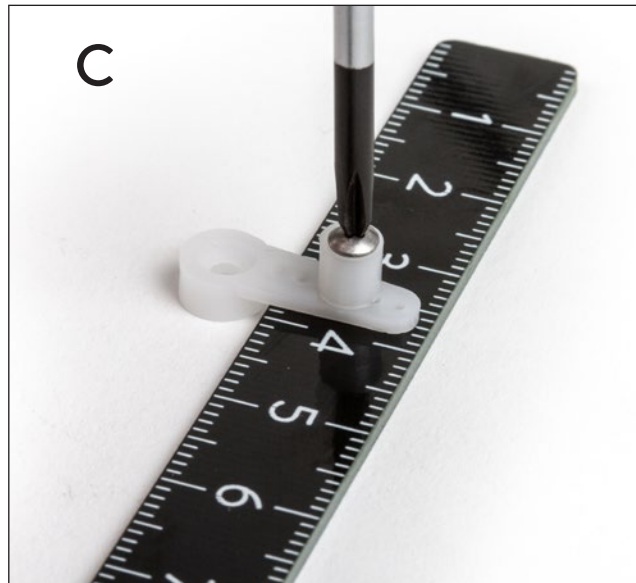
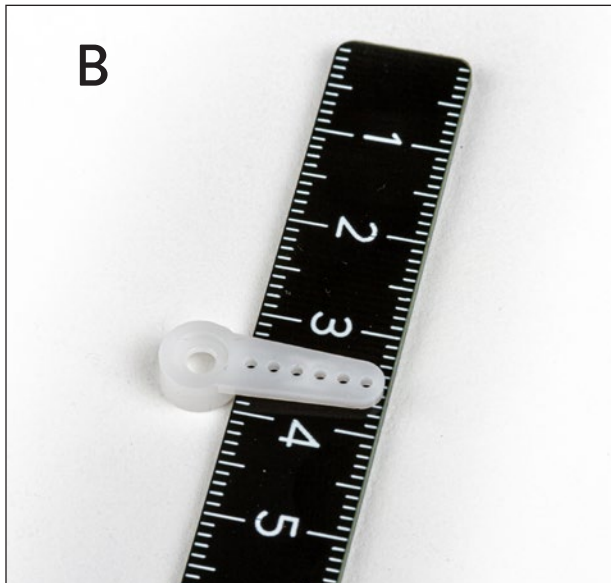
§5.7 Complete the wiring, continued

10. Loop a cable tie into the top of vertical slot in the EBB Support, out of the highest horizontal slot, and around the wrapped cable and support (J).
11. Cinch that cable tie very tight, to support the cable guide vertically (K), and cut off the excess length (L).



5.8 Servo horn

1. The micro servo motor **#54** has several small accessories packed with it (**A**). Of these, we need the single-ended white plastic “horn” **#54a** in this step and the single short screw, **#54b**, in the next.
2. Also identify short nylon spacer **#60** and Phillips truss-head screw **#61**. The nylon spacer is a short white plastic tube, and the screw can be identified by its wide head, silver color, and length of about 6 mm under the head.
3. Prop up the flat part of the servo horn on the ruler (**B**), and identify the third hole from the end (indicated by arrow).
4. Place the spacer over this hole, slip truss-head screw **#61** through the hole, and tighten it with your #0 Phillips driver (**C**). The horn is now ready to install (**D**).



5.9 Servo calibration

Before getting started: This is the last major assembly step. For this step you will need to have the AxiDraw software installed on your computer. Please visit: axidraw.com/sw for installation instructions.

1. Connect the AxiDraw MiniKit to power, using the included AC adapter and to your computer via USB (A).
2. On your computer, open Inkscape, and select from the menu: **Extensions > AxiDraw Control...**

Tip: If the AxiDraw software is not listed in the Extensions menu with Inkscape, then your software installation is not complete. Please refer to the link above for more about software installation.

3. Within AxiDraw Control, select the “Setup” tab. There (B), select the following settings:

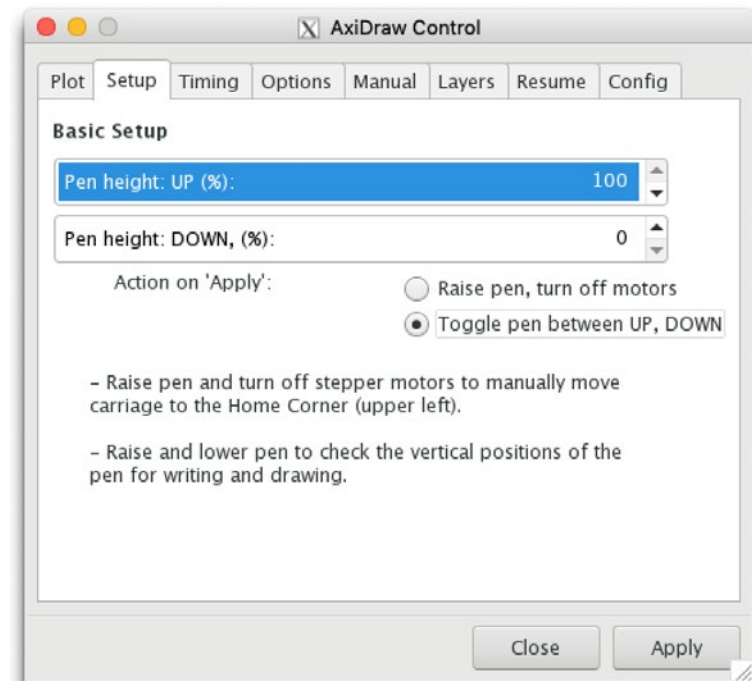
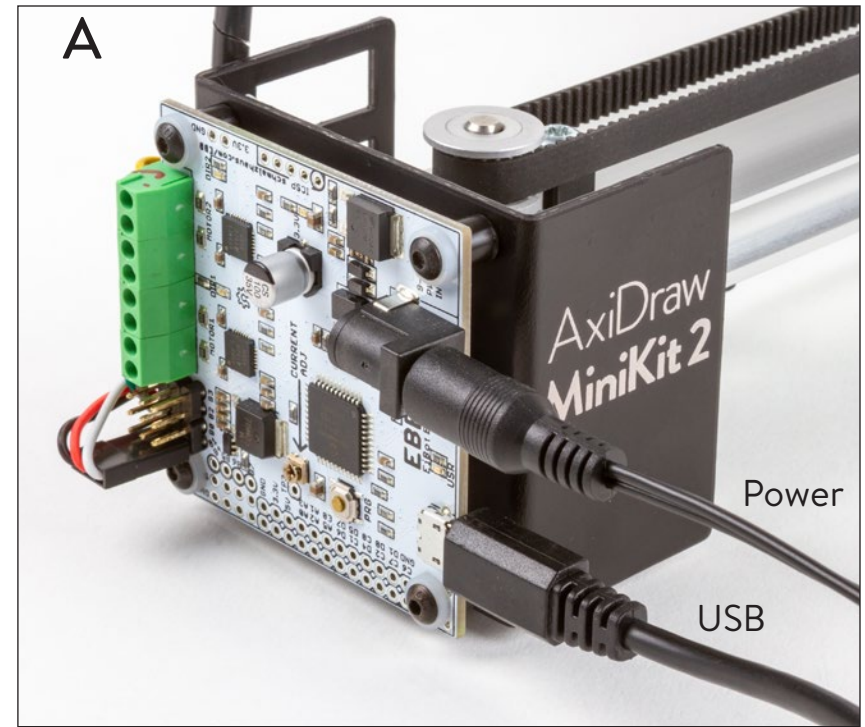
Pen height, up: 100%

Pen height, down: 0%

Action: Toggle pen between up, down

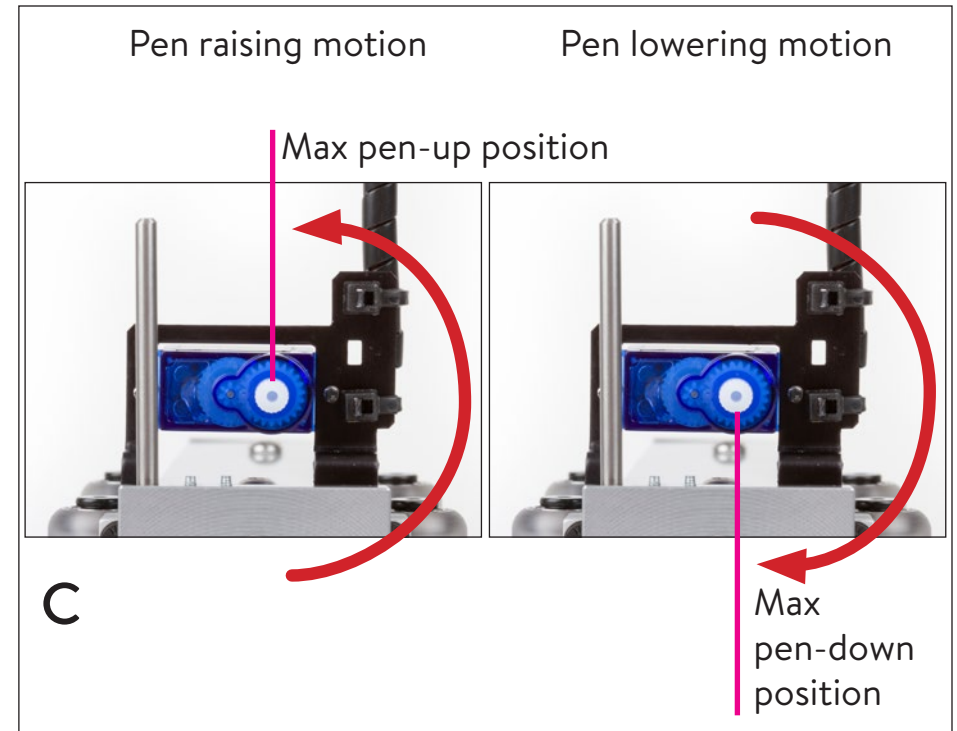
4. Click the **Apply** button several times to toggle the pen position between the pen-up and pen-down positions. If all is working correctly, you should hear the sound of the pen-lift micro servo moving between the pen-up and pen-down positions.

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§5.9 Servo calibration, continued

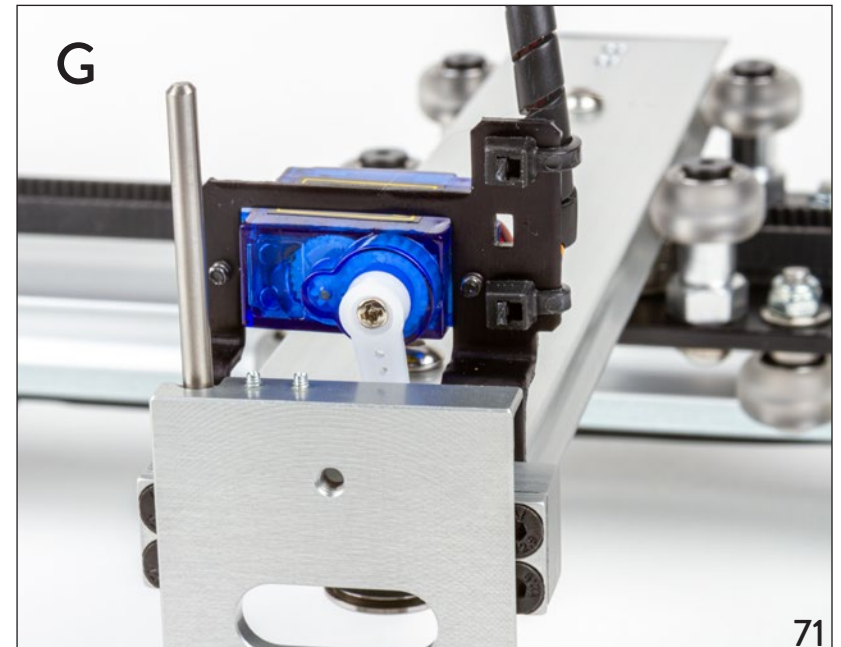
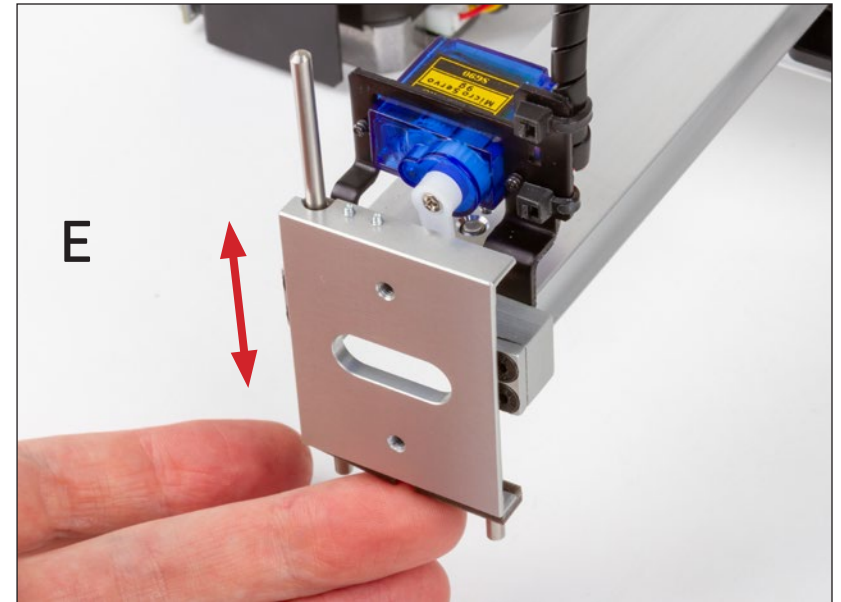
5. Place a finger tip on the output shaft of the servo motor – the little white cylindrical protrusion – so that you can feel when it moves.
6. The two movements that the servo makes (**C**) are a pen-raising motion (counterclockwise, viewed from the front) and a pen-lowering motion (clockwise, when viewed from the front). Press **Apply** a couple more times so that you can feel it move between the two positions.
7. Stop toggling when you are *certain* that the servo is in the pen-down position.
8. Pull the Z Slide up slightly, and press the servo horn into position on the servo output shaft (**D**). It should point straight down, or slightly towards the cable guide. It must not point to the left at all, past the “Max pen-down position” (**C**).

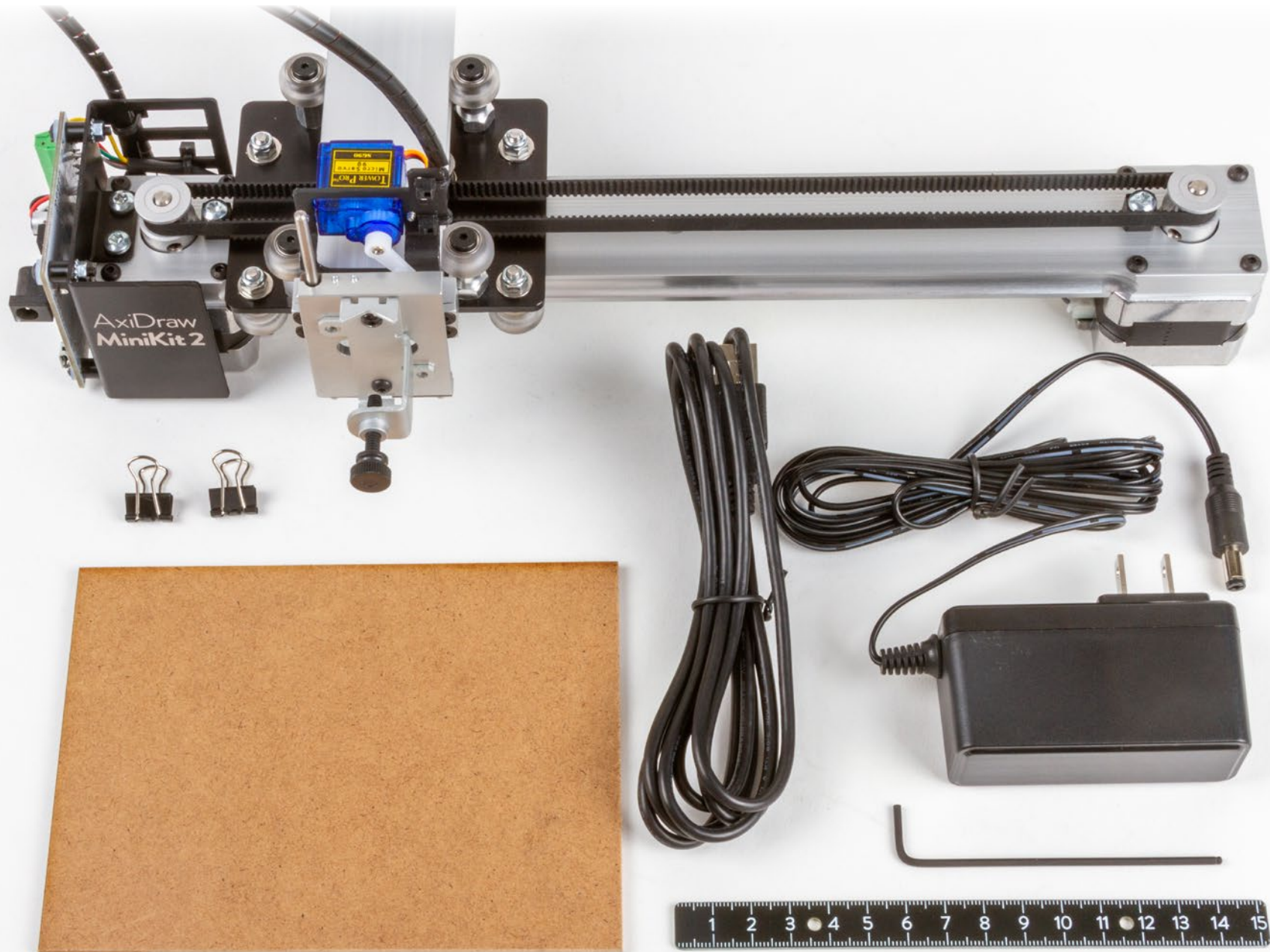


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§5.9 Servo calibration, continued

9. Check that the Z Slide moves freely up and down when moved by hand (**E**). It may need a little manual “jogging” to loosen up. (If you cannot get it to slide freely, please contact technical support for assistance.)
10. Toggle the pen up and down with AxiDraw Control (**F**). If things are set up properly, it will move between two vertical positions between the maximum pen-up and maximum pen-down positions described previously (**C**). It may not – and does not need to – reach either extreme.
11. If all looks well, unplug the machine from power and USB. Then, use your #0 Phillips screwdriver to add the little screw #54b to hold the servo horn to the output shaft (**G**).





Part 6: Using AxiDraw MiniKit

6.1 Accessories

The AxiDraw MiniKit 2 comes with certain accessories: The power supply, USB cable, and ruler that you've used by this point, plus the pen clip, screws for mounting the pen clip, the easel, and binder clips.

The pen clip is attached to the Z Slide of the AxiDraw by the two little screws, and there is a thumbscrew for holding the pen in place. Detailed instructions about the pen clip can be found in the main AxiDraw User Guide, available at:

<https://axidraw.com/guide>

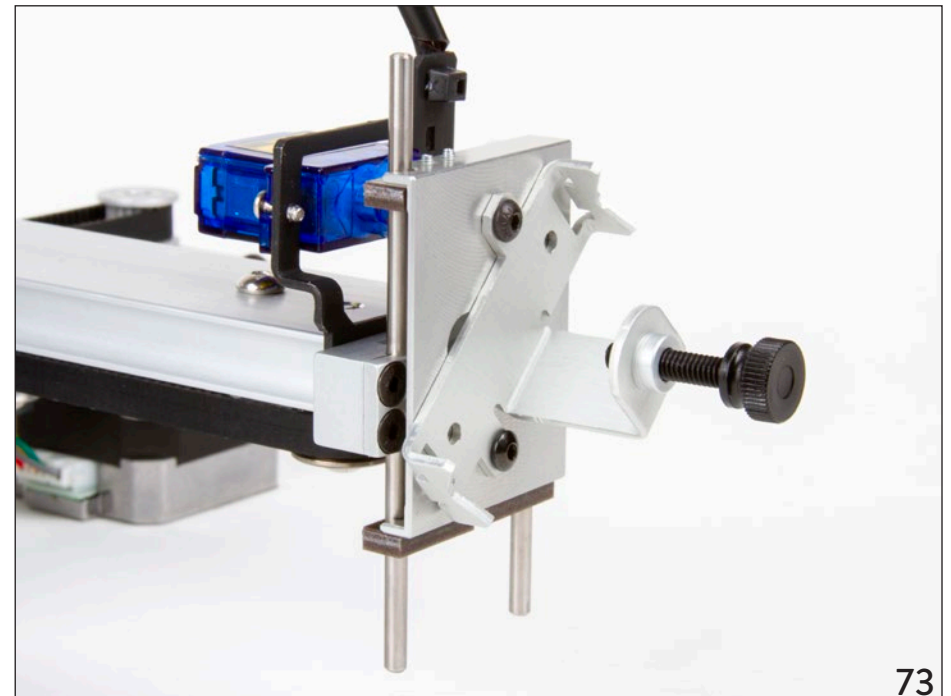
The easel comes as a bare piece of hardboard plus a packet of rubber feet. Six rubber feet are included. Press four of them at the corners of the hardboard, on the uglier or less-flat side. (Two are provided as spare, should they ever be needed.)

The binder clips can be used to attach print media (cards, pieces of paper, etc) to the easel while in use.

Additional AxiDraw accessories are available at:

<https://emsl.us/902>

Compatible accessories include the XL pen clip, Italic pen adapter, and Rigid End Effector.



6.2 The AxiDraw User Guide

The AxiDraw User Guide is the comprehensive reference to AxiDraw operation. While primarily oriented towards the AxiDraw V3 and other larger models that come pre-assembled, it contains a wealth of knowledge about AxiDraw family machines and how to use them from bare basics to advanced topics.

You can download the AxiDraw User Guide at:

<https://axidraw.com/guide>

6.3 Special considerations for MiniKit

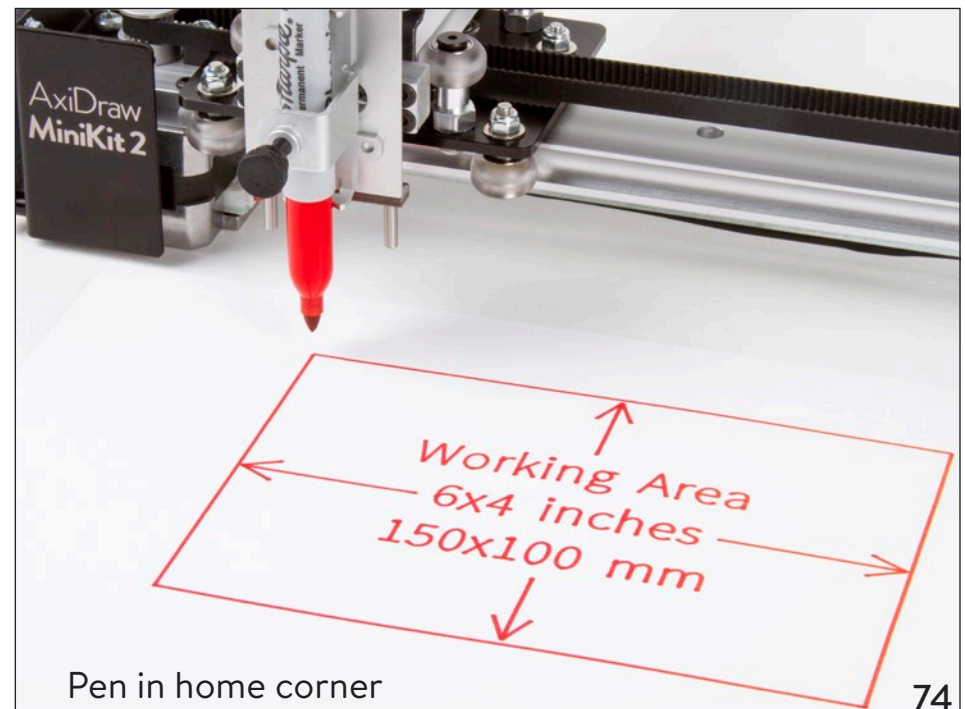
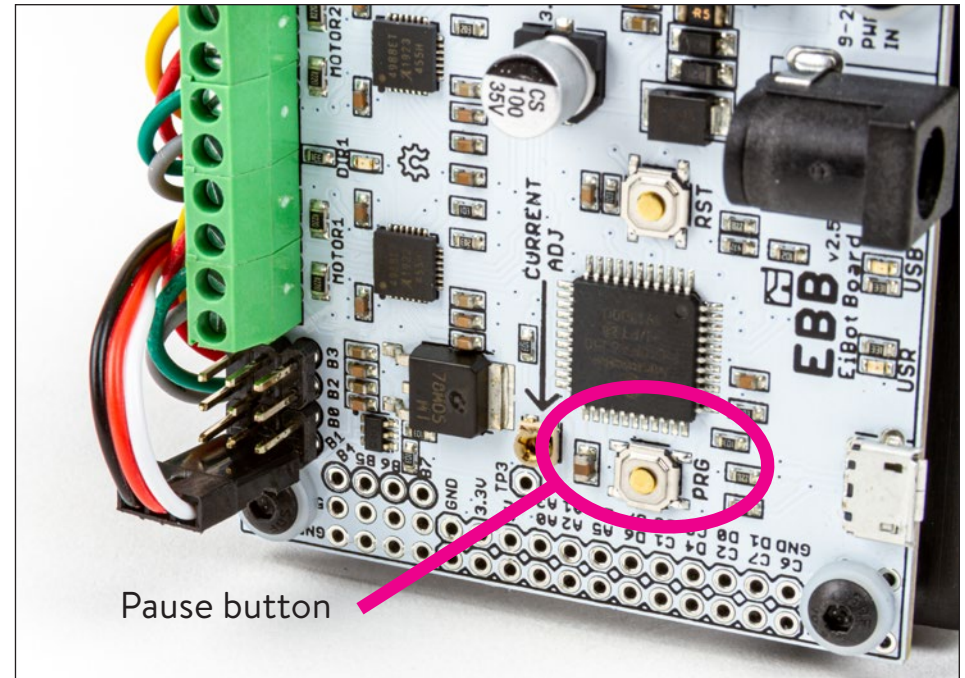
While the vast majority of the main AxiDraw User Guide is applicable to the MiniKit, there are several key differences that you should be aware of.

6.3.1 Pause button

The pause button on AxiDraw MiniKit is located directly on the EBB driver board, and is labeled “PRG”. It is in the same physical location as on other models (left side of the machine, behind the USB connector), but does not have the separate cover and button.

6.3.2 Home corner

The Home corner of the machine is labeled by the AxiDraw MiniKit logo, by the left-hand motor. The carriage is in the Home corner when it is moved fully back and left, such that the pen holder is as close as possible to the AxiDraw Mini-Kit logo.



6.3.3 Travel limits

The XY travel limits of the AxiDraw MiniKit are 160.0 × 101.6 mm (6.30 × 4.00 inches).

6.3.4 Pen weight

The maximum pen weight for the AxiDraw MiniKit is 30 g. It is recommended to use lighter-yet pens when possible.

6.3.4 Rubber bands

It is not recommended to use rubber bands or added weight to increase pen pressure with the AxiDraw MiniKit.

6.3.5 Speed and acceleration

The AxiDraw MiniKit is a light weight machine and typically needs to be operated at relatively low speeds compared to larger models that have a wider stance and much higher mass.

For best performance, speeds below 50% maximum are recommended for both pen-down and pen-up travel. The Acceleration parameter in the settings should be set to Standard (50%) or slower for most use cases.

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Additional Resources

Extended online documentation
& resources for AxiDraw:

axidraw.com/docs



Blog: www.evilmadscientist.com

Store: shop.evilmadscientist.com

Docs: wiki.evilmadscientist.com

Support Chat: discord.gg/axhTzmr

Humans: shop.evilmadscientist.com/contact