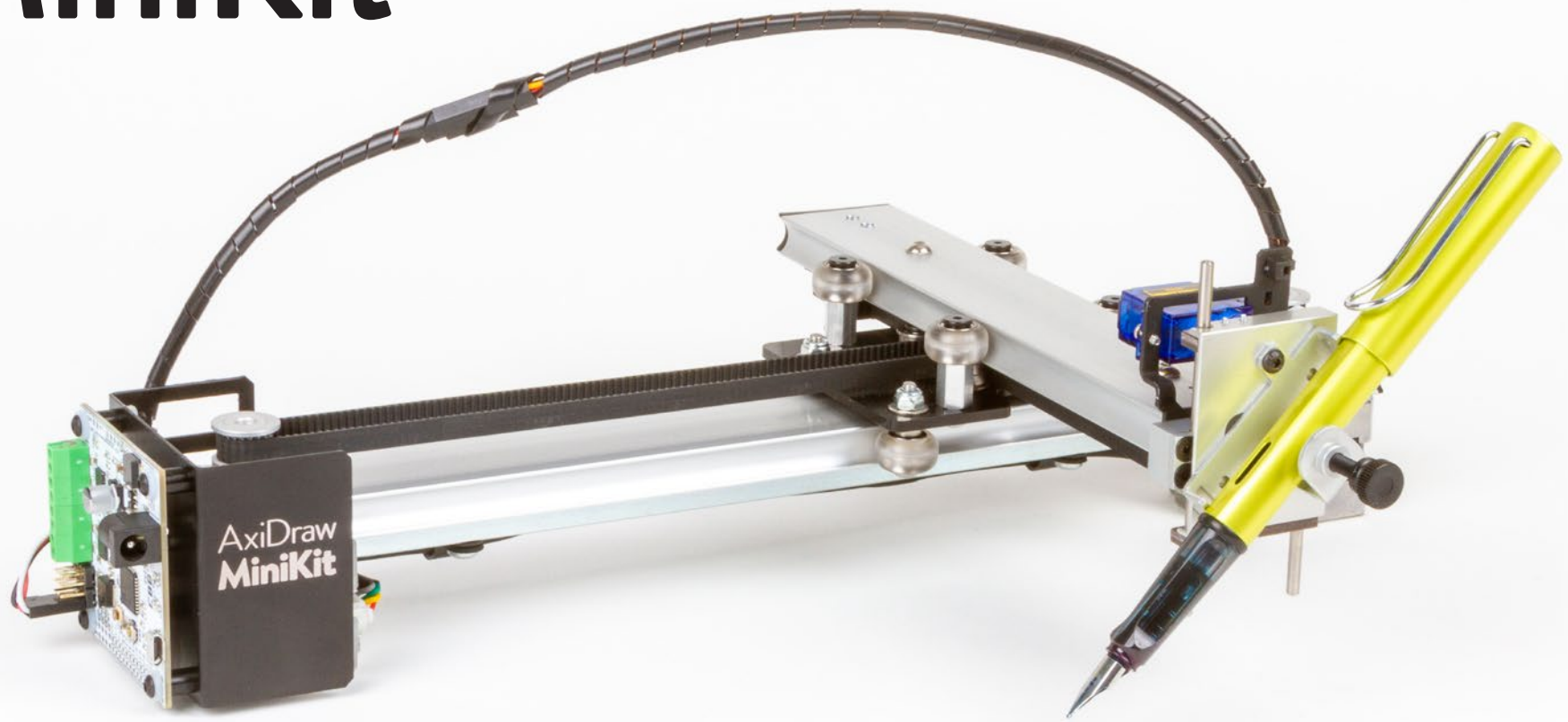
AxiDraw MiniKit

Evil Mad Scientist



Assembly Guide

Assembly guide v 1.0
Last updated: December 13, 2019

Model 2540
https://emsl.us/924

About this guide and this kit

This is the assembly guide for the AxiDraw MiniKit, a special compact "DIY kit" version of the AxiDraw writing and drawing machine.

It covers the steps needed to build the AxiDraw MiniKit, from opening the box to a working machine. This guide 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

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, there is an assembly step that requires that you have AxiDraw software installed on your computer. To get a head start, visit 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, components within this kit – particularly the aluminum extrusions – may have edges and points that are razor sharp. Exercise appropriate care when handling these parts, and keep out of the reach of 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

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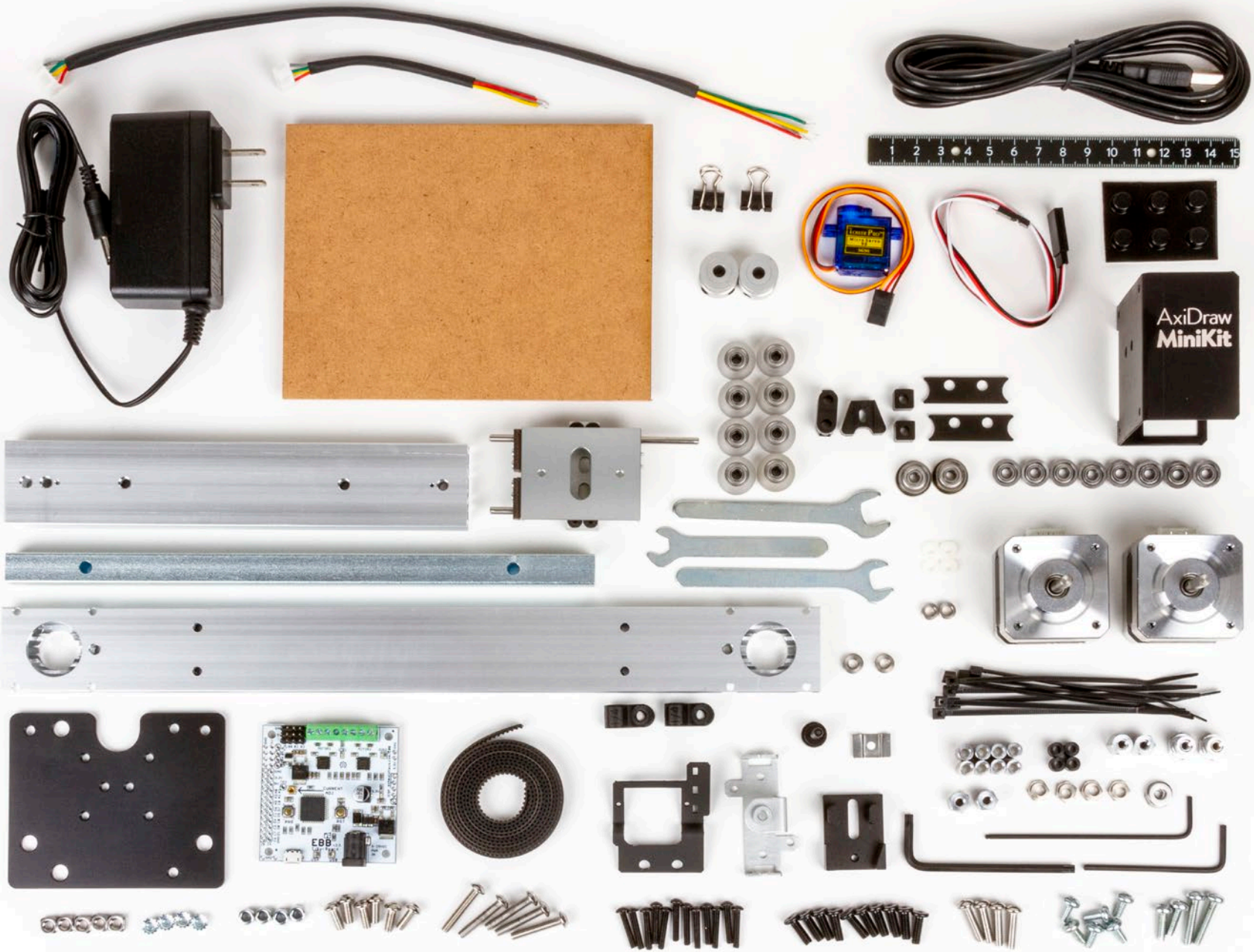
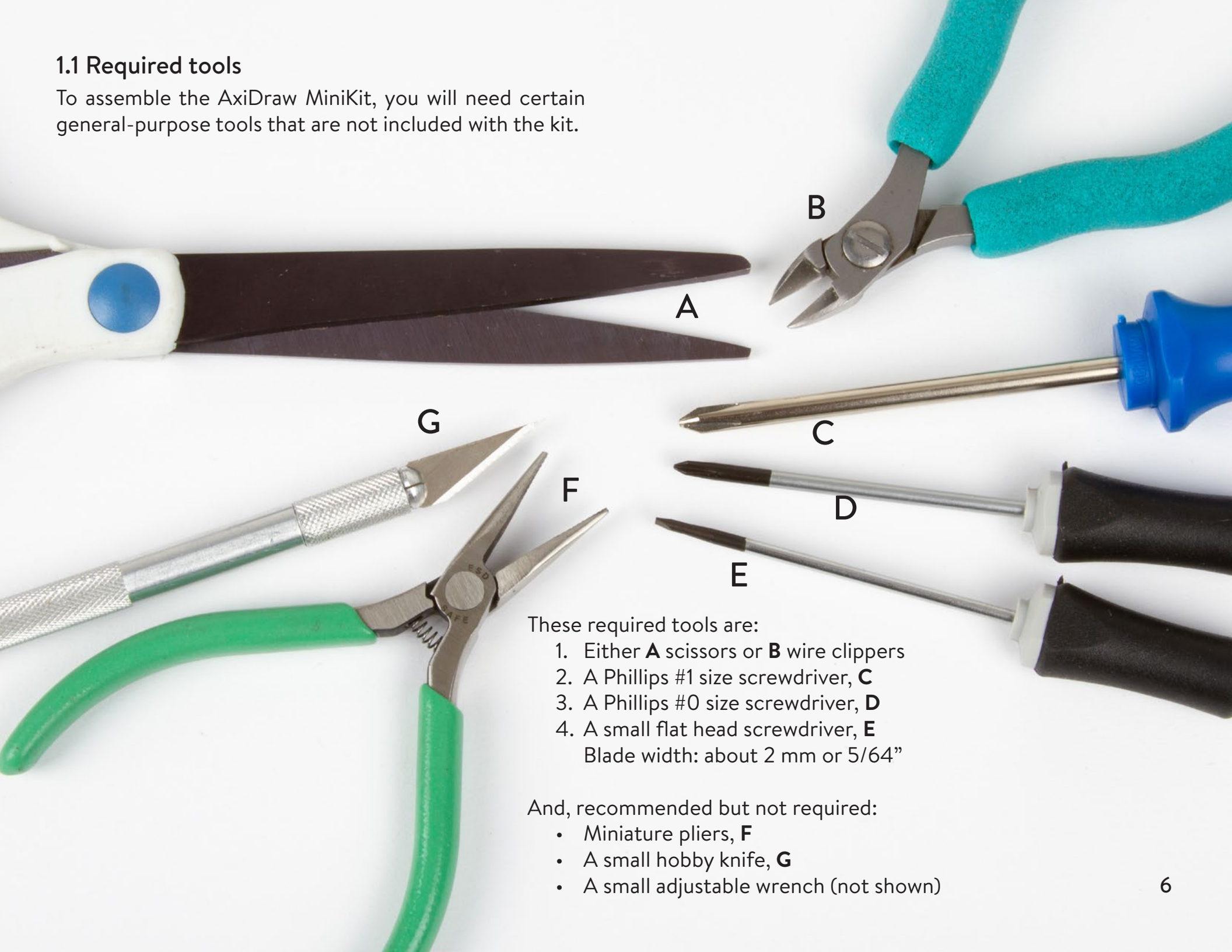


Part 1: Tools

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:

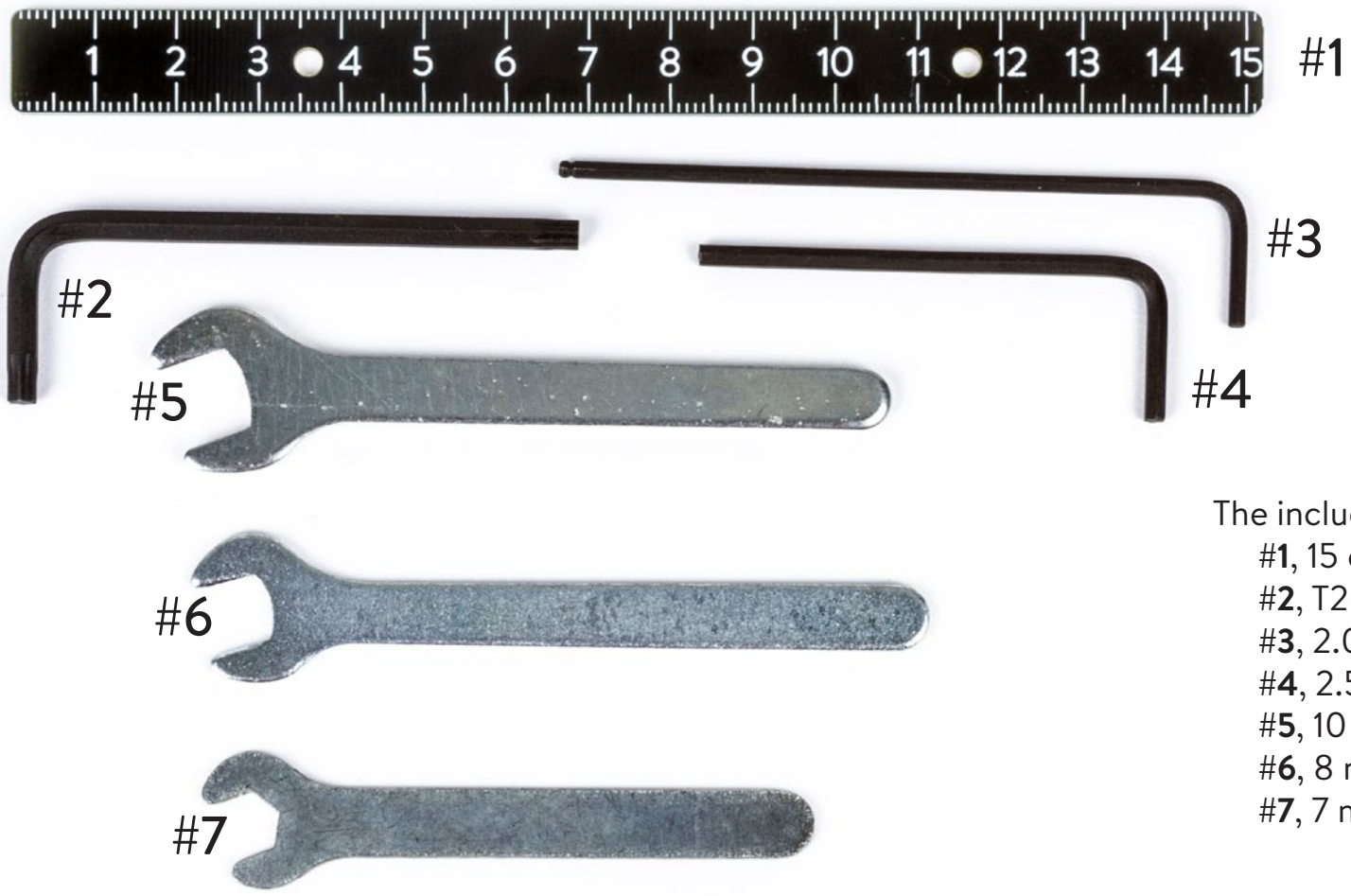
1. Either **A** scissors or **B** wire clippers
2. A Phillips #1 size screwdriver, **C**
3. A Phillips #0 size screwdriver, **D**
4. A small flat head screwdriver, **E**
   Blade width: about 2 mm or 5/64”

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:

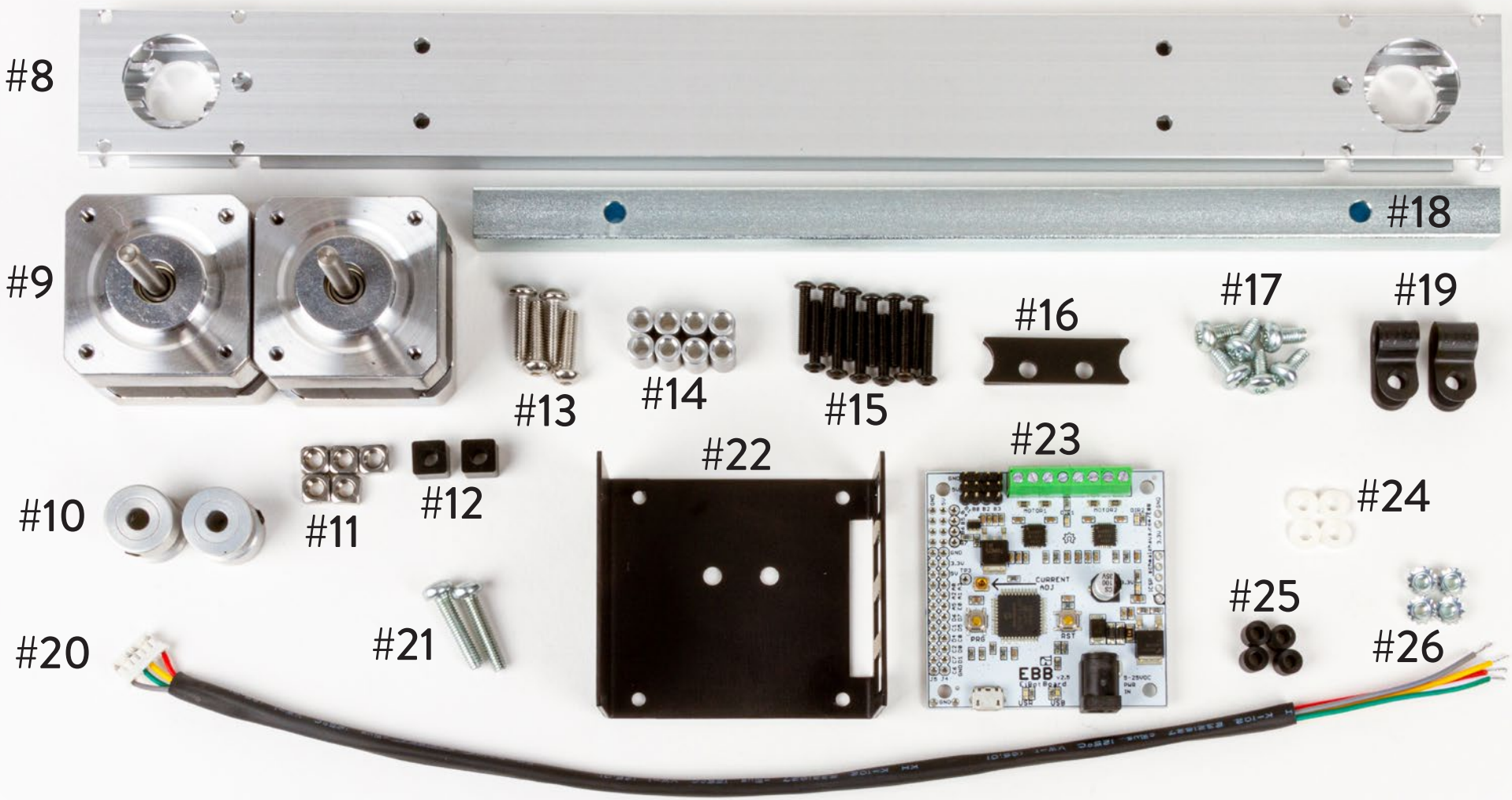
- #**1**, 15 cm / 6 inch ruler
- #**2**, T20-size Torx L-wrench
- #**3**, 2.0 mm ball-end hex L-wrench
- #**4**, 2.5 mm hex L-wrench
- #**5**, 10 mm low-profile wrench
- #**6**, 8 mm low-profile wrench
- #**7**, 7 mm low-profile wrench

You can distinguish the L-wrenches quickly, since only #**2** is a Torx (star-shaped) wrench, and only the 2 mm wrench, #**3**, has the ball end. The three low-profile wrenches are very similar in appearance; you might want to label them with a marker.

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

Part 2: The Base

2.1 Parts in the base assembly



#**8**, MiniKit Base Rail (1)
#**9**, Stepper Motor (2)
#**10**, Timing Belt Pulley (2)
#**11**, M4 Square Nut (5)
#**12**, X Endstop (2)
#**13**, M4×16 Button-head Screw (4)
#**14**, Aluminum Spacers (8)
#**15**, M3×16 Button-head Screw (12)

#**16**, Rail Endcap (2)
#**17**, M4×8 Torx Tapping Screw (6)
#**18**, Ballast Weight (1)
#**19**, Nylon Loop Clamp (2)
#**20**, Motor Wire Harness, Long (1)
#**21**, M4×20 Torx Tapping Screw (2)
#**22**, EBB Support (1)

#**23**, EBB Driver Board (1)
#**24**, White Nylon Washer (4)
#**25**, Black Nylon Spacers (4)
#**26**, M3 Kep Nut (4)

Some quantities will be used in future steps as well.

2.2 Add pulleys to motors

1. Locate the flat face (**A**) on the shafts of the stepper motors, #**9**.
2. Observe that the timing belt pulleys, part #**10**, each have two set screws (**B**). The wrench for these screws is the 2 mm ball-end hex 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 its bottom 8 mm above the uppermost part of the motor face (**C**). You can use a ruler to measure the gap or – *better* – borrow the long 8 mm hex standoff (#**35**) from a future step (“3.5 Y-Wheel Supports” on page 28) and use it as a spacer (**D**).

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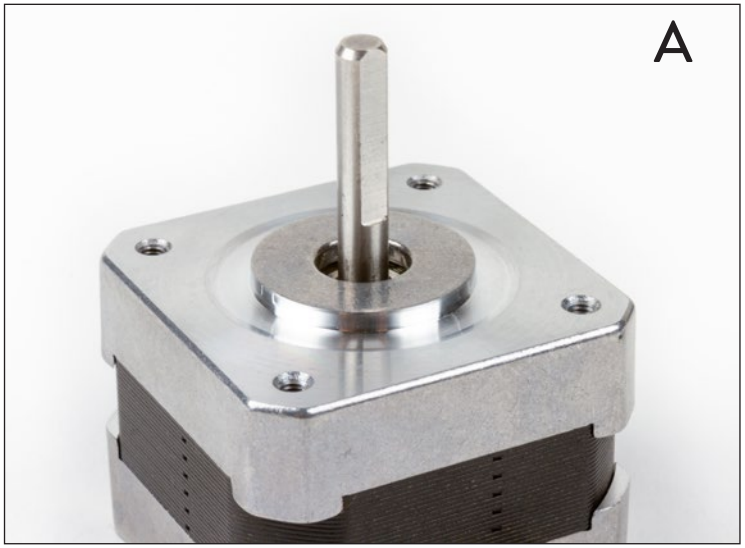
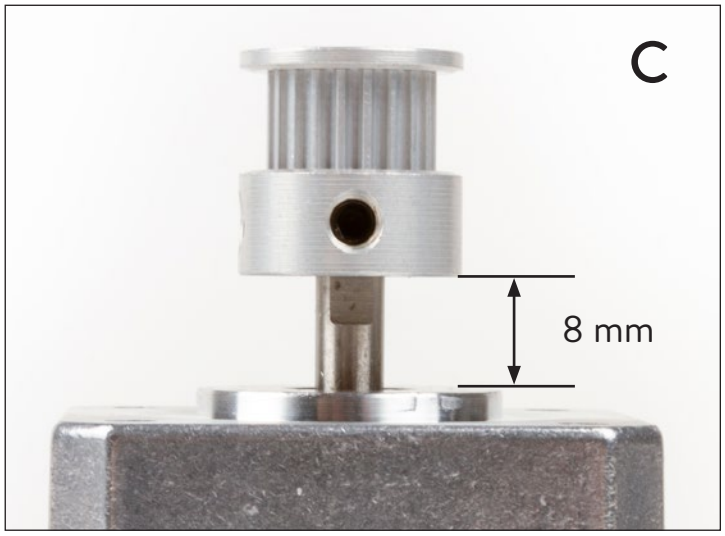
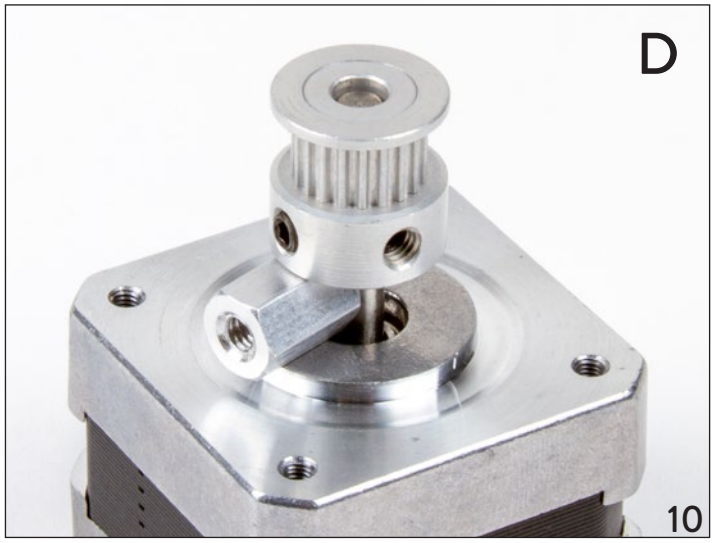
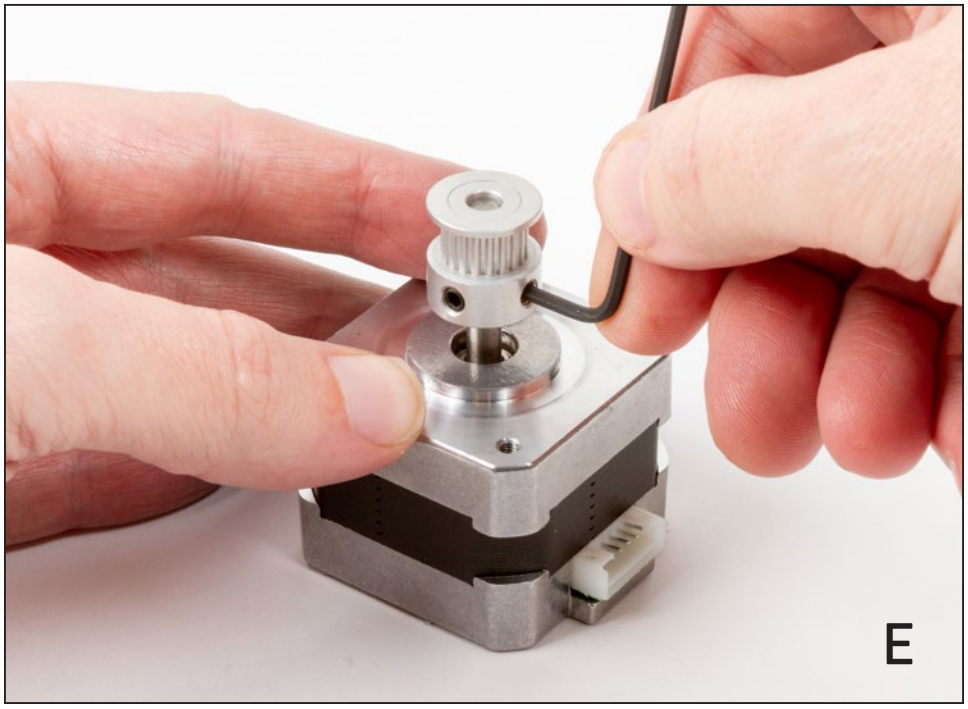






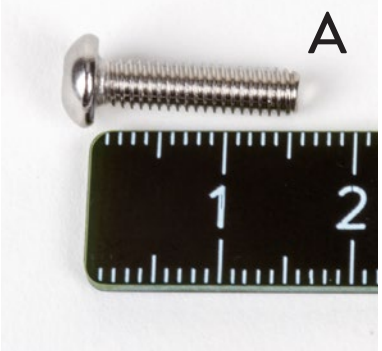
5. Firmly tighten the set screw against the flat face of the motor shaft, using the short end of the hex wrench (**E**).
6. Tighten the second set screw on the pulley, again using the short end of the hex wrench.
7. Use the same method to add the second pulley to the second motor (**F**).



2.3 X Endstops

In this step we will begin working with the extrusions. These extrusions have extremely sharp points and edges. *Handle them with appropriate care.*

1. Identify the M4 square nuts #**11**, the X-endstops, #**12**, and the M4×16 button socket cap screws, #**13**. This screw type can be identified by its silver color, a hex socket on its head, and a length of approximately 16 mm, as measured below the head (**A**).
2. Orient the MiniKit base rail, #**8**, such that the four holes in the middle – and the larger cutouts near the ends – are facing up (**B**).
3. Within the large cutout at the end, there is a half-height ledge, and within that ledge, a little slot. Set one of the M4 square nuts #11 into that slot (**C**).



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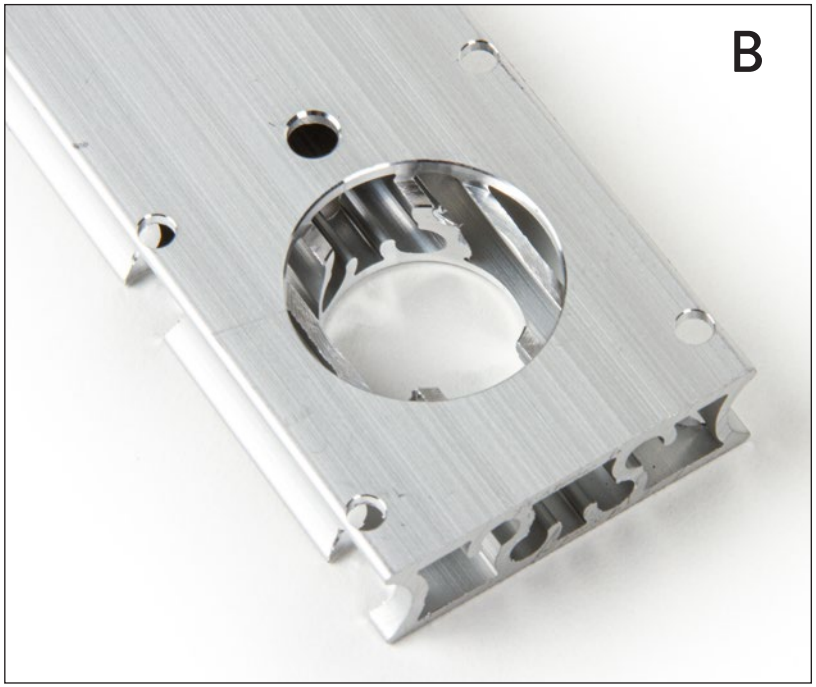


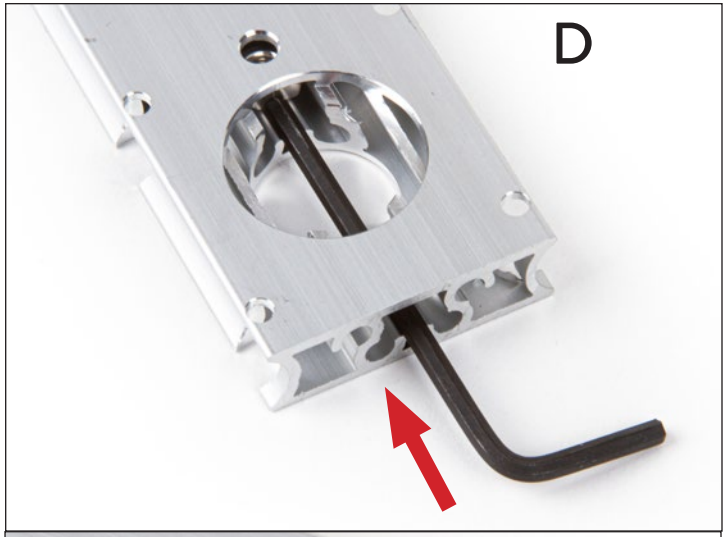
§2.3 X Endstops, continued

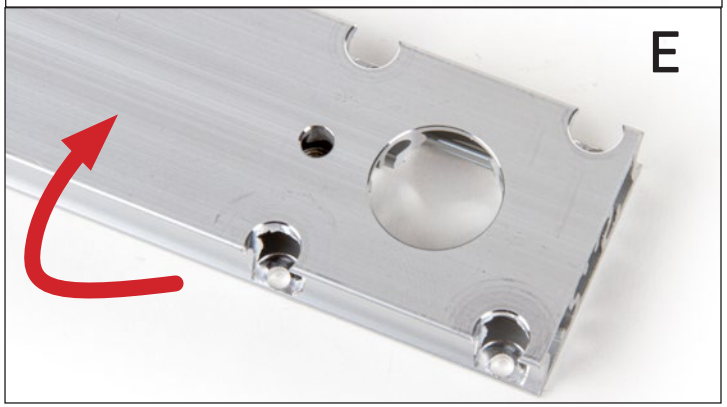
4. Using your 2.5 mm hex L-wrench (#**4**) – not your fingers – press the square nut in a little further, until it lines up with the first hole (**D**).

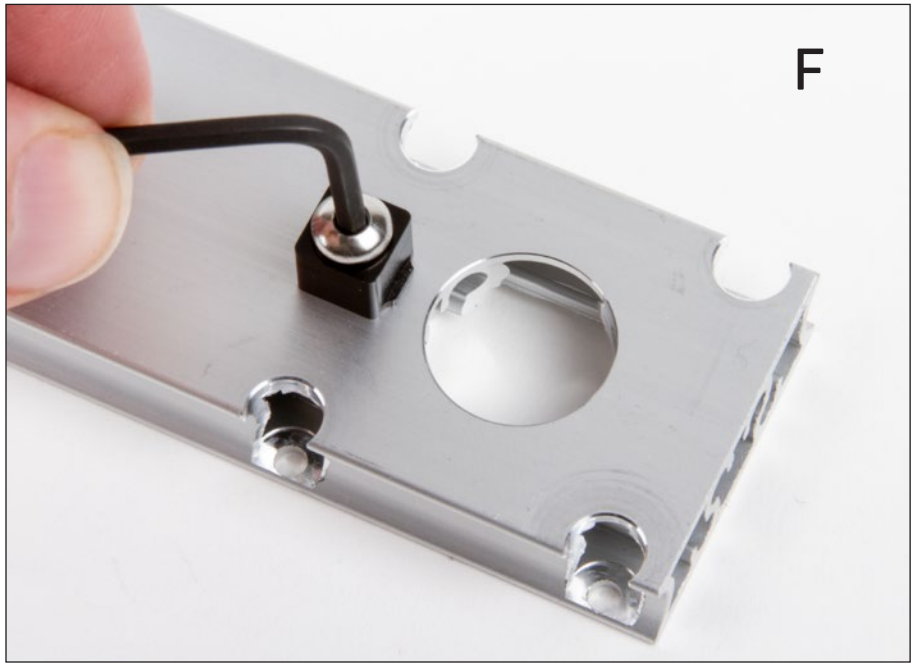
5. Carefully turn the base rail upside down, keeping the square nut in place (**E**). Insert one of the M4×16 screws through an X-endstop, then into the first hole and square nut.

   Tip: You can skewer the L-wrench through the hole and the nut to keep the nut in place while you flip it over.

6. Align the sides of the endstop parallel to the sides of the base rail, and tighten the screw to anchor the endstop in place (**F**). The endstop may have a small "tab" on one side. If so, point the tab towards the big hole. Repeat the steps above, to add the second endstop at the other end of the MiniKit base rail (**G**).





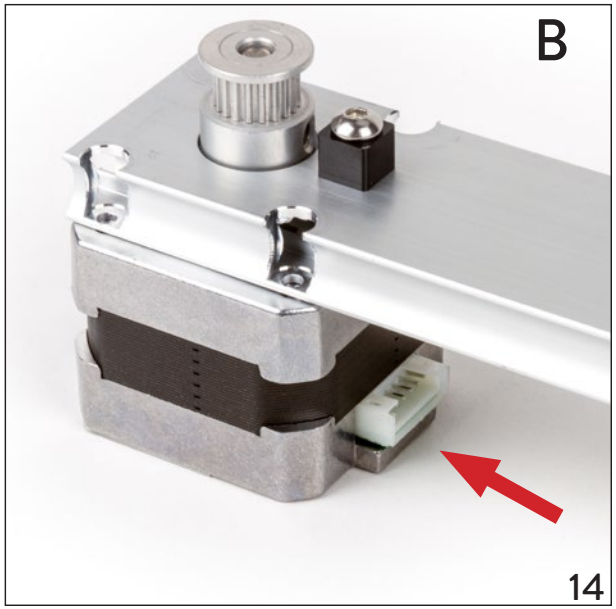


2.4 Mount the motors

1. Before mounting the motors, check for any stray or loose aluminum “flashing” or burrs on the exposed outer edges of the Base Rail. If there are any, you can remove them with the side of a screwdriver blade or a hobby knife.
2. Identify the aluminum spacers #**14**, and the M3×16 button socket cap screws, #**15**. These spacers are cylindrical tubes, about 9.5 mm (3/8”) long. The screw can be identified by its black color and length of approximately 16 mm, as measured below the head.
3. With the two X Endstops pointing up, set the Base Rail on top of the two motors, such that the pulleys fit through the large holes (**A**). Orient the motors such that their connectors face towards the center of the Base Rail (**B**).

#14

#15



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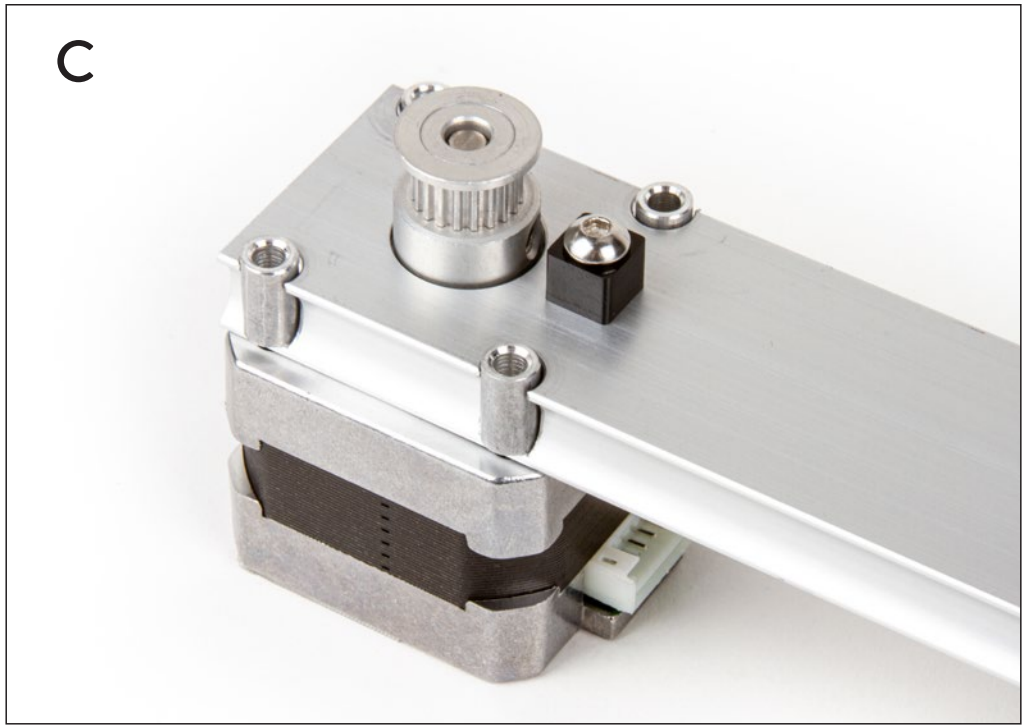
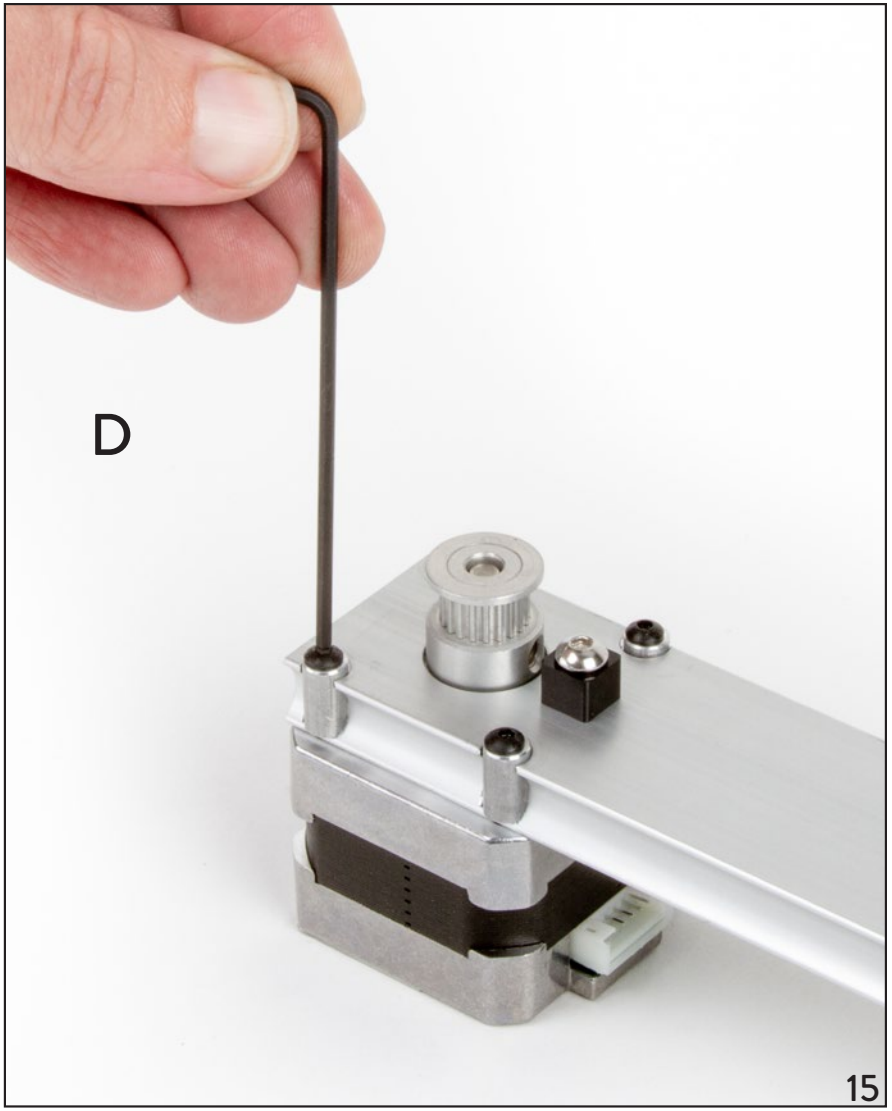
§2.4 Mount the motors, continued

4. Insert the 8 aluminum spacers into the four pockets around each pulley (**C**), and then insert an M3×16 screw into each spacer.
5. Use the 2 mm ball-end hex wrench (#**3**) to thread each screw into the place (**D**).
6. Finally, firmly tighten all 8 screws into place.

C



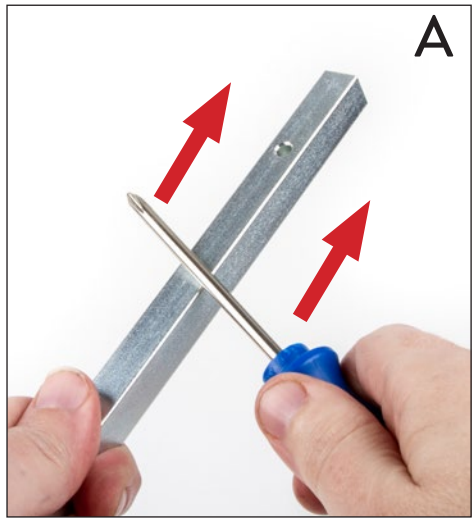
D



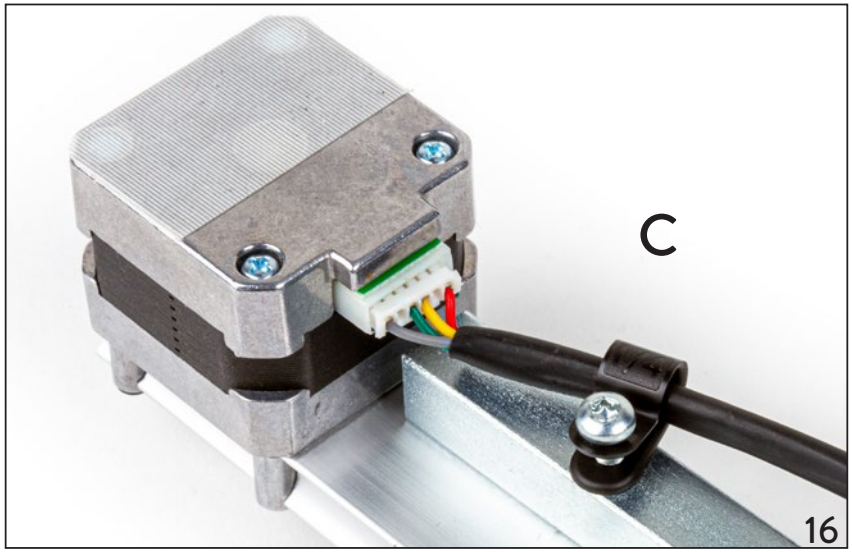
2.5 Ballast and motor wire

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

1. Identify the two nylon loop clamps #**19** and the M4×20 Torx tapping screws, #**21**. These screws can be identified by the star-shaped socket on their heads and length of approximately 20 mm, as measured below the head.
2. Also locate two larger parts, the ballast weight #**18** and the long motor wire harness #**20**, referring to the image on page 9.
3. Check the ballast weight for any sharp edges, and dull them if necessary using (for example) the side of a screwdriver blade (**A**).



4. Connect the long motor wire harness to one of the motors.
5. With the base assembly upside down and the motor with the connector on the left side, place the ballast weight over the two holes further away from you (**B**).
6. Slip one of the nylon loop clamps over the motor wire in the orientation shown, and insert a screw through the clamp into the hole in the ballast weight (**C**).



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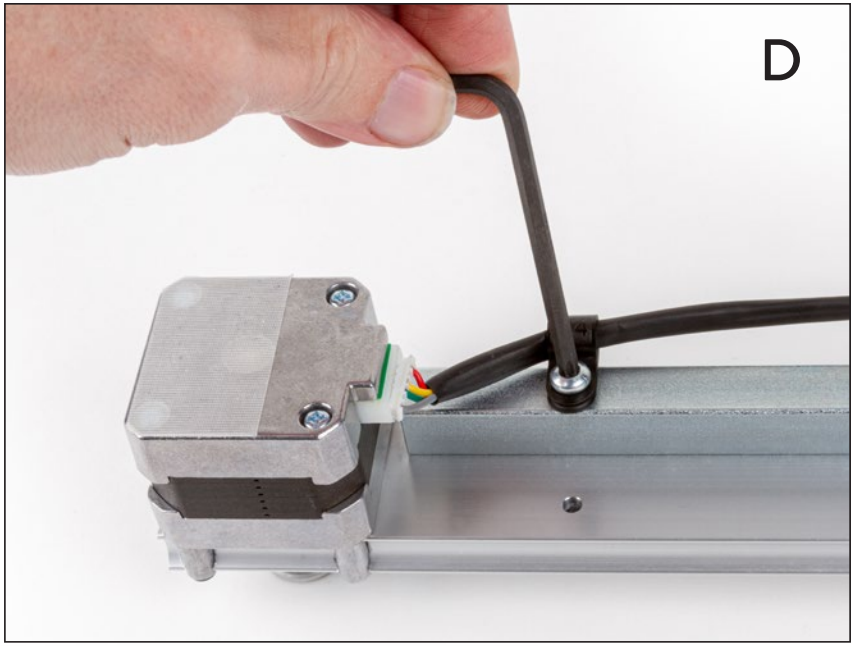
7. Use the Torx L-wrench, #**2**, to fasten the screw into place (**D**). Take care to only tighten it until it is just secure; do not over-tighten.
8. Add the second nylon loop clamp in the same way and fasten it into place (**E**). Set the base assembly back upright again (**F**).



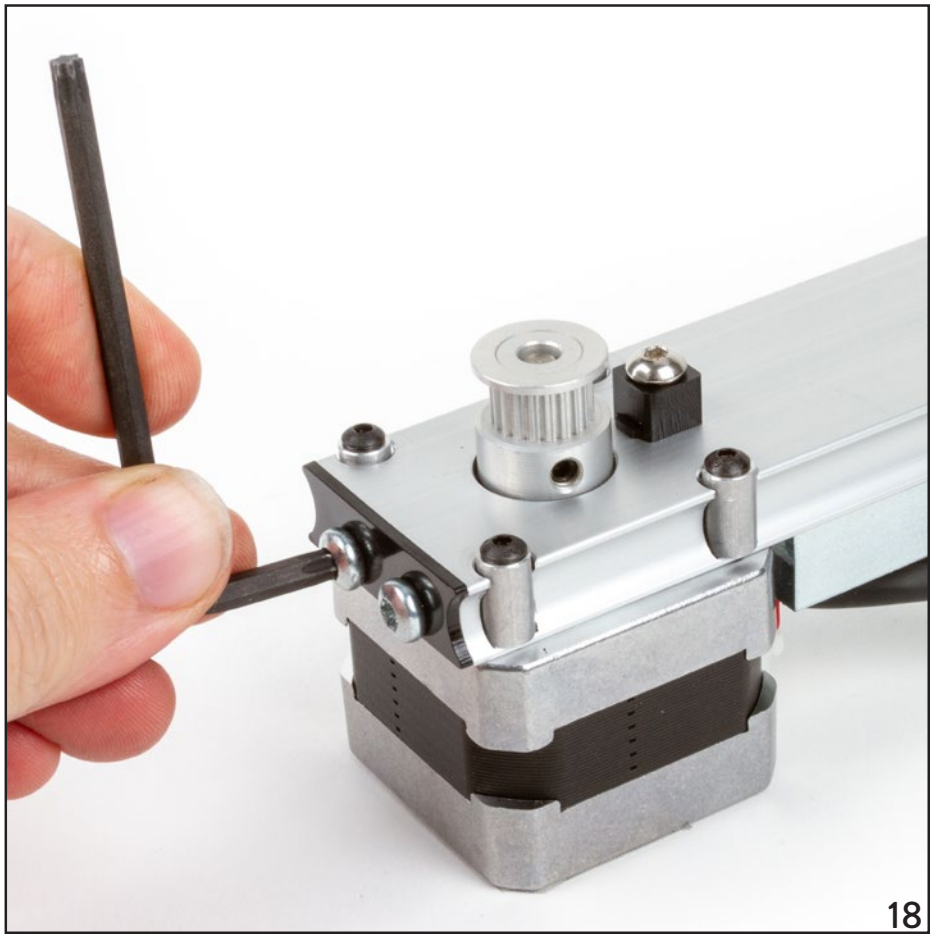
E

F

2.6 Base Endcap

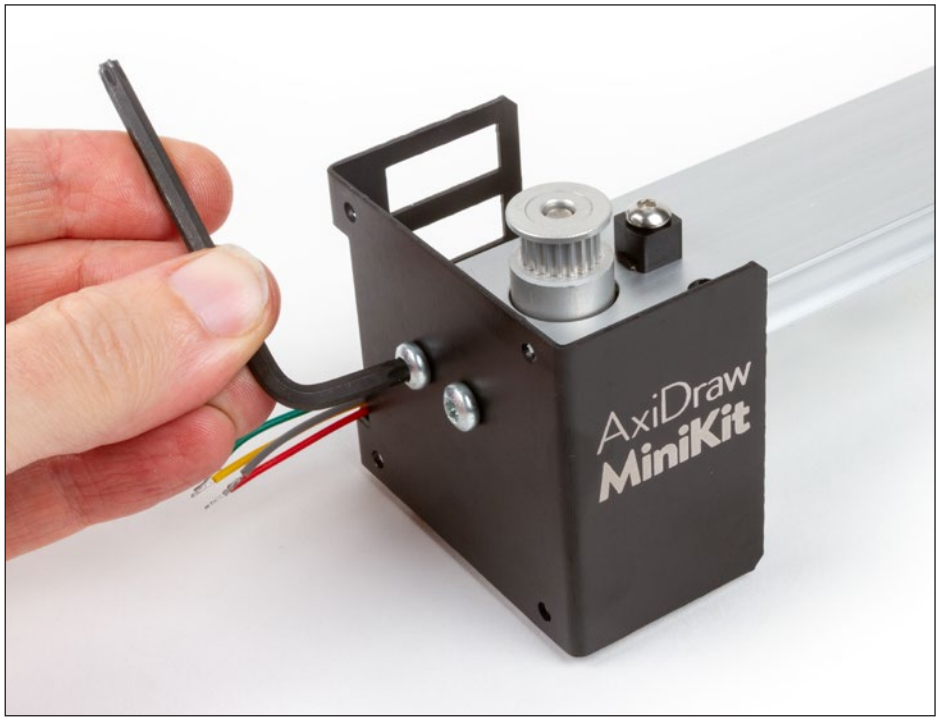
1. Identify the rail endcap #**16** and the M4×8 Torx tapping screws, #**17**. These screws can be identified by the star-shaped socket on their heads and length of approximately 8 mm, as measured below the head.
2. Position the endcap on the end of the base rail that has the “connectorized” motor. Align its two holes with the matching holes in the end of the base rail, and its outline to the shape of the base rail.
3. Use the Torx L-wrench, #**2**, to fasten the endcap into place with two of the screws. It may be easiest to hold the hold the base rail vertically while doing so. As you tighten it into place, keep its edges lined up with the base rail.

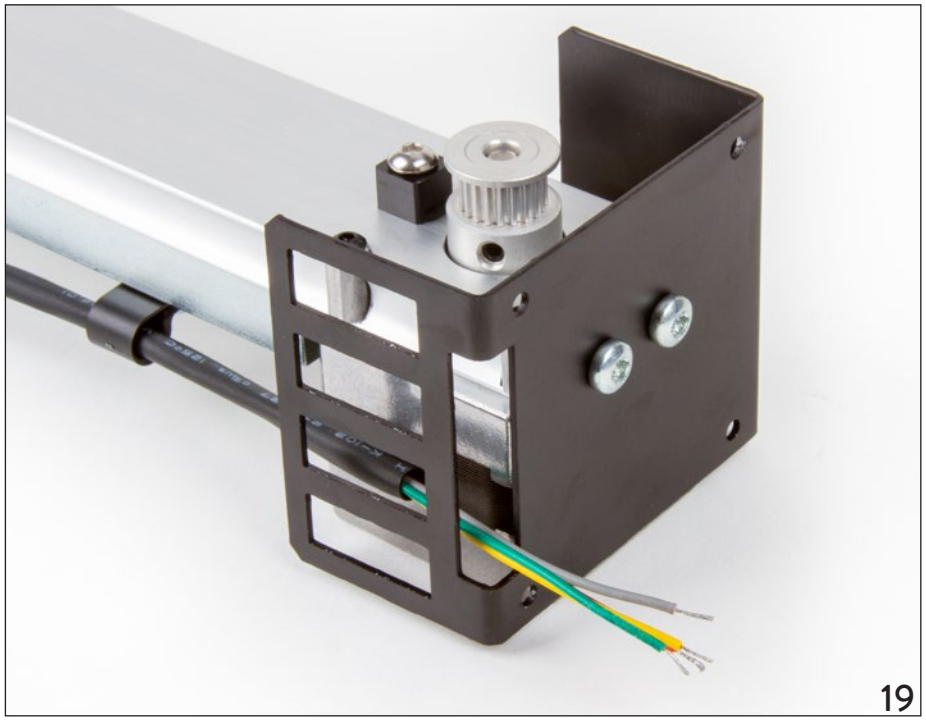
#16 #17



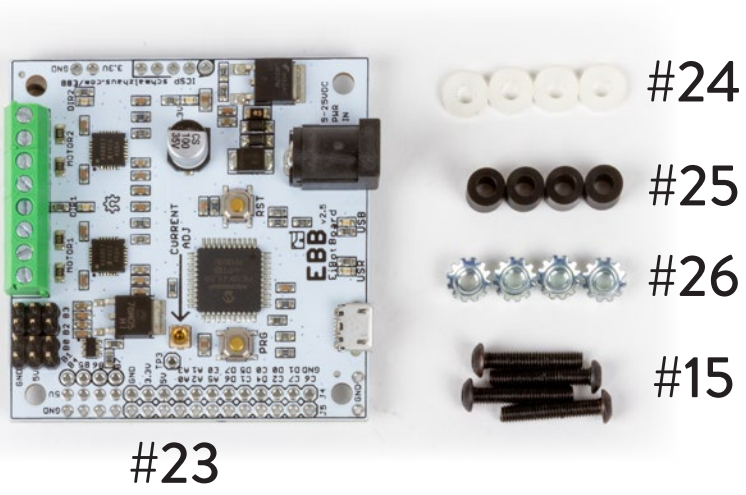
2.7 EBB Support

1. Position the EBB support #**22** at the open end of the base rail, where the loose wires are. Set it upright, such that you can read the text, and align the two large holes up with the matching holes in the end of the base rail.
2. Use two more of the M4×8 Torx Tapping Screws #**17** and your Torx L-wrench, #**2**, to securely tighten the EBB support in place.
3. Tuck the loose wire ends through the large vertical slot in the EBB Support.





2.8 Mounting the EBB



1. Identify the EBB driver board #**23**, the white nylon washers #**24**, the black nylon spacers #**25**, and the M3 kep nuts #**26**. The spacers are short black plastic tubes, and the nuts are distinguished by having a built-in toothed washer. You will also need four more of the M3×16 button socket cap screws, #**15**.
2. Place one of the white nylon washers over each corner hole of the EBB, and insert one of the M3×16 screws through each hole.

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

3. Holding the EBB vertically, slide one of the black nylon spacers over each M3×16 screw (**B**).

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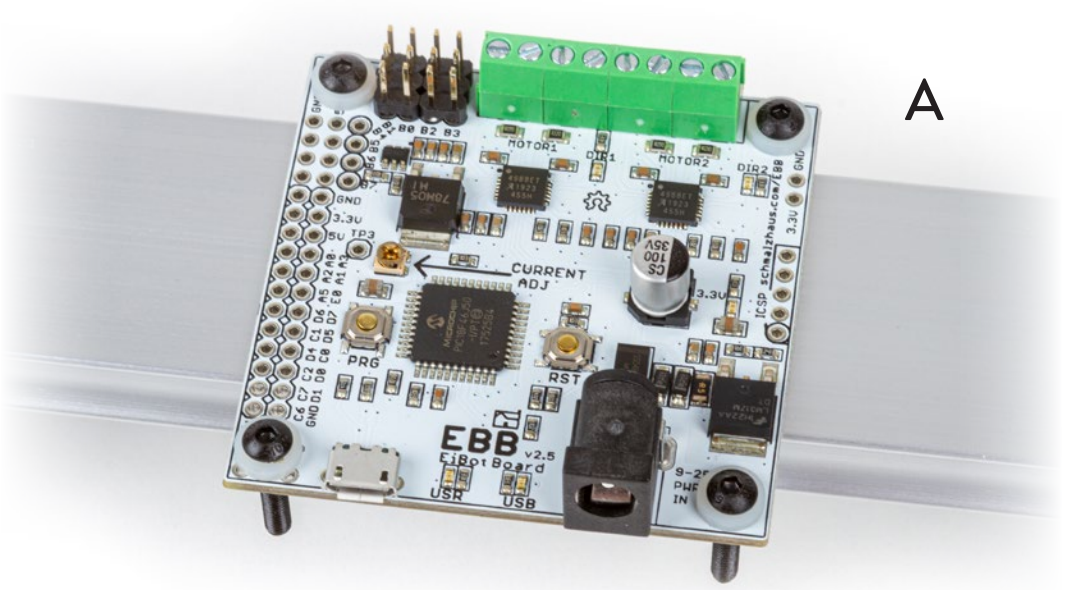

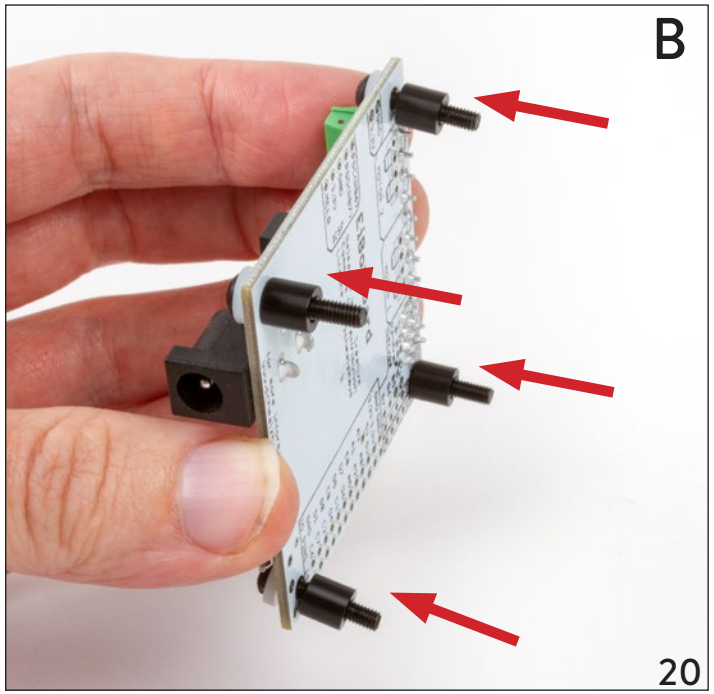

§2.8 Mounting the EBB, continued

4. Orient the EBB driver board such that the power jack and USB port face towards the “Axidraw MiniKit” logo. Then, two at a time, guide the four screws into the corner holes of the EBB support (**C**,**D**).
5. Use a finger to position one of the M3 kep nuts on the end of a screw, such that the “teeth” of the point towards the EBB. Tighten the screw with your 2 mm ball-end hex wrench (#**3**), continuing to steady the nut with your finger (**E**).

   Tip: While a finger is usually sufficient to steady the nut until it can be tightened, you can also brace the side of the nut against the EBB support with your 2.5 mm hex L-wrench (**F**).

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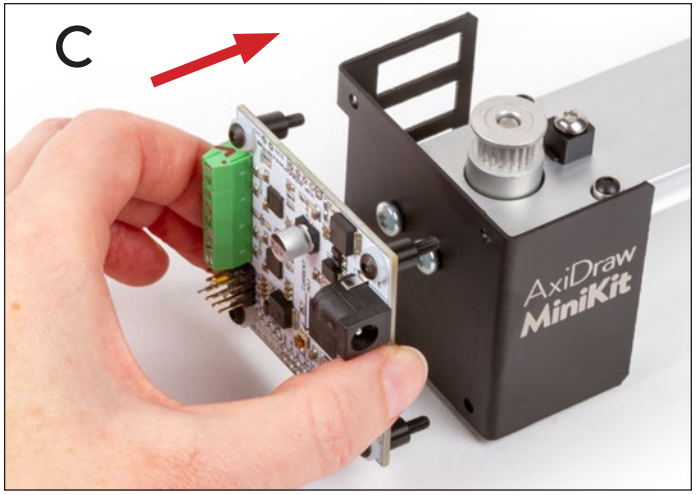
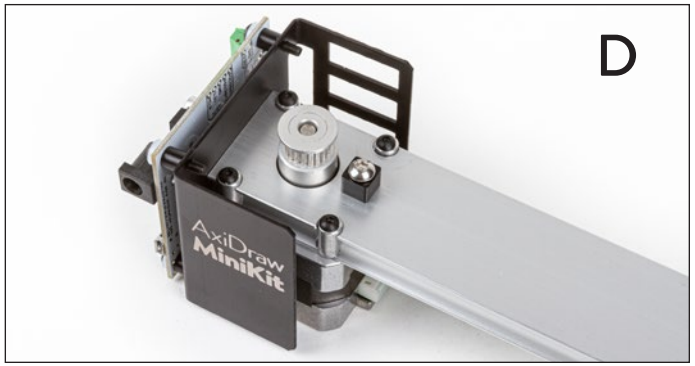
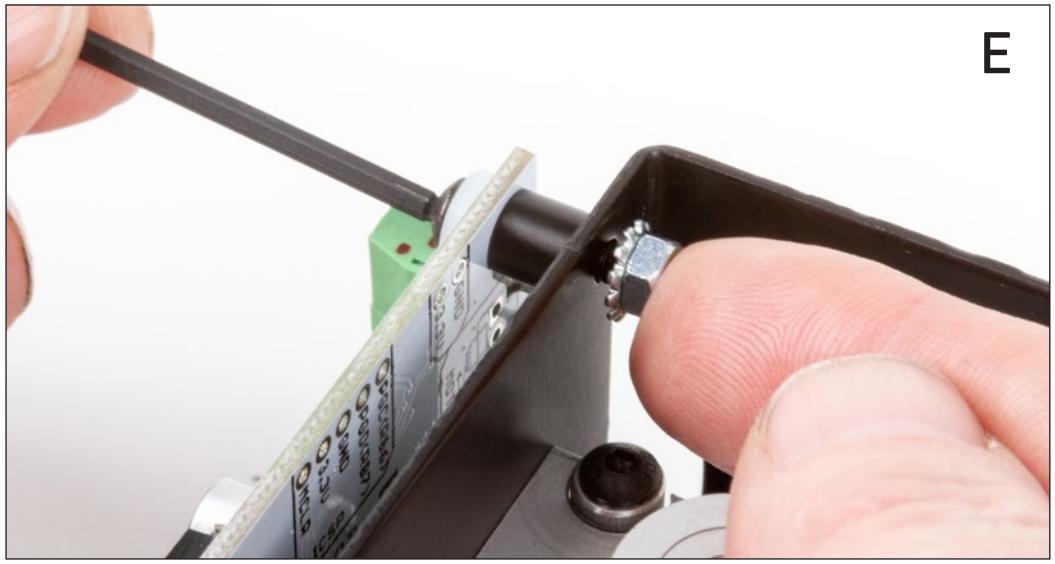
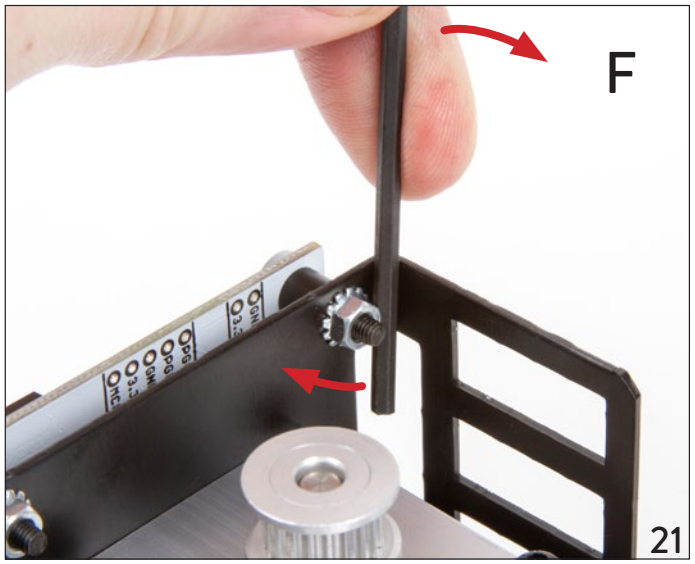
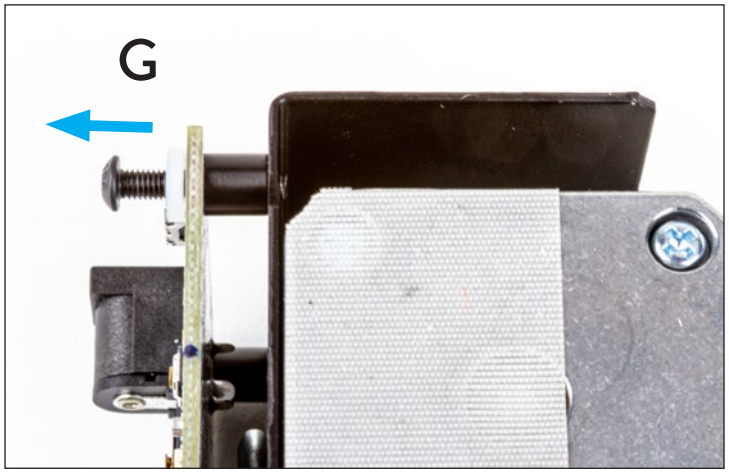


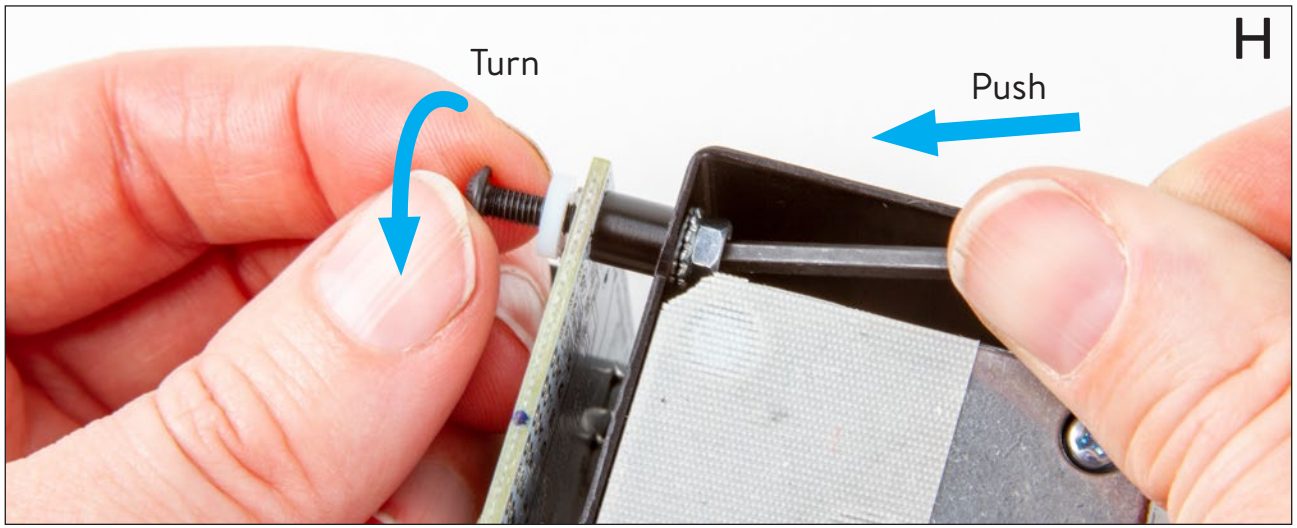


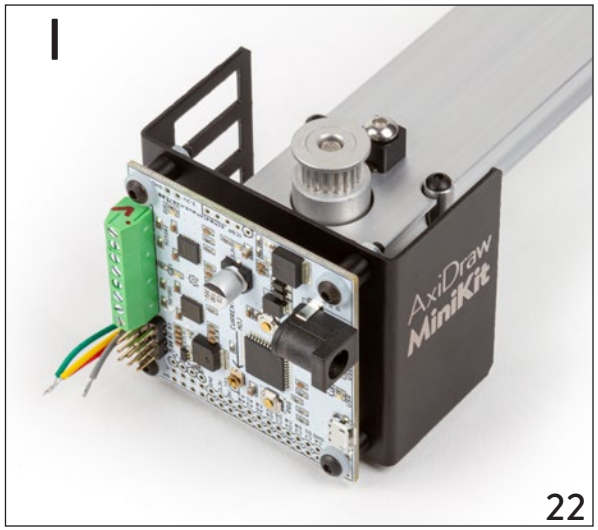


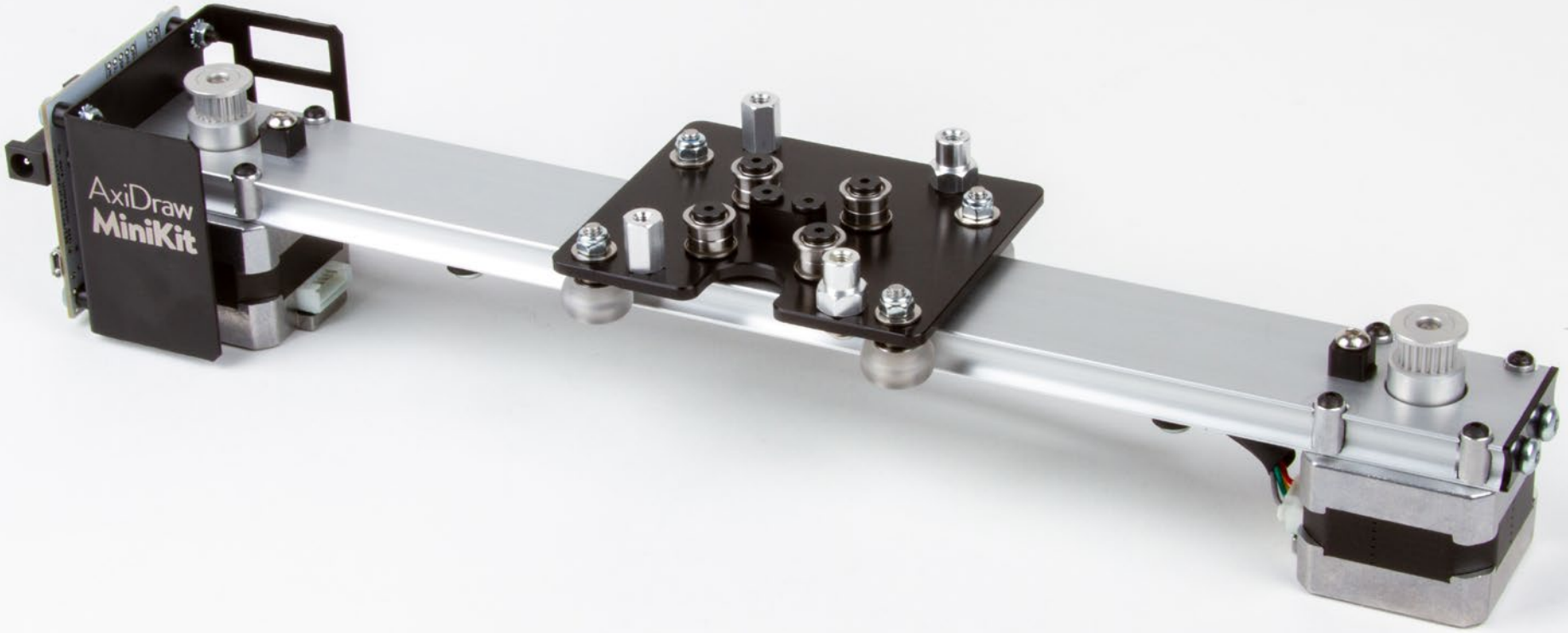


6. Install the second “upper” M3 kep nut in the same way.
7. For the lower two M3 kep nuts, there isn’t room for a finger to place the nut in position. Instead, pull the M3 screw out slightly (**G**) and use your 2.5 mm hex L-wrench to push the nut against the EBB support while you turn the screw enough to engage the threads (**H**).
8. Once the screw is engaged into the threads of the Kep Nut, tighten the screw the same way that you did with those on the top side, and repeat for the other “lower” M3 Kep Nut.
9. Check that the EBB and all four of its screws feel securely mounted in place (**I**).



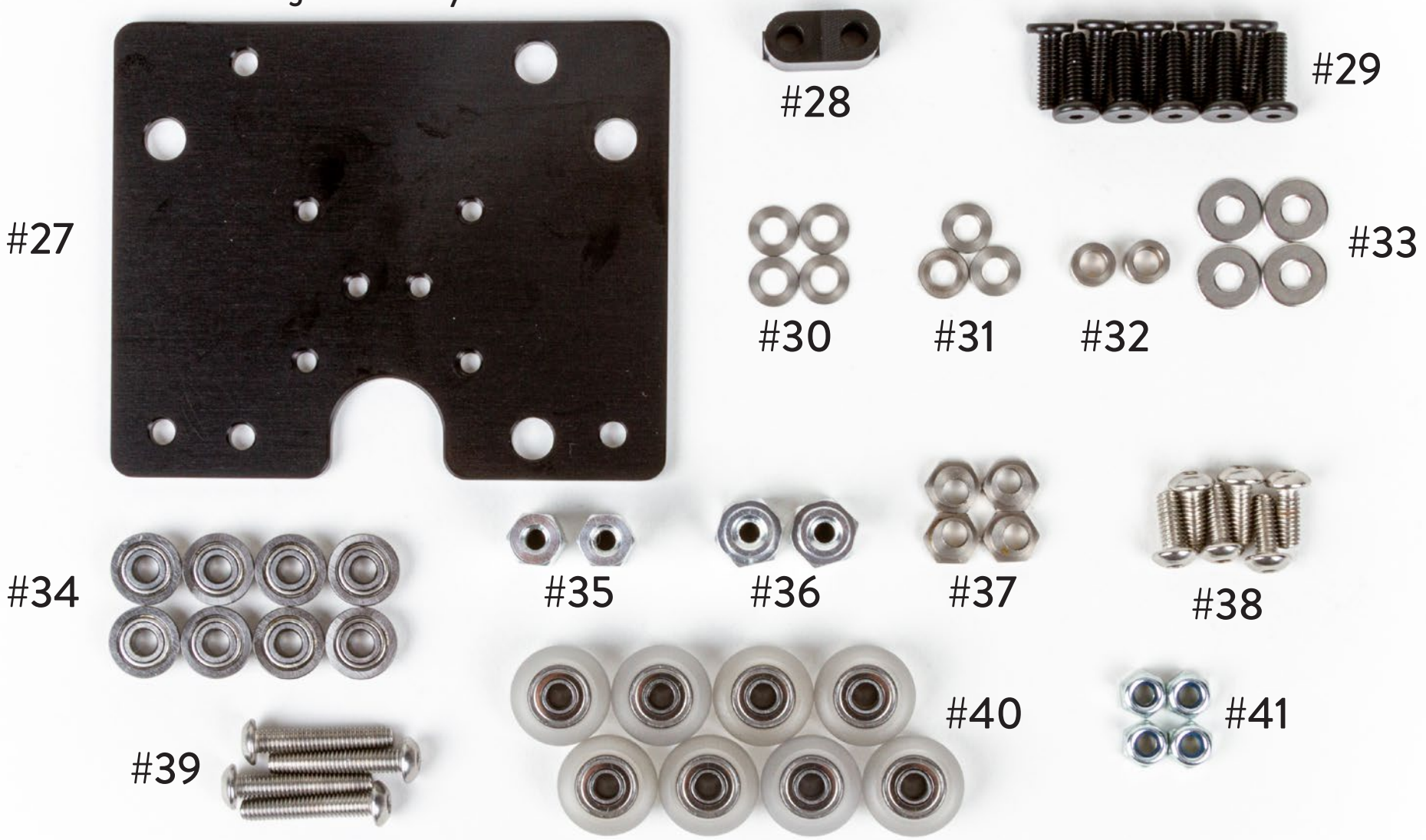






Part 3: The X Carriage

3.1 Parts in the X Carriage Assembly

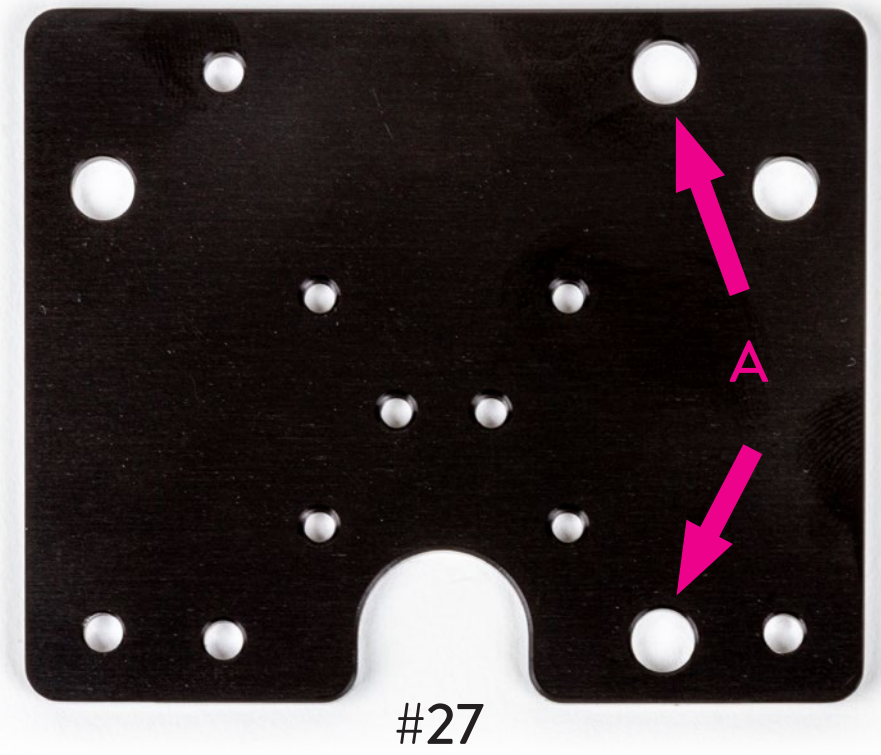


#**27**, Carriage Plate (1)
#**28**, Y Endstop (1)
#**29**, M4×12 Low Profile Screws (10)
#**30**, Precision Shim, M4×8×0.5 (4)
#**31**, Precision Shim, M4×8×1.0 (3)
#**32**, Spacer, M4×7×3.0 (2)
#**33**, Stamped washer, M4×10×1 (4)
#**34**, MF104 Ball Bearing (8)
#**35**, M4×8×12 Hex Standoff (2)
#**36**, M4×10×12 SemiHex Standoff (2)
#**37**, Eccentric spacer (4)
#**38**, M4×10 Button-head Screw (6)
#**39**, M4×22 Button-head Screw (5)
#**40**, Roller Wheel (8)
#**41**, M4 Nylon locknut (4)

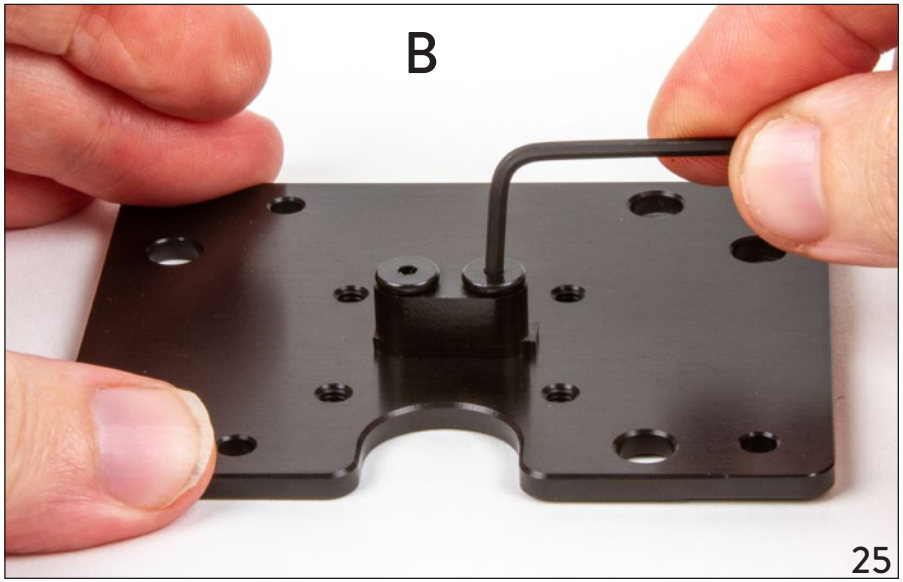
Some quantities will be used in future steps as well.

3.2 Install the Y Endstop

1. Orient the carriage plate #**27** top-side up: With the large notch – the **front** of the plate – facing you, the larger two larger holes should be on the right-hand side of the part (**A**).
2. Identify the Y endstop #**28**, and the M4×12 low profile cap screws #**29**. 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 of the low profile cap screws through the holes, and tighten them securely with the short end of the 2 mm hex L-wrench (#**3**).



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.

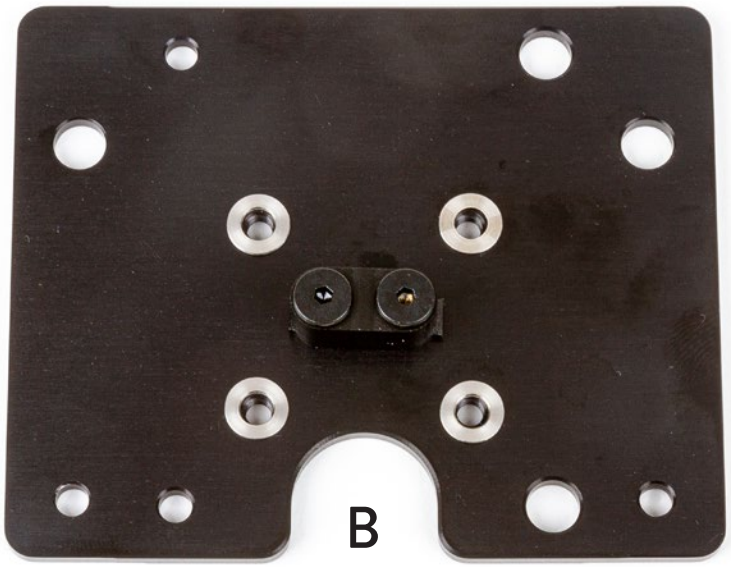
Precision machined shims #**30** and #**31** are both 8 mm in diameter. They are distinguished by thickness: #**30** is 0.5 mm thick, while #**31** is 1 mm thick. Side by side, you should be able to tell them apart.

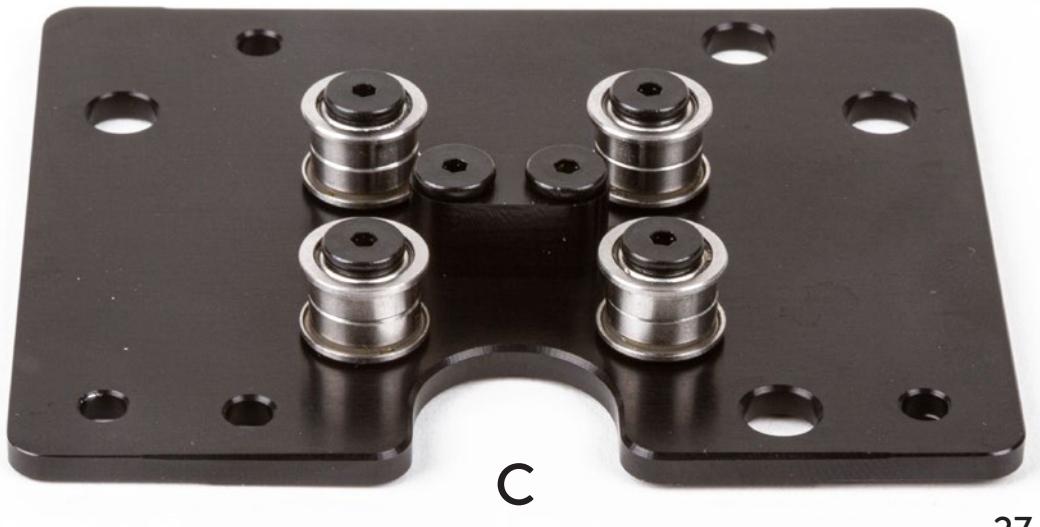
Part #**32** is a thicker spacer, 7 mm in outer diameter and 3 mm in height.

Part #**33** is a stamped washer, with a larger in diameter of 10 mm.

3.4 X Carriage Idler Pulleys

1. Identify part #**34**, the 8 small flanged ball bearings.
2. Assemble these bearings into four stacks of two, lined up with the flanges facing away from each other – like tiny metal sandwiches. Slip one of the M4×12 Low Profile Cap Screws #**29** through each pair (**A**).
3. Place the four *thin* shims #**30** 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 2 mm hex L-wrench (#**3**).





3.5 Y-Wheel Supports

1. Identify parts #**35**, and #**36**, threaded hexagonal standoffs, each 12 mm long. The straight hexagonal prisms are #**35**, the 8 mm hex standoffs. Parts #**36** are the SemiHex standoffs, with a 10 mm hex section on the lower half only.
2. Also locate parts #**37**, the eccentric spacers and the M4×10 button socket cap screws, #**38**. The eccentric spacers have a hexagonal outline and a non-centered hole. This screw type can be identified by its silver color, a hex socket on its head, and a length of approximately 10 mm below the head.
3. Turn the carriage plate upside down so that the bearings and endstop are facing down. Slip M4×10 screws into the two indicated holes (**A**), which are the two small-diameter holes that are not near the corners of the part.
4. On the top side of the carriage, thread the two M4×8 hex standoffs #**35** onto the protruding screws (**B**).

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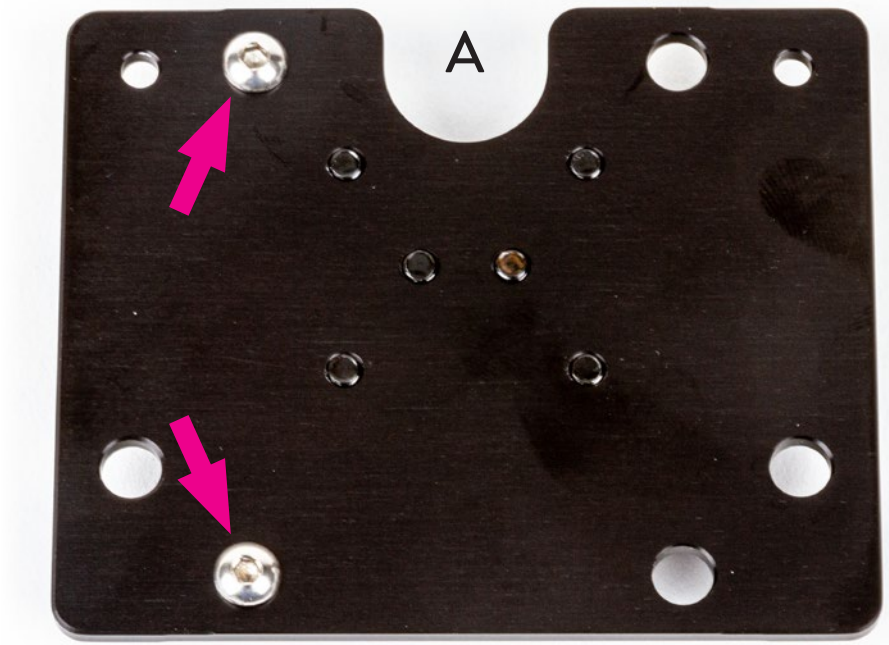
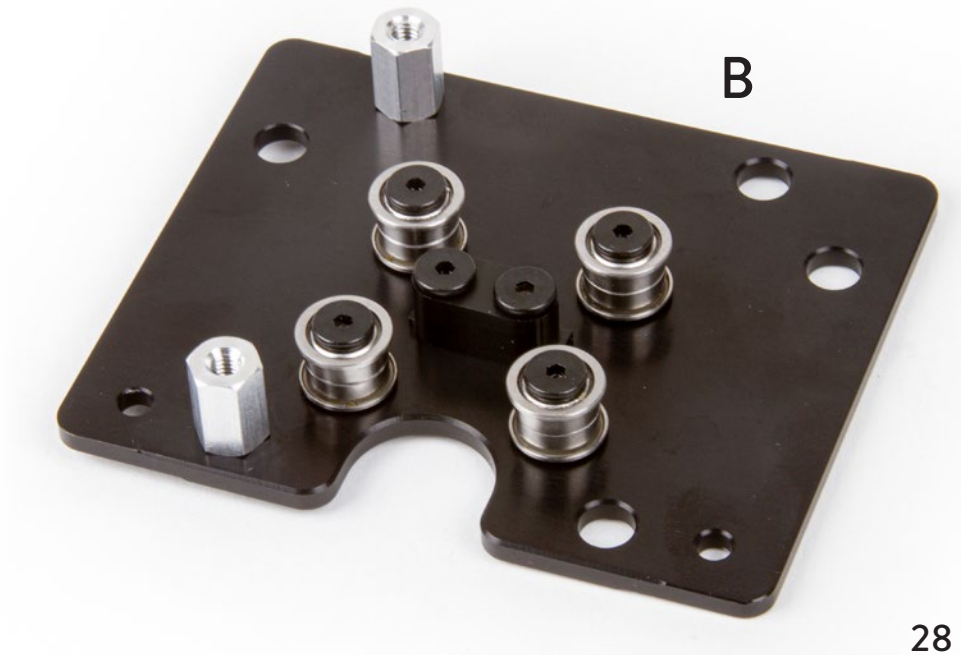
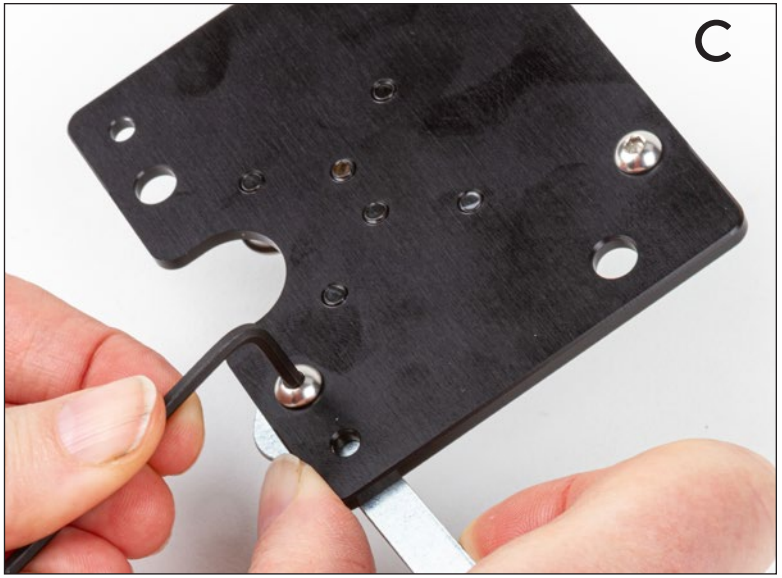




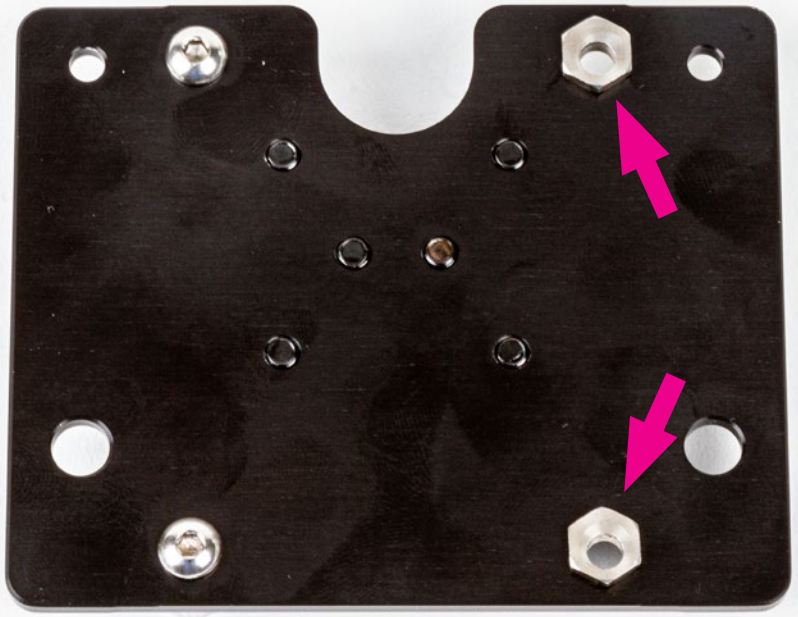
5. Using the 2.5 mm hex L-wrench #**4** and the 8 mm low-profile wrench #**6**, firmly tighten the two hex standoffs into place (**C**).

   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.


C

6. Observe that the #**37** eccentric spacers have an upper part that is cylindrical, above the hexagonal outline (**D**).
7. 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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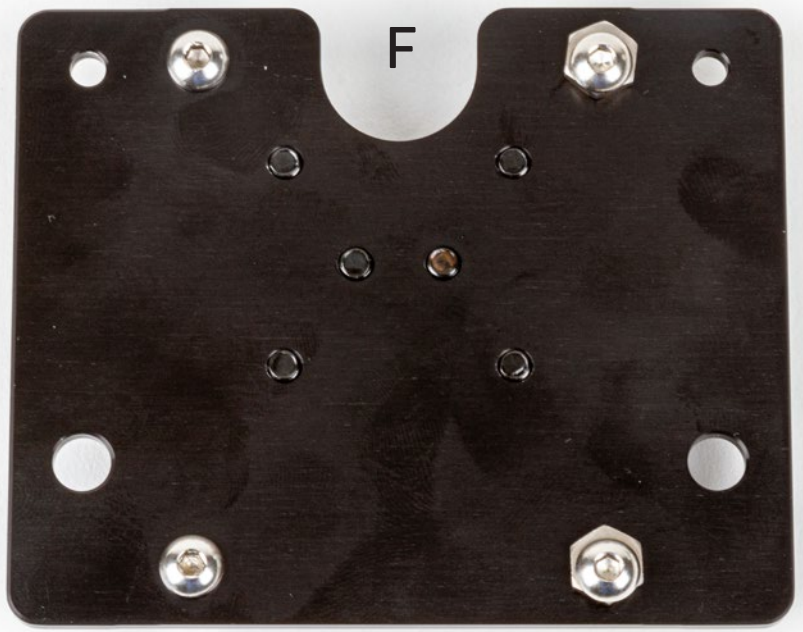
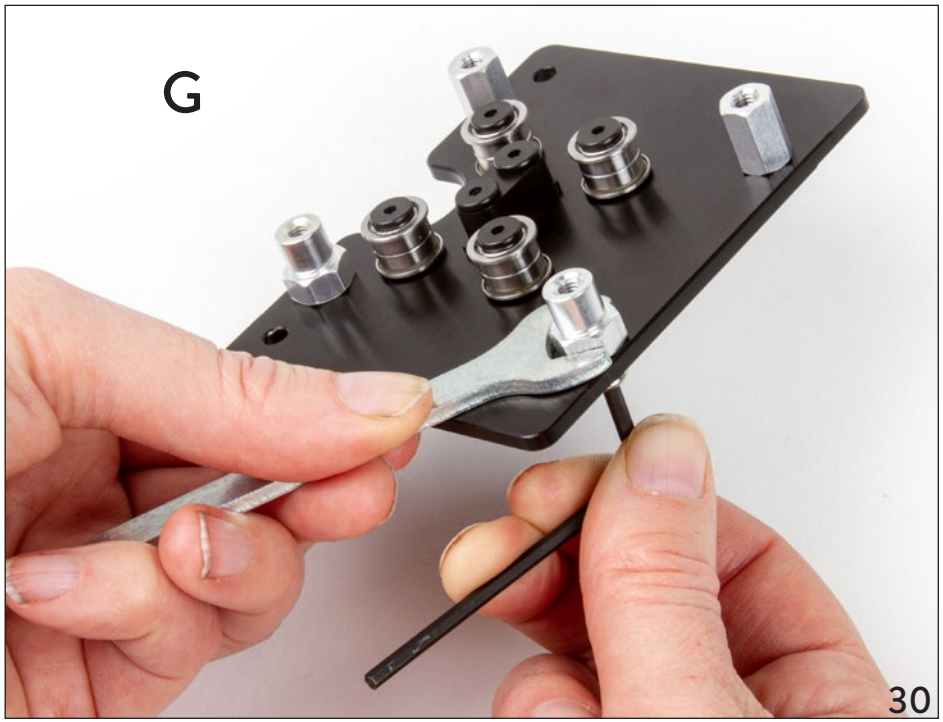
8. Slip another M4×10 button socket cap screw through the hole in each eccentric spacer (**F**).
9. Thread a SemiHex spacer onto each of the protruding screws, with the wide hexagonal surface in contact with the carriage plate. Tighten both SemiHex spacers securely in place (**G**) with the 2.5 mm hex L wrench and the 10 mm low-profile wrench, #**5**.



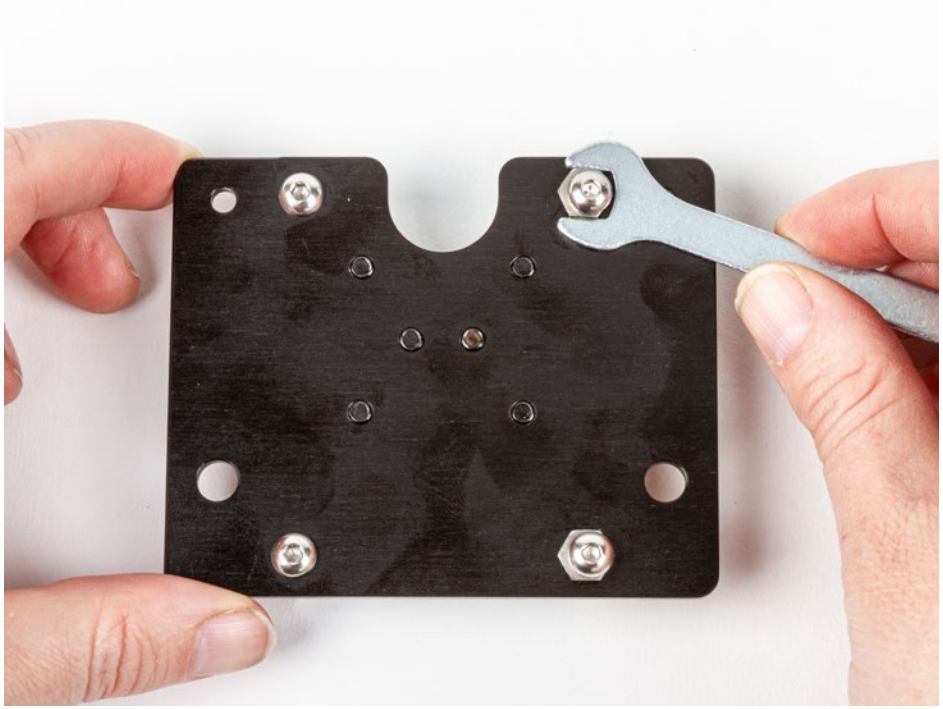


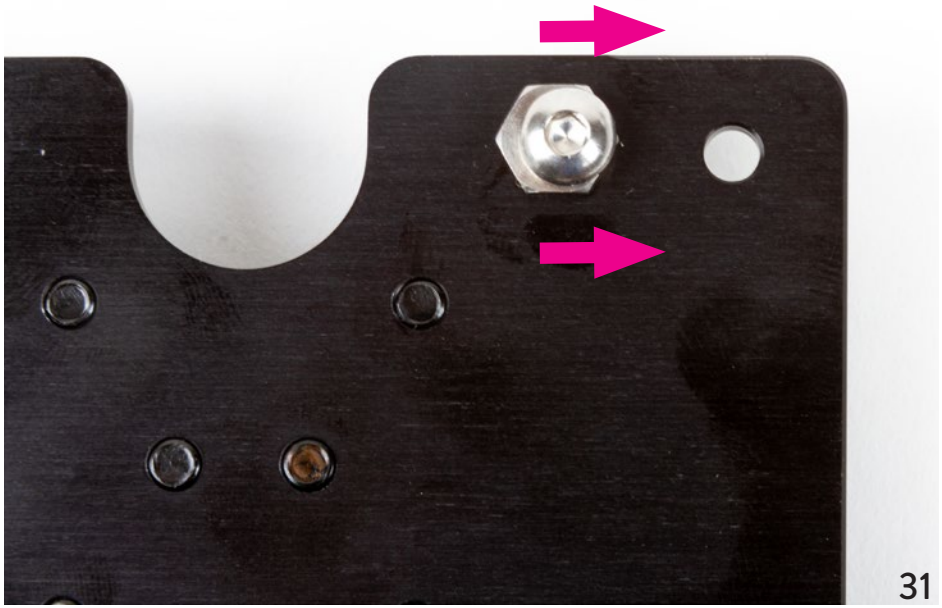
3.6 Preset Y Eccentrics

The eccentric spacers can be rotated to move the screw position closer or further from the a given point. 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 #**39**, #**40**, and #**41**, the M4×22 button socket cap screws, roller wheels, and M4 locknuts. The screws are the longest in the kit, 22 mm long. The M4 Locknuts have a hexagonal outline and rounded tops.
2. Also locate the thick round spacers #**32** and wide washers #**33** which will be used in this step. Refer to §3.3, "Spacers, shims, and washers" on page 26 if needed.
3. Slip one of the M4×22 screws through a wheel, and then through one of the thick 3 mm spacers #**32**. 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 wrench to push the shim back into position so that the screw fits easily.

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 washer #**33** over each screw and then thread on a #**41** M4 Locknut.

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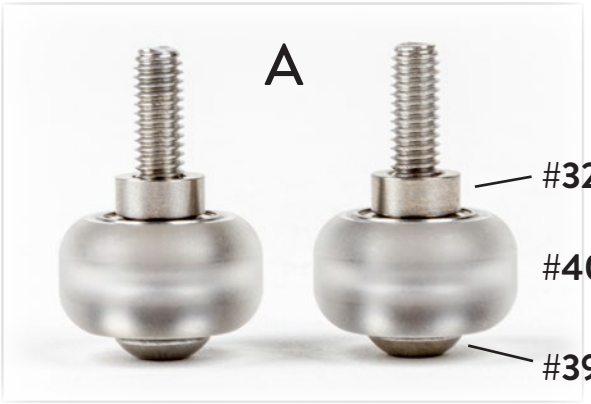
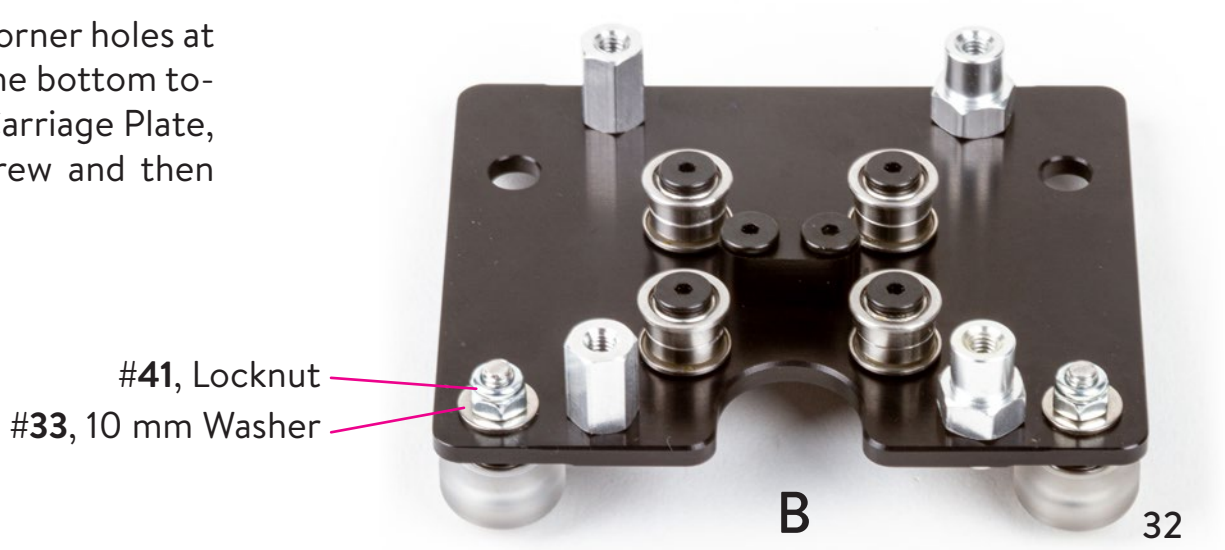
#39 #40 #41

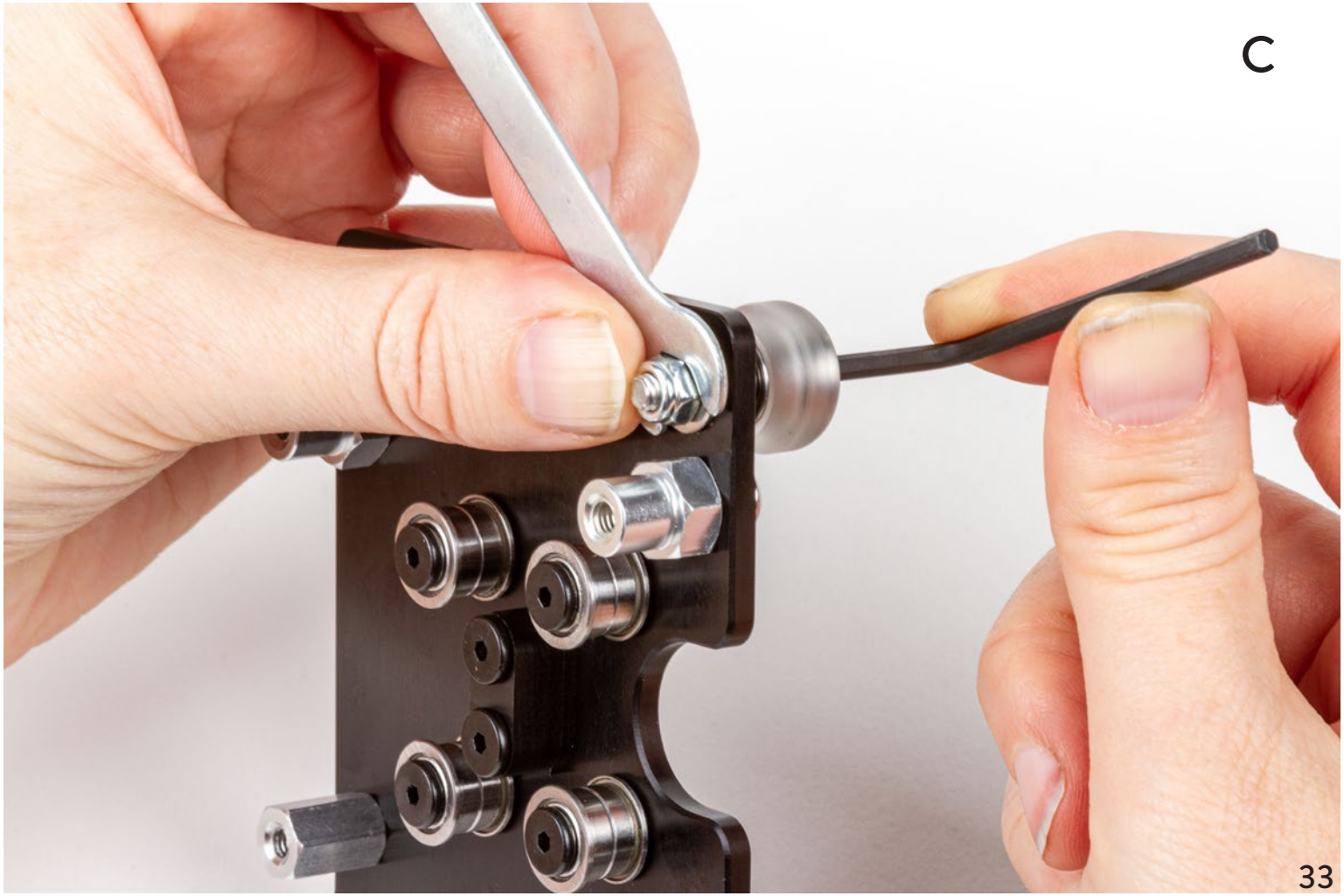




§3.7 Front X Wheels, continued

5. Tighten both wheels securely in place using the 2.5 mm hex L-wrench and #**7**, the 7 mm low-profile wrench to steady the locknut (**C**). *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 nut against the plate with your thumb while you turn – *not press* – the screw with the 2.5 mm hex 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 logo) is on the left (**A**).
2. Slip one #**39** M4×22 screw through a wheel, through an 8 mm × 1 mm thick shim spacer #**31**, and then into *the hexagonal end* of an eccentric spacer, #**37**. 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 the eccentric spacer to sit in the hole.
4. On the top side of the carriage plate, place a 10 mm washer #**33** over each screw and then thread on a #**41** M4 Locknut (**C**).

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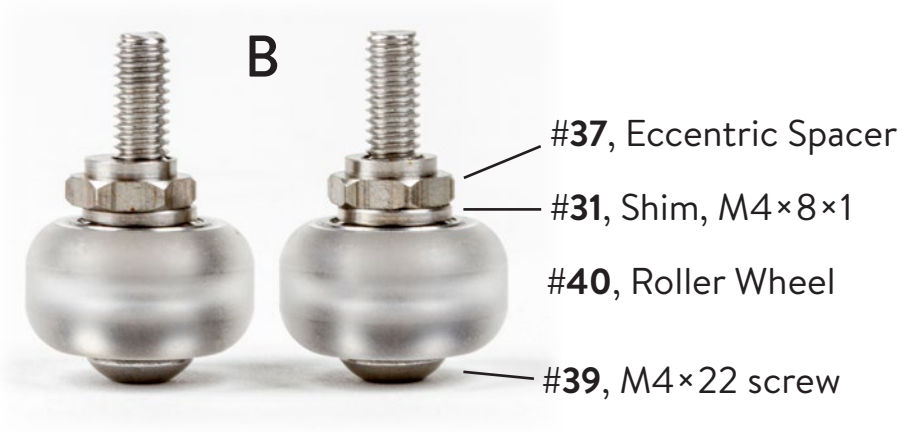
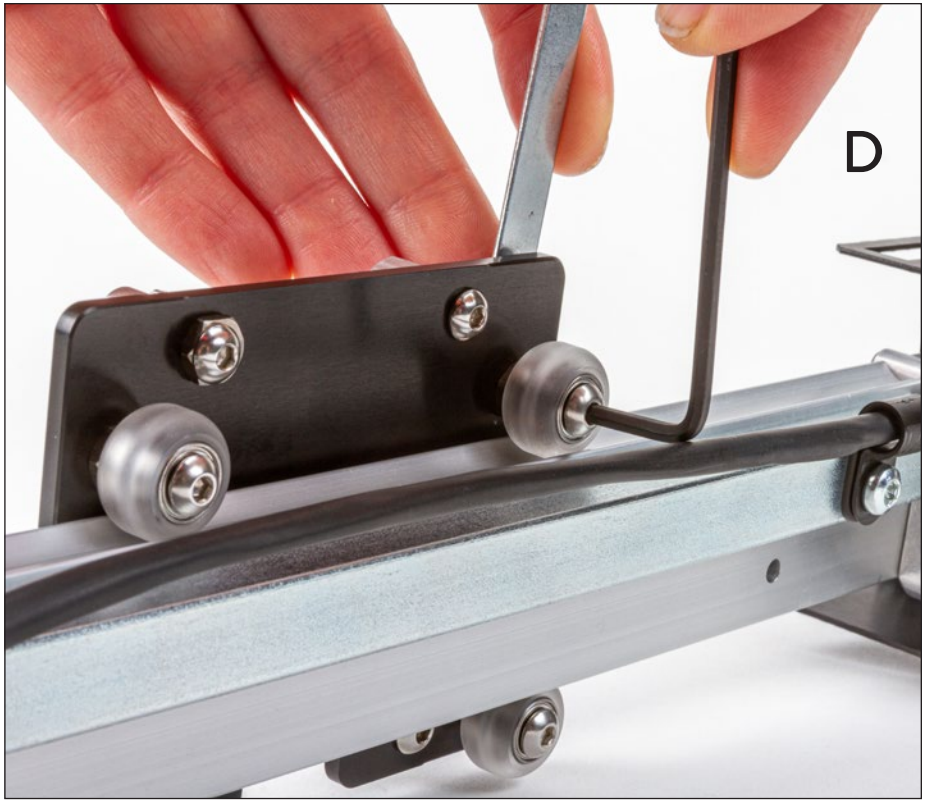


5. Now, tighten both wheels – *only until barely tight* – using the 2.5 mm hex L-wrench and #**7**, the 7 mm low-profile wrench to steady the locknut (**D**). Final tightening will come in a subsequent step.

   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 spacers is inserted into its hole (**E**).



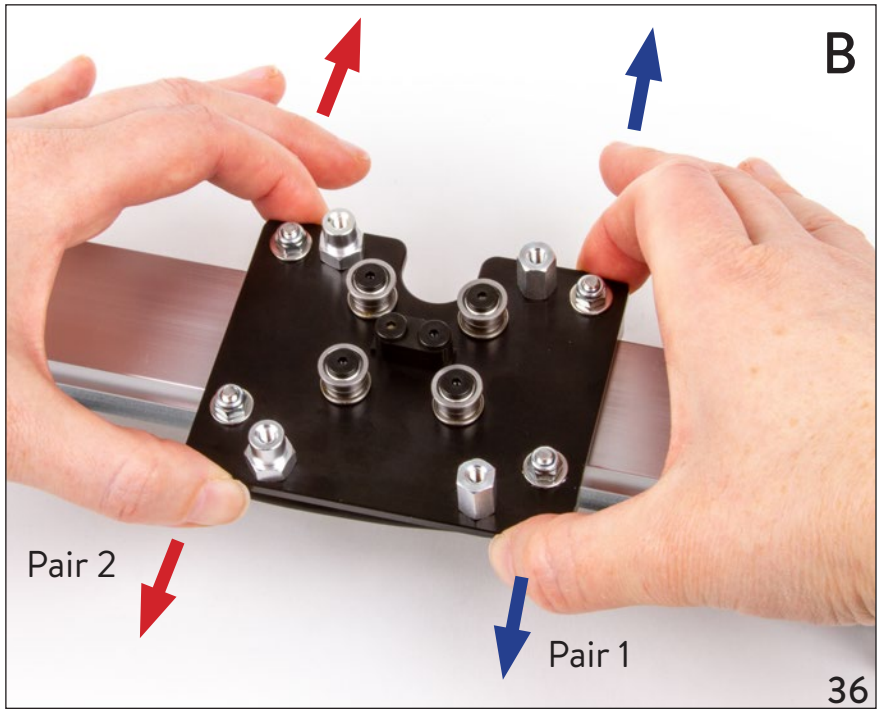
3.9 Tuning the X Carriage

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 wheels and the base rail, so that the carriage moves smoothly and without slack.

The total range of adjustment on the eccentrics – 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 31).

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 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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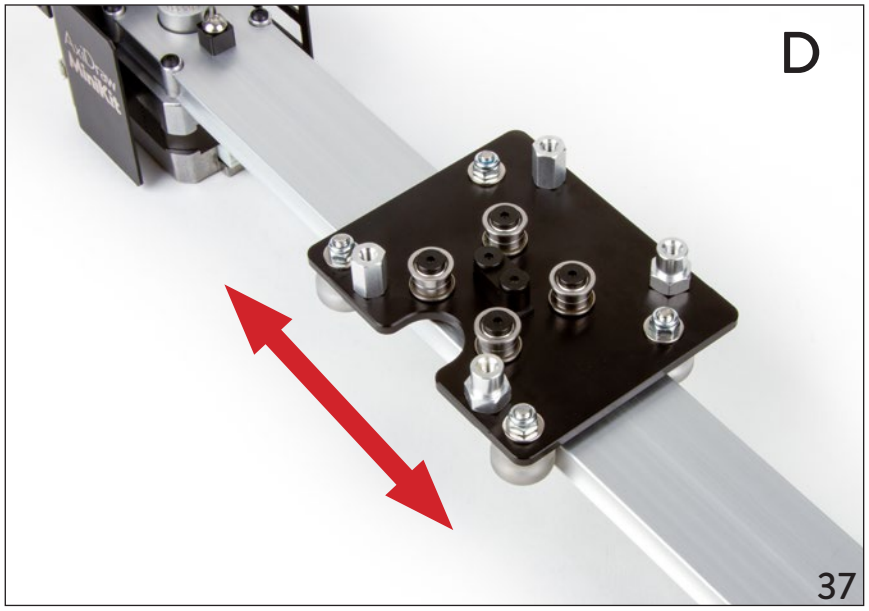
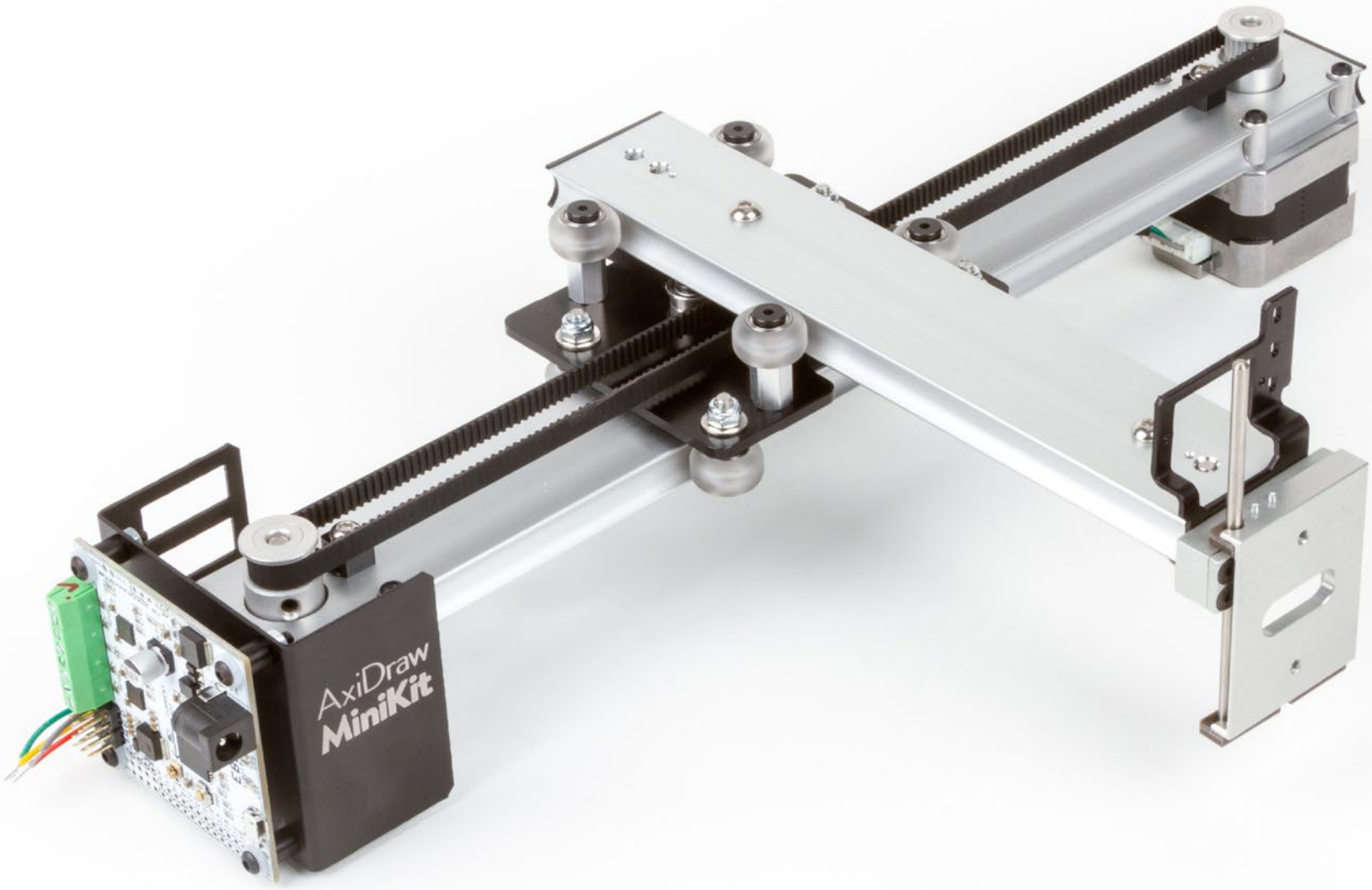
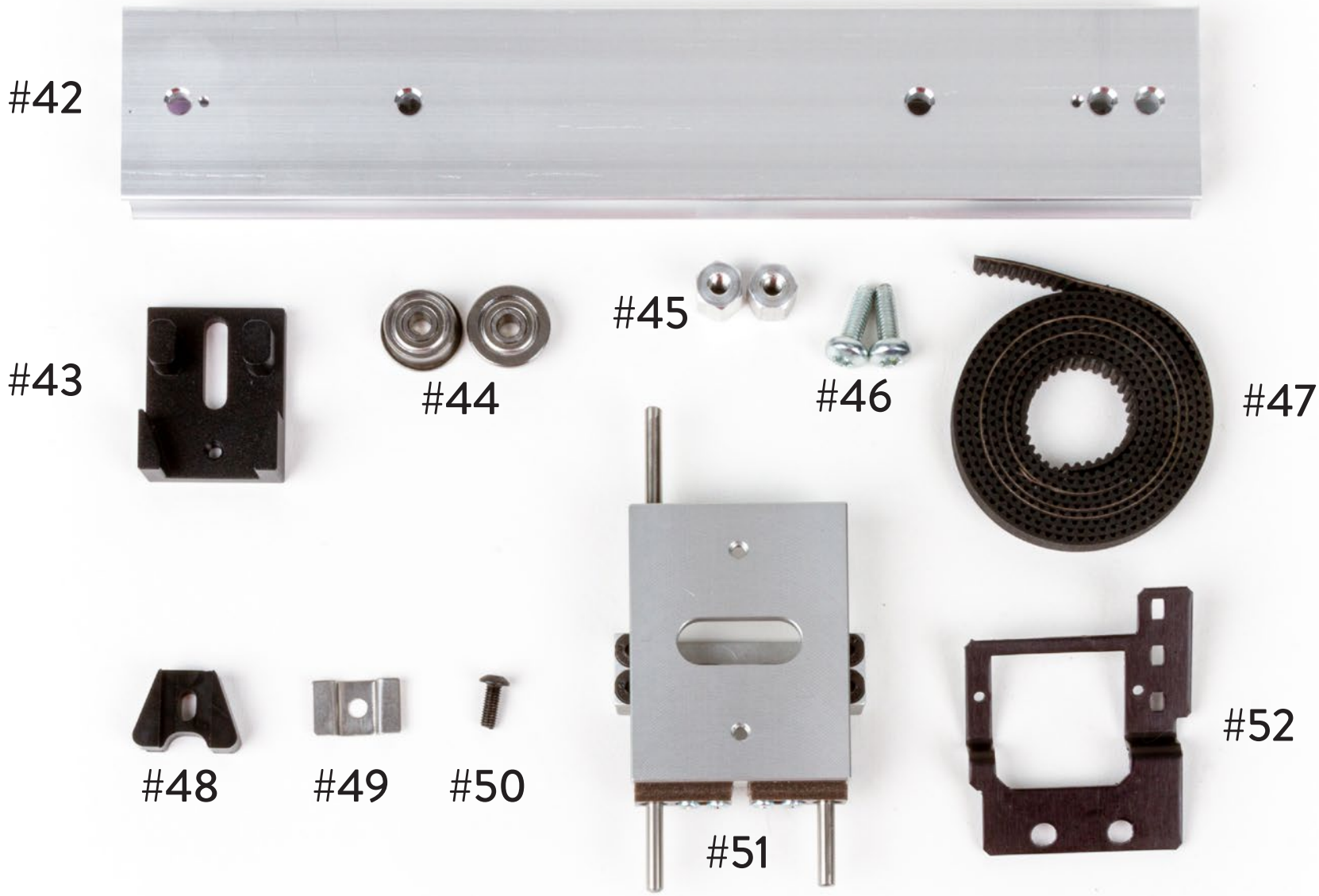
4. If you can feel any slack movement in Pair 1 alone, make a small adjustment to the eccentric position (**C**), and test again. Repeat until there is no slack movement in line with these two wheels. The pair is properly adjusted when there is no slack movement when tested as in (**B**), but the rear 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 and with little effort along the length of the base rail, from endstop to endstop (**D**).





Part 4: Y, Belt, and Z

4.1 Parts in the Y, Belt, and Z assemblies



#**42**, MiniKit Y Rail (1)
#**43**, Tensioning block (1)
#**44**, F624 Ball Bearing (2)
#**45**, M4×8×8 Hex Standoff (2)
#**46**, M4×12 Torx tapping screw (2)
#**47**, Timing belt (1)
#**48**, Belt spacer (1)
#**49**, Belt retaining clip (1)
#**50**, M3×8 Button-head Screw (1)
#**51**, Z Slide assembly (1)
#**52**, Servo mount (1)

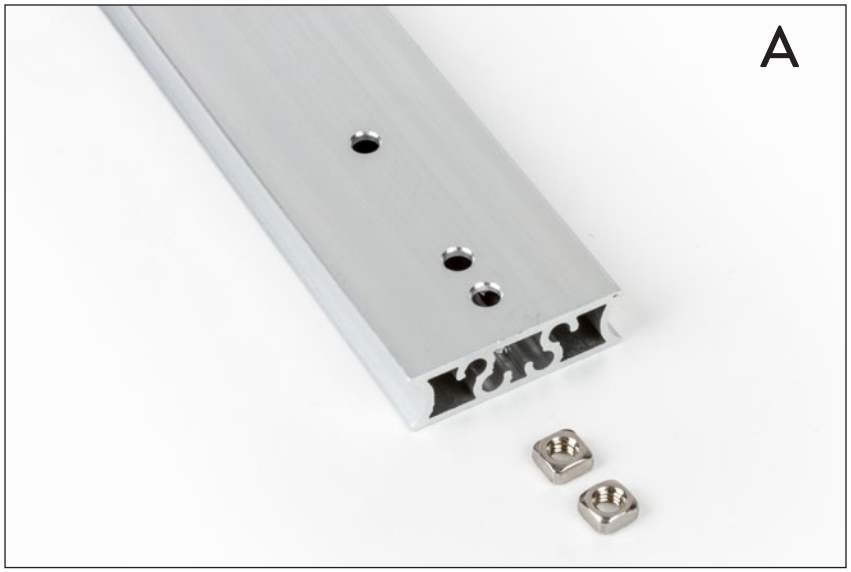
4.2 Tensioning block

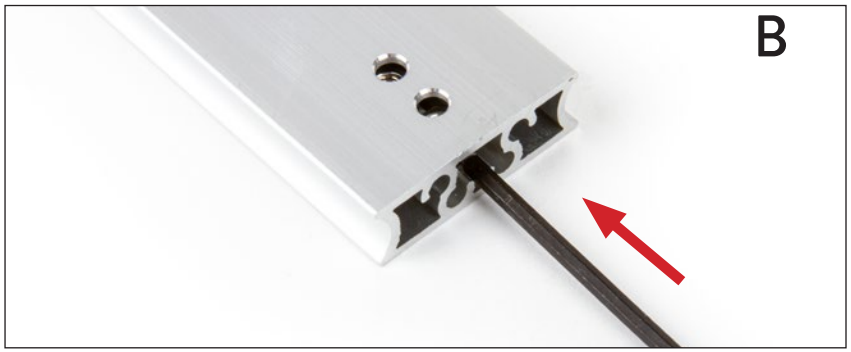
> The Y Rail may have extremely sharp points and edges. *Handle with appropriate care.*

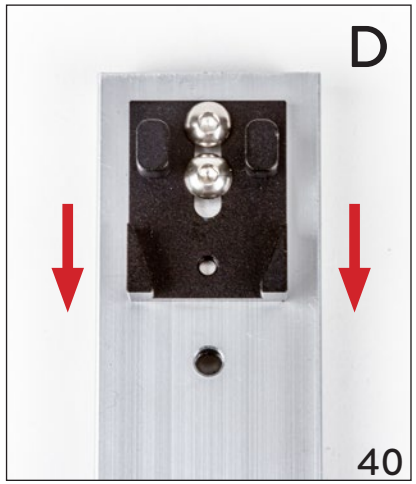
1. Begin with the MiniKit Y rail #**42**. For this step, orient it as shown (**A**), with the further-apart set of holes (visible on the ends) facing up. Locate the end that has the two holes close together.
2. Insert two of the #**11** M4 square nuts into the center channel of that end, and push them with the 2.5 mm hex wrench (**B**), until they line up with the first two holes.

   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 #**43** 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, #**38**, through the slot and into the square nuts. Thread them into the nuts with the 2.5 mm hex 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.)

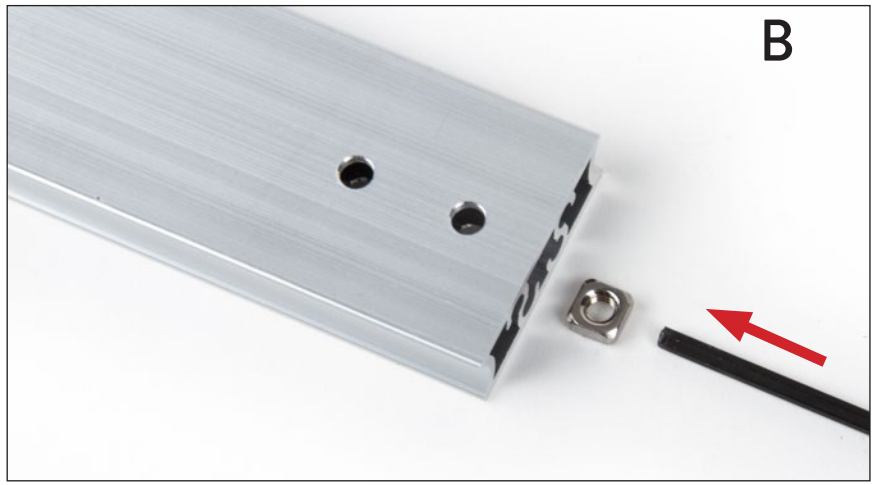


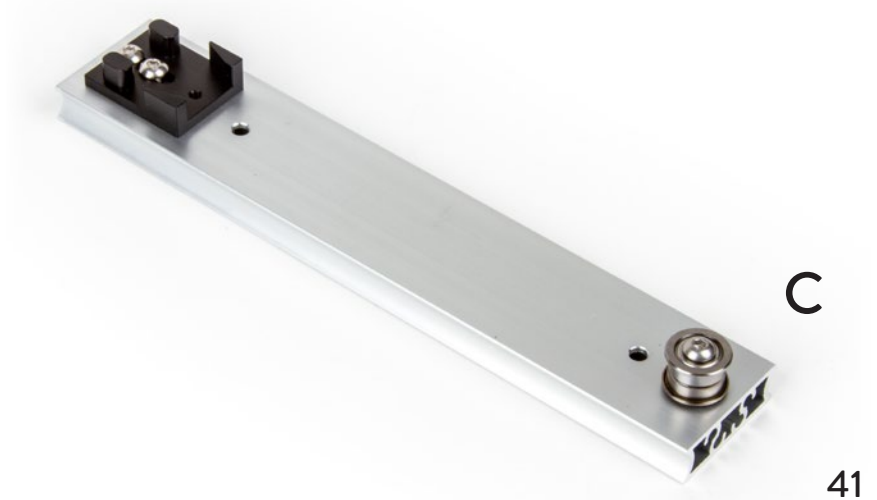




4.3 Y Carriage Idler Pulley

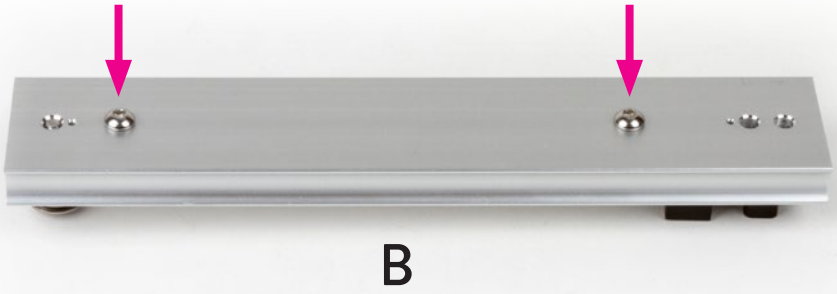
1. Identify part #**44**, the 2 large flanged ball bearings.
2. Slip the remaining #**39** M4×22 button socket cap screw through the two ball bearings, with the flanges facing away from each other – once again like a tiny metal sandwich. Then, slip on the remaining #**31** 8 mm × 1 mm thick shim spacer (**A**).
3. Insert the remaining #**11** M4 square nut 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 (**A**) 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.

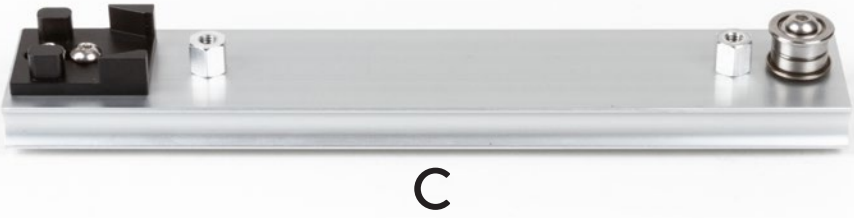


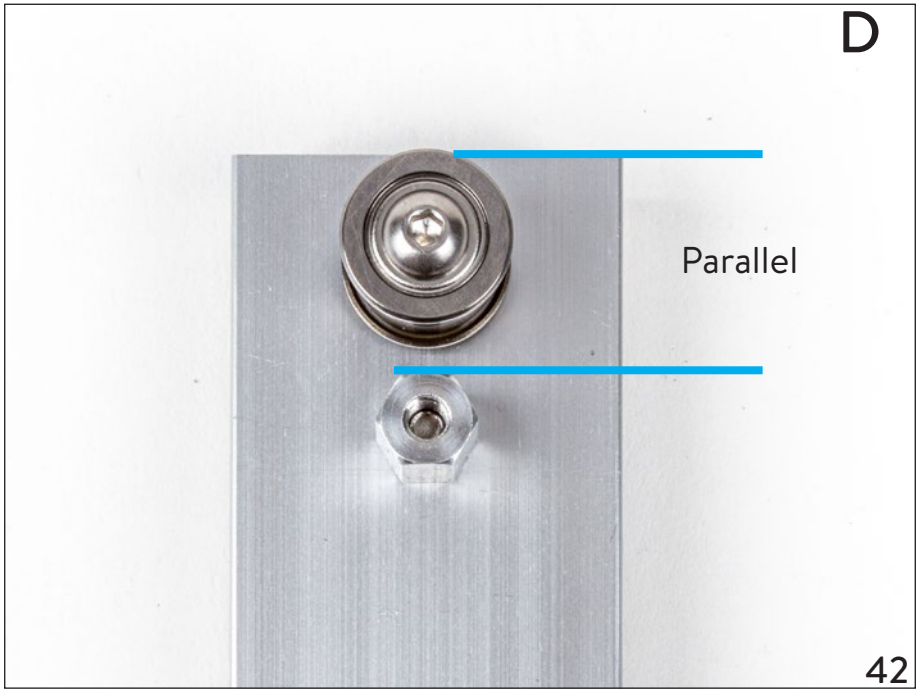


4.4 Y Carriage Travel Limits

1. Identify part #**45**, threaded hex standoffs, 8 mm across and 8 mm tall.
2. Slip the remaining #**13** M4×16 button socket cap 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 (**B**).
3. On the bottom side, thread the #**45** hex standoffs onto the screws (**C**).
4. Tighten the standoffs firmly into place with the 2.5 mm hex L-wrench and #**6**, the 8 mm low-profile wrench. As you tighten it, line up one side of each hex standoff to be parallel to the end of the Y rail (**D**).

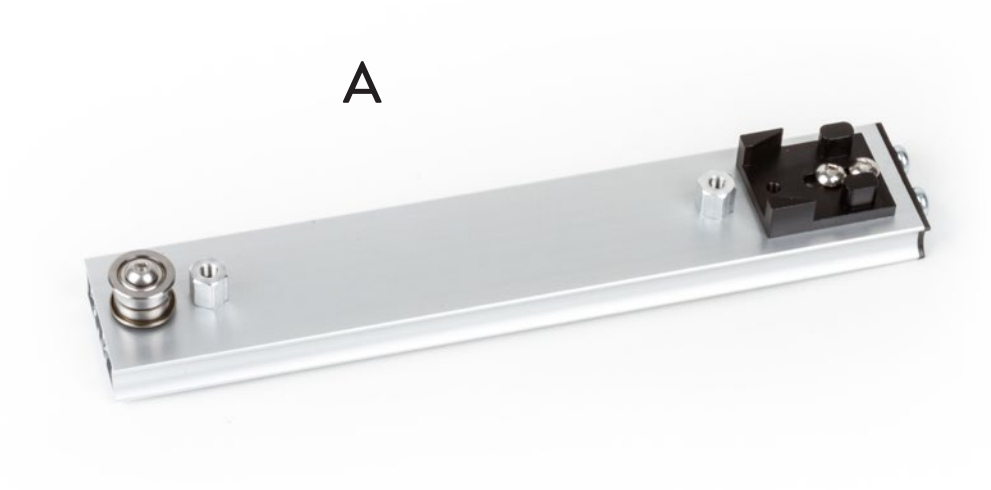


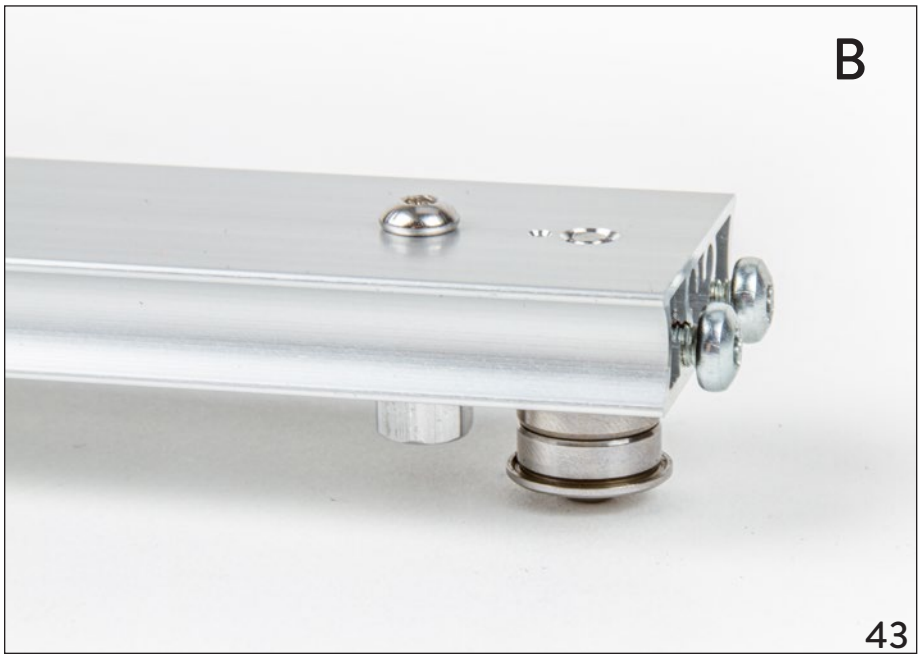




4.5 Y Endcap and pre-threading

1. Following the same procedure as in §2.6 “Base Endcap” on page 18, install the second Rail Endcap #**16** on the “back” end of the rail, which is the end by the tensioning block (**A**). You will need the remaining two M4×8 Torx Tapping Screws, #**17** and the Torx L-wrench, #**2**.
2. Identify the two M4×12 Torx Tapping Screws, #**46**. These screws can be identified by the star-shaped socket on their heads and length of approximately 12 mm, as measured below the head.
3. 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. (This operation adds threads to these holes, which will make a subsequent step much easier.)

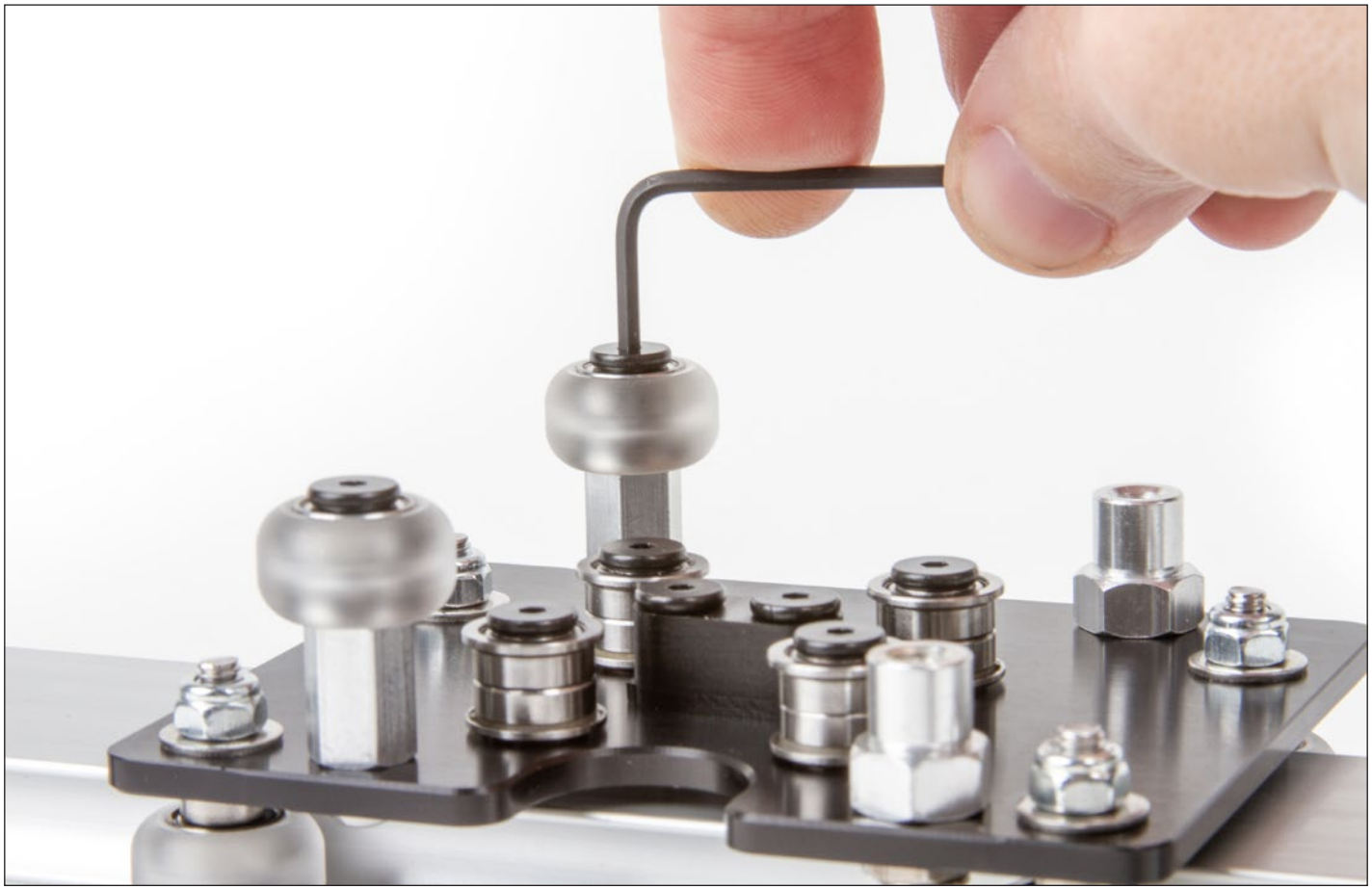




4.6 Fixed Y Wheels

Next, attach roller wheels #**40** to the top of the two tall and straight hex standoffs #**35** 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 Cap Screws #**29**, and tighten them securely in place with the short side of the 2 mm ball-end hex L-wrench #**3**.



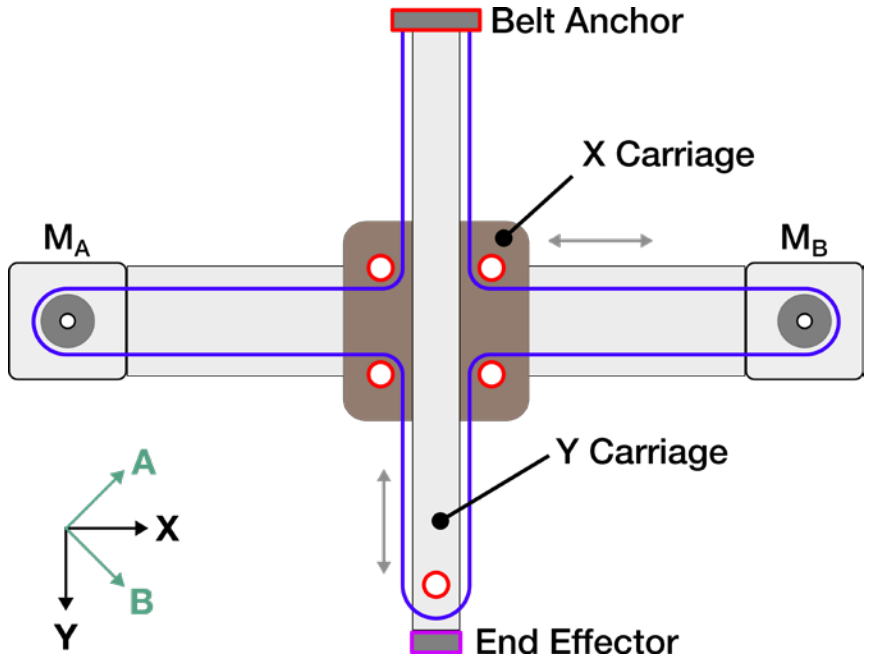
4.7 Aside: AxiDraw kinematics

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.

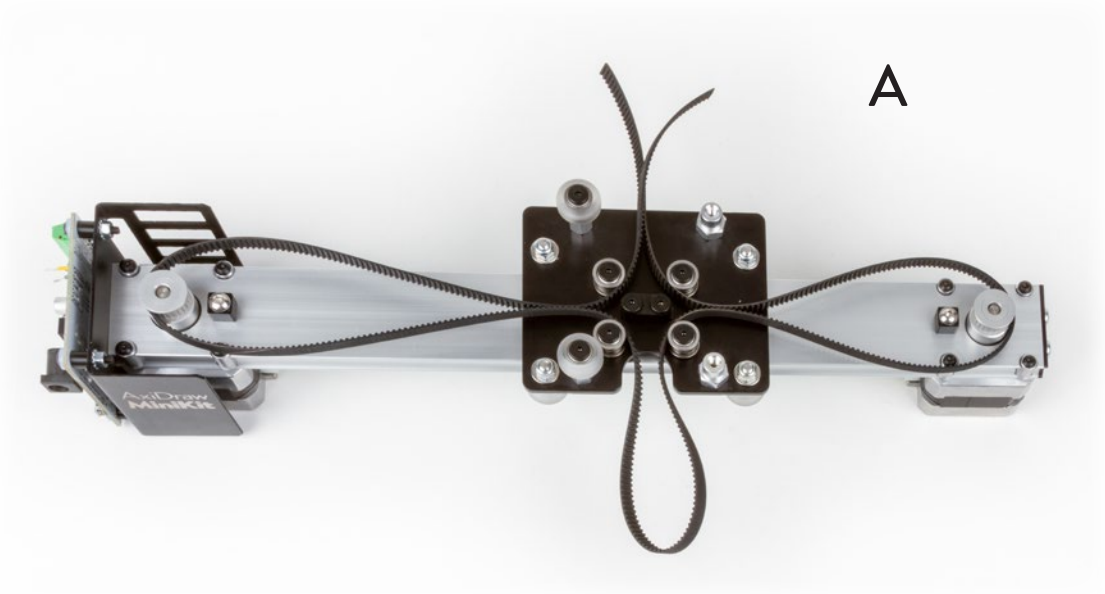
The X carriage contains four idler pulleys, arranged essentially in a square. The Y carriage has one idler pulley at the front near the end effector (pen holder) and an anchor point (the tensioning block) for the belt at the back, farthest from the pen holder.

When the left-hand motor ($\mathbf{M_A}$) but the right-hand motor ($\mathbf{M_B}$) 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 roughly in place. Position its loose ends to come out the back of the carriage and 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 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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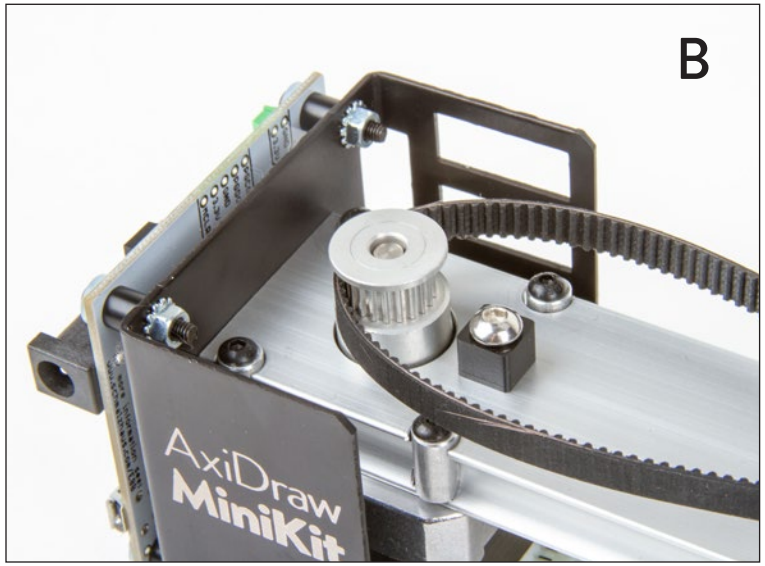
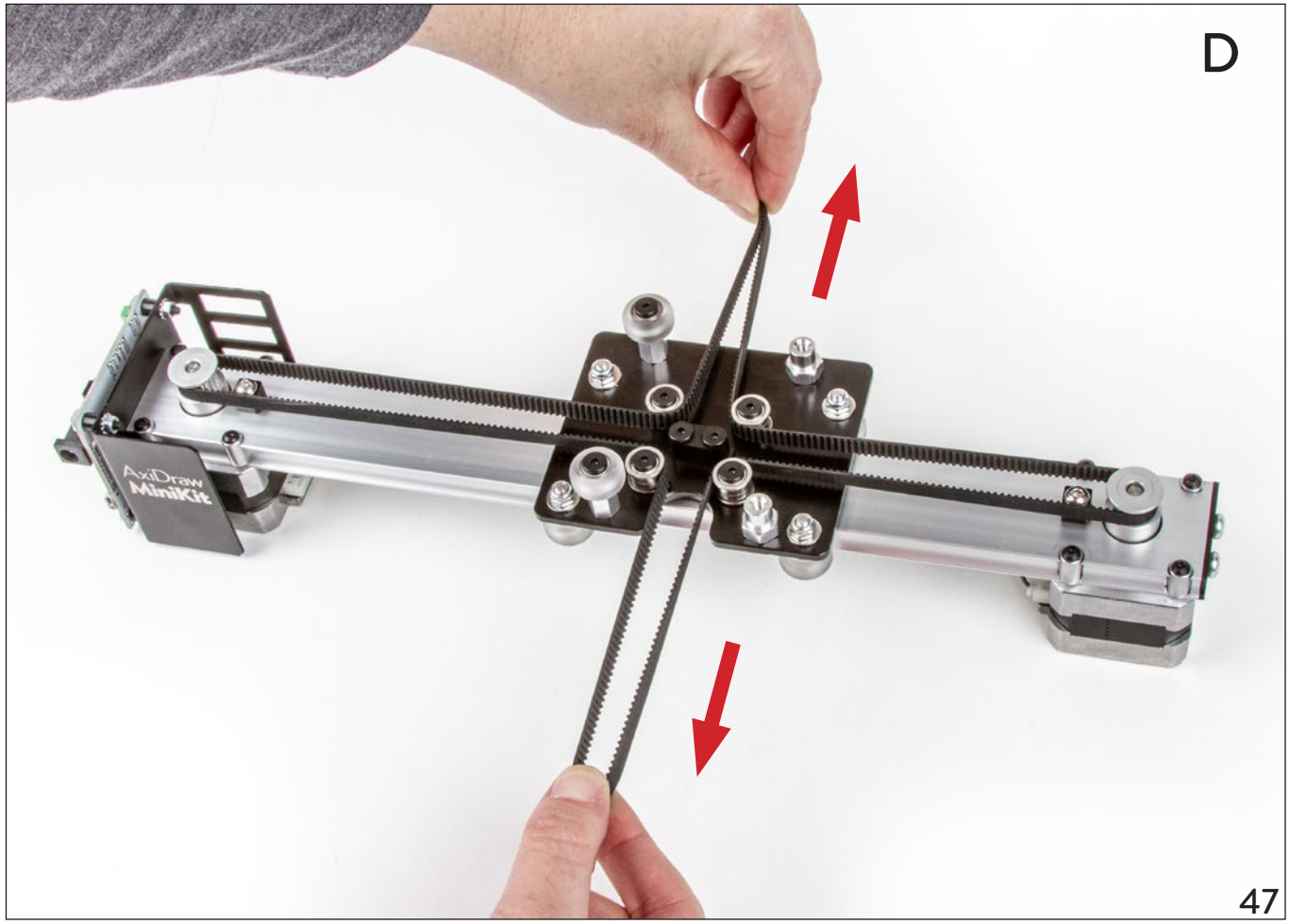
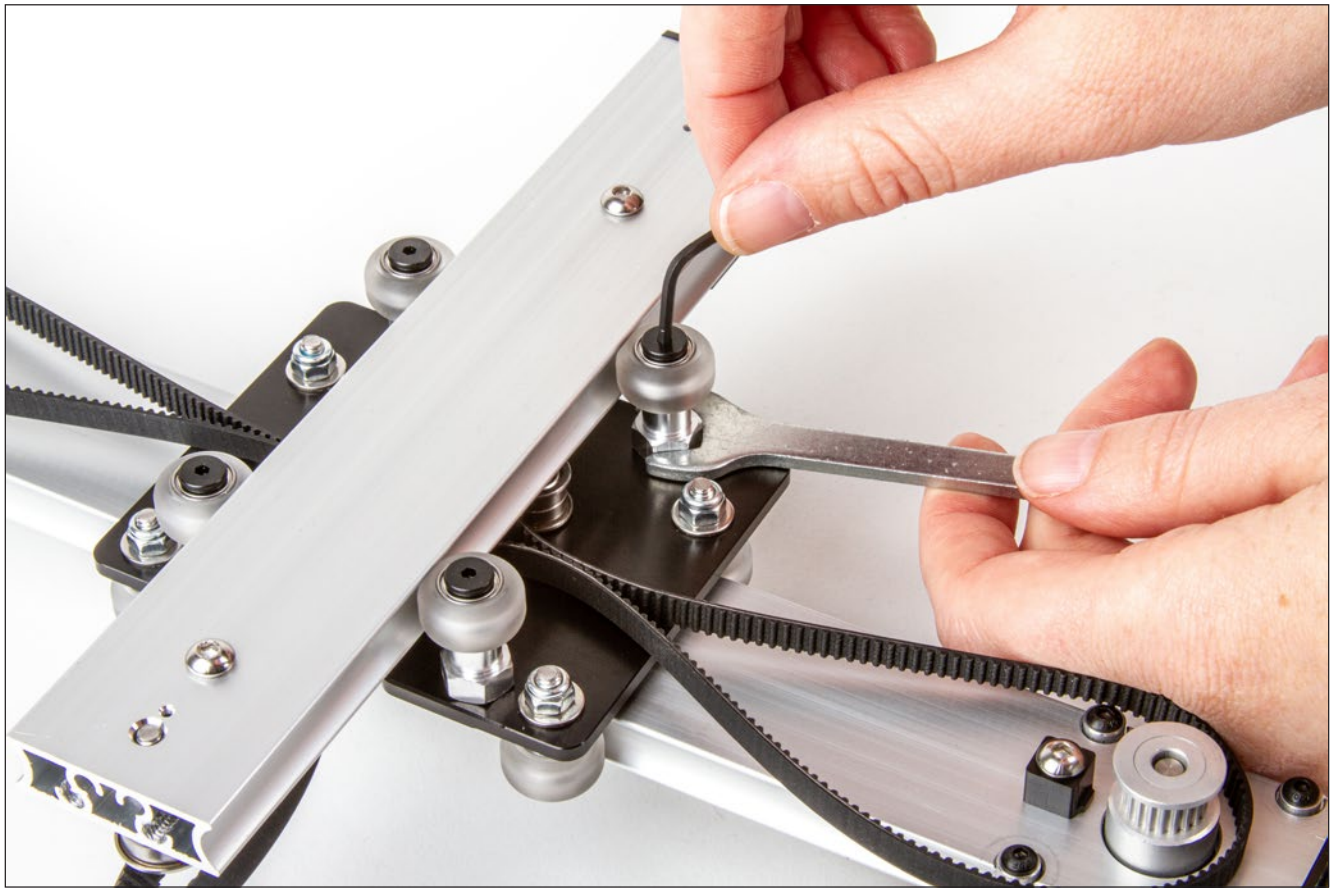


4. Once the belt seems to be in the right place, test its placement by pulling the loose ends (pinched together) straight back while pulling the front loop straight forward (**D**).
5. While holding the belt in tension, make sure that it is flat rather than twisted, engaged in the teeth of both motors, 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.

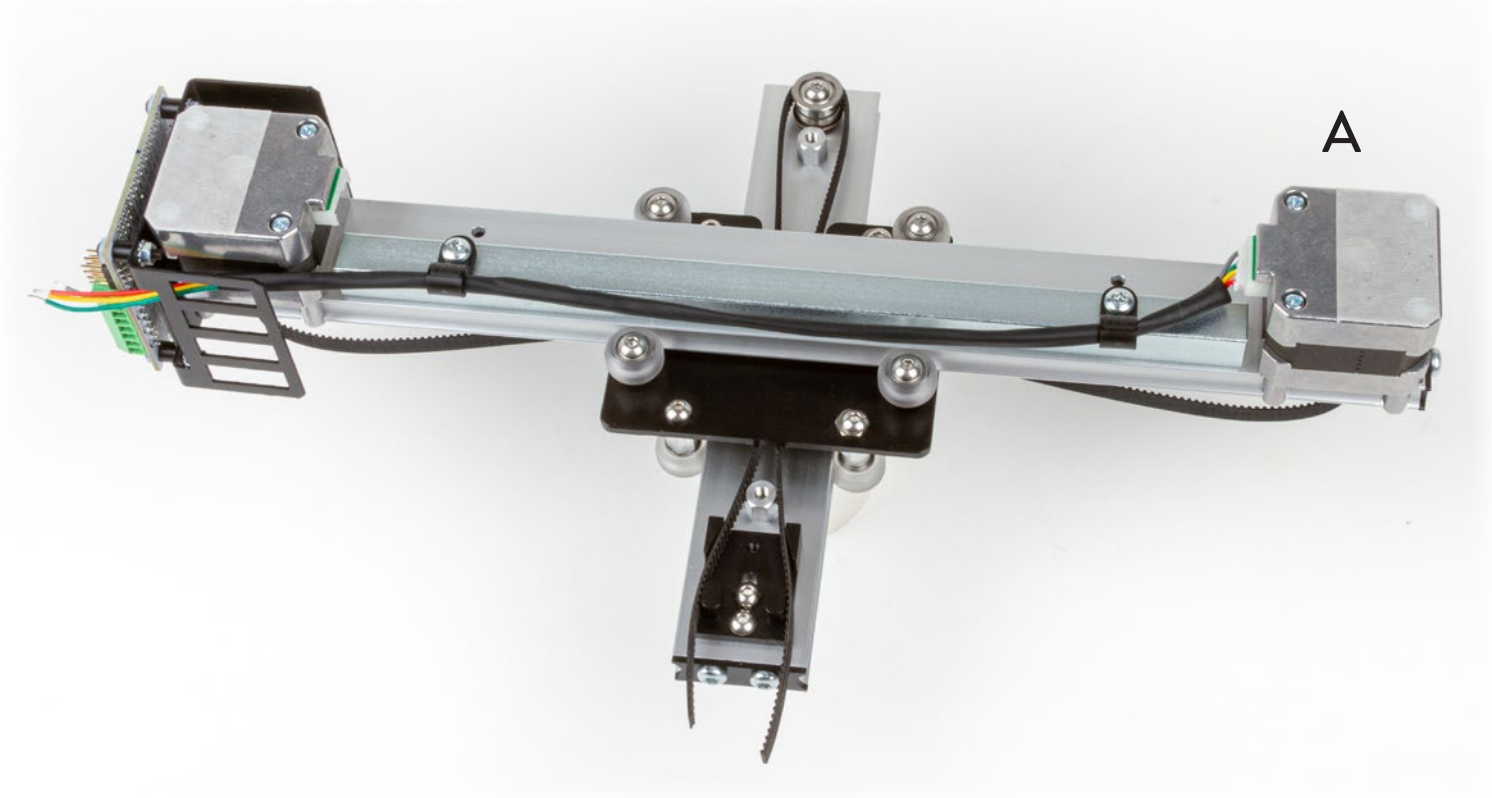


4.9 Add the Y Carriage

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 – the side with the belt loop not the loose belt ends.
2. Set one of the M4×12 Low Profile Cap Screws #**29** through a roller wheel #**40** and set it on top of one of the SemiHex standoffs #**36** 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 2 mm ball-end hex L-wrench #**3**. *Take care to not rotate the standoff.*
4. Repeat these steps to add the other roller wheel to the other SemiHex standoff.



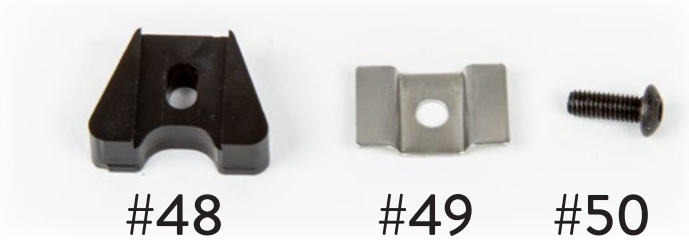
4.10 Belt tensioning



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 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 socket cap head screw #**50**. The screw is distinguished by its 2 mm hex socket, black color, and length of approximately 8 mm below the head.



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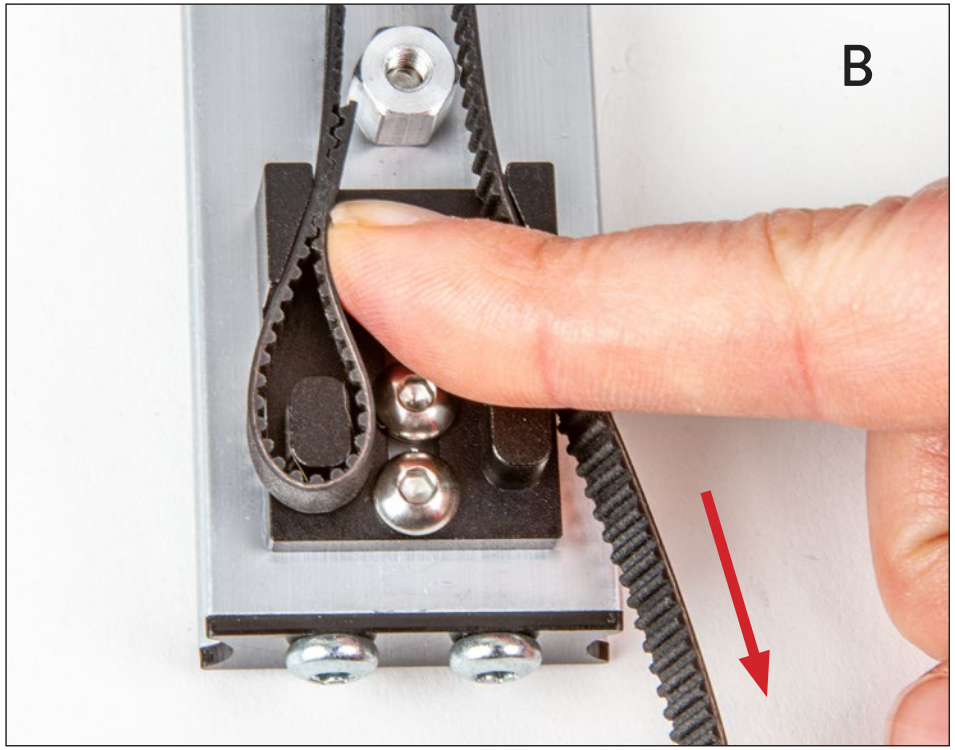
4. Loop one end of the belt around the rounded post near the end of the tensioning block, and fold it back up so that the belt teeth engage with each other (**B**).
5. Holding the belt steady by the engaged teeth, pull the loose end to establish a little tension and ensure that the belt is still looped around the motors and 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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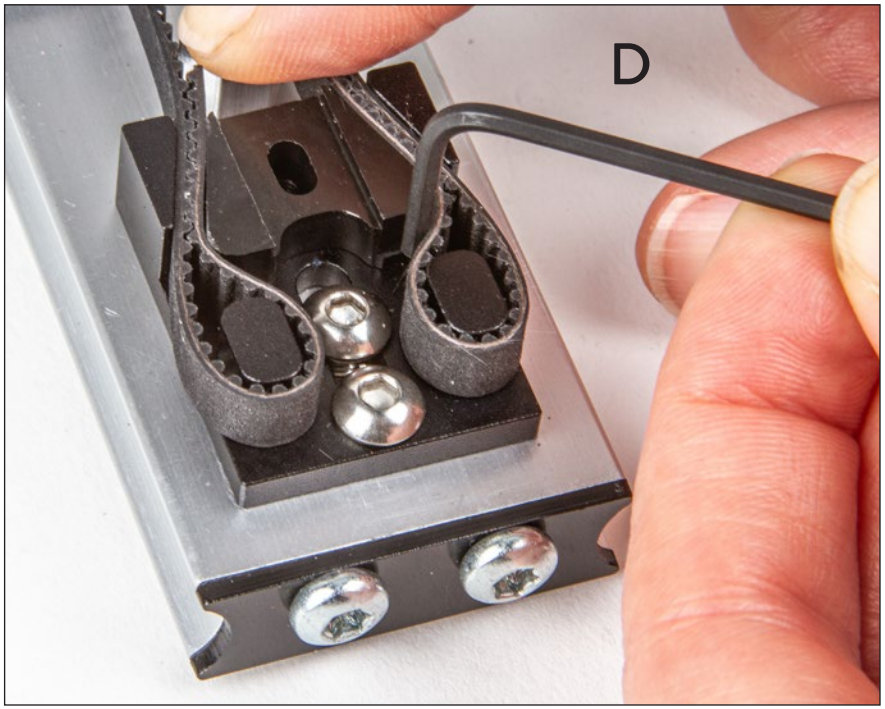
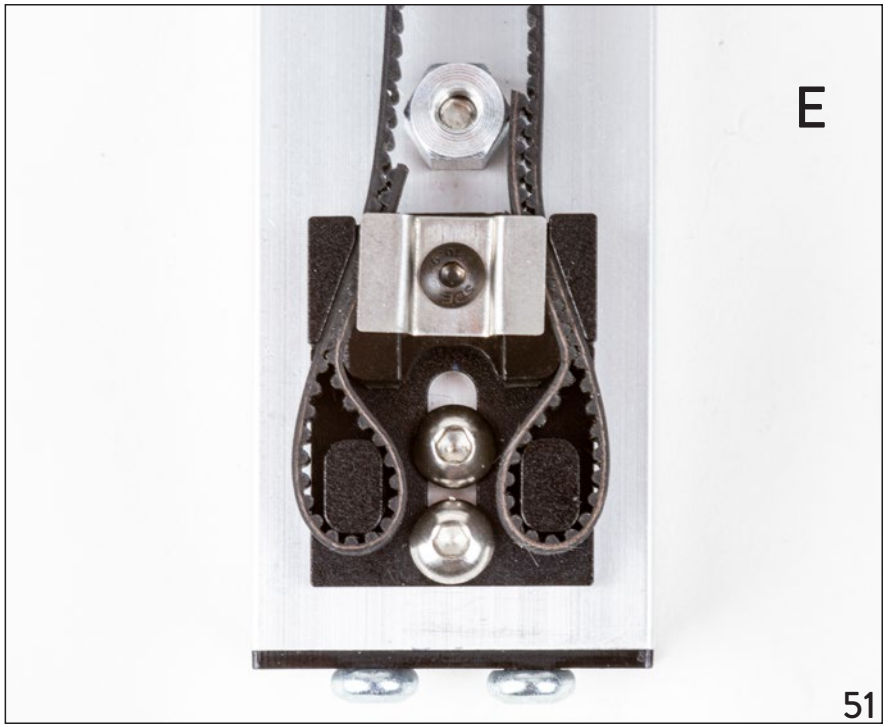
7. Insert the belt spacer, with its recessed side pointing up, into the gap in the middle of the tensioning block (**D**). Its function is to pinch the two looped ends of the belt, and thus anchor the belt.

   Tip: Use your 2 mm 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 socket cap 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 wrench (**E**).





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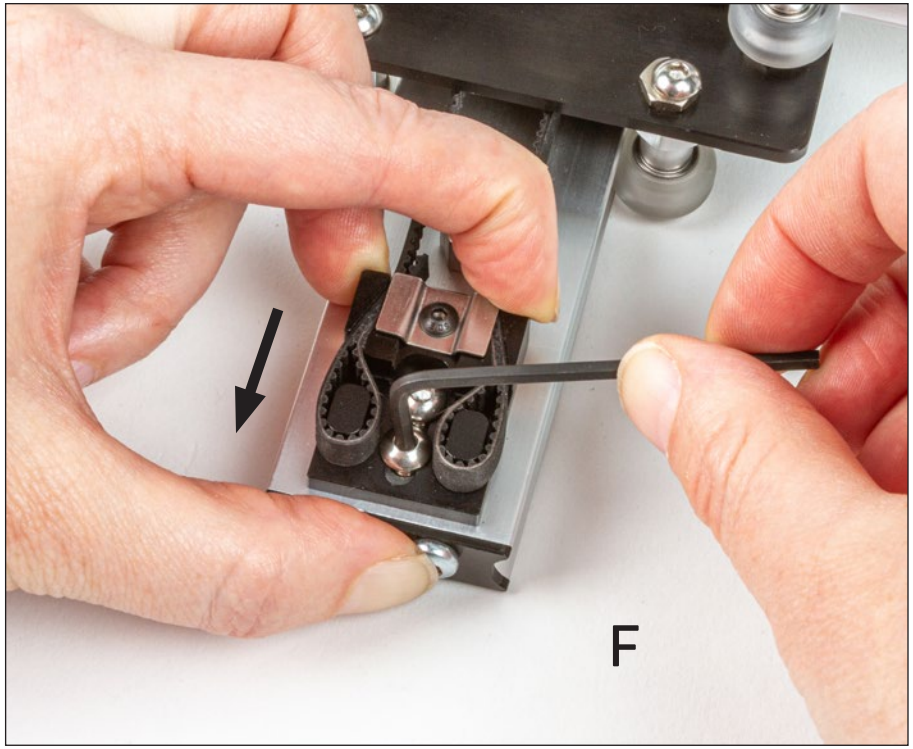
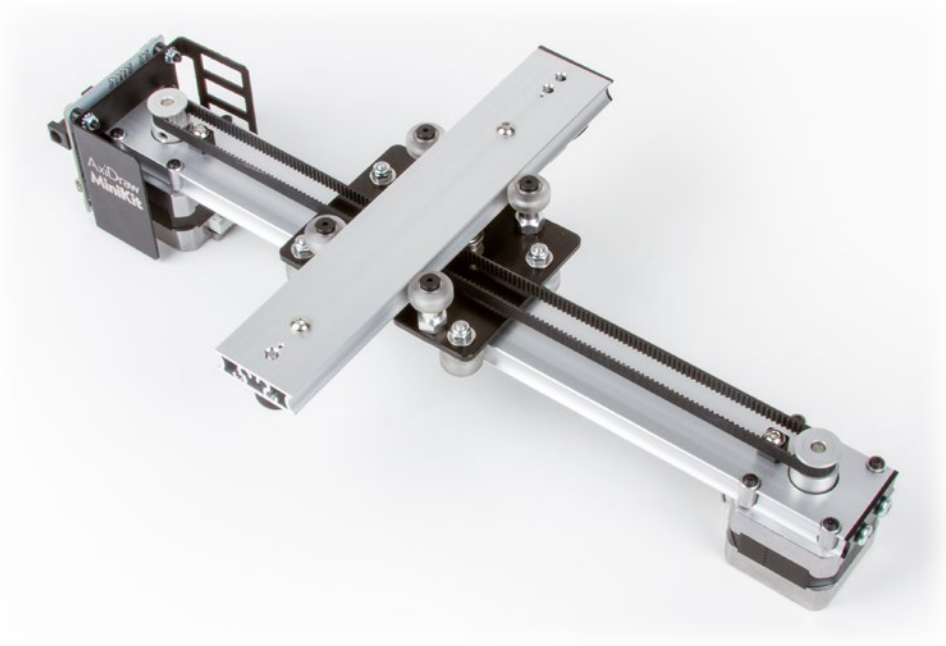
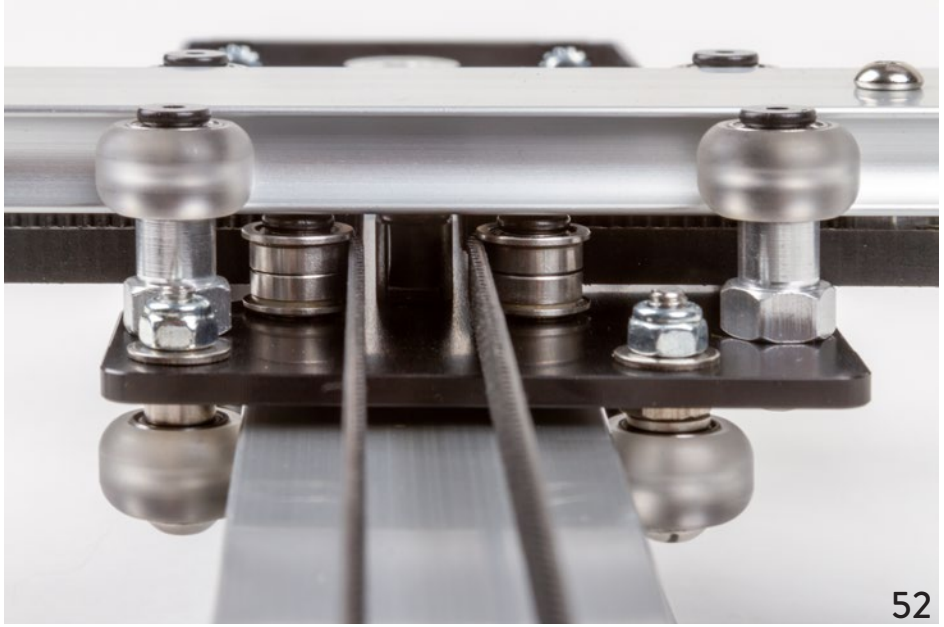
§4.10 Belt tensioning, continued

10. Using the 2.5 mm hex 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.*
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.





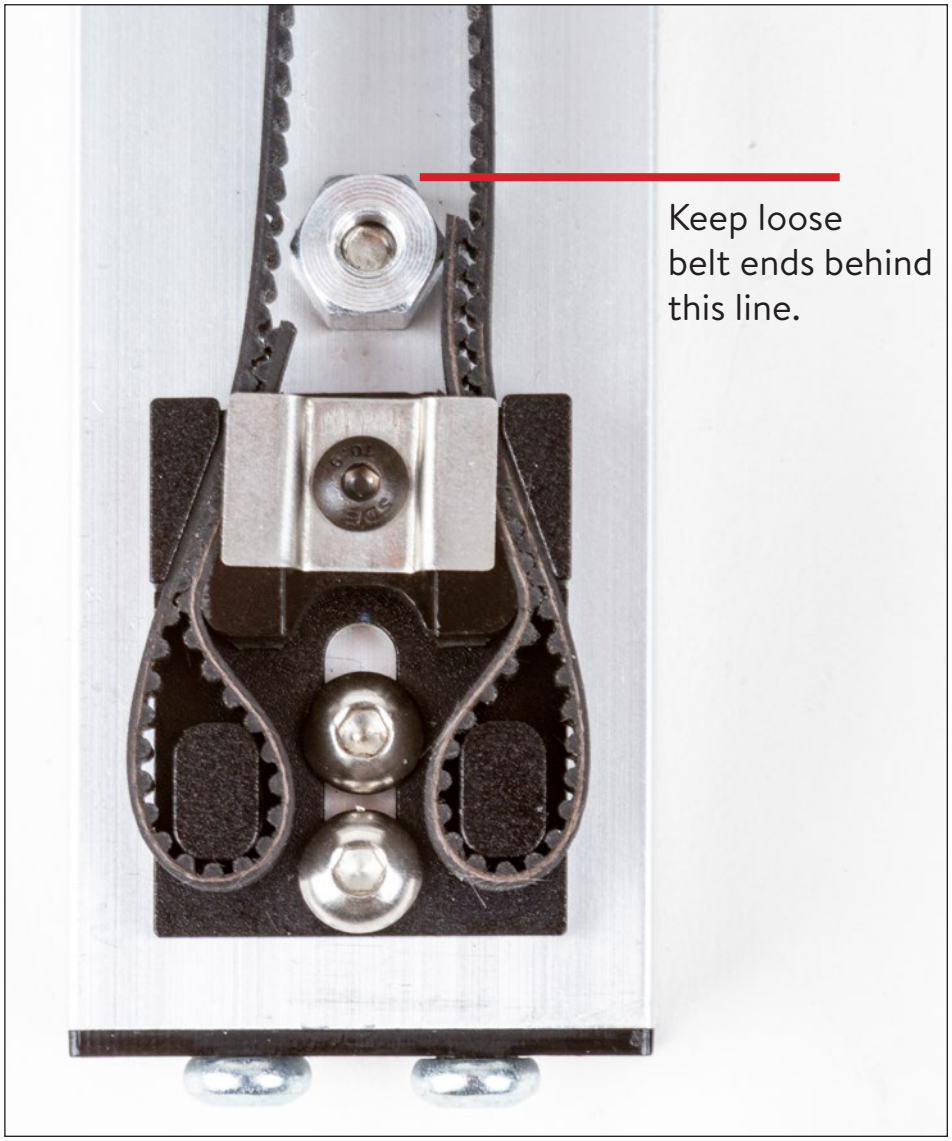


4.11 Trim the belt ends

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 36.

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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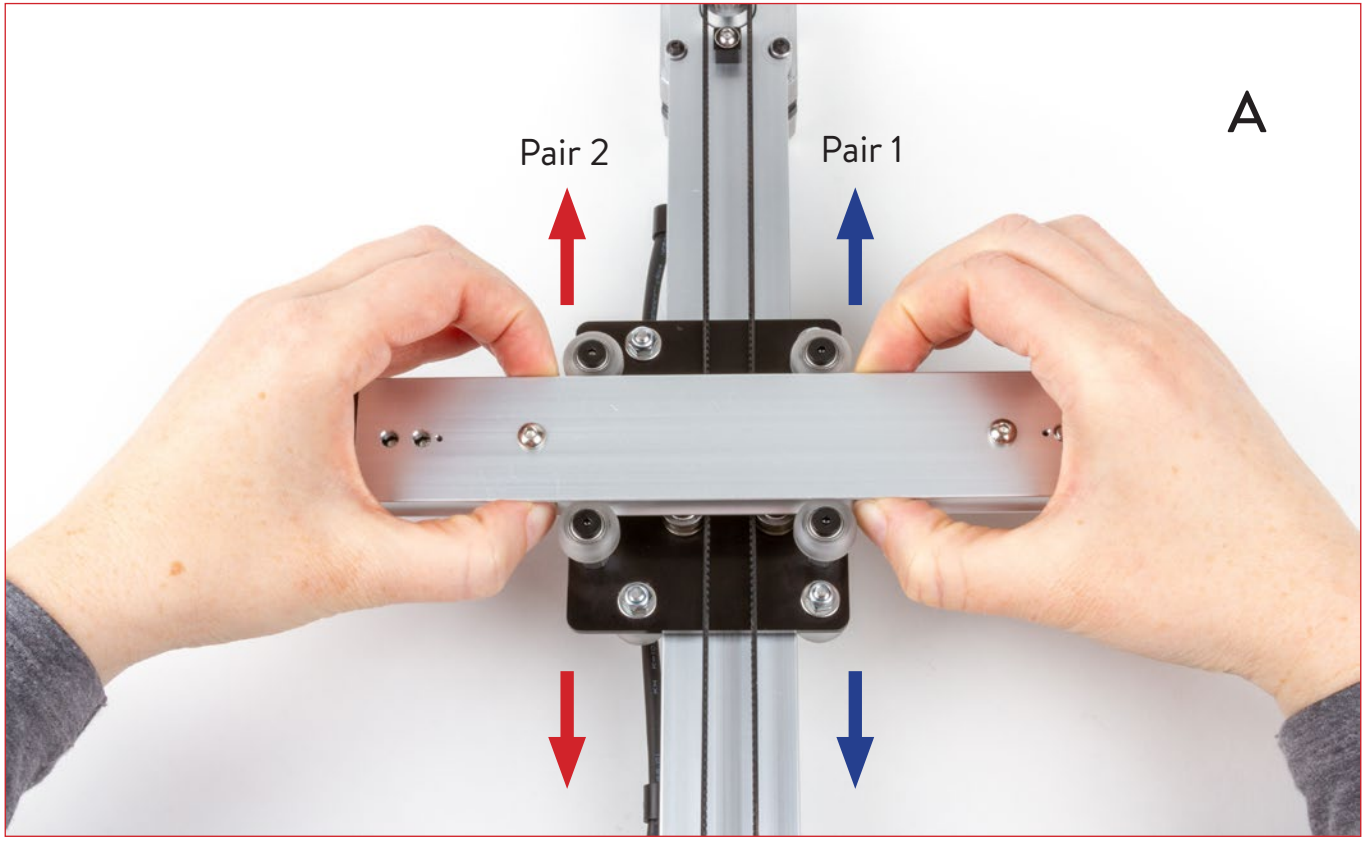
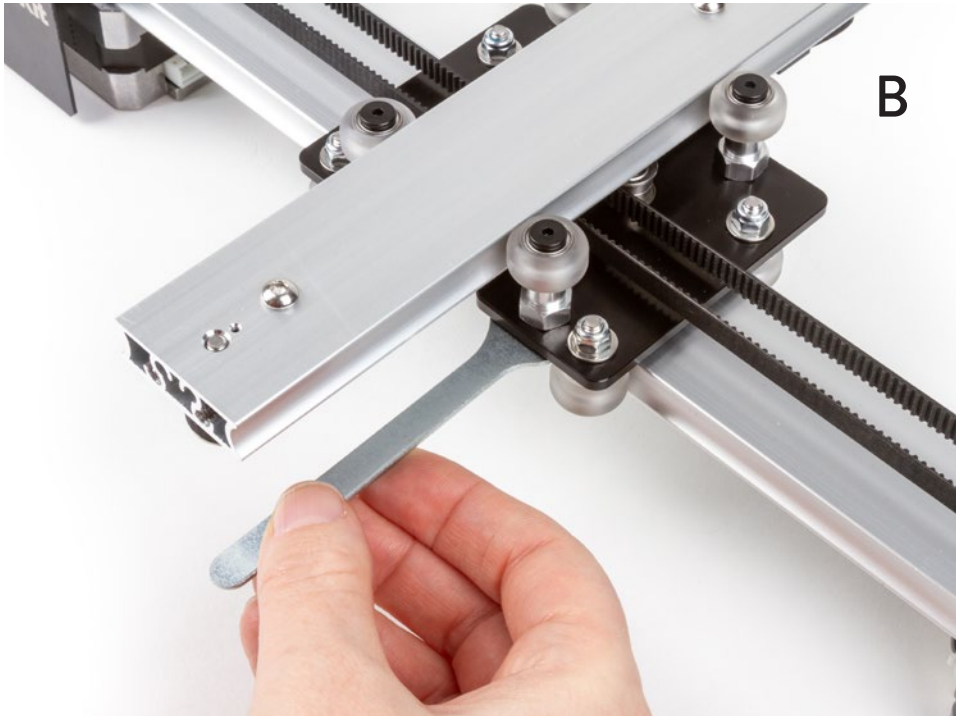
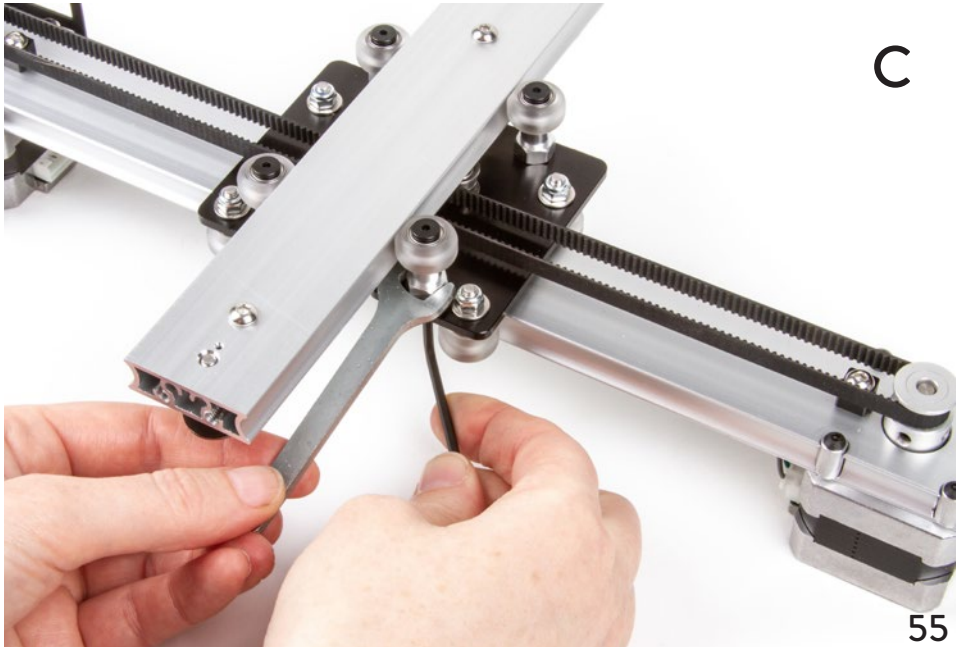


2. If you can feel any slack movement in Pair 1 alone, make a small adjustment to the position of the eccentric spacer beneath the SemiHex standoff (**B**). Repeat until there is no slack movement in line with these two wheels. The pair is properly adjusted when there is no slack movement when tested 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, #**52**, 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 #**51**, 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 #**46** 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 engages only with the mounting bracket of the Z slide *not* the front face.

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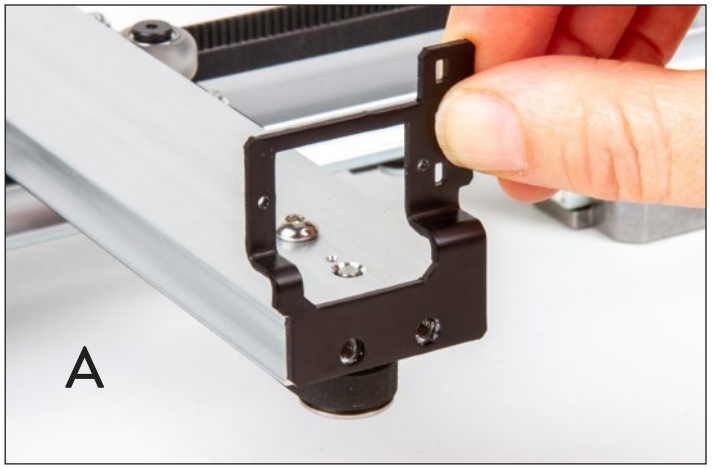
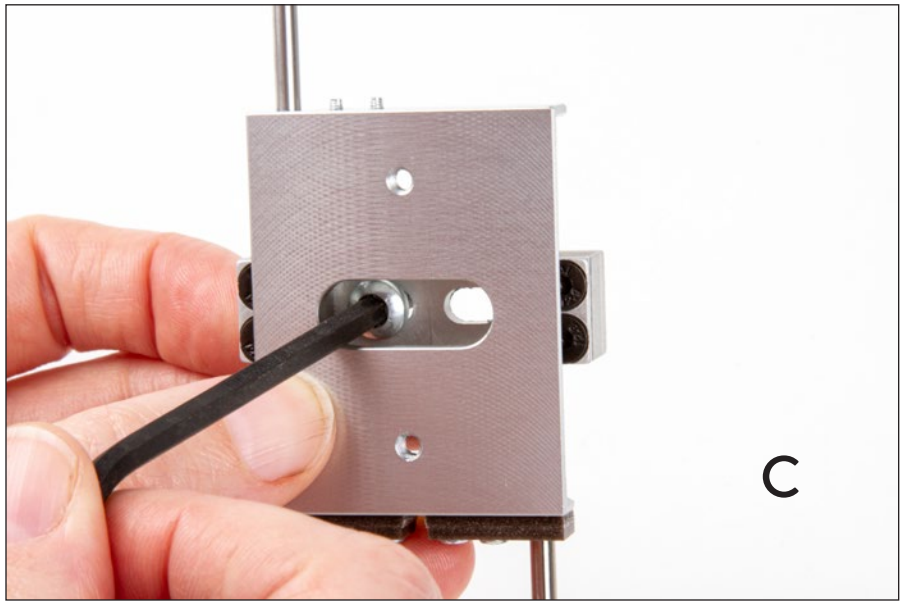
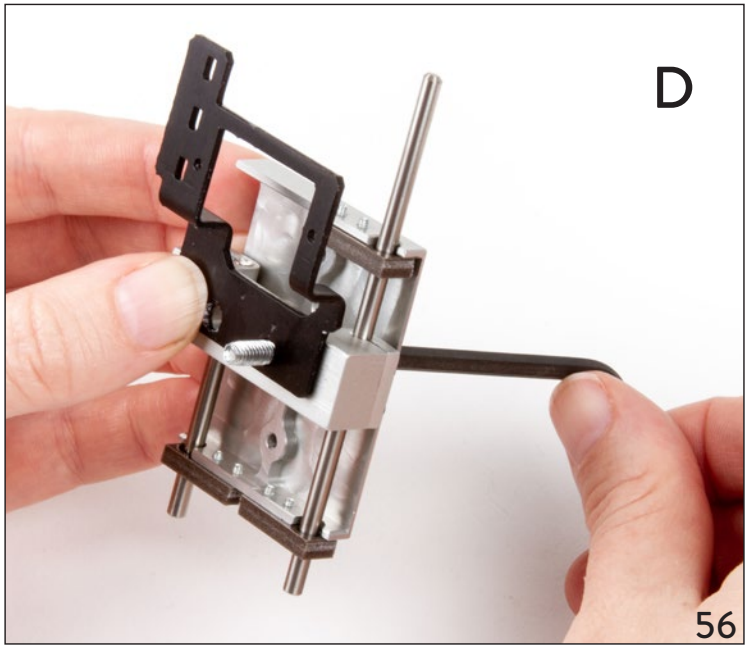
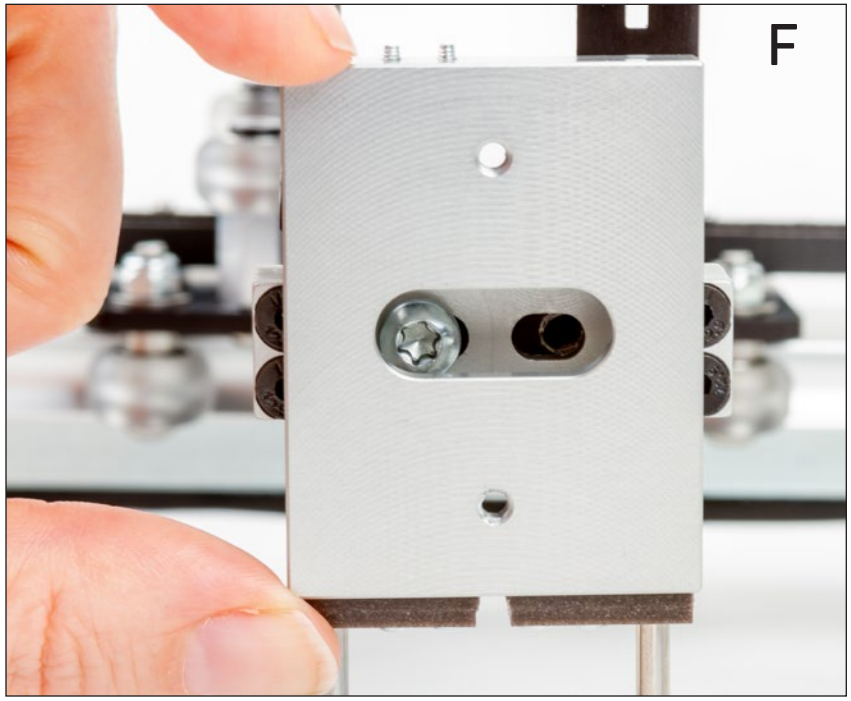
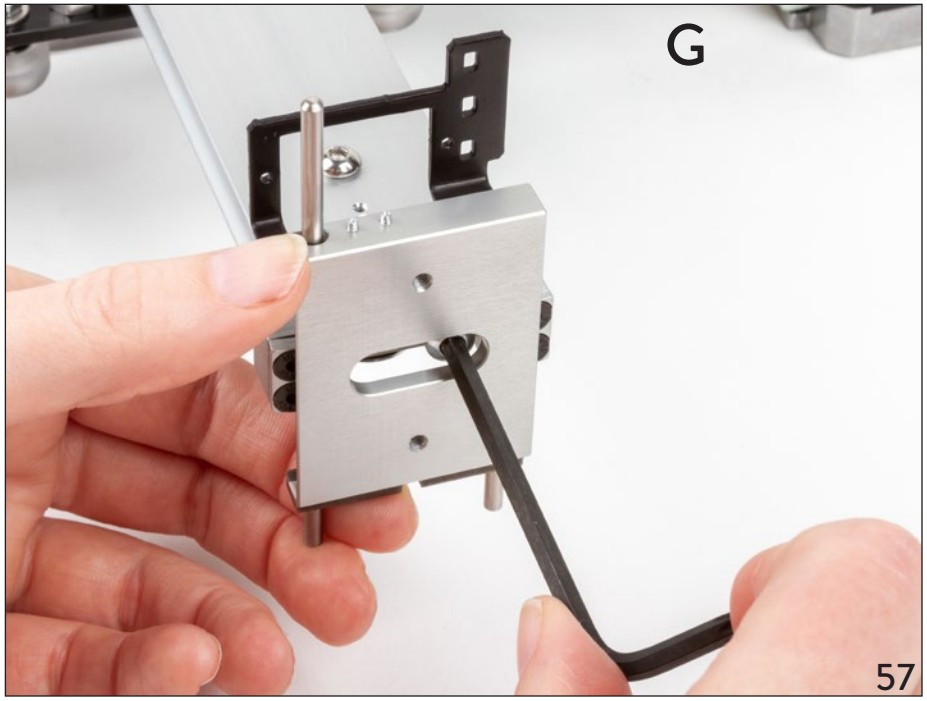


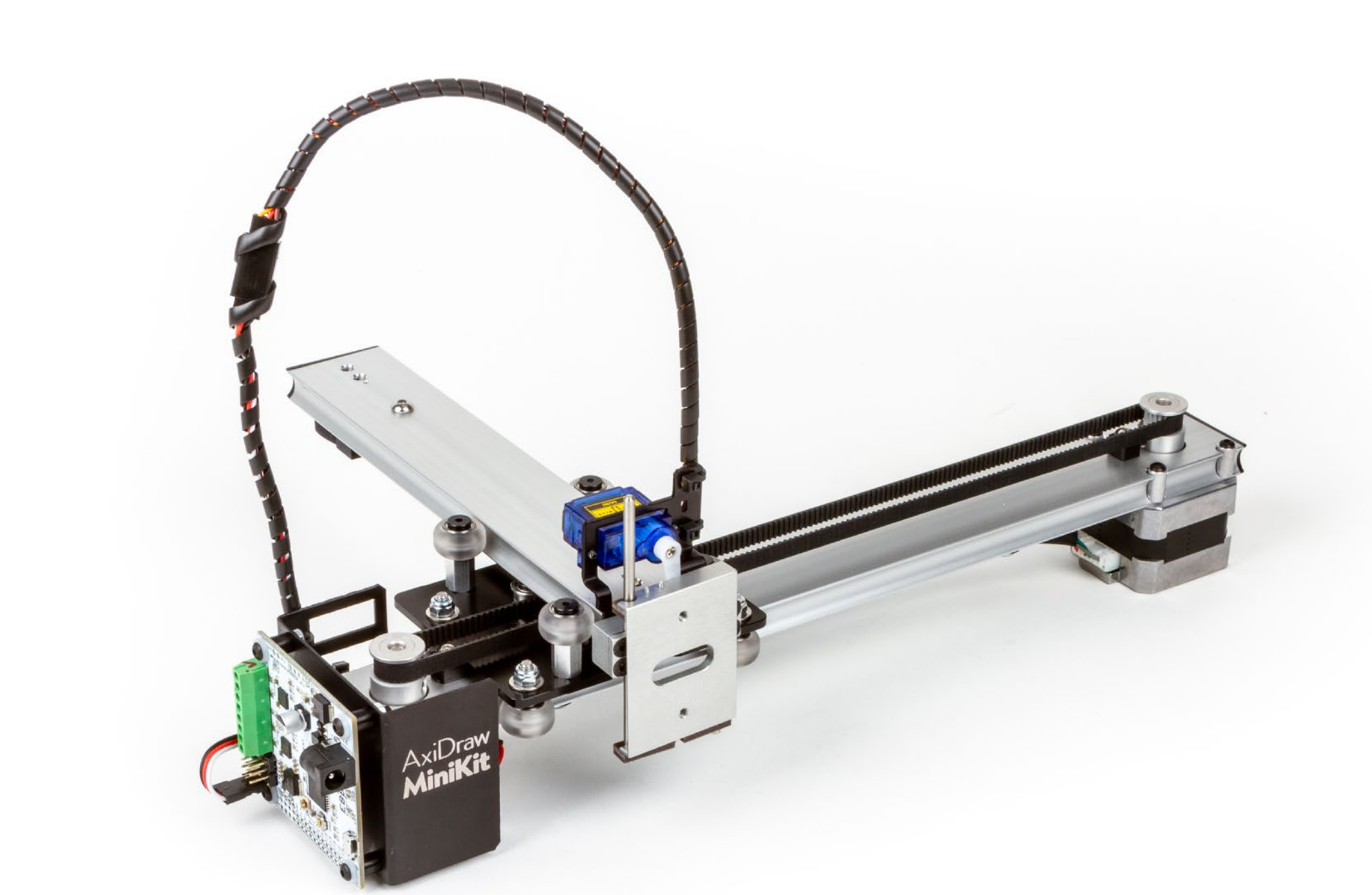




4. Engage the screw into the tapped hole in the end of the Y carriage, and bring it to *almost* tight (**E**).
5. Align the Z slide mounting bracket and servo mount such that the path is clear for the second screw (**F**).
6. Add the second screw (**G**). Again, ensure that the screw head engages with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

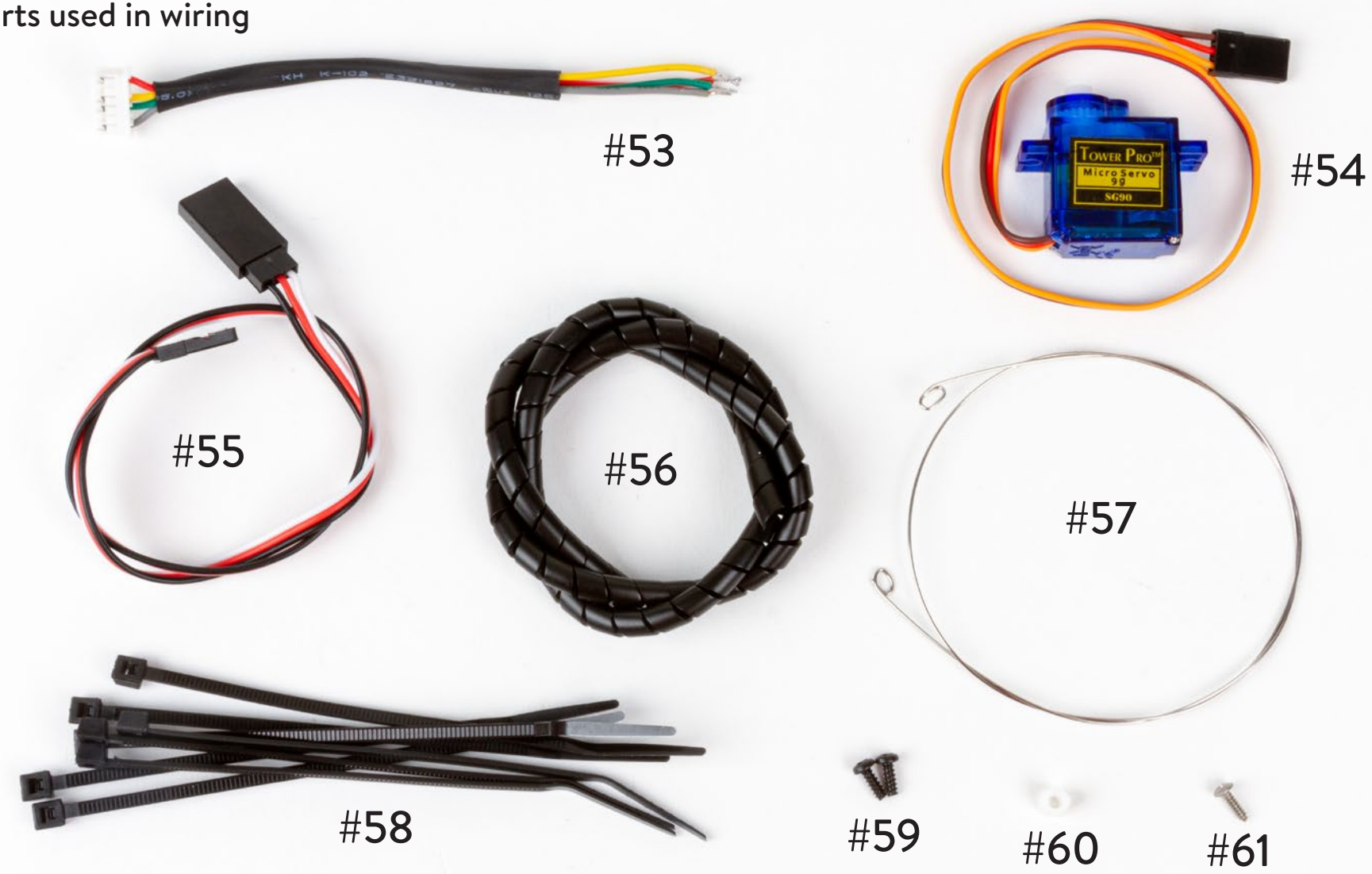






Part 5: Servo and wiring

5.1 Parts used in wiring

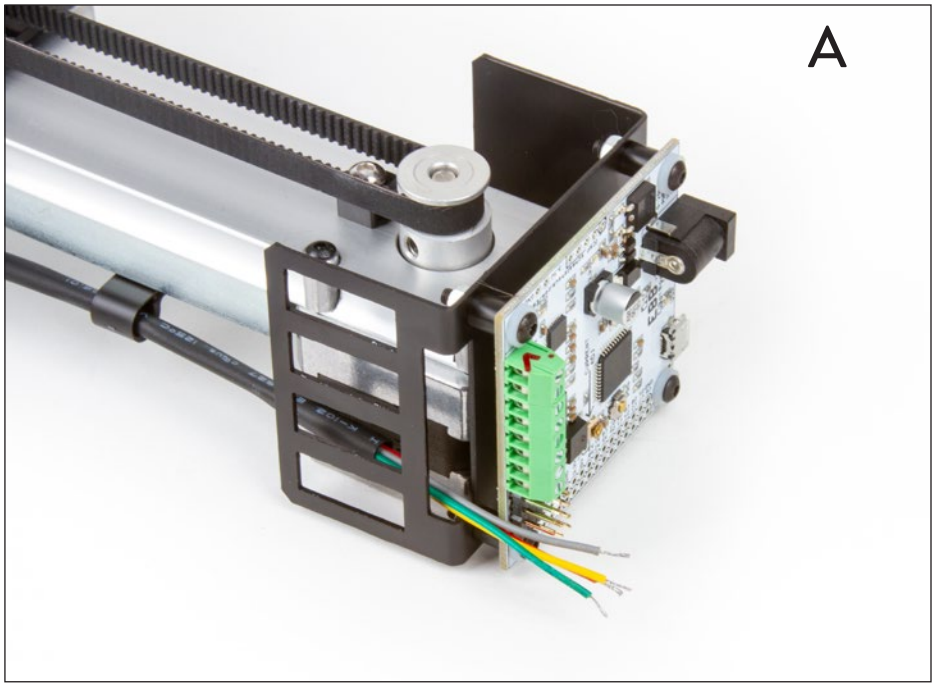


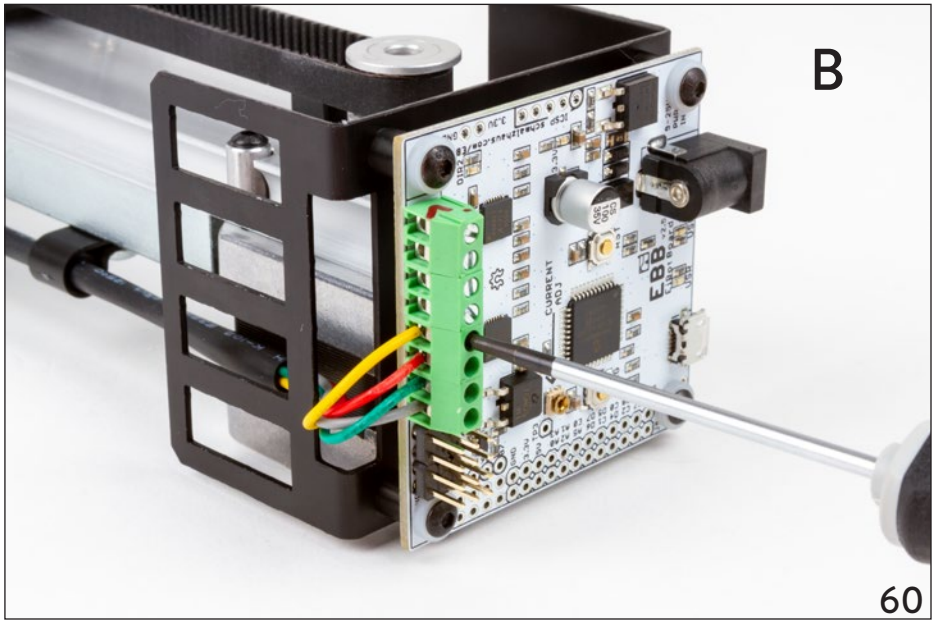
#**53**, Motor wire harness, short (1)
#**54**, Micro servo motor (1)
#**55**, Servo extension cable (1)
#**56**, Spiral wrap tubing (1)
#**57**, Support wire (1)
#**58**, Cable ties (8)
#**59**, No. 2 sheet metal screws (2)
#**60**, Short nylon spacer (1)
#**61**, No. 1 truss-head screw (1)

5.2 Stepper wiring 1

1. Your EBB and wiring should currently look as shown (**A**), with the wires from the right-hand motor tucked through the large slot in the EBB support, following §2.7 EBB Support on page 19.
2. One by one, insert the four wire ends into the terminal block and tighten them firmly with your small flat-head wrench. The wires go into the lowest four (“motor 1”) positions on the driver board, and the wire order is, bottom to top: Gray, Green, Red, Yellow.

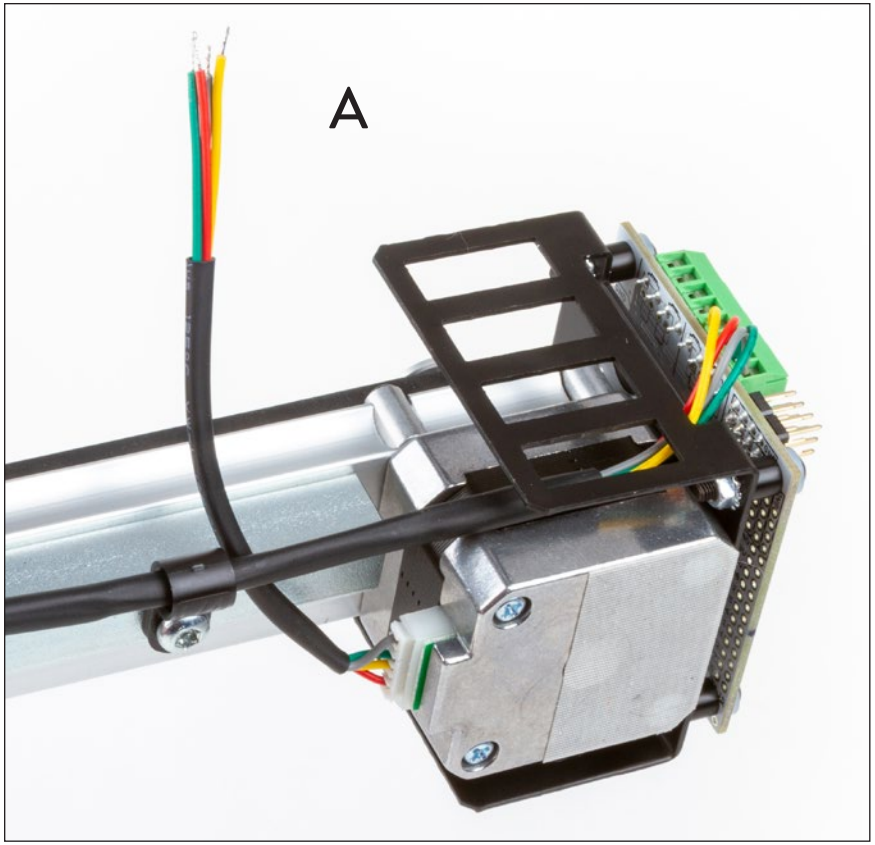
   Tip: If you unable to tell the wires apart by color, please contact technical support for assistance.

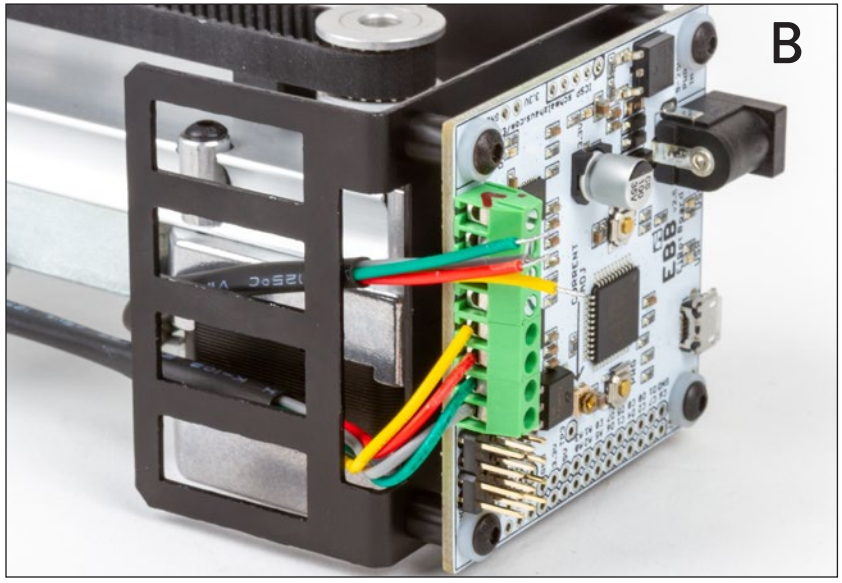


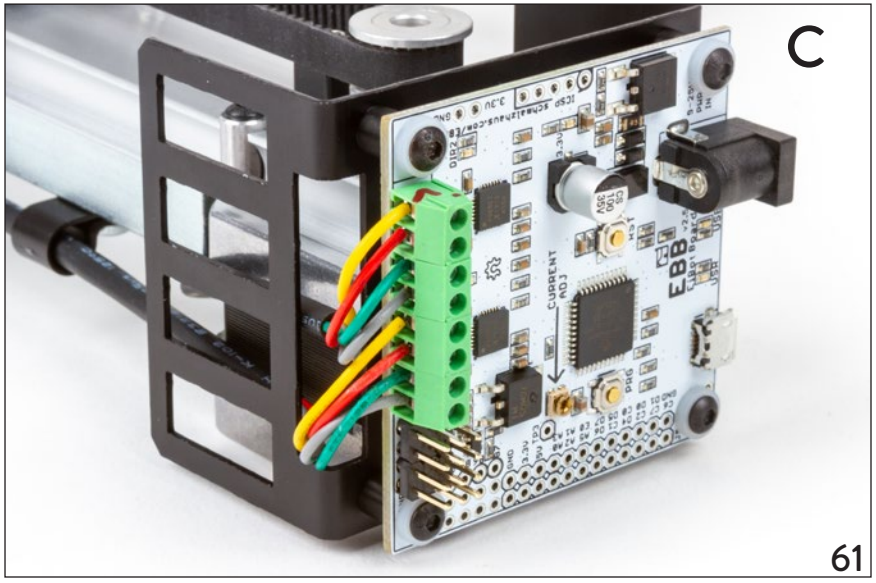


5.3 Stepper wiring 2

1. Attach the short motor wiring harness #**53** to the left-hand stepper motor, with its loose end guided through the gap by the motor above the long motor wiring harness (**A**).
2. Guide the wires over through the vertical slot, above the other wiring harness (**B**).
3. Connect the four wire ends to the upper four slots of the terminal block (**C**). The wire order, bottom to top, is Gray, Green, Red, Yellow.







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**. Keep and set aside 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 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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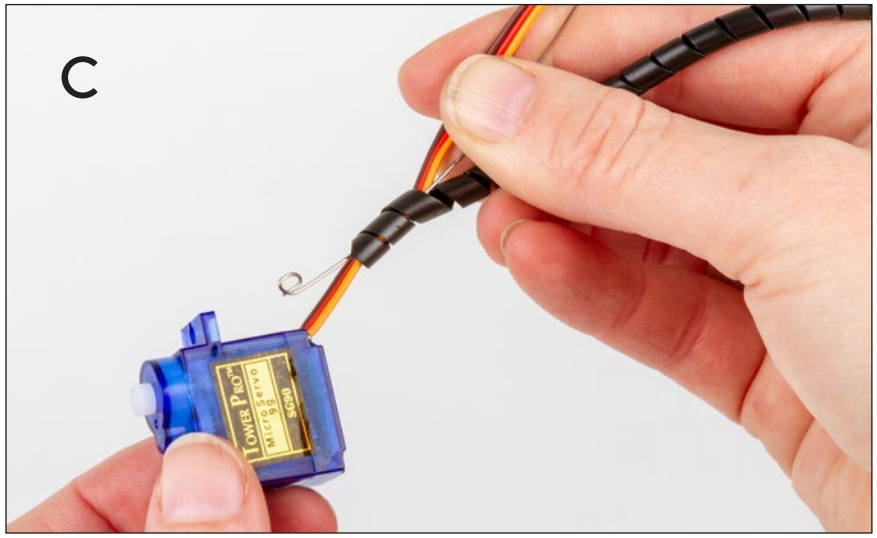
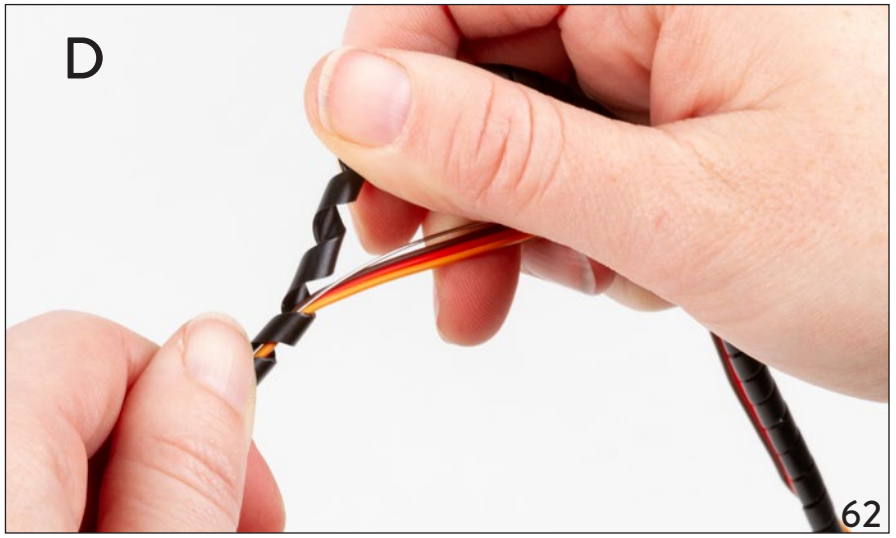
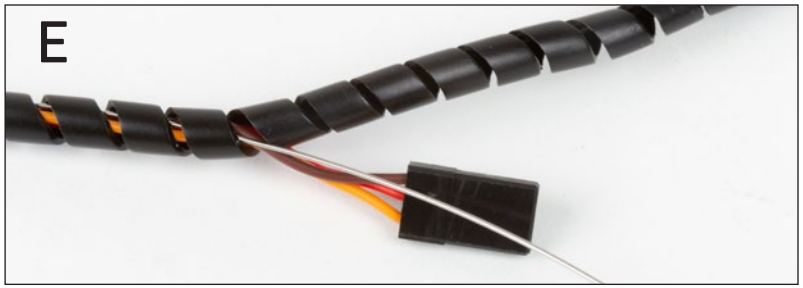
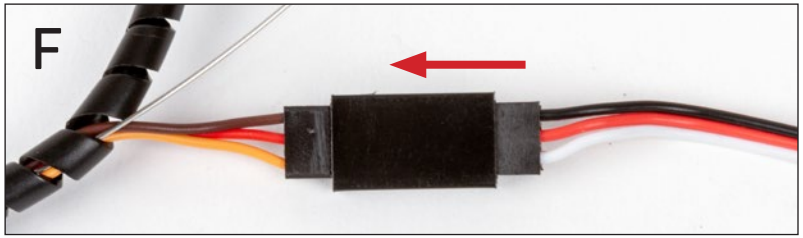


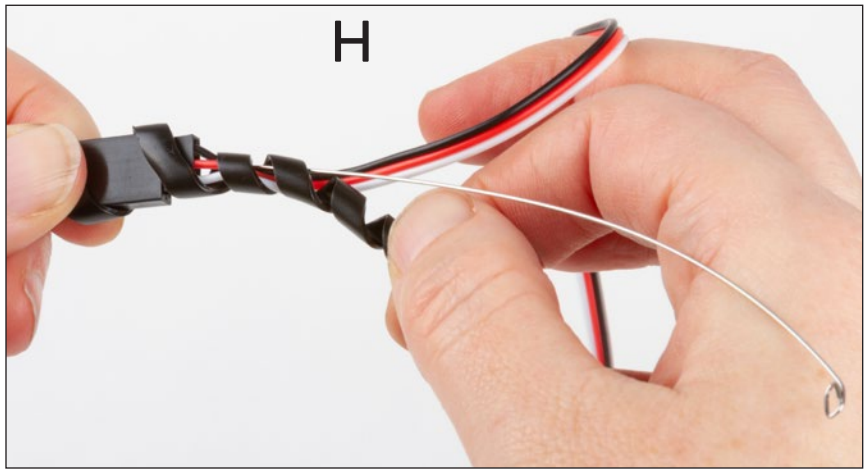


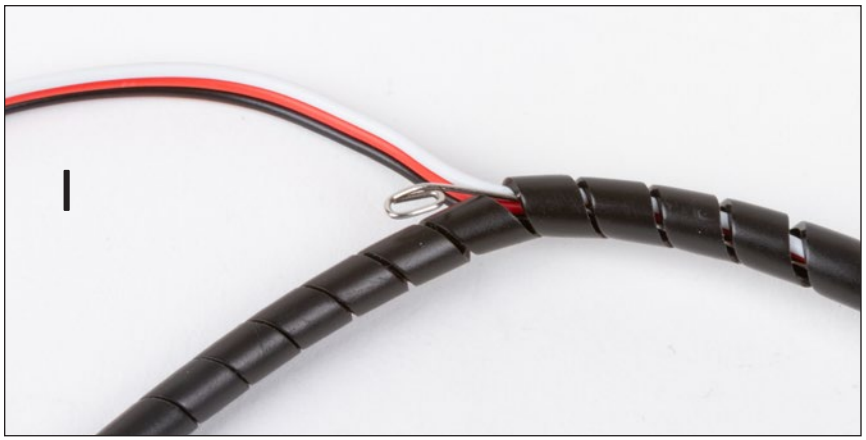
§5.4 Cable guide wrapping, continued

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**).



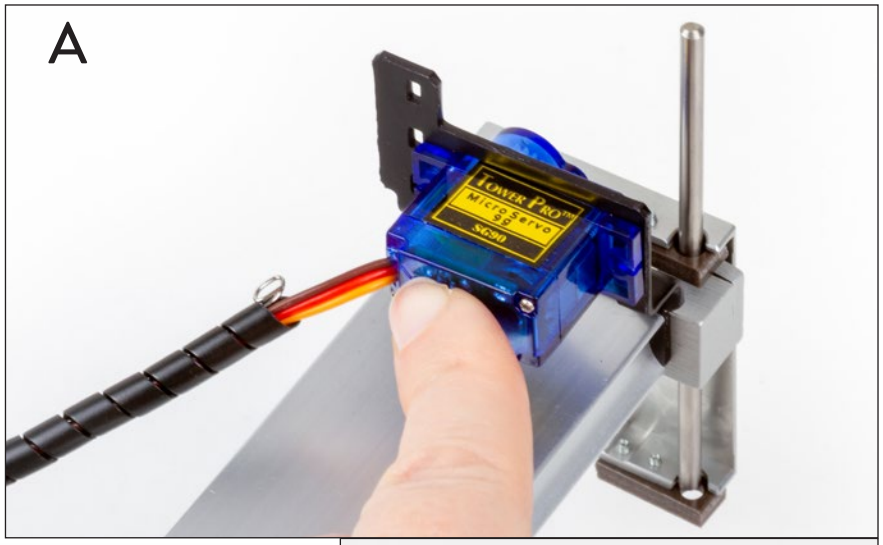




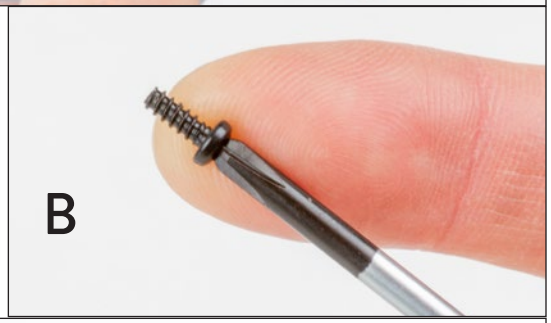


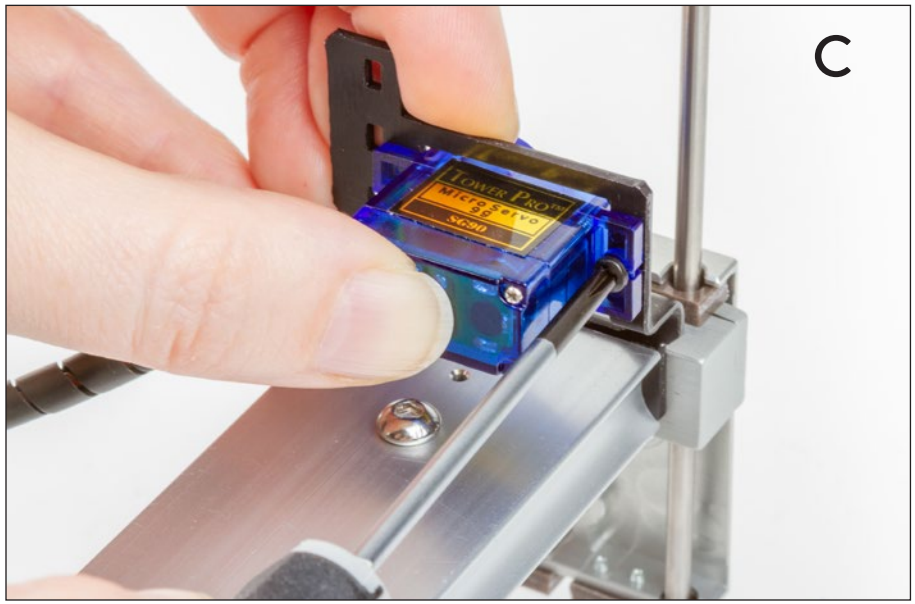
5.5 Mounting the servo

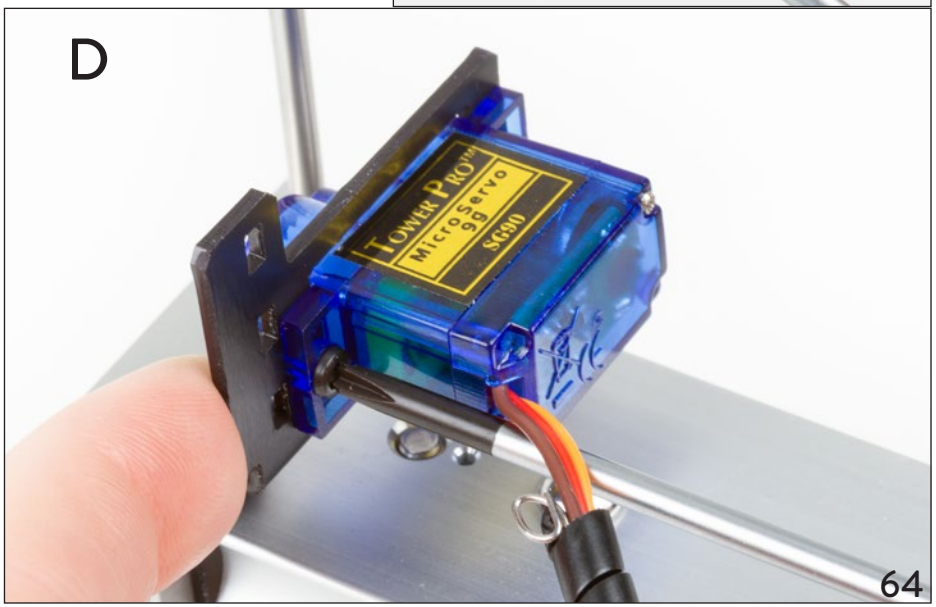
1. Test fit the servo motor. It will sit behind the servo mount, with the cable oriented towards the highest part of the servo mount (**A**).
2. Identify the two small sheet metal screws, #**59**. These screws are small and black, with a Phillips head and a length of about 6 mm under the head.
3. Put 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.



#59

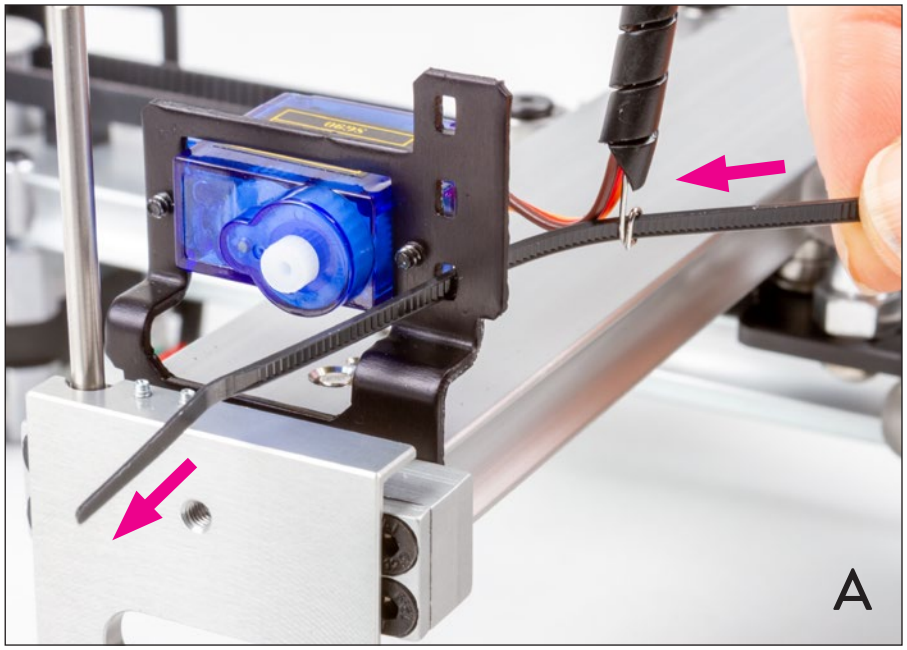






5.6 Mount the cable guide

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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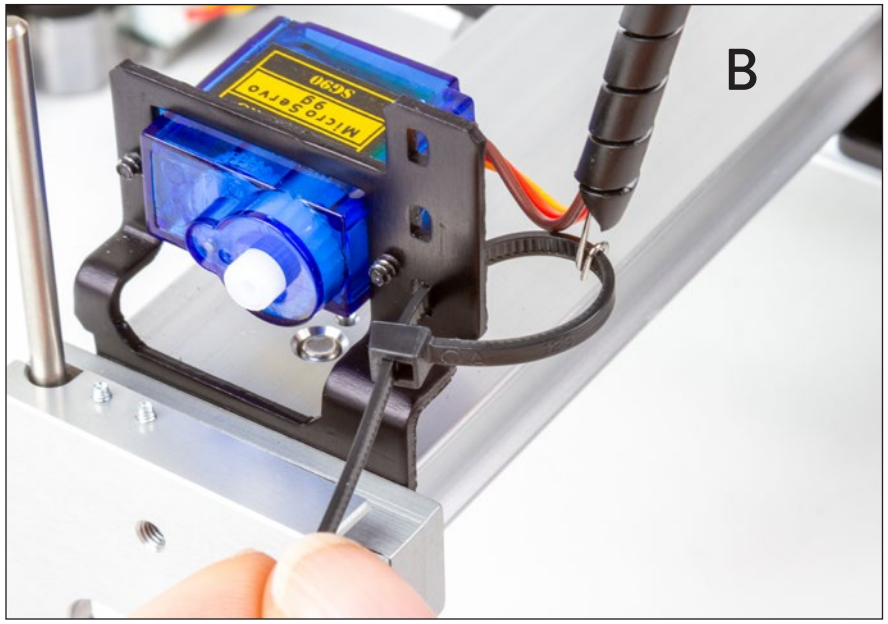
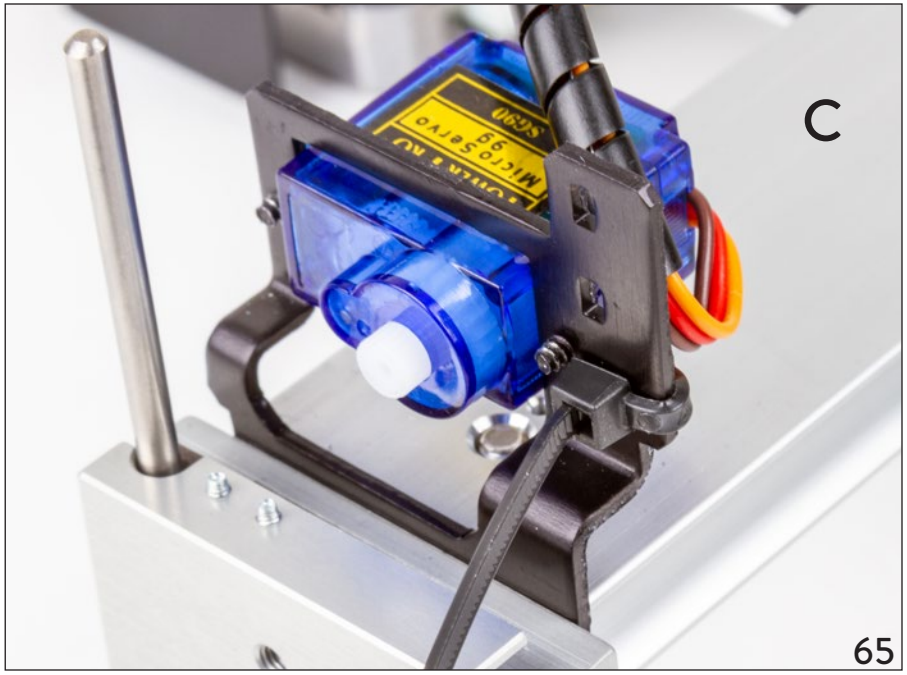
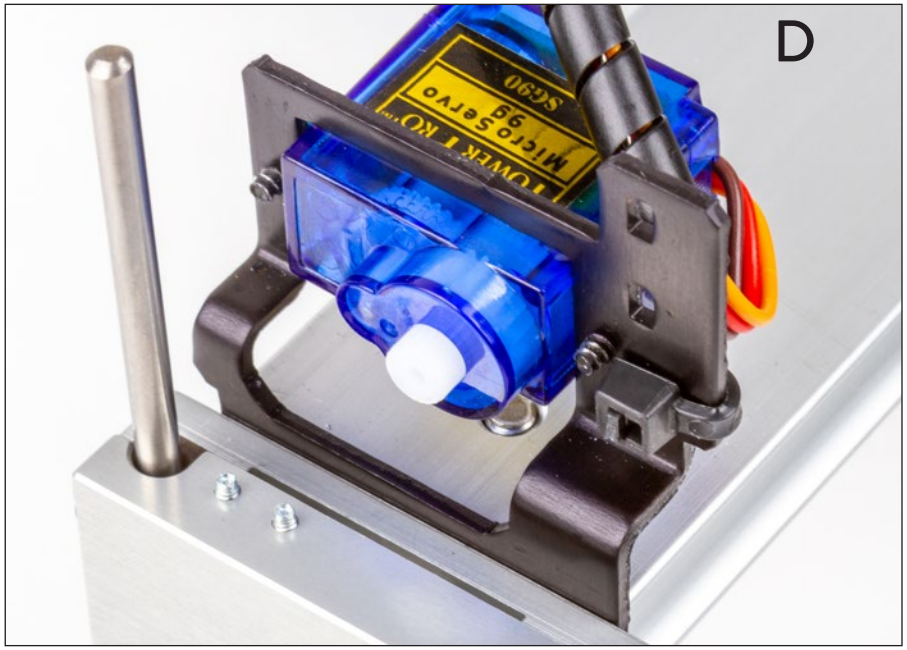
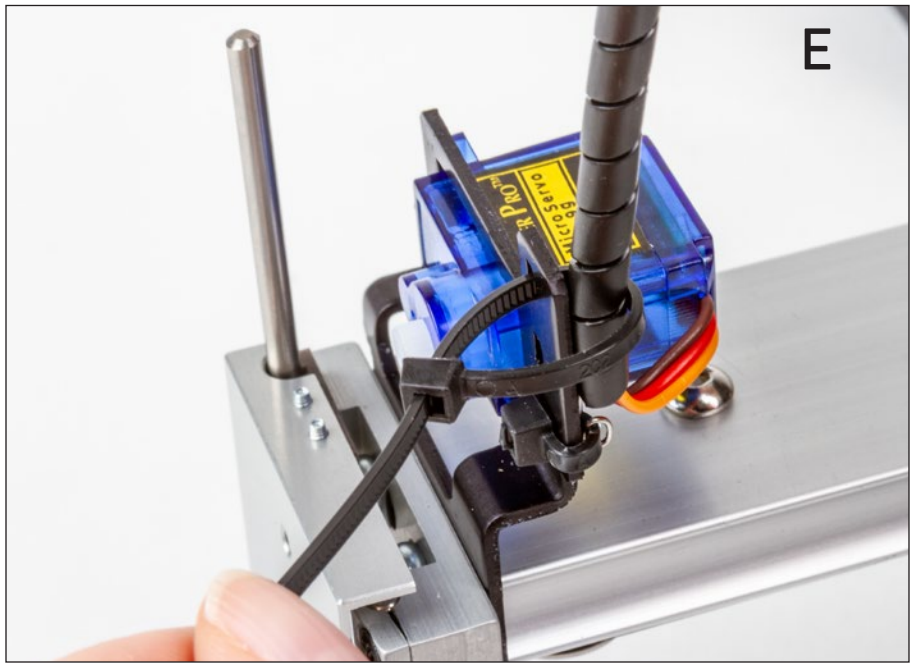


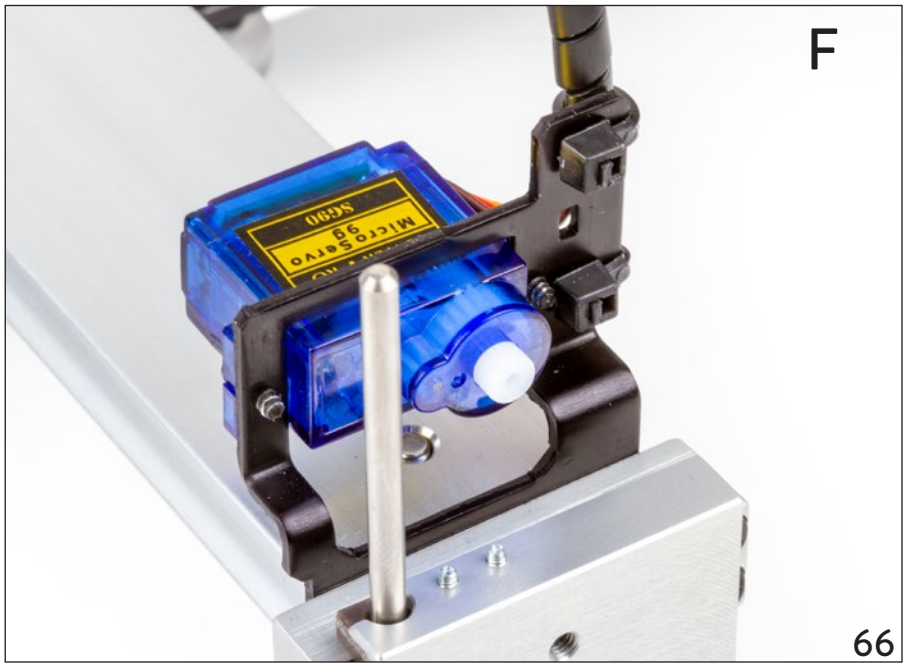


§5.6 Mount the cable guide, continued

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**).

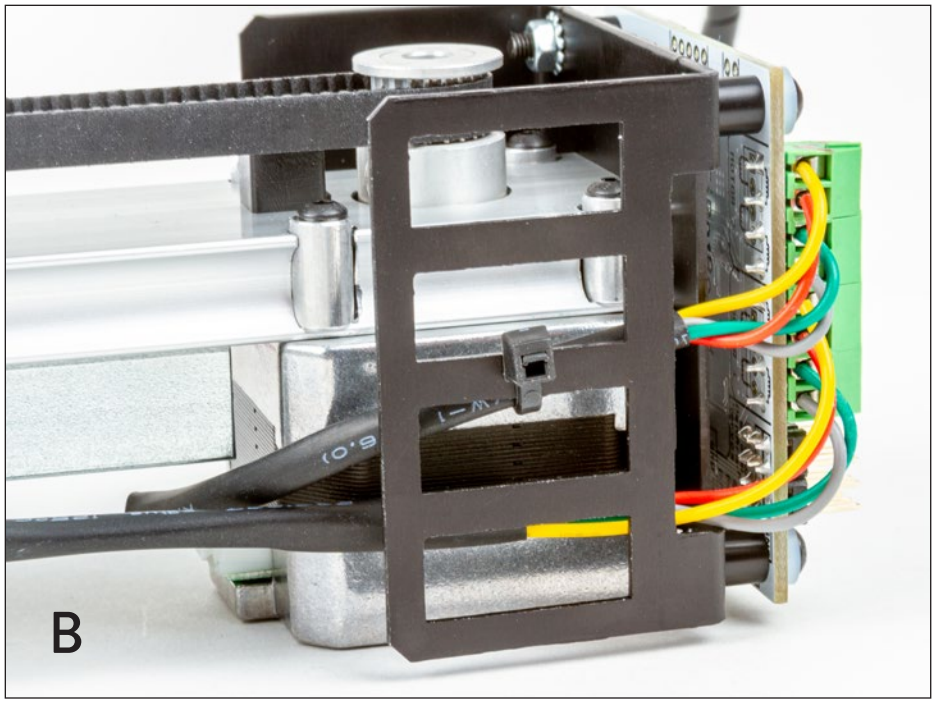


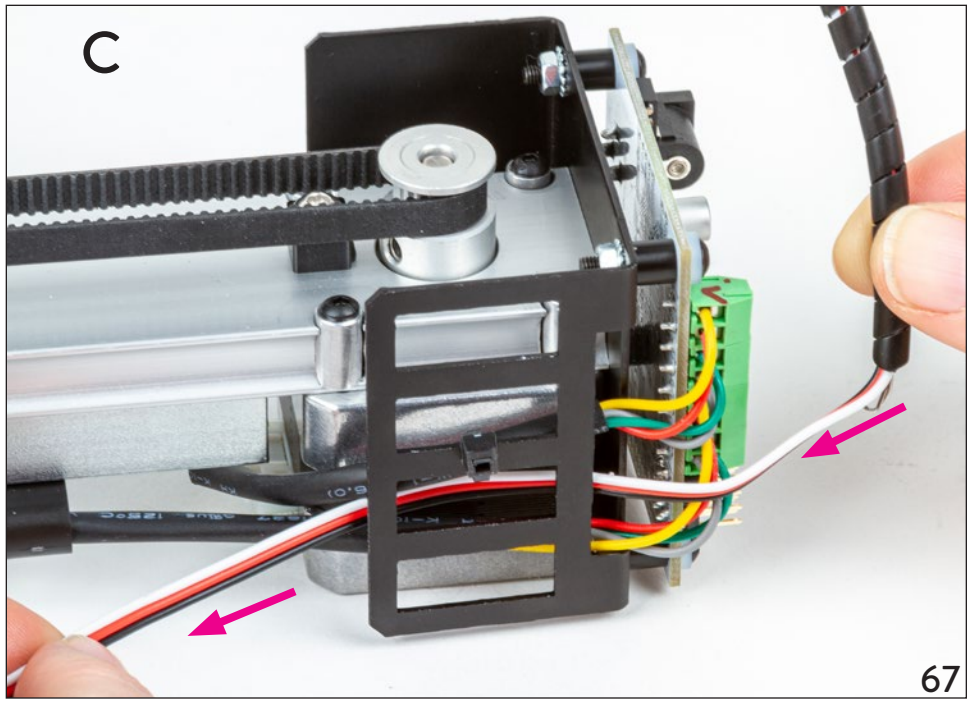




5.7 Complete the wiring

1. Use a cable tie to attach the left-hand (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**).





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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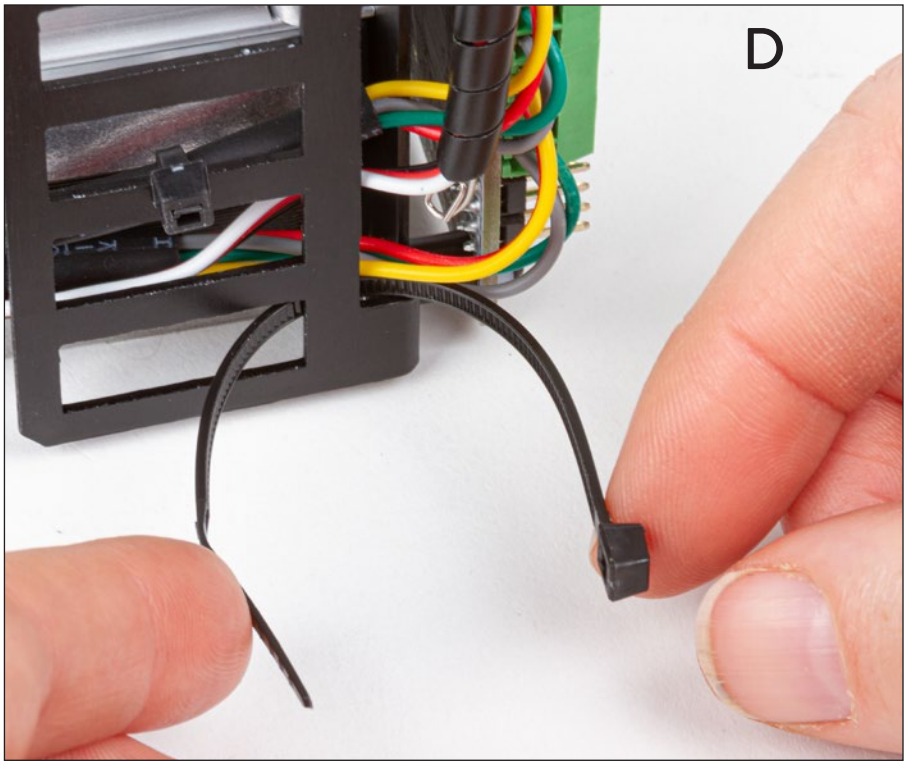
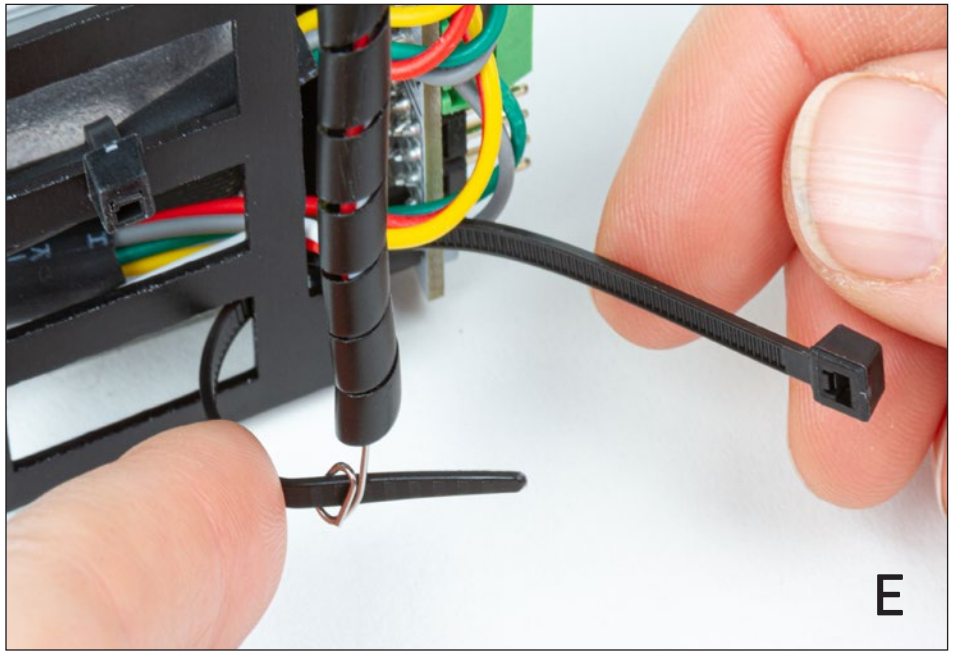
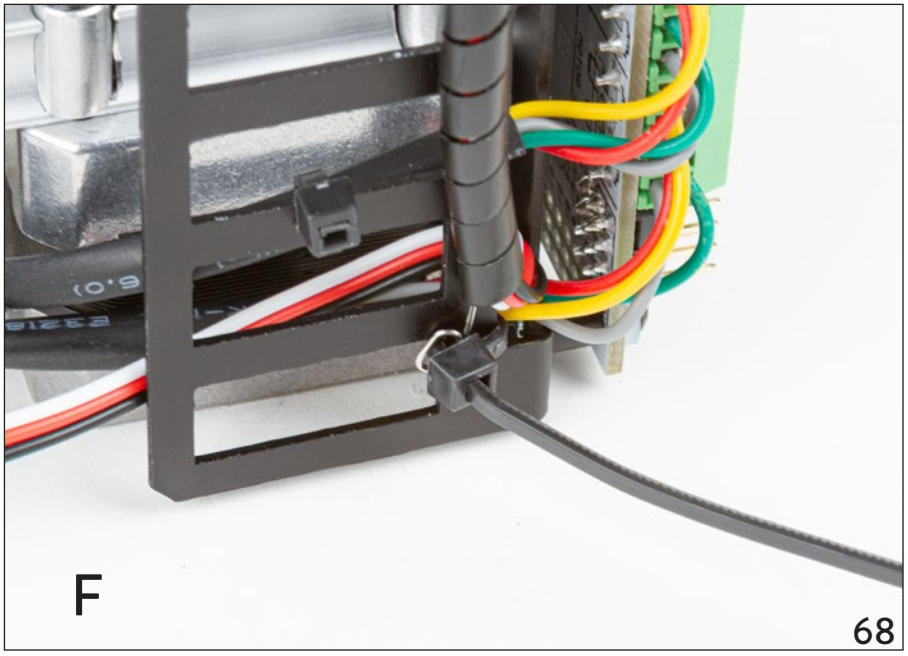
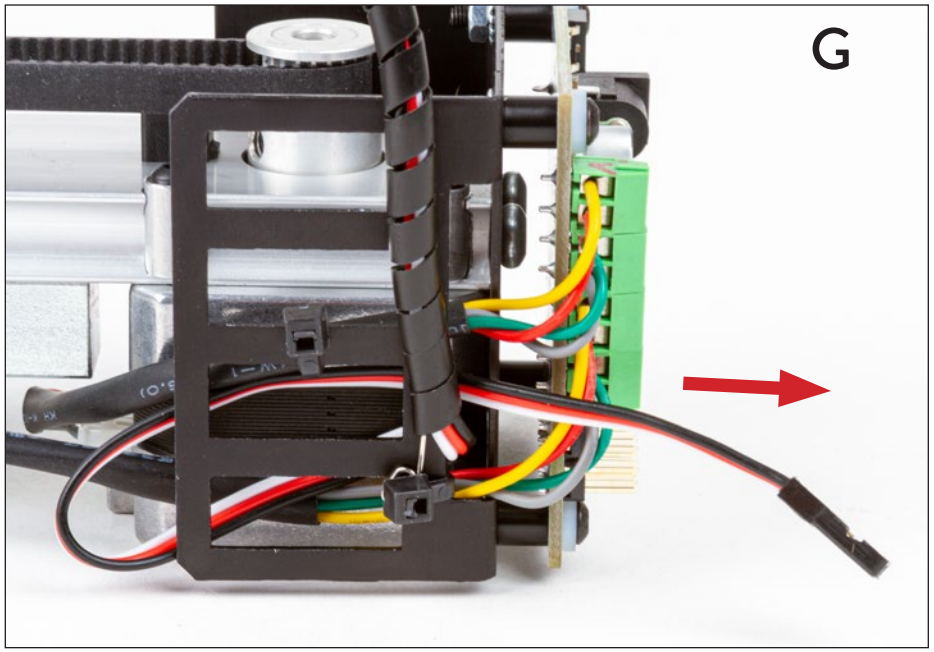






§5.7 Complete the wiring, continued

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.



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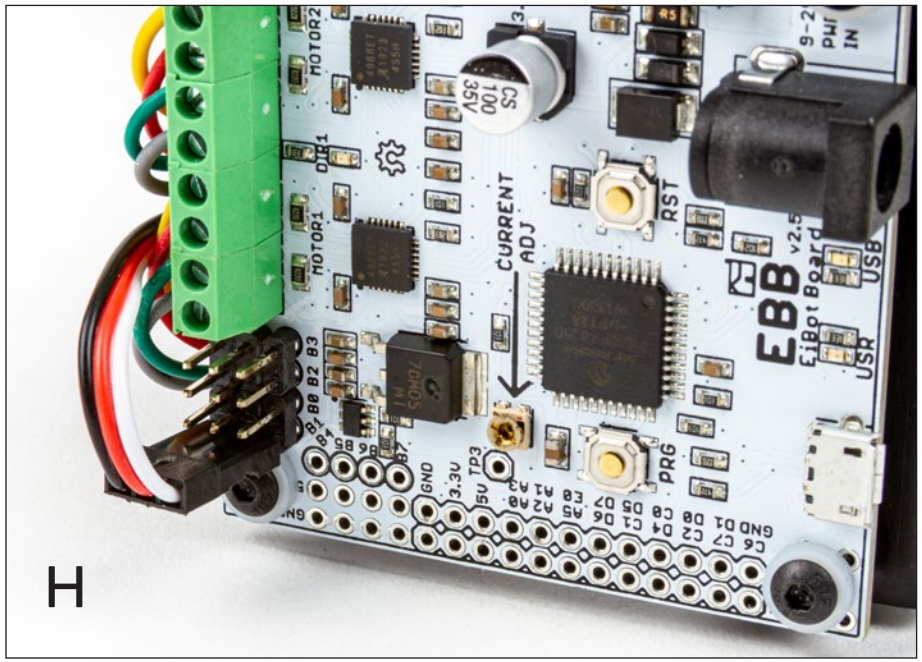
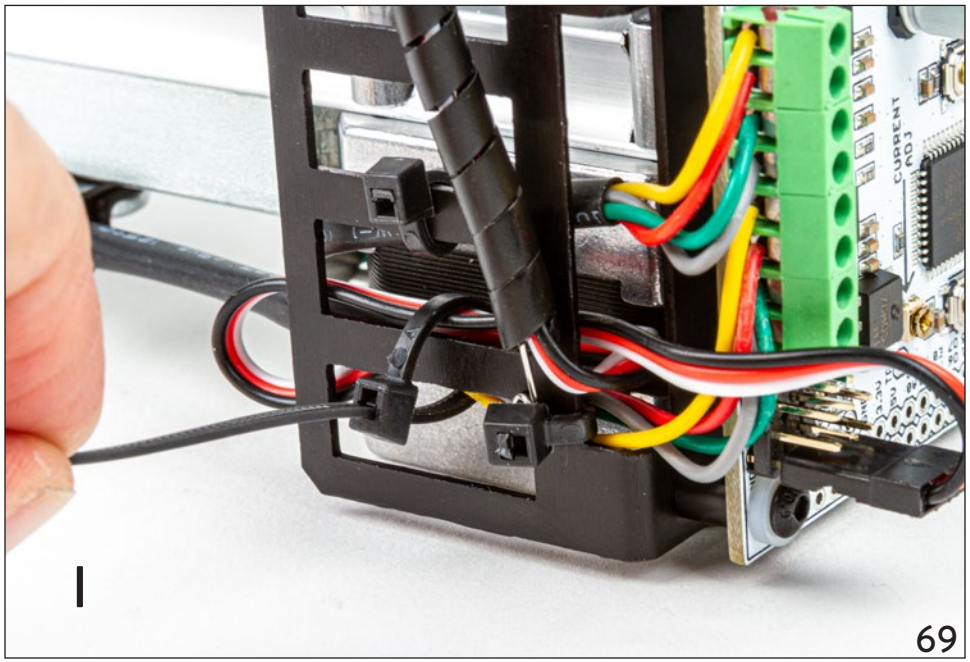
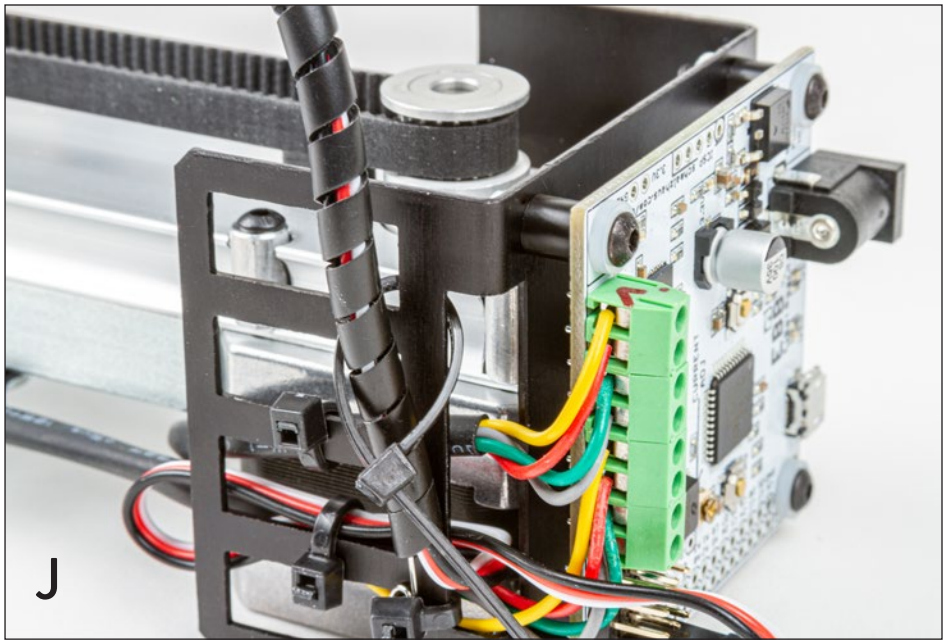
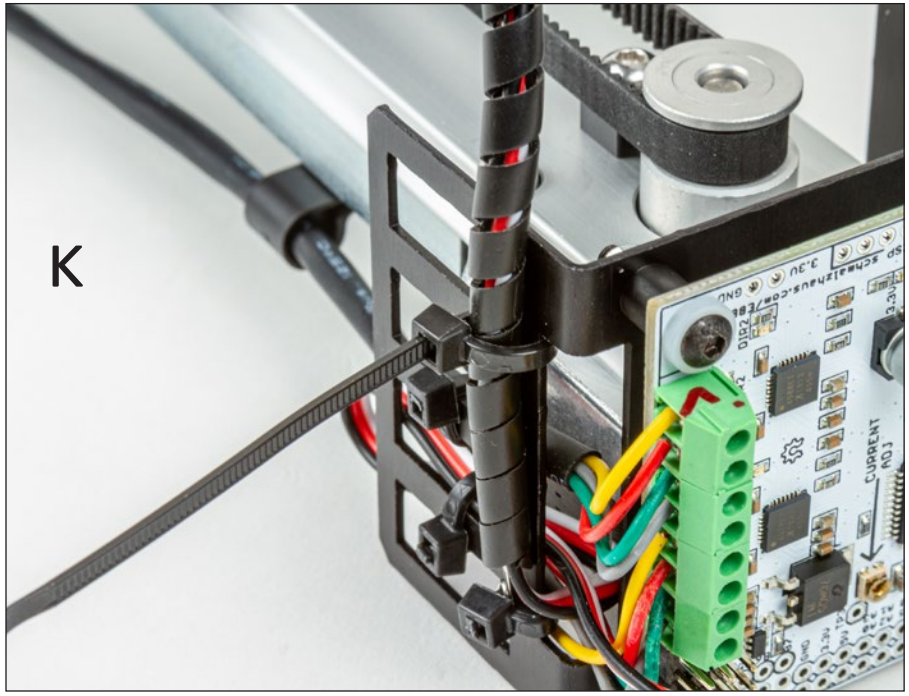


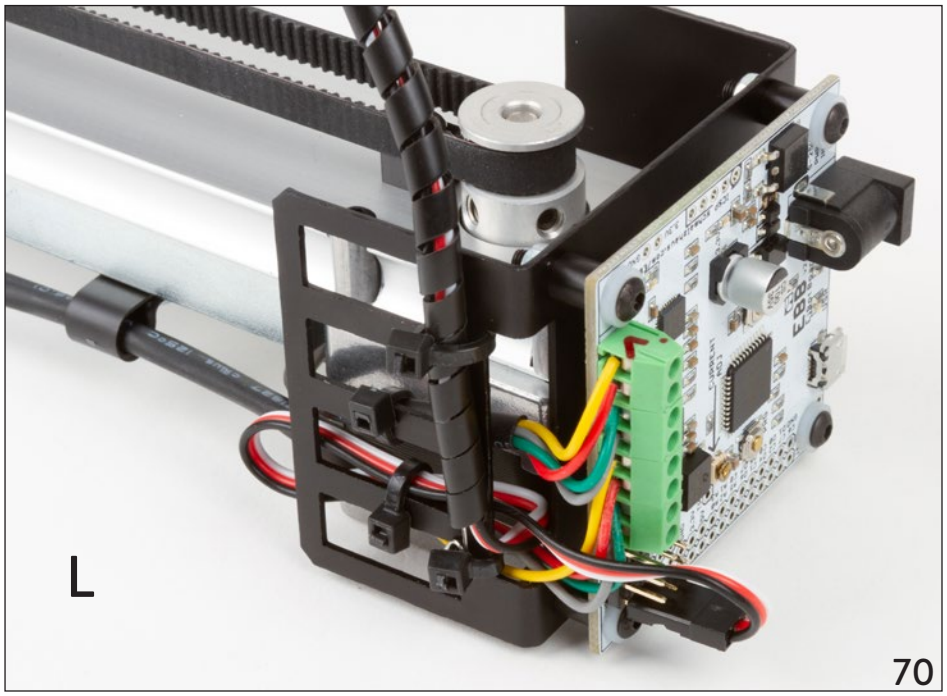


§5.7 Complete the wiring, continued

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**).
12. Close and cinch the cable tie (**L**), pull it tight, and cut off the excess length.

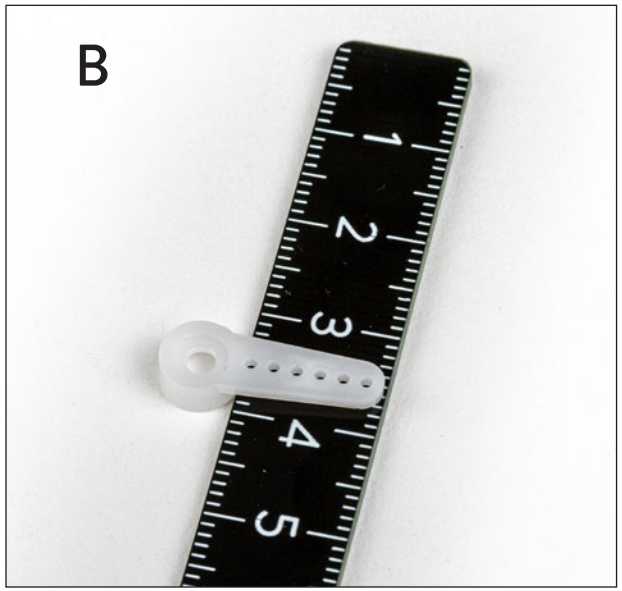


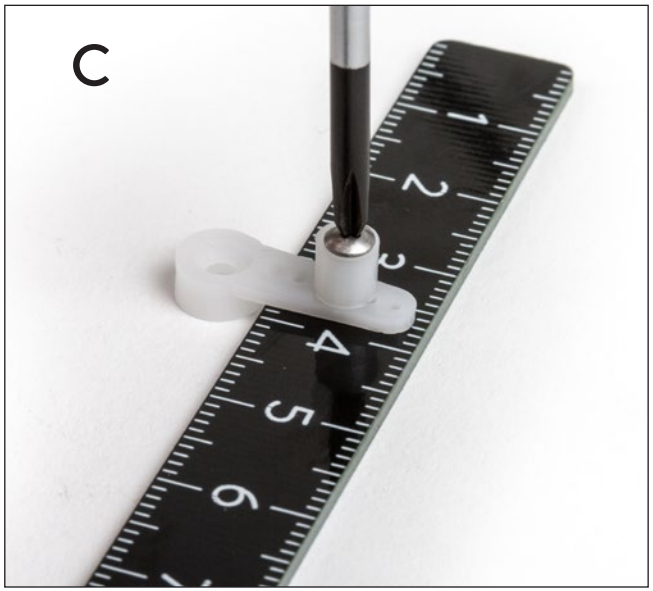


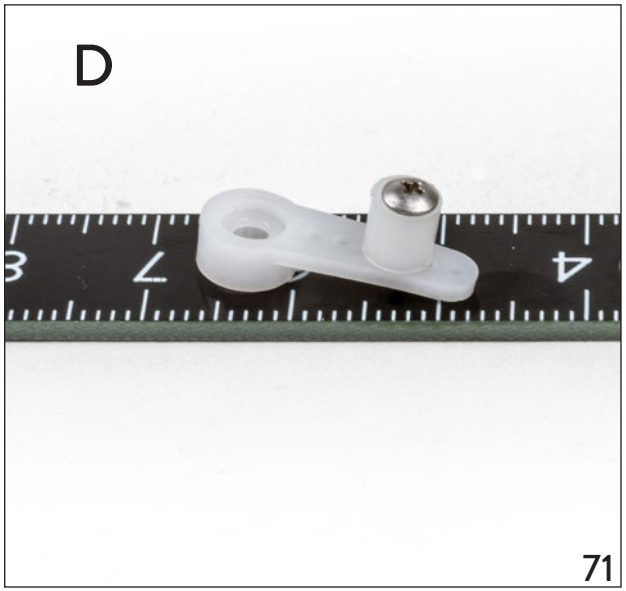


5.8 Servo horn

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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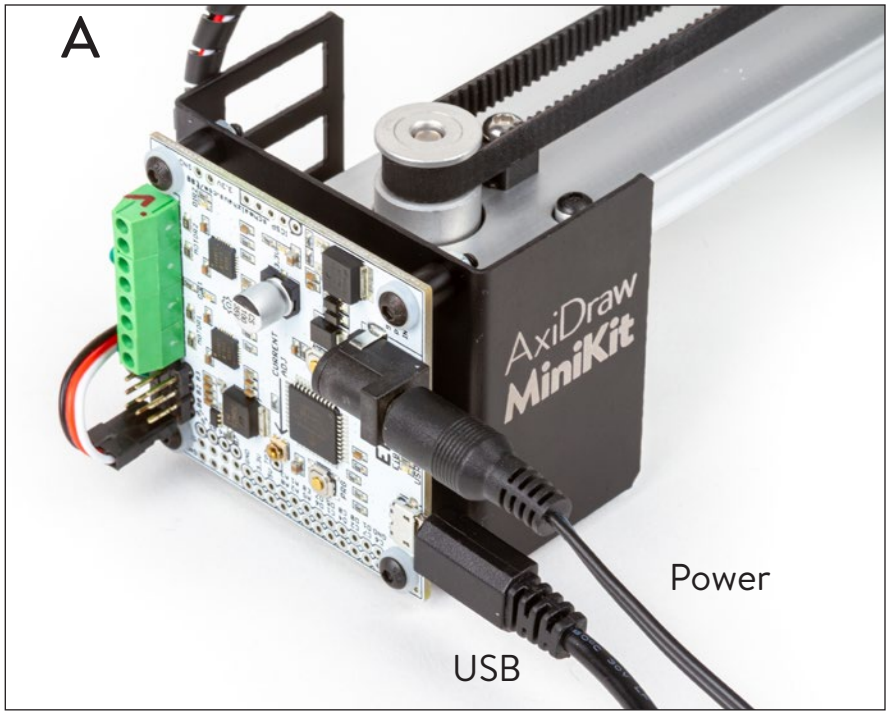
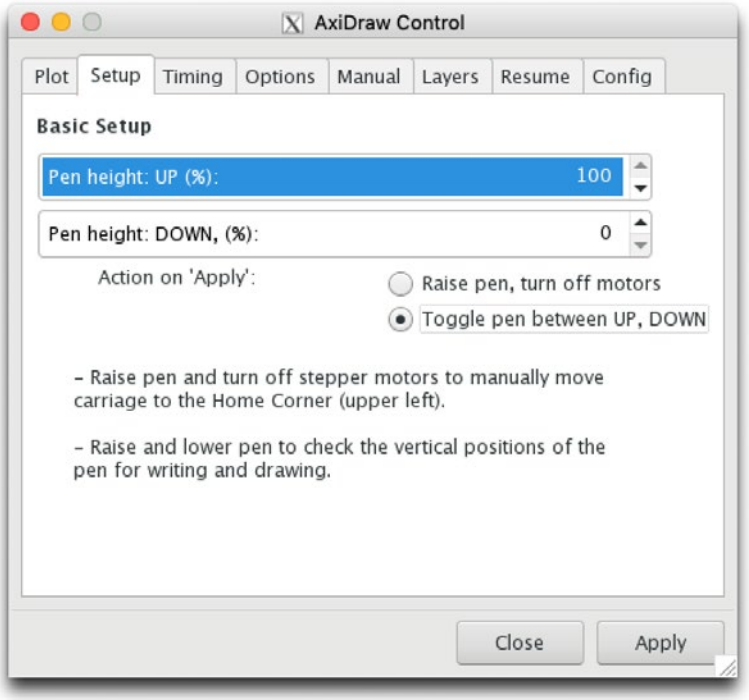
A



B



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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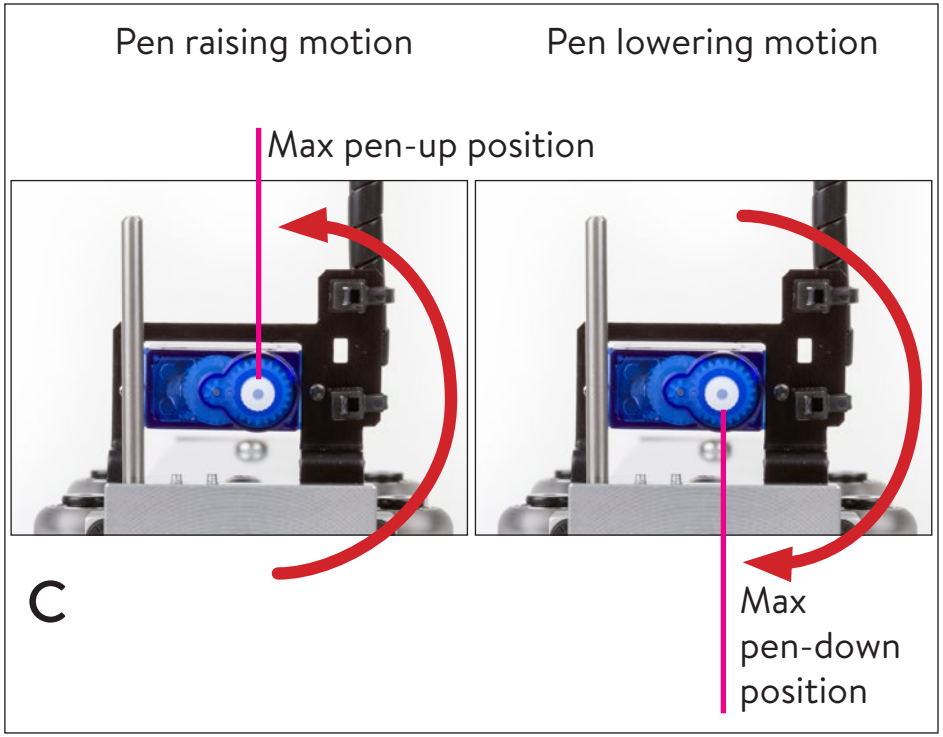
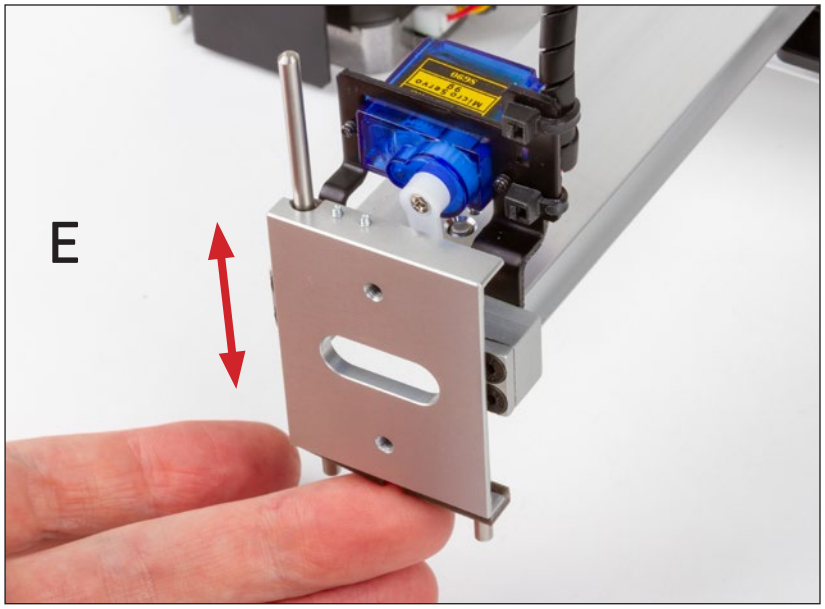


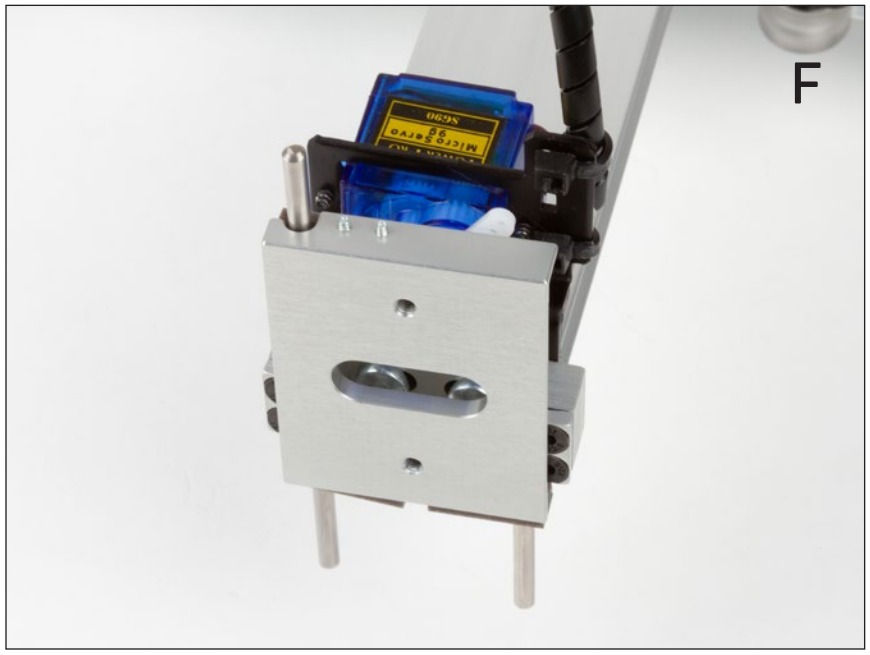
C

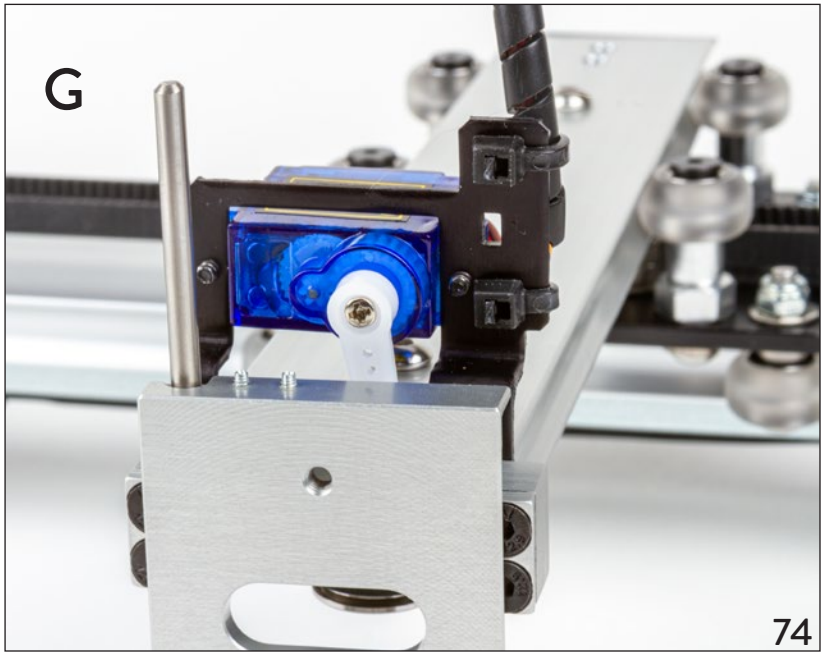
D

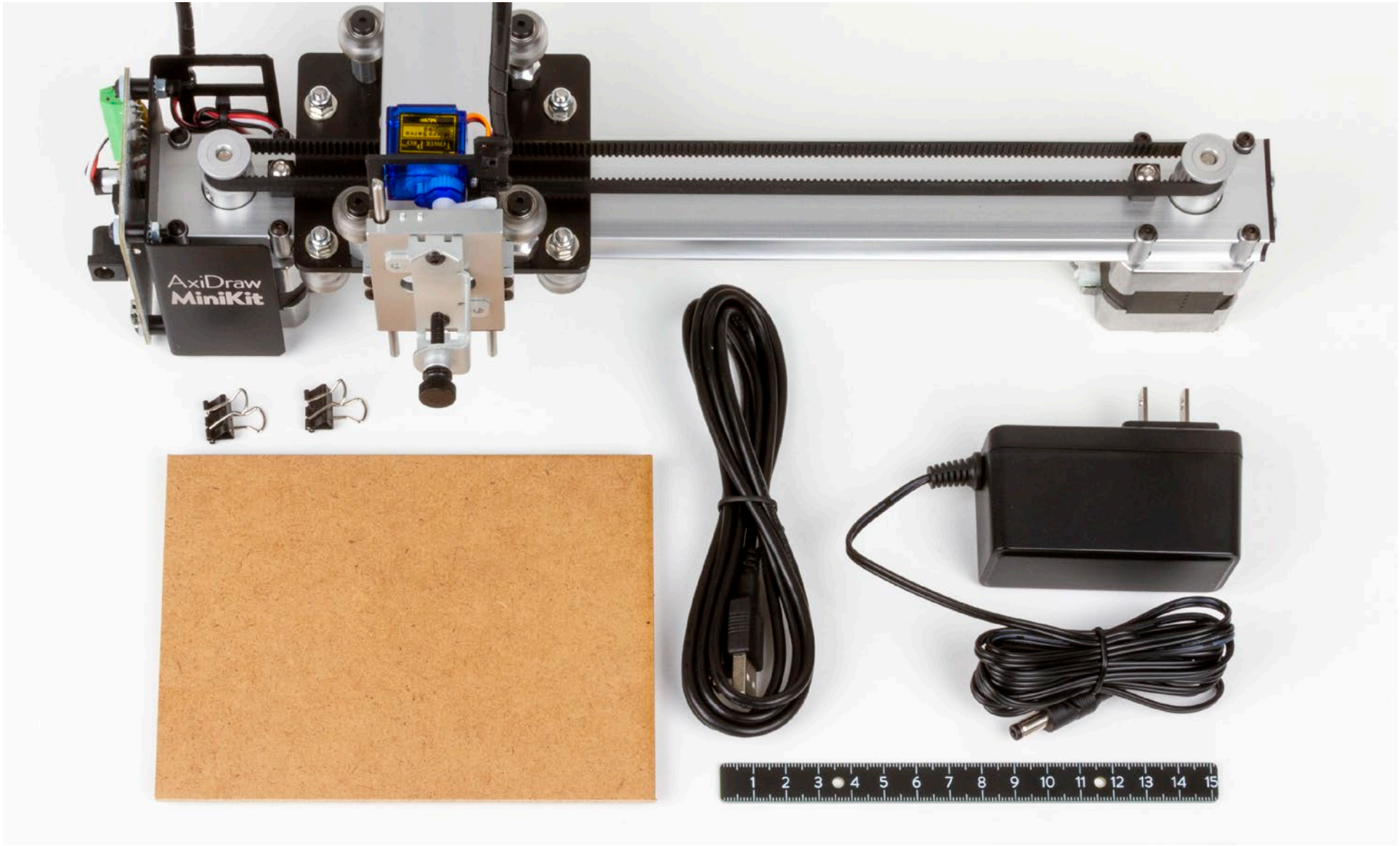
§5.9 Servo calibration, continued

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

AxiDraw MiniKit 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.

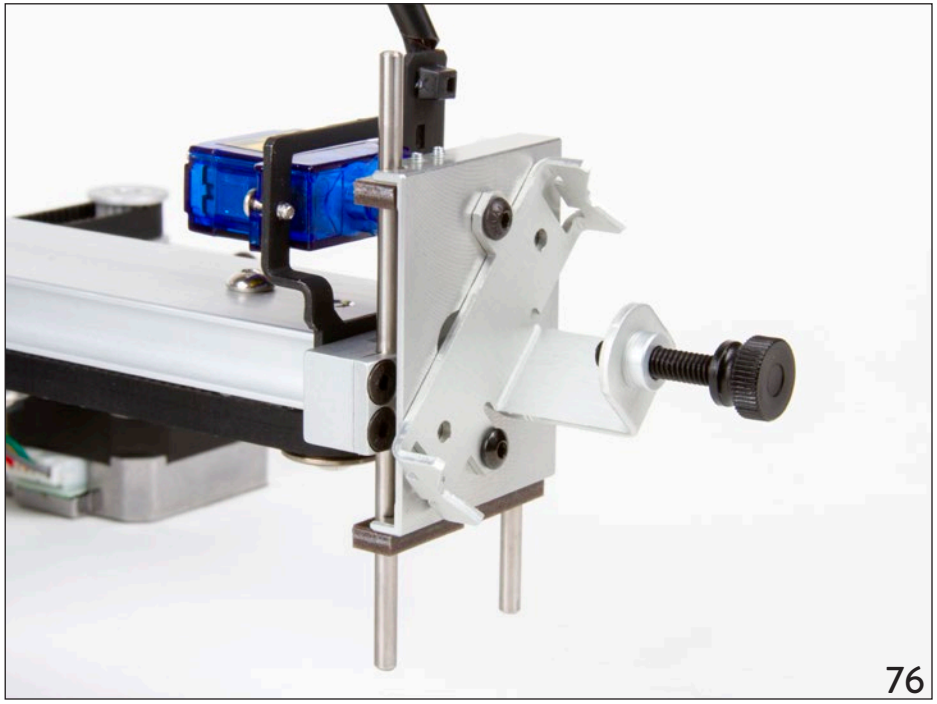
The pen clip is attached to the Z slide of the AxiDraw by the two little screws, and there is a thumbscrew for holding the pen in place. Detailed instructions about the pen clip can be found in the main AxiDraw User Guide.

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.

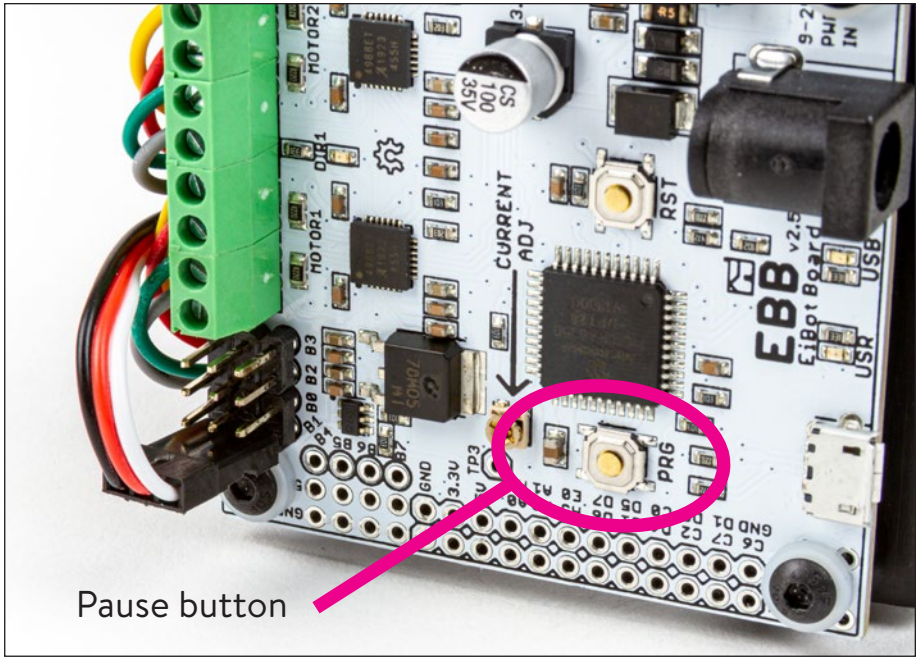
You can download the AxiDraw User Guide at:
https://axidraw.com/guide

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

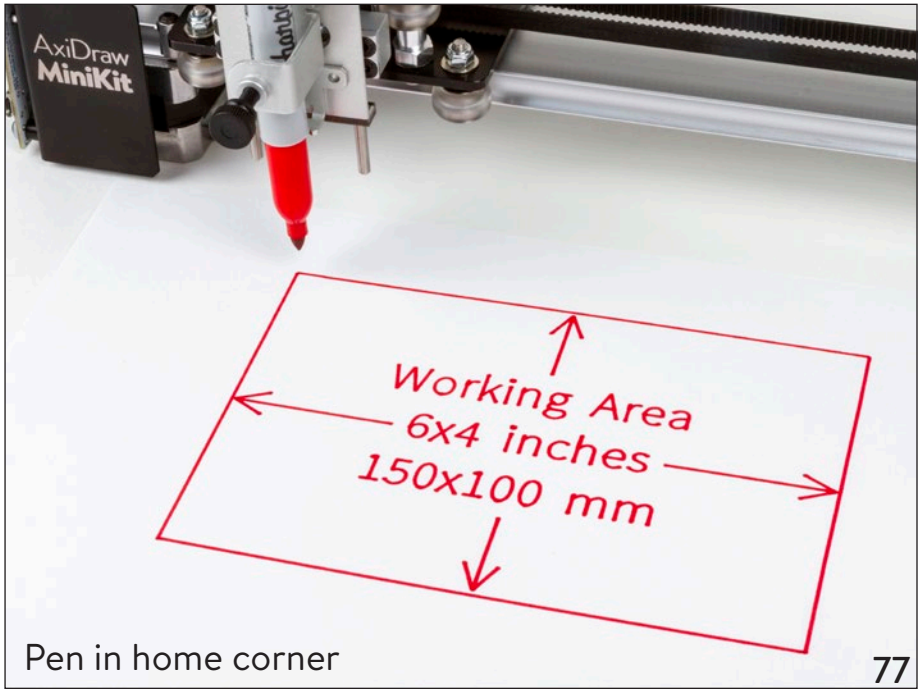
The pause button on AxiDraw MiniKit is located directly on the EBB driver board, and is labeled “PRG”. It is in the same physical location as on other models (left side of the machine, behind the USB connector), but does not have the separate cover and button.



Pause button

6.3.2 Home corner

The Home corner of the machine is labeled by the AxiDraw MiniKit logo, over 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 MiniKit logo.



Pen in home corner

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 25 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.

Extended online documentation
& resources for AxiDraw:

axidraw.com/docs

Evil Mad Scientist

Blog: www.evilmadscientist.com

Store: shop.evilmadscientist.com

Docs: wiki.evilmadscientist.com

Forum: www.evilmadscientist.com/forums

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