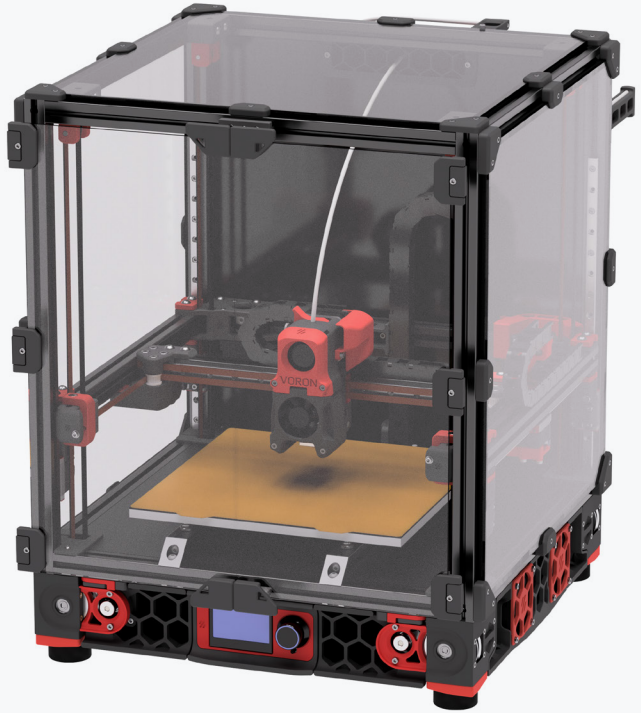
VORON



VORON2 2.4R2 BUILD GUIDE

We build space shuttles with gardening tools
so anyone can have a space shuttle of their own.

VERSION 2022-07-04

Before you begin on your journey, a word of caution.

In the comfort of your own home you are about to assemble a robot. This machine can maim, burn, and electrocute you if you are not careful. Please do not become the first VORON fatality. There is no special Reddit flair for that.

Please, read the entire manual before you start assembly. As you begin wrenching, please check our Discord channels for any tips and questions that may halt your progress.

Most of all, good luck!

THE VORON TEAM

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PART PRINTING GUIDELINES

The Voron Team has provided the following print guidelines for you to follow in order to have the best chance at success with your parts. There are often questions about substituting materials or changing printing standards, but we recommend you follow these:

3D PRINTING PROCESS

Fused Deposition Modeling (FDM)

MATERIAL

ABS

LAYER HEIGHT

Recommended: 0.2mm

EXTRUSION WIDTH

Recommended: Forced 0.4mm

INFILL TYPE

Grid, Gyroid, Honeycomb, Triangle or Cubic

INFILL PERCENTAGE

Recommended: 40%

WALL COUNT

Recommended: 4

SOLID TOP/BOTTOM LAYERS

Recommended: 5

PRINT IT FORWARD (PIF)

Often times community members that have issues printing ABS will bootstrap themselves into a VORON using our Print It Forward program. This is a service where approved members with VORON printers can make you a functional set of parts to get your own machine up and running.
Check Discord if you have any interest in having someone help you out.

FILE NAMING

By this time you should have already downloaded our STL files from the Voron GitHub. You might have noticed that we have used a unique naming convention for the files. This is how to use them.

PRIMARY COLOR

Example z_joint_lower_x4.stl

These files will have nothing at the start of the filename.

ACCENT COLOR

Example [a]_tensioner_left.stl

We have added "[a]" to the front of any STL file that is intended to be printed with accent color.

QUANTITY REQUIRED

Example [a]_z_belt_clip_lower_x4.stl

If any file ends with "_x#", that is telling you the quantity of that part required to build the machine.

HOW TO GET HELP

If you need assistance with your build, we're here to help. Head on over to our Discord group and post your questions. This is our primary medium to help VORON Users and we have a great community that can help you out if you get stuck.

https://discord.gg/voron

REPORTING ISSUES

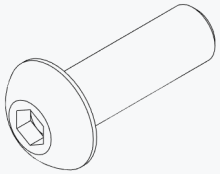
Should you find an issue in the documentation or have a suggestion for an improvement please consider opening an issue on GitHub (https://github.com/VoronDesign/Voron-2/issues). When raising an issue please include the relevant page numbers and a short description; annotated screenshots are also very welcome. We periodically update the manual based on the feedback we get.

THIS IS JUST A REFERENCE

This manual is designed to be a simple reference manual. Building a Voron can be a complex endeavour and for that reason we recommend downloading the CAD files off our Github repository if there are sections you need clarification on. It can sometimes be easier to follow along when you have the whole assembly in front of you.

https://github.com/vorondesign

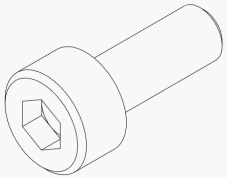
https://docs.vorondesign.com/



BUTTON HEAD CAP SCREW (BHCS)

Metric fastener with a domed shape head and hex drive. Most commonly found in locations where M5 fasteners are used.

ISO 7380-1



SOCKET HEAD CAP SCREW (SHCS)

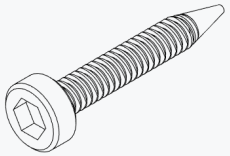
Metric fastener with a cylindrical head and hex drive. The most common fastener used on the Voron.

ISO 4762

FLAT HEAD COUNTERSUNK SCREW (FHCS)

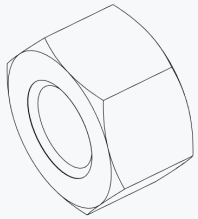
Metric fastener with a cone shaped head and a flat top.

ISO 10642



SELF TAPPING SCREW

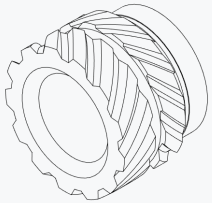
Fastener with a pronounced thread profile that is screwed directly into plastic.



HEX NUT

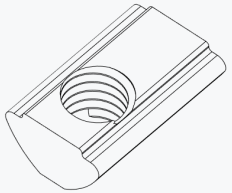
Hex nuts couple with bolts to create a tight, secure joint. You'll see these used in both M3 and M5 variants throughout this guide.

ISO 4032



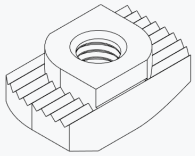
HEAT SET INSERT

Heat inserts with a soldering tip so that they melt the plastic when installed. As the plastic cools, it solidifies around the knurls and ridges on the insert for excellent resistance to both torque and pull-out.



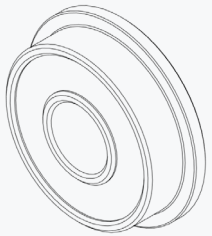
POST INSTALL T-SLOT NUT (T-NUT)

Nut that can be inserted into the slot of an aluminium profile. Used in both M3 and M5 variants throughout this guide. Often also called "roll-in t-nut".



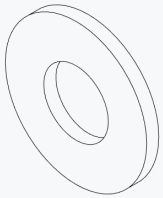
HAMMERHEAD NUT

Nut that can be inserted into the slot of an aluminium profile. Used exclusively for panel mounting, all other components use T-Slot nuts.



F695 BEARING

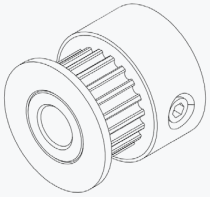
A ball bearing with a flange used in various gantry locations.



SHIM

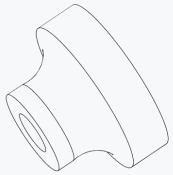
Not to be confused with stamped washers. These are used in all M5 call-out locations in this manual.

DIN 988



PULLEY

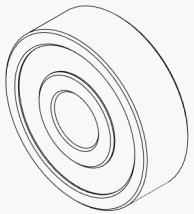
GT2 pulley used on the motion system of the Voron.



THUMB NUT

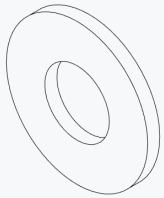
Used in the print bed as a spacer.

DIN 466-B



625 BEARING

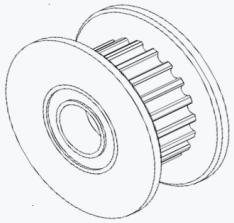
A ball bearing used on the Voron Z drives.



WASHER

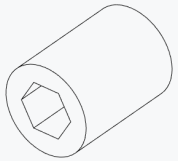
Usually stamped from sheet metal this type of spacer is not as consistent in thickness as the shims are. Only used in M3 size.

DIN 125



IDLER

GT2 idler used in the motion system of the Voron.



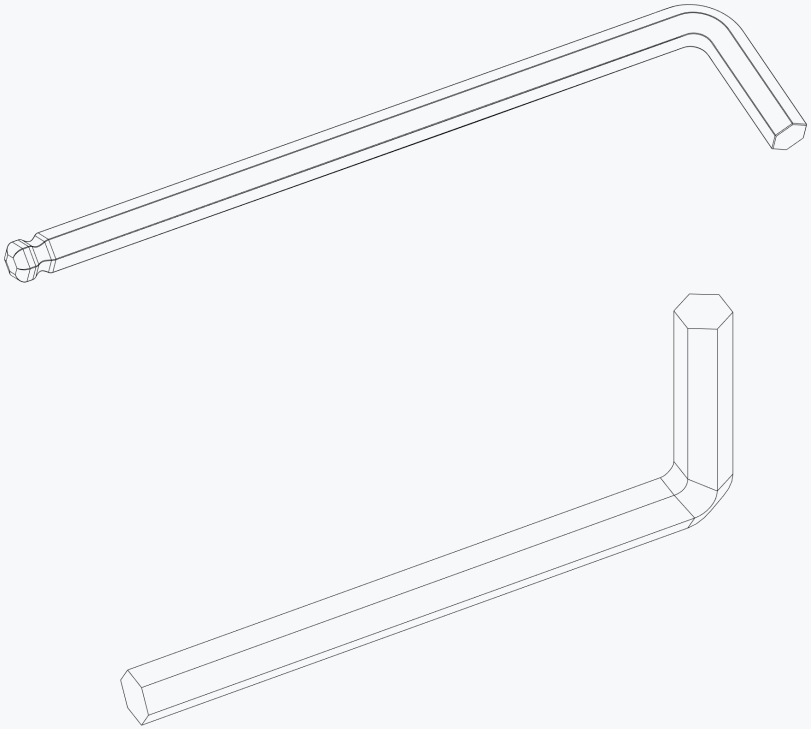
SET SCREW

Small headless screw with an internal drive. Used in pulleys and other gears. Also called a grub screw.

ISO 4026

BALL-END DRIVER

Some parts of this design require the use of a ball-end hex driver for assembly. We recommend you get a 2.0mm, 2.5mm and 3mm one.

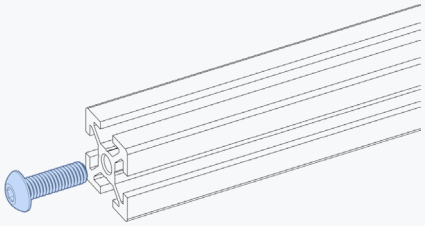


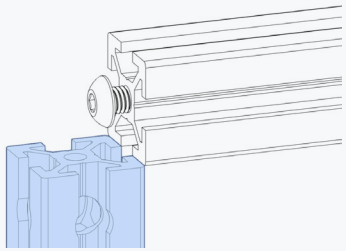
2.5MM HEX DRIVER

The 2.5mm hex driver will see a lot of use in this build. A quality driver is strongly recommended. Refer to the sourcing guide for suggestions.

ADDITIONAL TOOLS

We provide additional tool recommendations in our sourcing guide. Visit https://vorondesign.com/sourcing_guide and switch to the "Voron Tools" tab at the bottom of the page.





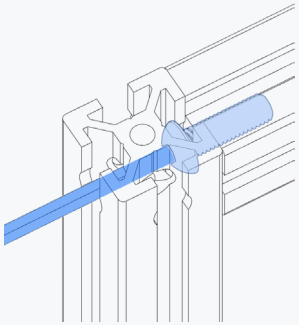
BLIND JOINT BASICS

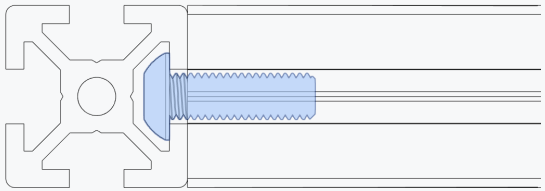
Blind Joints provide a cost effective and rigid assembly method.

The head of the BHCS is slid into the channel of another extrusion and securely fastened through a small access hole in the extrusion.

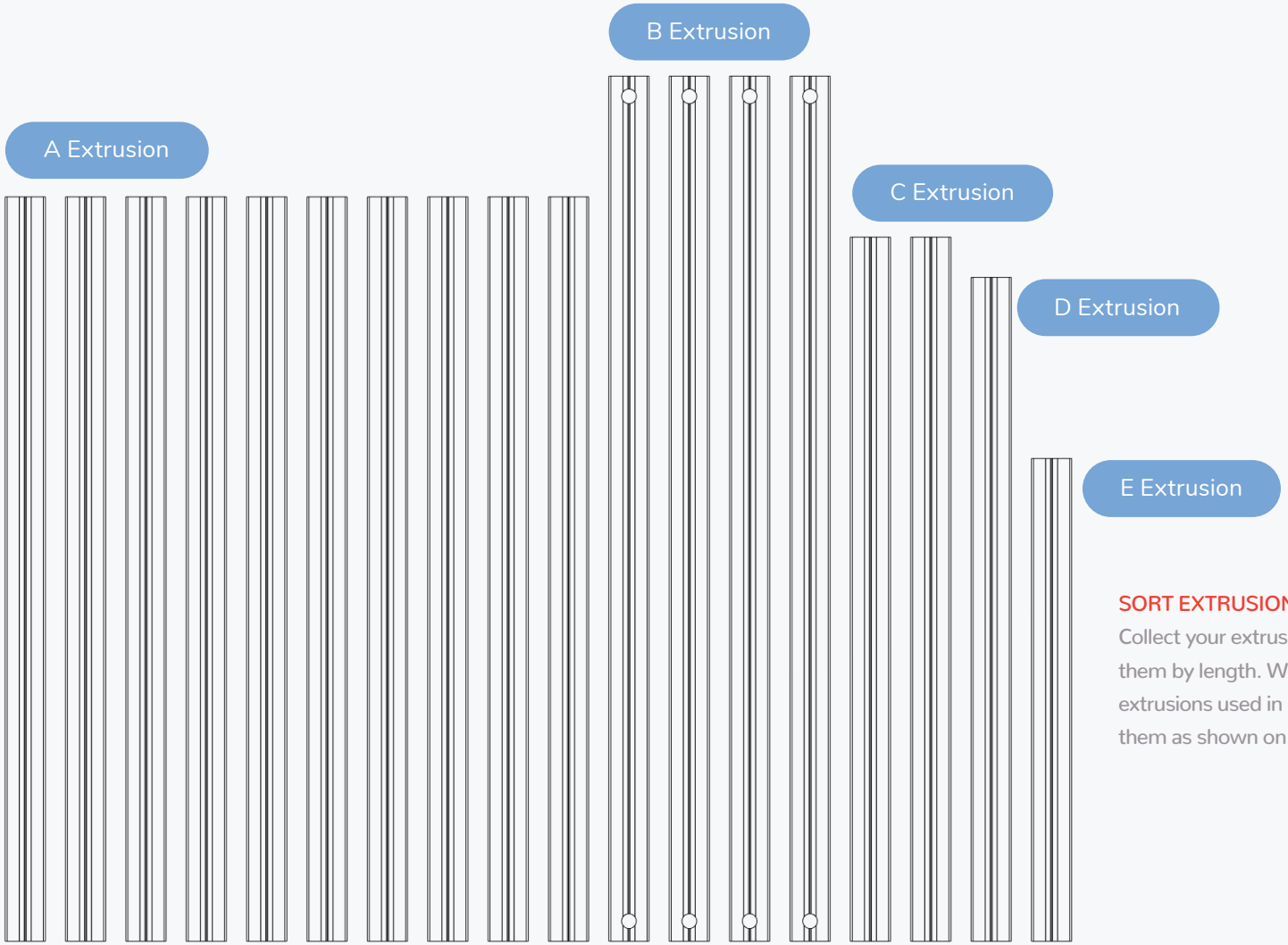
If you've never assembled one before we recommend you watch the linked guide.

https://voron.link/onjwmcd



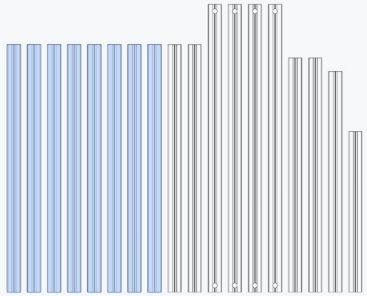


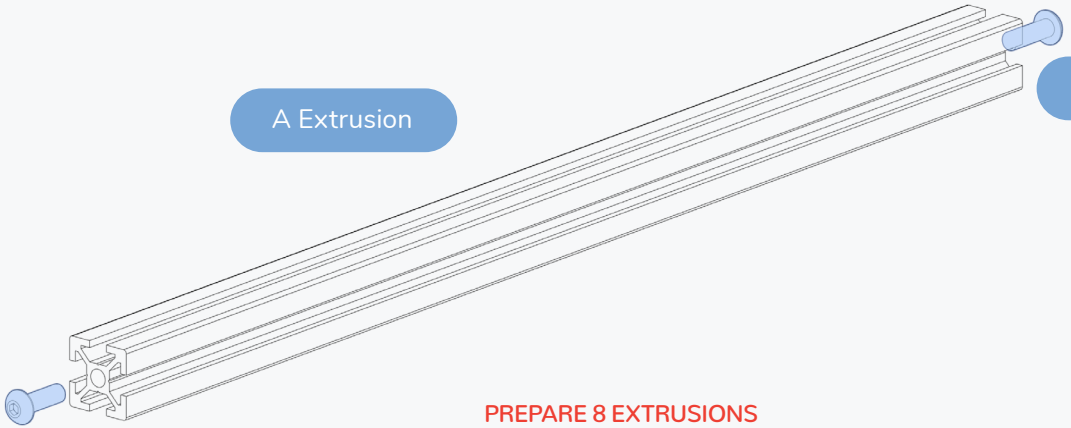
The first Voron printer was released to the public on March 10 2016.



SORT EXTRUSIONS

Collect your extrusions and sort them by length. We will highlight the extrusions used in each step and label them as shown on this page.





PREPARE 8 EXTRUSIONS

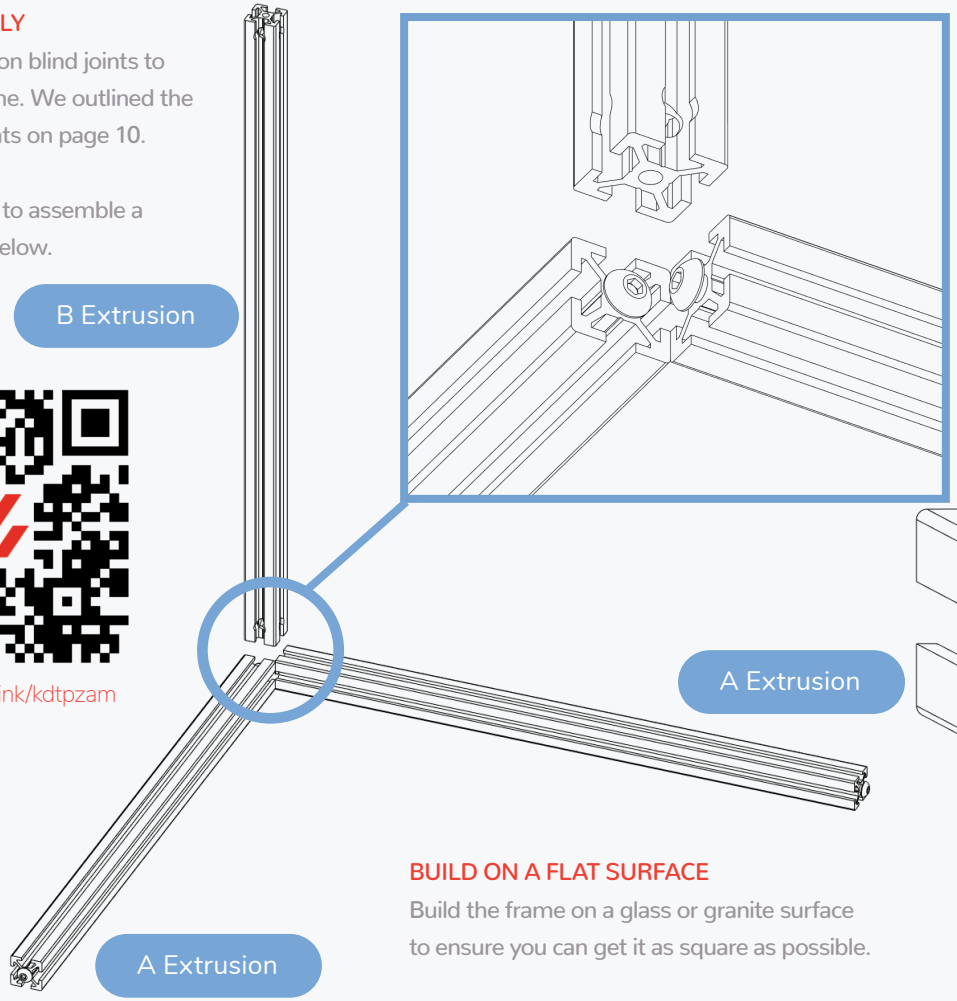
The extrusions are going to be used in this section. Prepare them as shown above.

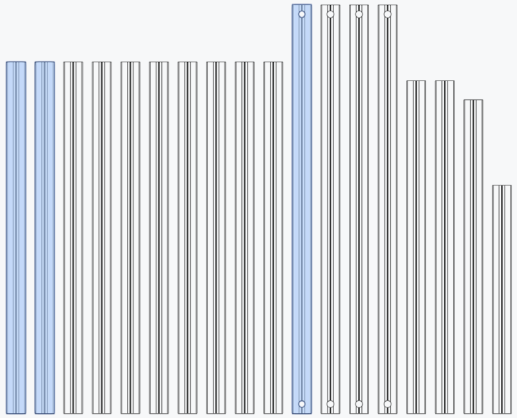
FRAME ASSEMBLY

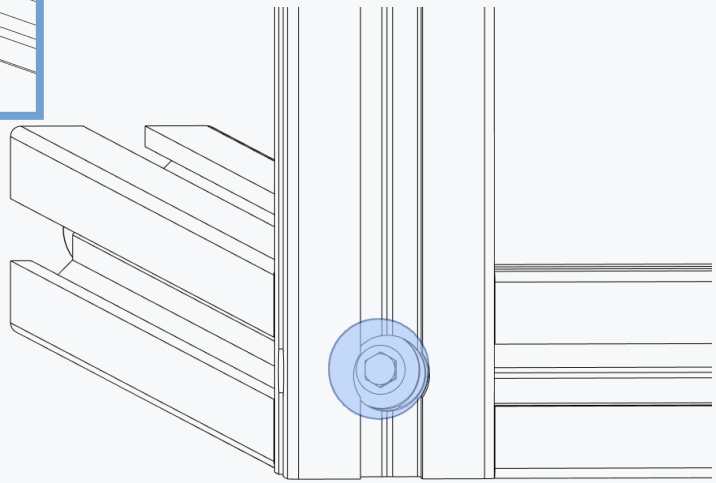
This design relies on blind joints to assemble the frame. We outlined the basics of blind joints on page 10.

More tips on how to assemble a frame are linked below.

https://voron.link/kdtpzam

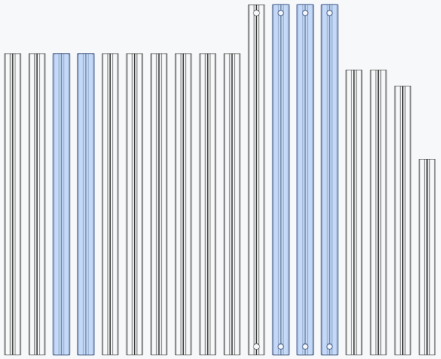


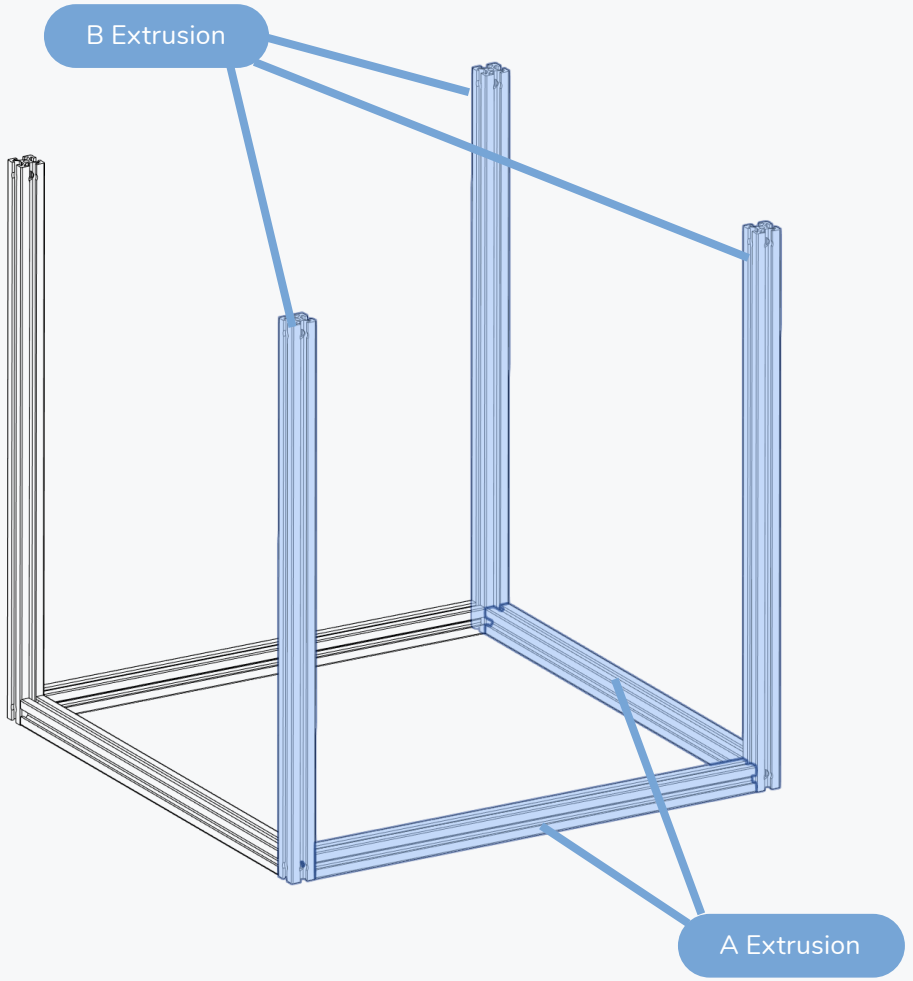


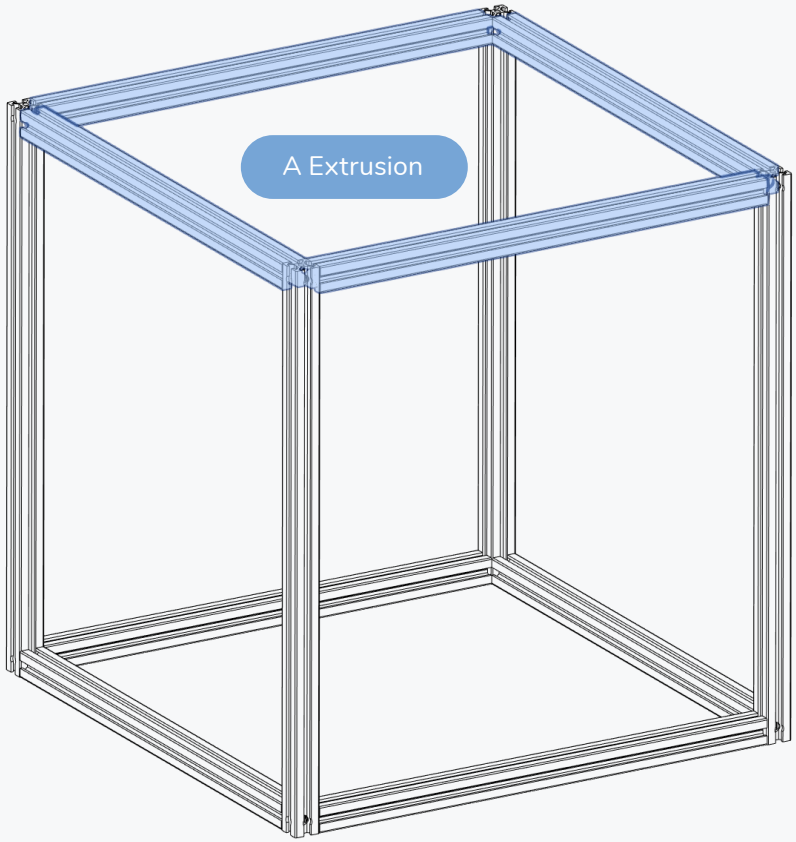


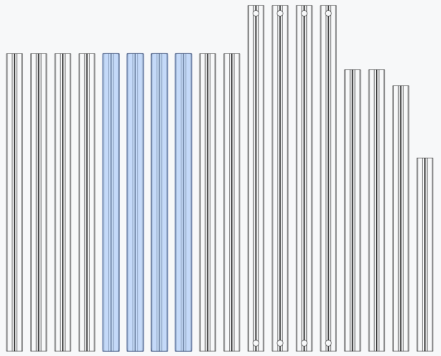
BUILD ON A FLAT SURFACE

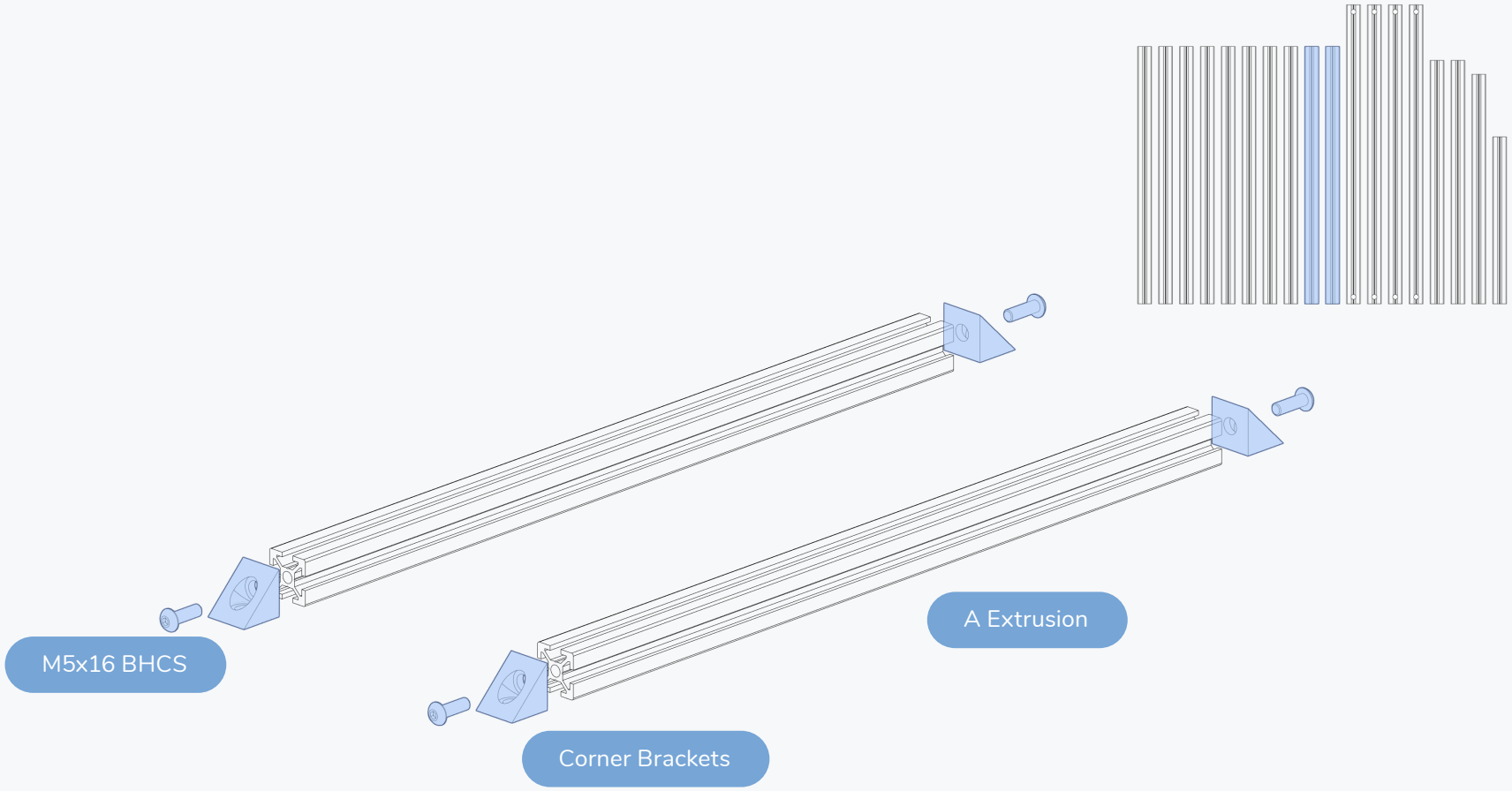
Build the frame on a glass or granite surface to ensure you can get it as square as possible.

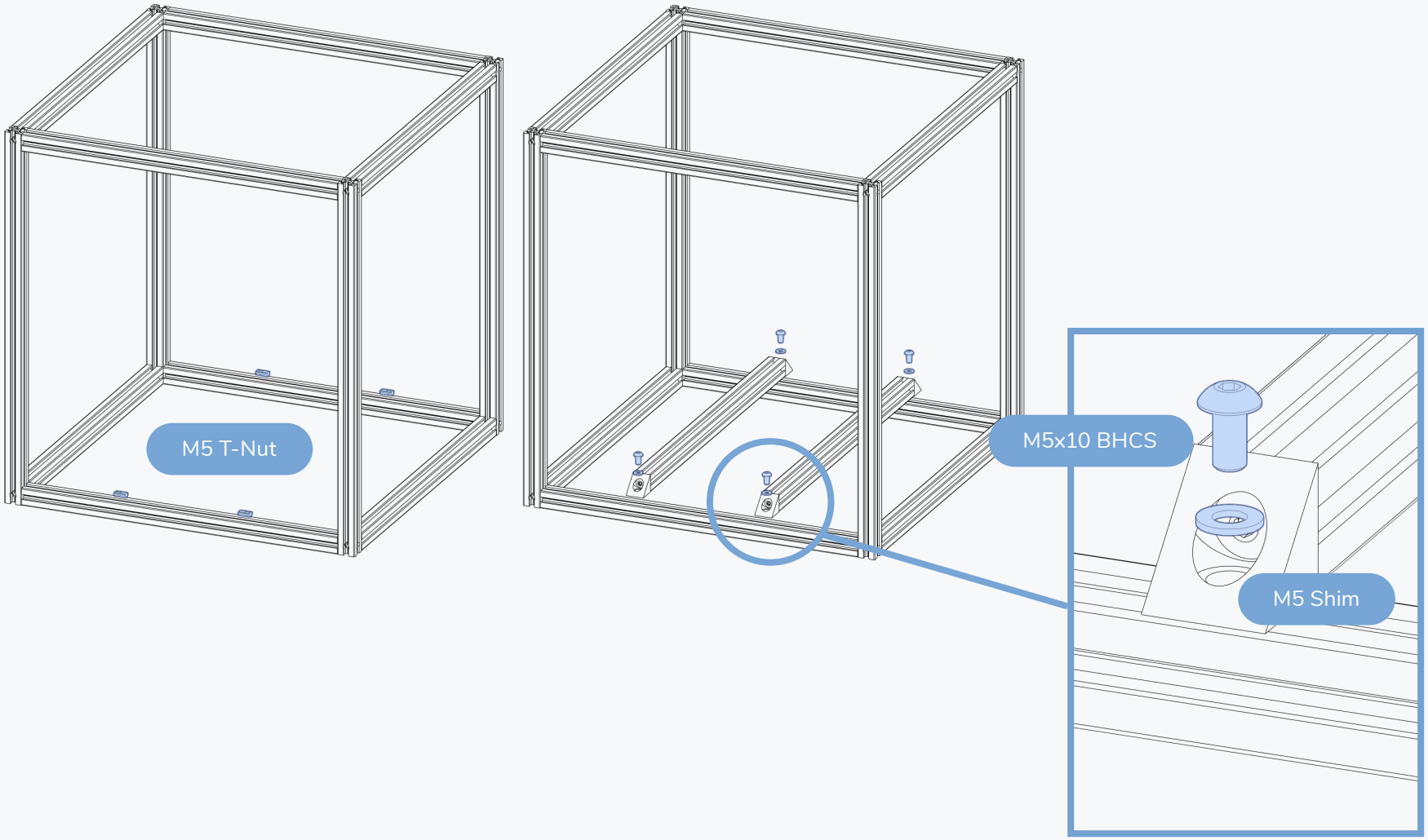


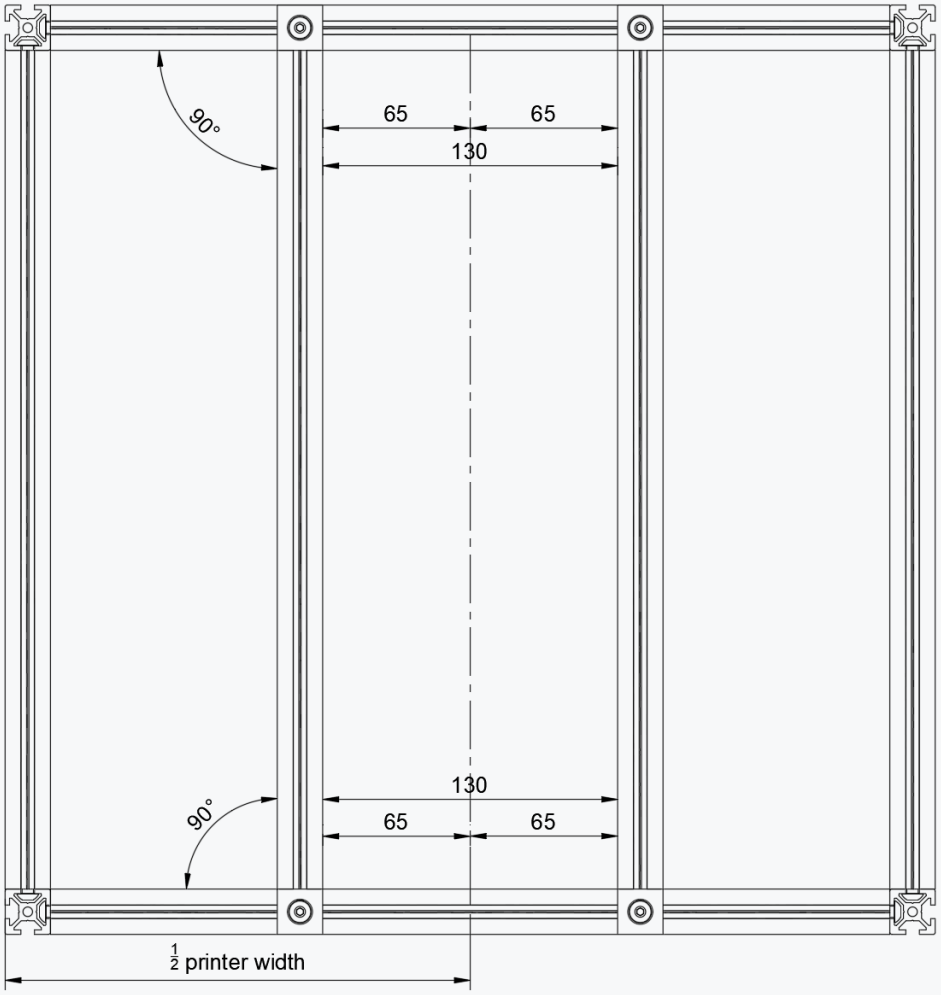

B Extrusion
A Extrusion


A Extrusion




M5x16 BHCS
A Extrusion
Corner Brackets


M5 T-Nut
M5x10 BHCS
M5 Shim



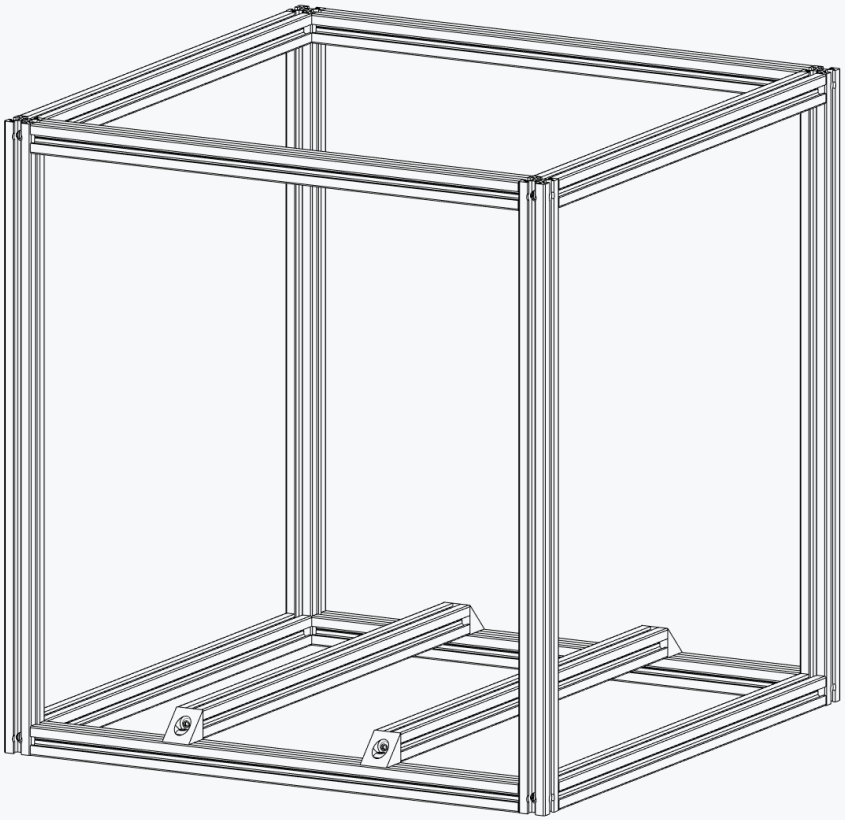
POSITION BED EXTRUSIONS

Find the centreline of the printer and position the bed extrusions as shown in the diagram to the left. The distance between the extrusions is 130mm centred on the centreline of the printer.

1/2 printer width for standard sizes:
250 spec 205mm
300 spec 230mm
350 spec 255mm

ALL UNITS ARE METRIC

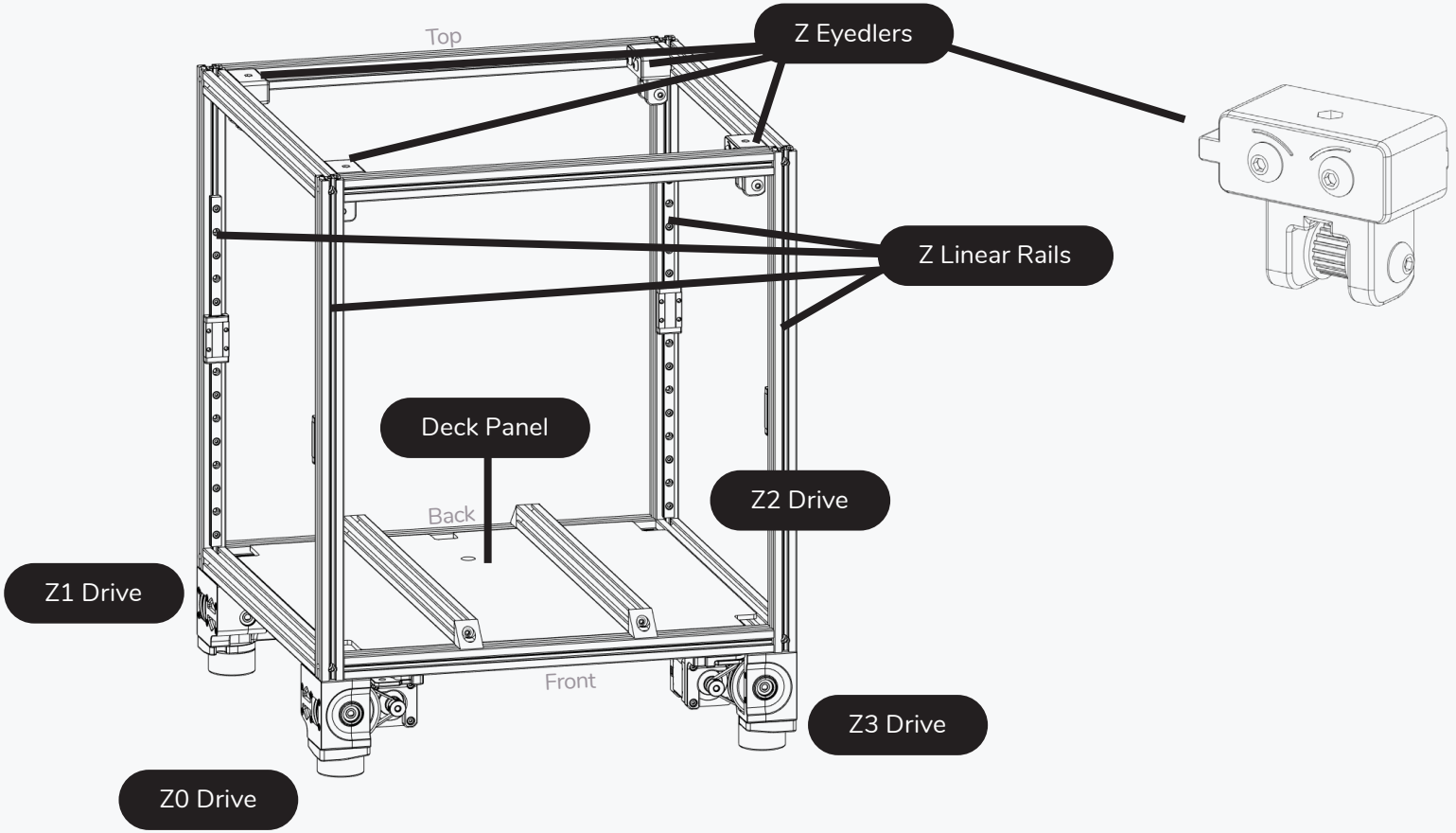
If a unit is not specified assume it's metric.
All distances are called out in millimeters.



CHECK FOR SQUARENESS

Verify the angle of all corners and the overall squareness by measuring the diagonals. Refer to the second half of the linked video for additional information.

https://voron.link/kdtpzam

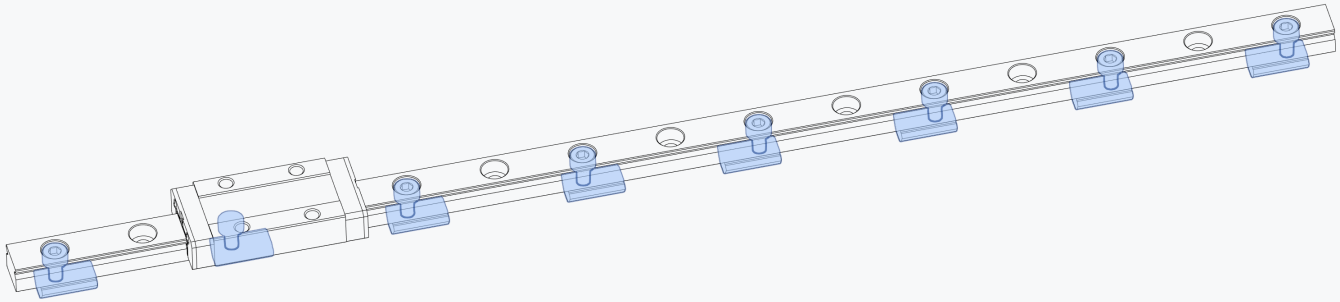


OVERVIEW

Individual chapters start with an overview of the components that will be built/added to the printer in the chapter.

HANDLE WITH CARE

The carriage can slide off the rail if not handled properly. Dropping the carriage will likely damage it.
Any marks, dents or nicks might cause the linear rail to misbehave in operation.



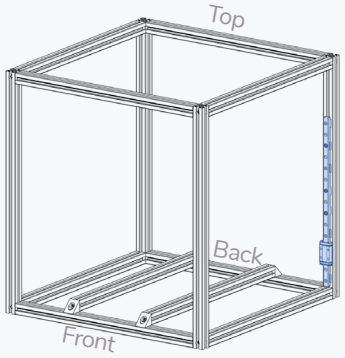
LINEAR RAILS - PREPARATION AND MOUNTING

Most linear rails arrive with shipping oil. To ensure a smooth gliding motion and long service life, this oil needs to be removed and its rail carriage greased. See the Voron sourcing guide for a recommended list of lubricants. We attached a link to a video guide to get you started.

We opted to skip every other mounting hole in the linear rail when designing the mounting pattern for this printer. This cuts down on mounting hardware and still meets the requirements for our use case.

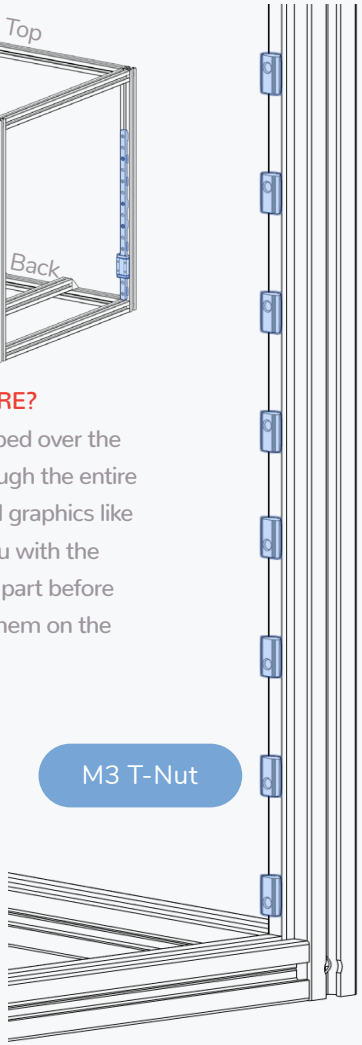
When tightening the bolts tighten them from the center outward to ensure that the rail sits flush on the extrusion.

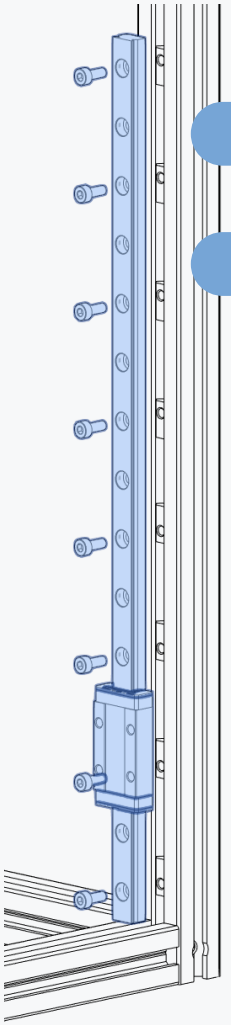
https://voron.link/agu0nes



WHY IS THIS HERE?

As you likely skipped over the advice to flip through the entire manual we added graphics like these to assist you with the orientation of the part before you actually put them on the printer.

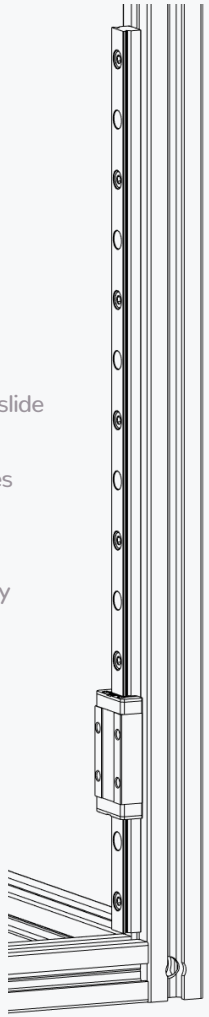


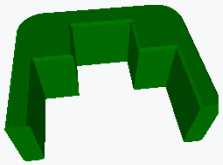


MIND THE CARRIAGE

The carriages are designed to slide along the rail easily.
This unfortunately also includes sliding off the rails.

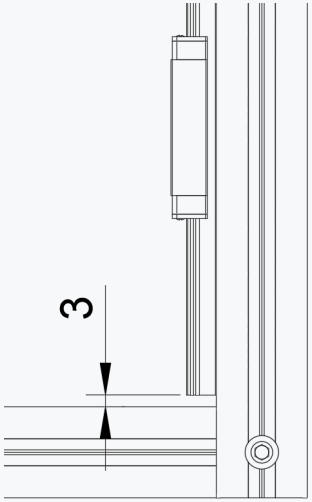
Dropping the carriage will likely damage it.





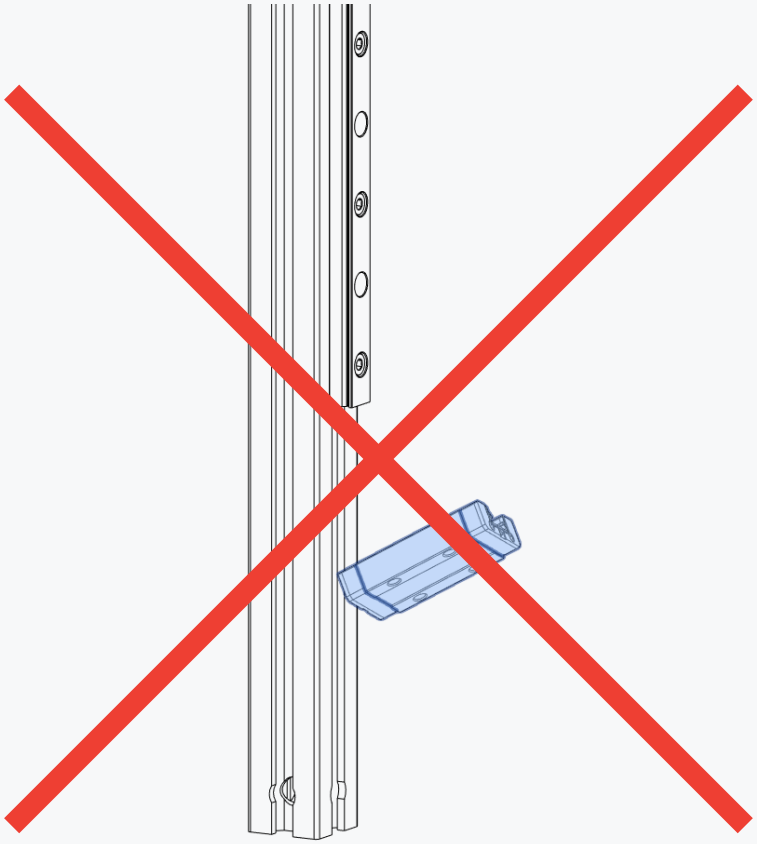
CENTRED RAIL INSTALLATION GUIDE

Use the MGN9 guides to position the rail in the center of the extrusion prior to fastening the screws.



BOTTOM GAP

Leave a gap between the printer frame and the rail. ~3mm is fine.



For illustration purposes only. Do not attempt to replicate.

RAIL SAFETY

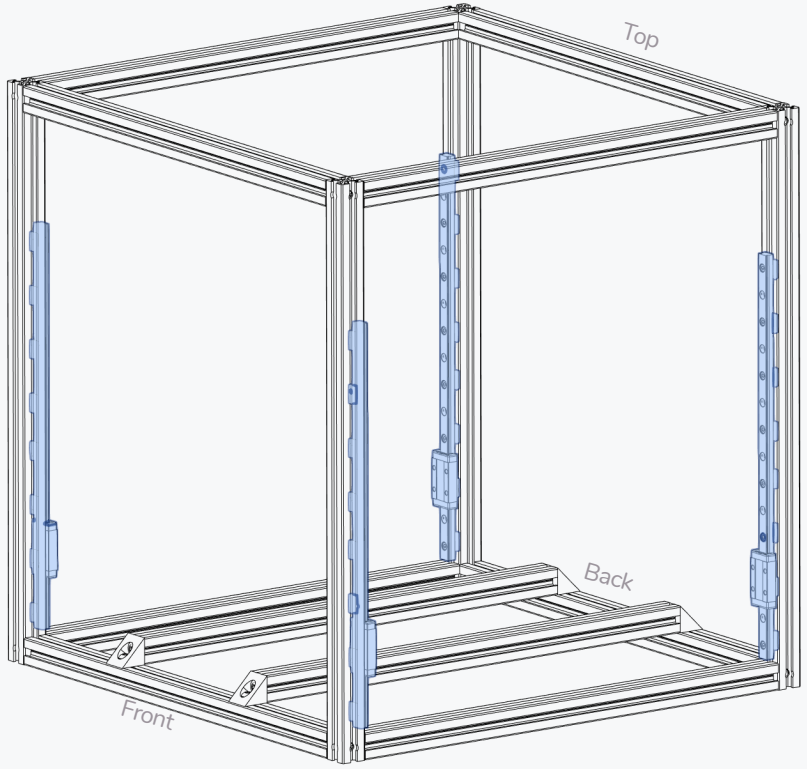
As we will turn the printer upside down during further assembly make sure to fix each carriage in position with a piece of sticky tape.

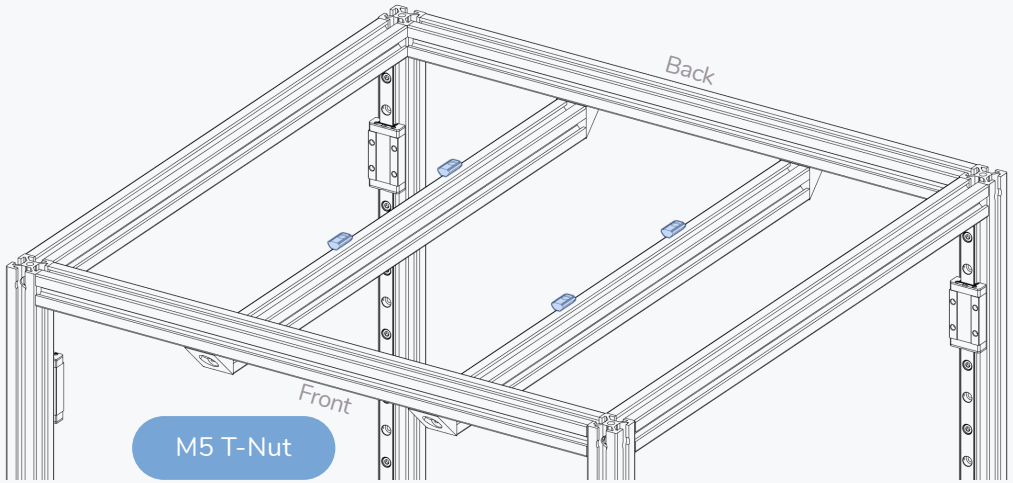
If your rails were delivered with plastic stoppers you can also temporarily reinstall them to prevent carriages from falling off their rails and spilling their bearing balls..

INSTALL REMAINING Z RAILS

Add the remaining Z rails following the same instructions.

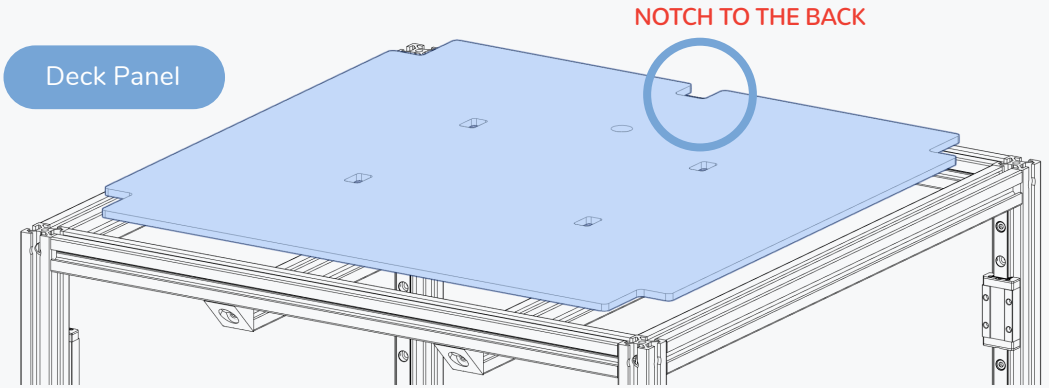
Make sure the rails face each other as shown in the graphic.

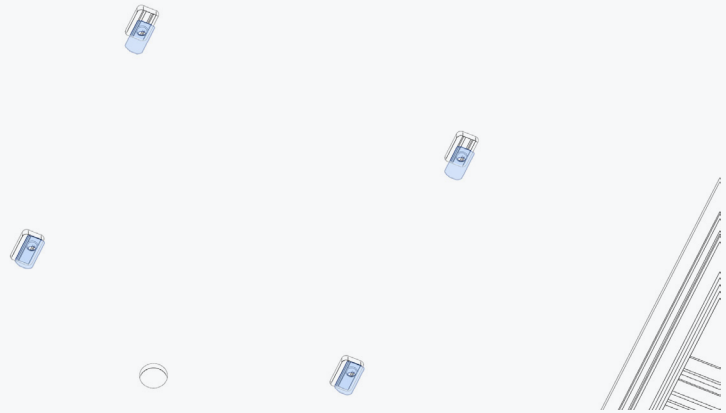




FLIP PRINTER UPSIDE DOWN

It's easier working with gravity than against it. But make sure the rail carriages are secure before doing so.



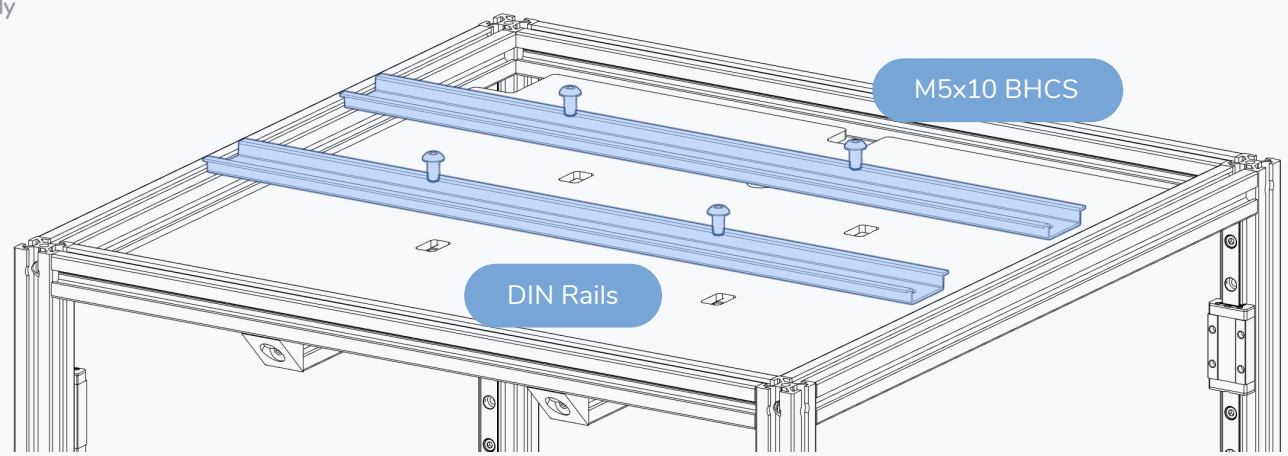


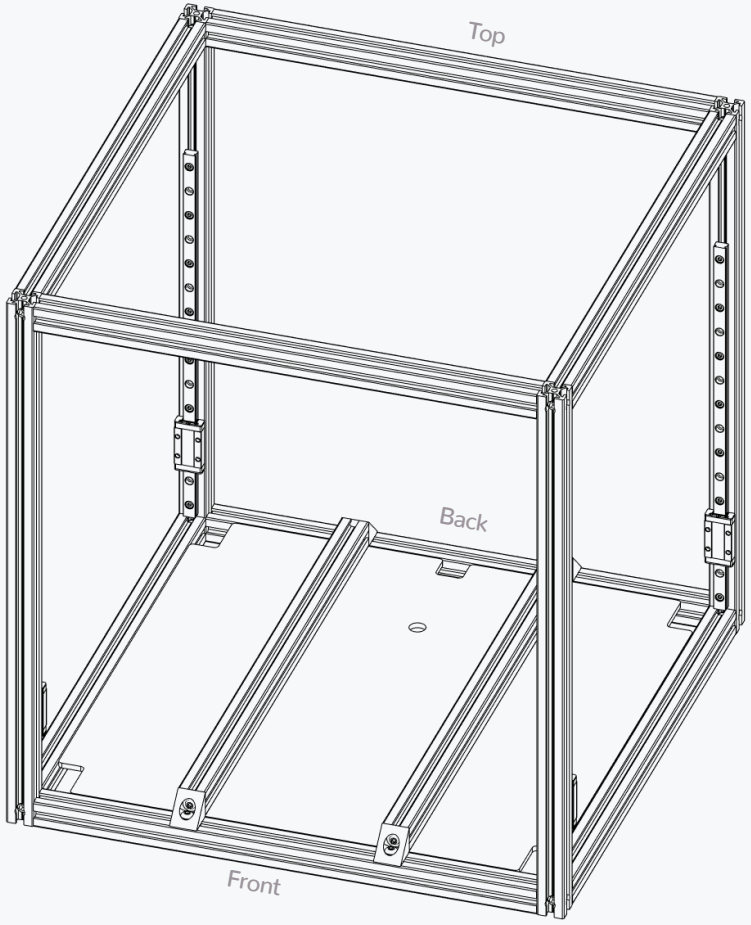
ALIGN T-NUTS WITH HOLES

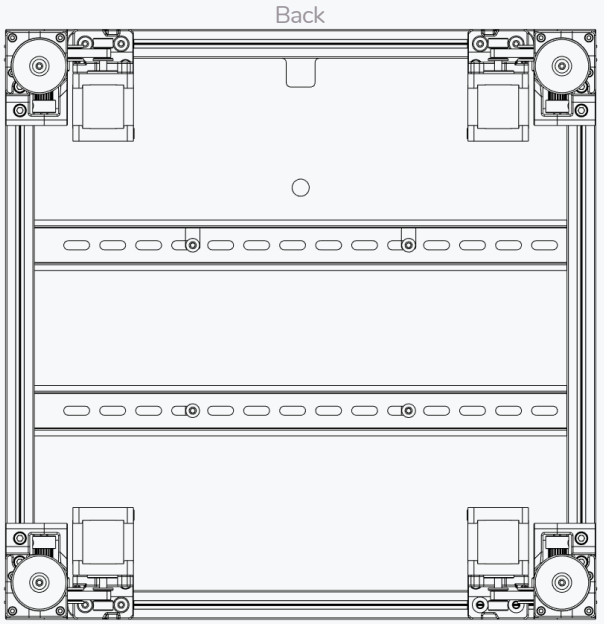
Position the 4 T-nuts so they are directly below the 4 holes in the deck panel.

DIN RAIL SLOTS

If the slots in the rails do not line up with the t-nut you can shorten the DIN rails by a few mm.

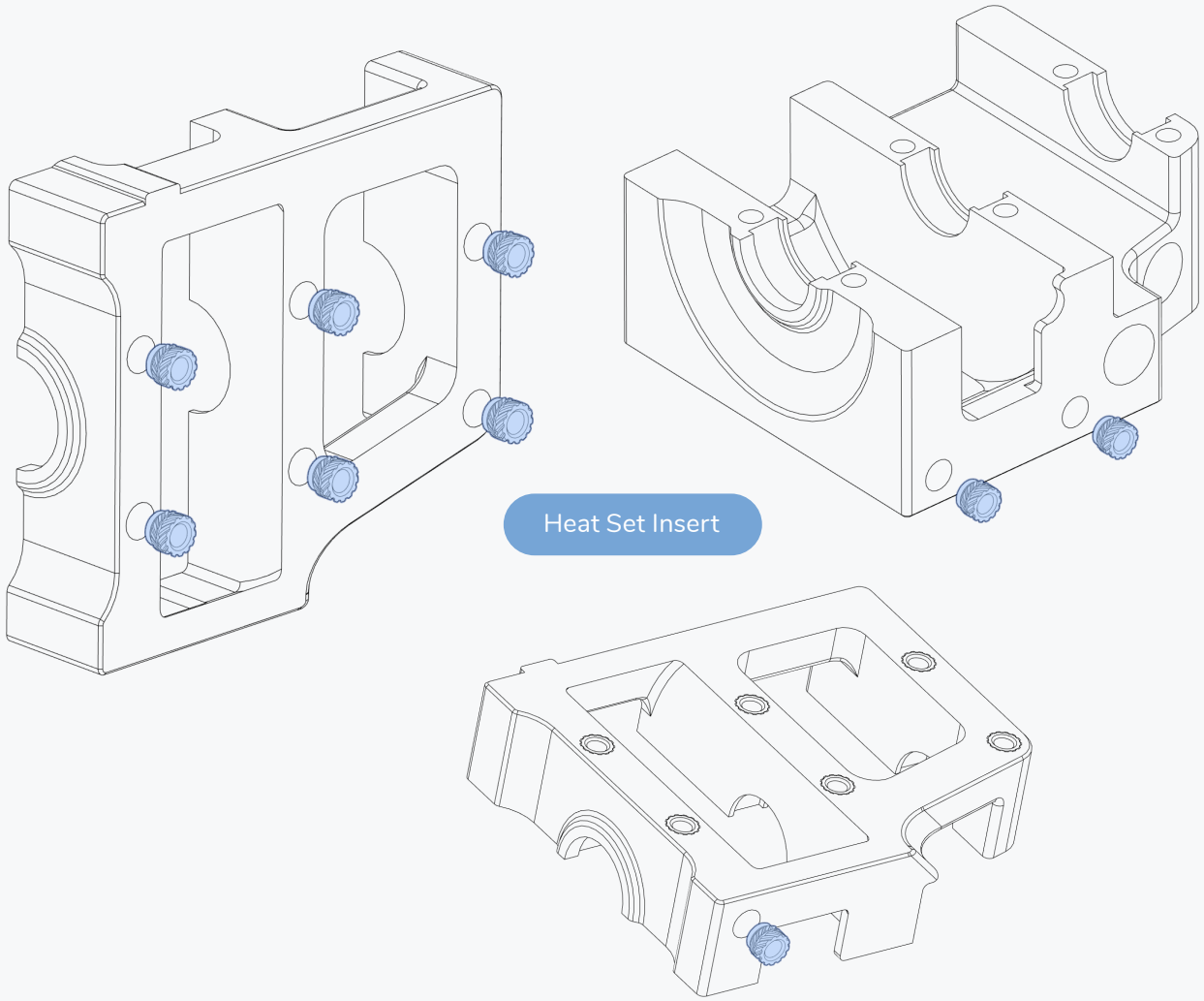






PRINTER ORIENTATION

We regularly insert graphics like the ones above to help you along the build process. The sides are labeled to make it easier to keep track.

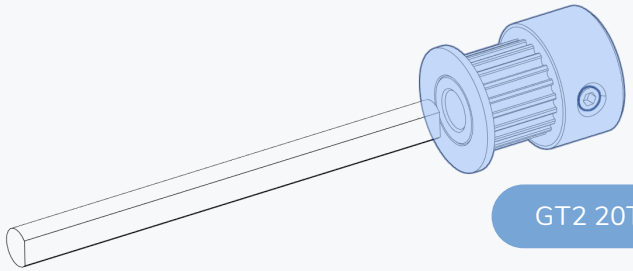


HEAT SET INSERTS

This design relies heavily on heat set inserts. Make sure you have the proper inserts (check the hardware reference for a close up picture and the BOM for dimensions).

If you've never worked with heat set inserts before we recommend you watch the linked guide.

https://voron.link/m5ybt4d

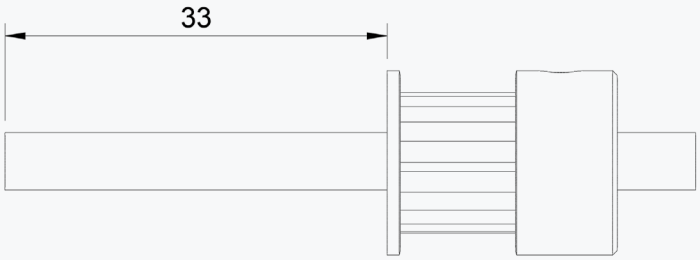


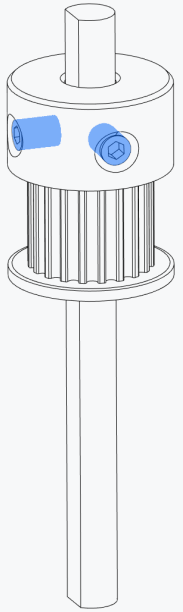
GT2 20T 9mm wide Pulley

5x60 Shaft

POSITION AS SHOWN

Make sure one of the set screws is oriented with the D cut, as shown in the image.





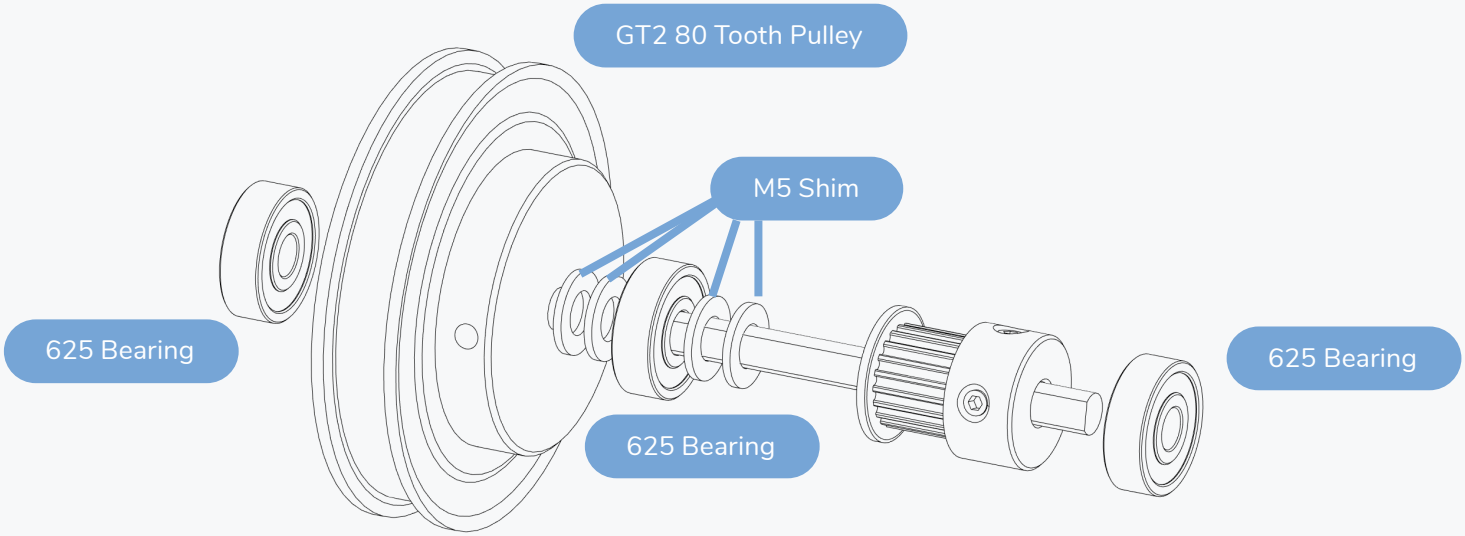
SET SCREWS

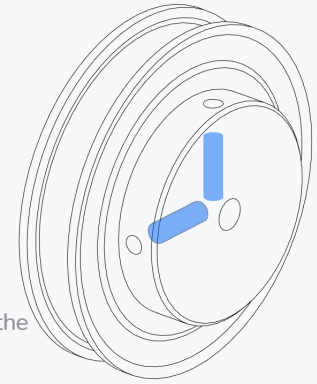
AKA THE ROOT OF ALL ISSUES

Insert both set screws and use thread locker on all set screws.
Use a high quality hex driver to prevent the hex profile from stripping. Ball-end drivers are not recommended.

Loose set screws account for the majority of issues that our users report. Save yourself hours of troubleshooting and apply thread locker to all set screws during the build.

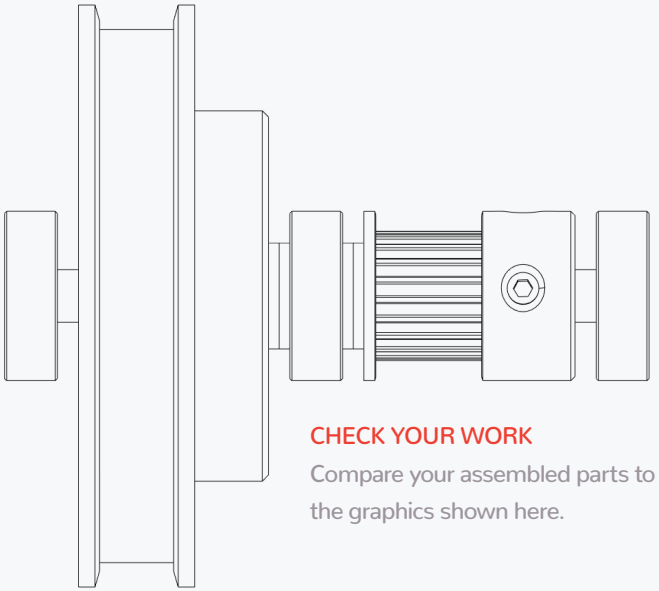
See the product's application notes for instructions - keep away from printed parts.





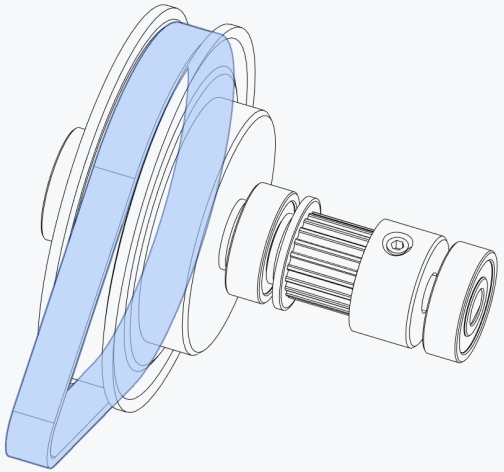
APPLY THREAD LOCKER

Make sure to use thread locker on the set screws.

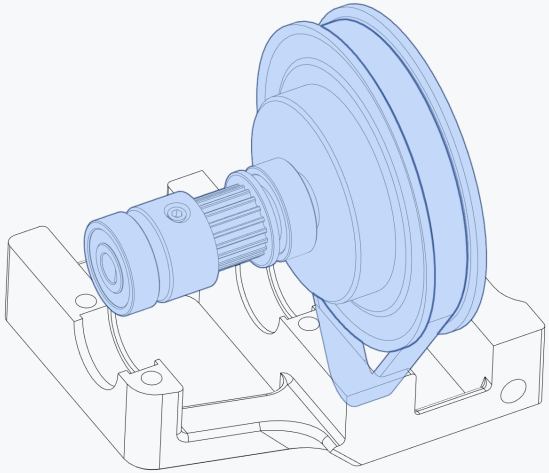


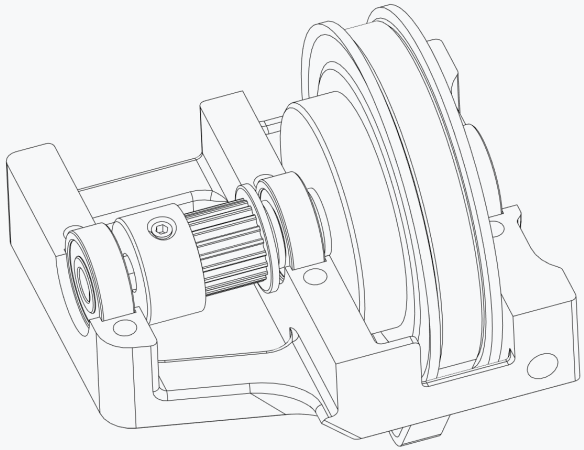
CHECK YOUR WORK

Compare your assembled parts to the graphics shown here.



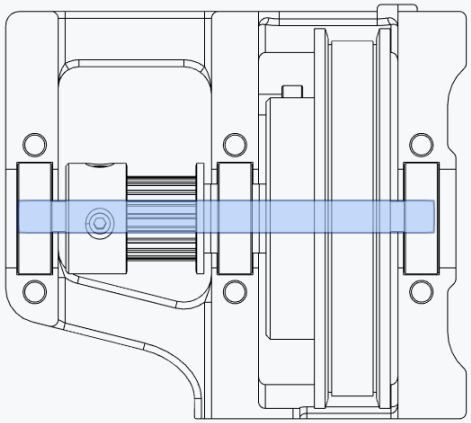
GT2 188mm Belt Loop

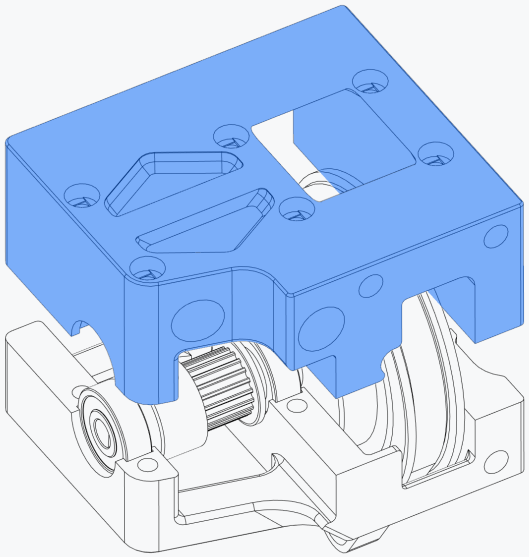


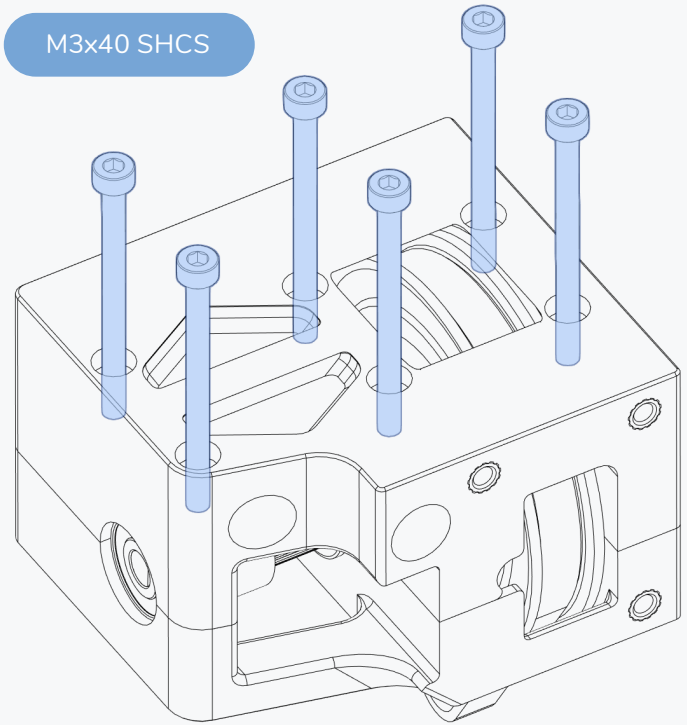


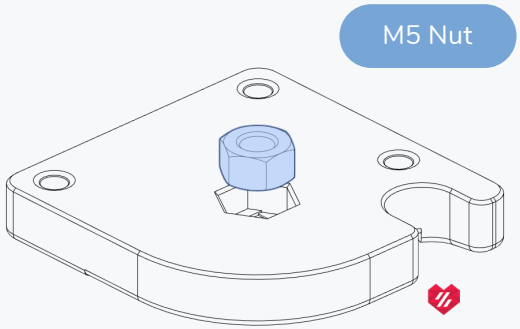
CHECK SHAFT POSITION

Compare your assembled parts to the graphics shown here.



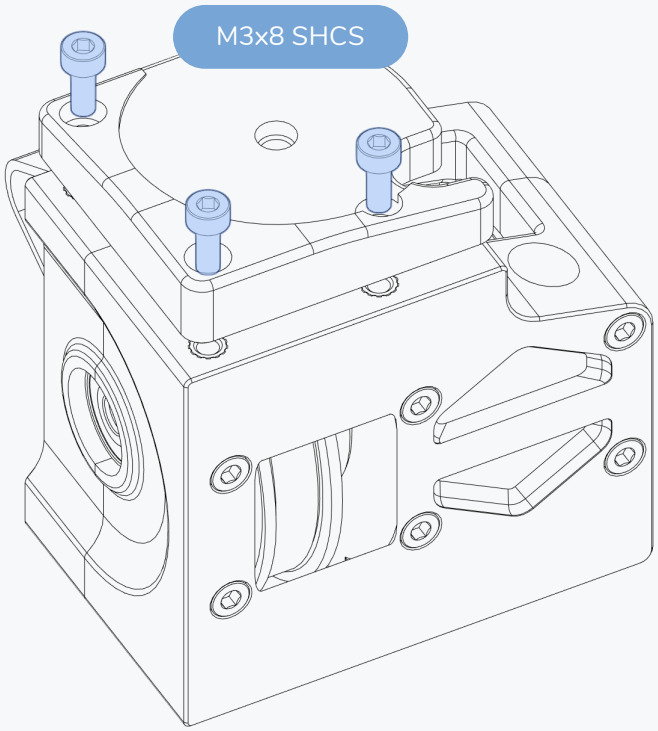


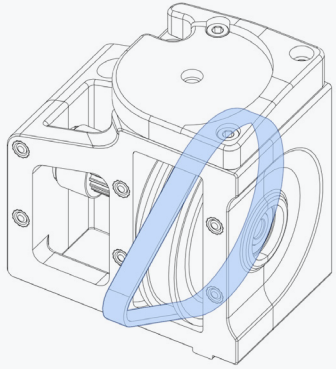

M3x40 SHCS



ACCENT PART?

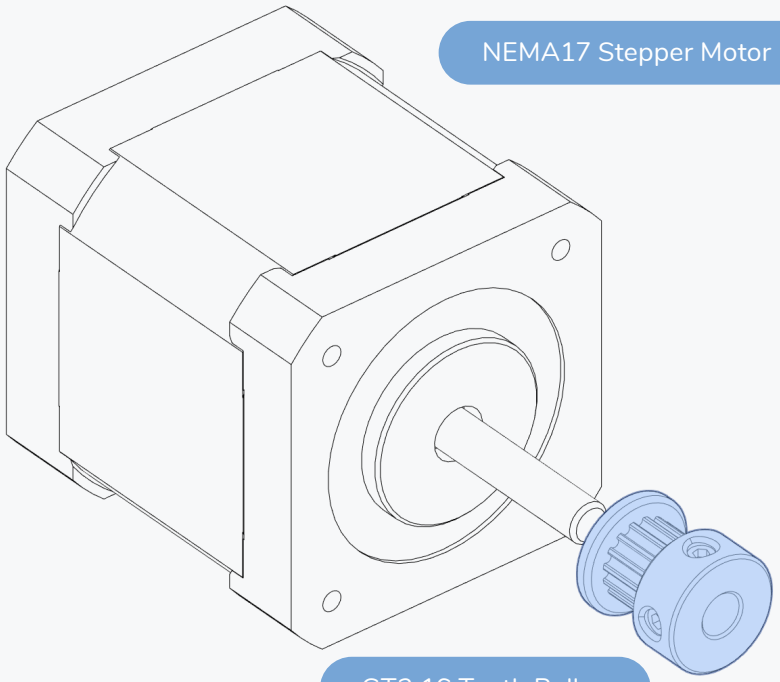
Look for Voron heart next to the part.
It indicates that this is an accent part.





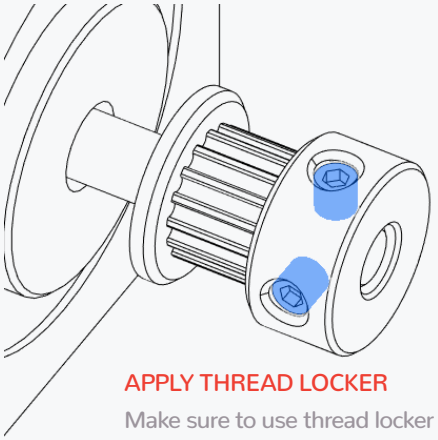
CHECK FOR BELT

Make sure the closed belt loop is in the part.



16 TOOTH PULLEYS

The Z drive motors are the only place in the printer that use 16 tooth pulleys!
Remove the pulleys from your work surface after you finish this chapter.



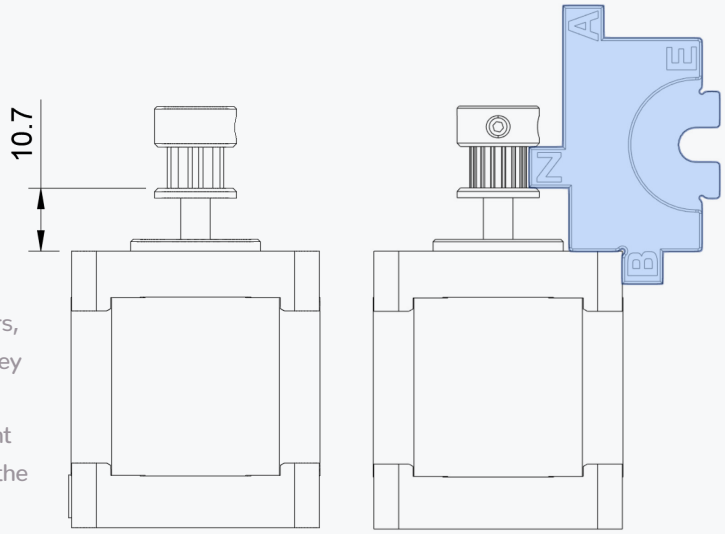
APPLY THREAD LOCKER

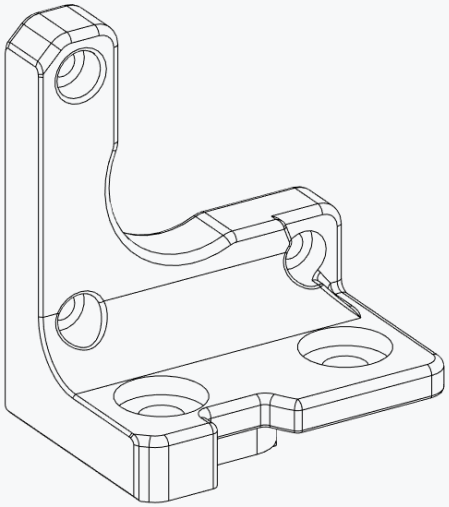
Make sure to use thread locker on the set screws.

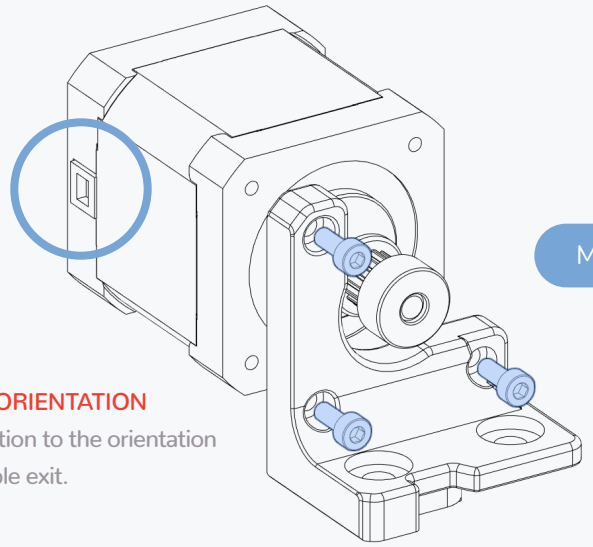
https://voron.link/fx10m8e

PULLEY POSITION

Depending on your motors, you may find that the pulley sits better in the opposite orientation. The important thing is the placement of the actual teeth.

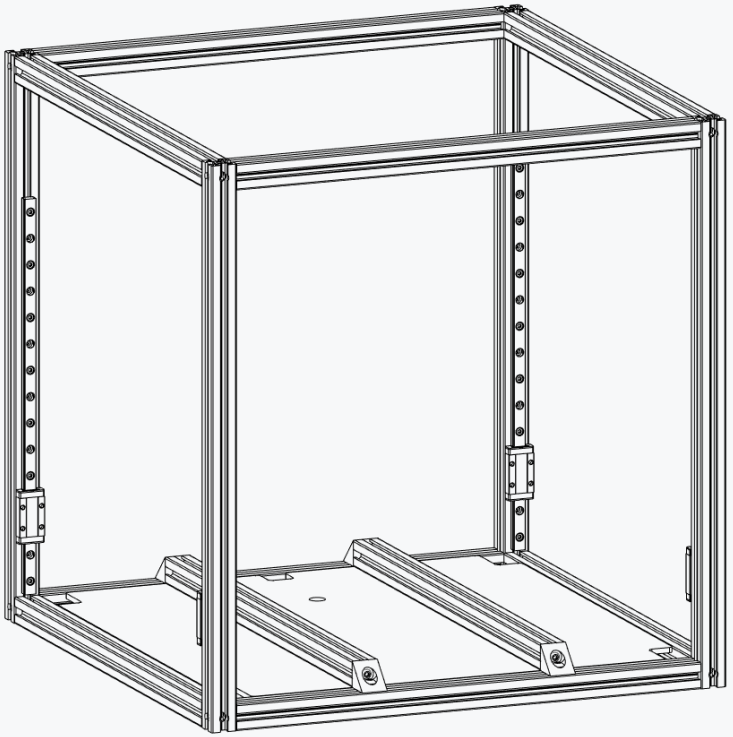


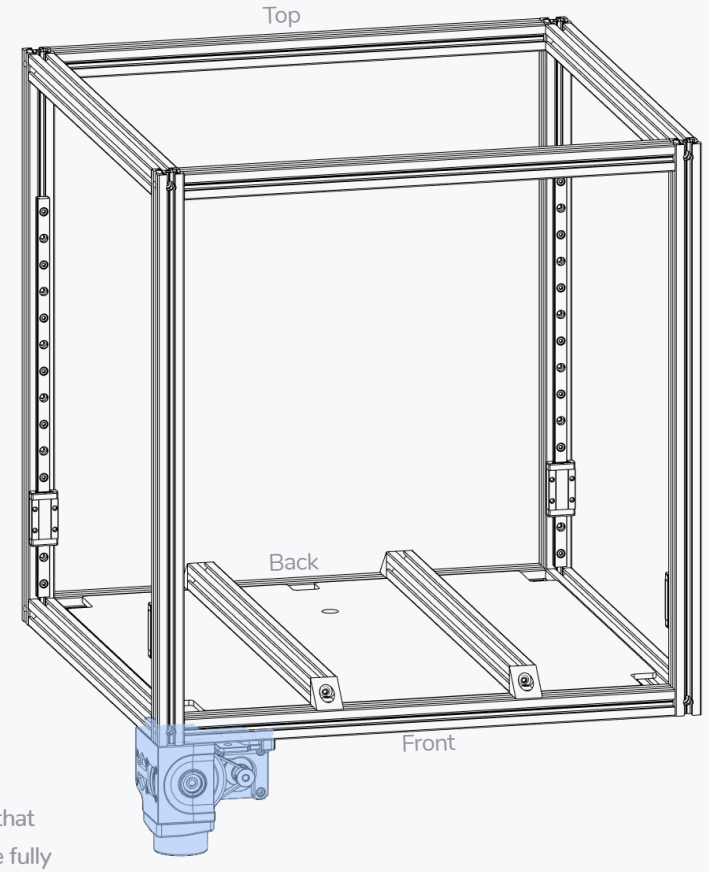




MOTOR ORIENTATION

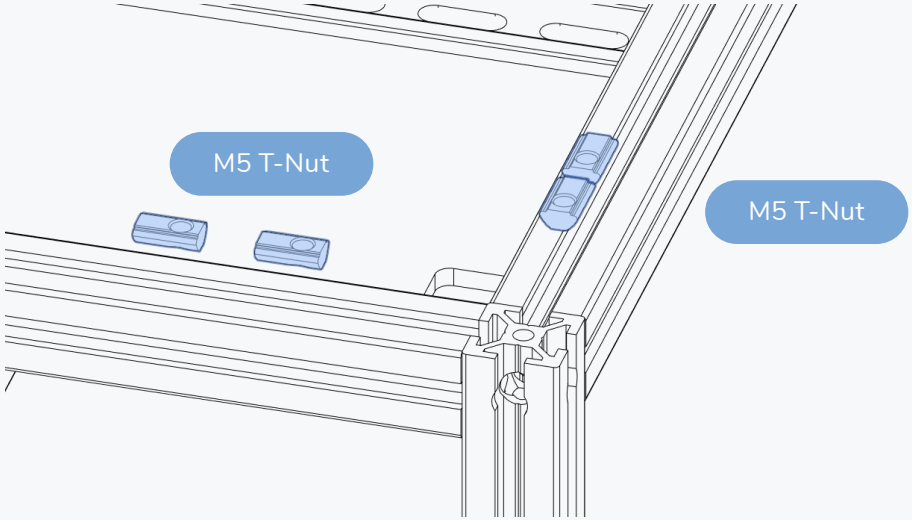
Pay attention to the orientation of the cable exit.

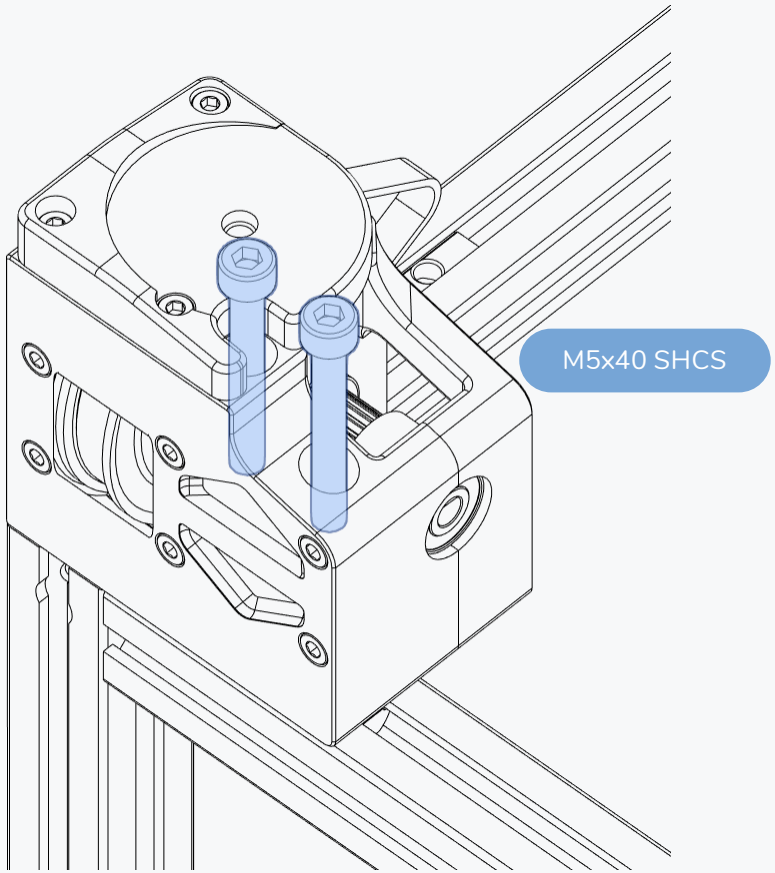




PICTURE FOR ORIENTATION

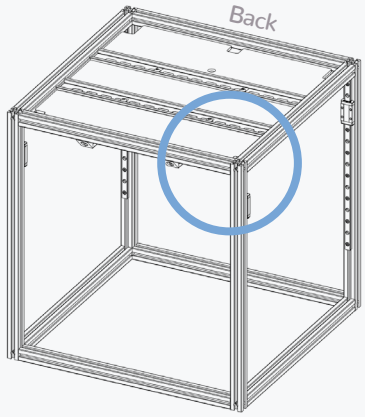
The Z0 drive is the first Z drive that will be added to the printer. The fully assembled Z Drive is highlighted in blue.





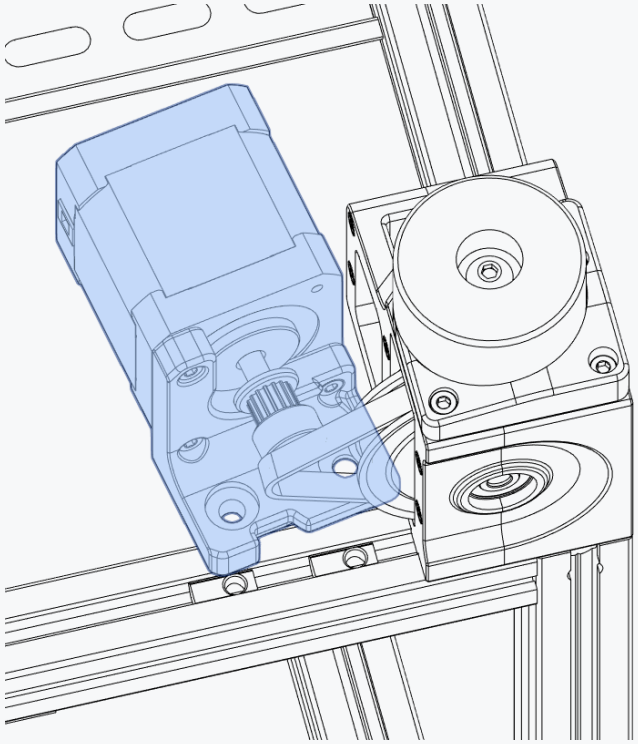
WHICH CORNER IS THIS?

We highlighted the corner with a circle.



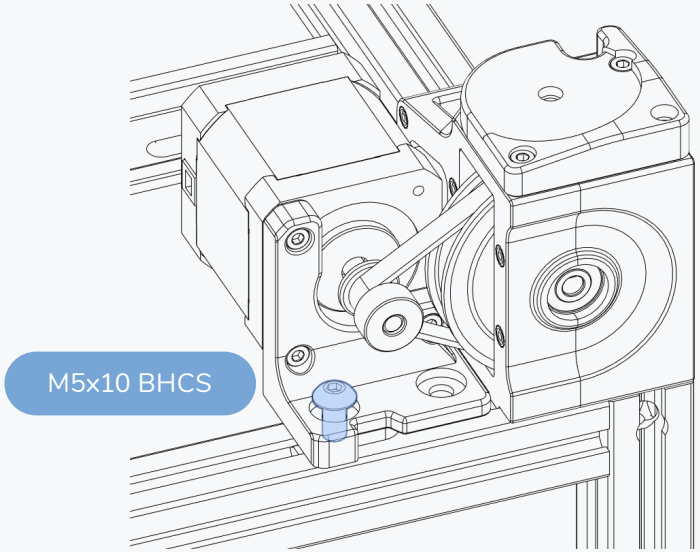
UPSIDE DOWN ASSEMBLY

For ease of assembly we recommend flipping the printer on its head for the next steps.



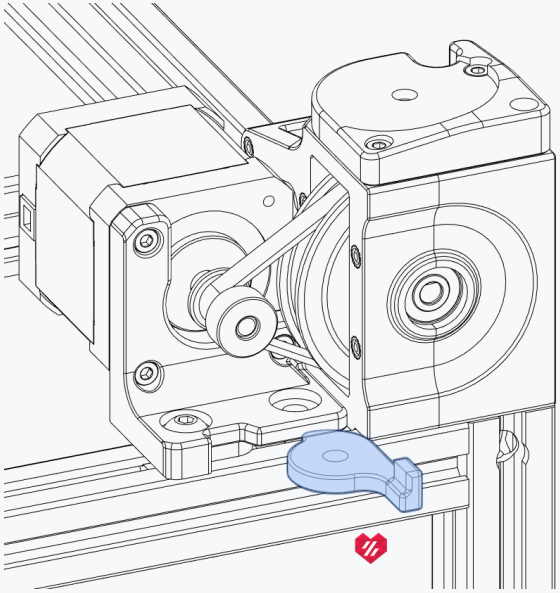
SLIDE INTO PLACE

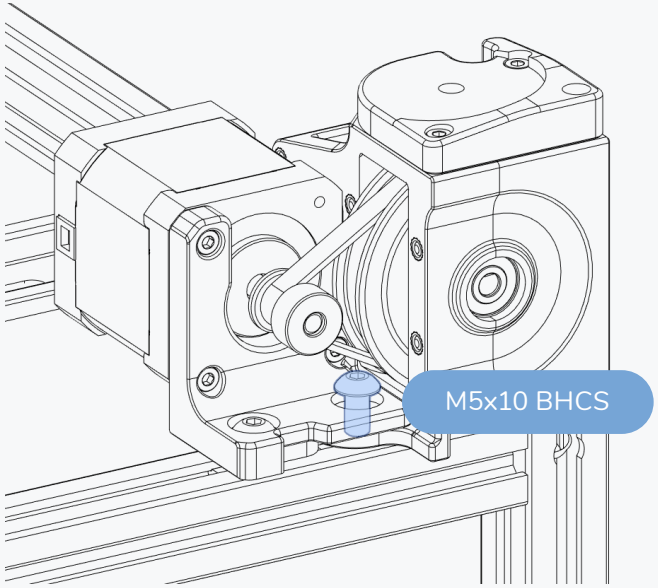
Insert at an angle and slide into place.



DON'T TIGHTEN

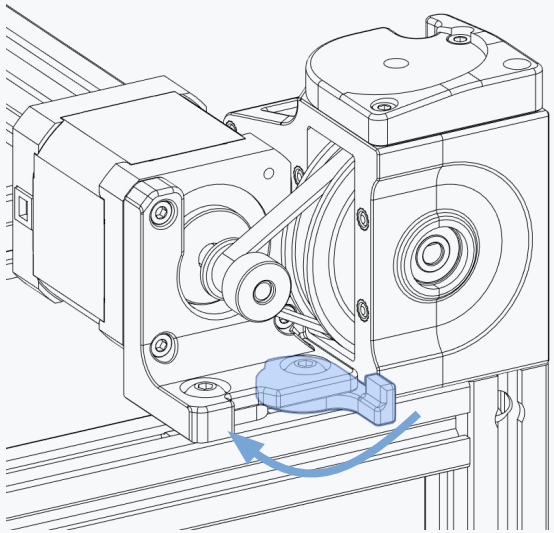
Leave the bolt loose for the next step.

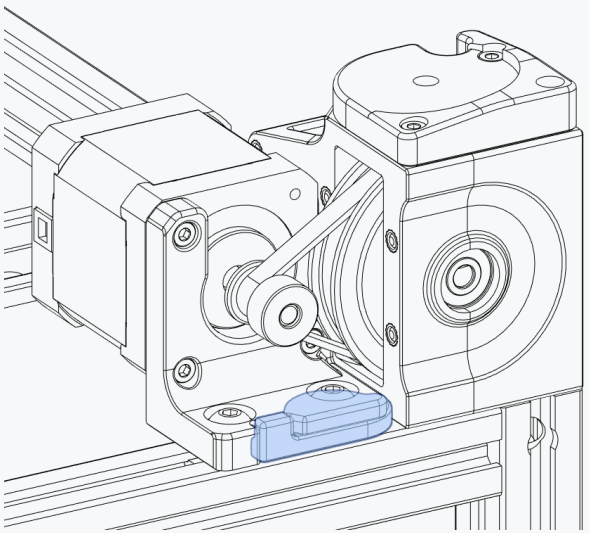




DON'T TIGHTEN

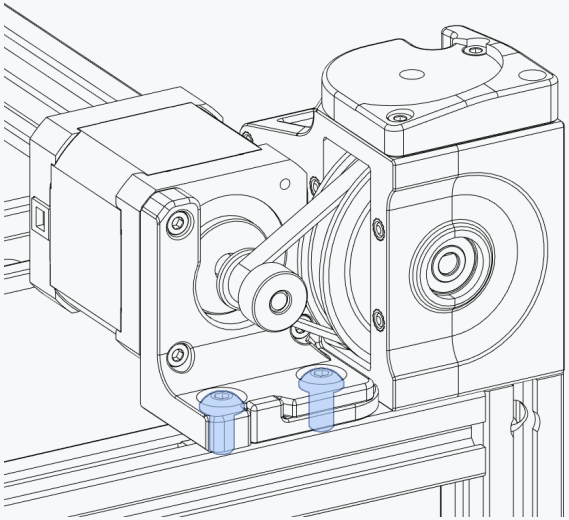
Leave the bolt loose for the next step.





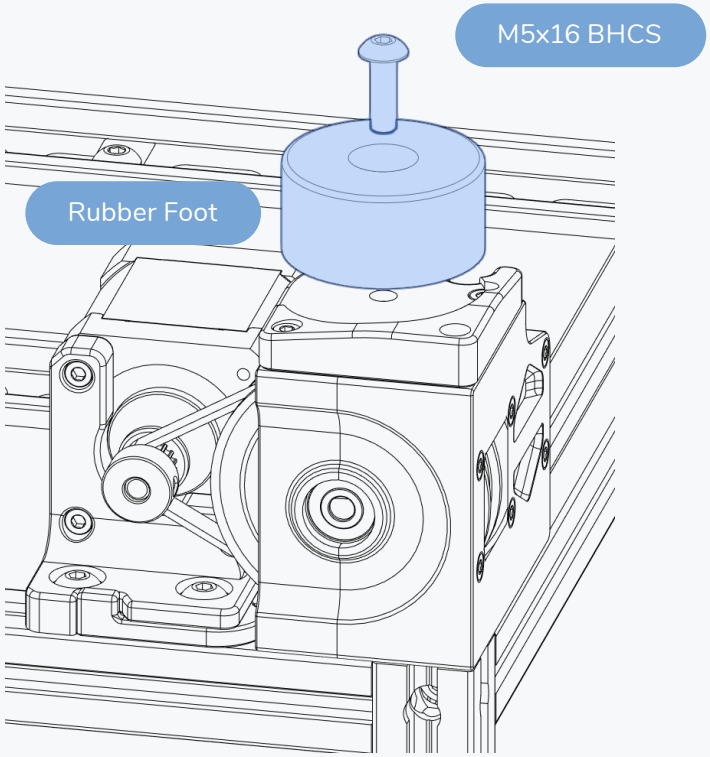
CLOSE THE BELT TENSIONER

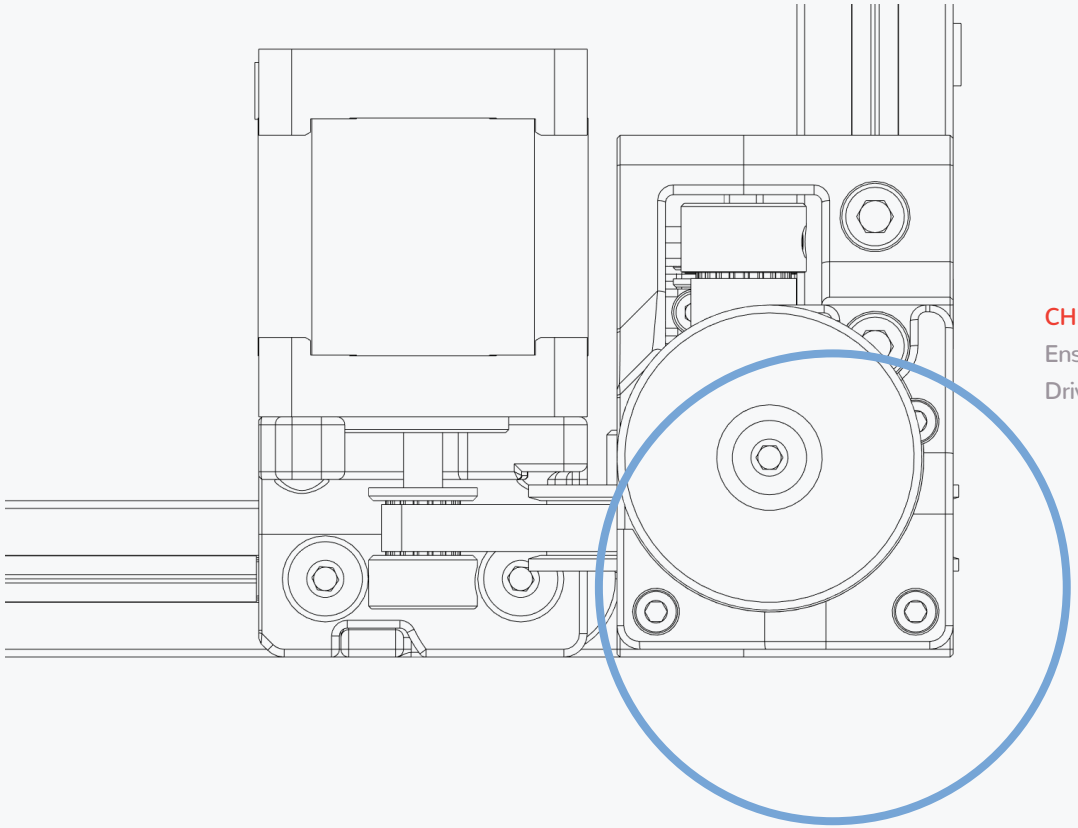
Flip the belt tensioner latch closed.



TIGHTEN BOLTS

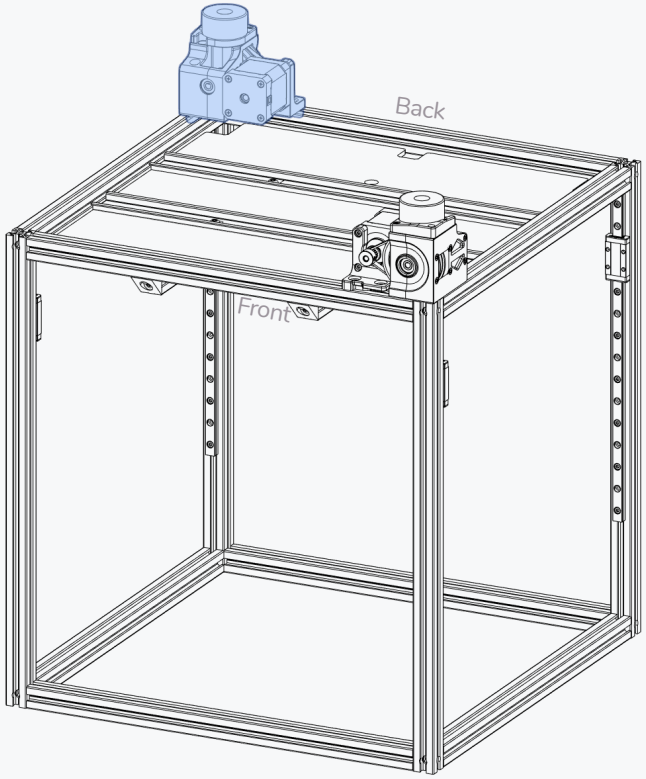
After closing the tensioner the M5 bolts can be properly fastened.





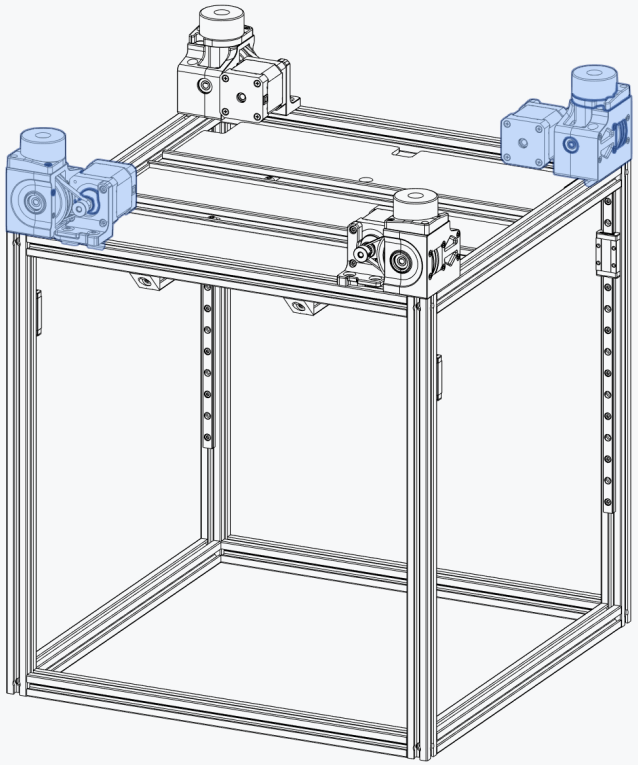
CHECK POSITION

Ensure that closing the belt tensioner did not cause the Z Drive to move/shift. If it did undo the bolts and realign.



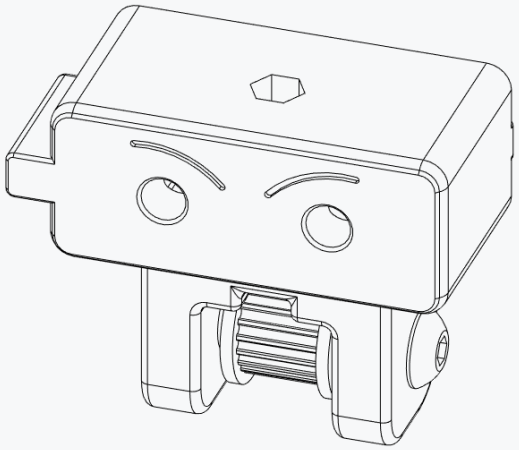
REPEAT INSTRUCTIONS FOR OPPOSING CORNER

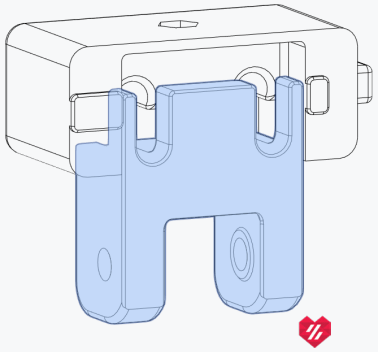
Build another Z drive, following the same instructions.

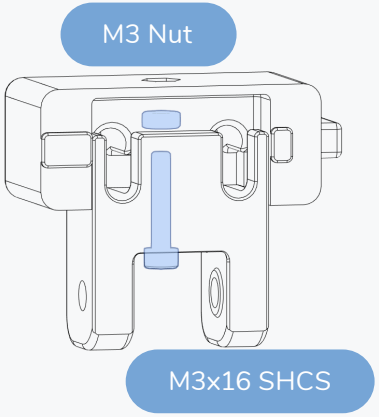


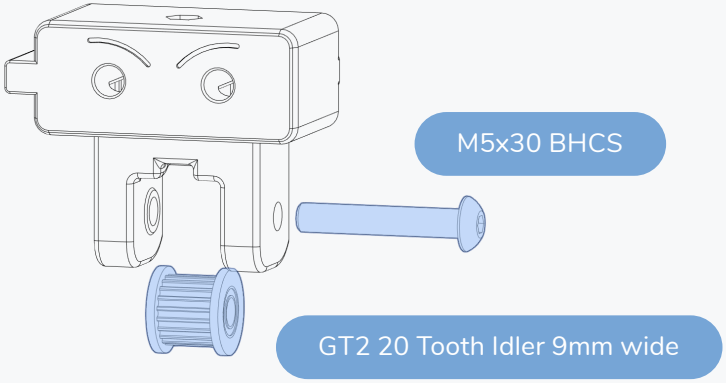
REPEAT INSTRUCTIONS FOR THE MIRRORED DRIVES

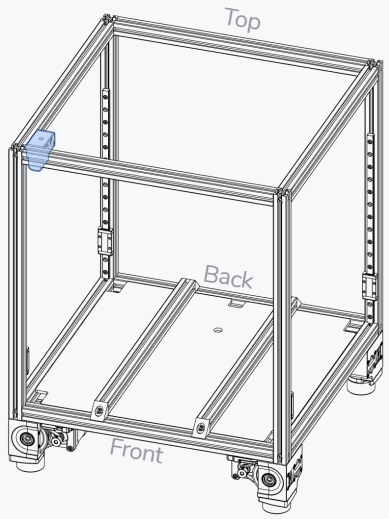
Build two more Z drives following the instructions that came before. The printed parts are mirrored.






M3 Nut
M3x16 SHCS

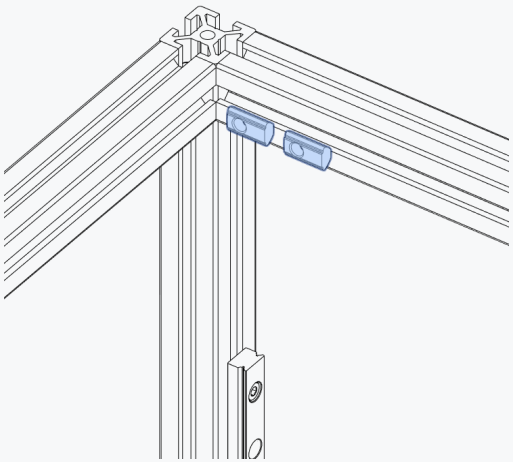

M5x30 BHCS
GT2 20 Tooth Idler 9mm wide

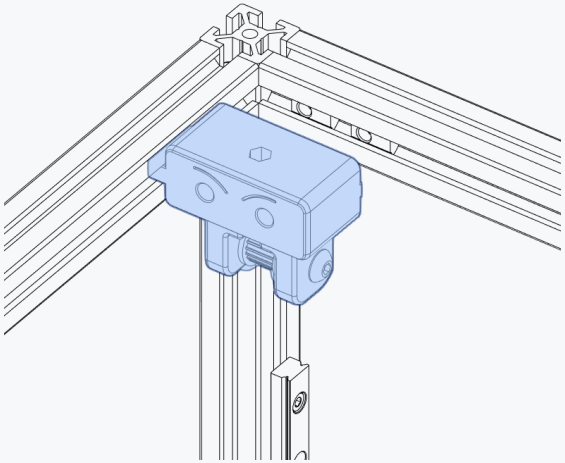


IDLER ORIENTATION

Mind the idler orientation. The idler must face in the same orientation as the pulley in the drive below it.

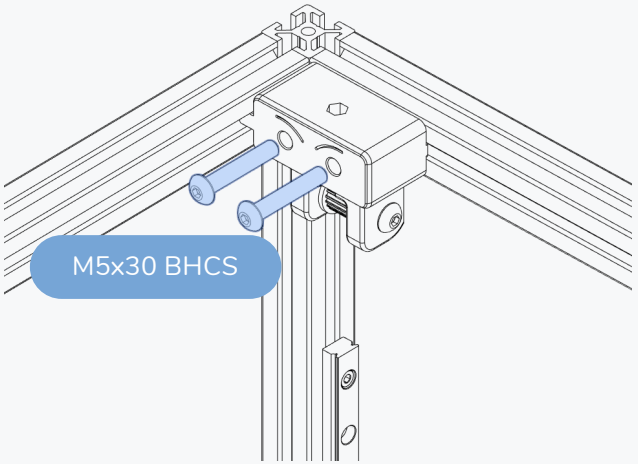
M5 T-Nut

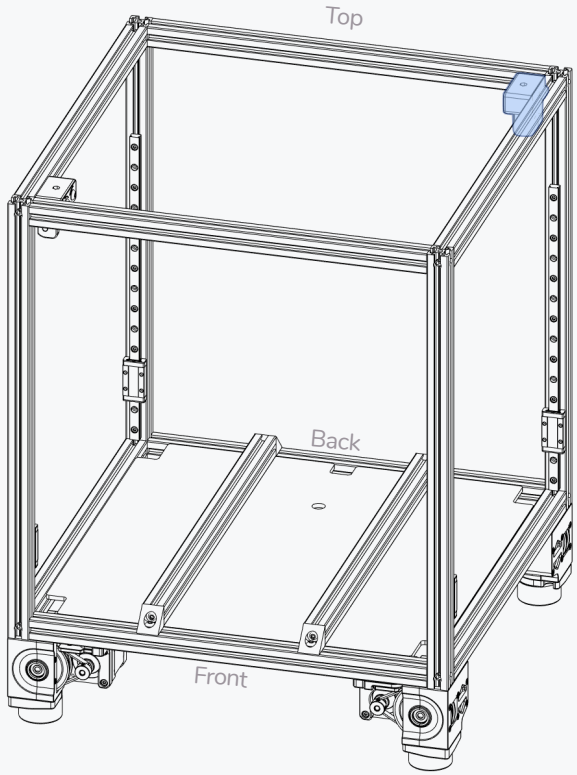


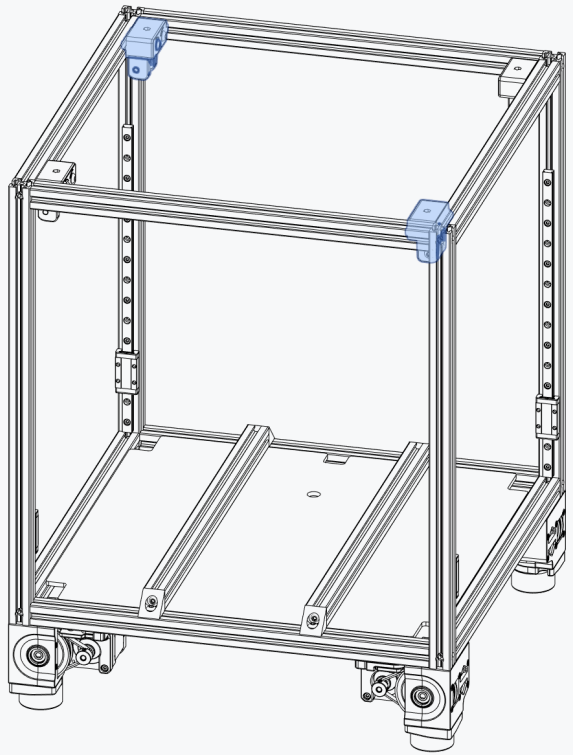


SEAT IN CORNER

Ensure idler is pressed firmly into corner before tightening.







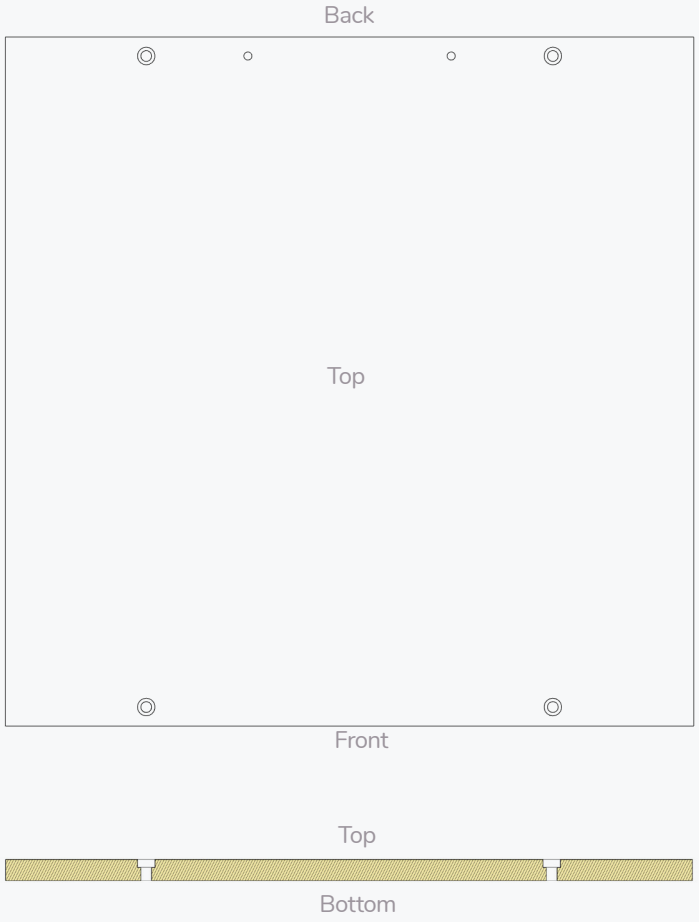
REPEAT INSTRUCTIONS FOR OPPOSING CORNER

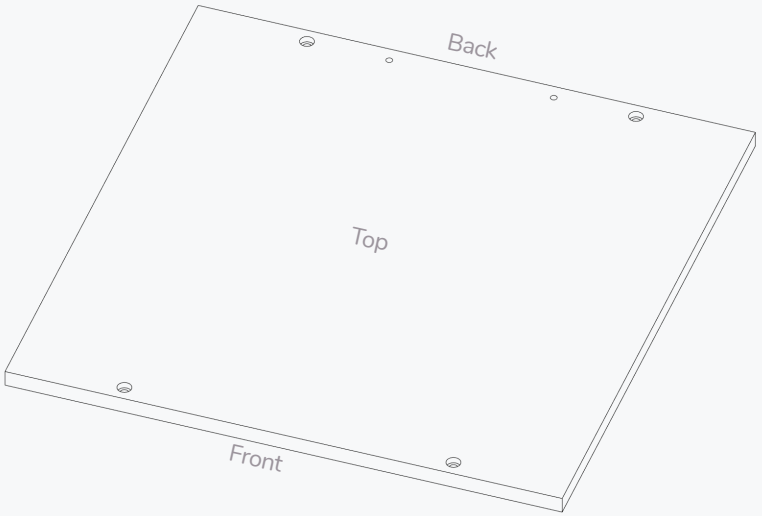
Build another Z idler following the same instructions.

REPEAT INSTRUCTIONS FOR THE MIRRORED DRIVES

Build two more Z idlers following the instructions that came before. The printed parts are mirrored.

The first design released under the name Voron was the “Voron Geared Extruder”. This was on January 28 2015.

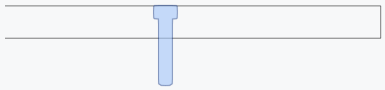




WHICH SIDE IS WHICH?

The top of the plate has mounting holes with bores that allow boltheads to sit flush/below the surface.

The plate has additional tapped holes to secure the Protective Earth (PE) connection and a thermal fuse, those are on the back side of the plate.



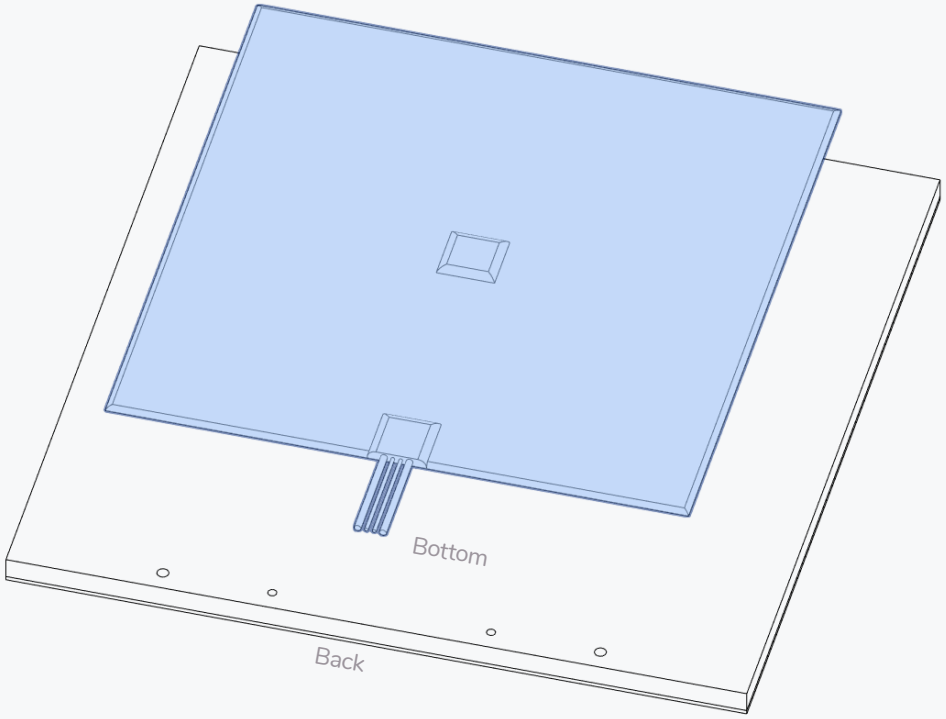
MAGNET APPLICATION

Clean the plate with isopropyl alcohol or similar cleaner prior to applying the magnet.

Use the edge of a plastic object or a small roller to firmly press the magnet on the plate to get a good bond from the adhesive backing.

If you have never done this before we recommend you watch the linked guide.

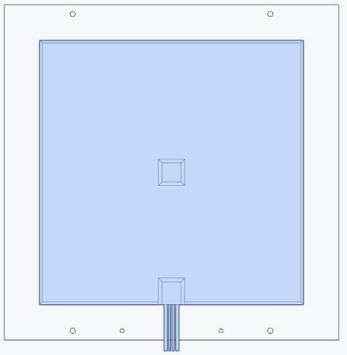
https://voron.link/rm6tpld

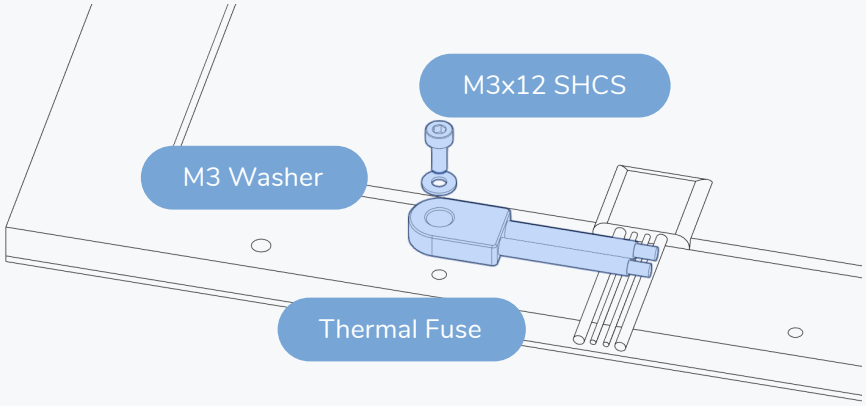


HEATER APPLICATION

The heater is installed in the same fashion as the magnet.

Centre it on the bottom side of the build plate and make sure to firmly press it onto the build plate.



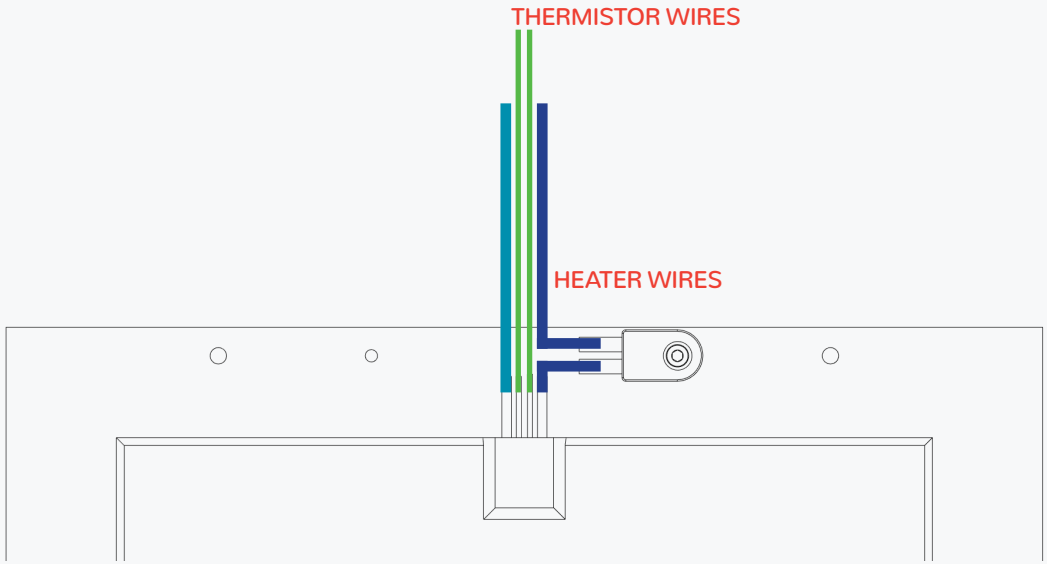


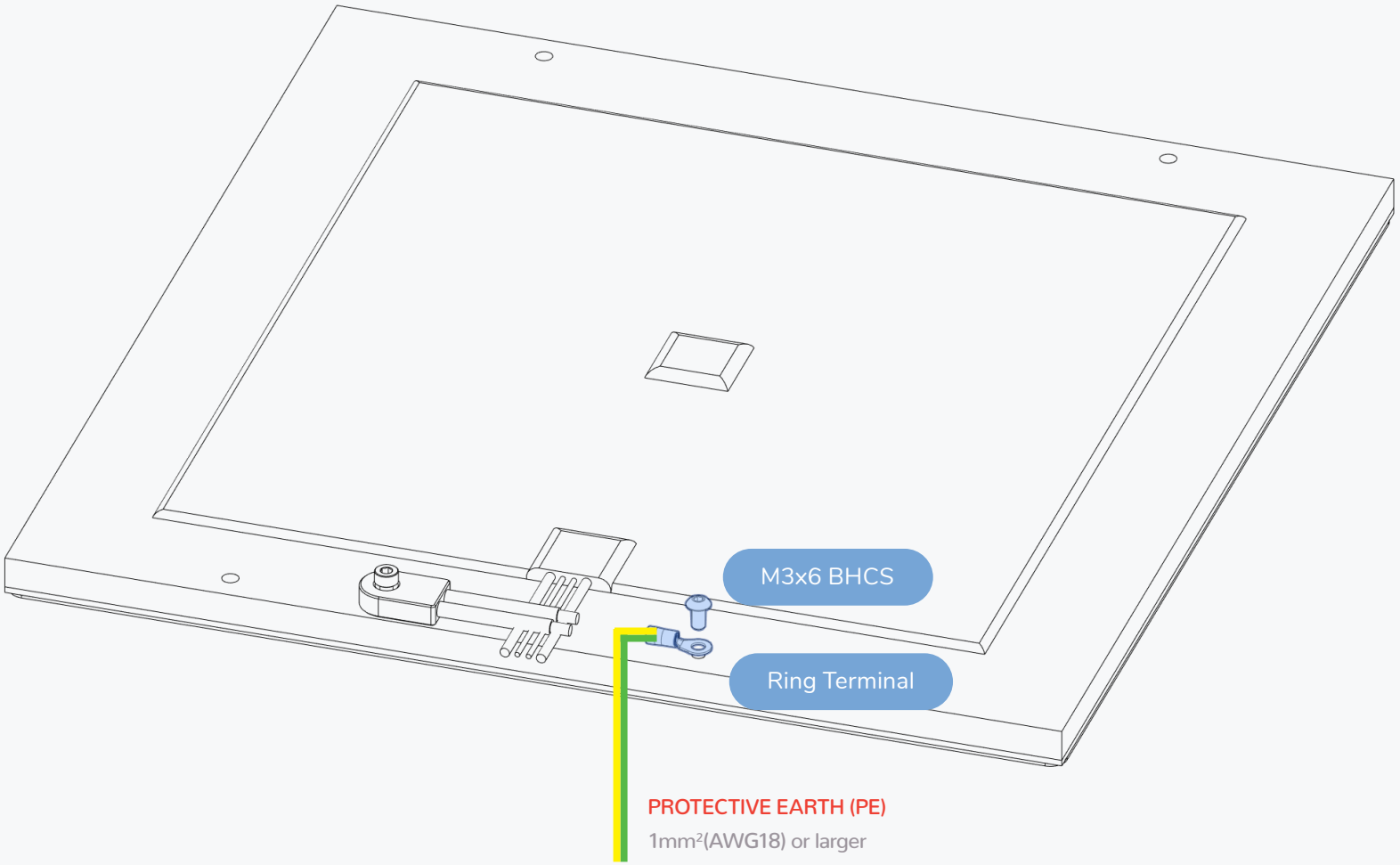
THERMAL FUSE

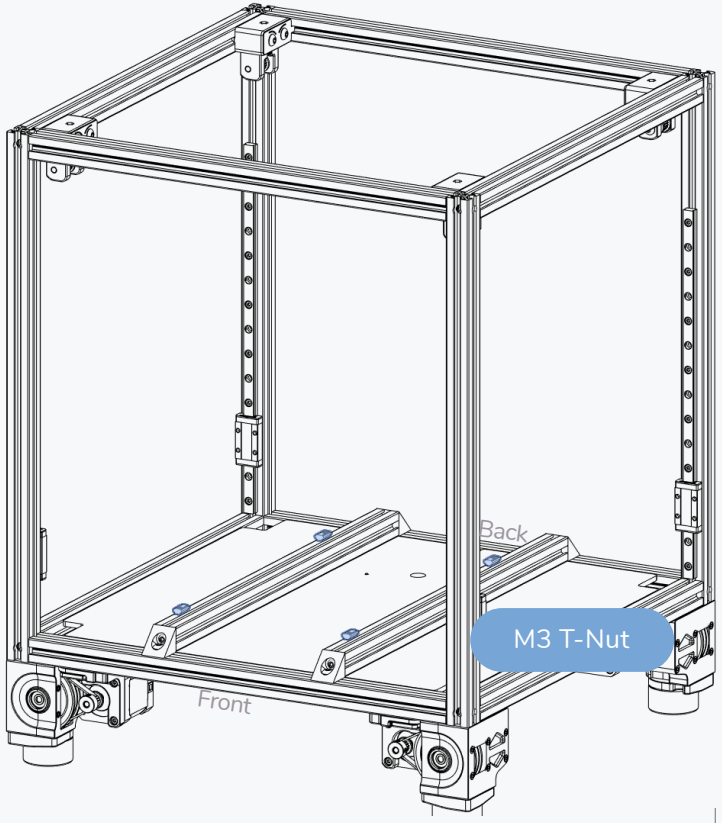
While not required to operate the printer, a thermal fuse attached to the build plate adds an additional layer of protection against potentially dangerous malfunctions.

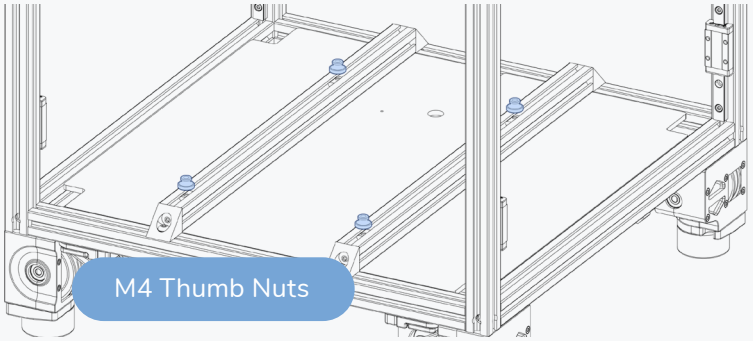
The thermal fuse is wired in-line with the heater wires.

Depending on the tapped holes in the plate you may need to use a shorter bolt.



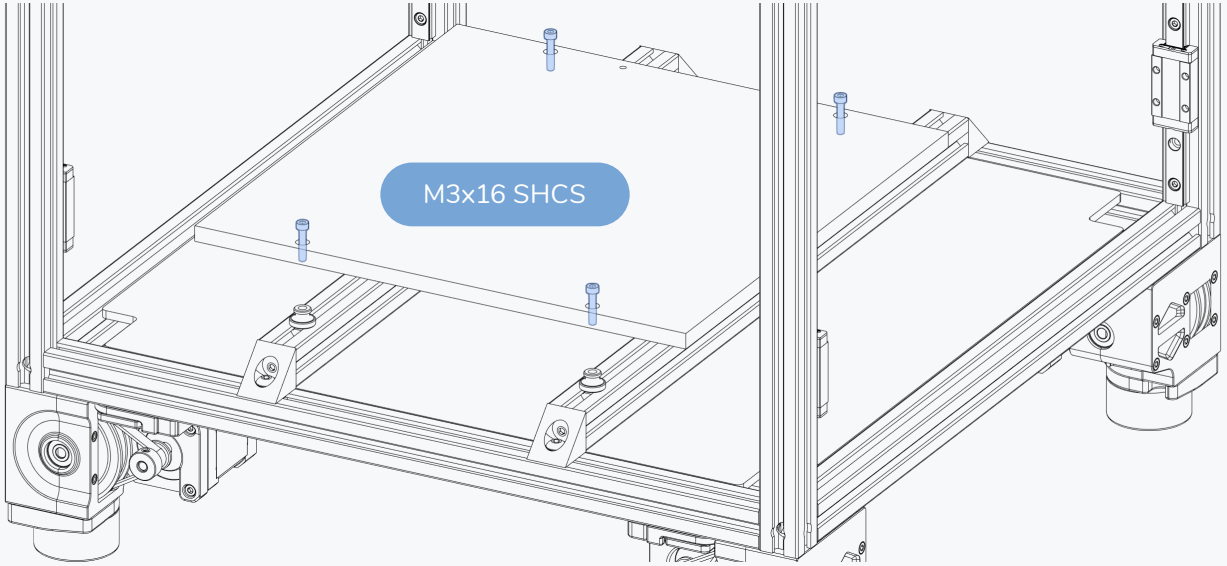

M3x6 BHCS
Ring Terminal
PROTECTIVE EARTH (PE)
1mm²(AWG18) or larger





M4 NUT FOR A M3 BOLT?

We use the thumb nuts as spacers. You can replace them with different heat resistant spacers of the same length.

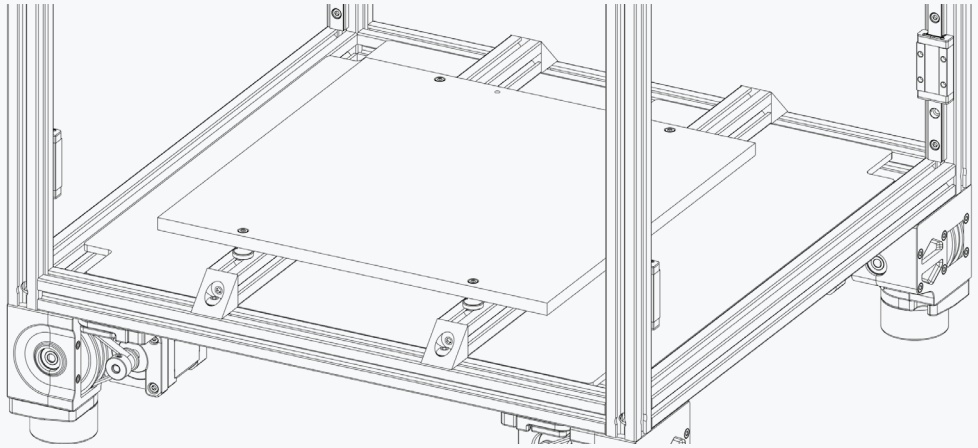


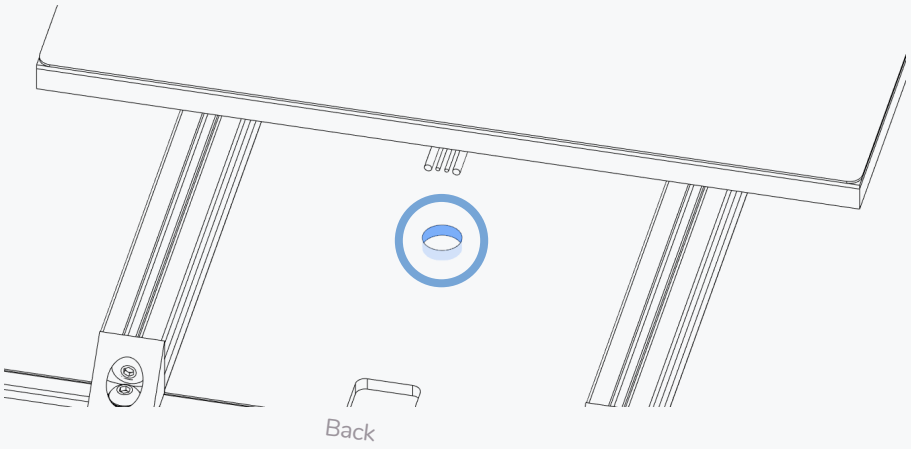
BED AND SPACER THICKNESS

Depending on the combination of bed and spacer thickness you may need to use longer bolts to secure the bed.

DON'T TIGHTEN

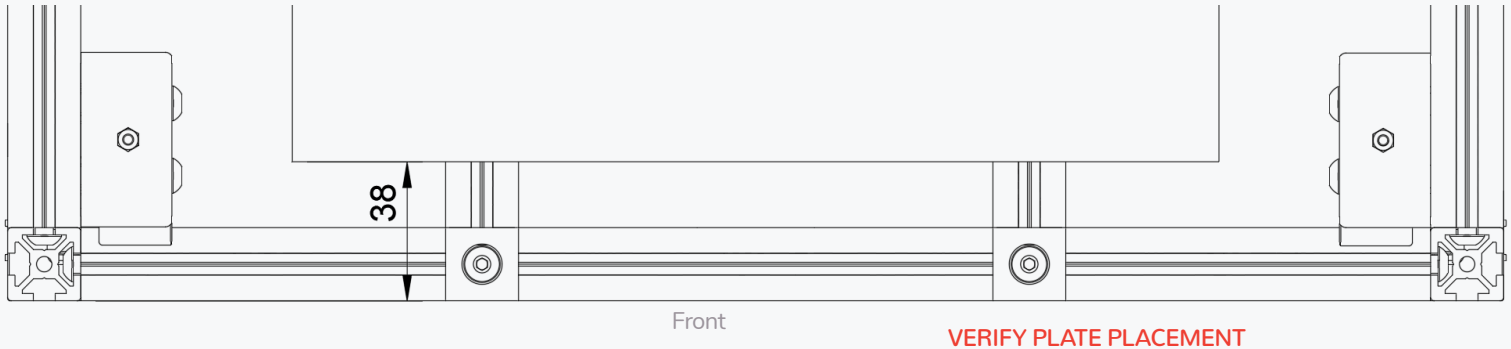
Only tighten one bolt fully.
Leave the remaining bolts slightly loose.
This will allow for thermal expansion without putting additional stress on the plate.





WIRE PASSTHROUGH

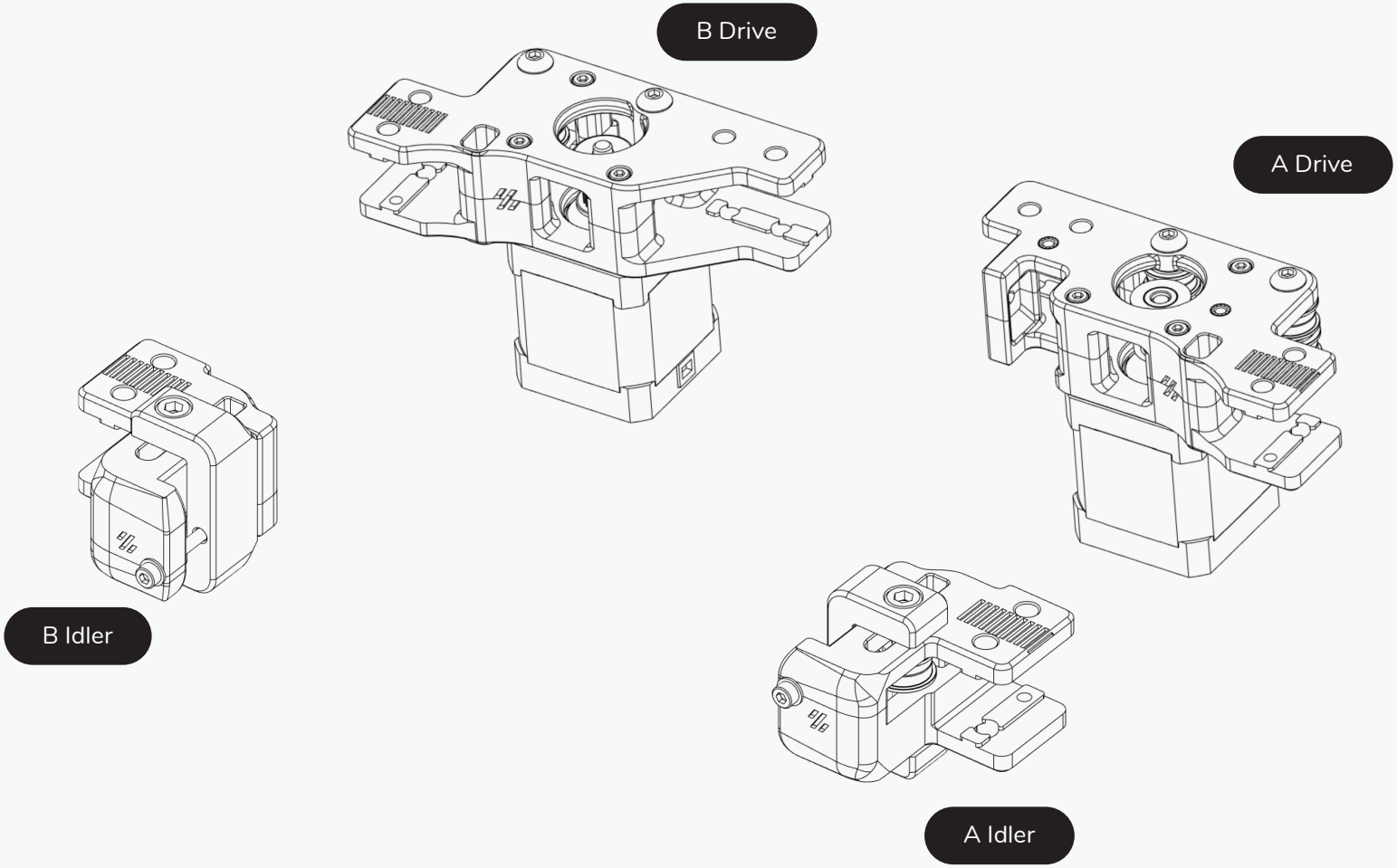
Feed the bed related wires through the opening in the deck plate.

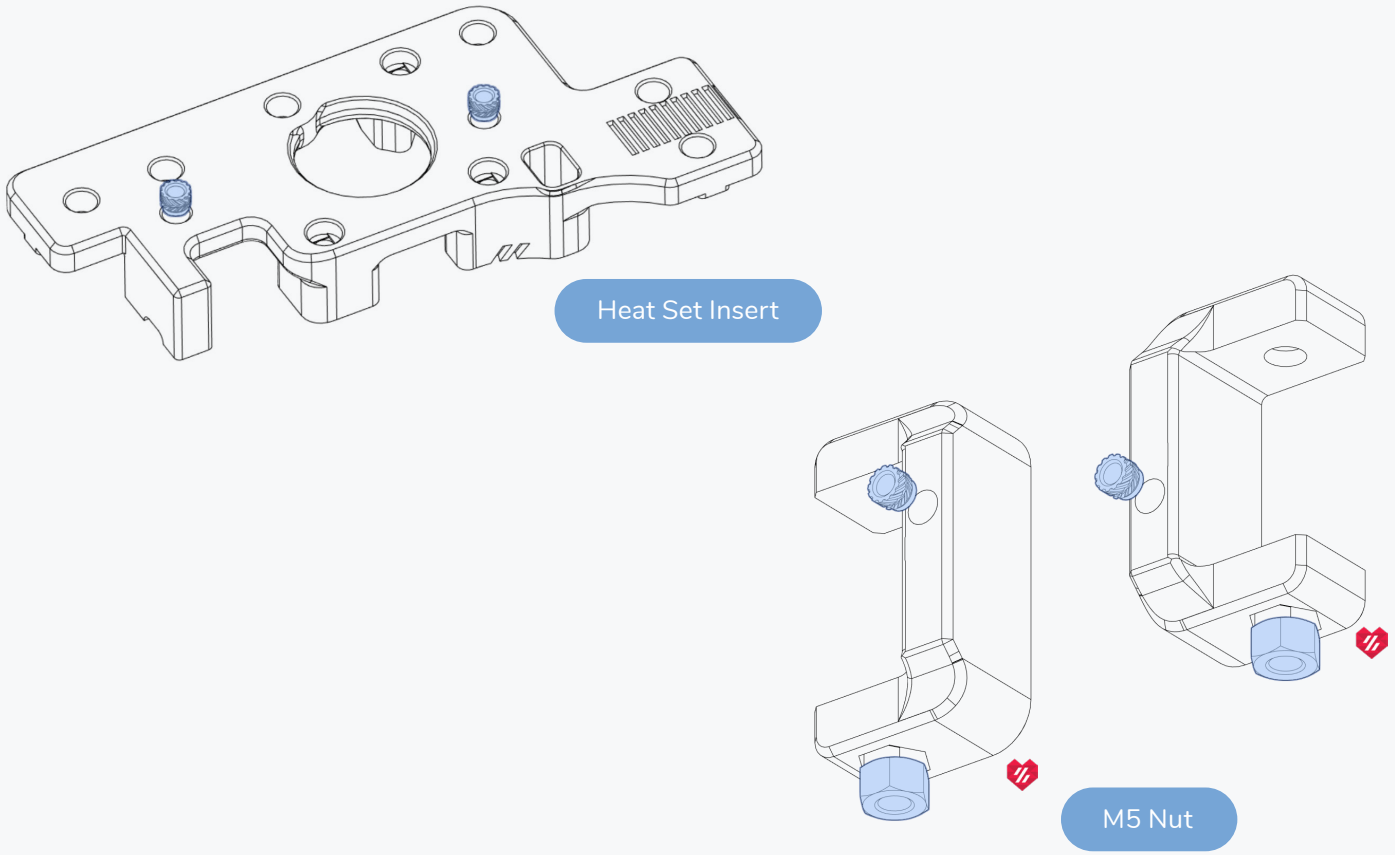


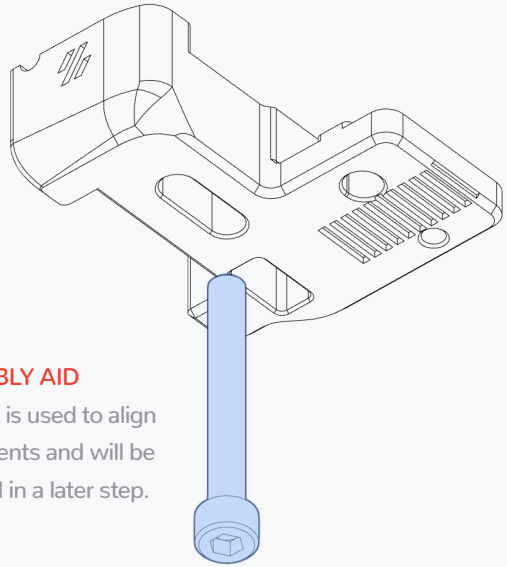
VERIFY PLATE PLACEMENT

The front edge of the print plate should sit 38mm behind the front edge of the frame.

The Voron Legacy is a modernized design true to the spirit of the original Voron 1.0.


B Drive
A Drive
B Idler
A Idler


Heat Set Insert
M5 Nut



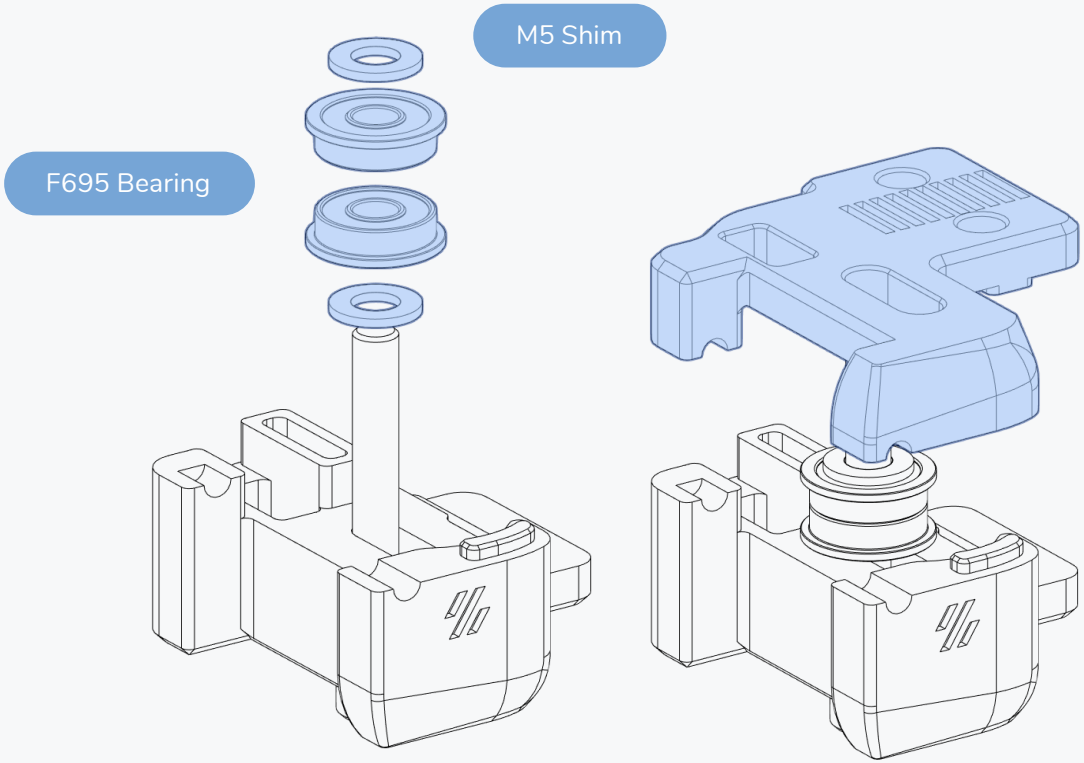
ASSEMBLY AID

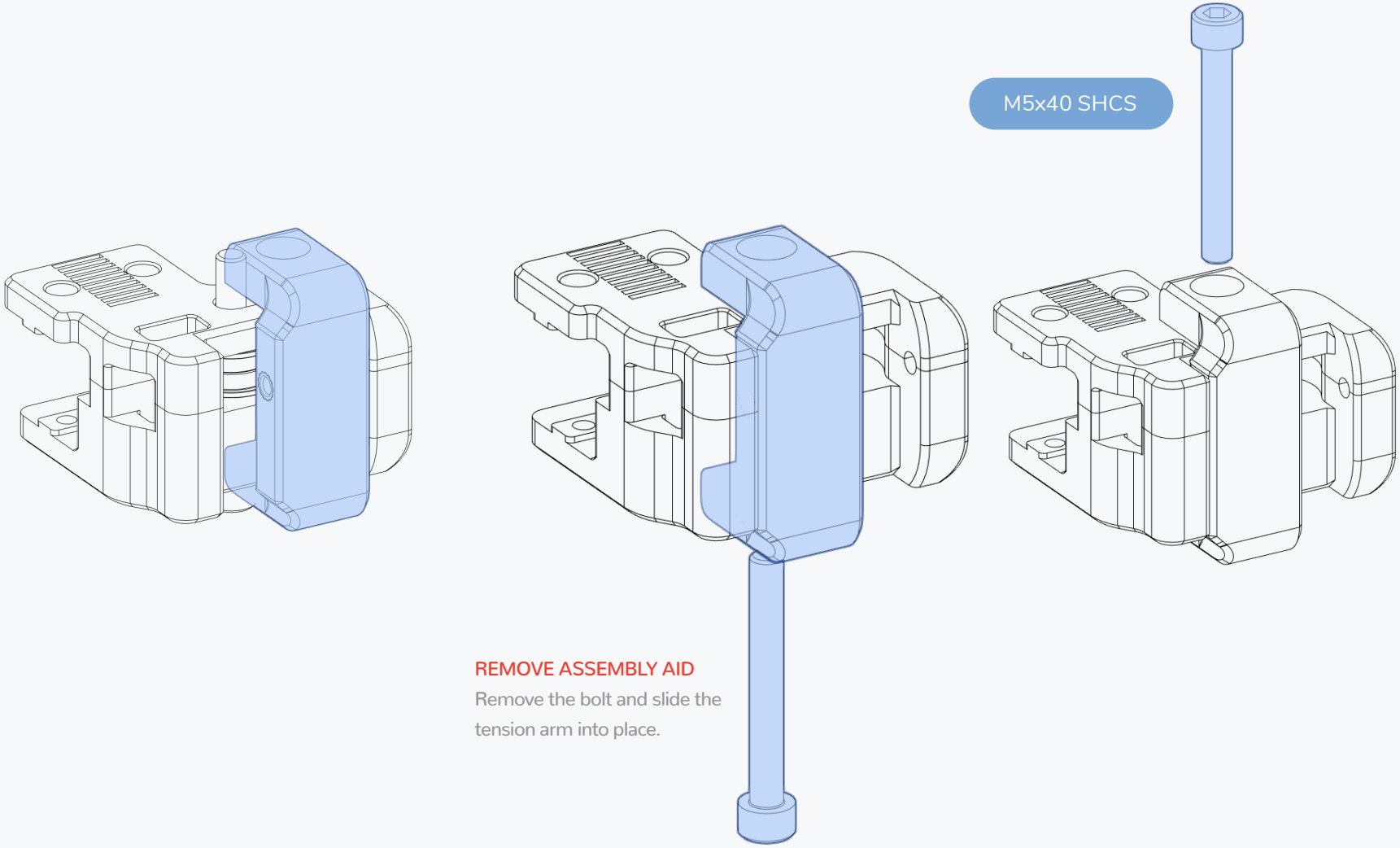
This bolt is used to align components and will be removed in a later step.

M5x40 SHCS

M5 Shim

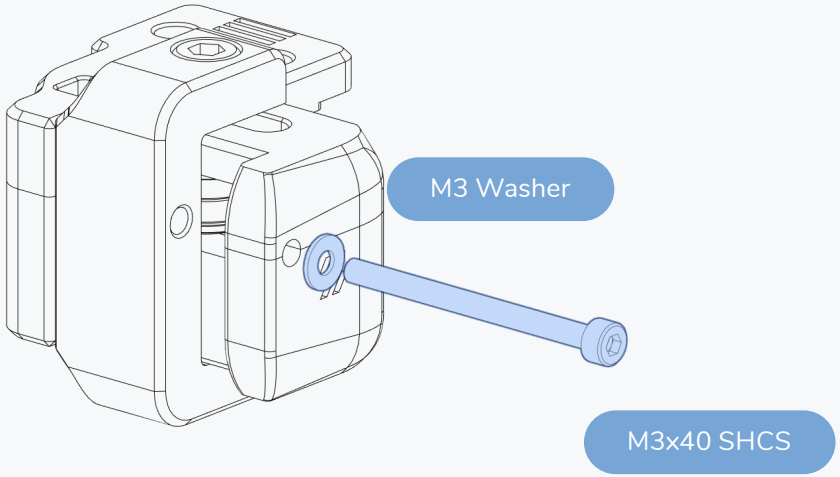
F695 Bearing

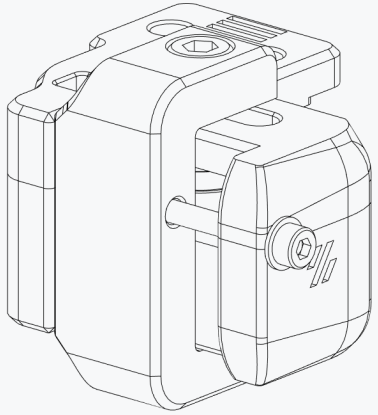




REMOVE ASSEMBLY AID

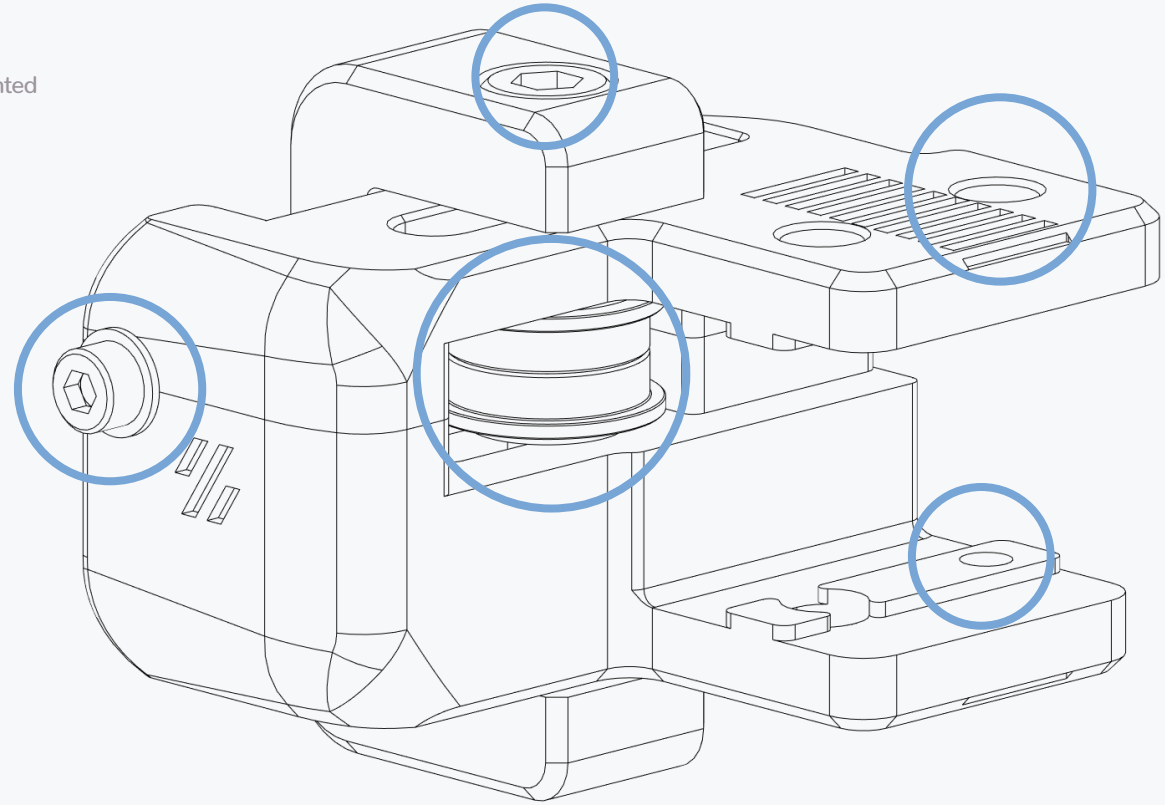
Remove the bolt and slide the tension arm into place.

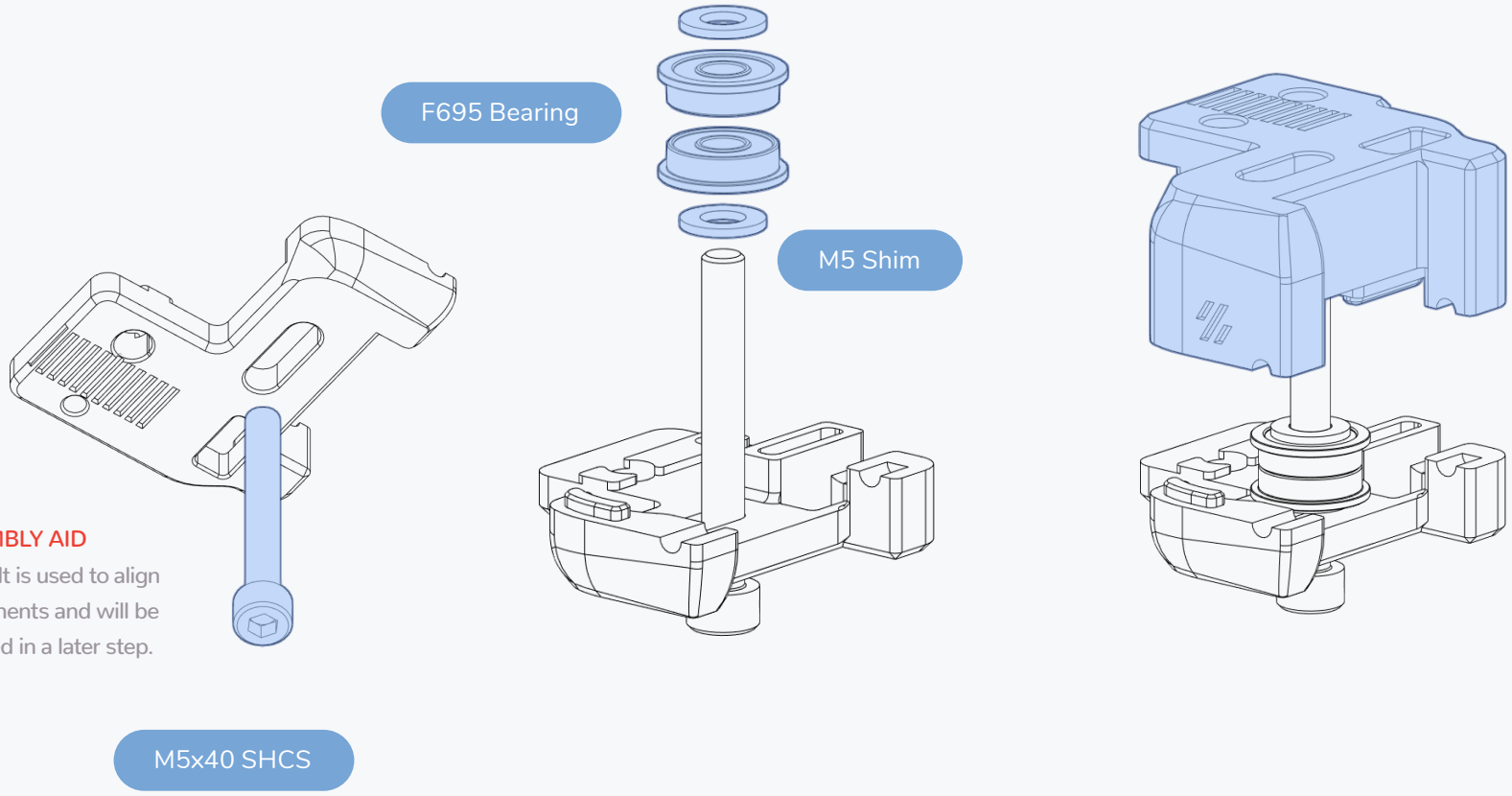

M3 Washer
M3x40 SHCS



CHECK YOUR WORK

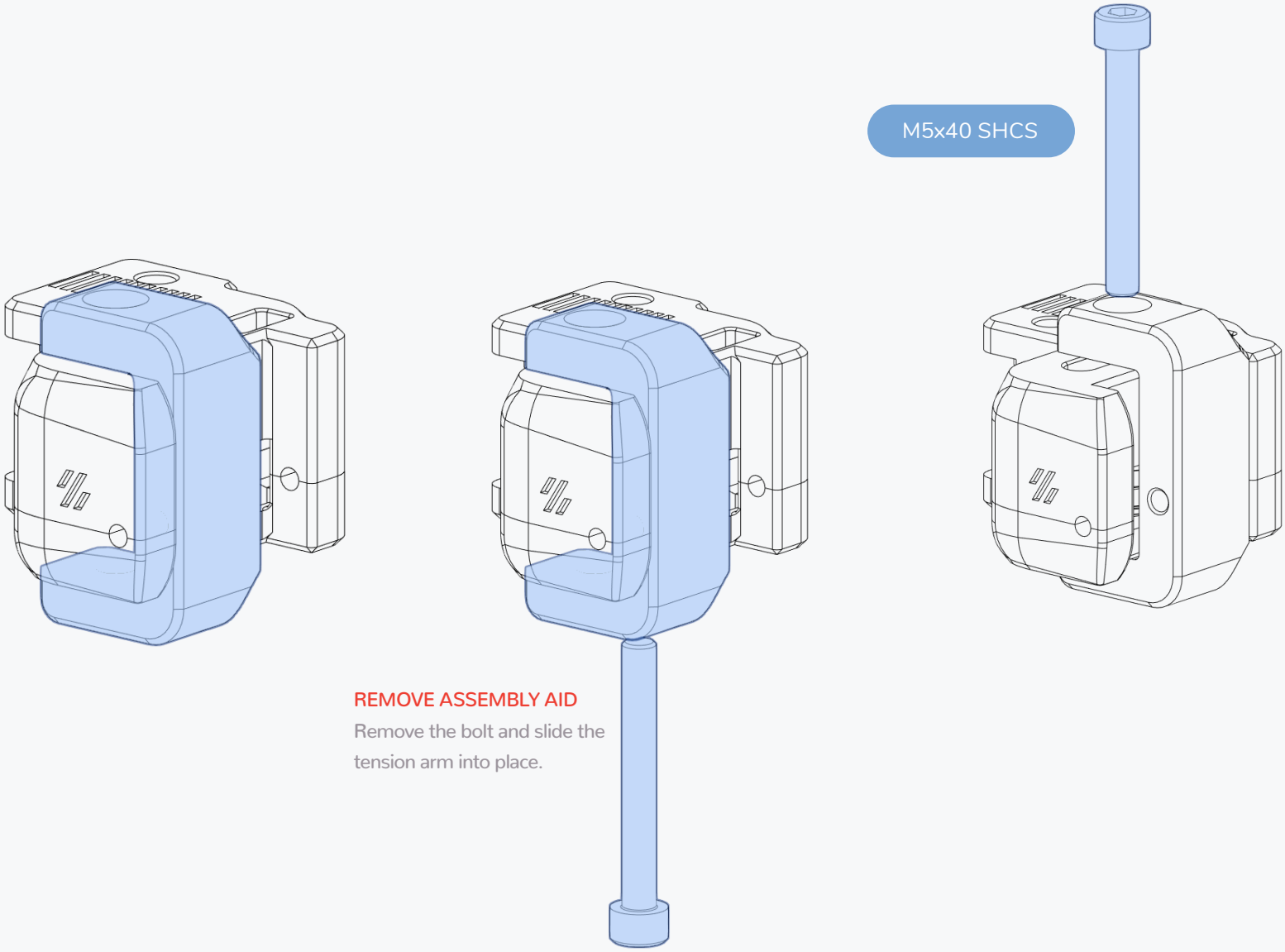
Compare your assembled parts to the graphics shown here. Pay attention to the features highlighted by the circles.





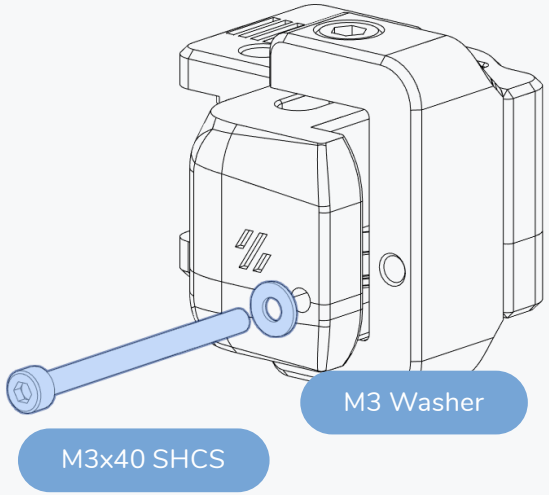
ASSEMBLY AID

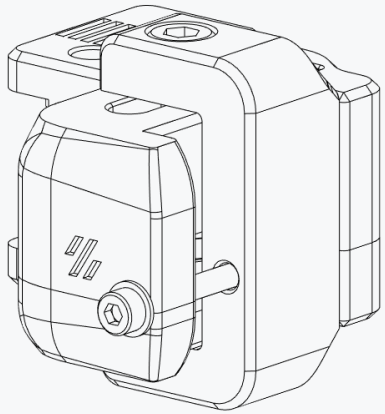
This bolt is used to align components and will be removed in a later step.

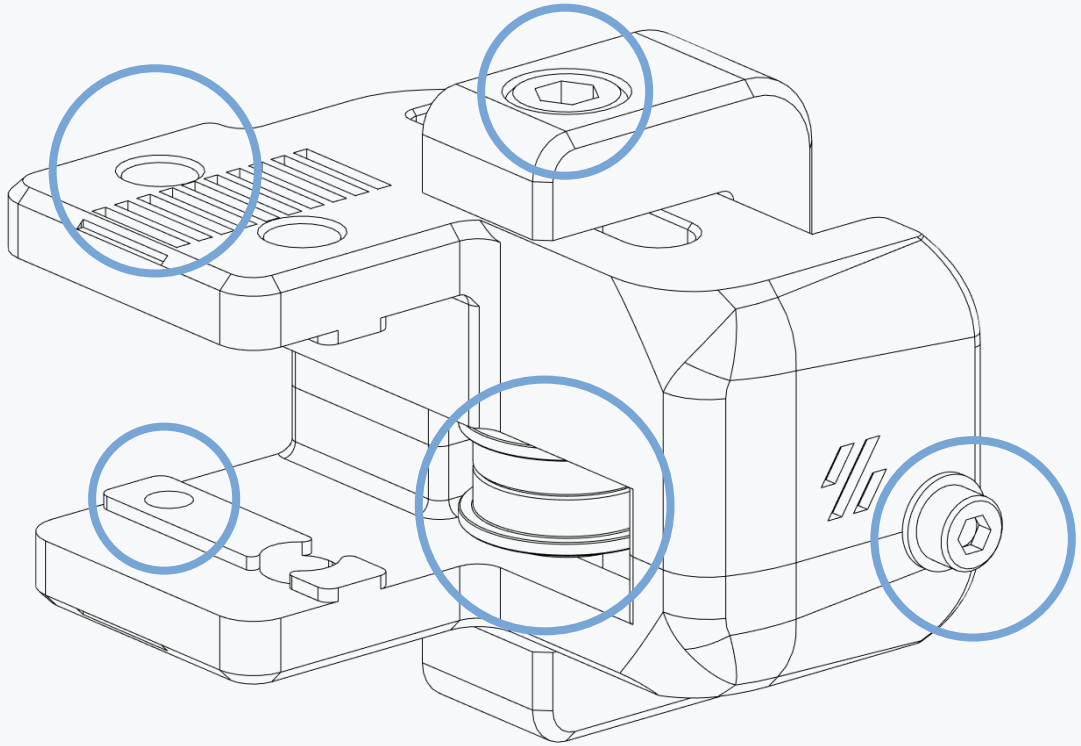


REMOVE ASSEMBLY AID

Remove the bolt and slide the tension arm into place.


M3 Washer
M3x40 SHCS





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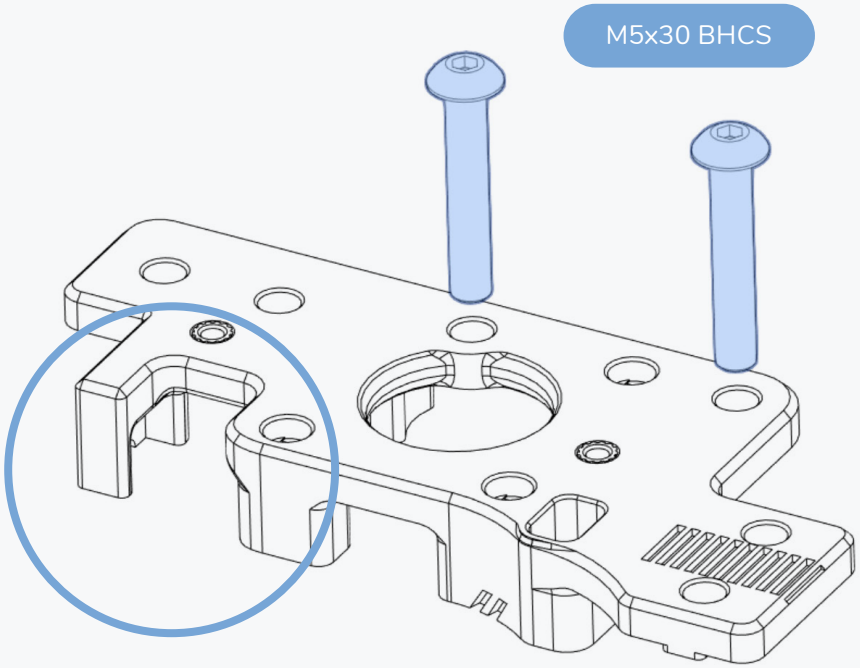
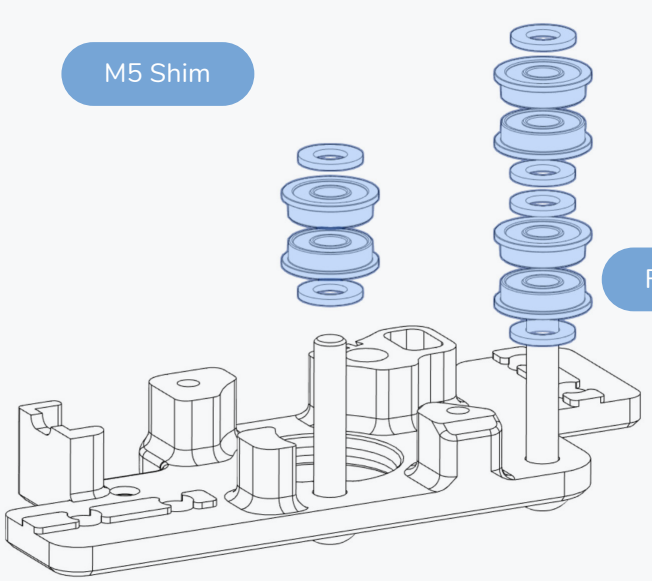
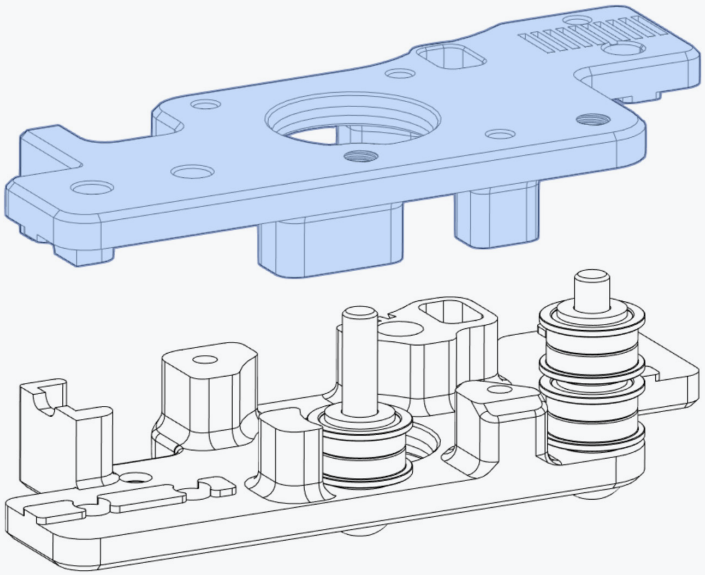


CUTOUT

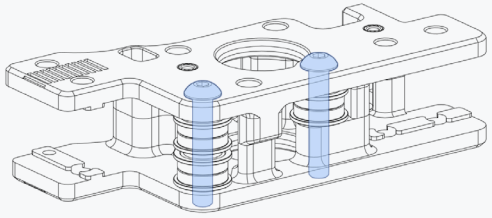
The printed parts for the A drive have a cutout.





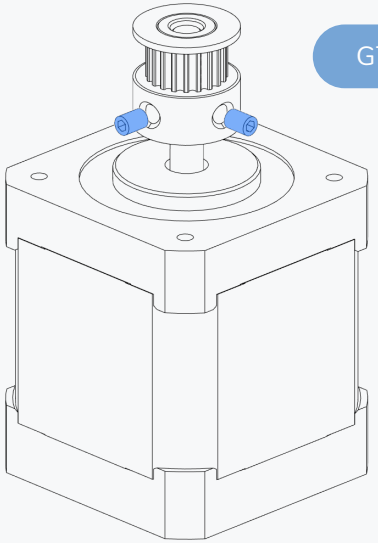
UPSIDE DOWN ASSEMBLY

For ease of assembly we recommend to assemble the A and B drives upside down.



DON'T OVER TIGHTEN

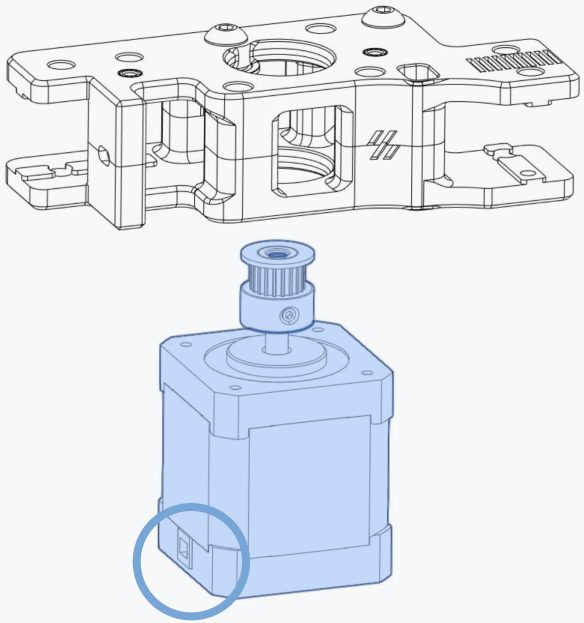
The M5 bolts are threaded directly into plastic.

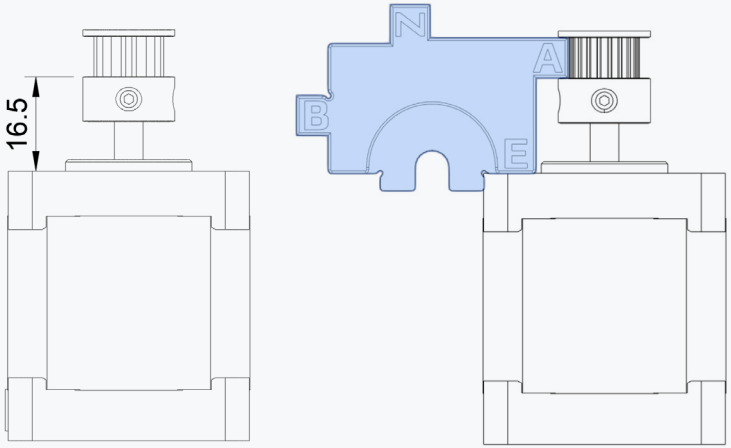


GT2 20 Tooth Pulley

APPLY THREAD LOCKER

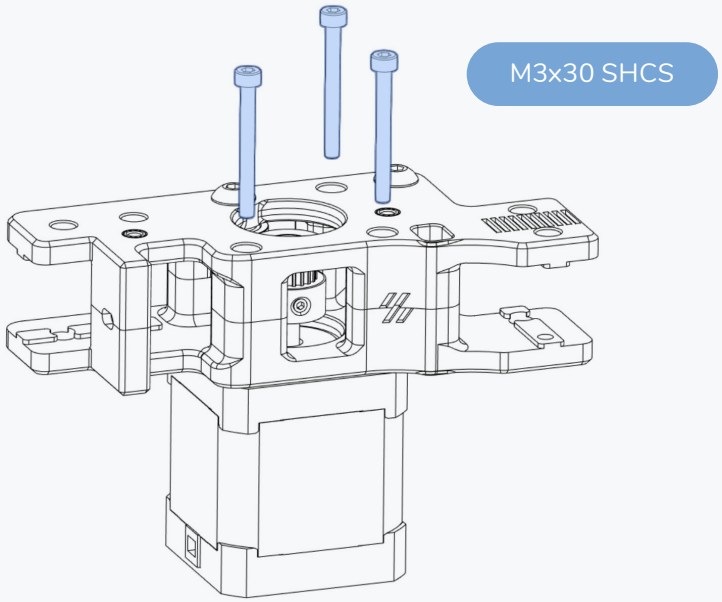
Make sure to use thread locker on the set screws.

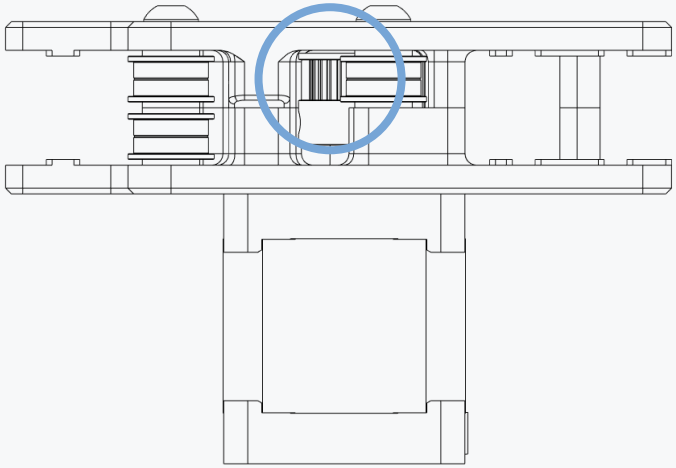




MOTOR ORIENTATION

Pay attention to the orientation of the cable exit. The wires from the motors will be pointing towards each other once fully assembled.

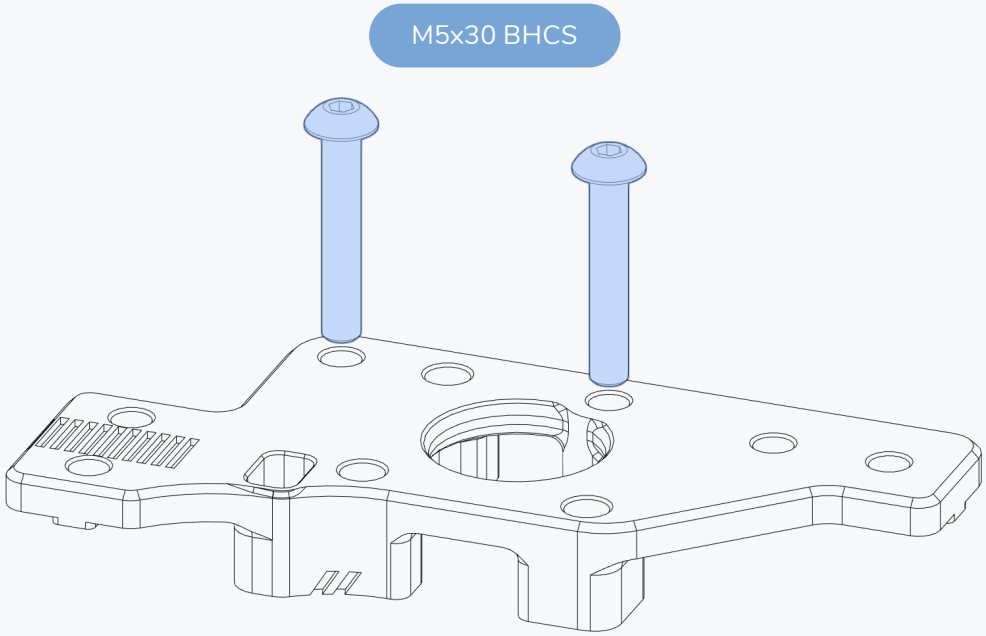


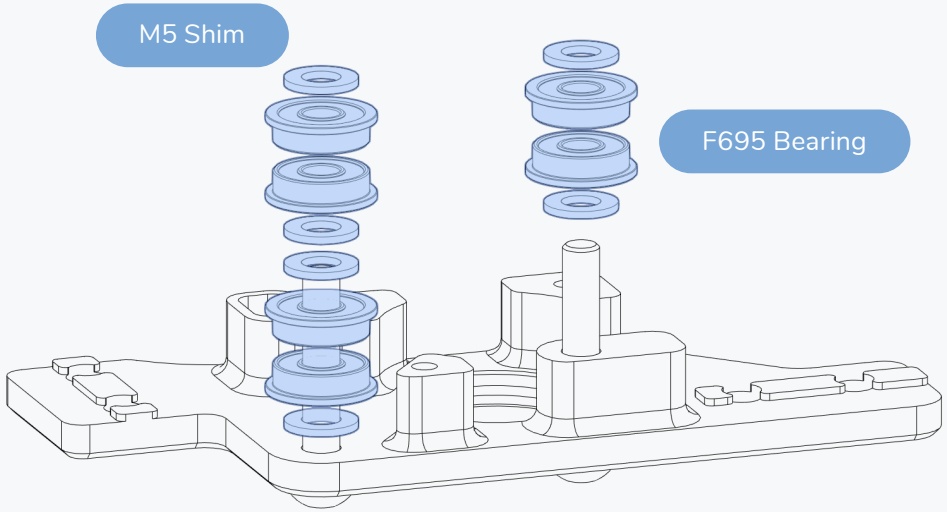


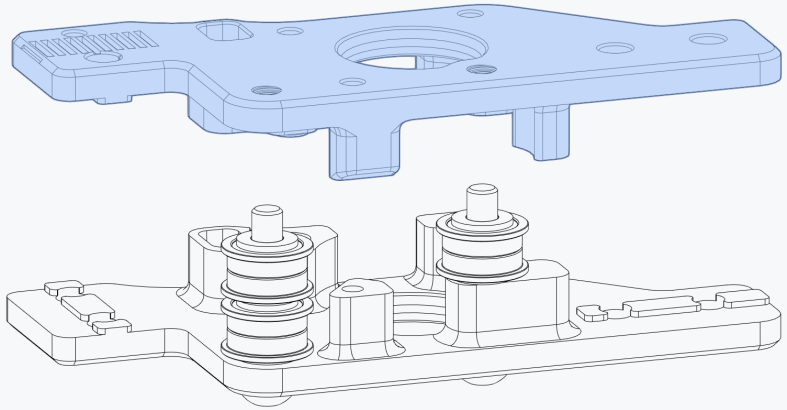
CHECK YOUR WORK

Compare your assembled part to the graphic shown here.

Pay attention to the pulley orientation and alignment with the bearing stack ups.


M5x30 BHCS





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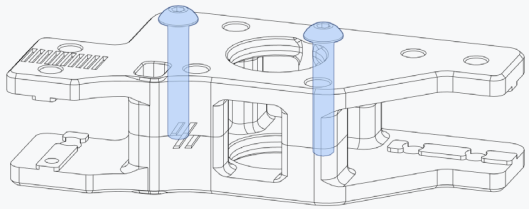
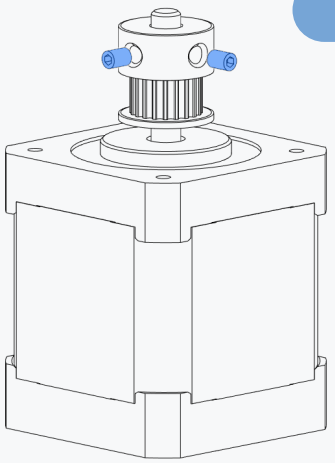
DON'T OVER TIGHTEN

The M5 bolts are threaded directly into plastic.

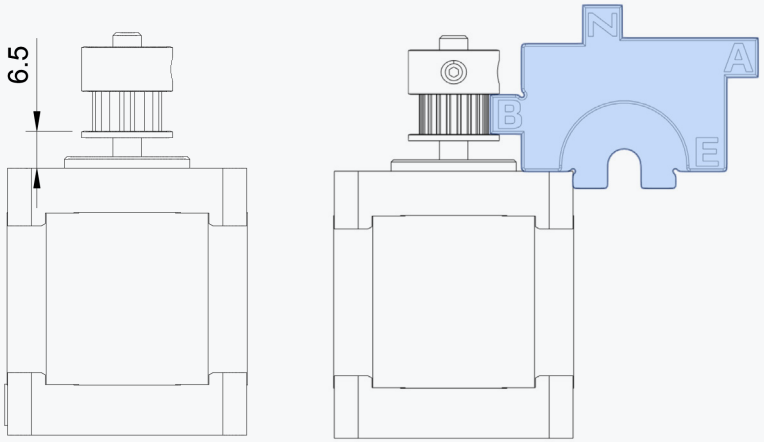


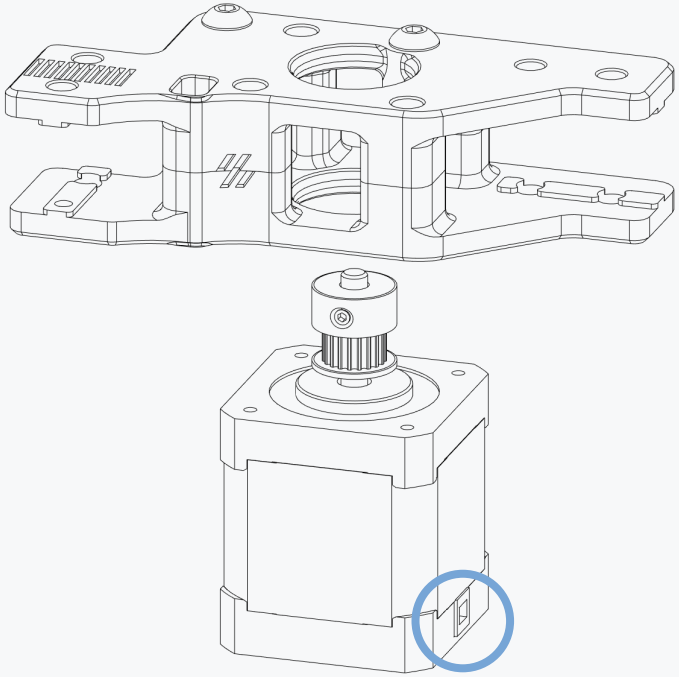
GT2 20 Tooth Pulley



APPLY THREAD LOCKER

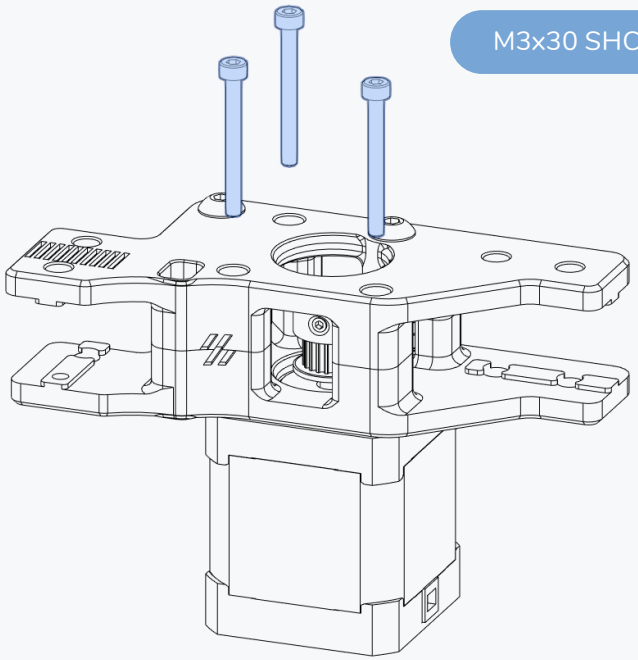
Make sure to use thread locker on the set screws.

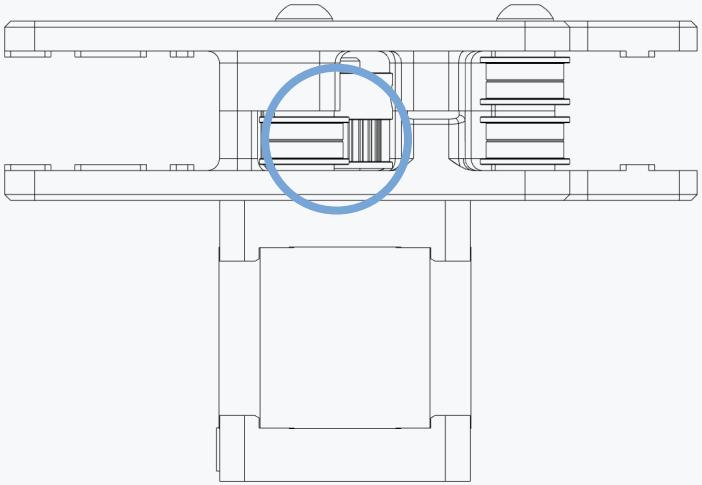




MOTOR ORIENTATION

Pay attention to the orientation of the cable exit.



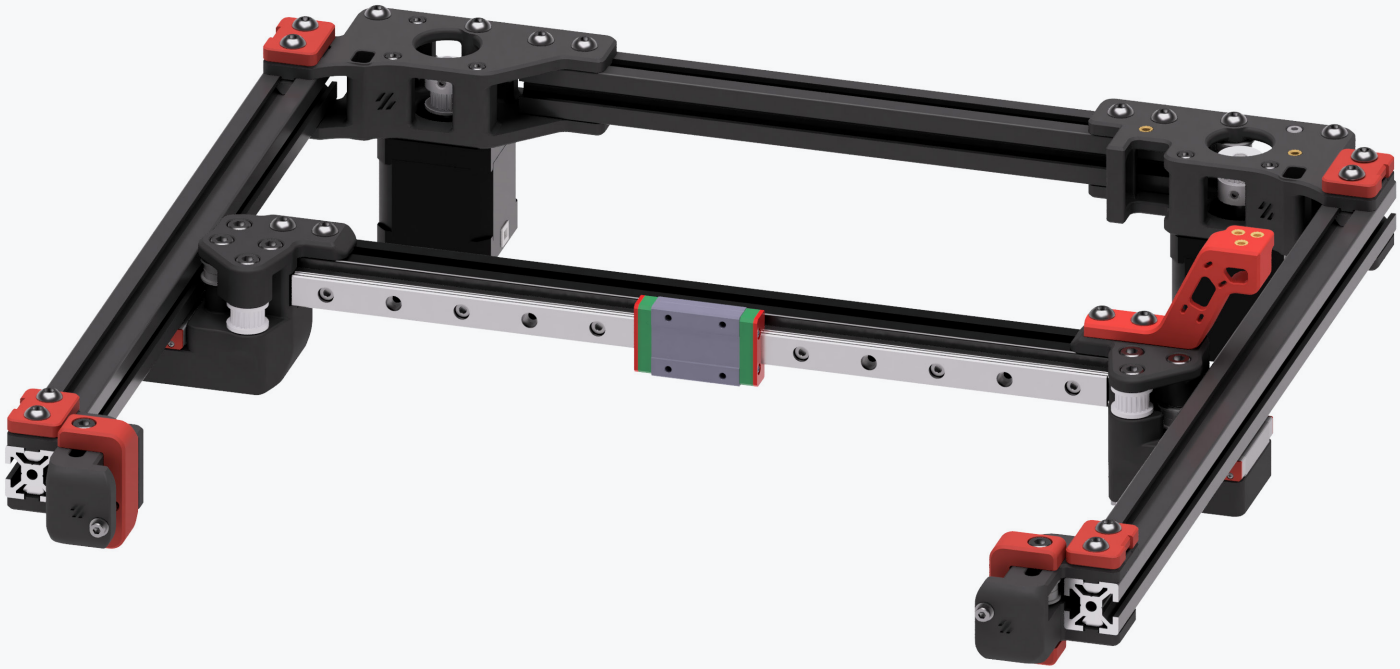


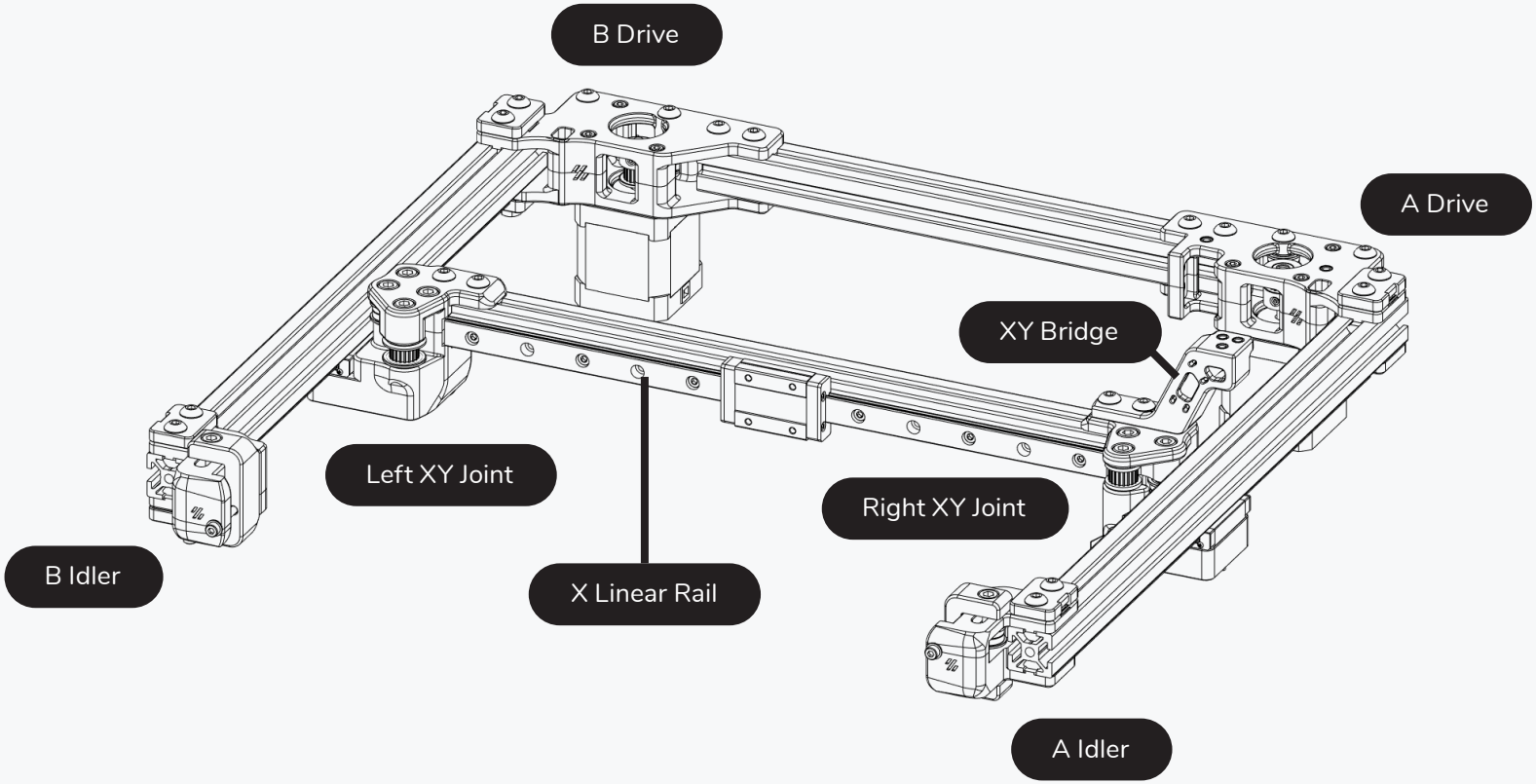
CHECK YOUR WORK

Compare your assembled part to the graphic shown here.

Pay attention to the pulley orientation and alignment with the bearing stacks.

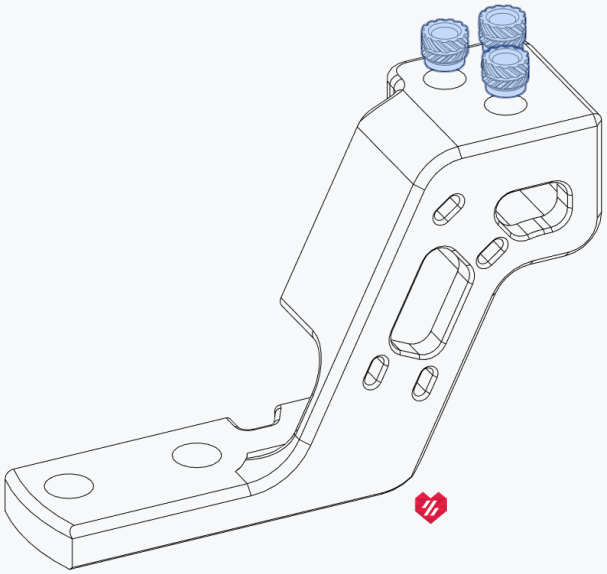
V24 (not V2.4) was an experimental design, only 2 have ever been built. It's design became the basis for the Voron2.




B Drive
A Drive
XY Bridge
Left XY Joint
Right XY Joint
B Idler
X Linear Rail
A Idler

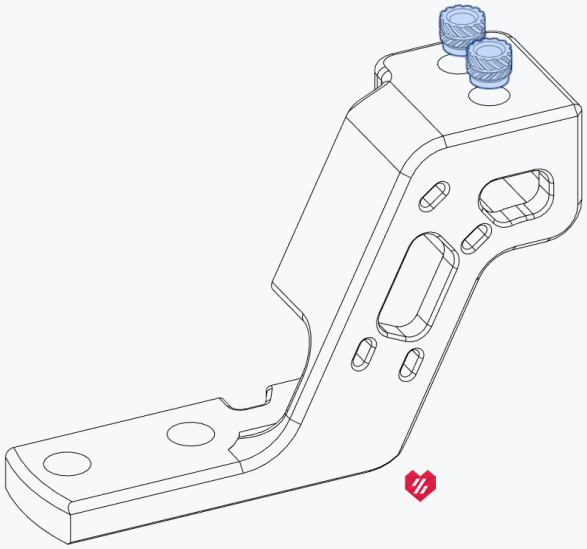
GENERIC CABLE CHAINS

The 3 hole pattern is usually found on generic cable chains.



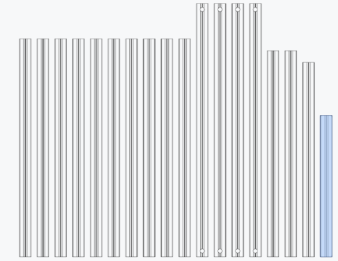
IGUS CABLE CHAINS

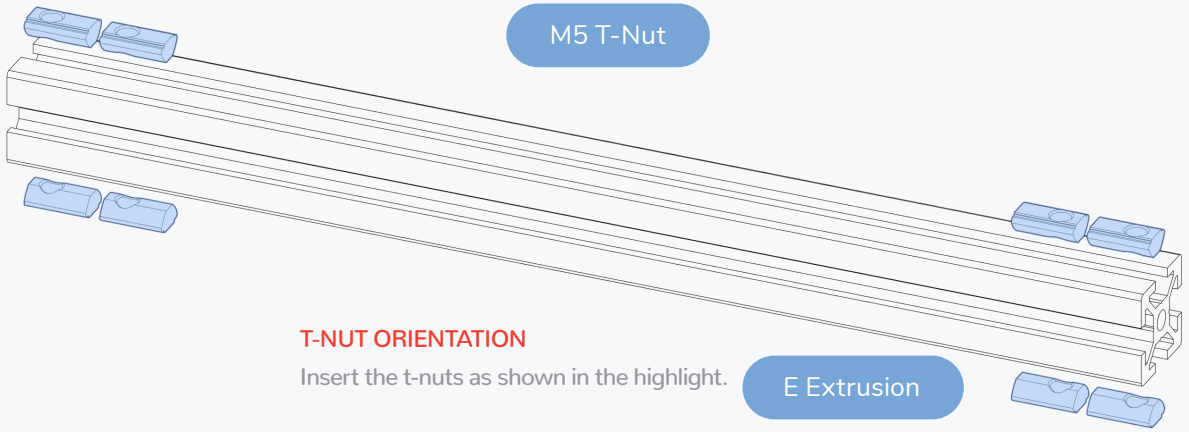
IGUS chains have 2 mounting holes.



WHICH TO CHOOSE?

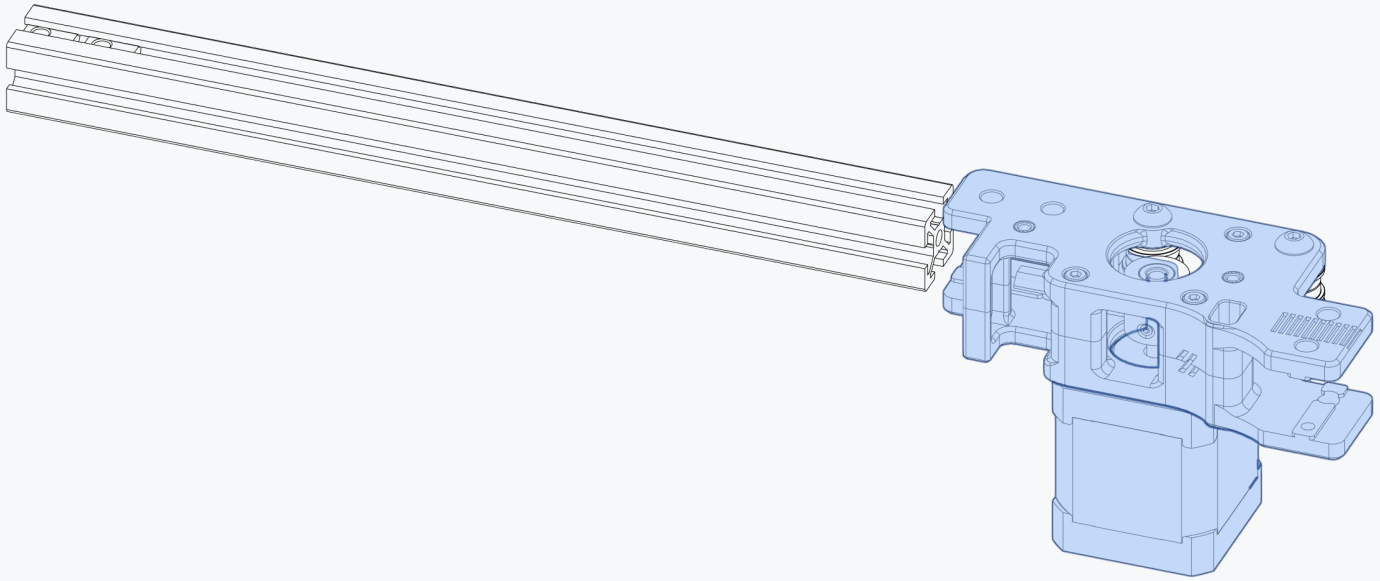
Pick the style that matches the mounting pattern of your cable chains.

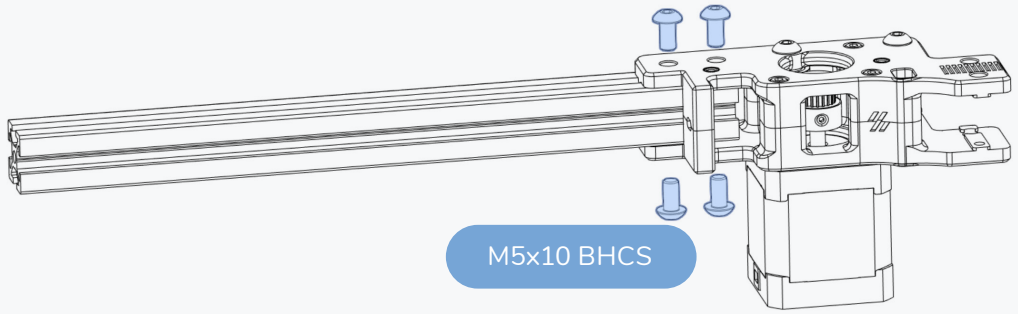


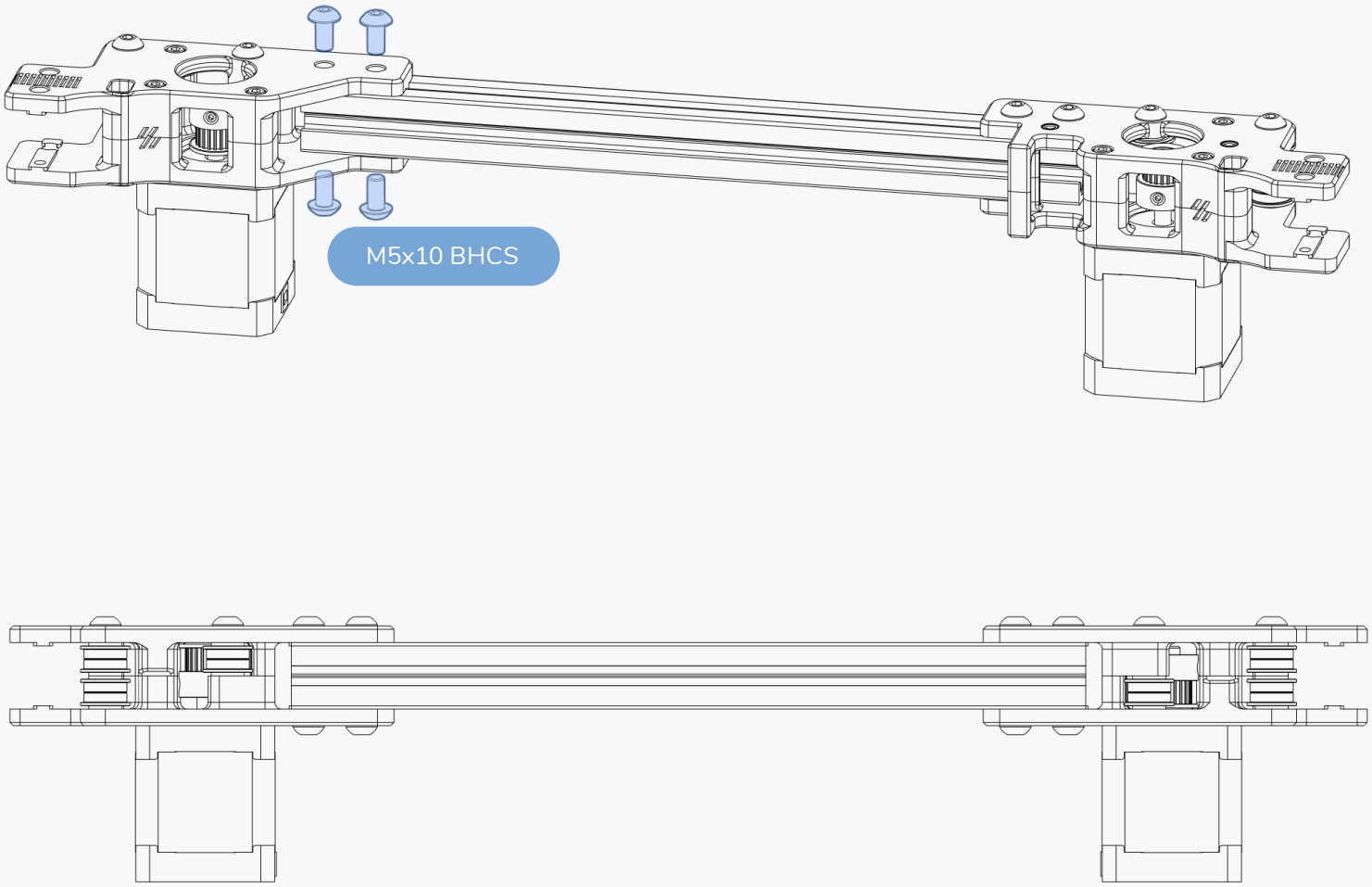


T-NUT ORIENTATION

Insert the t-nuts as shown in the highlight.

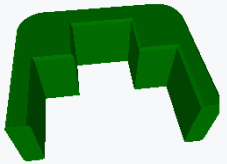



M5x10 BHCS


M5x10 BHCS

CENTRED RAIL INSTALLATION GUIDE

Use the MGN9 guides to position the rail in the centre of the extrusion prior to fastening the screws.

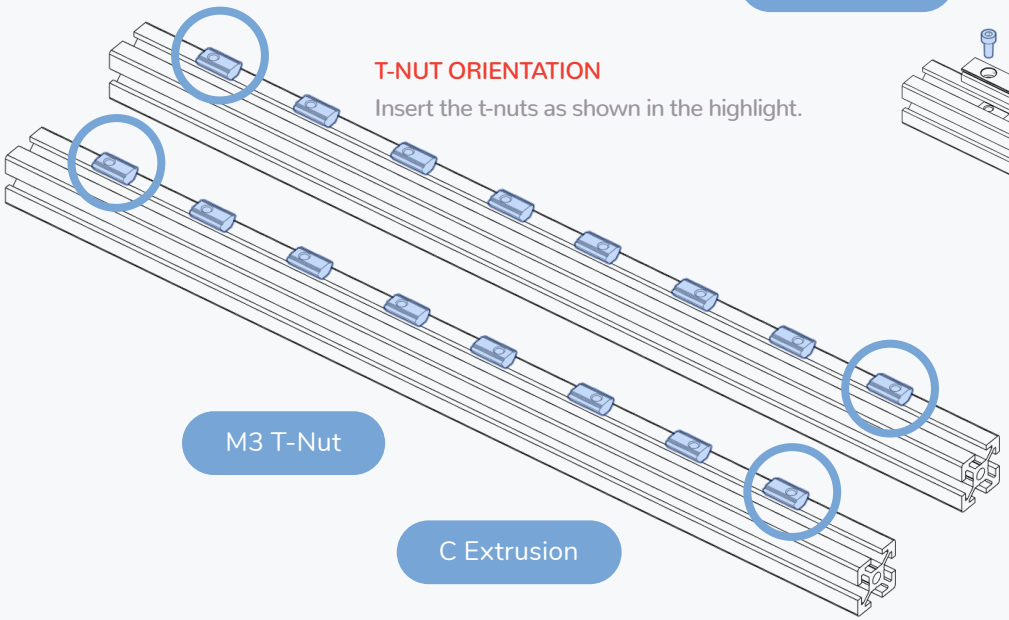


MGN9 Rail

M3x8 SHCS

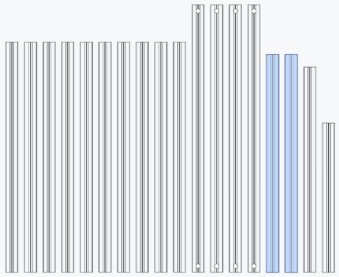
T-NUT ORIENTATION

Insert the t-nuts as shown in the highlight.



M3 T-Nut

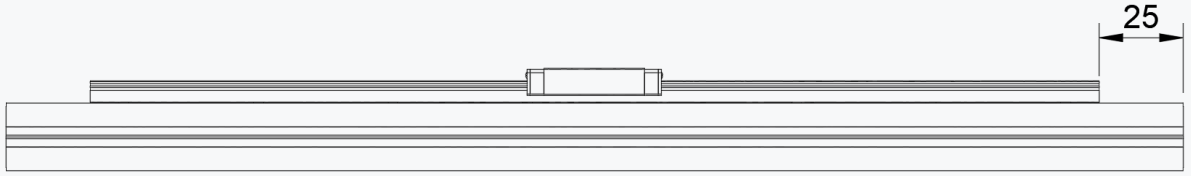
C Extrusion

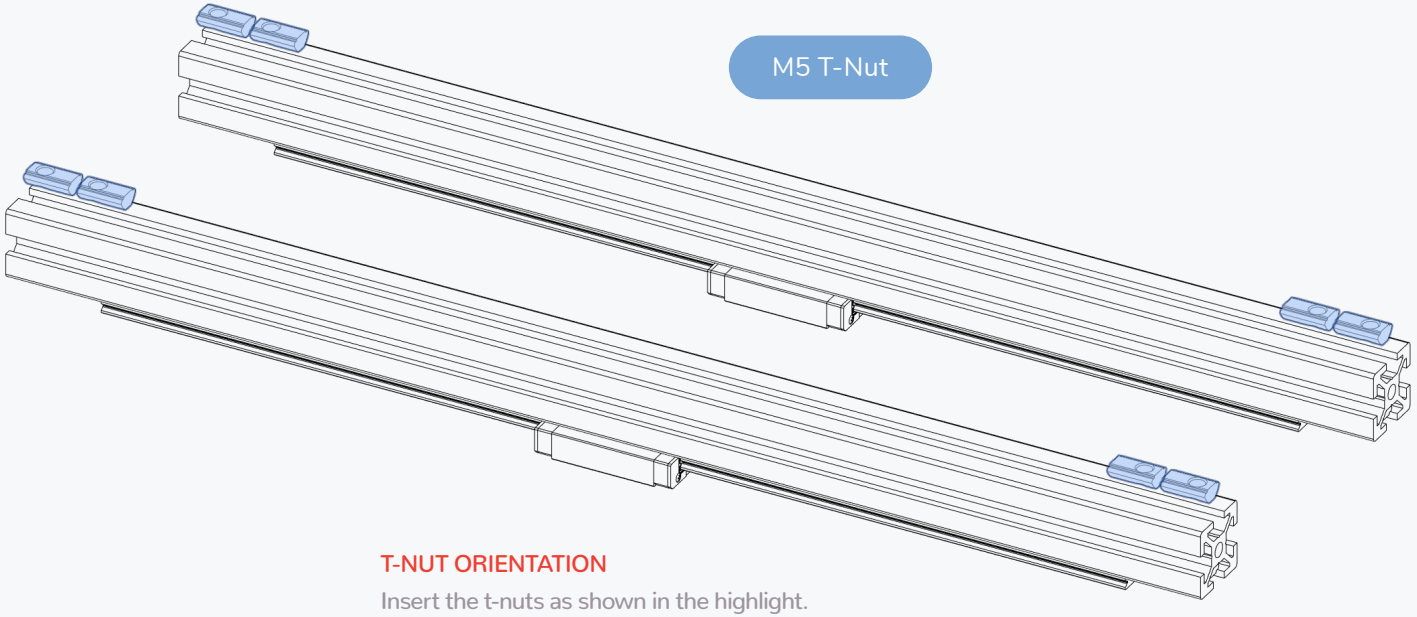


MIND THE CARRIAGE

The carriages are designed to slide along the rail easily. This unfortunately also includes sliding off the rails.

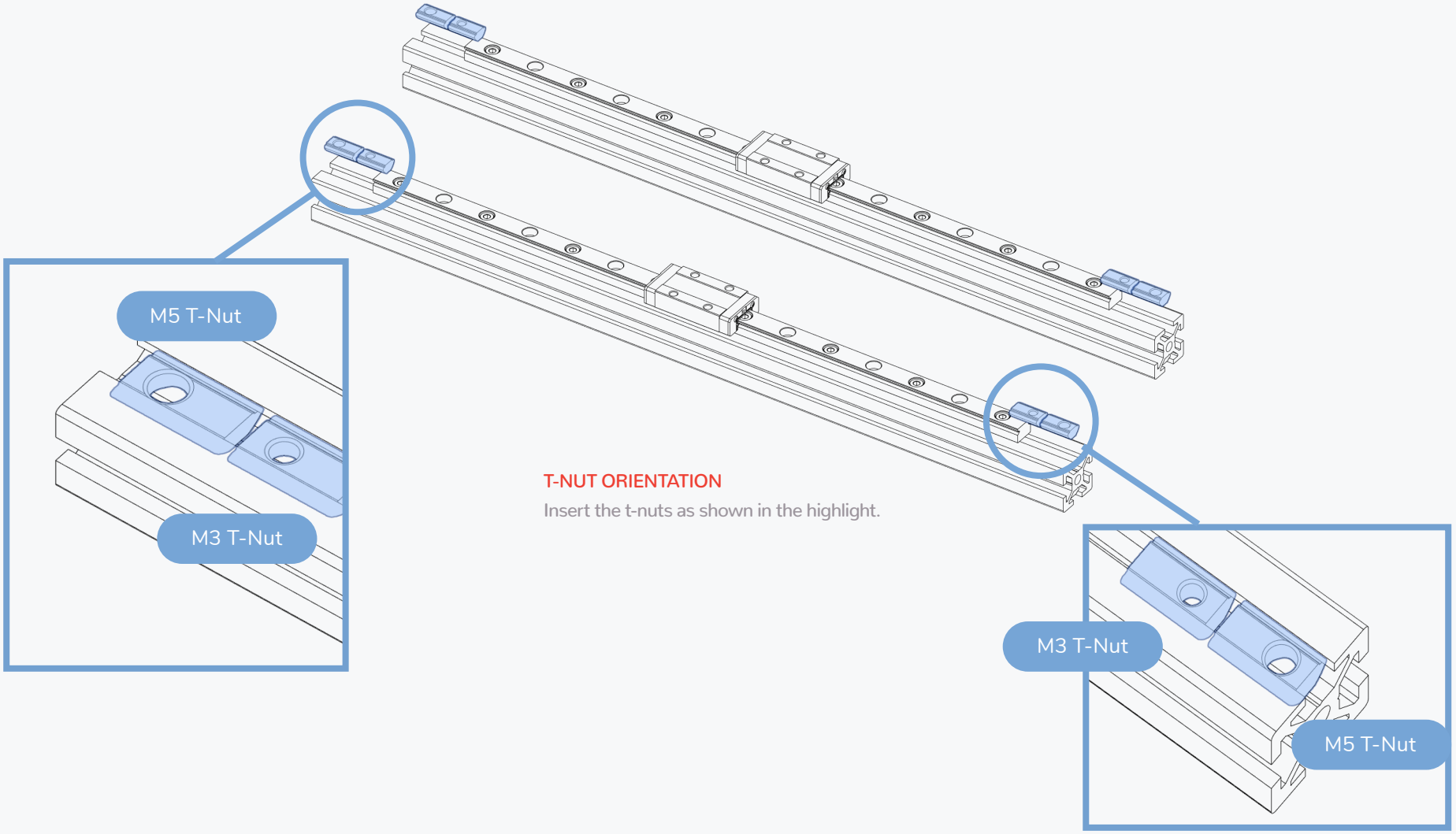
Dropping the carriage likely irreparably damages it.





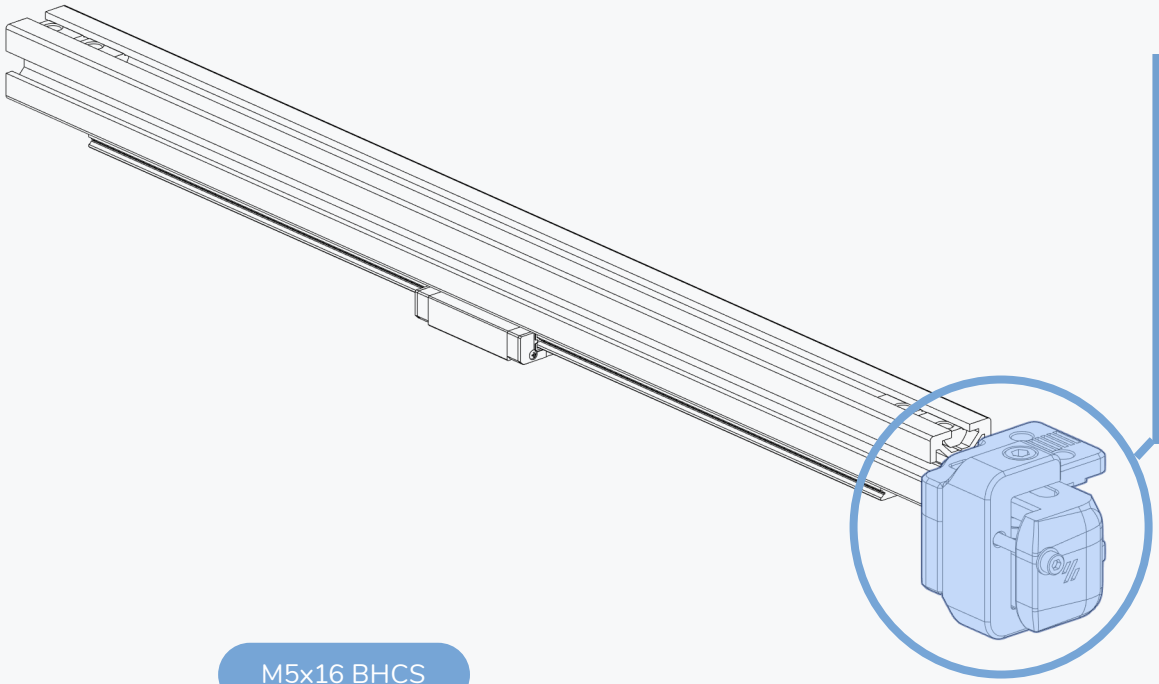
T-NUT ORIENTATION

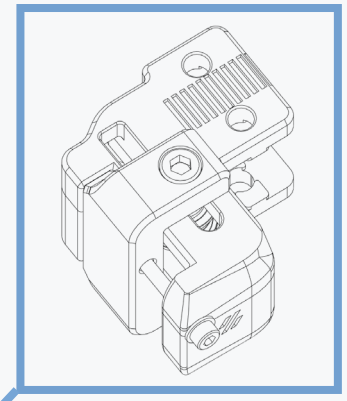
Insert the t-nuts as shown in the highlight.



T-NUT ORIENTATION

Insert the t-nuts as shown in the highlight.

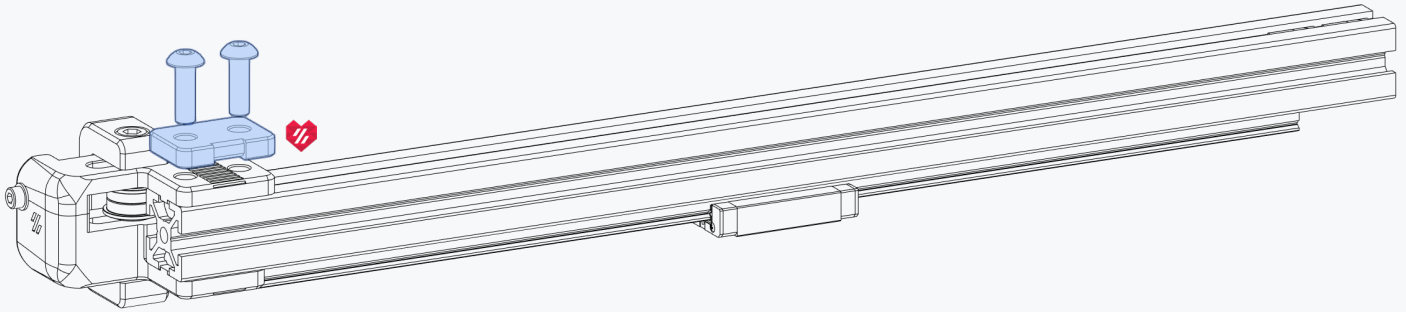


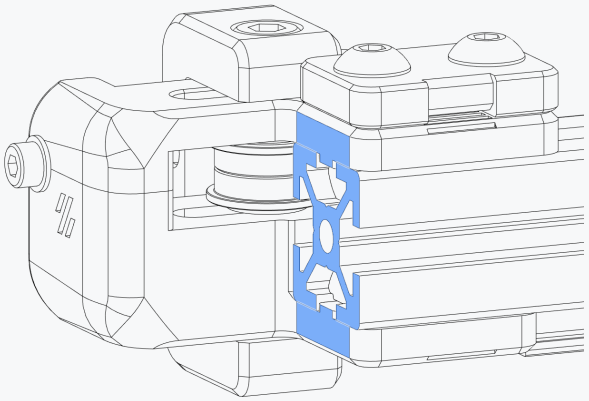


5MM HOLES ON TOP

Make sure to use the idler that has 2 holes for M5 bolts in the top when oriented as shown.

M5x16 BHCS



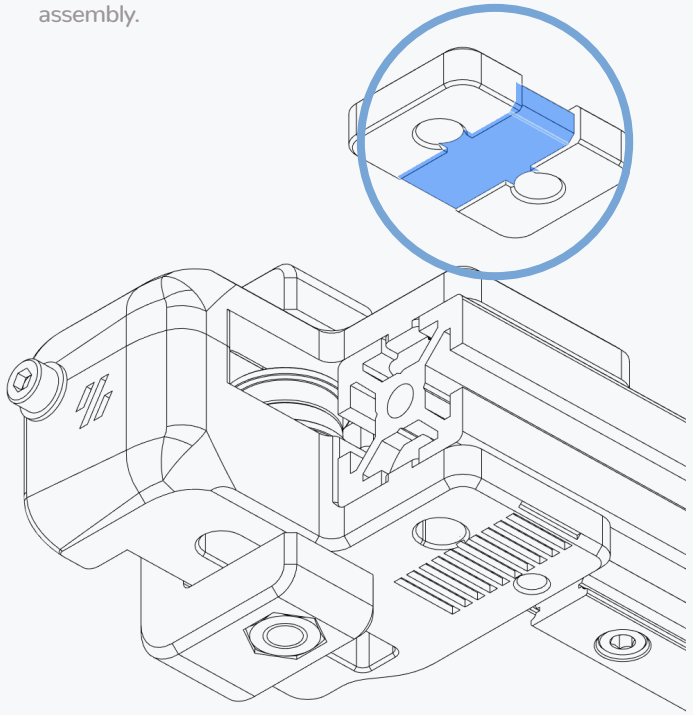


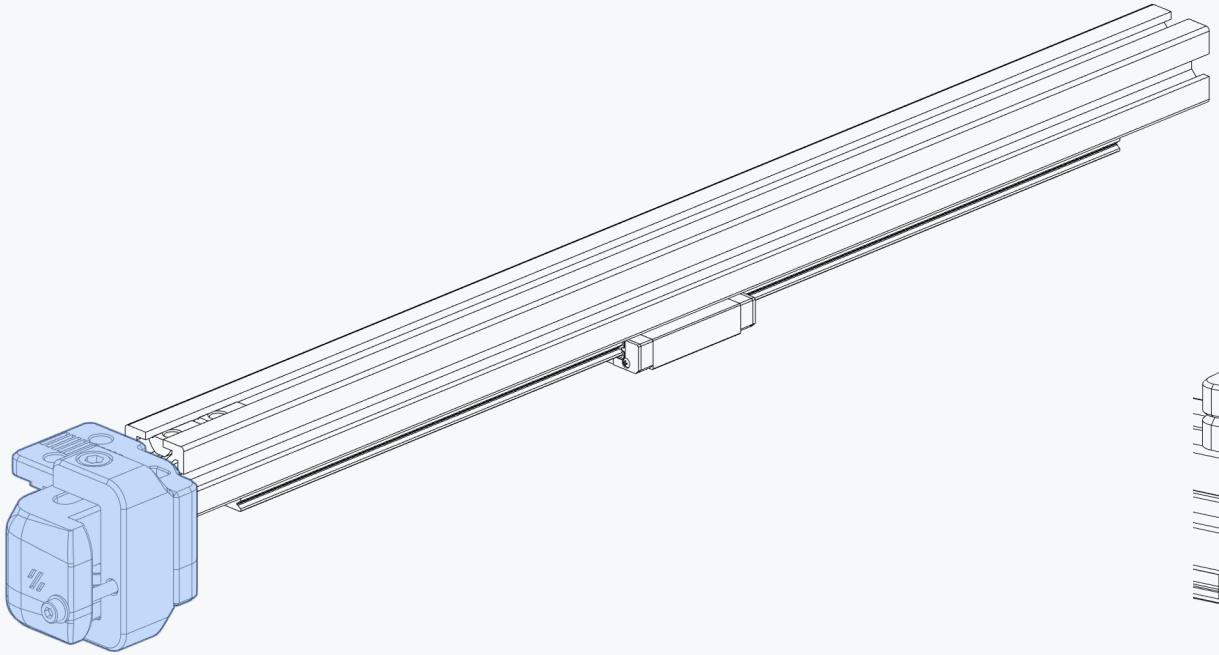
FLUSH INSTALL

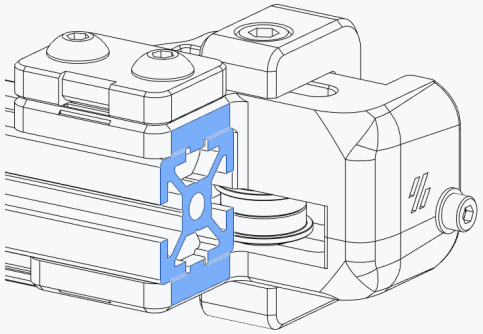
Make sure the plastic part sits flush with the end of the extrusion. If not flush check if you installed the correct idler.

NOTCH ORIENTATION

The indentation along the part is designed to clamp on the belt. The notch points away from the idler assembly.

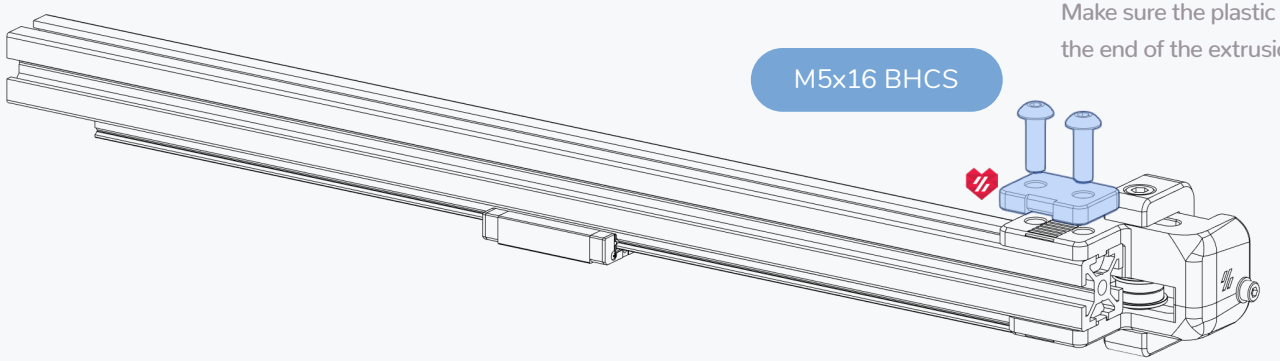


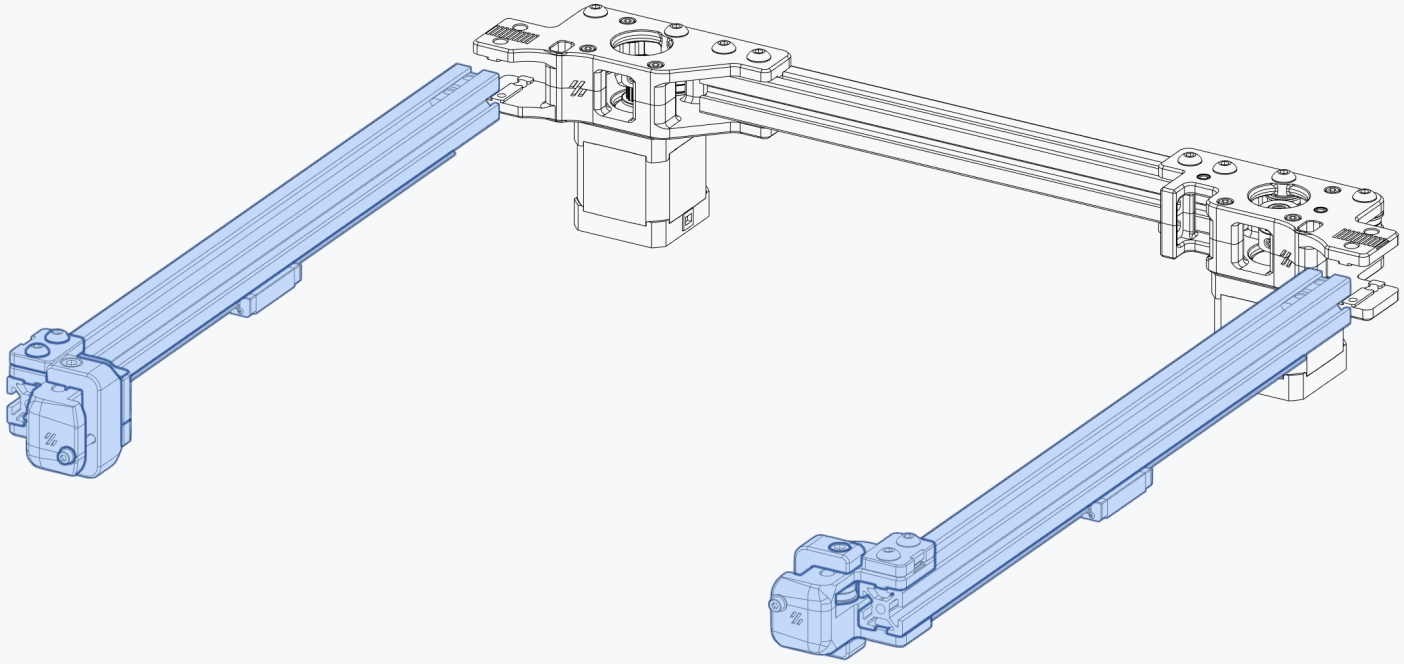


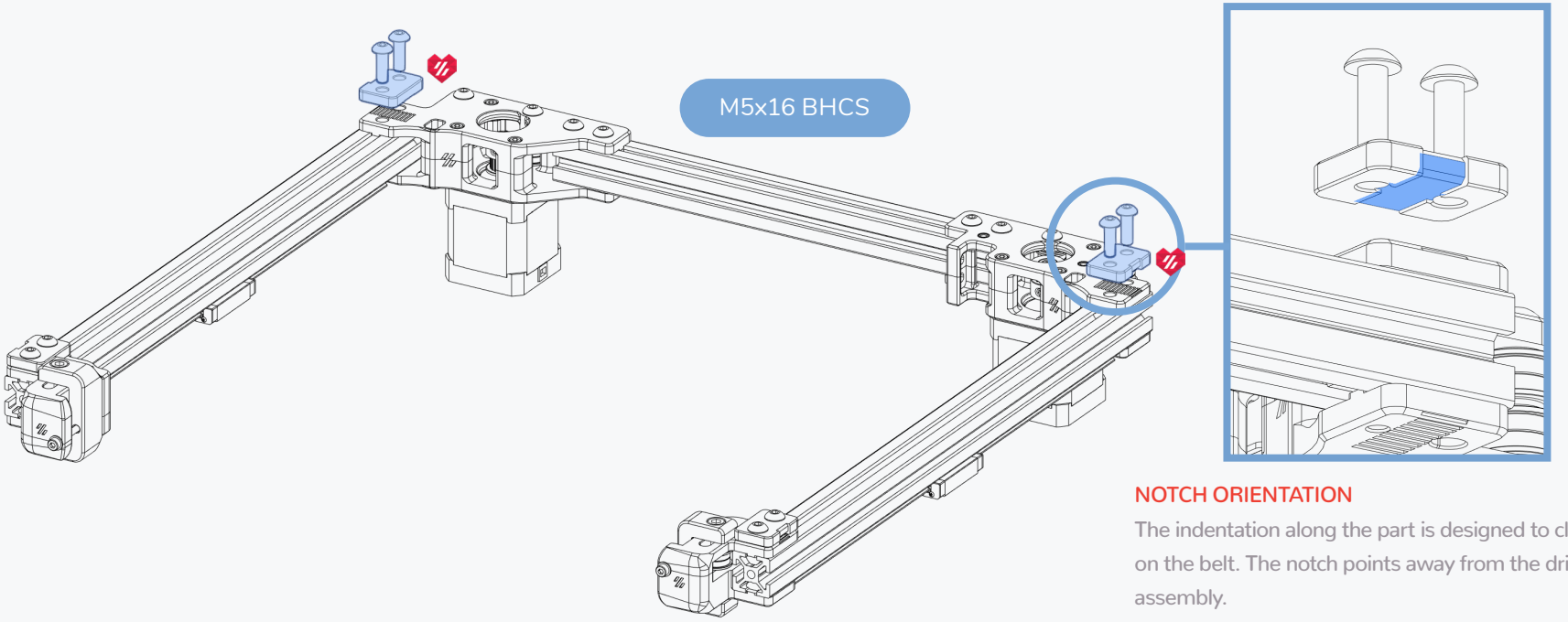


FLUSH INSTALL

Make sure the plastic part sits flush with the end of the extrusion.





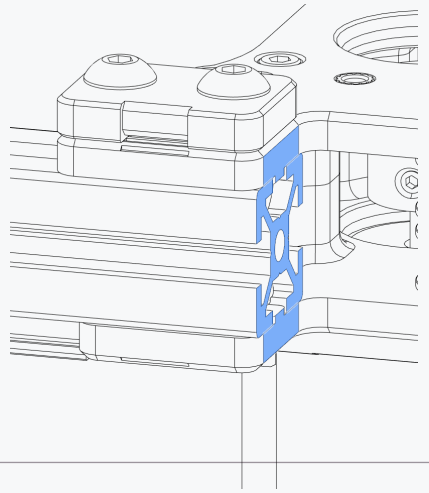


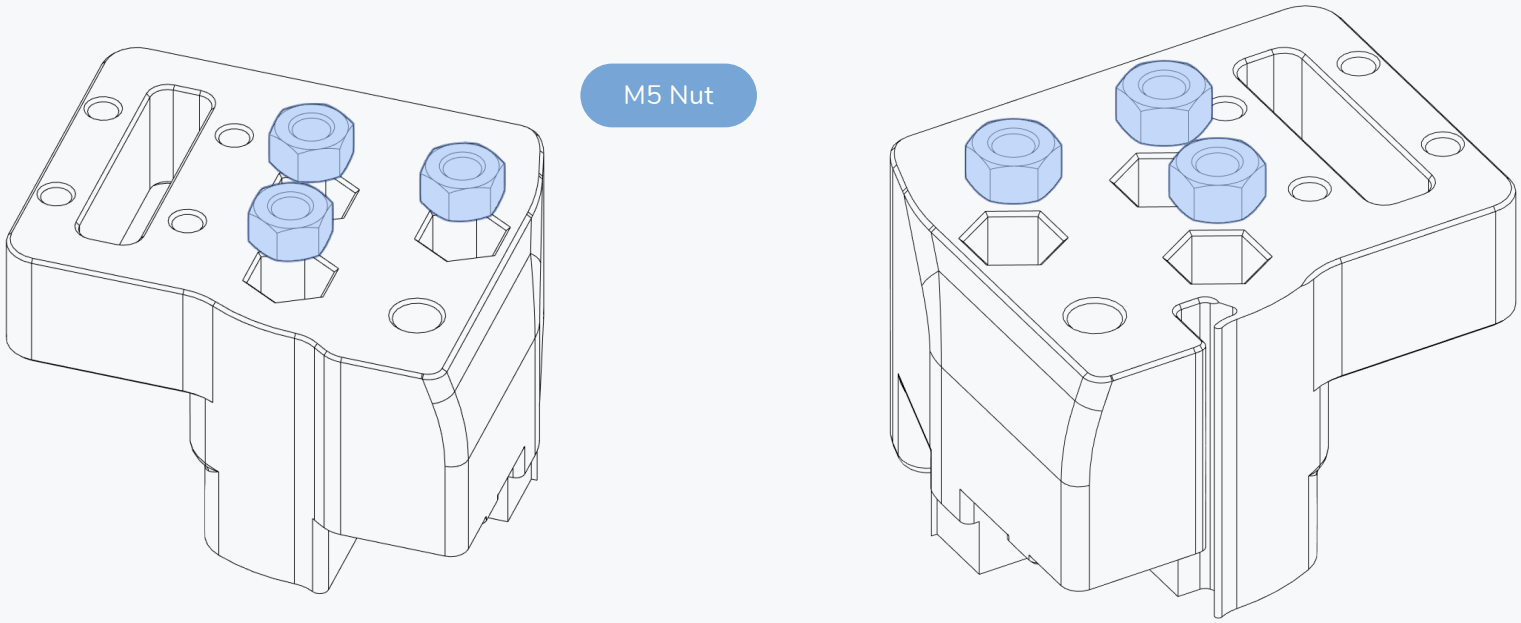
NOTCH ORIENTATION

The indentation along the part is designed to clamp on the belt. The notch points away from the drive assembly.

FLUSH INSTALL

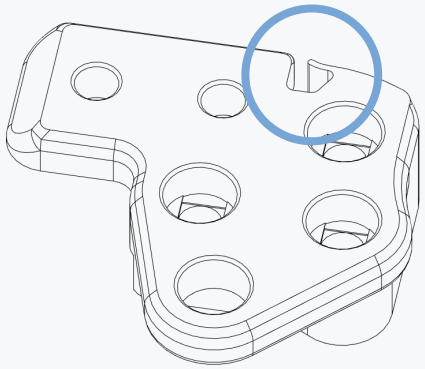
Make sure the plastic part sits flush with the end of the extrusion.

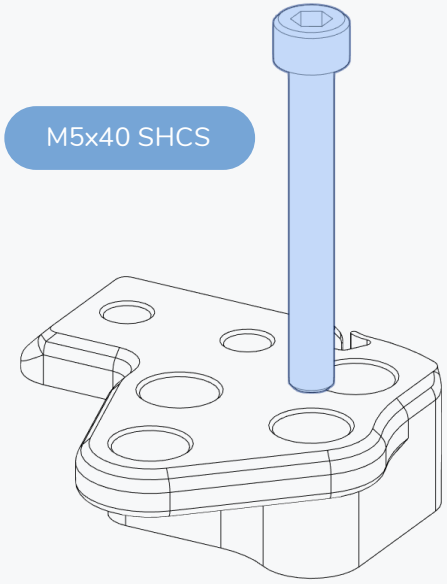


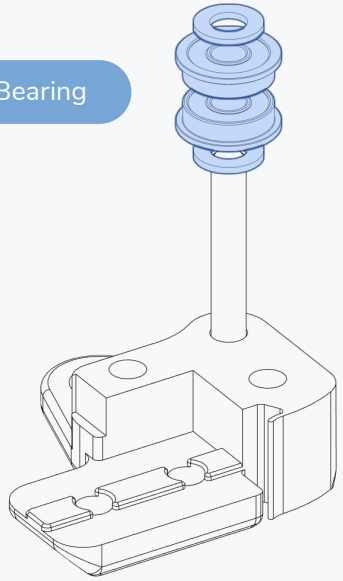

M5 Nut

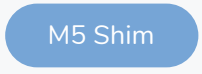
CABLE PATH

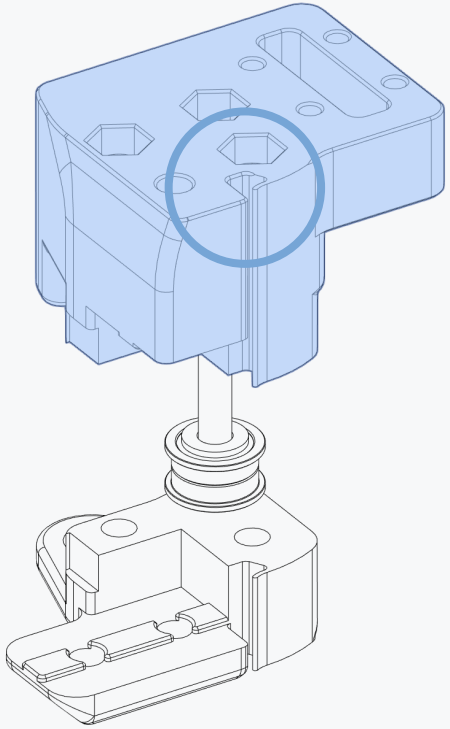
The printed parts for the right XY joint have a small channel to guide the end stop wires..

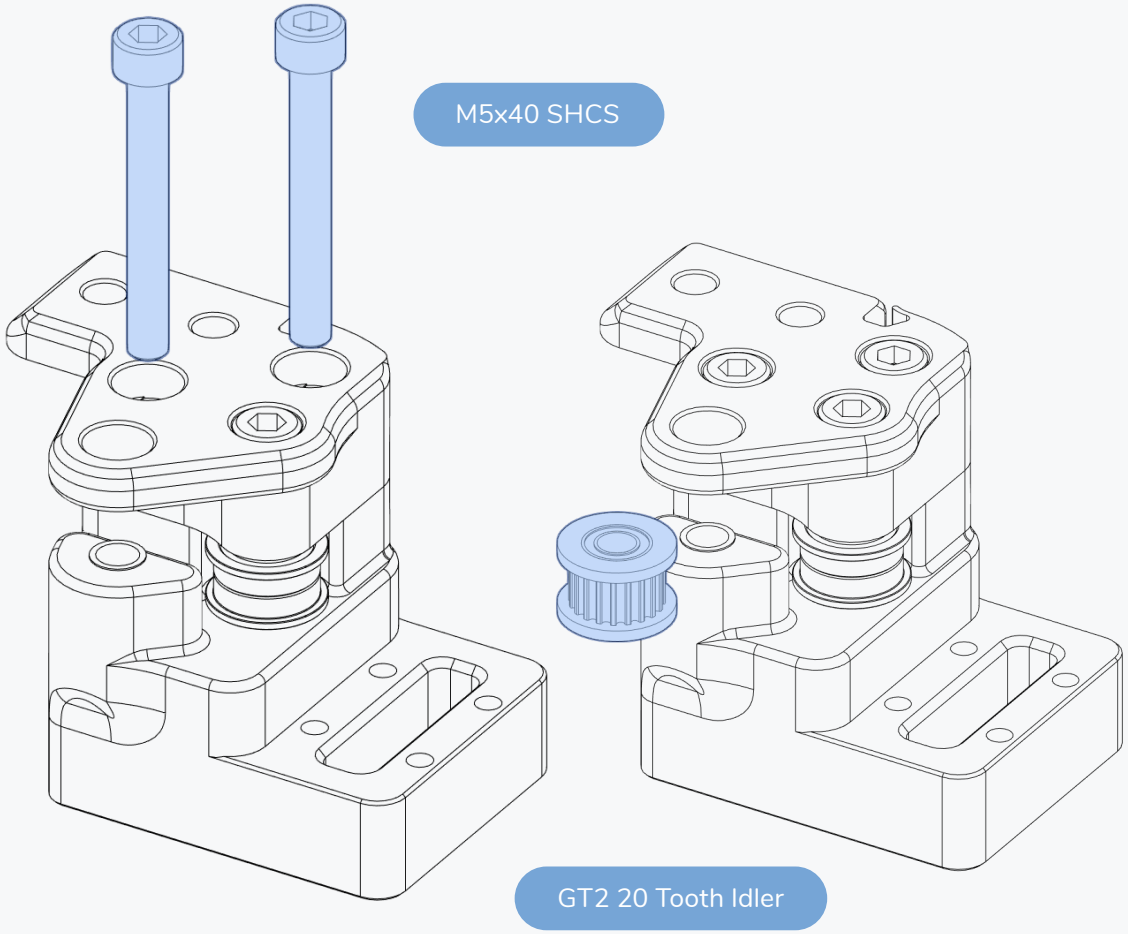


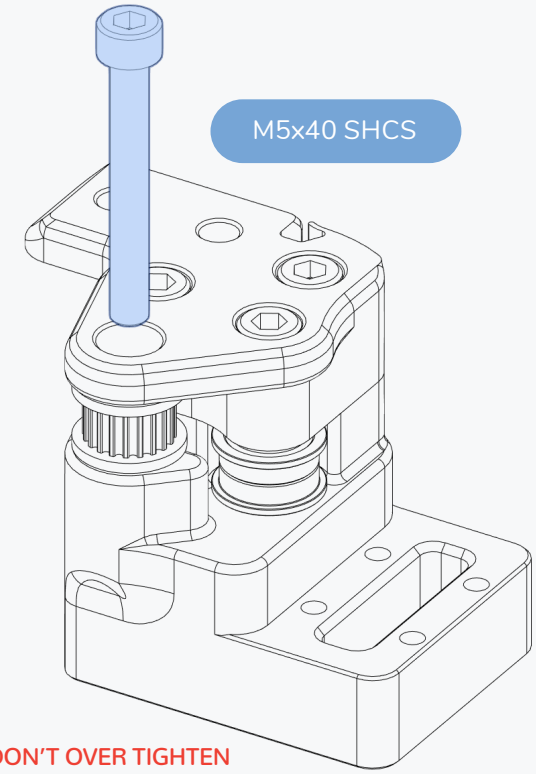






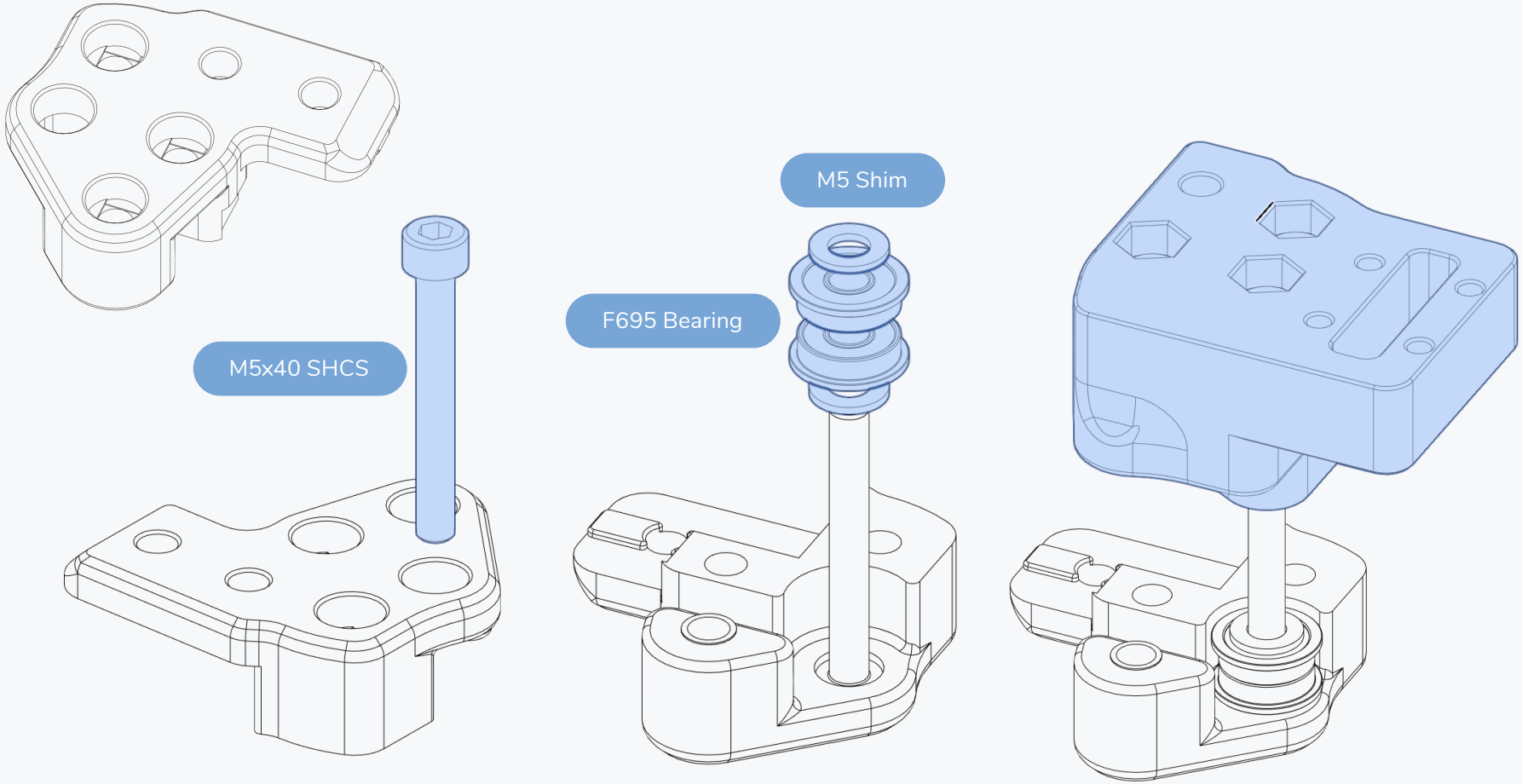


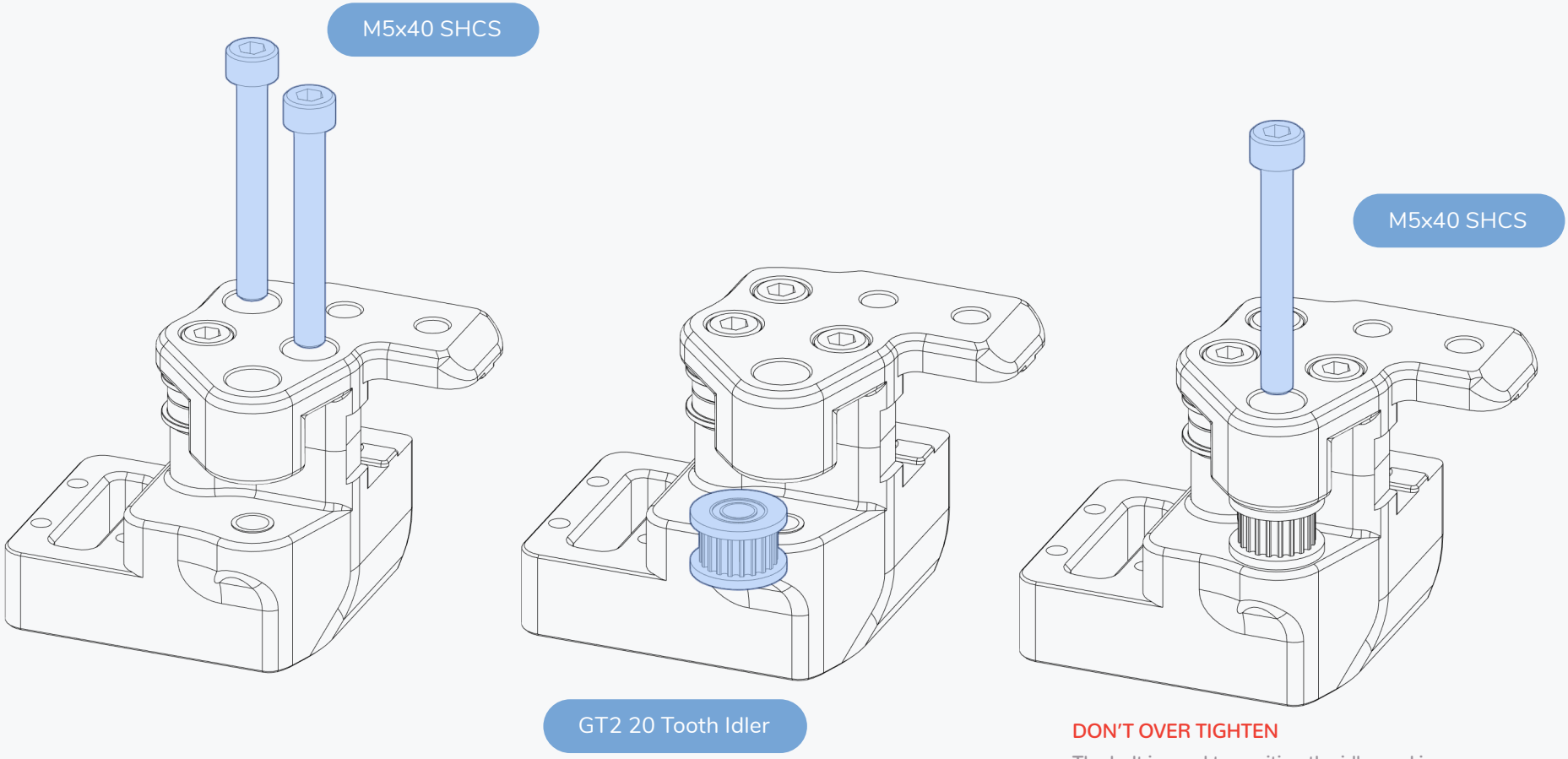




DON'T OVER TIGHTEN

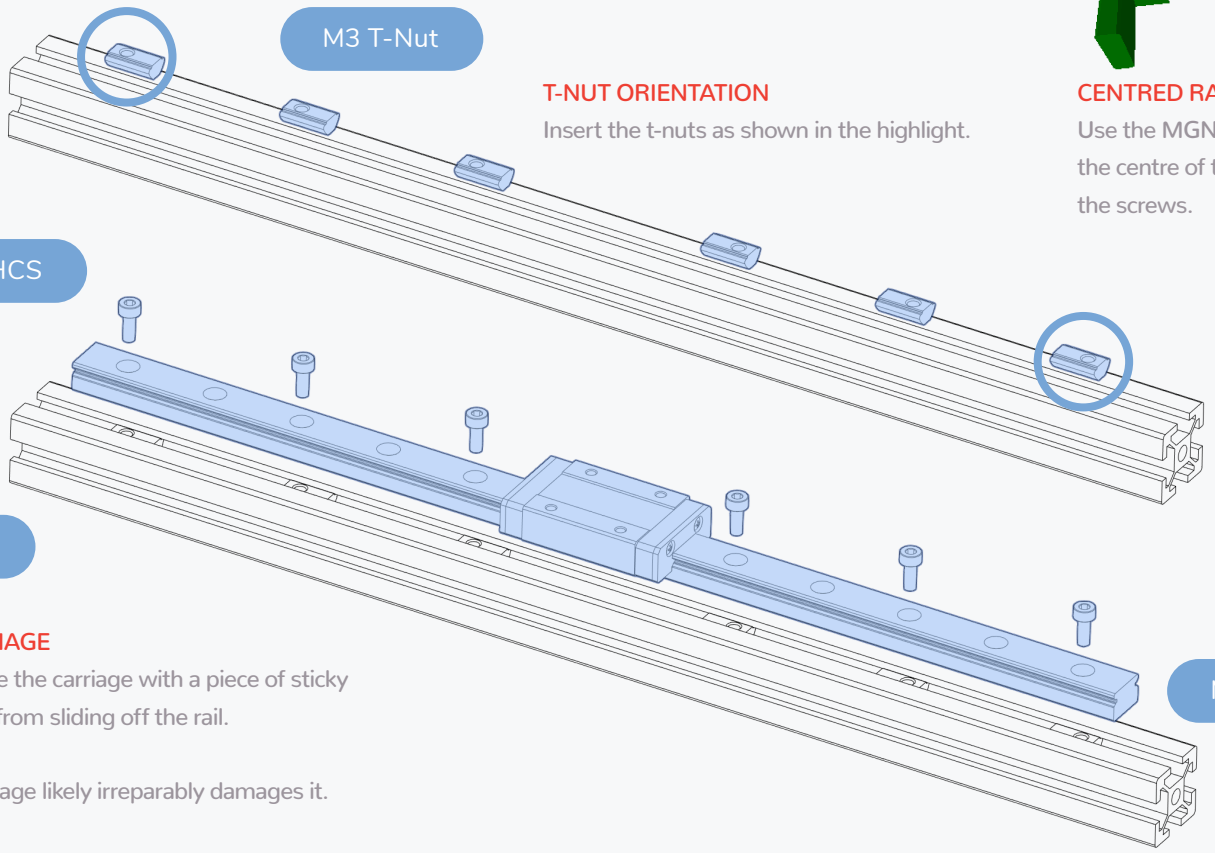
The bolt is used to position the idler and is screwed directly into plastic.
The idler must spin freely.


M5x40 SHCS
F695 Bearing
M5 Shim



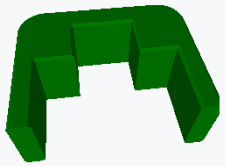
DON'T OVER TIGHTEN

The bolt is used to position the idler and is screwed directly into plastic.
The idler must spin freely.



T-NUT ORIENTATION

Insert the t-nuts as shown in the highlight.



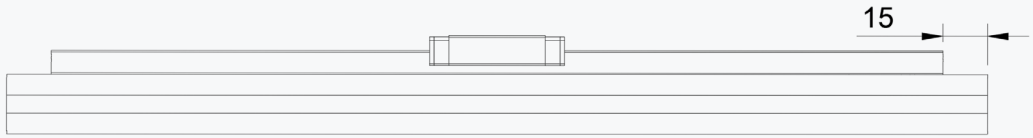
CENTRED RAIL INSTALLATION GUIDE

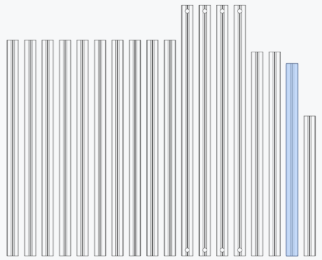
Use the MGN12 guides to position the rail in the centre of the extrusion prior to fastening the screws.

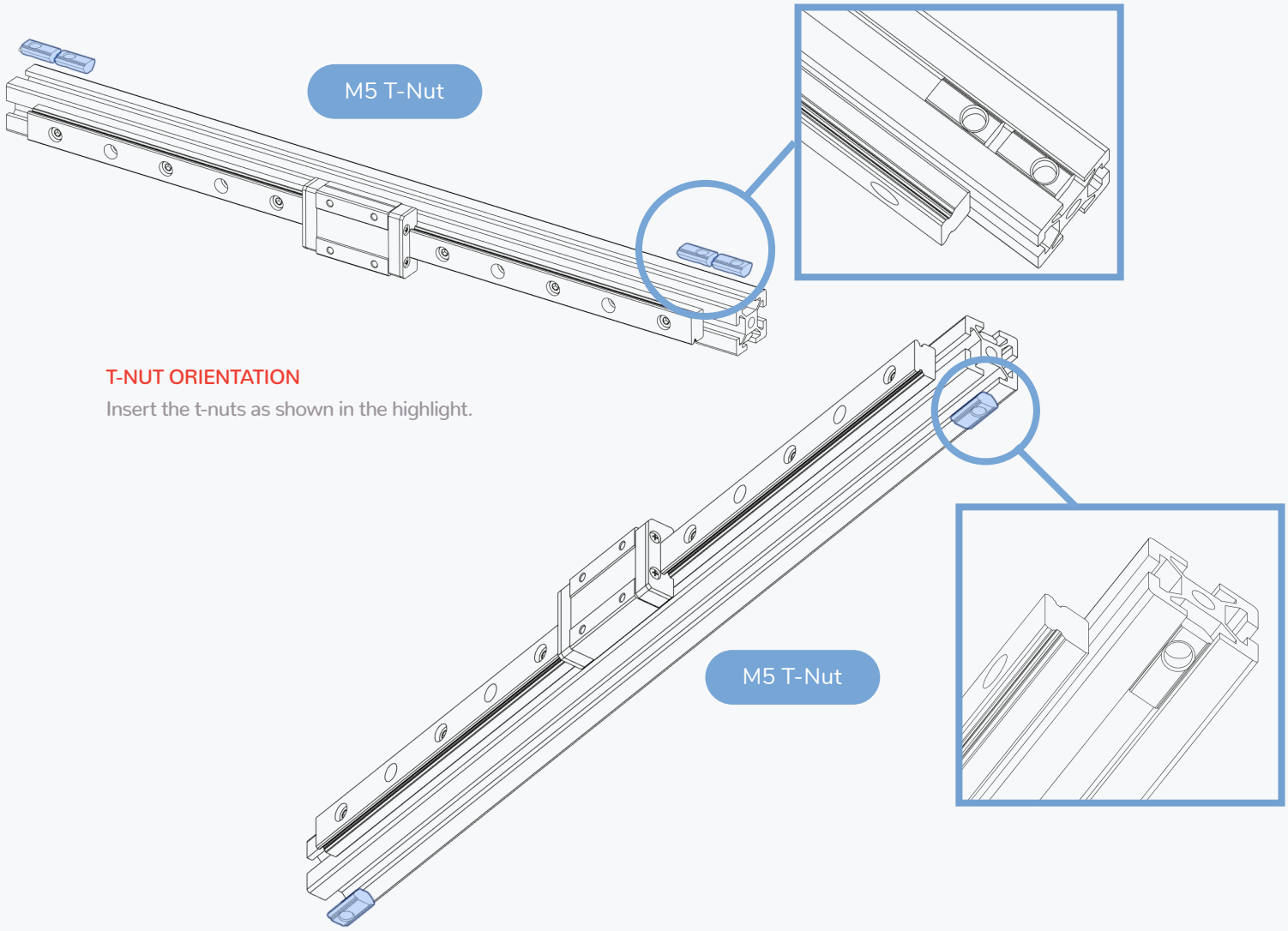
MIND THE CARRIAGE

Temporarily secure the carriage with a piece of sticky tape to prevent it from sliding off the rail.

Dropping the carriage likely irreparably damages it.

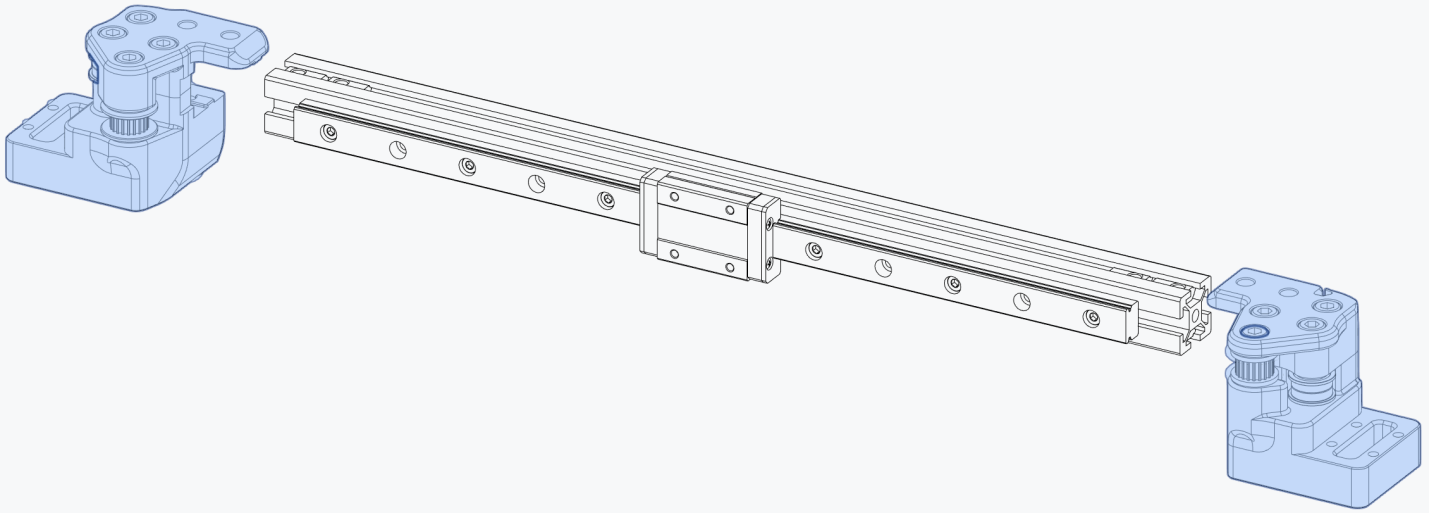


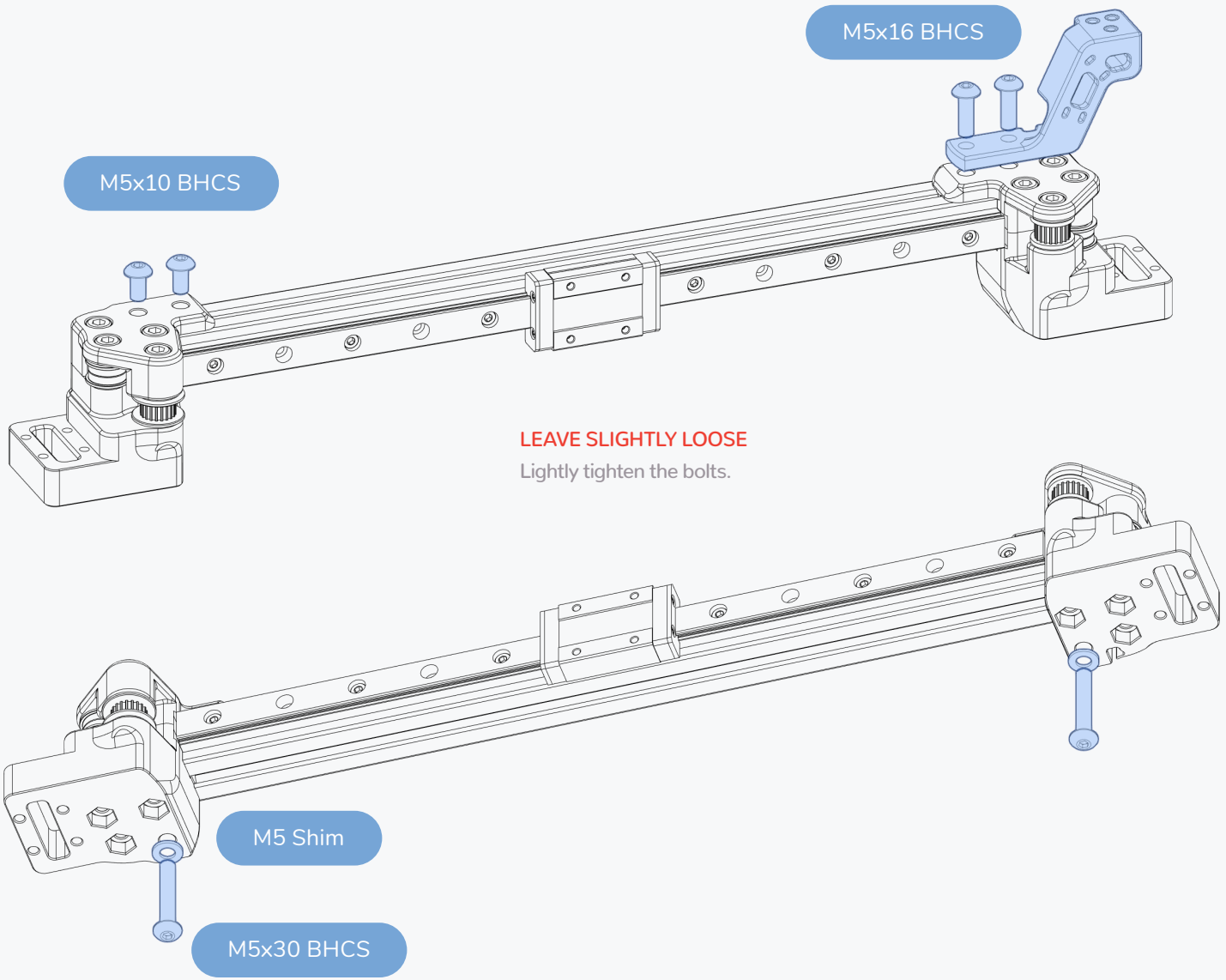


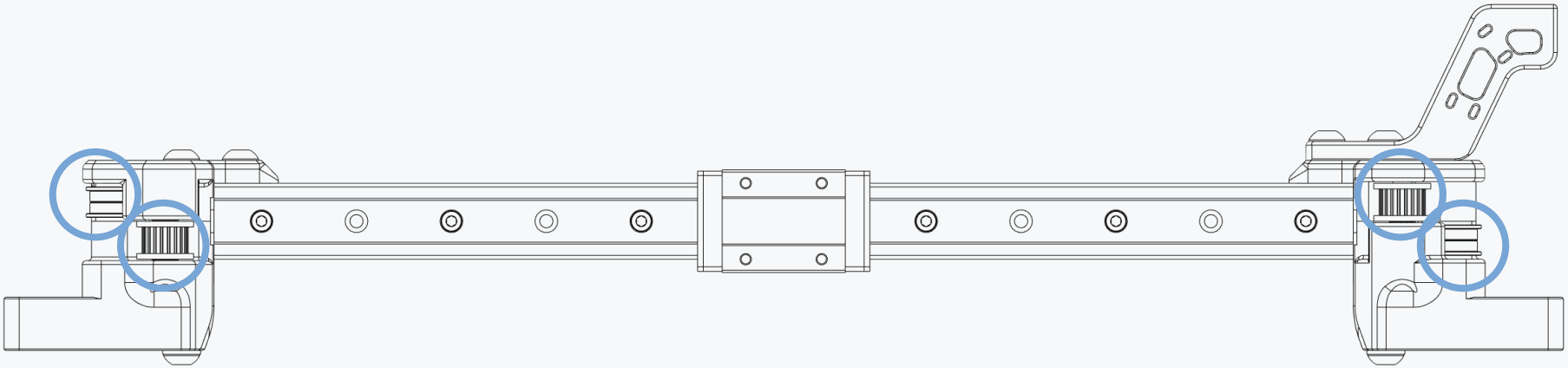


T-NUT ORIENTATION

Insert the t-nuts as shown in the highlight.




M5x16 BHCS
M5x10 BHCS
LEAVE SLIGHTLY LOOSE
Lightly tighten the bolts.
M5 Shim
M5x30 BHCS



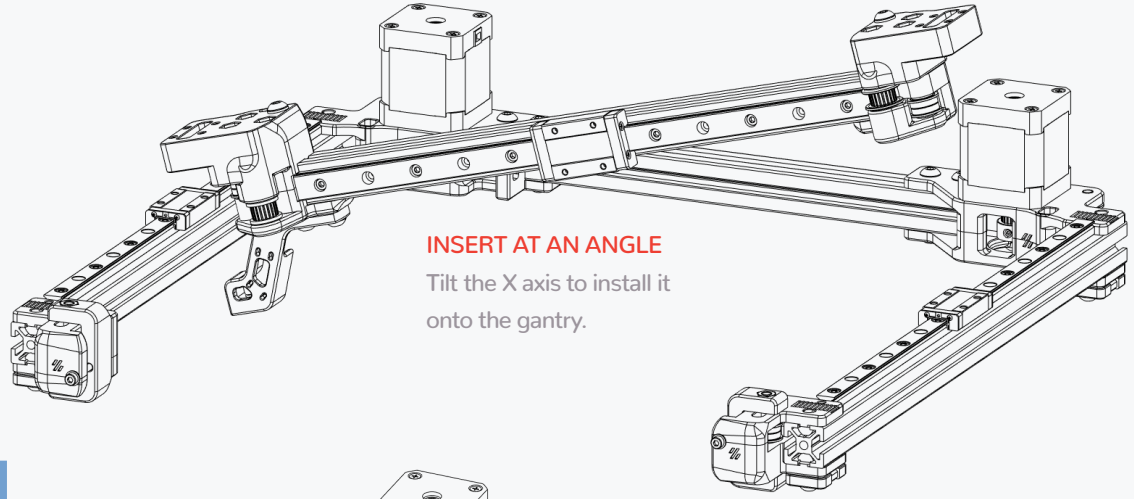
CHECK YOUR WORK

Compare your assembled part to the graphic shown here.

Pay attention to the pulley orientation and alignment with the bearing stack ups.

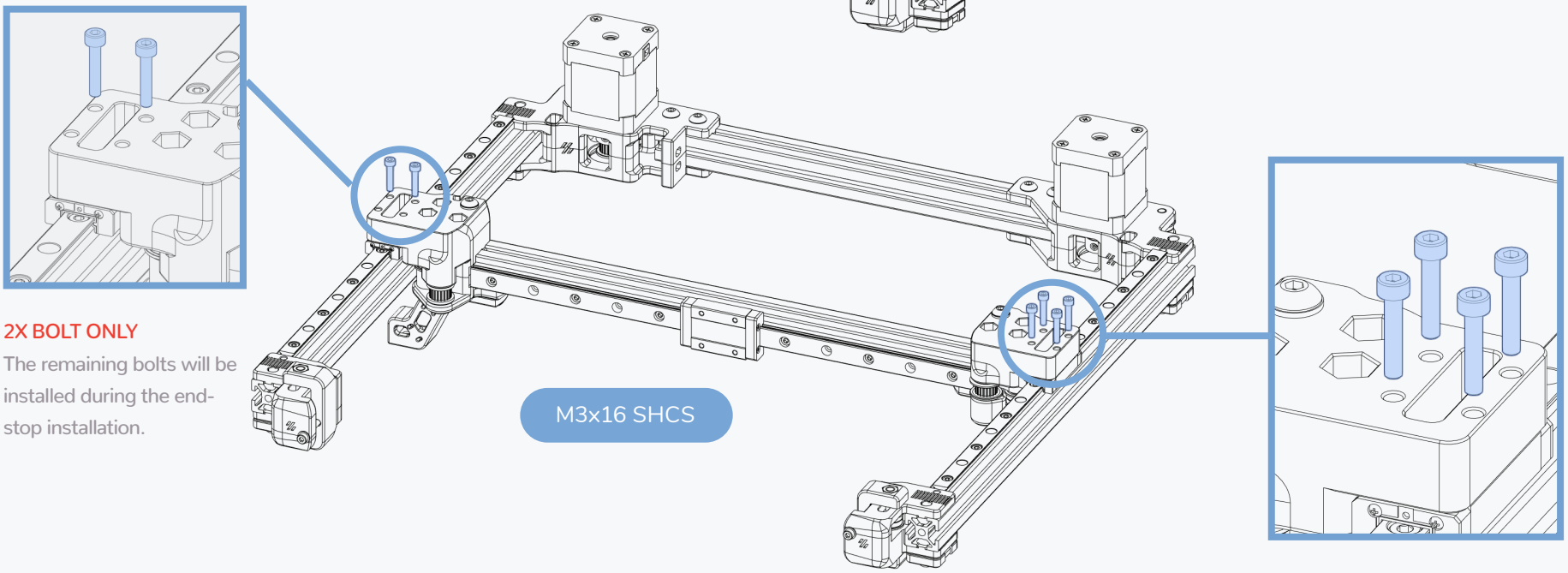
FLIP GANTRY

Turn the gantry around for the next step.



INSERT AT AN ANGLE

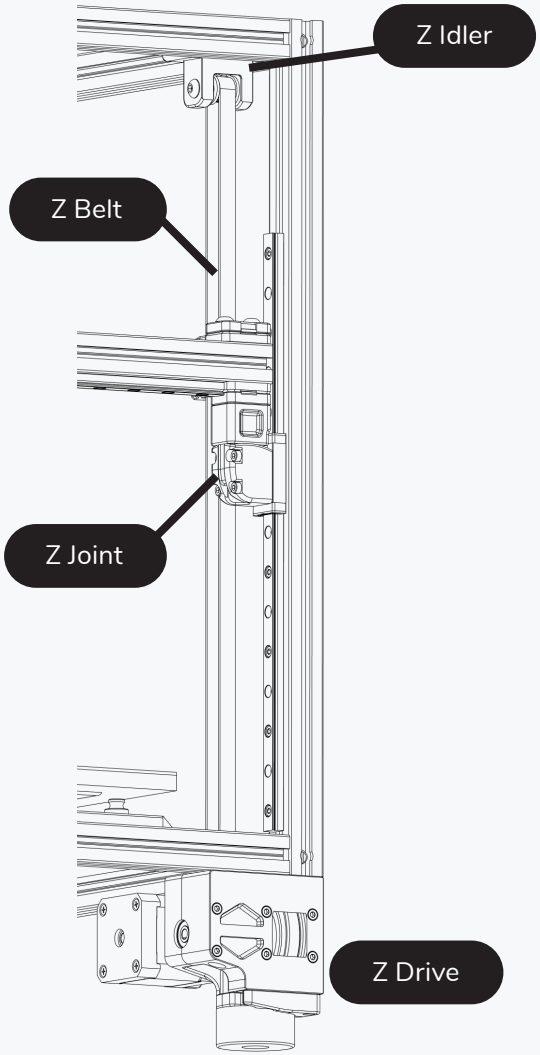
Tilt the X axis to install it onto the gantry.

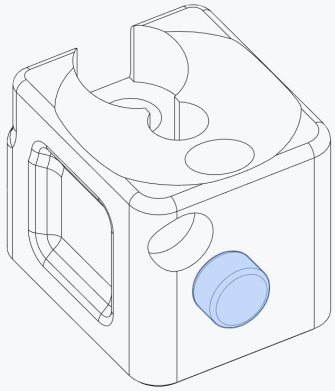


2X BOLT ONLY

The remaining bolts will be installed during the end-stop installation.

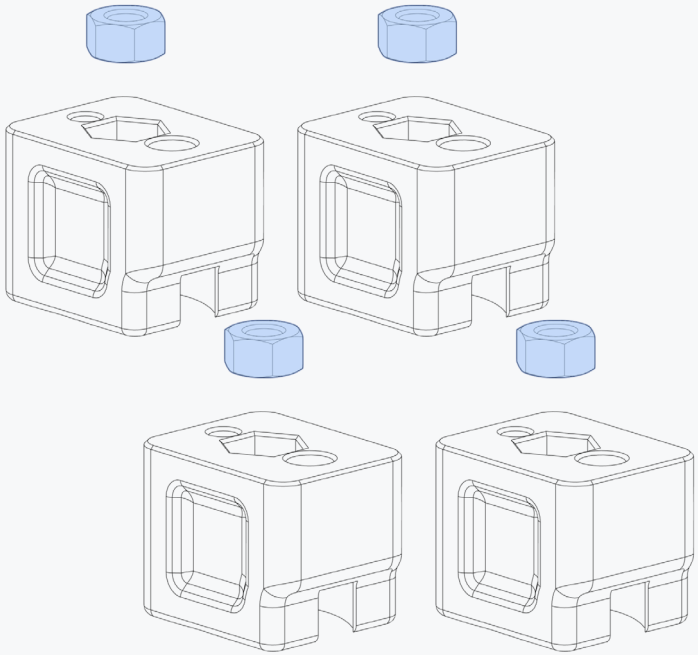
V1 and V2 are not version numbers but the printer models/lines. We renamed the V1 to Voron Trident to address the confusion this caused.


Z Idler
Z Belt
Z Joint
Z Drive



6x3 Magnet

M5 Nut

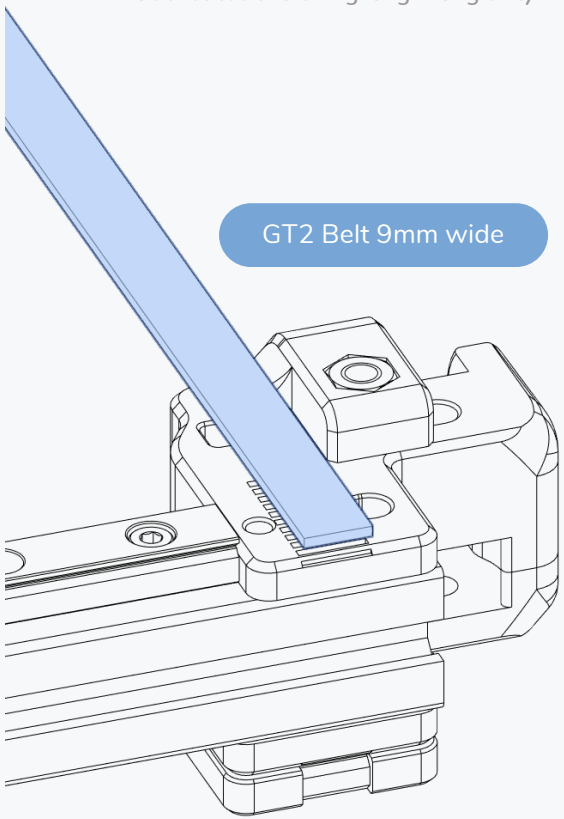


OPTION: HALL EFFECT ENDSTOP

If you are building your printer with a Hall Effect Endstop add a magnet to the cutout.

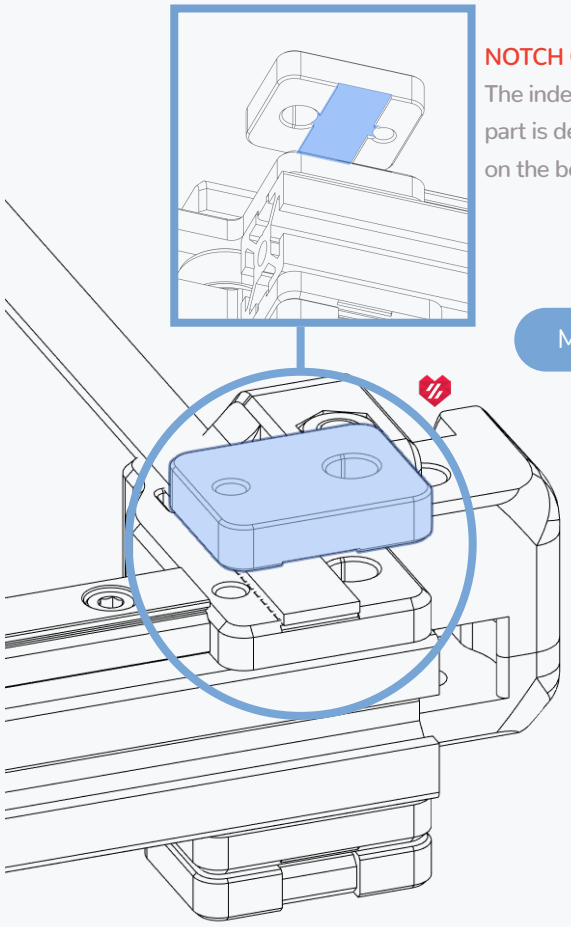
GANTRY IS STILL UPSIDE DOWN

It's a lot easier than fighting with gravity.



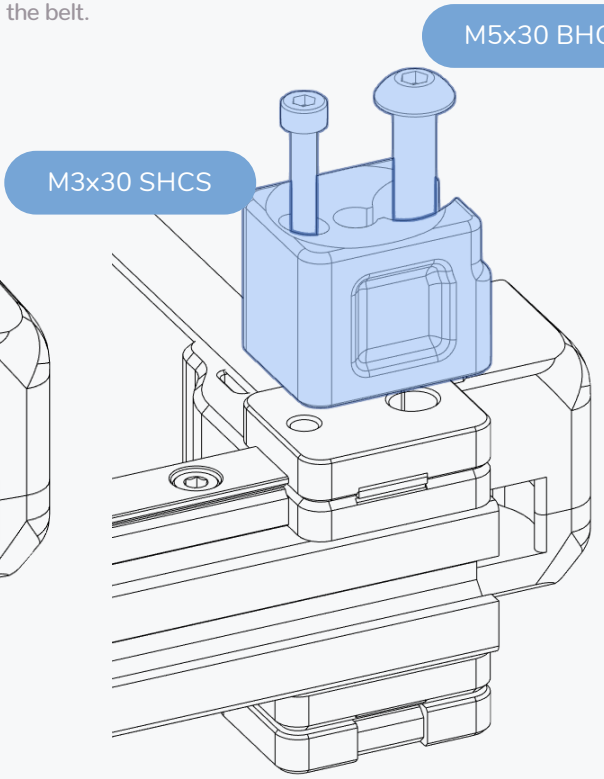
TEETH DOWN

The teeth of the belts are facing down into the serrations in the printed part.



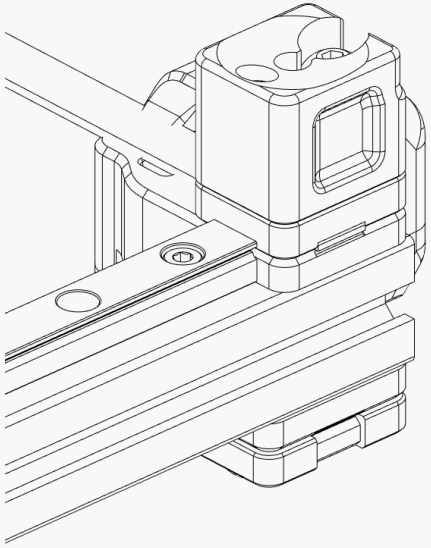
NOTCH ORIENTATION

The indentation along the part is designed to clamp on the belt.



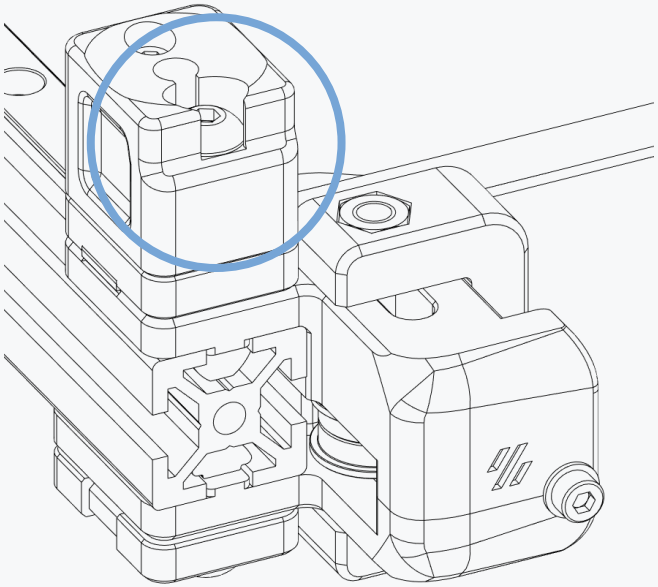
MINIMUM RECOMMENDED BELT CUT LENGTH

250 spec 1000mm
300 spec 1100mm
350 spec 1200mm



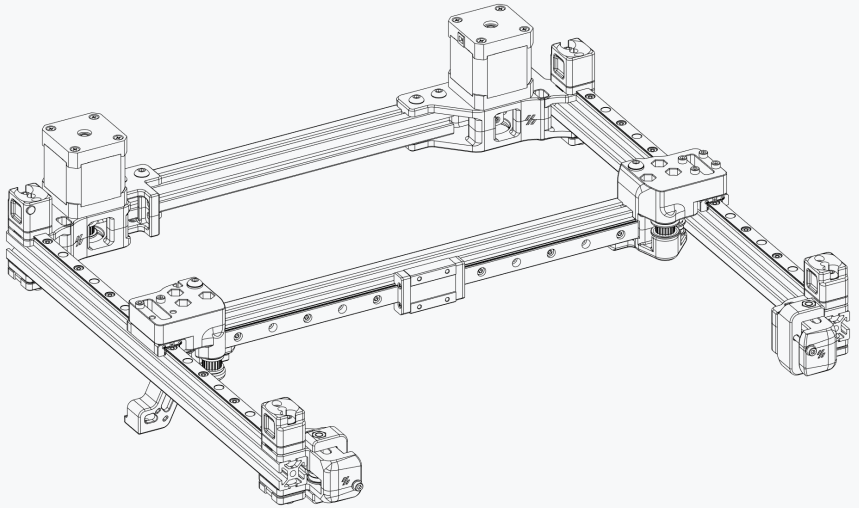
MIND THE PART ORIENTATION

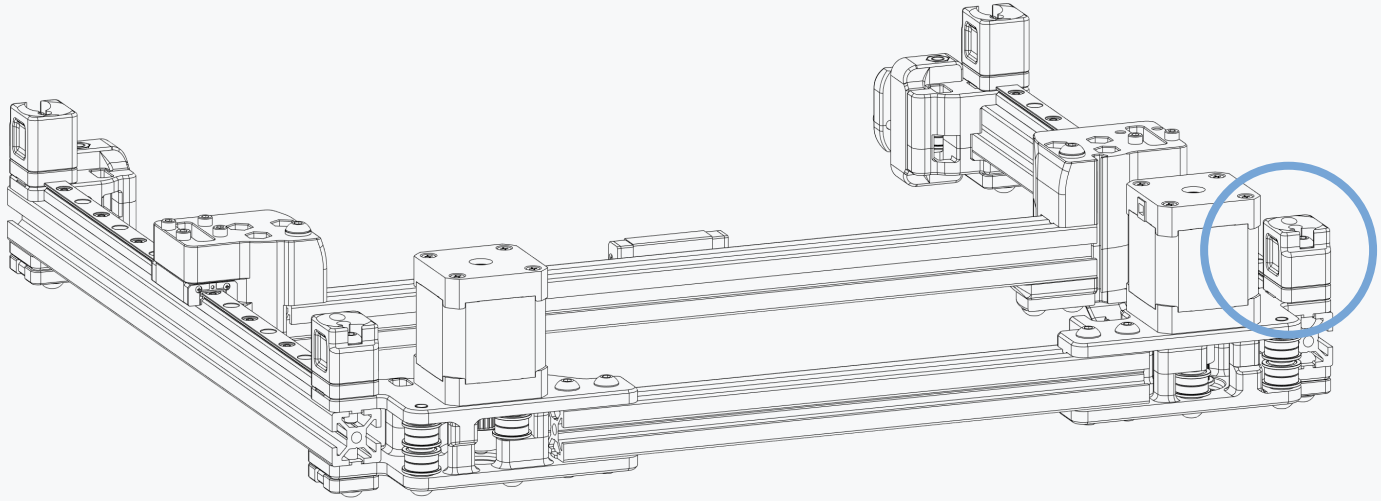
The cutout goes towards the outside.



REPEAT BELT INSTALL FOR ALL 4 BLOCKS

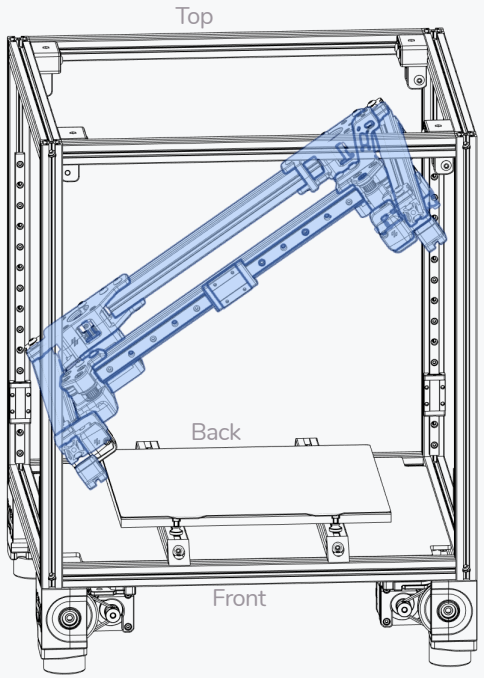
We are not showing the belts in the pictures on this page.





OPTION: HALL ENDSTOP

Install the block with the magnet in this position. The magnet faces the XY joint.



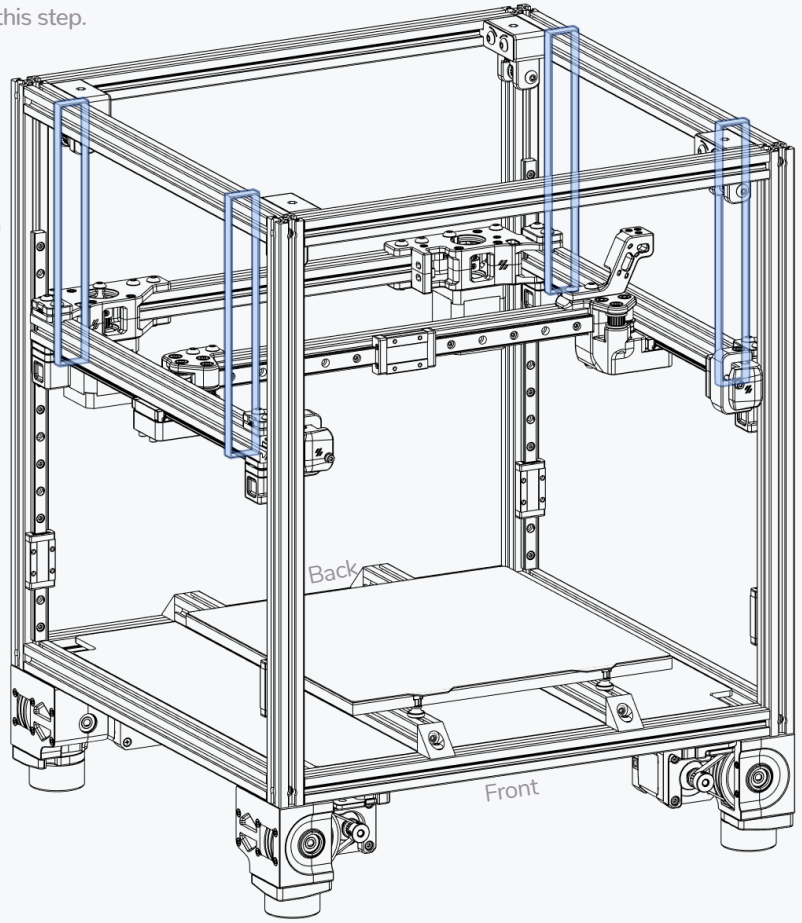
INSERT AT AN ANGLE

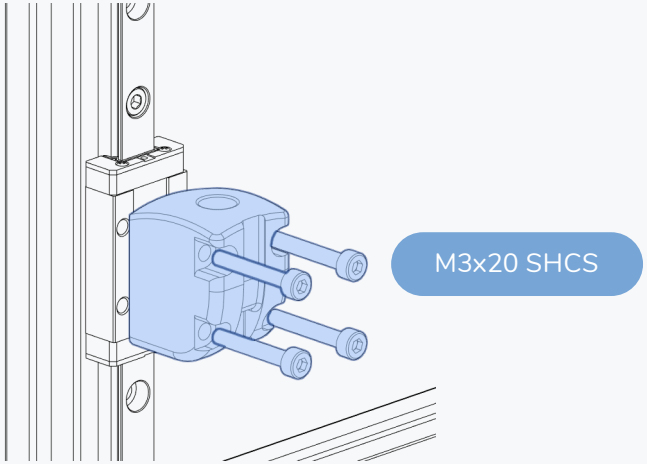
Tilt the gantry to move it past the uprights.

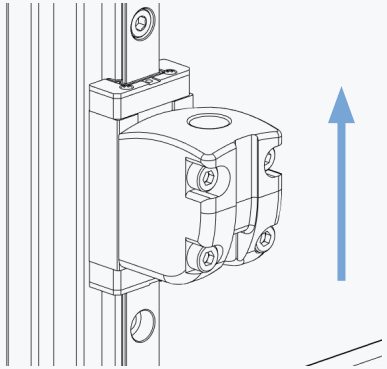
A HELPING HAND

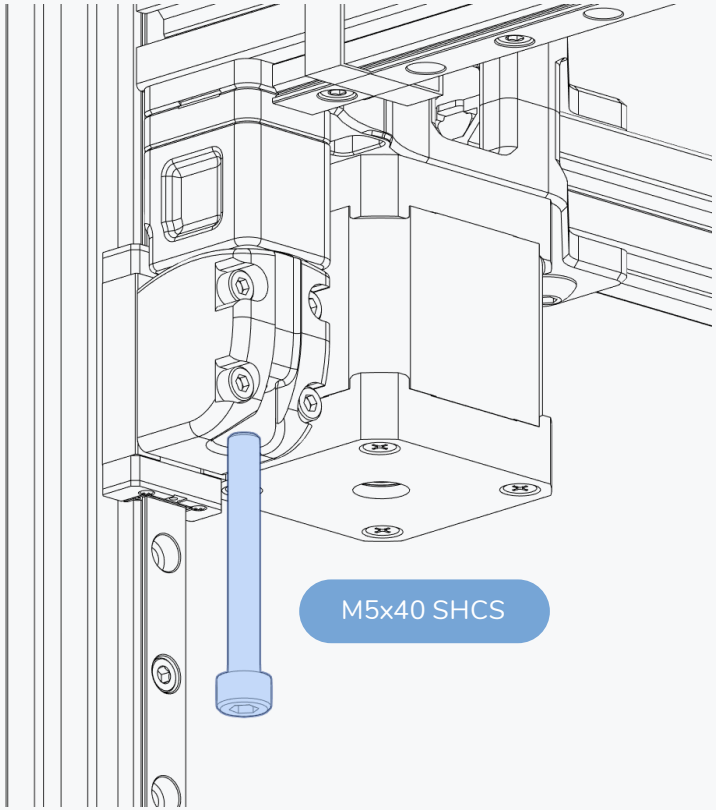
Secure the gantry with long zipties or similar while the gantry is being installed. An extra pair of hands helps with this step.

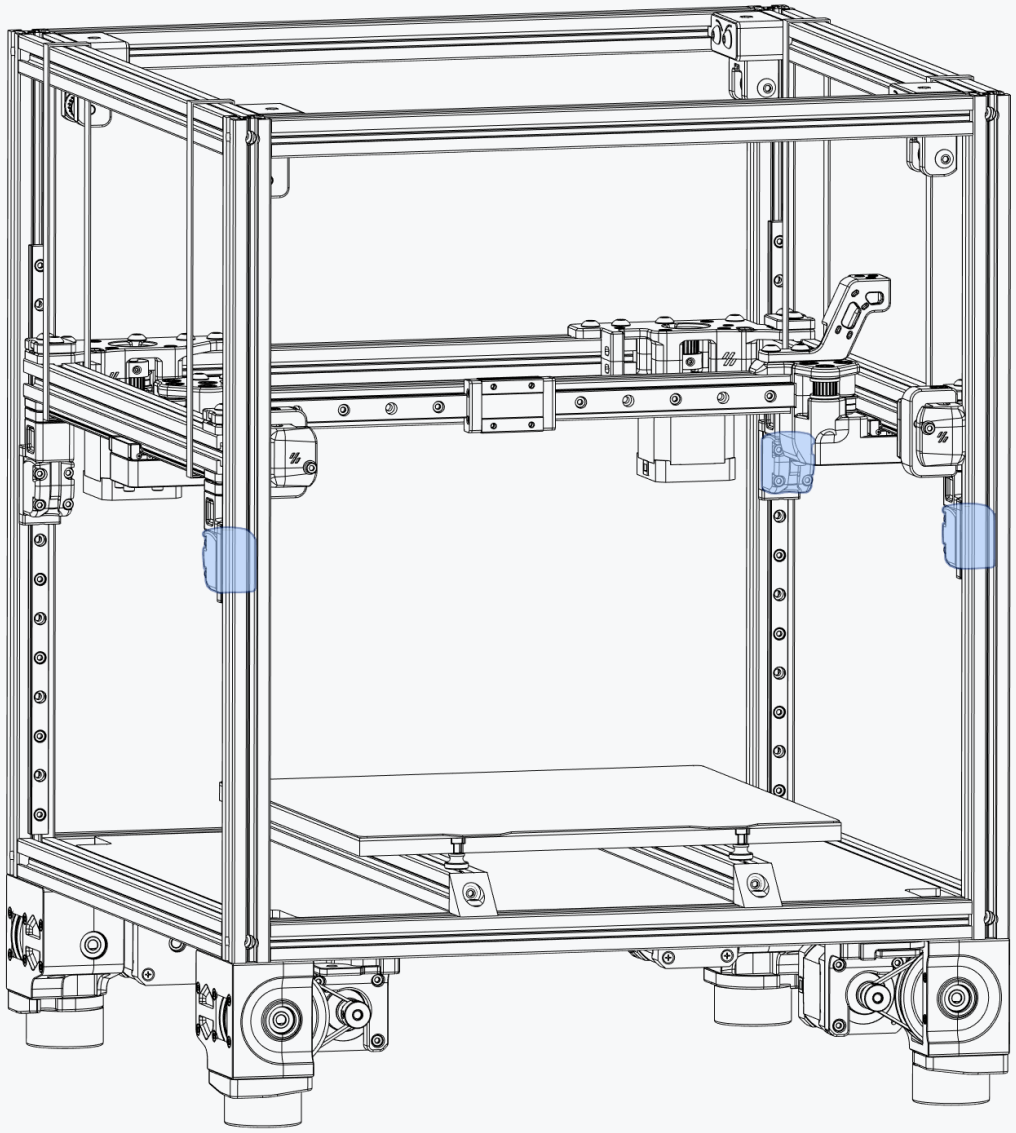
Long Zipties




M3x20 SHCS

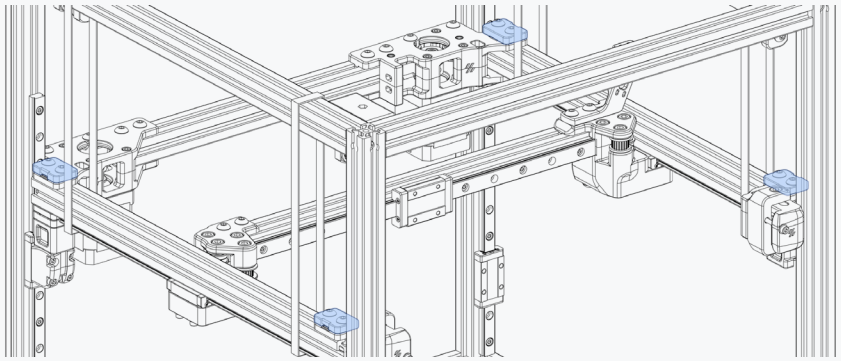



M5x40 SHCS



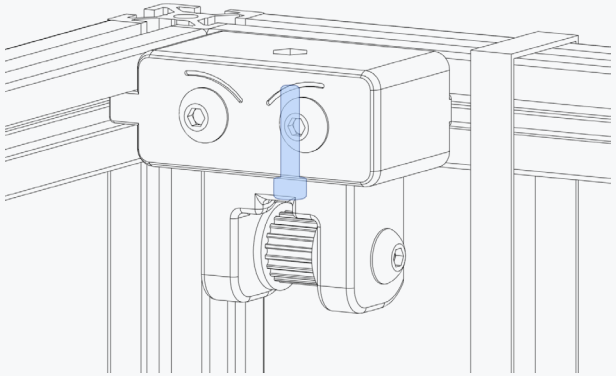
INSTALL REMAINING JOINTS

Add the other 3 joints repeating the same steps.



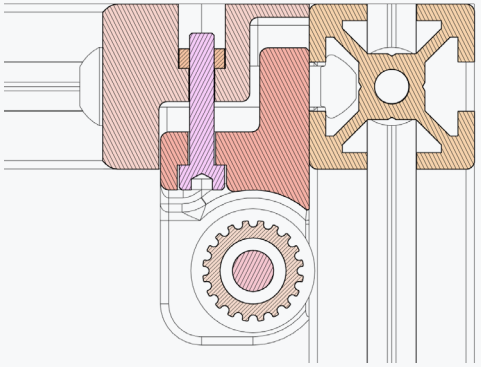
LOOSEN TOP BELT CLAMPS

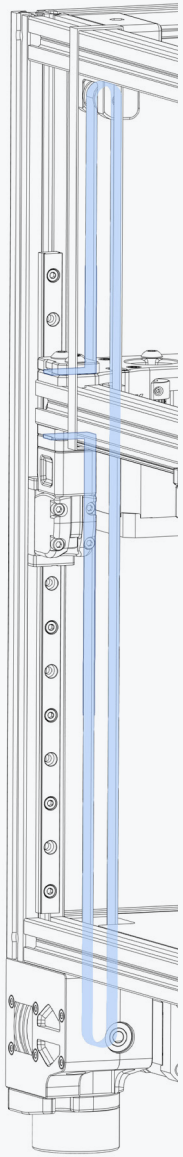
Undo the top belt clamps, we'll be installing the belts in the next steps.

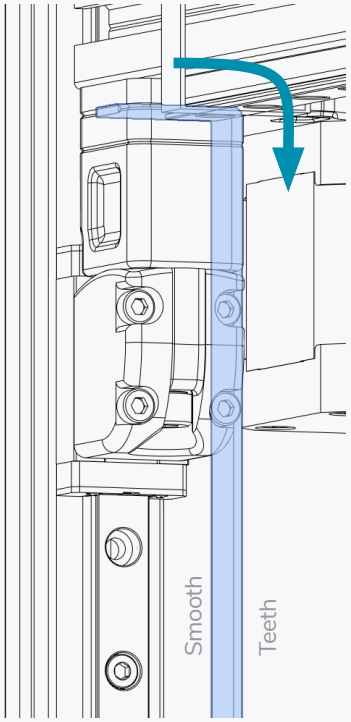


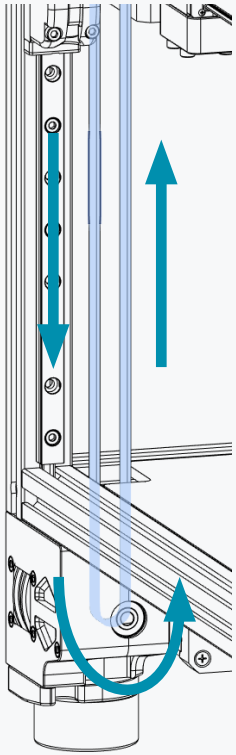
EXTEND IDLER

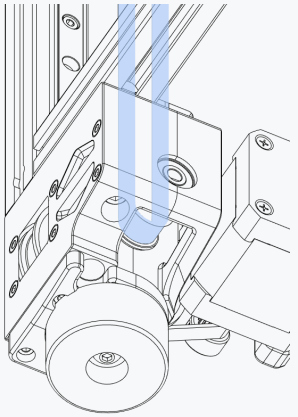
Loosen the idler bolt to extend the idler. Once extended to the maximum before becoming undone tighten 4 turns. Repeat for all 4 idlers.







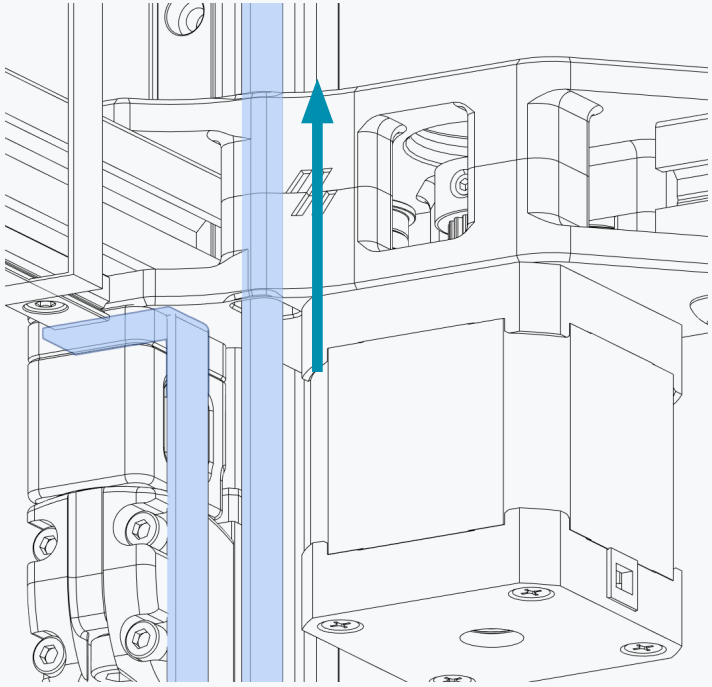


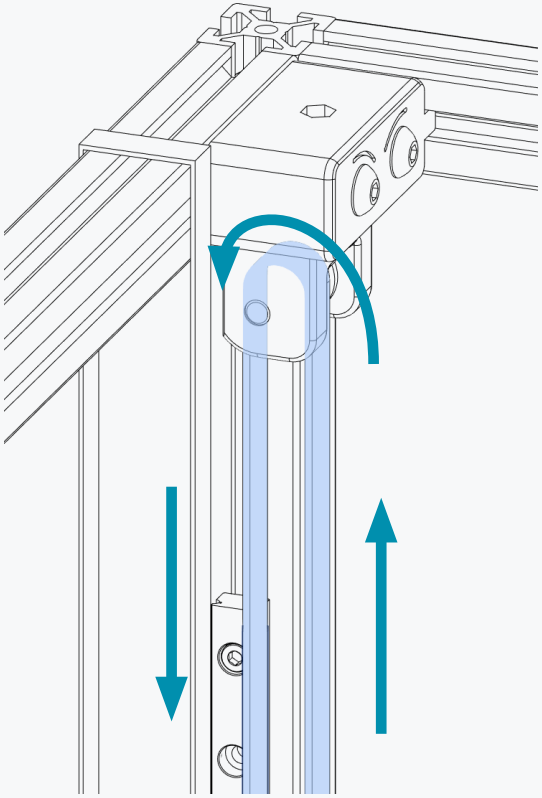


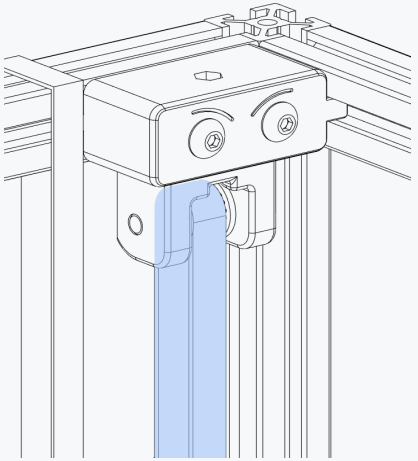
Z BELT ROUTING

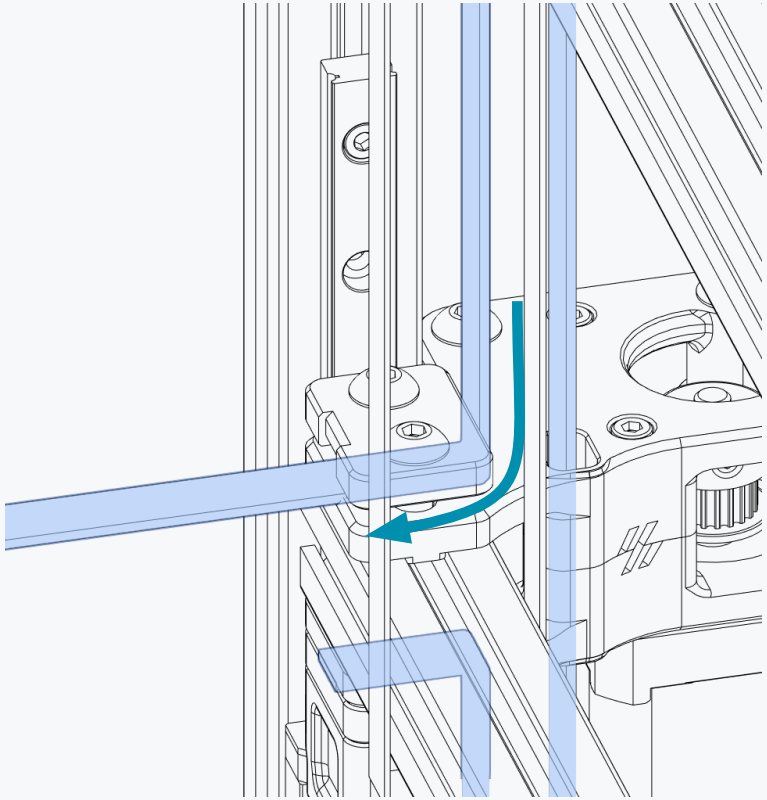
Follow the path pointed out by the arrows. Needle nose pliers, tweezers or similar tools can help in this step.

The belt teeth are on the inside of the loop.



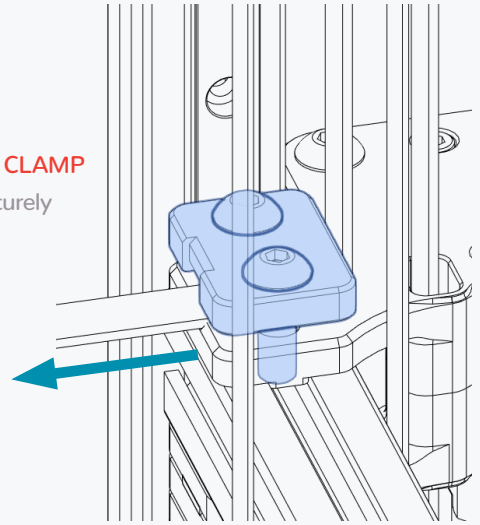






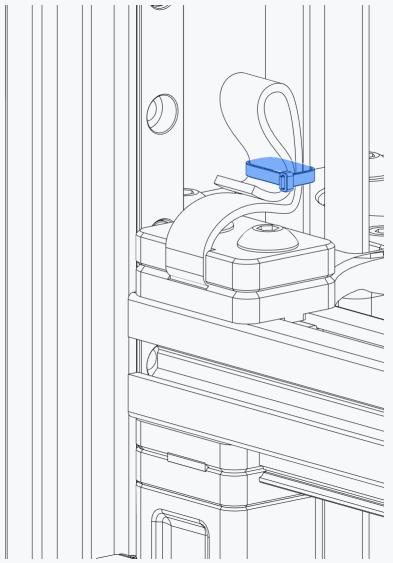
PULL TIGHT AND SECURE BELT CLAMP

Pull on the end of the belt and securely fasten the top belt clamp.



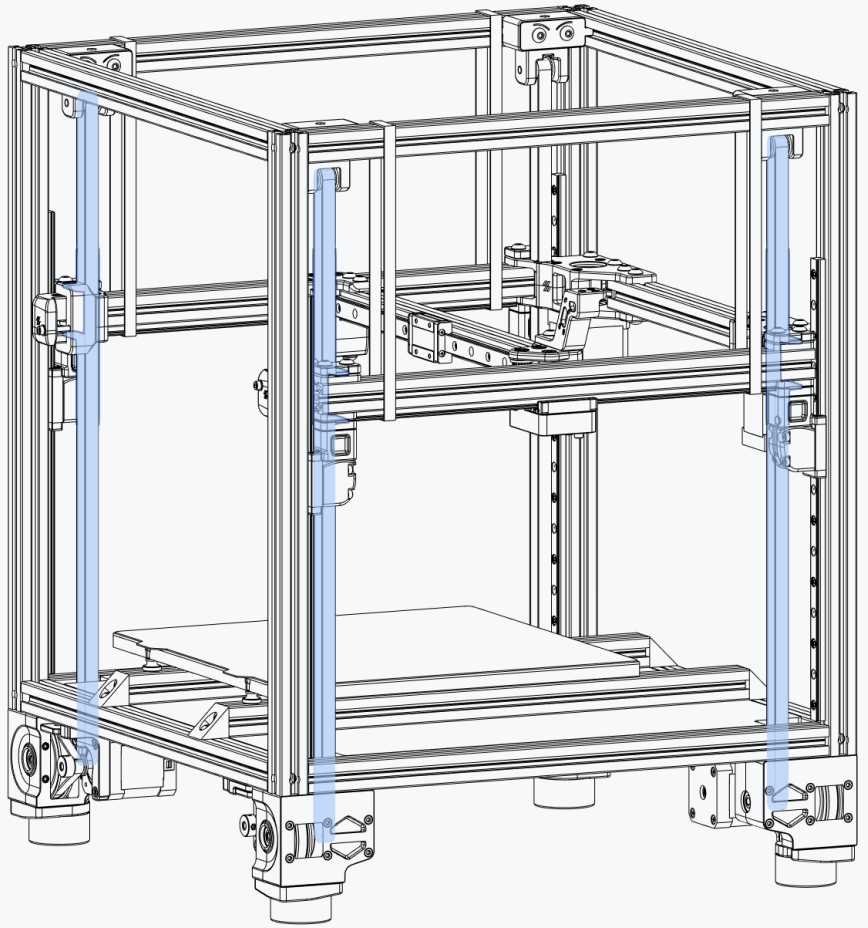
EXCESS BELT

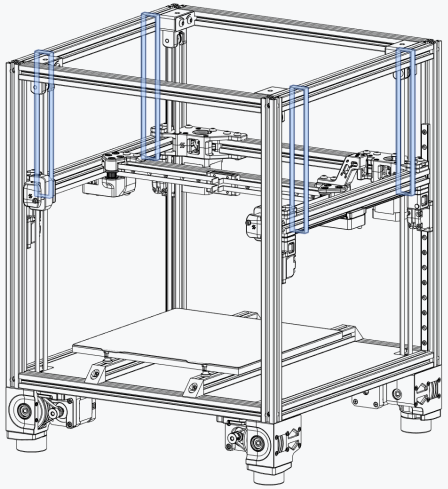
Fold the excess belt over and use a small ziptie to secure the end.



INSTALL REMAINING Z BELTS

Repeat the install instructions for the other 3 Z belts.





REMOVE ZIPTIES

With the belts installed the gantry will stay in position.

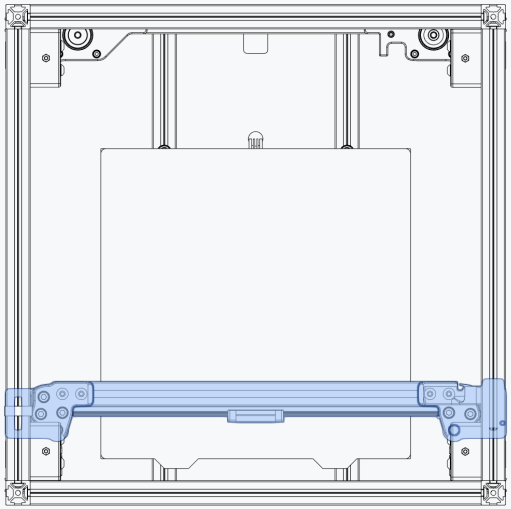
SQUARING THE GANTRY

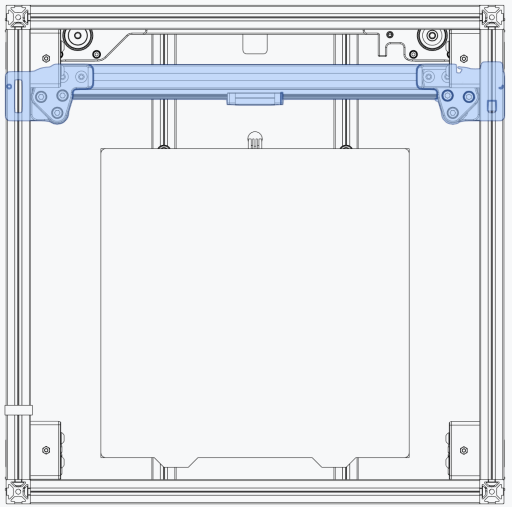
Move the gantry all the way back until it hits the A and B drive on both sides.

Fully tighten all screws on the X axis.

You may need to adjust the distance between the A and B drive to square the gantry. To do this loosen the bolts that secures the B drive to the rear gantry extrusion. Repeat the steps above and secure the fasteners again.

https://voron.link/cekh81l





Voron2.0 was never officially released.

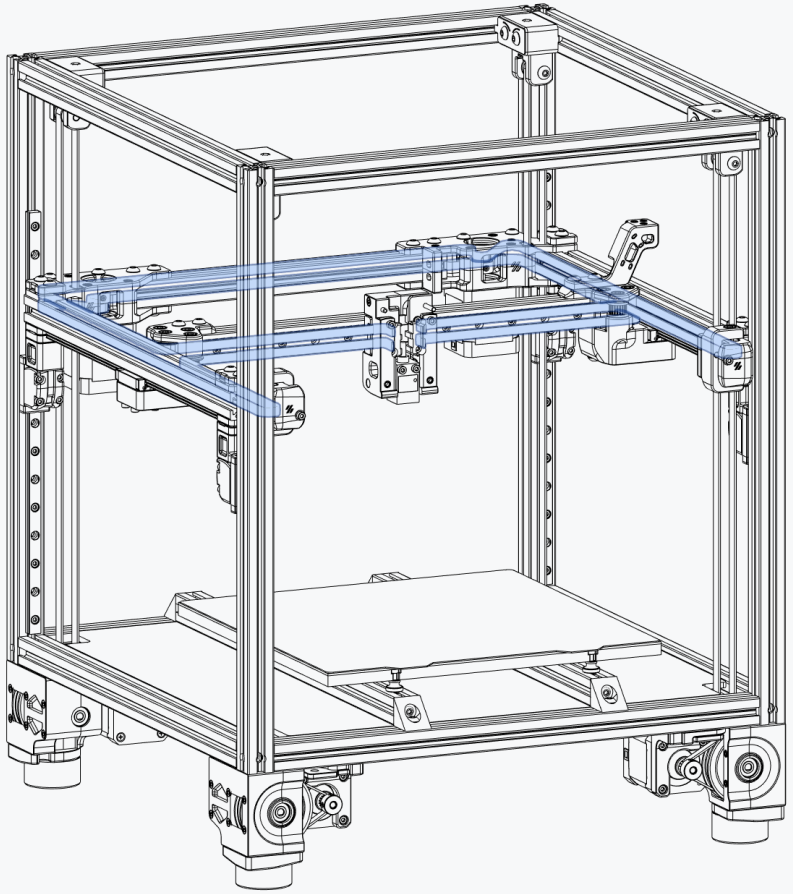
THE VORON BELT PATH

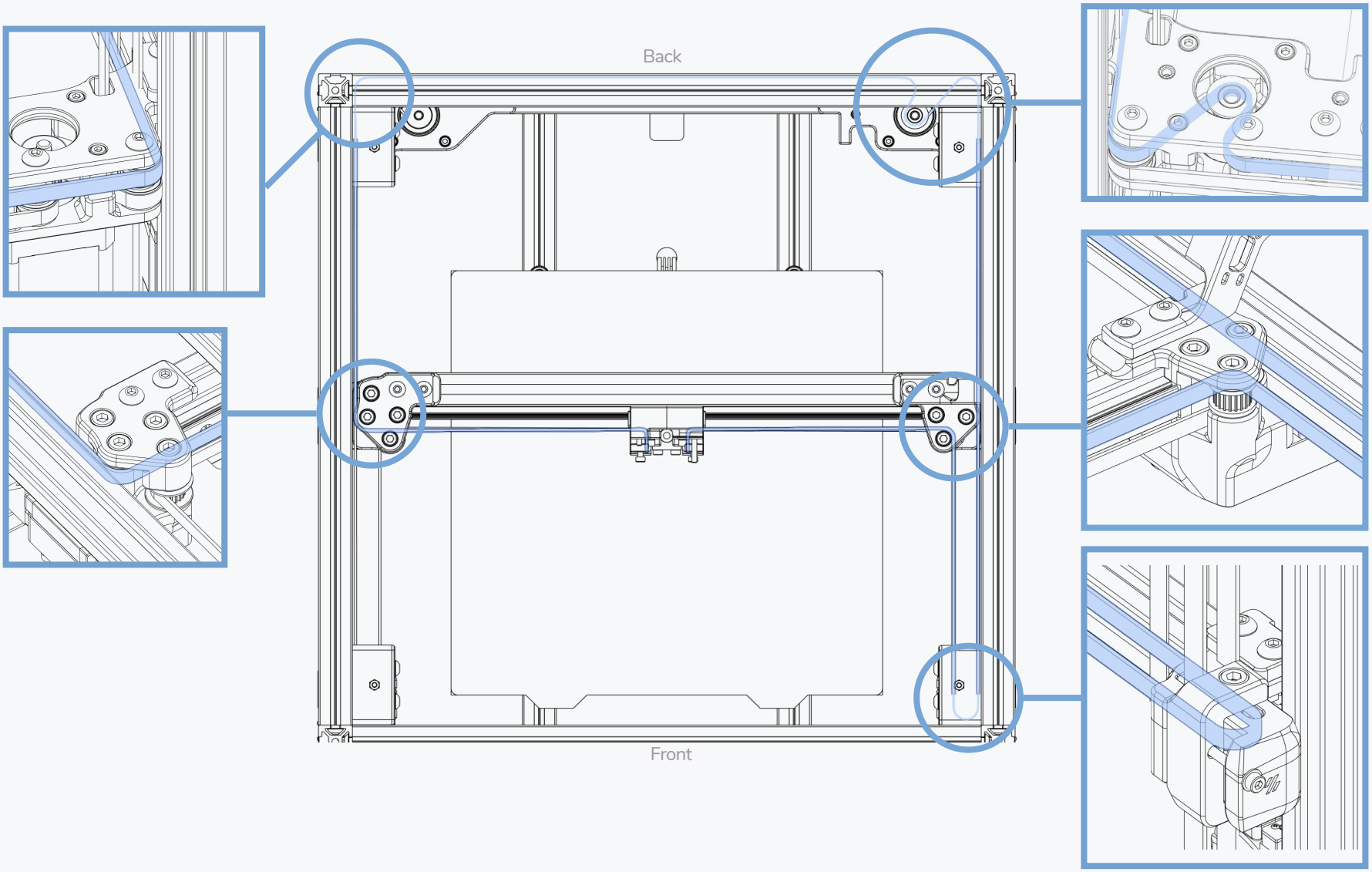
Voron printers use a belt path based on the popular CoreXY pattern.

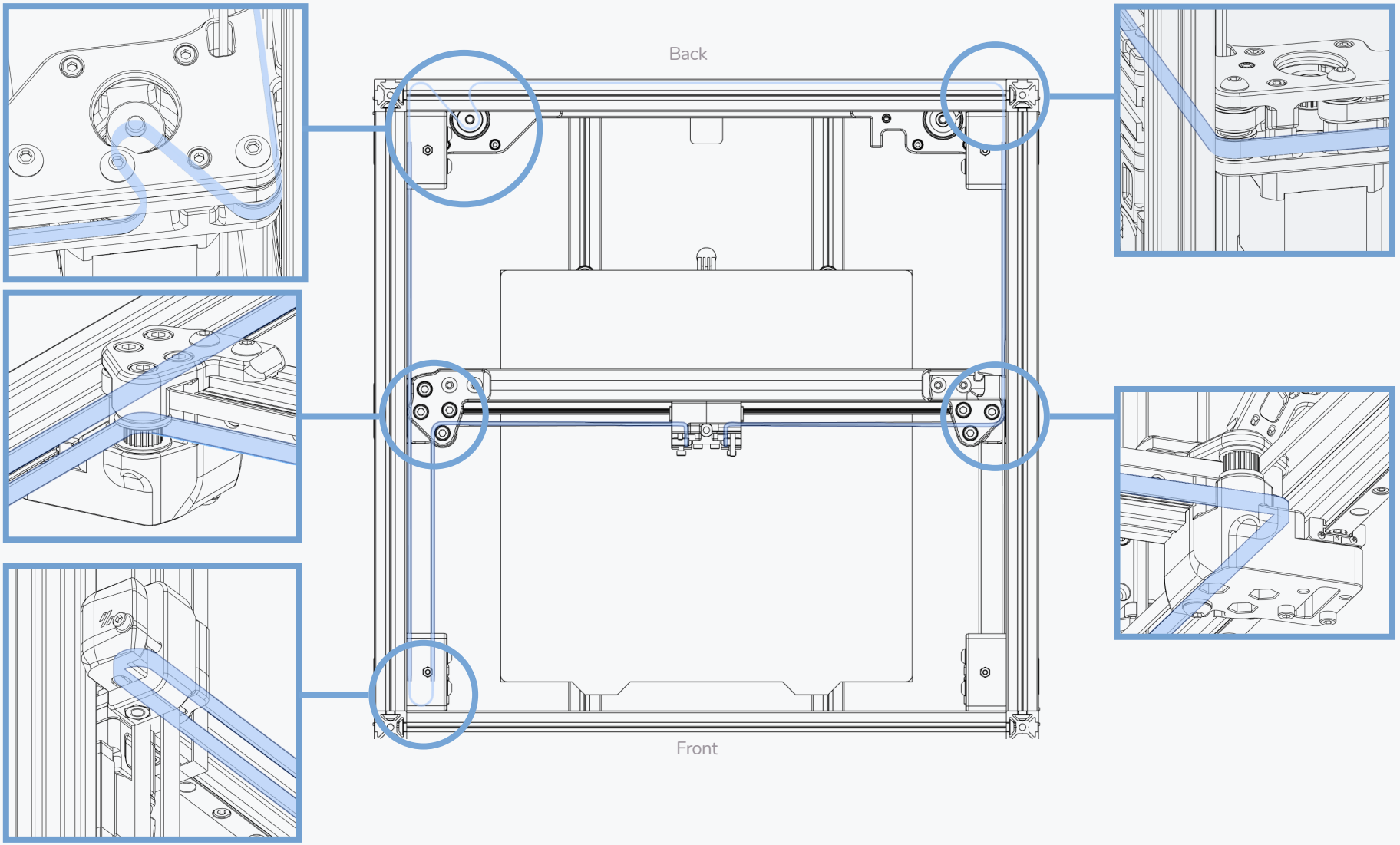
The individual belt paths are stacked on top of each other and the crossing often found in CoreXY designs is omitted. Compared to many other implementations, the motors are moved to a less intrusive position. To learn more about the principles behind CoreXY visit https://voron.link/ef72dd6

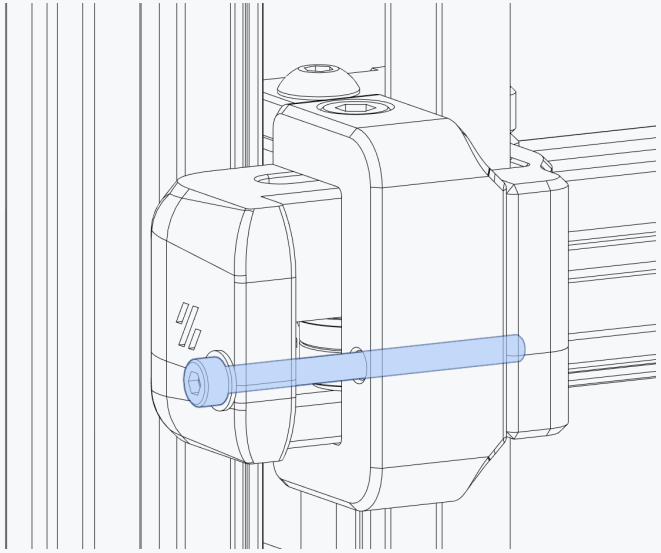
Equal belt tension is important to the proper function of a CoreXY motion system.

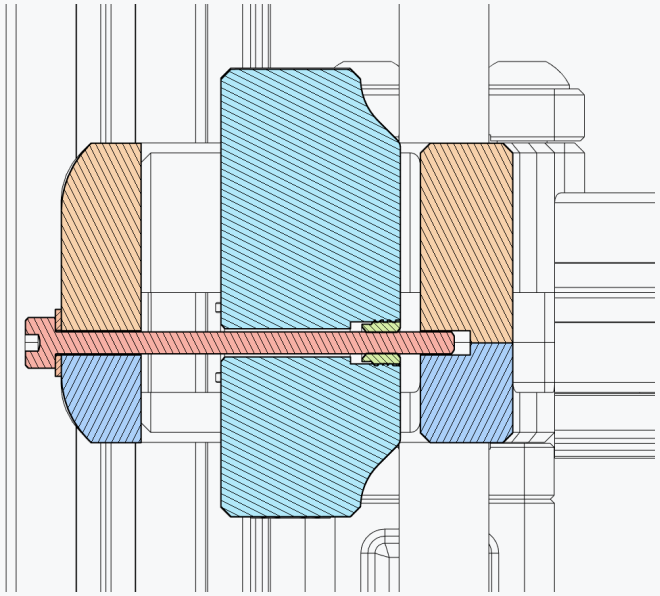
We recommend to run one belt to get the required length, remove the belt from the printer and cut the second belt to the exact same length.
As both belt paths have the same length this is an easy way of getting a consistent tension.




Back
Front


Back
Front



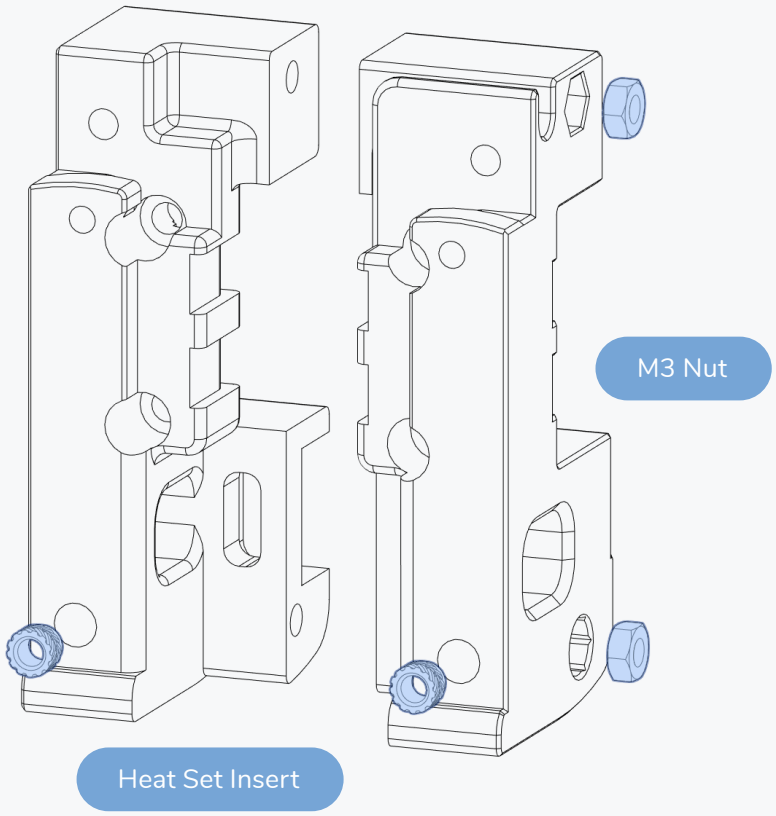


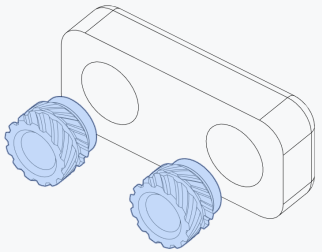
EXTEND IDLER

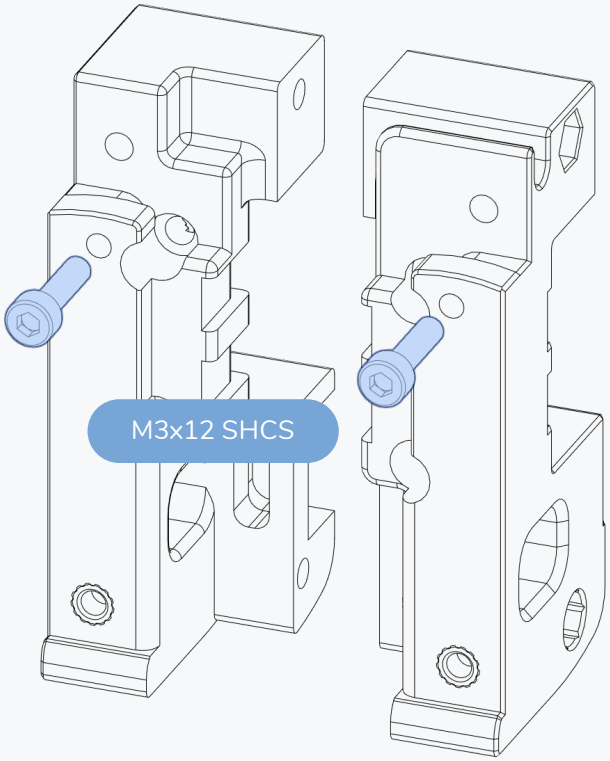
Loosen the idler bolt to extend the idler.

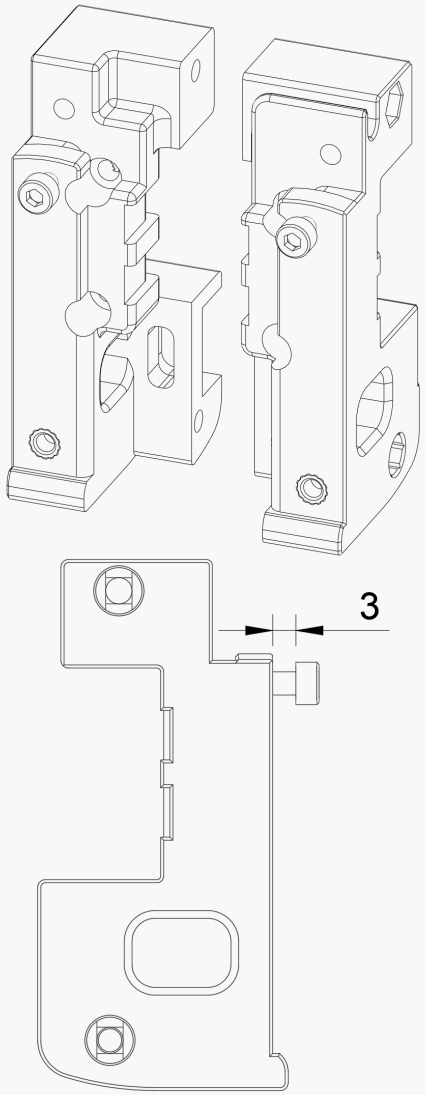
Once extended to the maximum tighten 4 turns.

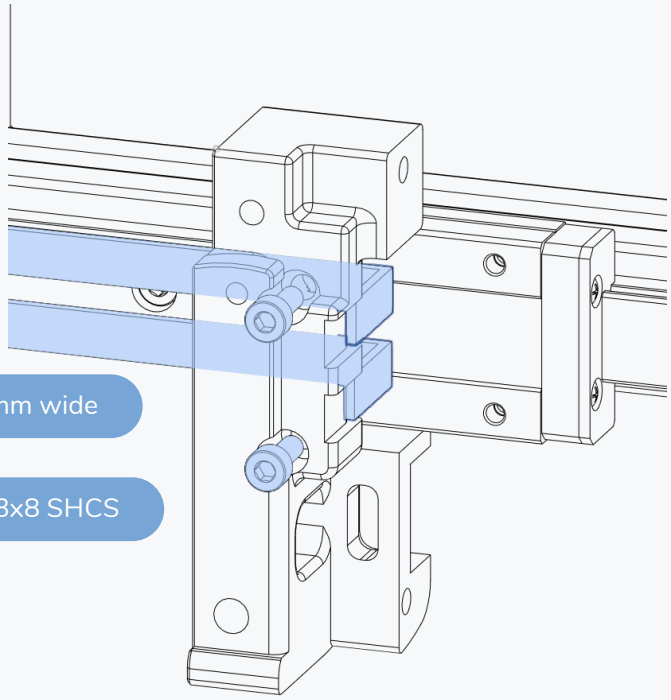
Repeat for the second idler.

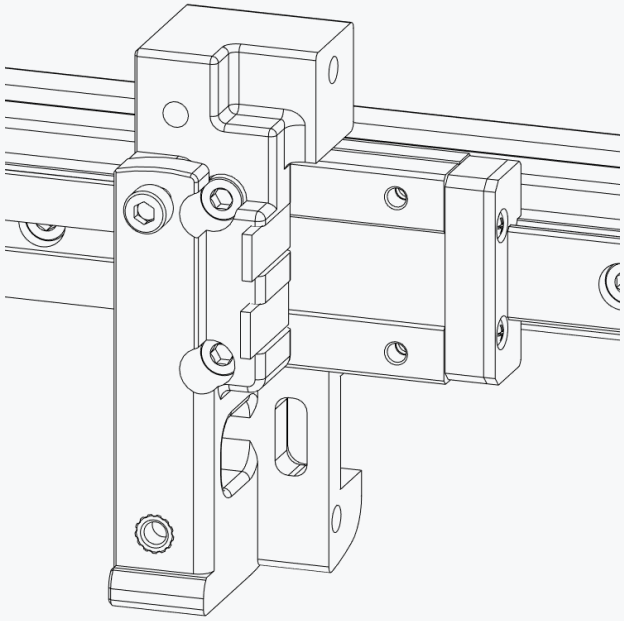

M3 Nut
Heat Set Insert


Heat Set Insert


M3x12 SHCS


3

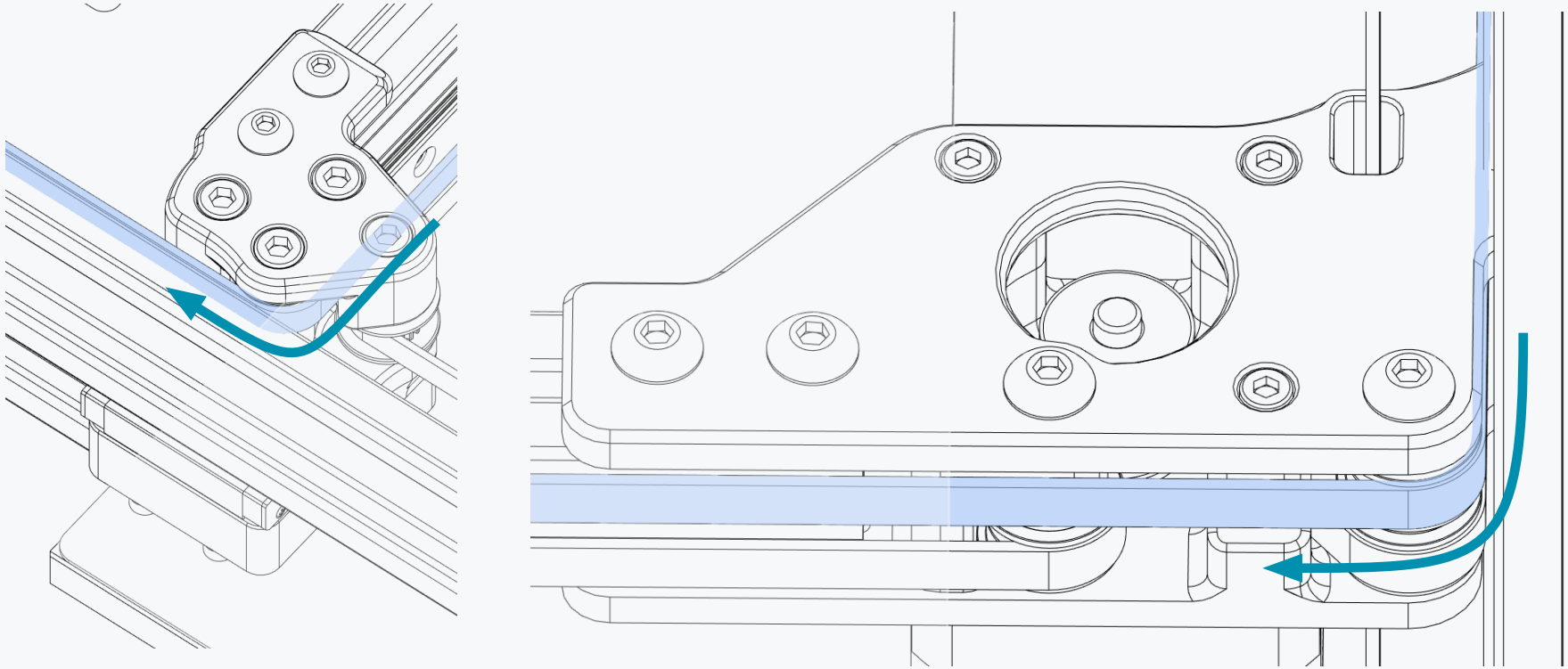




CLAMP BELTS

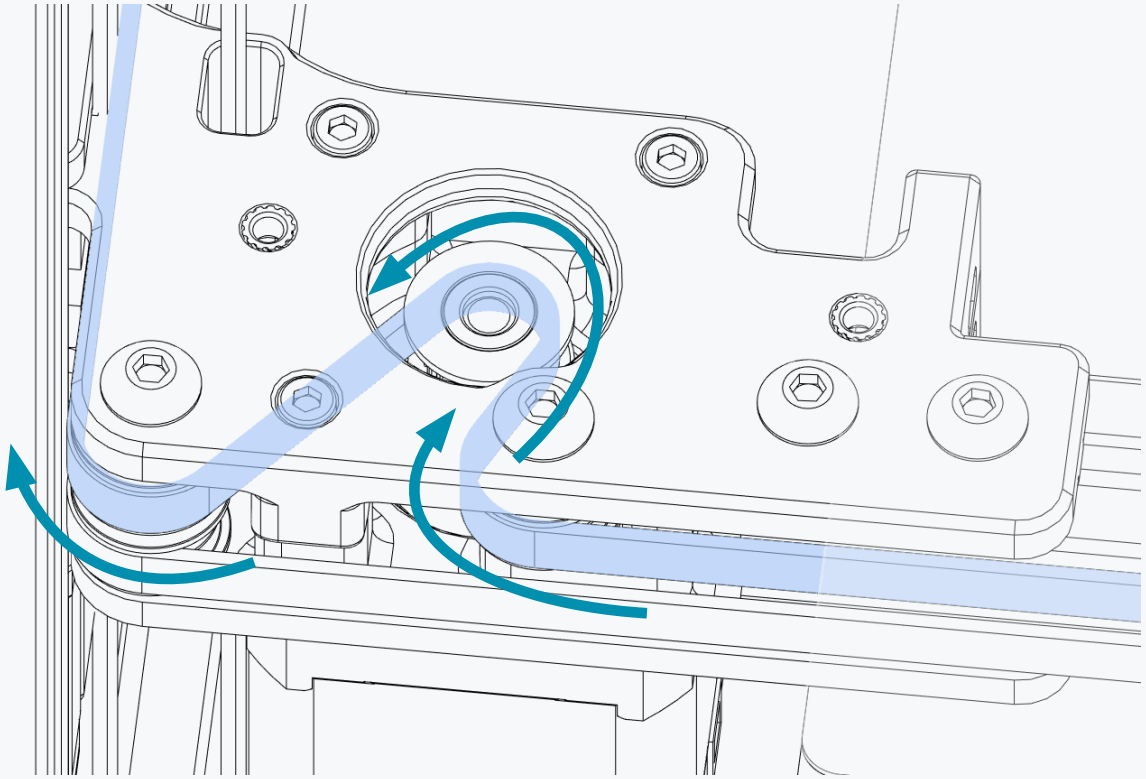
Clamp both A and B belts in place by installing the left X carriage part.

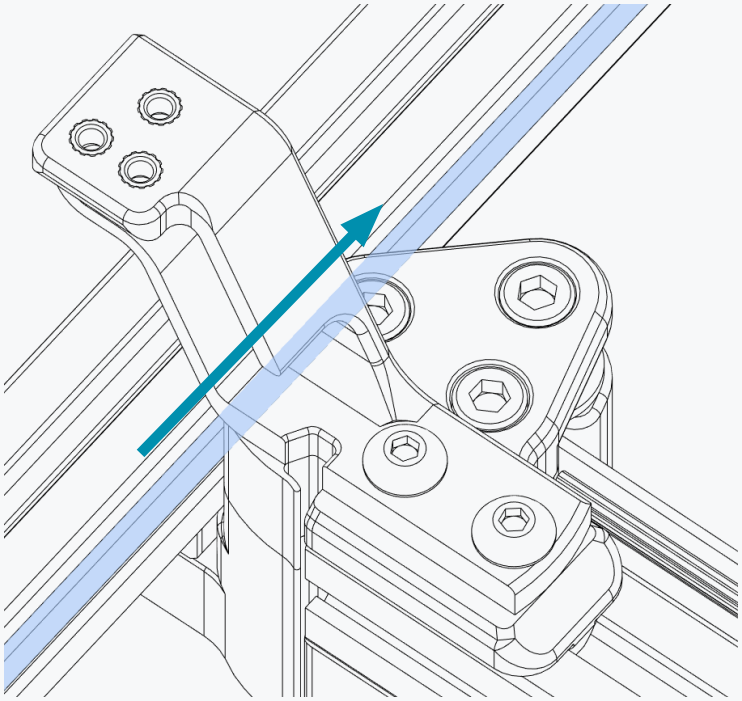
The belt teeth face away from the extrusion.

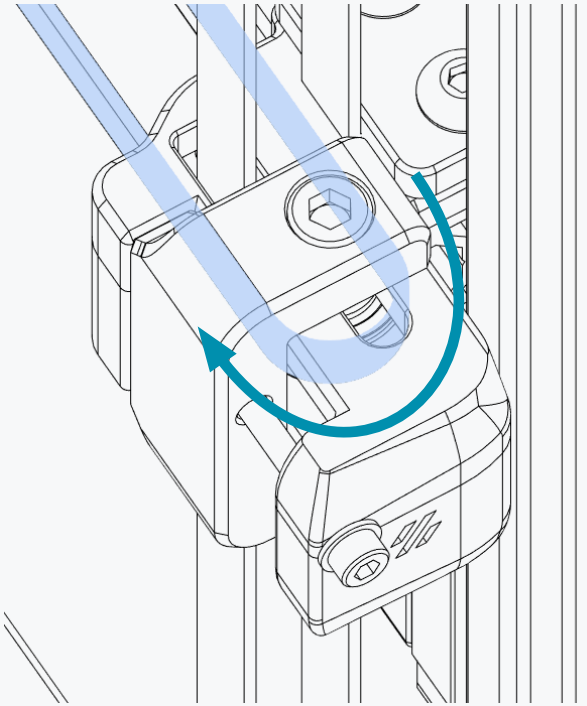


A BELT ROUTING

Follow the path pointed out by the arrows.
Needle nose pliers, tweezers or similar tools
can help in this step.

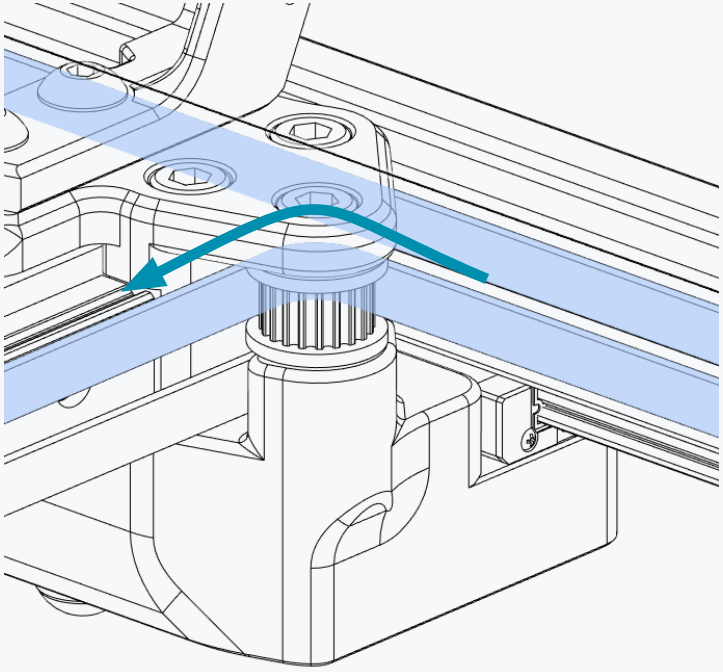


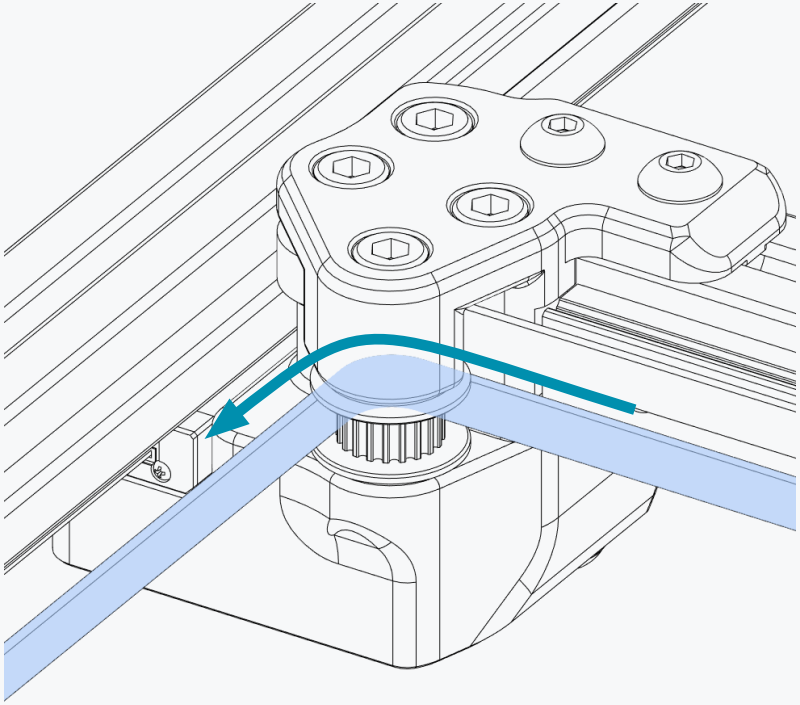




BELTING IDLERS

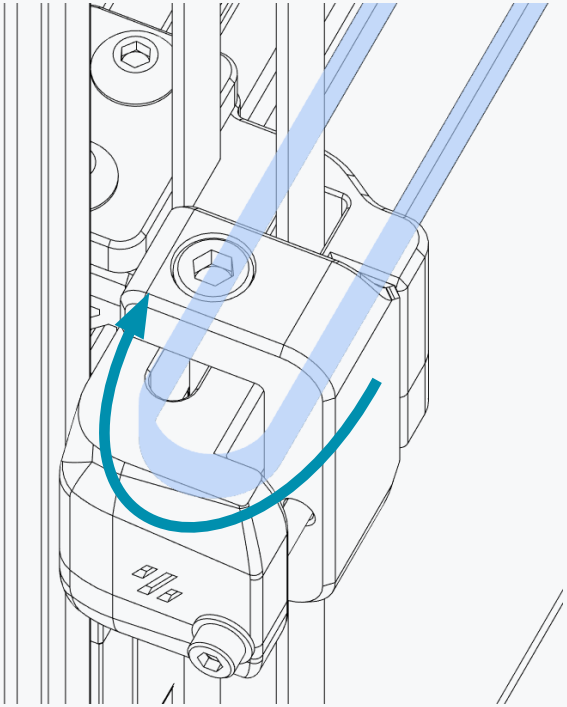
If you're having trouble guiding the belts around the bearing stack temporarily remove the M3x40 SHCS to get better access.





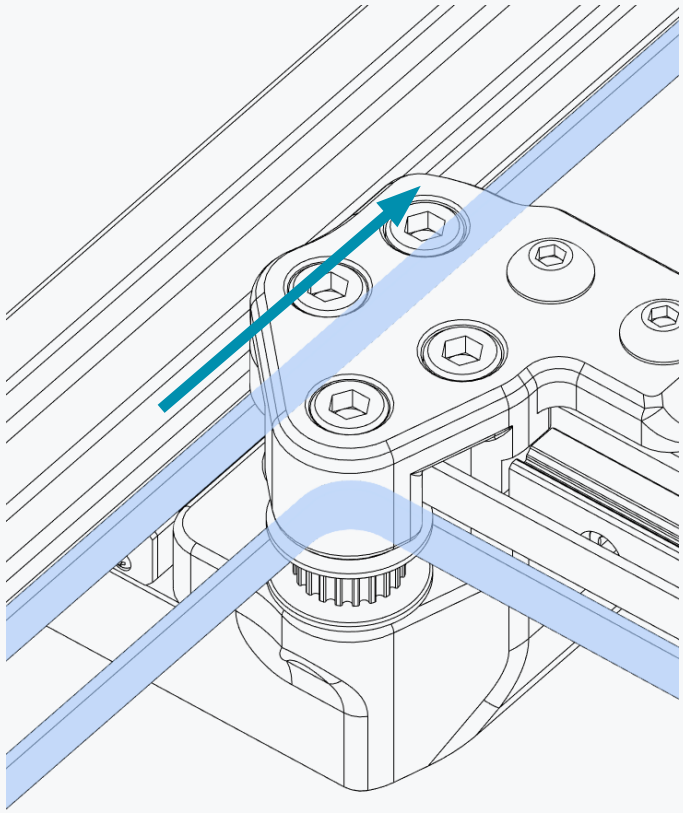
B BELT ROUTING

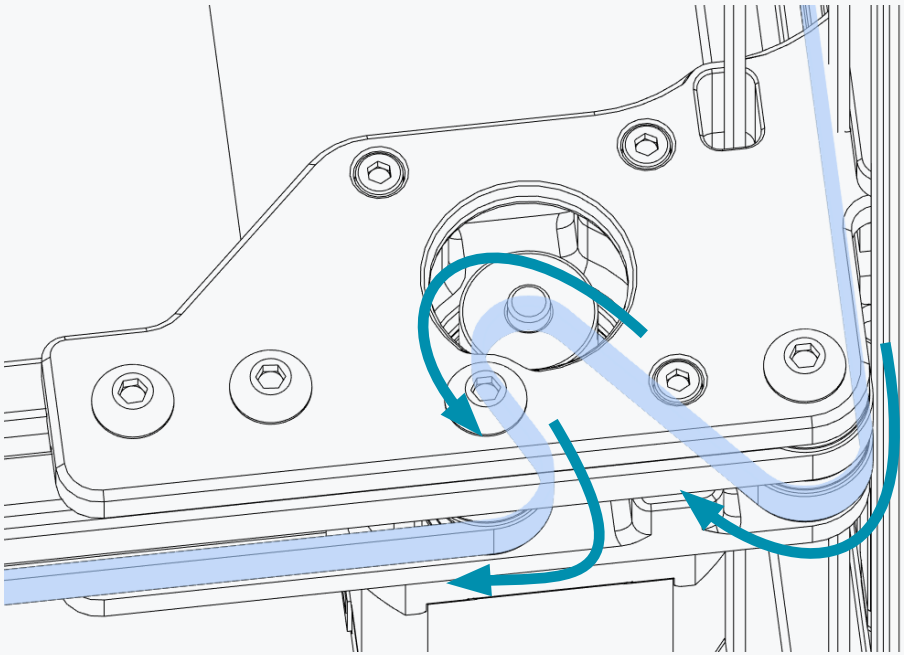
Follow the path pointed out by the arrows. Needle nose pliers, tweezers or similar tools can help in this step.

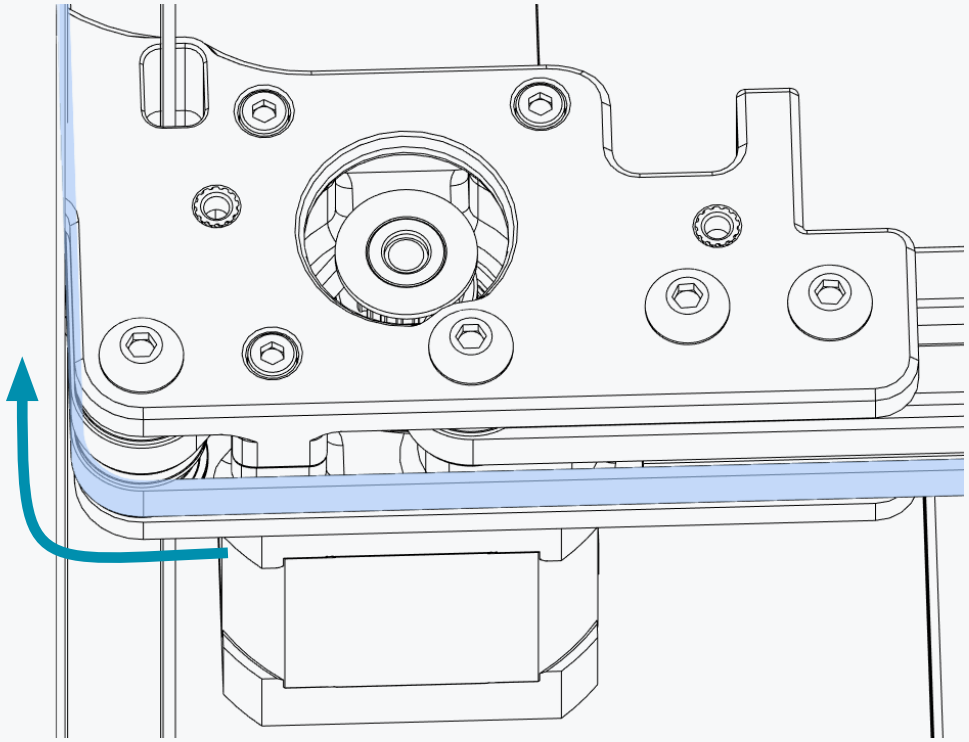


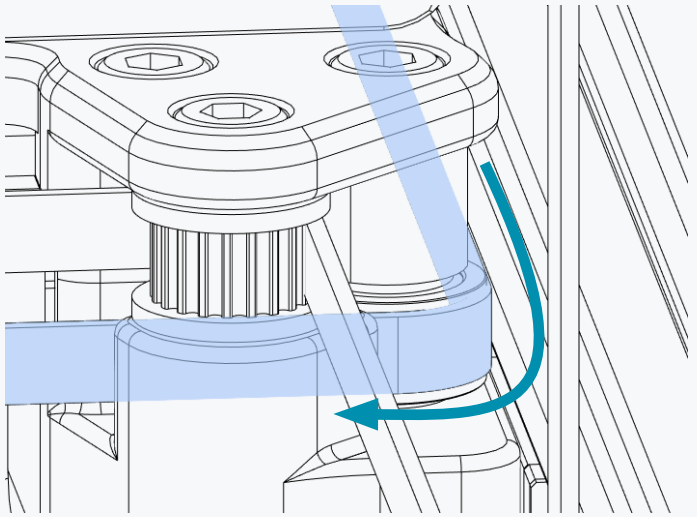
BELTING IDLERS

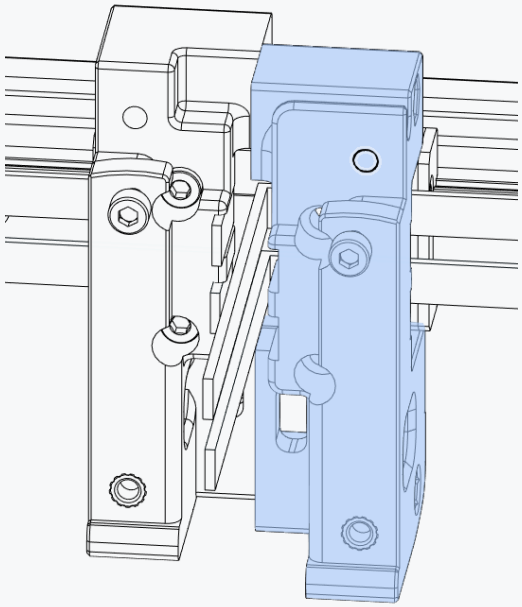
If you're having trouble guiding the belts around the bearing stack temporarily remove the M3x40 SHCS to get better access.





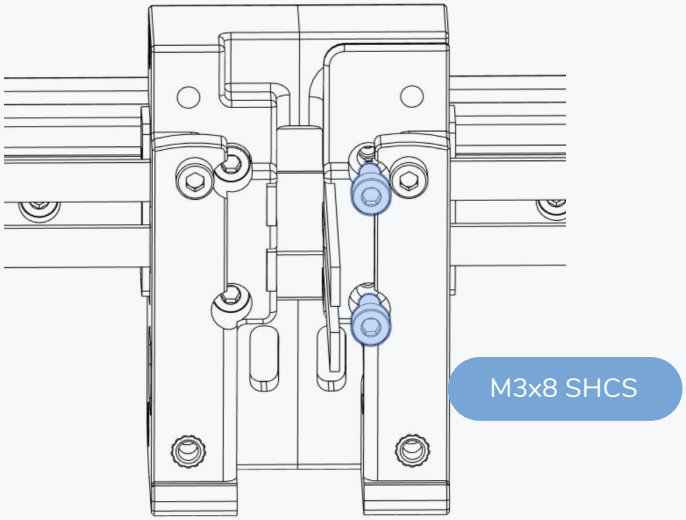






X CARRIAGE

Use the second part of the X carriage to capture the belt ends.



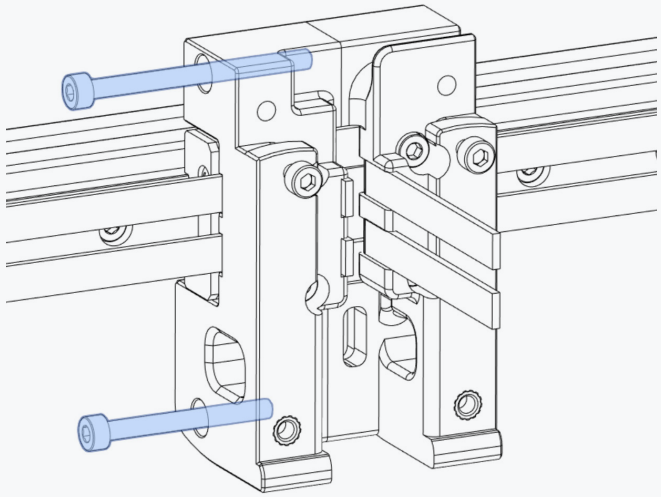
M3x8 SHCS

FIX BELTS

Lightly tighten the screws.

The belt must still be able to move.

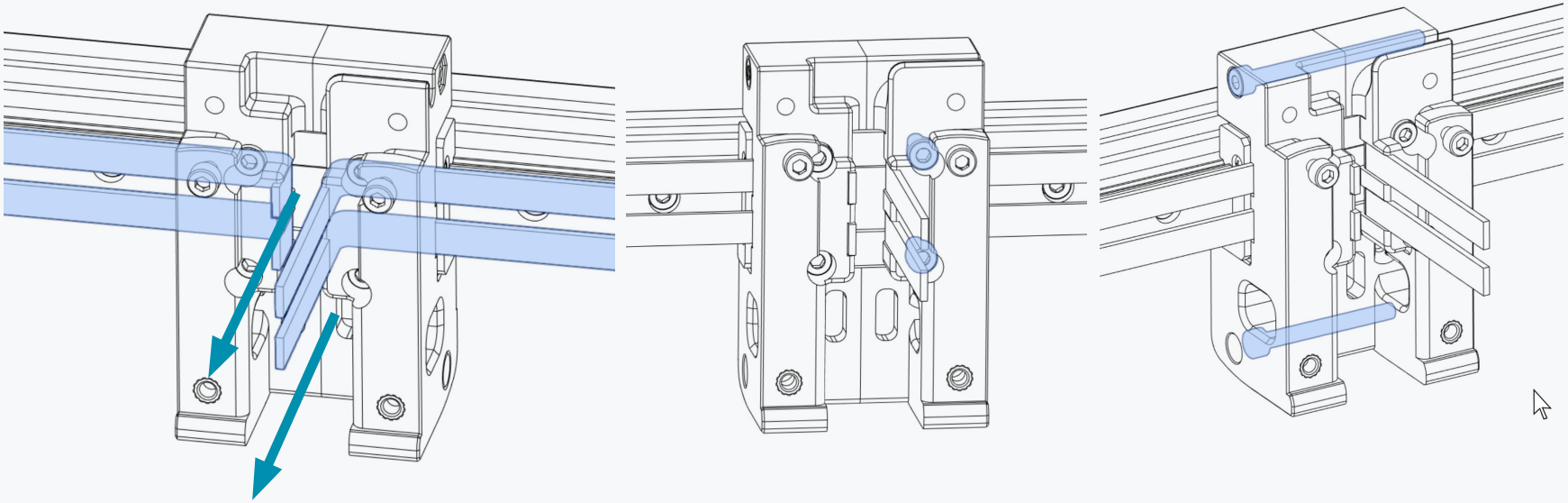
M3x40 SHCS



M3x30 SHCS

LEAVE LOOSE

Lightly tighten the bolts.



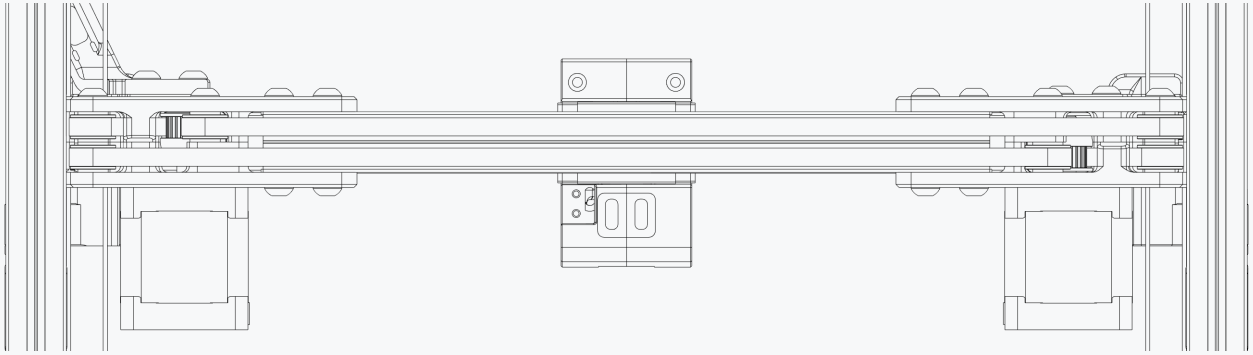
PULL TIGHT

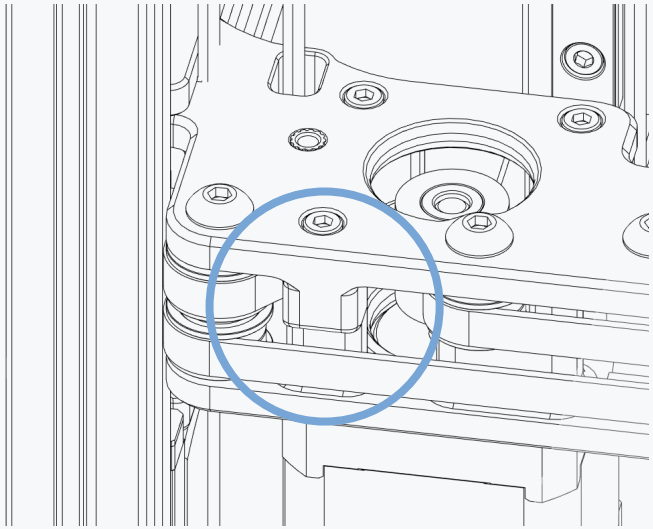
Grab both belt ends with a pair of pliers and pull the belt tight.

As both belts are cut to the exact same total length and the belt paths are equal length in this design make sure the same length of belt protrudes from the carriage.

TIGHTEN BOLTS

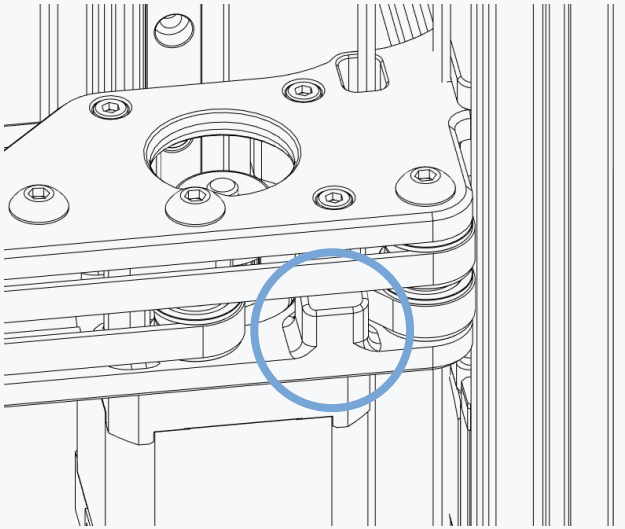
Fully tighten the carriage bolts.

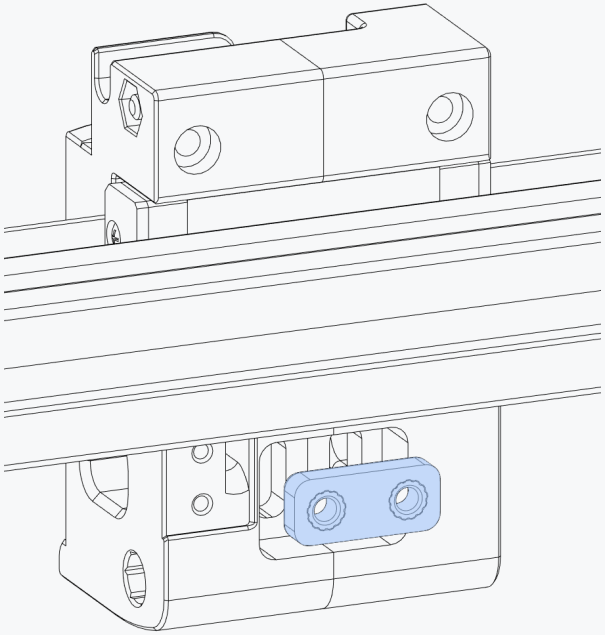




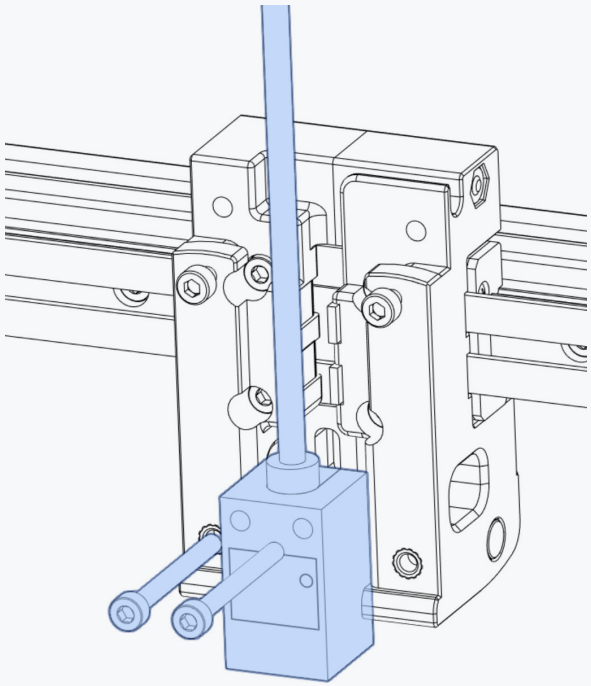
CHECK YOUR WORK

Make sure that the belt is not riding on the plastic parts.





M3x30 SHCS



Inductive Probe

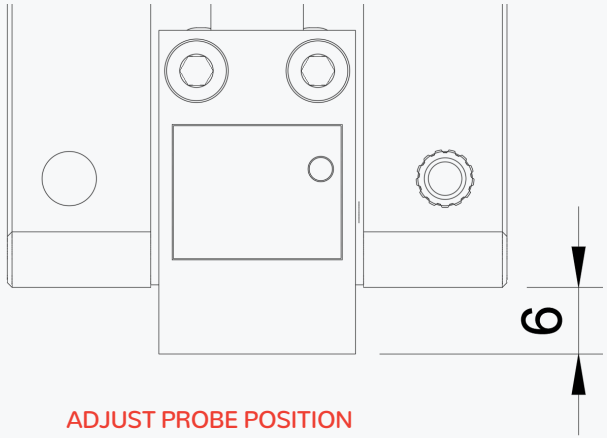
PROBE WIRES

Cut the probe wires to about 150mm.

OTHER PROBE TYPES

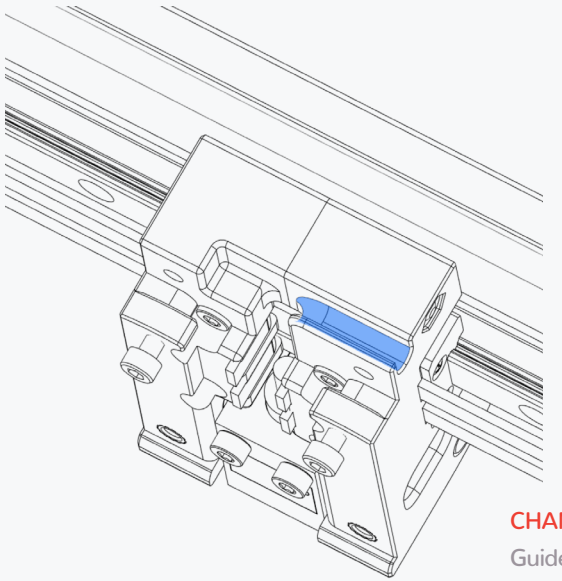
The picture shows the recommended Omron TL-Q5MC probe.

Other probes with a similar form factor and characteristics might work as well. A design for a PINDA probe adapter is included in the released files.



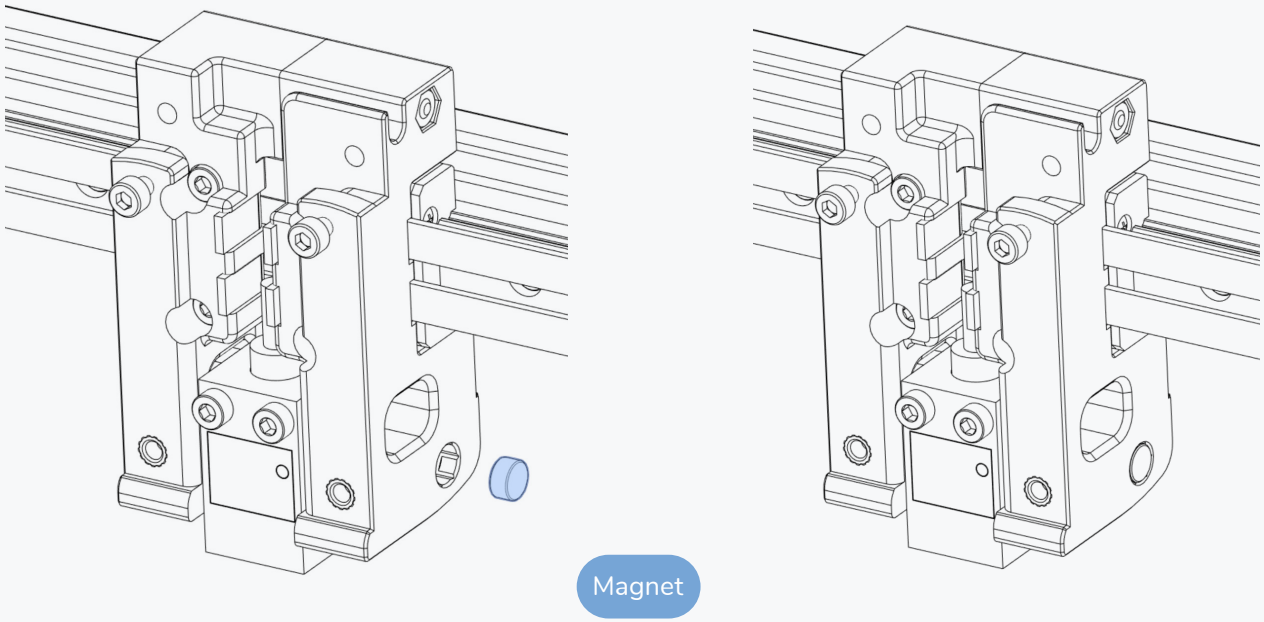
ADJUST PROBE POSITION

The position can be fine-tuned later. Set an initial position of about 6mm below the plastic part.



CHANNEL FOR PROBE CABLE

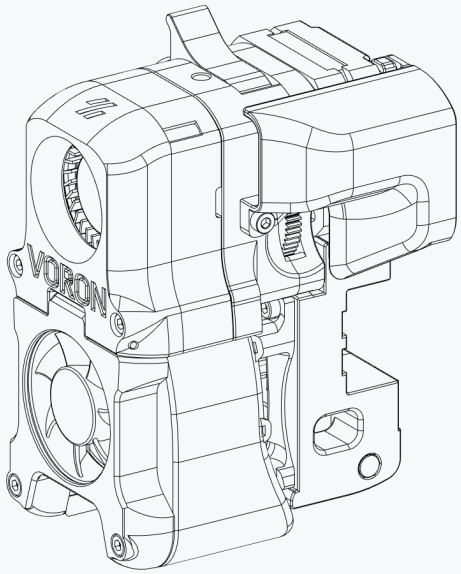
Guide the probe cable into the highlighted slot.

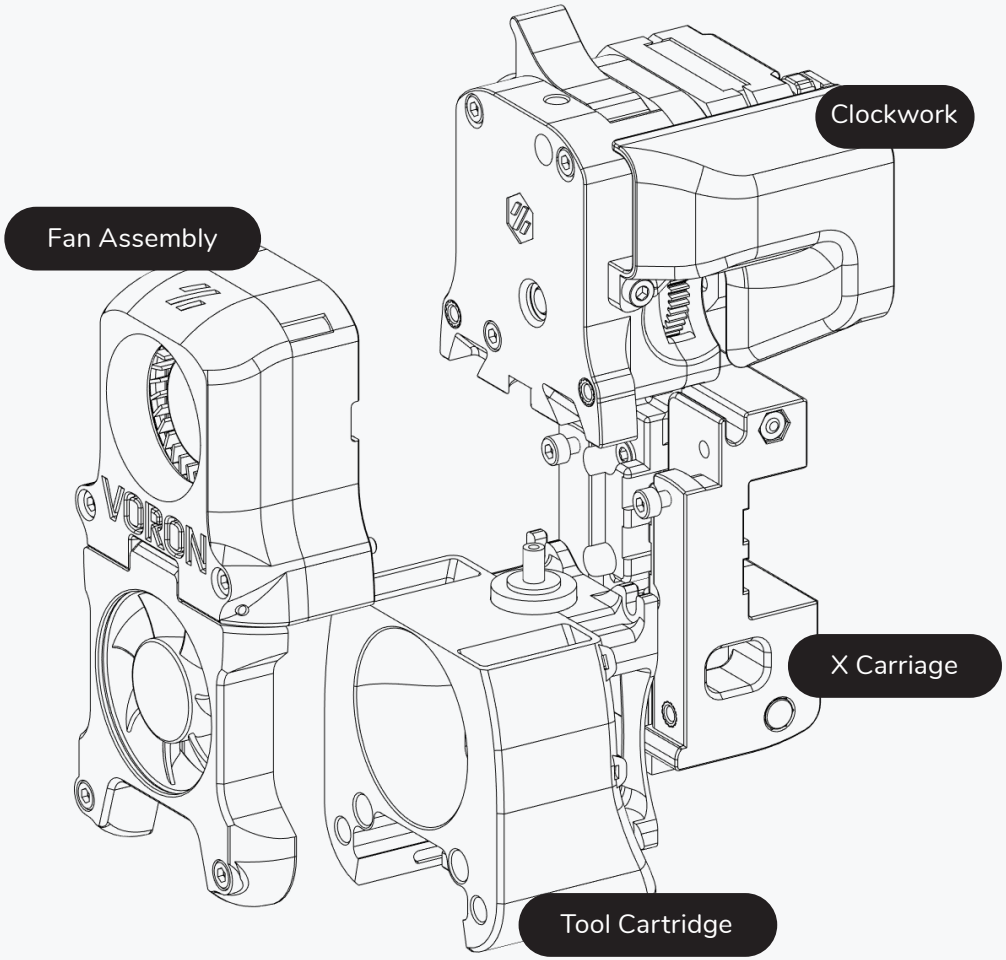


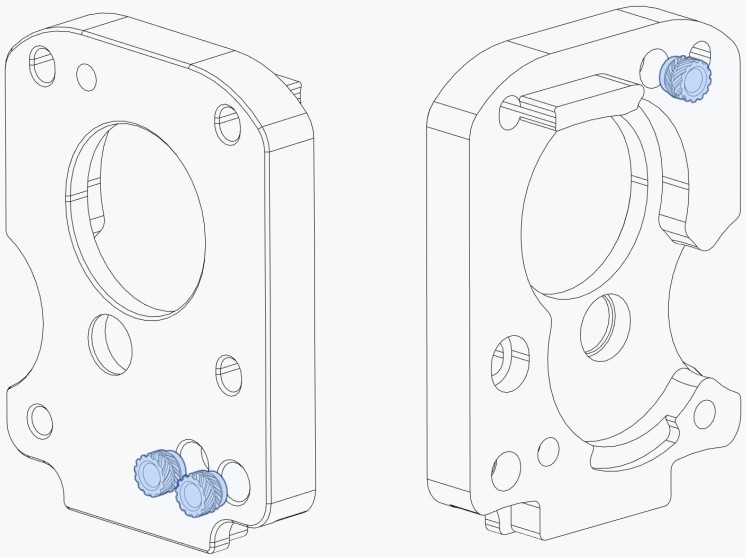
OPTION: HALL EFFECT ENDSTOP

If you are using a Hall Effect Endstop insert a 3x6 magnet into the highlighted position.

VORON


VORON


Clockwork
Fan Assembly
VORON
X Carriage
Tool Cartridge



Heat Set Insert

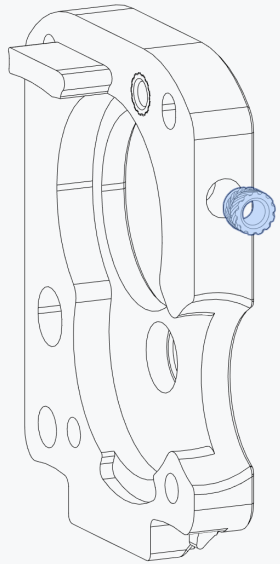
HEAT SET INSERTS

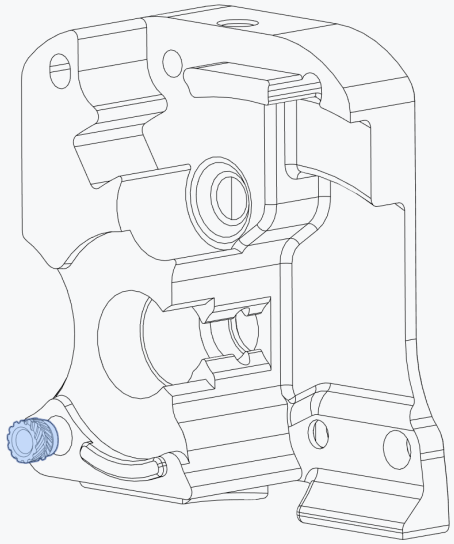
You will need to install heat set inserts into various plastic parts.

If you need help on the correct procedure, ask in Discord.

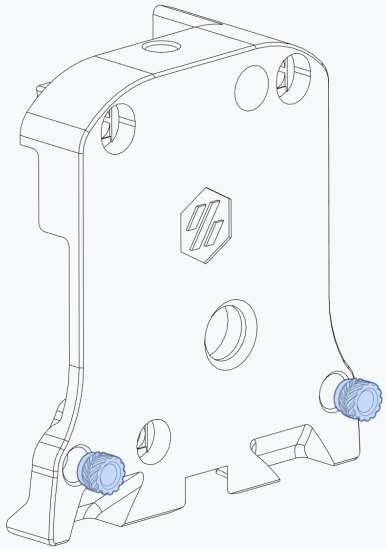
OPTION: TOOLHEAD PCB

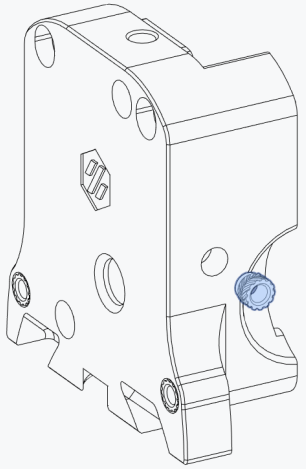
If you opt to use a toolhead PCB, add an additional heat set insert into the alternate part.





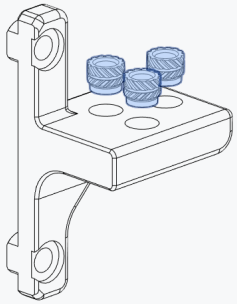
Heat Set Insert





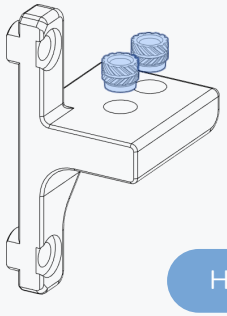
GENERIC CABLE CHAINS

The 3 hole pattern is usually found on generic cable chains.

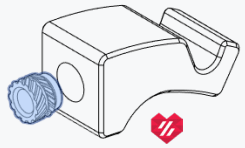


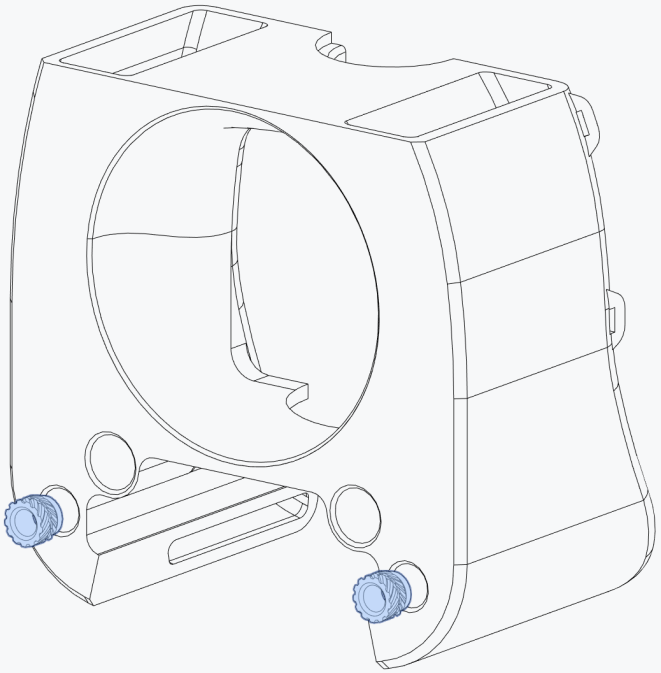
IGUS CABLE CHAINS

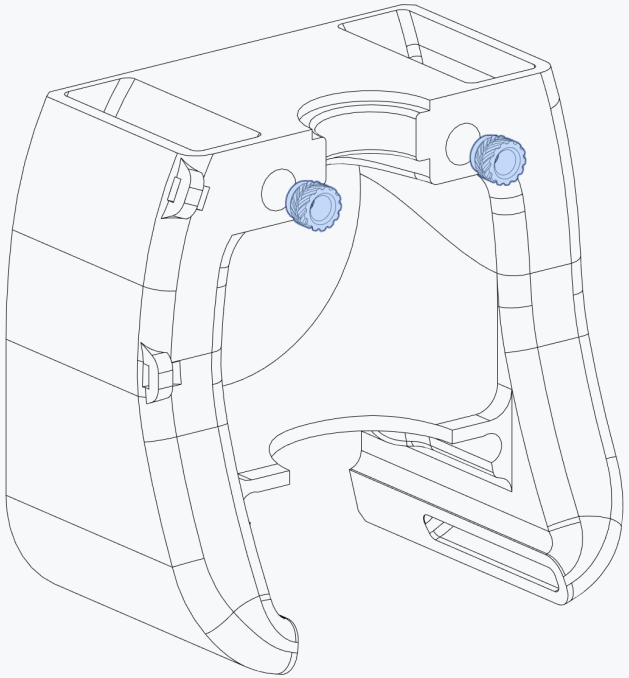
IGUS chains have 2 mounting holes.



Heat Set Insert



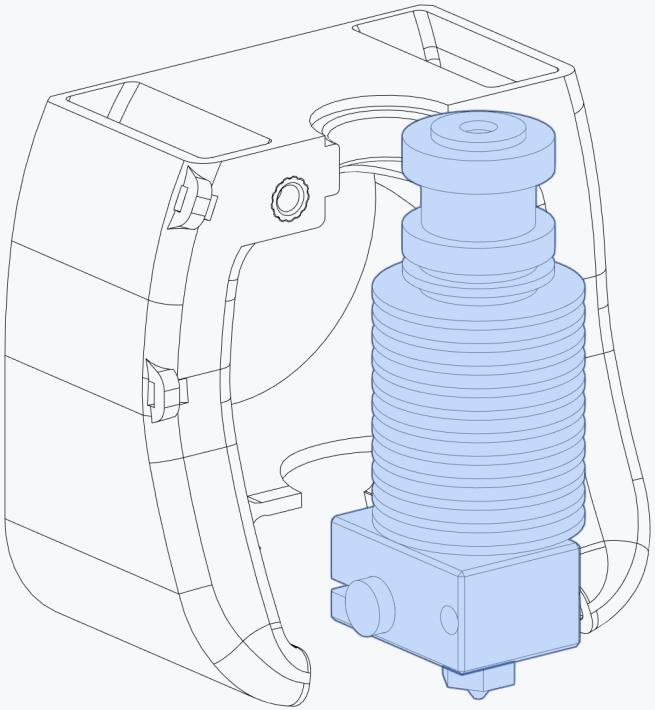


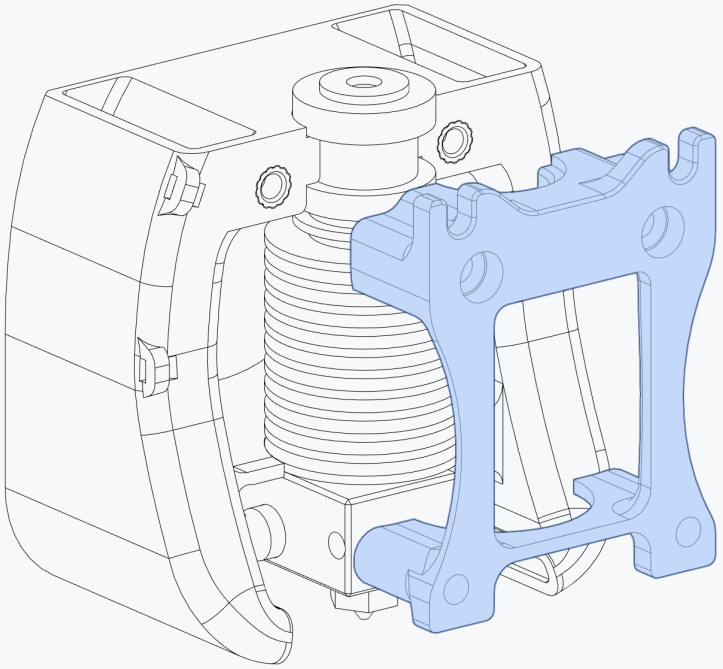


Heat Set Insert

AVAILABLE MOUNTS

We also provide mounts for other hotends.
They are assembled in a similar manner.





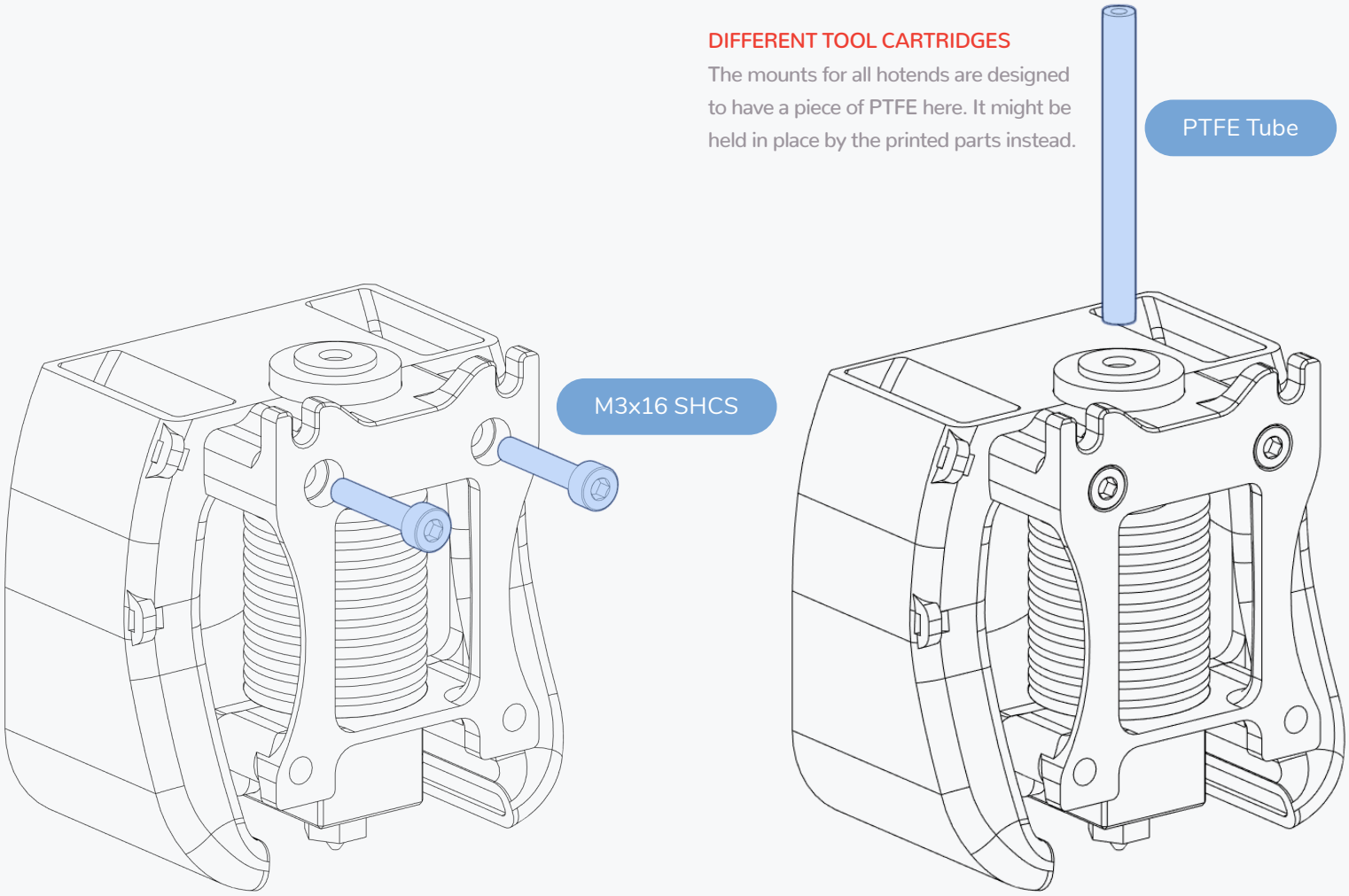
E3D V6 Hot End

HEATER AND SENSOR

We do not show the heater and temperature sensor cartridge in the drawing. Install them prior to assembling the toolhead.

DIFFERENT TOOL CARTRIDGES

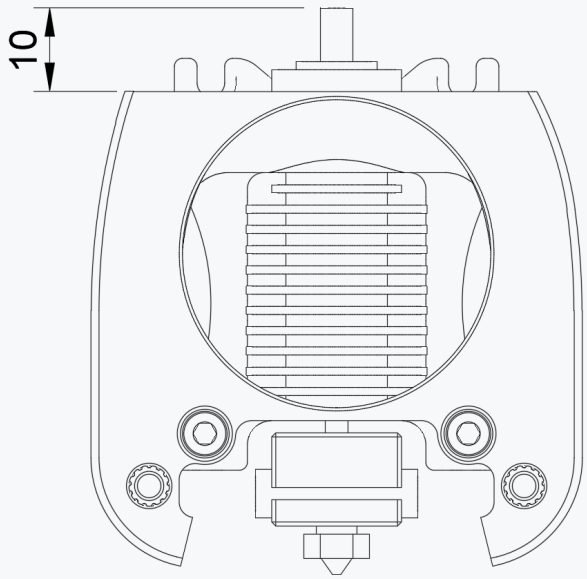
The mounts for all hotends are designed to have a piece of PTFE here. It might be held in place by the printed parts instead.

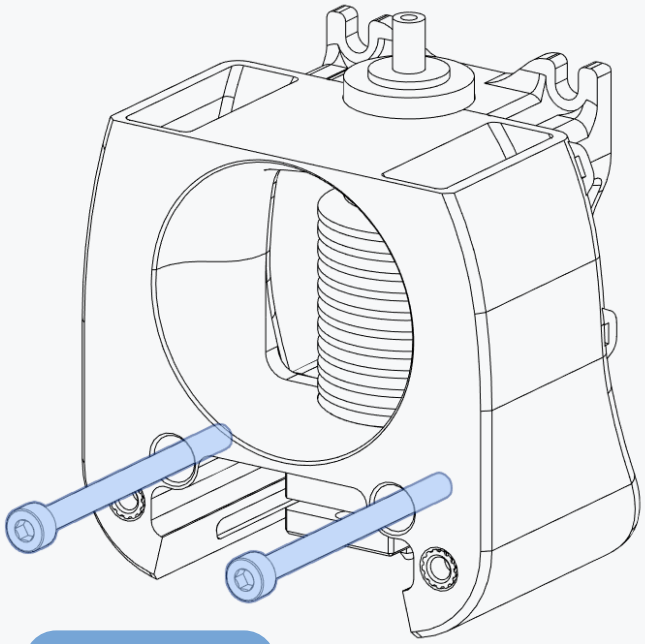


PTFE STICKOUT

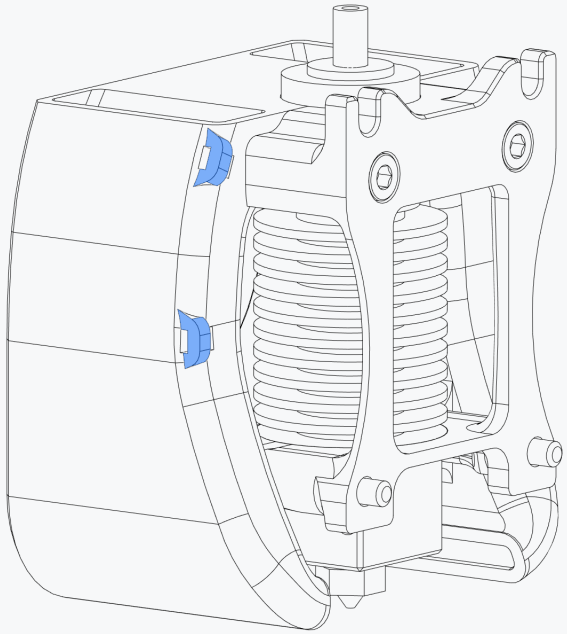
The PTFE tube should end 10mm above the surface of the printed part.

The stick out length might vary if you use an extruder other than the Clockwork.



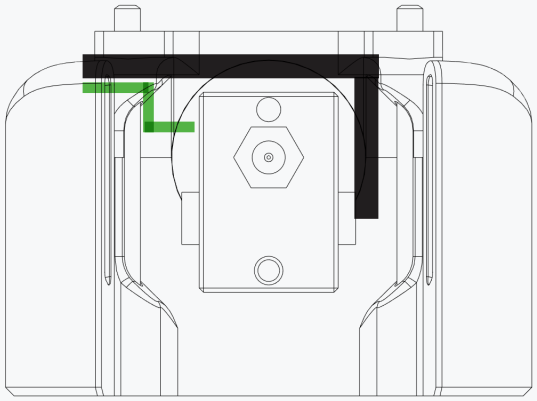


M3x40 SHCS



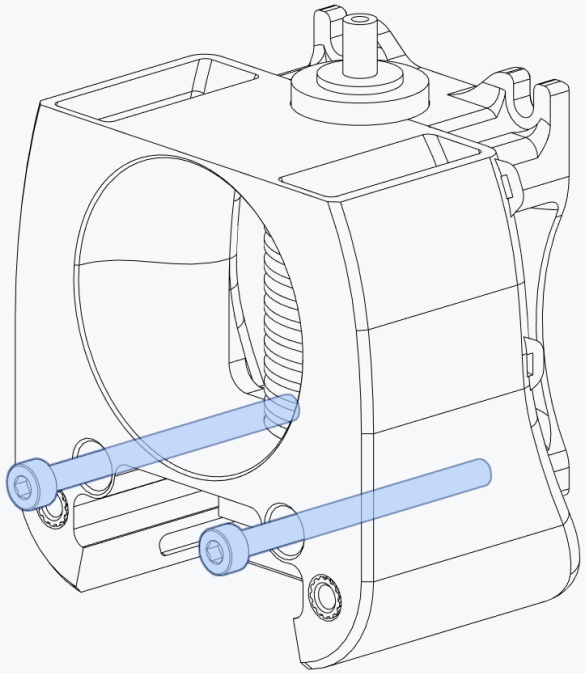
WIRING PATH

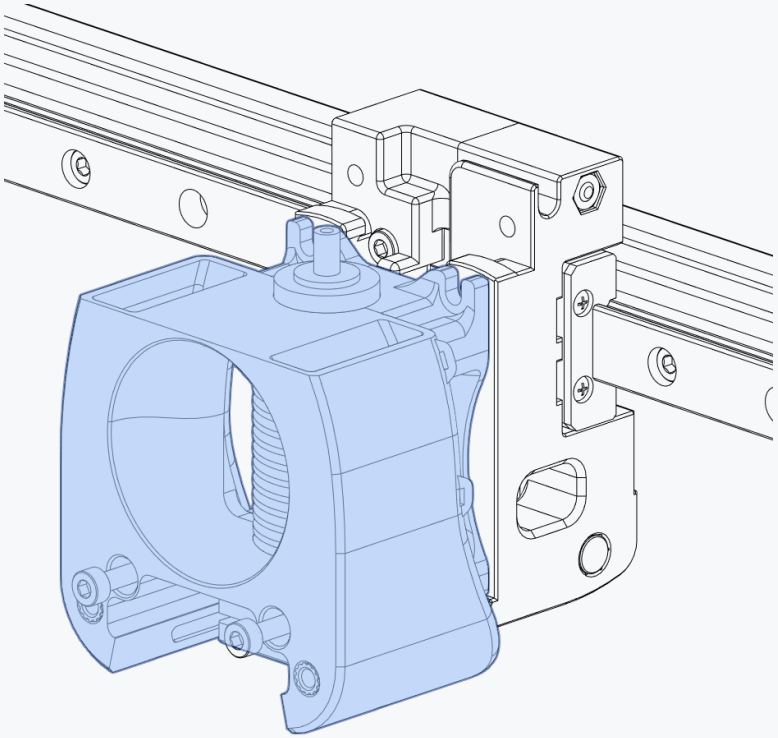
Guide the wires in the highlighted path.

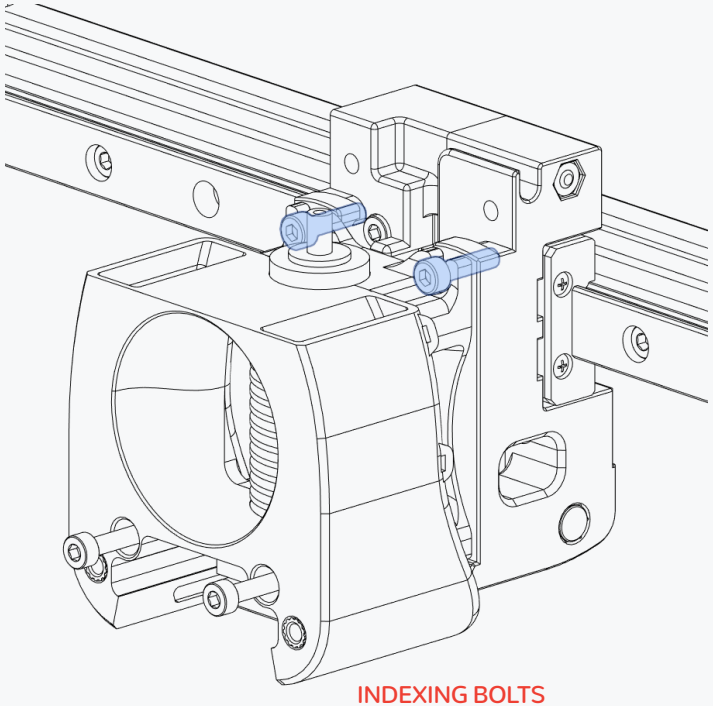


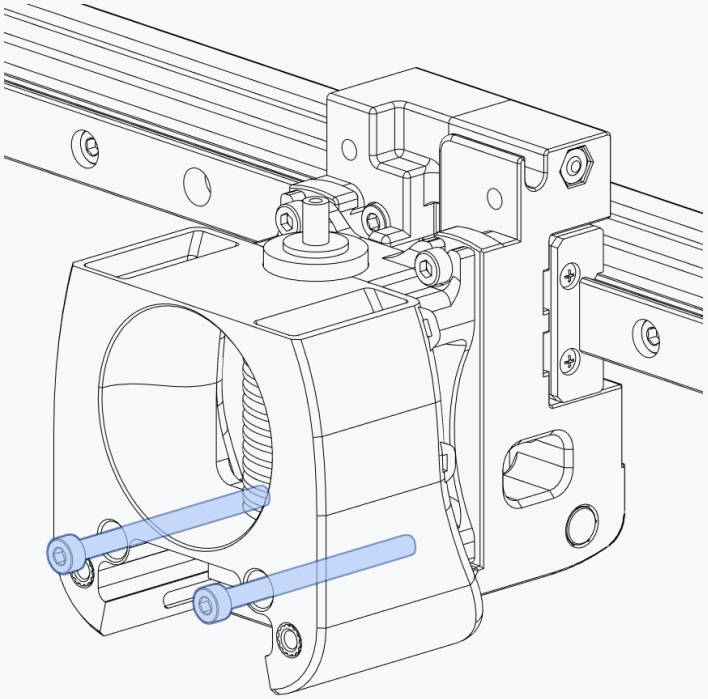
CHECK ORIENTATION

The heater block must point forwards.





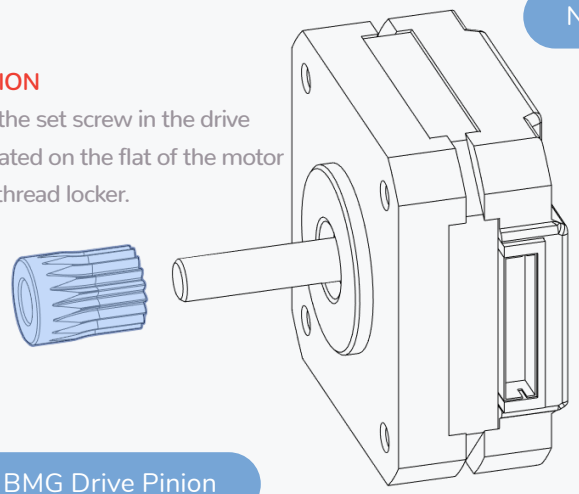




INDEXING BOLTS

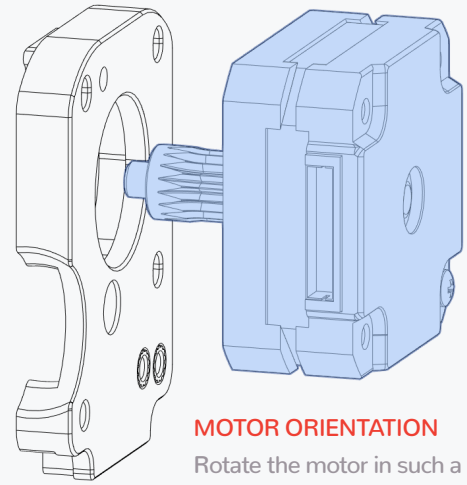
The bolts are used to index the tool cartridge. Leave them slightly loose so that the cartridge can be slid out.

NEMA 17 Stepper



DRIVE PINION

Make sure the set screw in the drive pinion is seated on the flat of the motor shaft. Use thread locker.

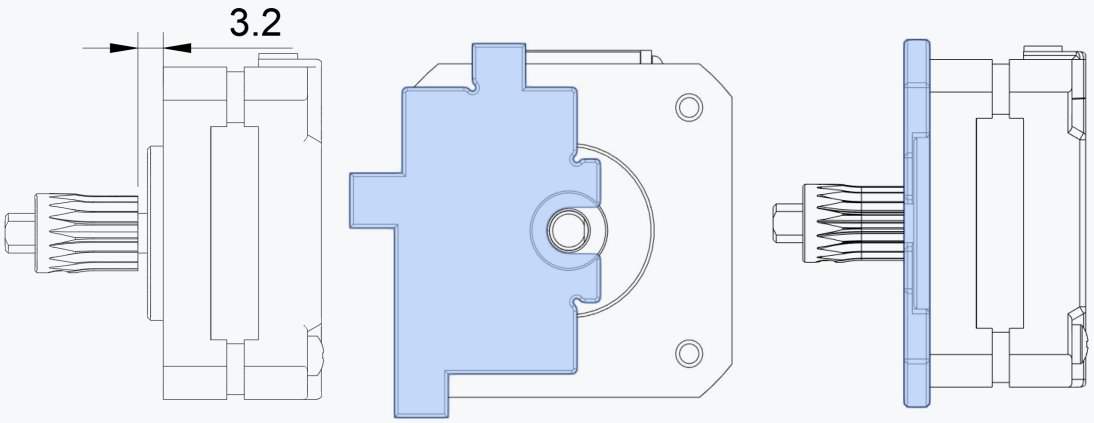


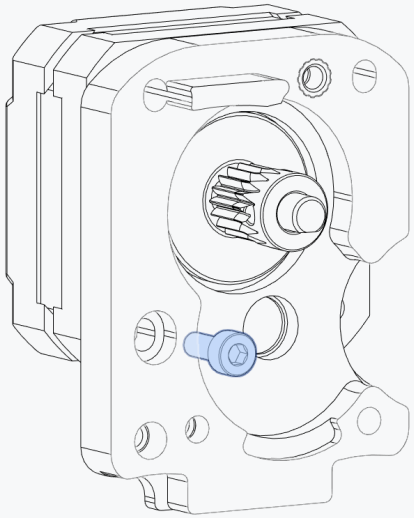
MOTOR ORIENTATION

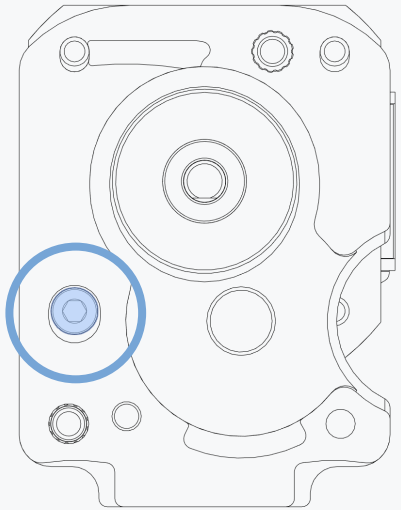
Rotate the motor in such a way that the connector/wires are on the left side when looking at it from the back.

This side will be covered by the cable cover later.

BMG Drive Pinion



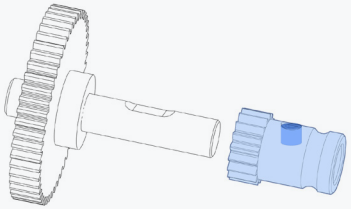




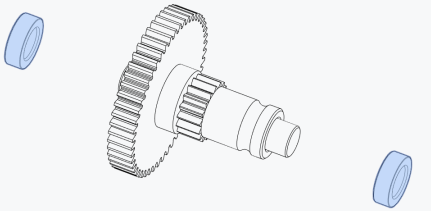
ADJUSTABLE MOTOR POSITION

The motor position is adjustable to allow for a proper meshing of the drive gears.

Start in the topmost position of the slot.



BMG Drive Gear



MR85 Bearing

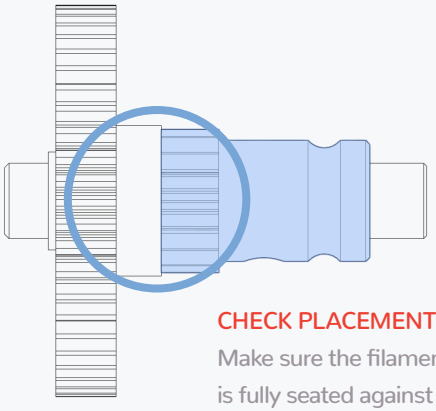
DRIVE GEAR

Make sure the set screw in the filament drive gear is seated against the notch in the shaft. Carefully tighten the set screw, the head is easy to strip.

CHECK BEARING FIT

The bearings must slip on and off the shaft easily to allow the gear to self-centre. Do not shim into position.

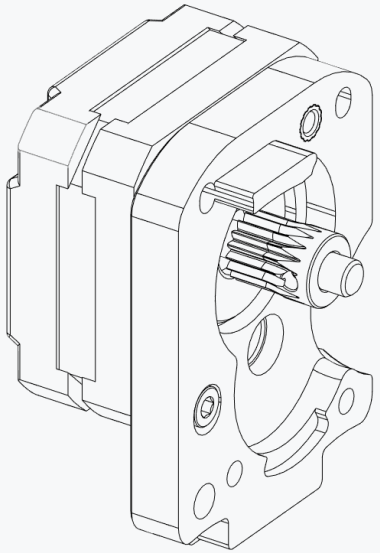
Pressing the bearings on the shaft will damage them.
Lightly sand the shaft if required.

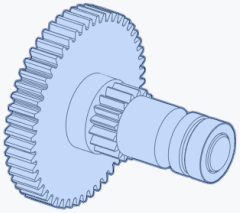


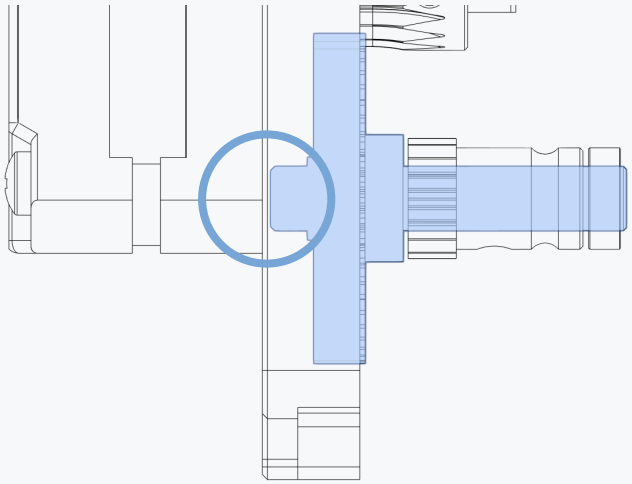
CHECK PLACEMENT

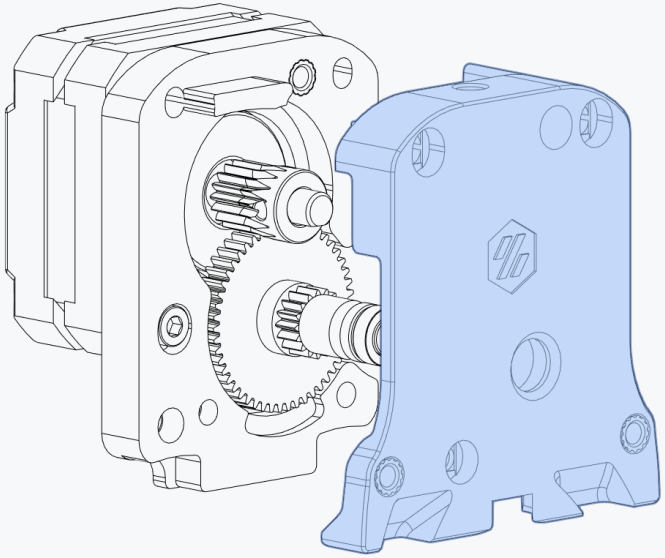
Make sure the filament drive gear is fully seated against the drive shaft gear.

https://voron.link/p0xac5e

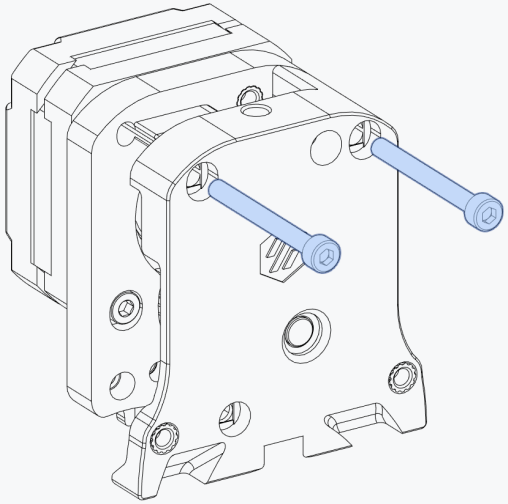








M3x30 SHCS

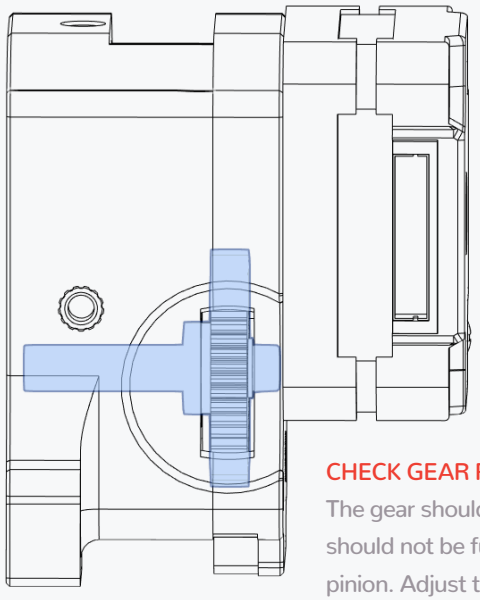


CHECK FOR CLEARANCE

The drive shaft must not touch the motor housing.

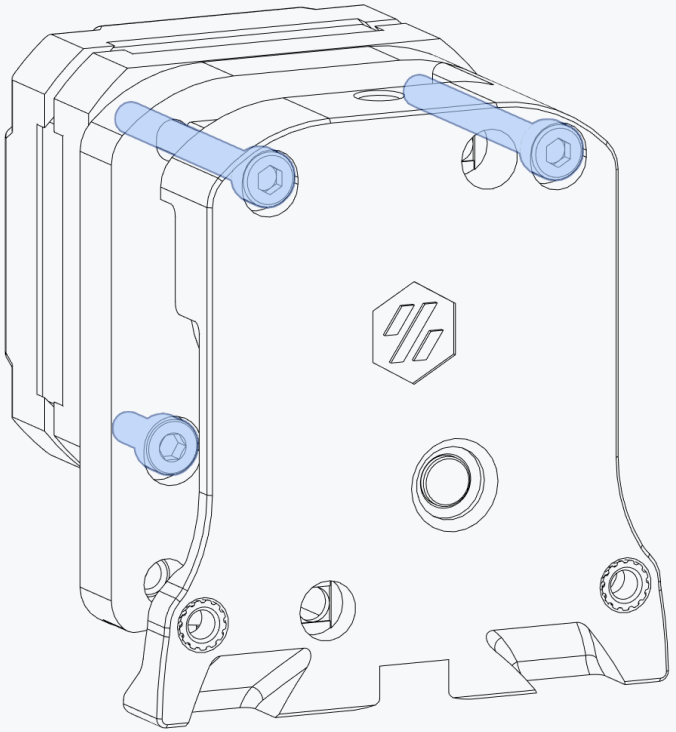
Check if the shaft has sufficient clearance when fully seated.

Sand the face of shaft if required.



CHECK GEAR PLAY

The gear should have a slight play and should not be fully tight against the pinion. Adjust the position of the motor until you have a faint play.

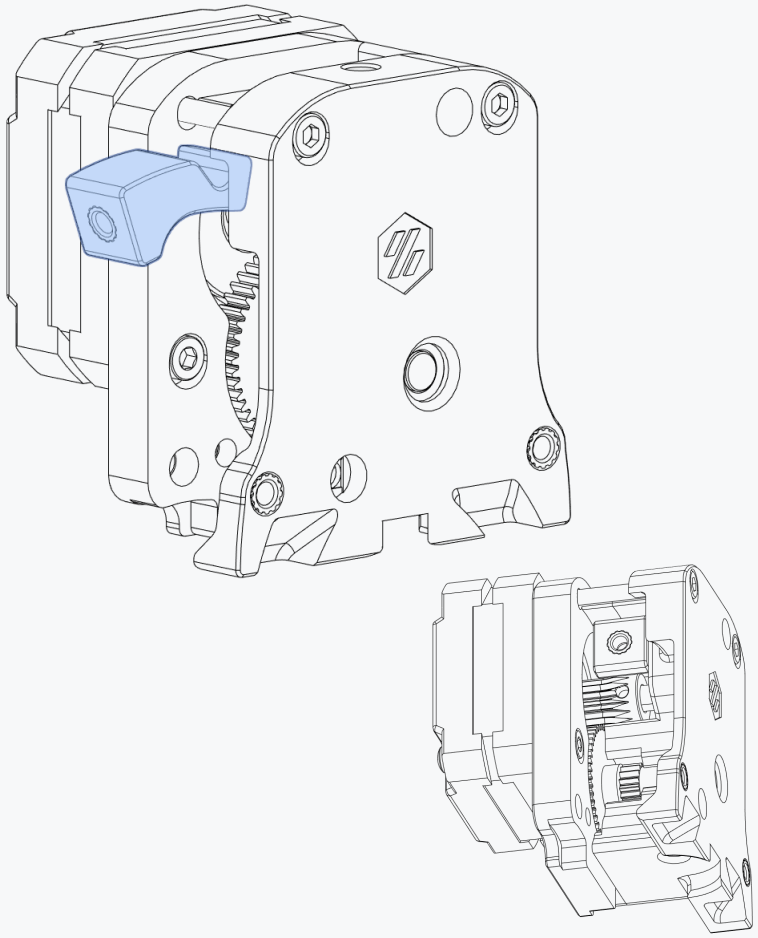


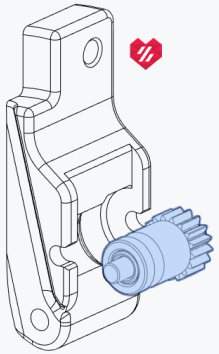
LUBRICATE BEARINGS

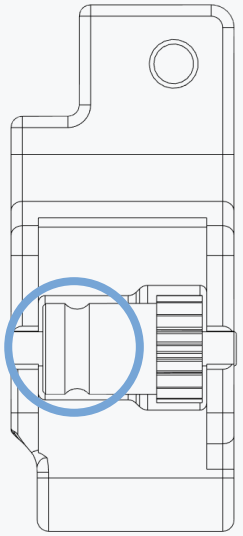
A lubrication film is required to ensure smooth operation and longevity.
Refer to the BOM for lubricant options - look for a “light grease”.

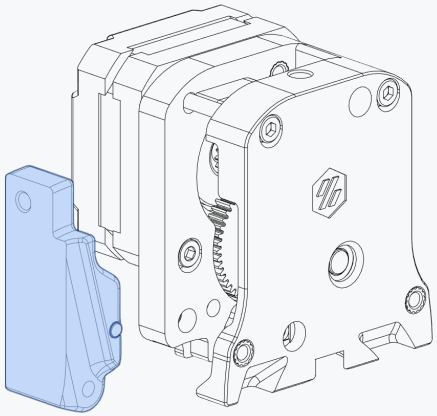
https://voron.link/dncvwdm

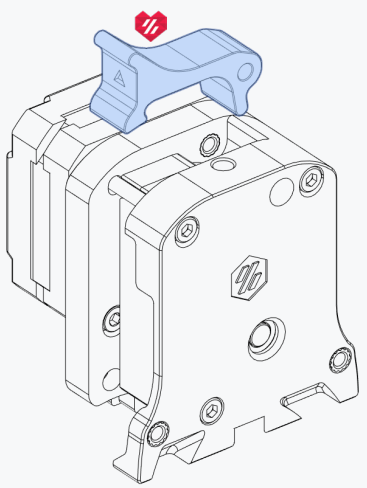
BMG Idler Assembly

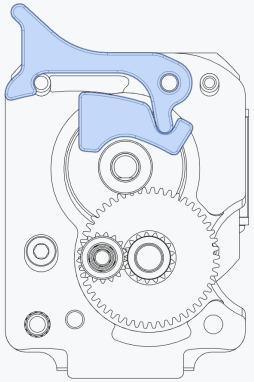


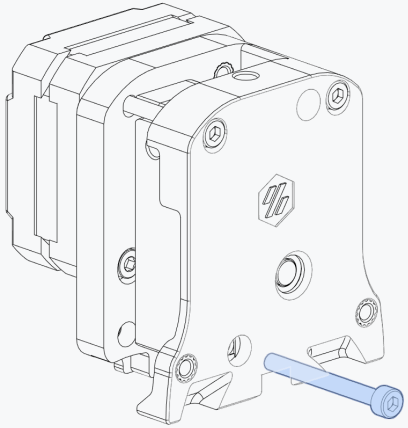




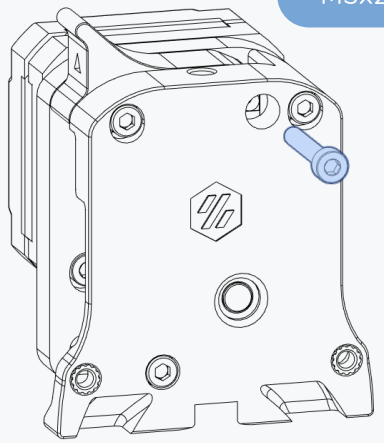






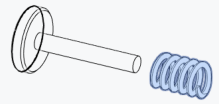


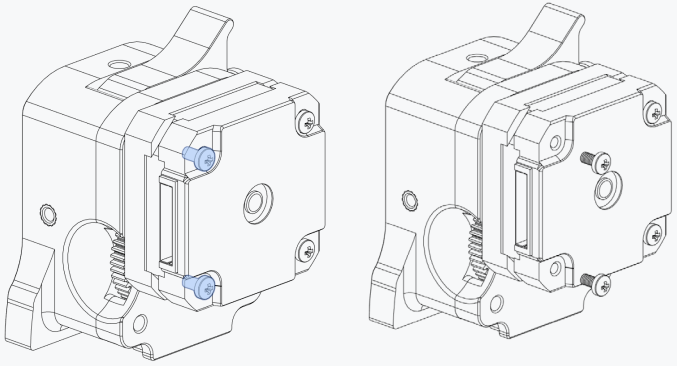
M3x30 SHCS



M3x20 SHCS

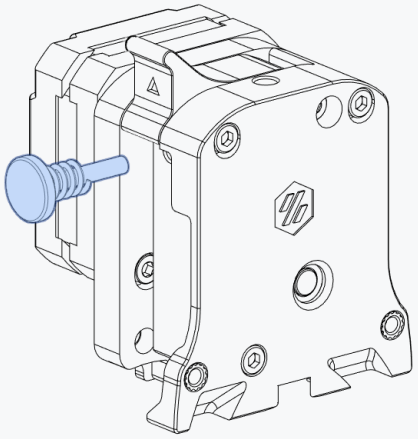
BMG Thumb Screw

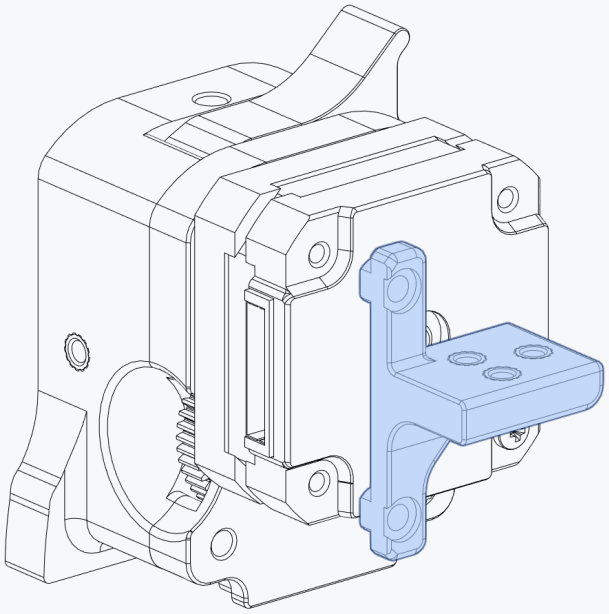


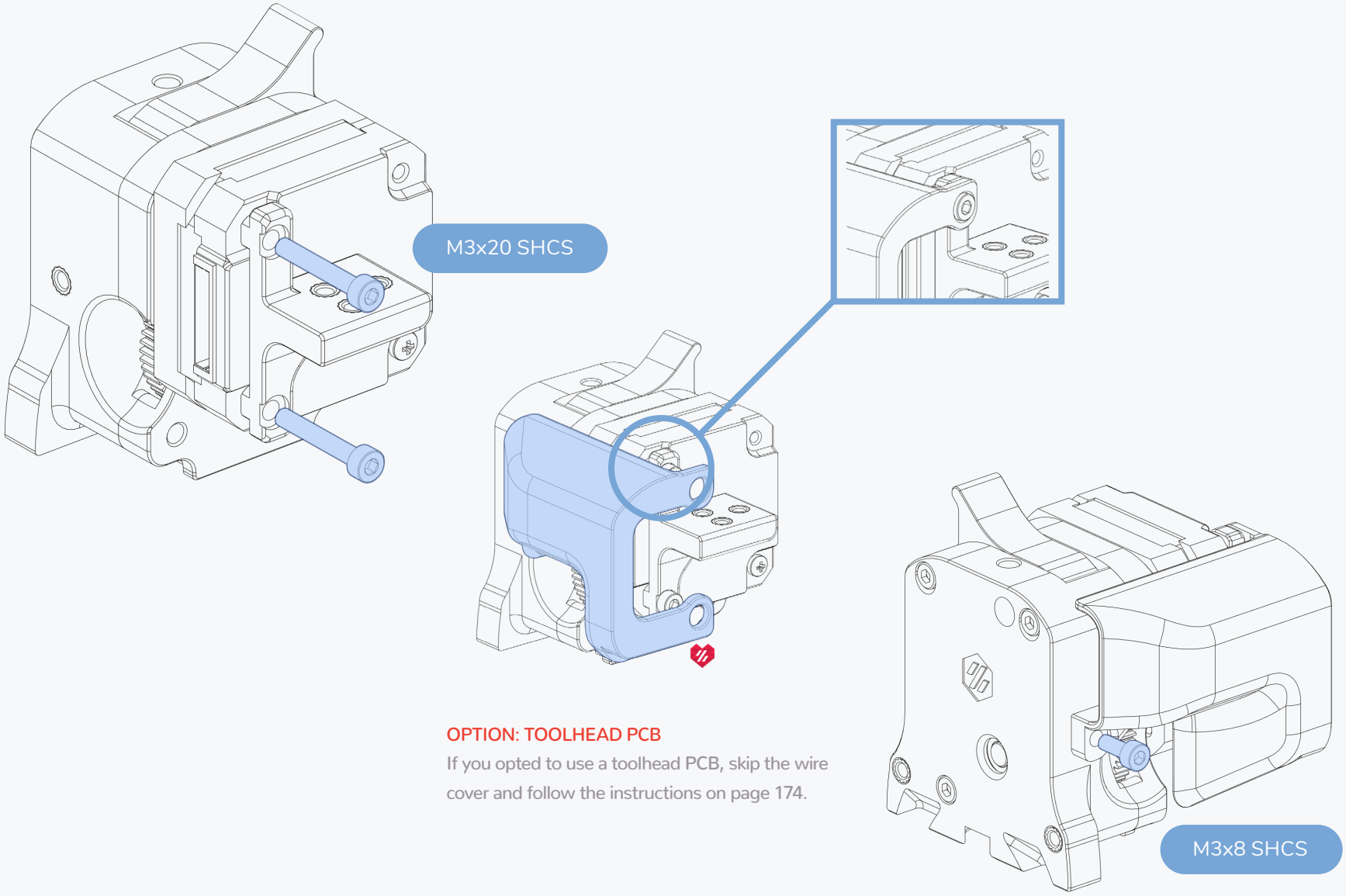


REMOVE SCREWS

Carefully remove the screws from the left side of the motor. They will be replaced with new bolts in the next step.

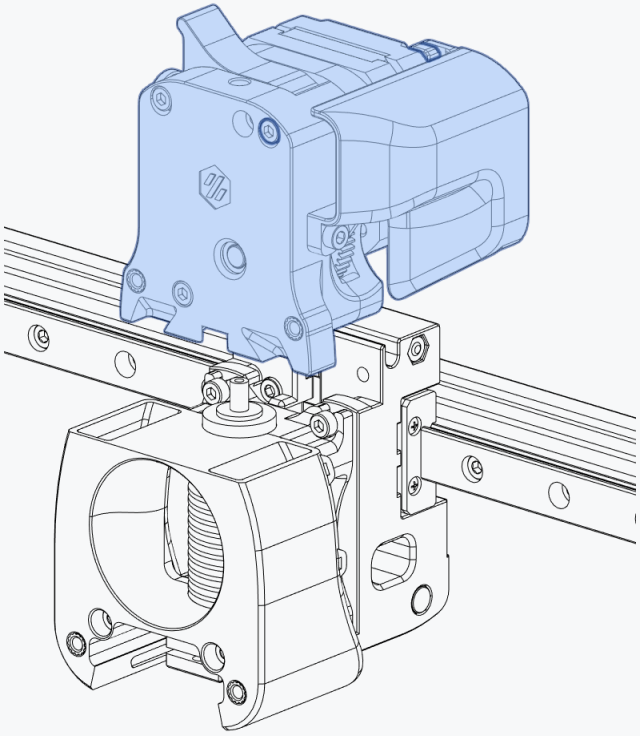


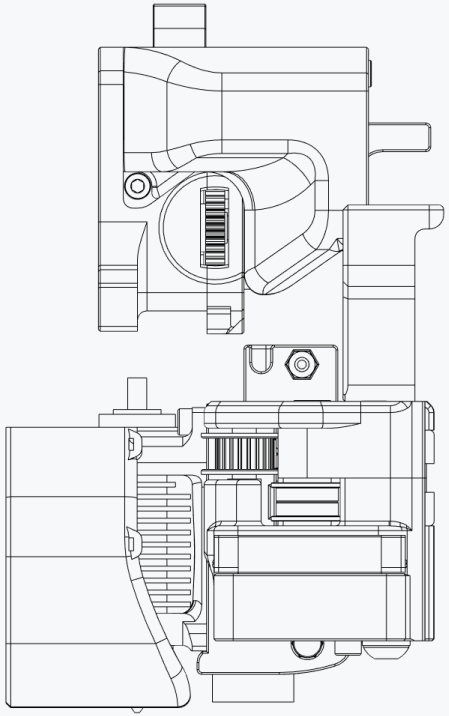


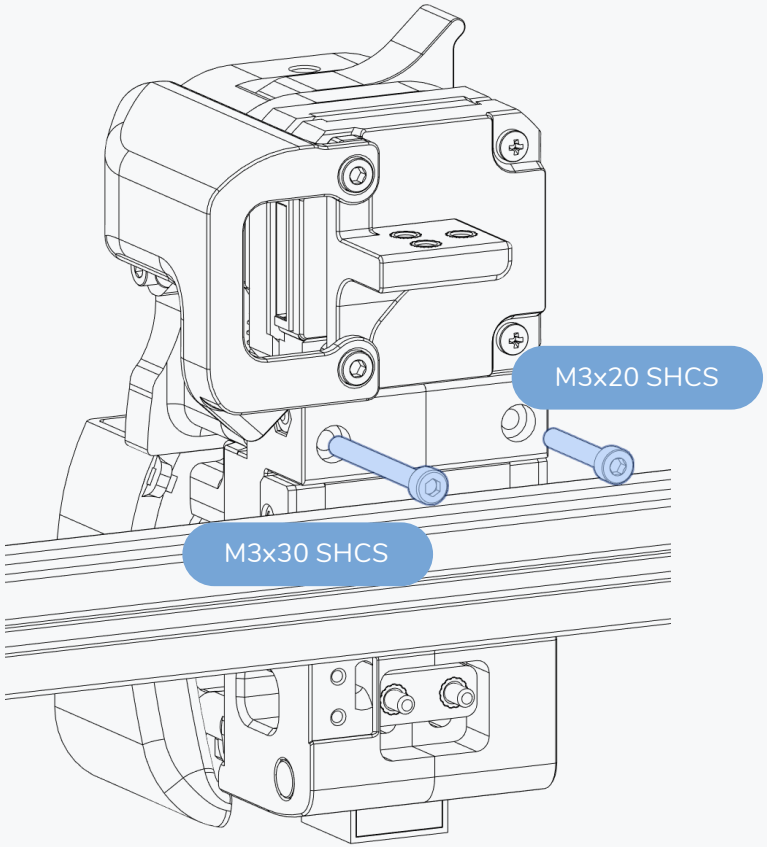


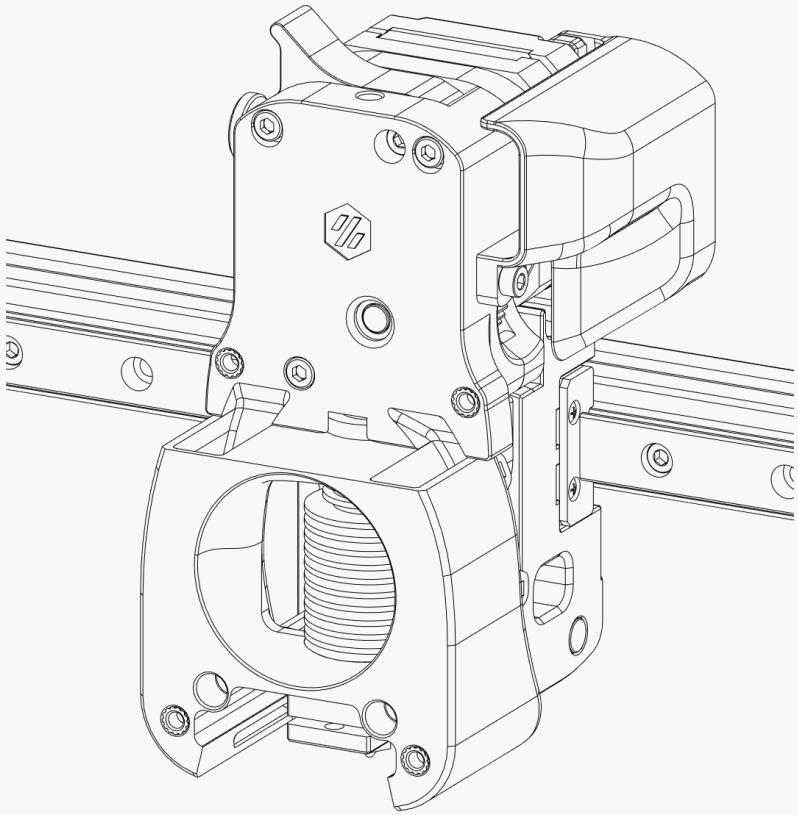
OPTION: TOOLHEAD PCB

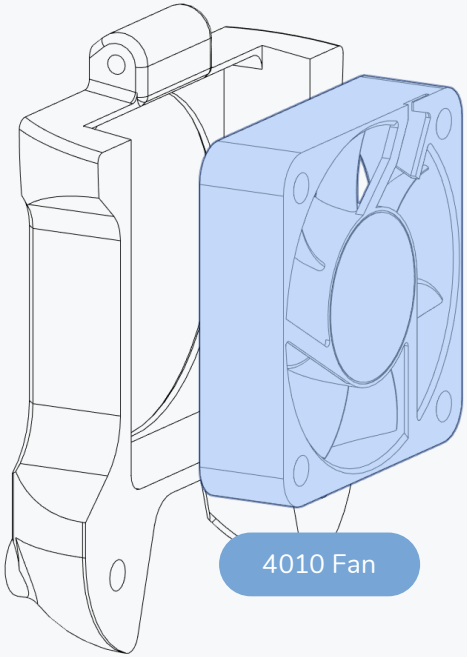
If you opted to use a toolhead PCB, skip the wire cover and follow the instructions on page 174.

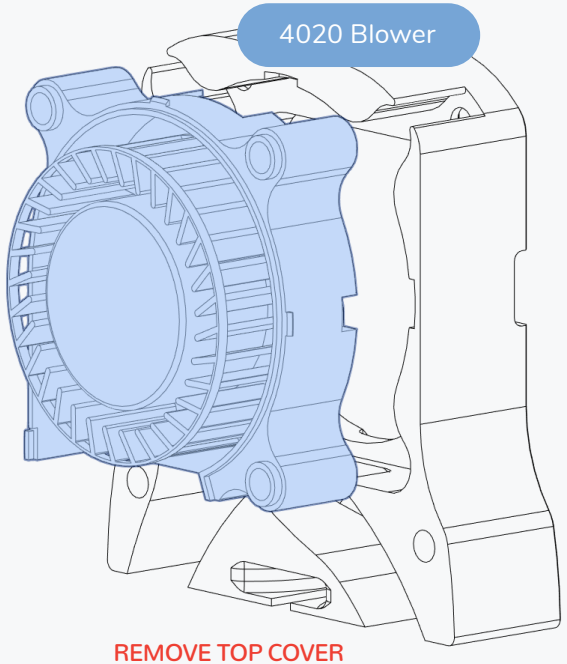





M3x20 SHCS
M3x30 SHCS



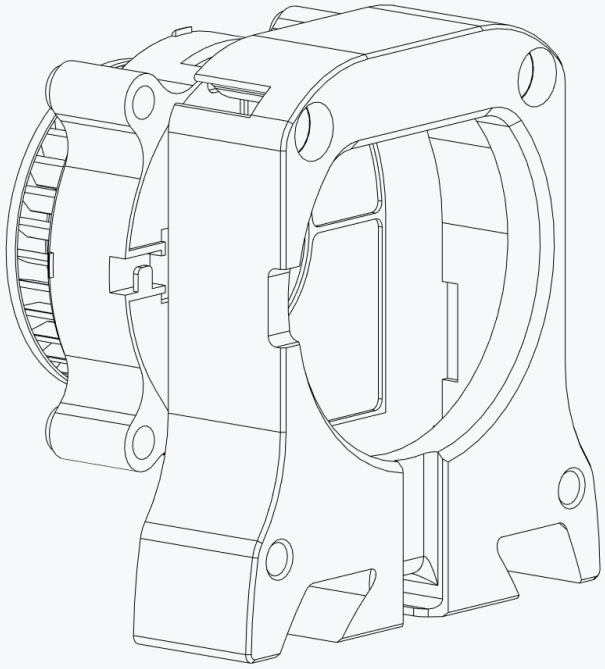


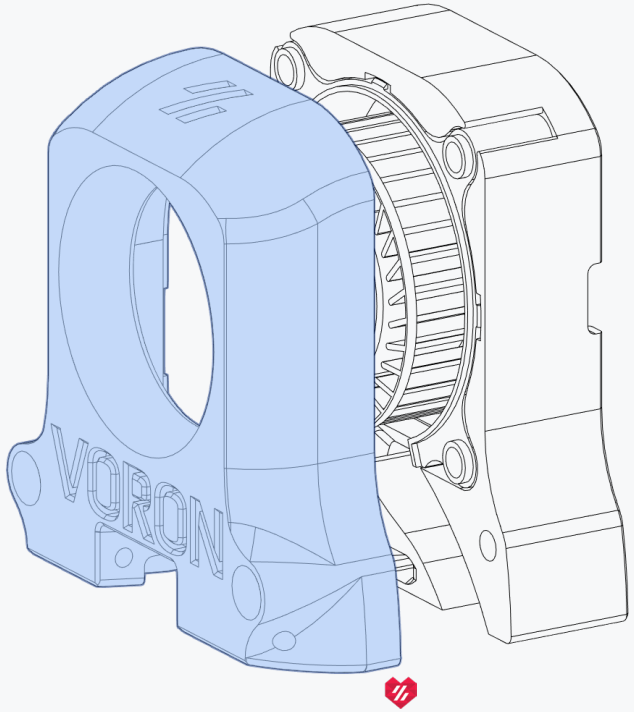


REMOVE TOP COVER

Split the fan open by bending the tabs on the side.

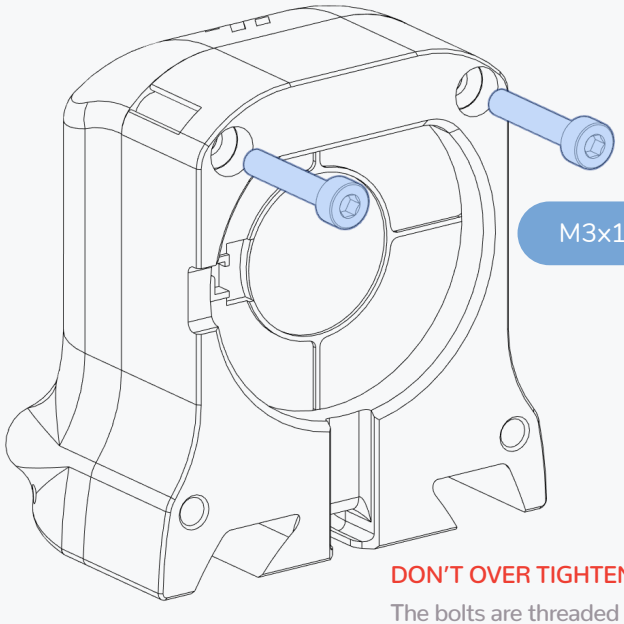
https://voron.link/vyvtcpa





WIRING PATH

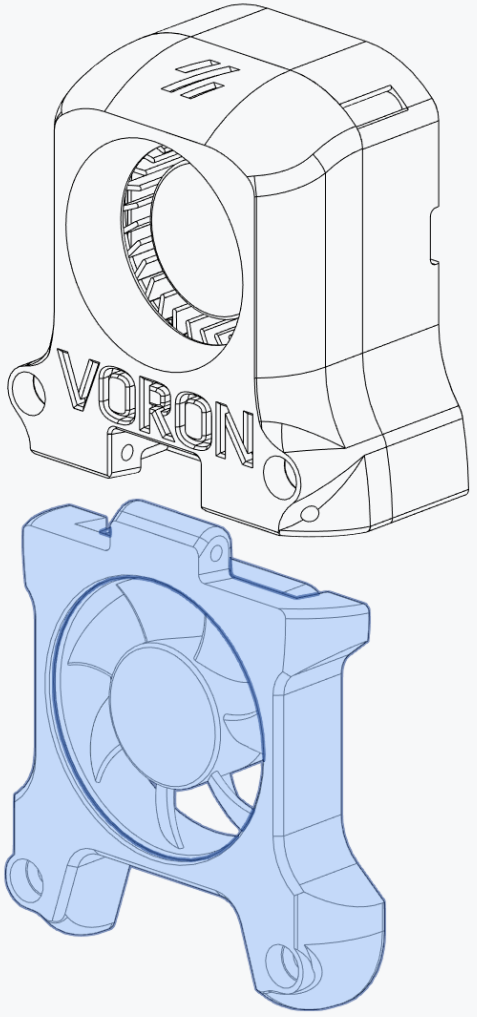
Route the wires through the large opening in the back.

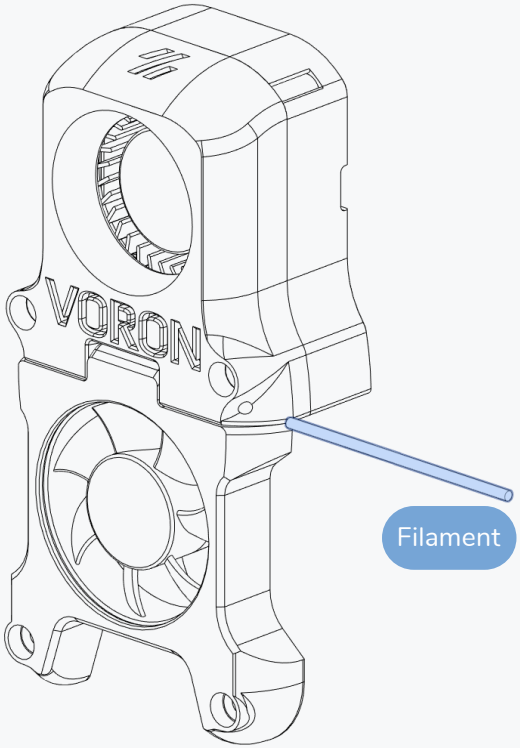


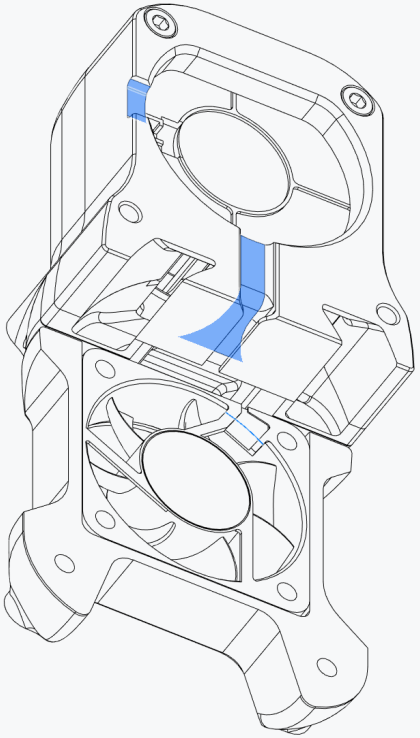
M3x16 SHCS

DON'T OVER TIGHTEN

The bolts are threaded directly into plastic.

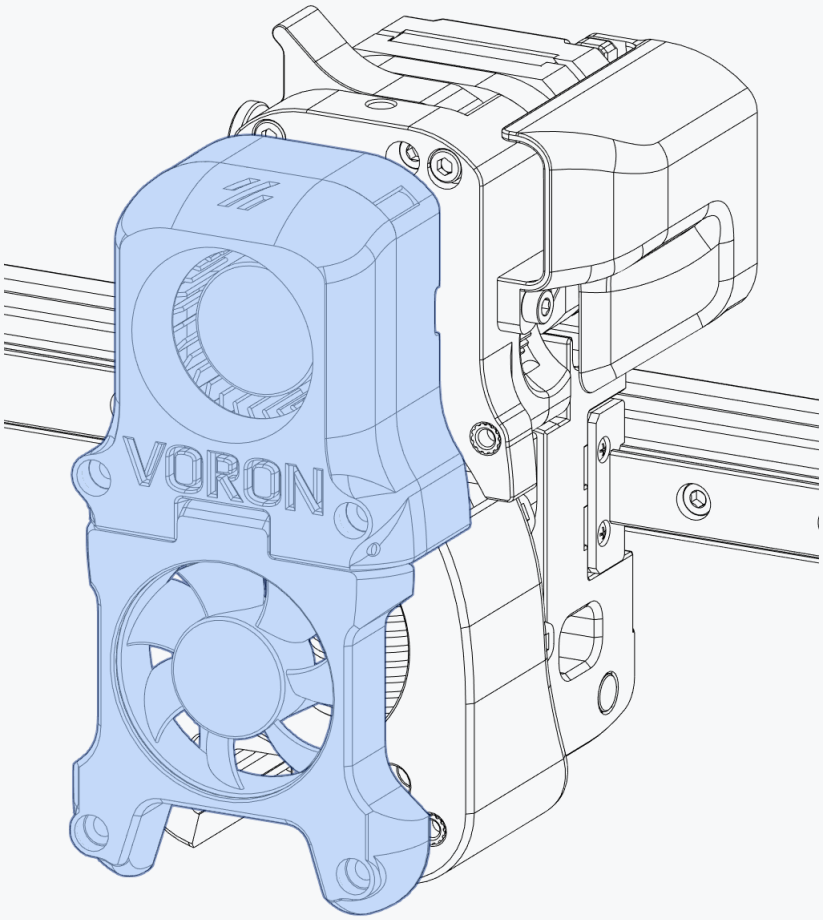


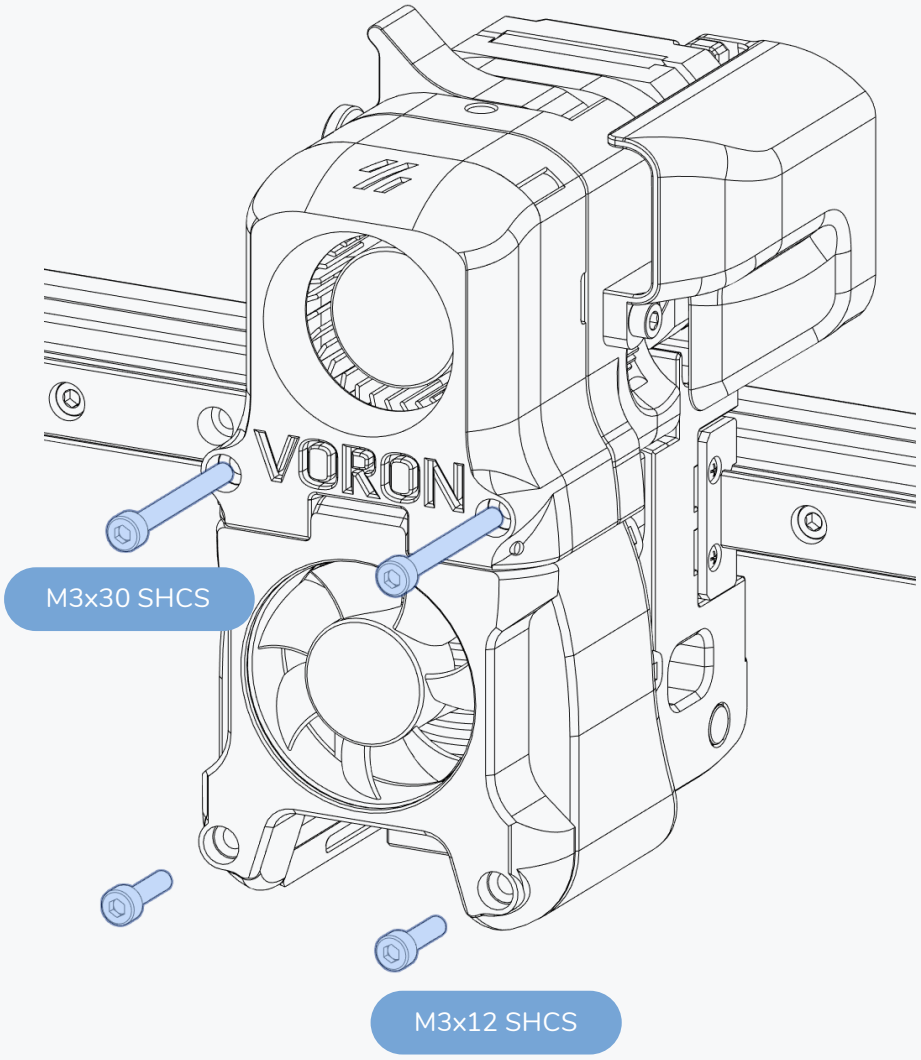




WIRING PATH

Guide the wires in the highlighted path.

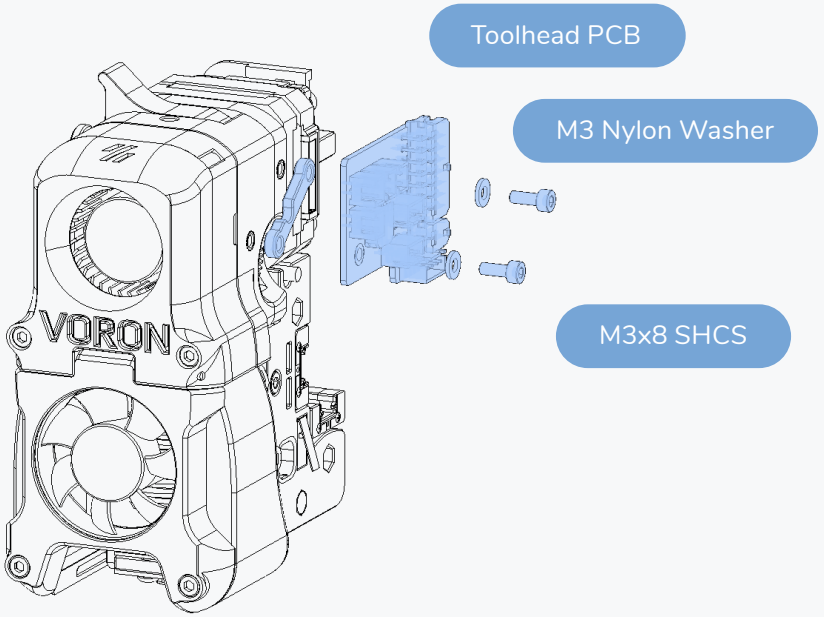

VORON


VORON
M3x30 SHCS
M3x12 SHCS

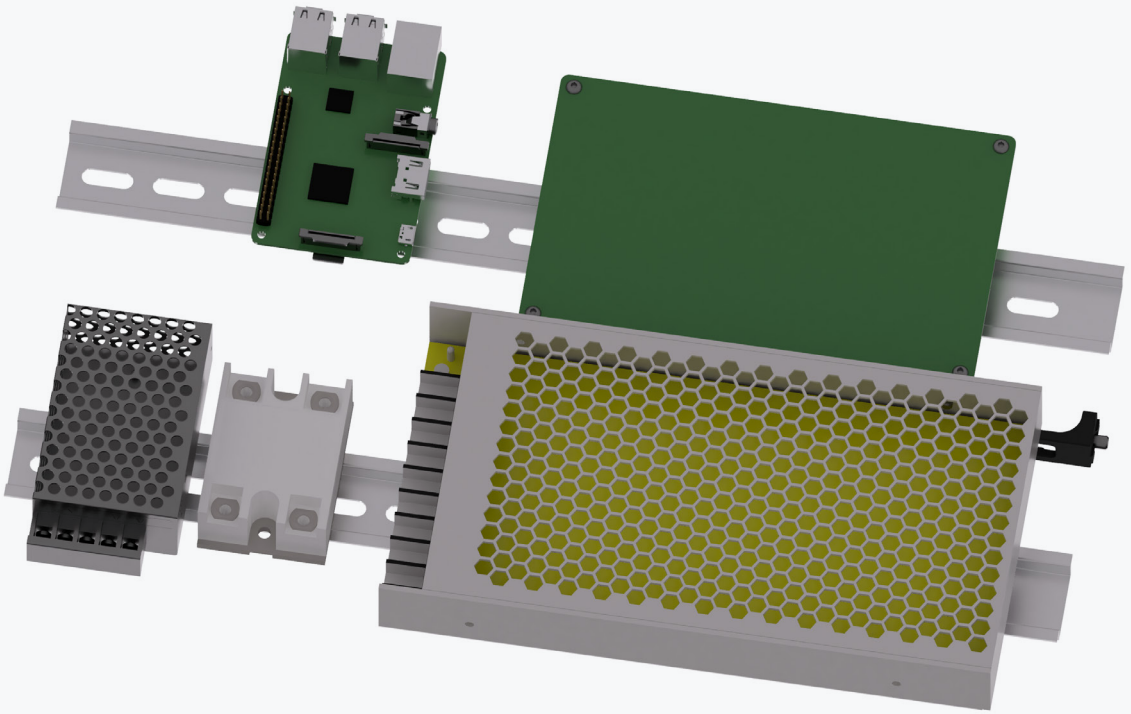
OPTION: TOOLHEAD PCB

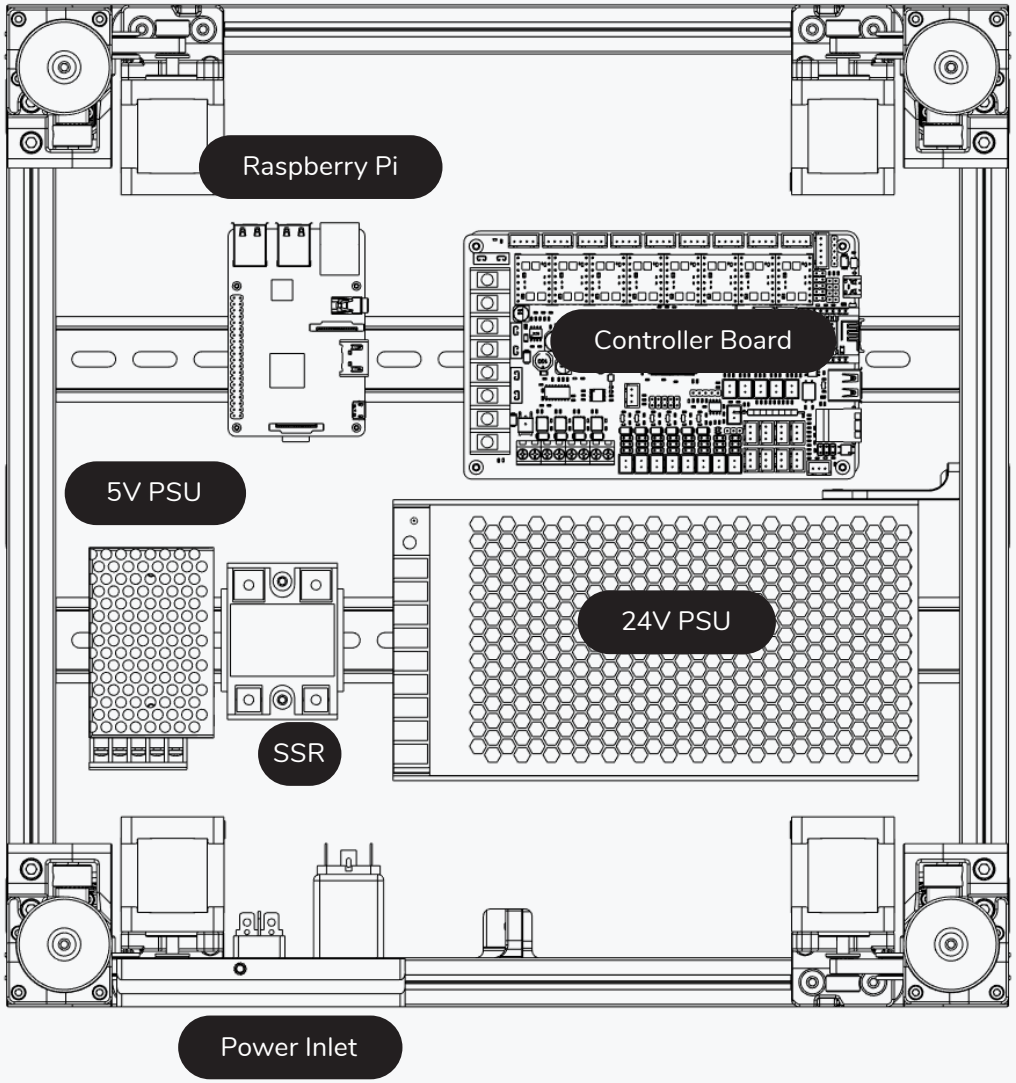
If you opted to use a toolhead PCB, install it instead of the cable cover.

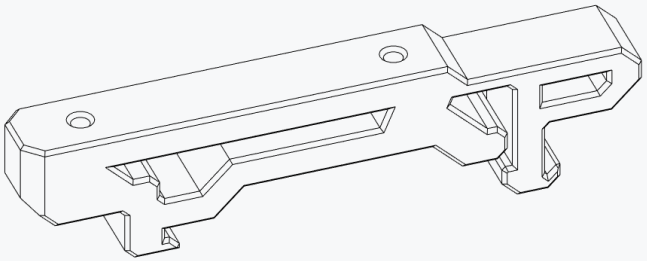
While not strictly required the use of plastic (e.g. nylon) washers is recommended.

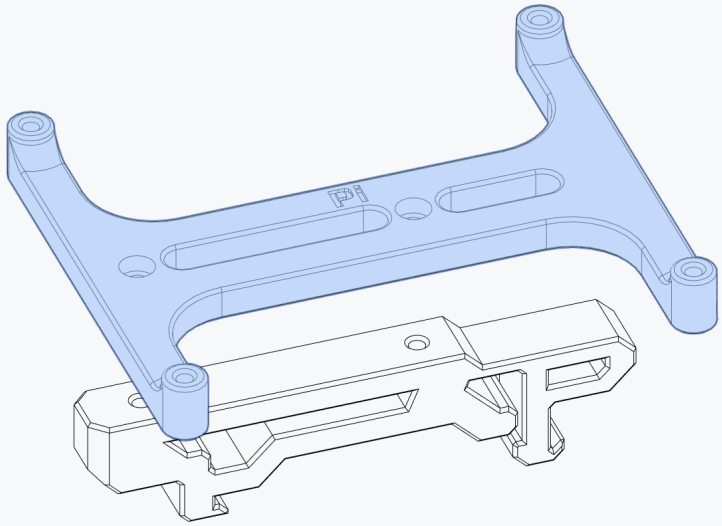


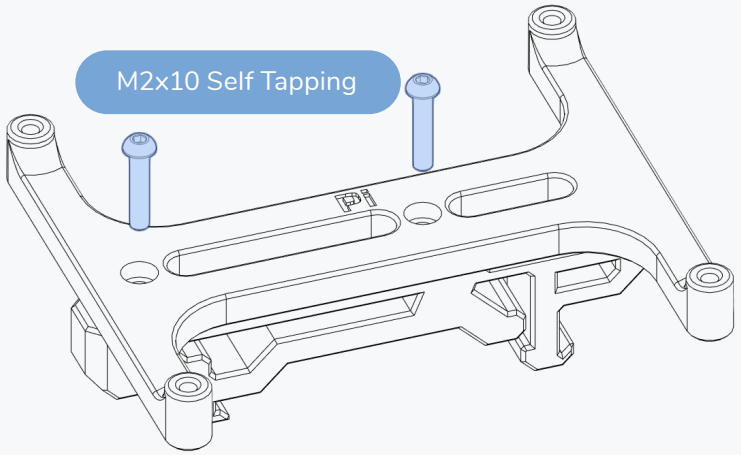
Voron2.1 was released on November 5 2018.

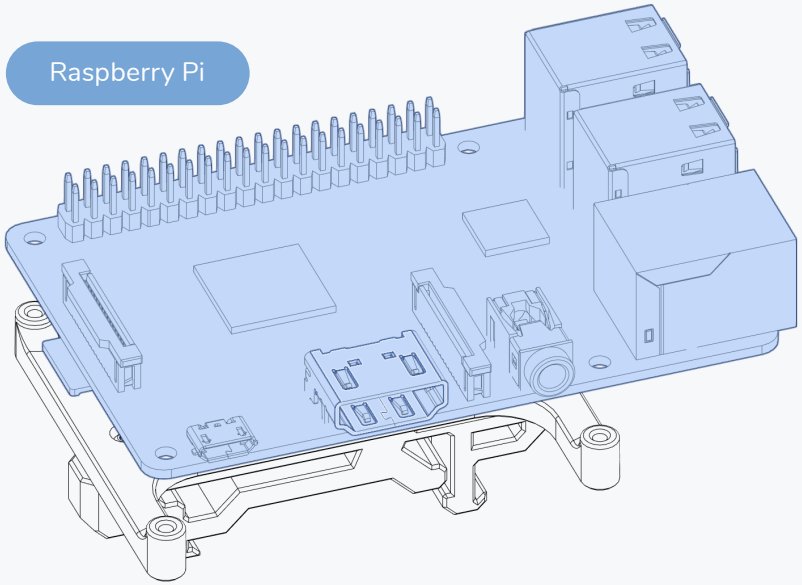


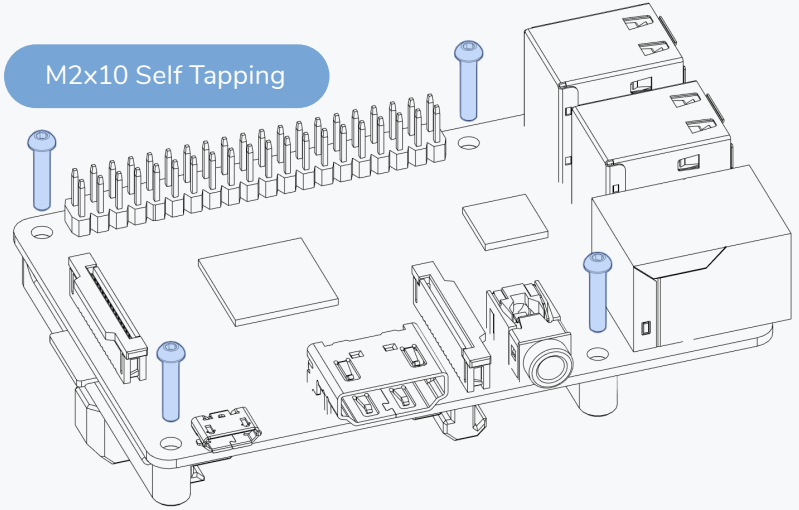

Raspberry Pi
Controller Board
5V PSU
24V PSU
SSR
Power Inlet

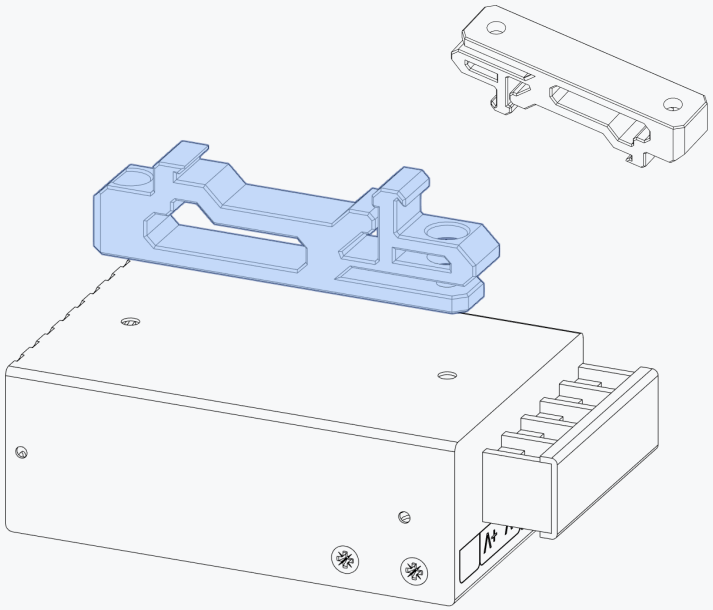




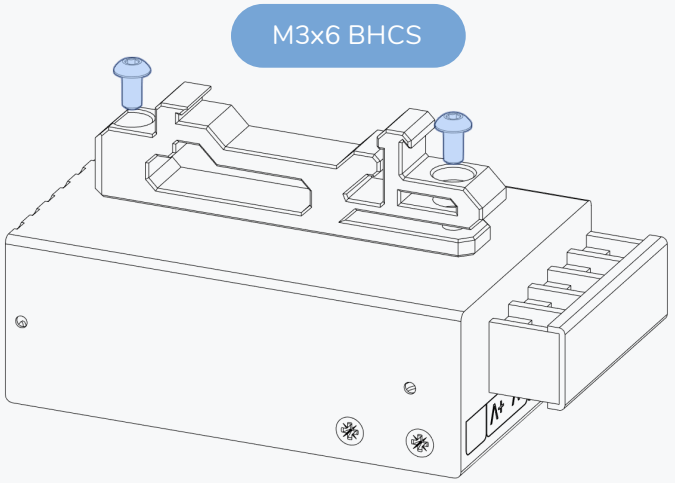

M2x10 Self Tapping

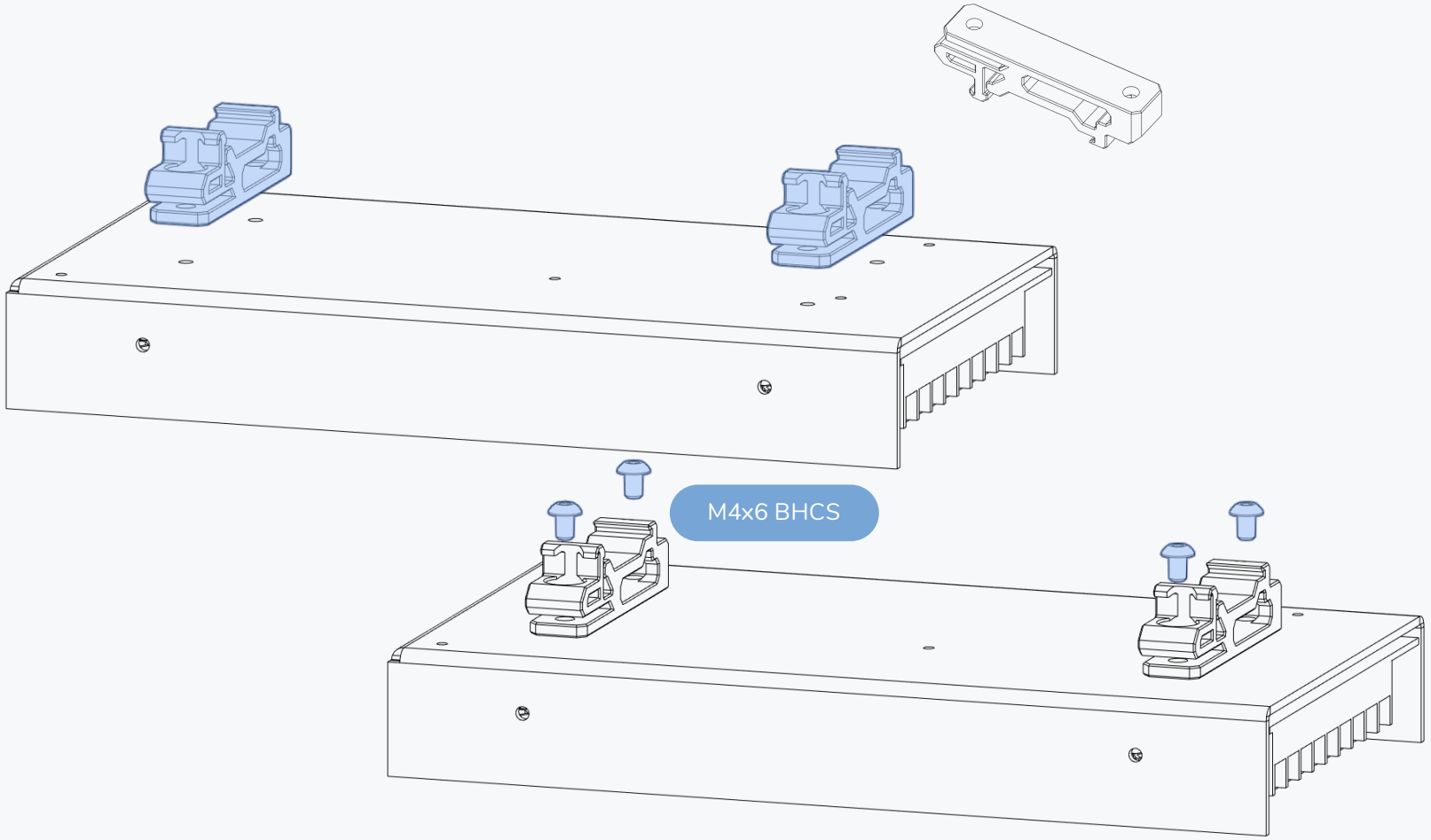

Raspberry Pi

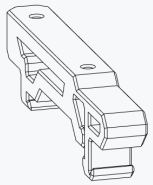

M2x10 Self Tapping

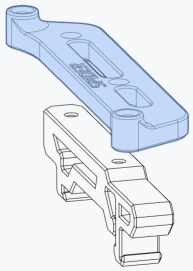


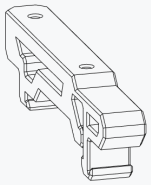
RS25-5 PSU

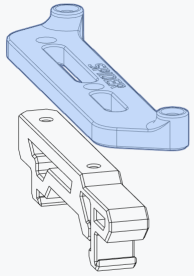


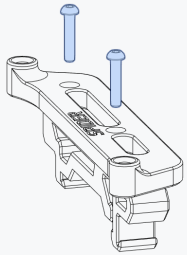

M4x6 BHCS



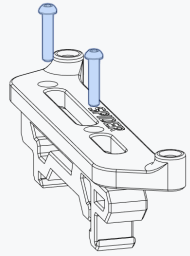






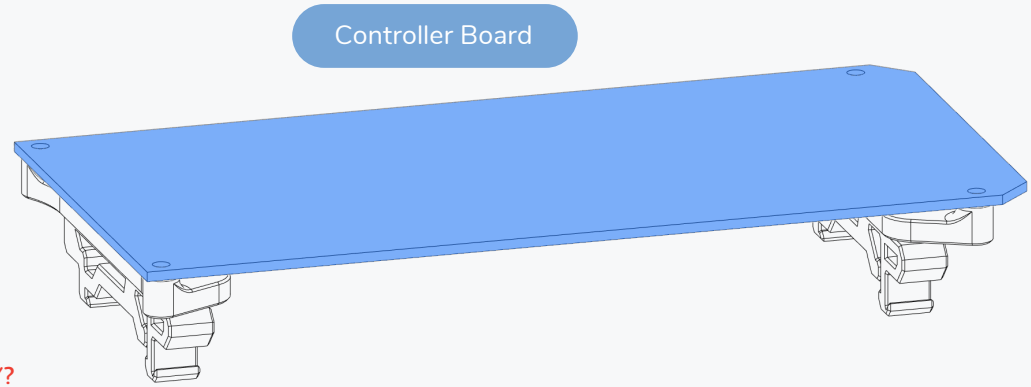


M2x10 Self Tapping



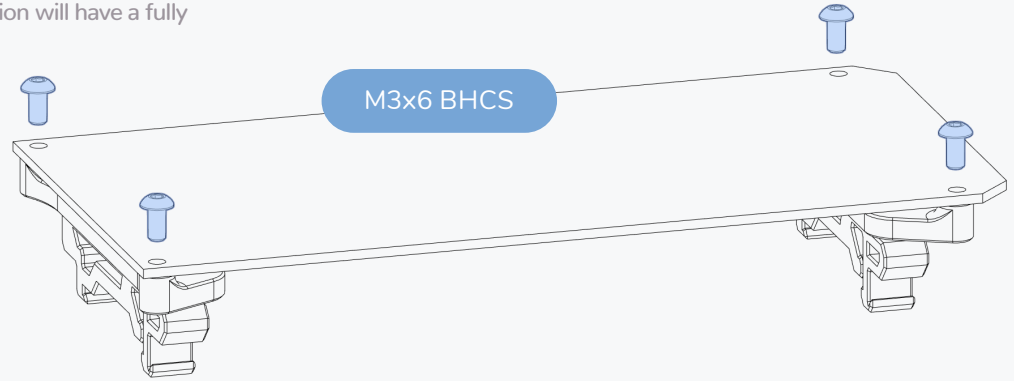
AVAILABLE MOUNTS

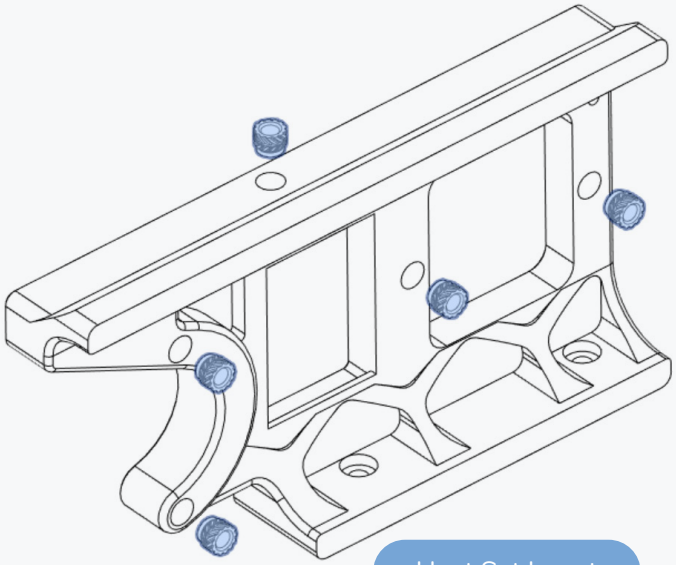
We also provide mounts for other controller boards. They are assembled in a similar manner.

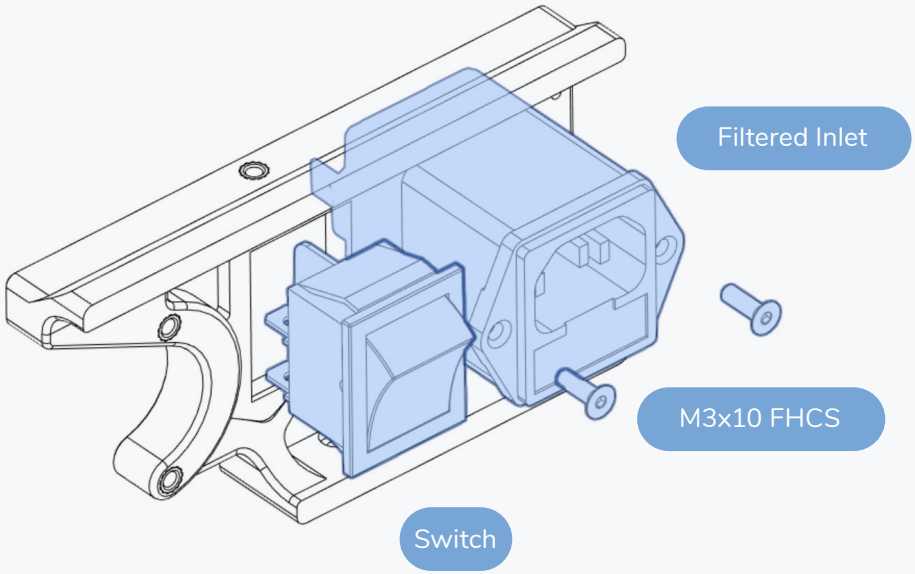


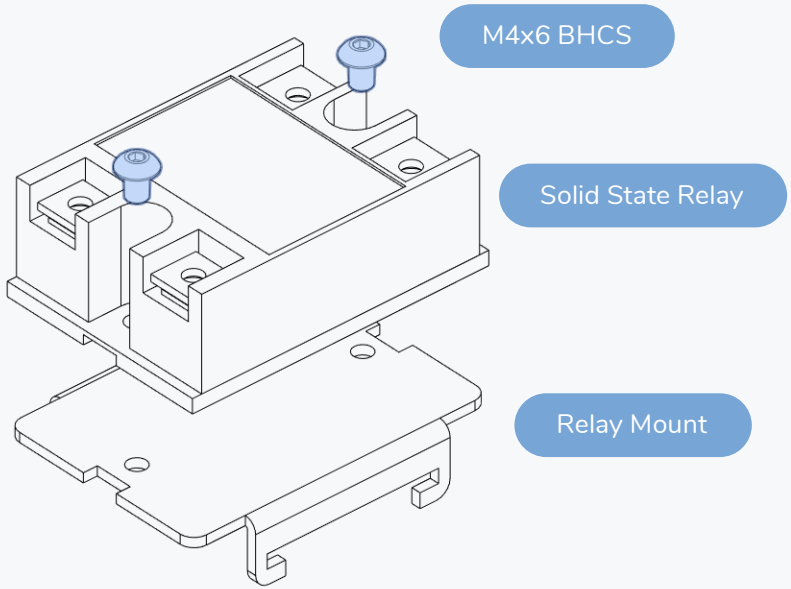
WHY DOES IT LOOK THAT WAY?

We used a dummy to keep the file size of the printers CAD manageable. The wiring section will have a fully featured image.




Heat Set Insert

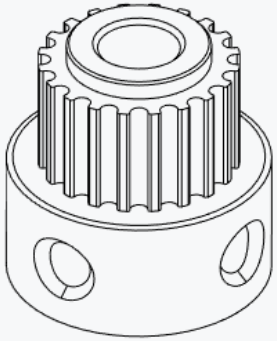

Filtered Inlet
M3x10 FHCS
Switch



WHERE CAN I FIND THE RELAY MOUNT?

The SSR mount is an off the shelf part. Look for a metal bracket in your pile of parts.
There is no printed mount.

GT2 20 Tooth Pulley



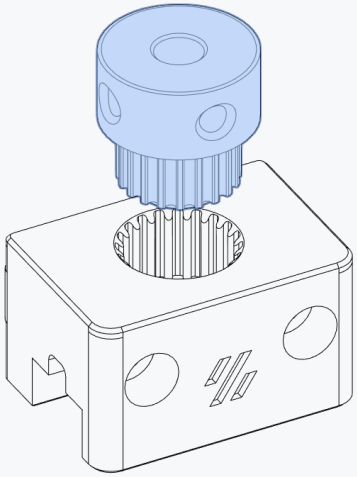
REMOVE FLANGE & SET SCREWS

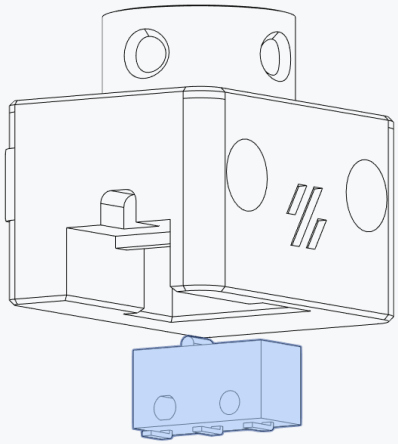
Use a bottle opener or some pliers to remove the top flange.

https://voron.link/ict0j6x

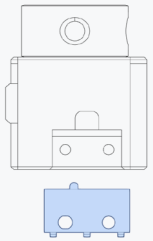
PRESS FIT

Apply the required force to fully seat the pulley in the printed part.

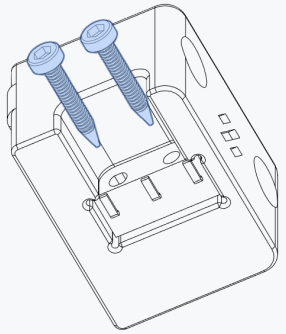




Microswitch

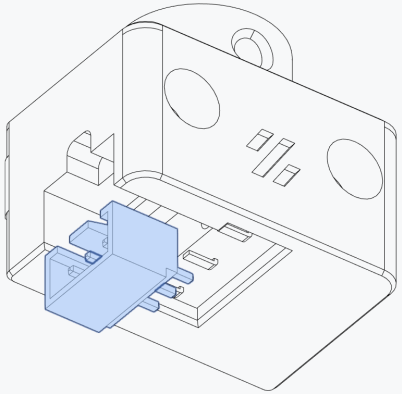


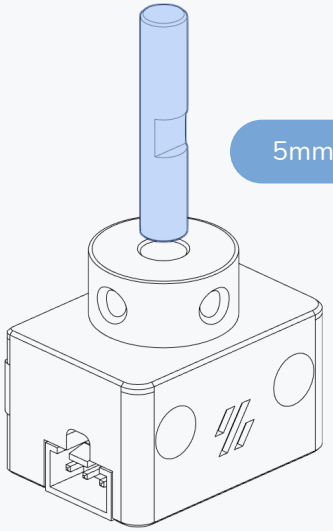
M2x10 Self Tapping



SWITCH W/OUT LEVER

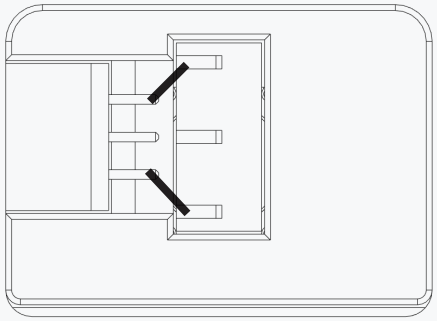
This part requires a switch without lever to be installed in the shown orientation.
You can remove the lever from microswitches by gently pressing on the lever's hinge point.





PREVENTING MISHAPS

You can add a notch to the Z endstop point and capture it with a set screw to prevent it from falling out.

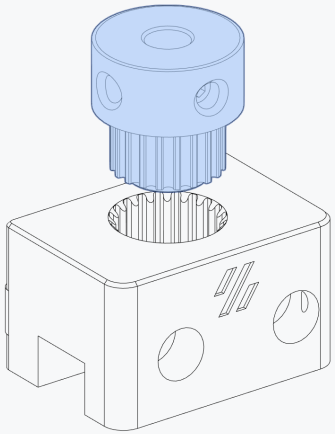


SOLDER CONNECTOR

Solder a connection from the outer two terminals of the microswitch to the connector.

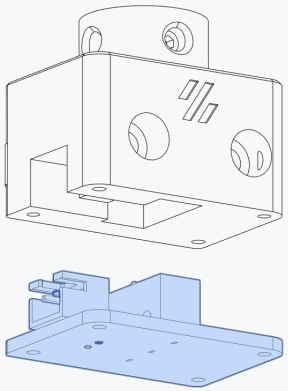
OPTION: Z ENDSTOP BOARD

GT2 20 Tooth Pulley

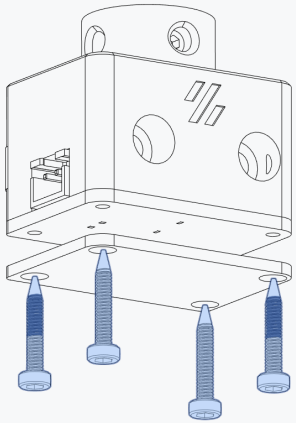


PRESS FIT

Apply the required force to fully seat the pulley in the printed part.

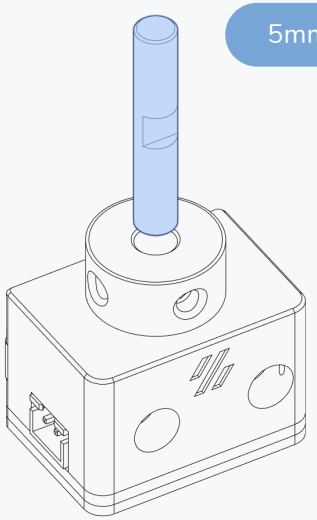


Microswitch Z Endstop Board



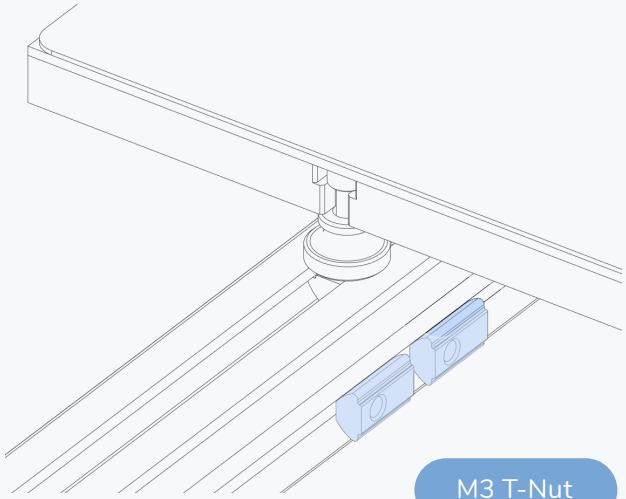
M2x10 Self Tapping

5mm Shaft

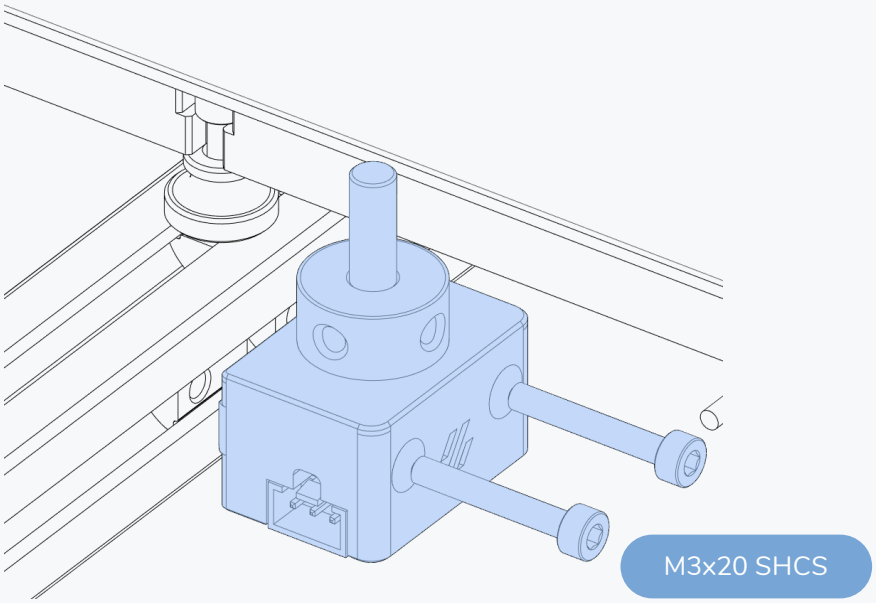


ADDITIONAL INFORMATION

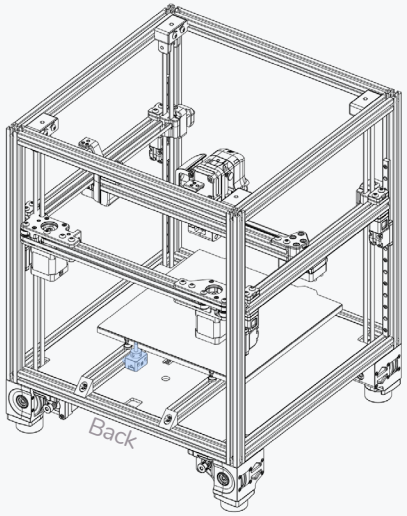
Visit voron.link/3bwwnqy for design files and BOM.



M3 T-Nut

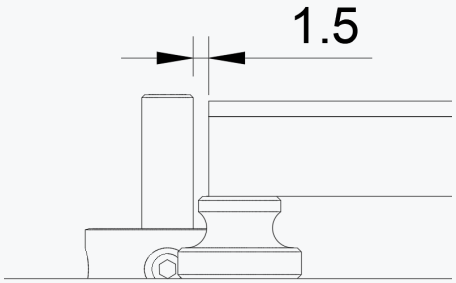


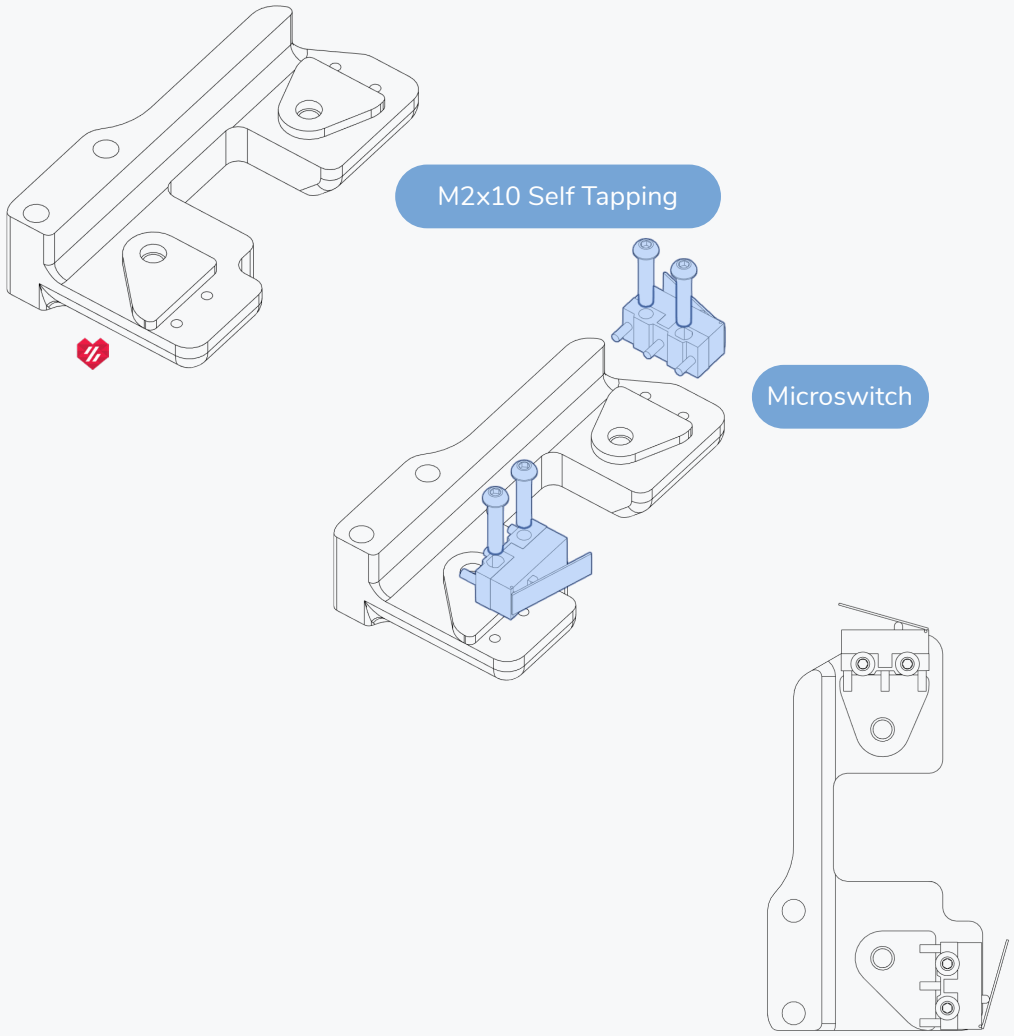
M3x20 SHCS

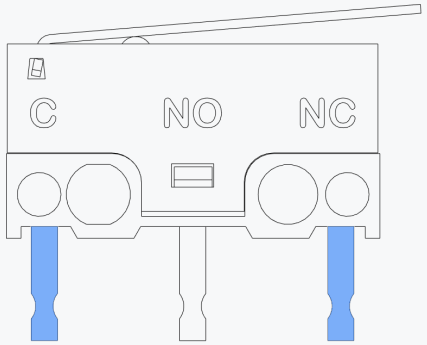


ADJUST Z ENDSTOP POSITION

The shaft of the Z Endstop must not touch the print bed.
Adjust the position if required.





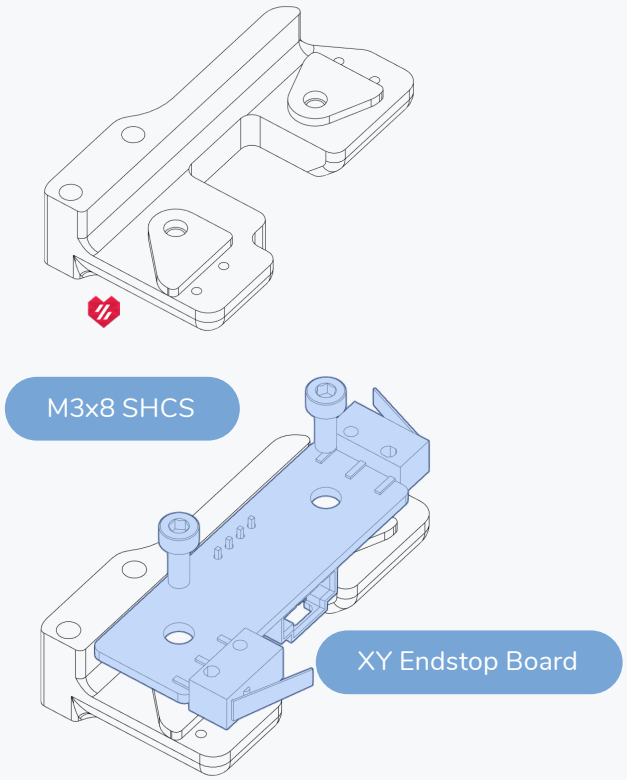


END-STOP SWITCHES FOR X AND Y

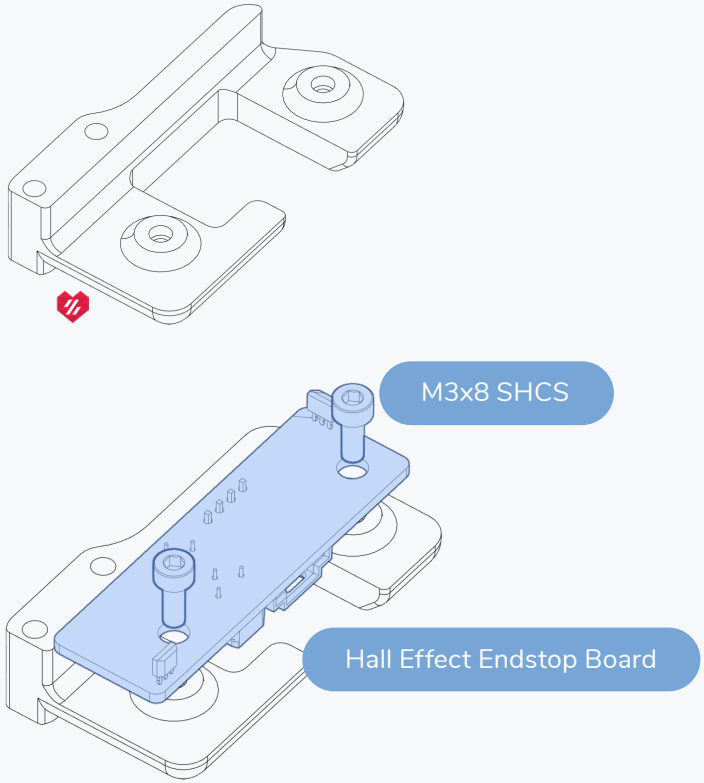
End-stops are wired in a “Normally Closed” configuration. On microswitches those are the 2 outer terminals indicated by C and NC.

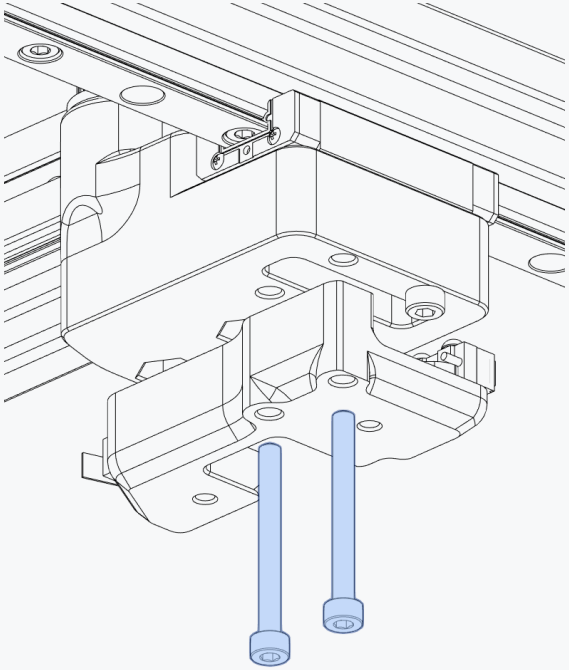
Prepare the switches for X and Y by soldering 150mm of wire to each of the outer terminals.

OPTION: XY ENDSTOP BOARD

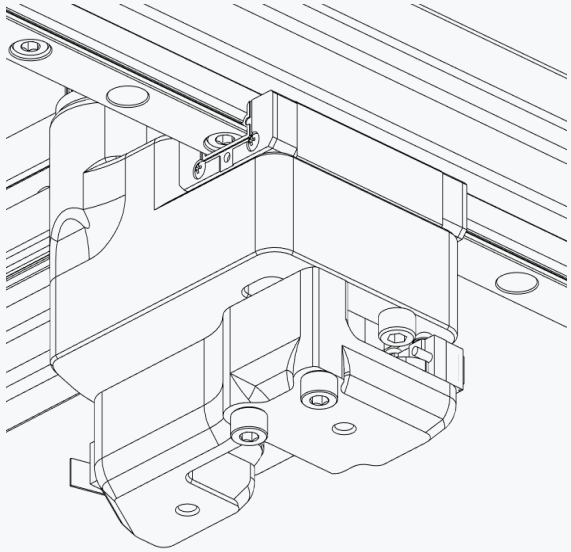


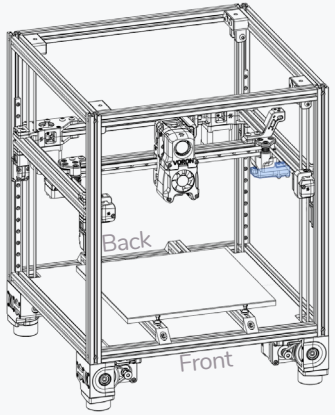
OPTION: HALL EFFECT ENDSTOP BOARD



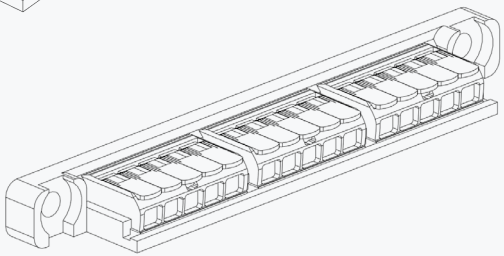


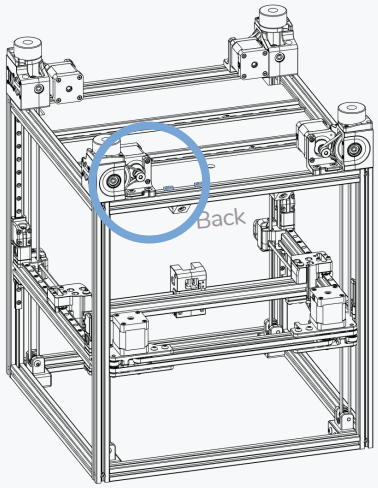
M3x30 SHCS

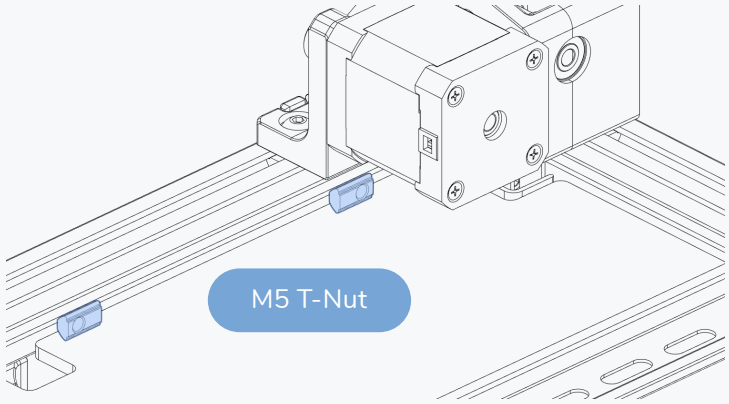




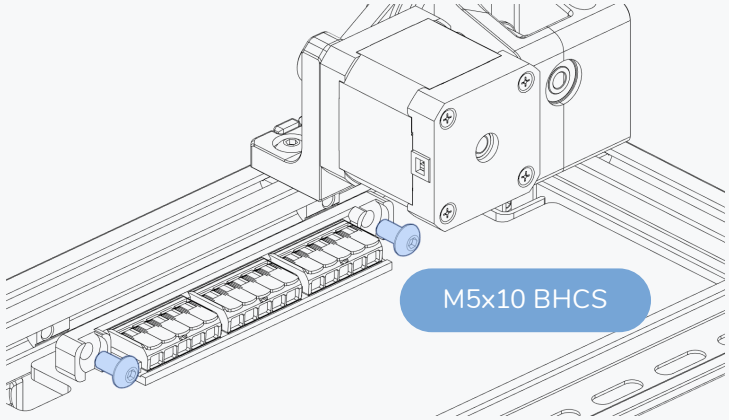
WAGO 221 415 Clamps







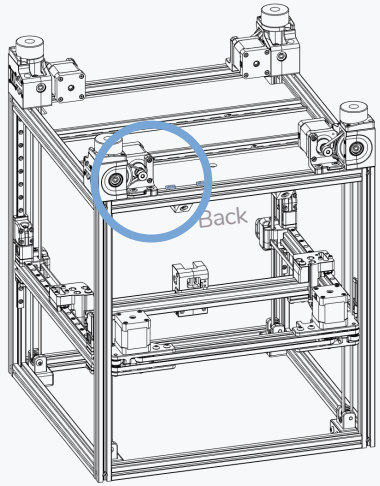
M5 T-Nut

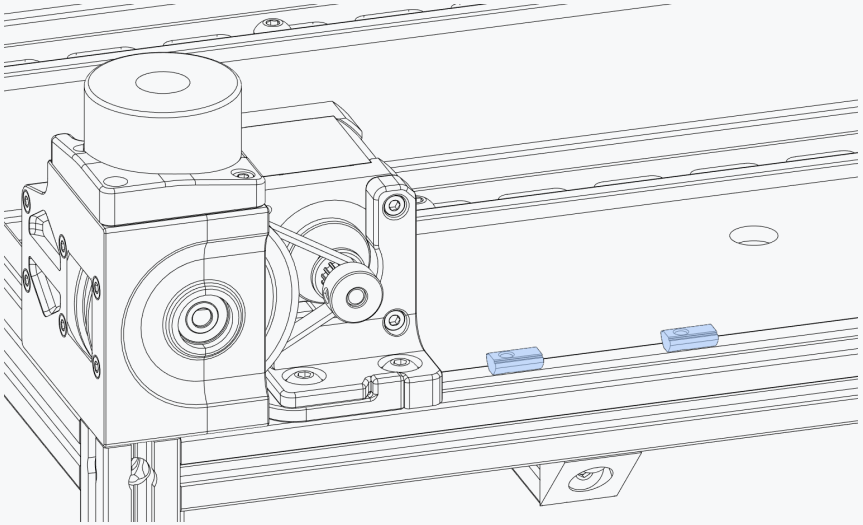


M5x10 BHCS

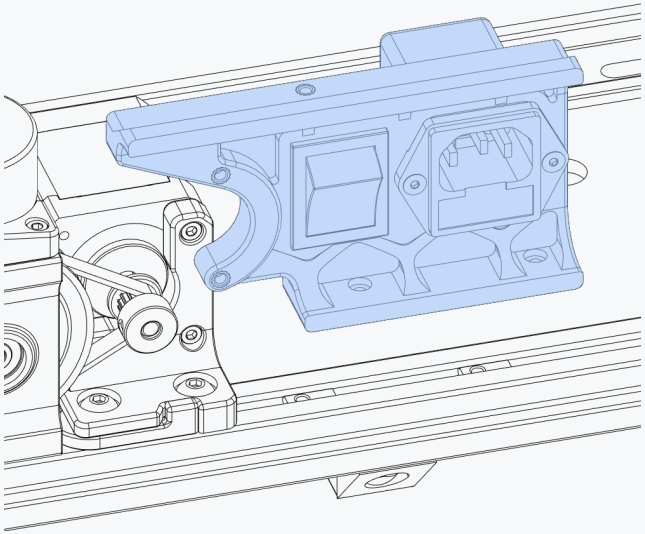
UPSIDE DOWN ASSEMBLY

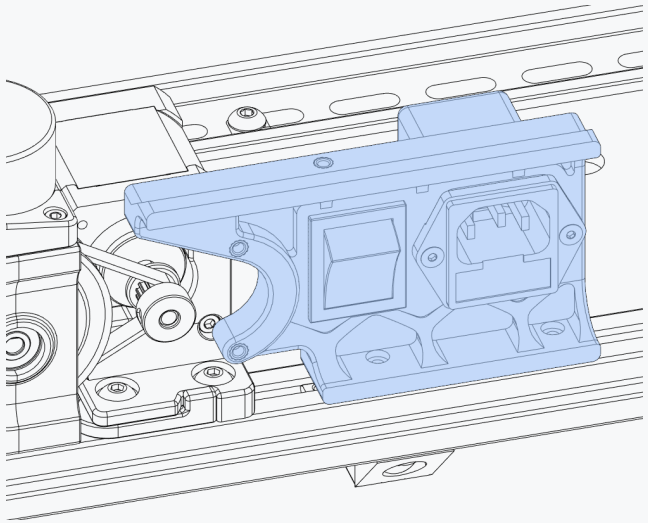
For ease of assembly we recommend to flip the printer on its head for the next steps. Hope you don't regret building a 350.

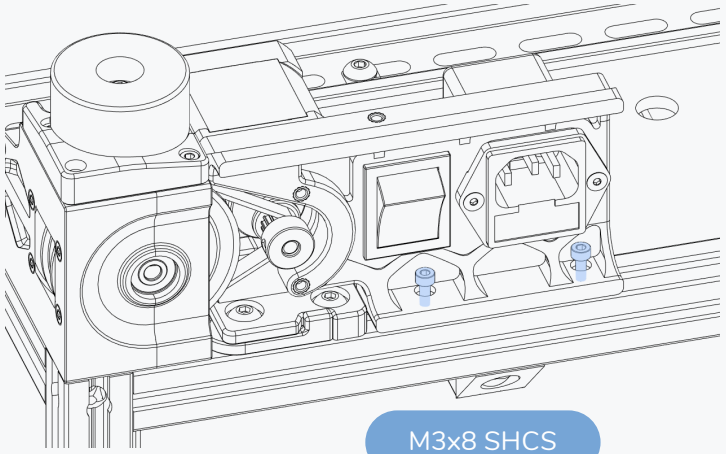


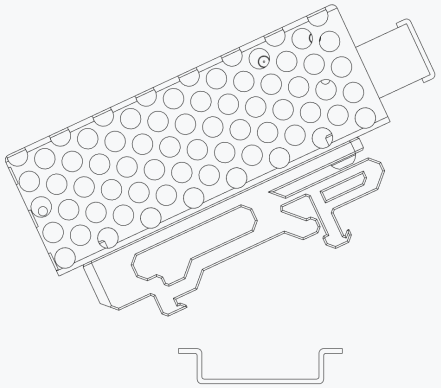


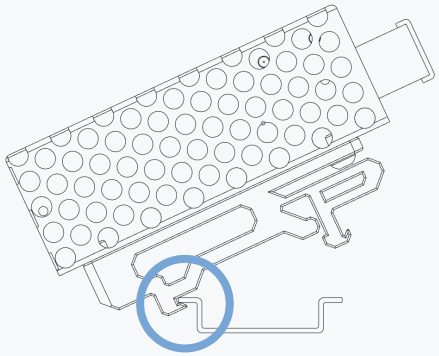
M3 T-Nut





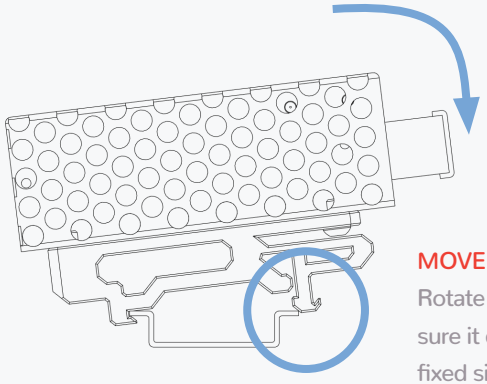

M3x8 SHCS





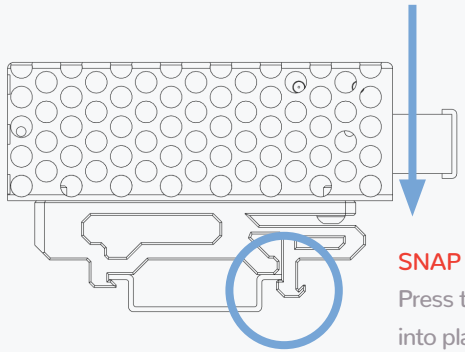
HOOK FIXED SIDE

Hook the fixed side of the printed mount on side of DIN rail.



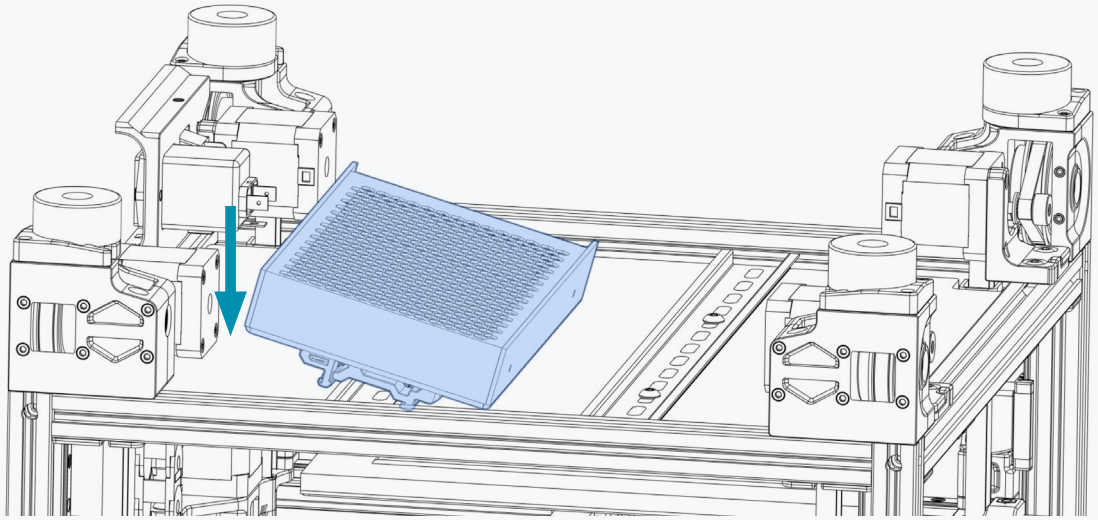
MOVE INTO POSITION

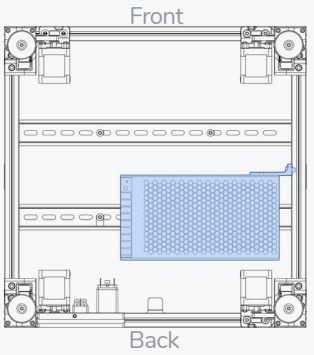
Rotate the part into place, make sure it does not unhook from the fixed side.

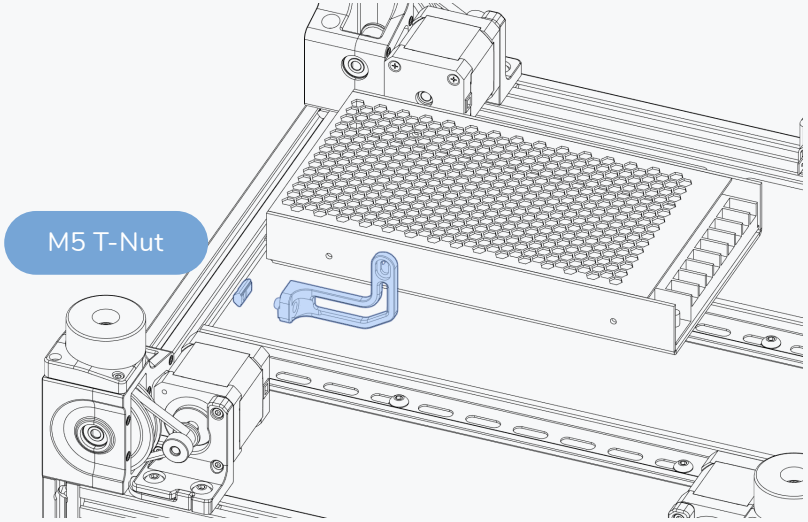


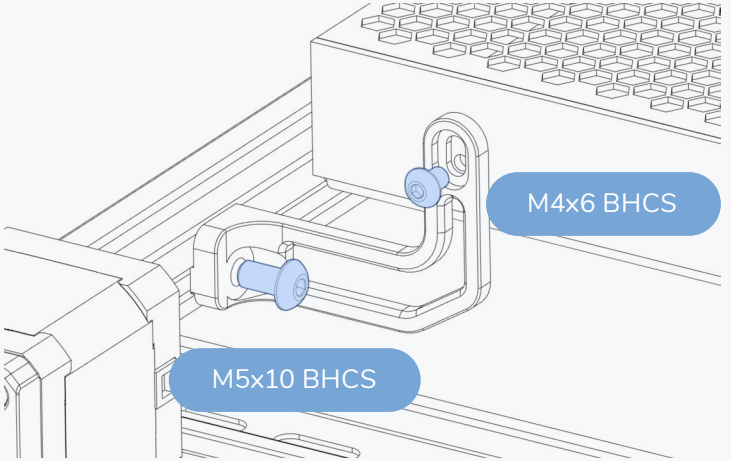
SNAP INTO PLACE

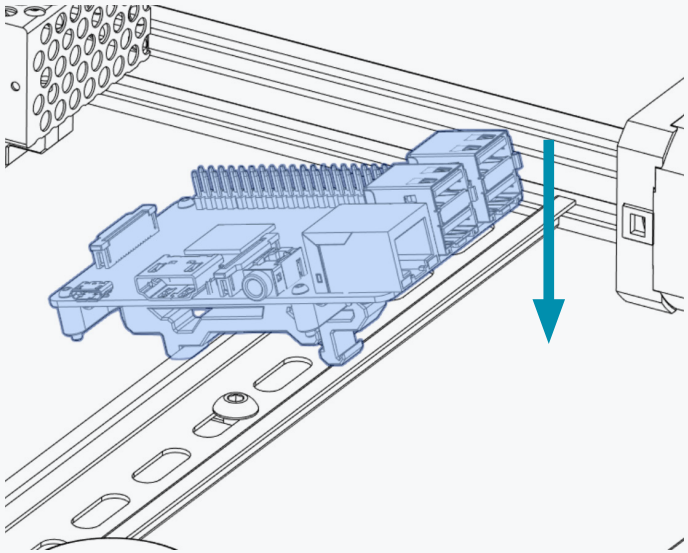
Press to snap the free side into place. The part should now sit securely on the DIN rail.

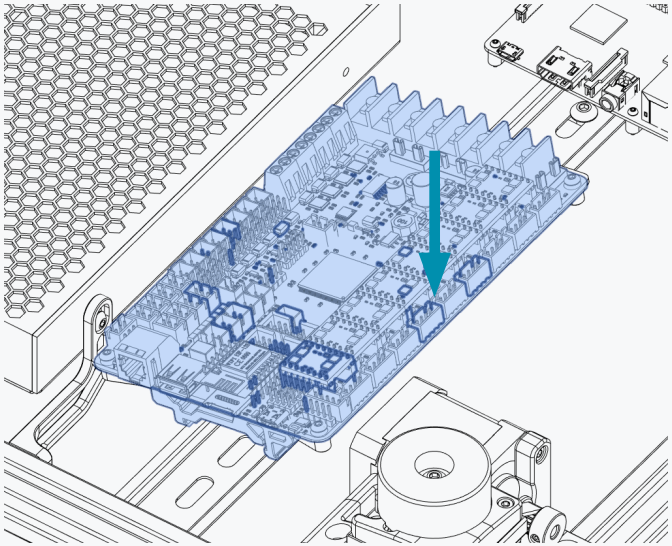


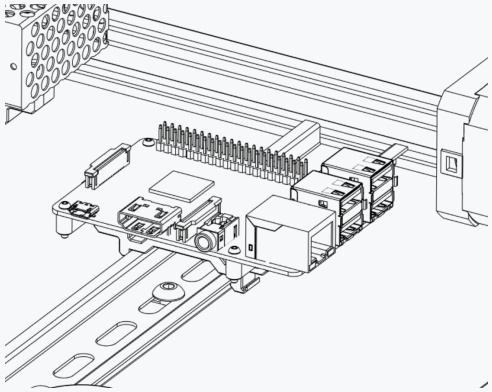

Front
Back

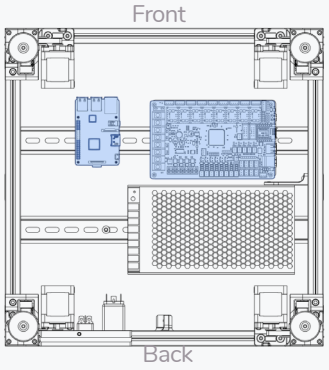

M5 T-Nut

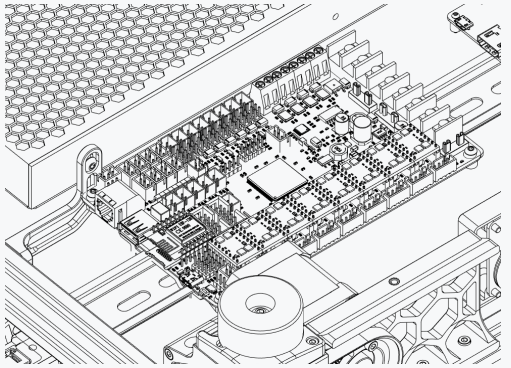

M4x6 BHCS
M5x10 BHCS

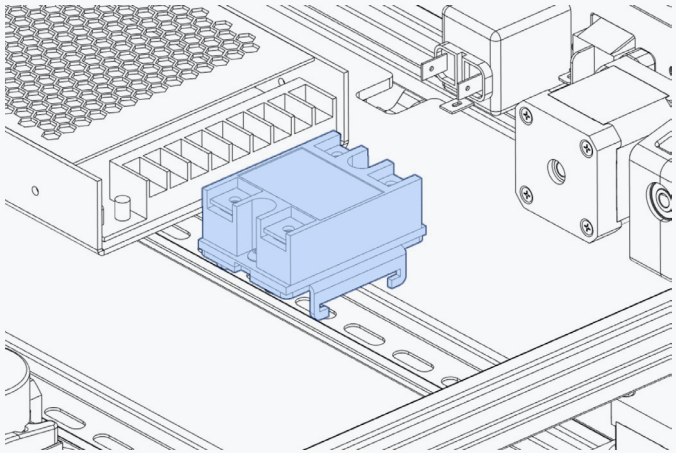


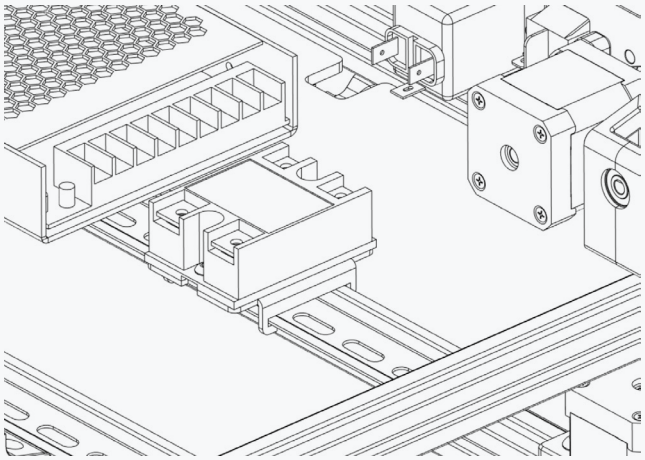


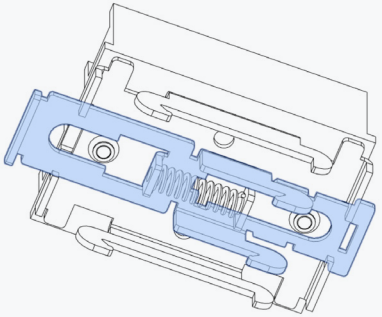


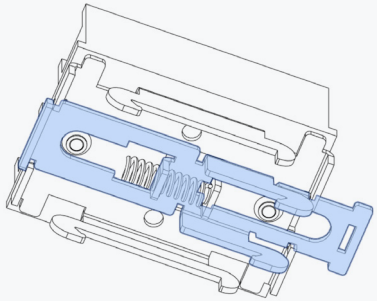

Front
Back









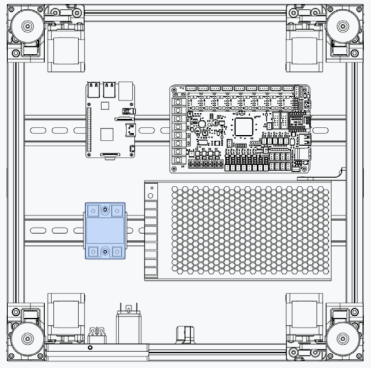


SPRING-LOADED

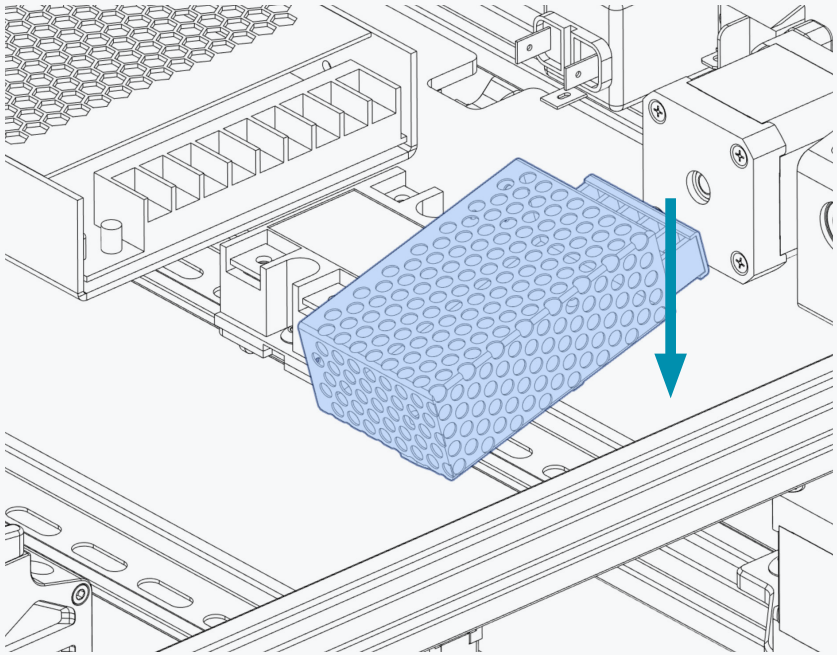
Use a flat head screw driver to pull the latch open. It will lock open.

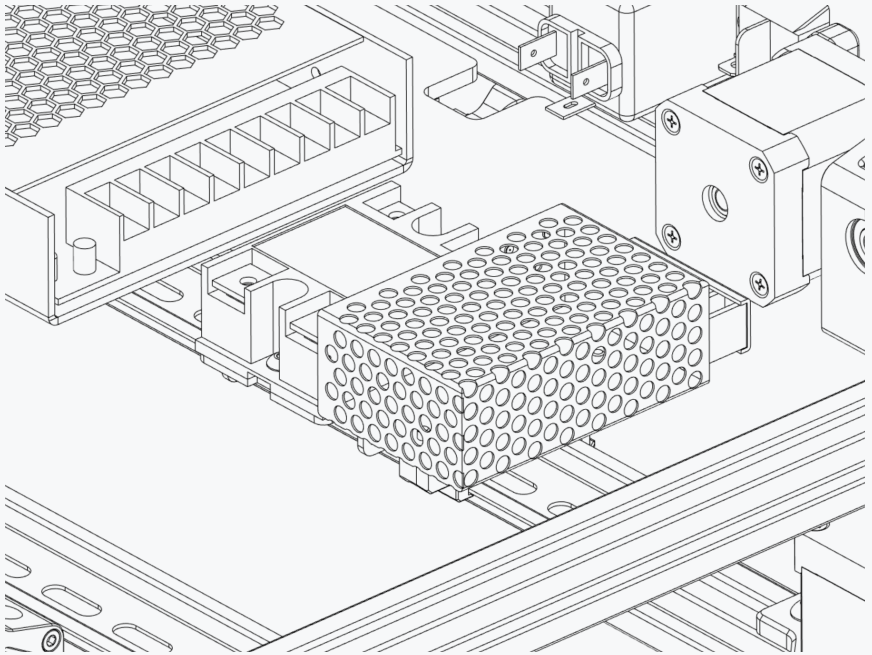
Be careful when releasing the latch, it will snap back into place. Mind your fingers.

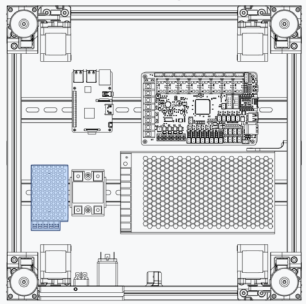
Front



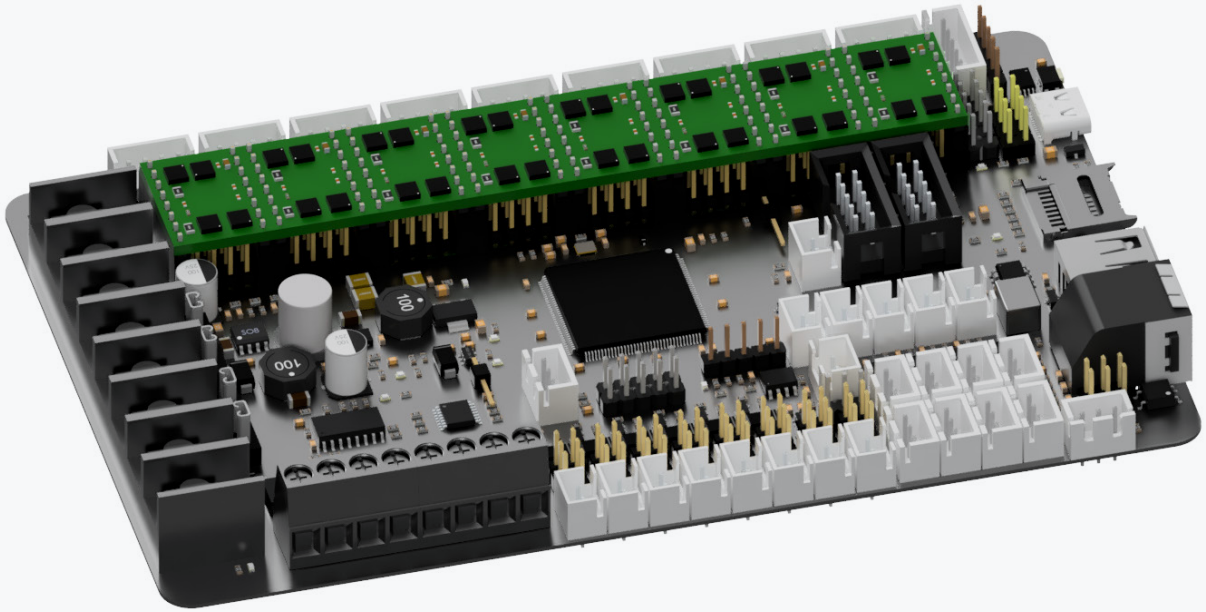
Back






Front
Back

By Feburary 2019 over 100 Voron2 printers had been built and serialized.



CONTROLLER BOARD

The assembly manual will outline the wiring for a Bigtreetech Octopus V1.1 board. You can find additional documentation and alternative configurations on docs.vorondesign.com

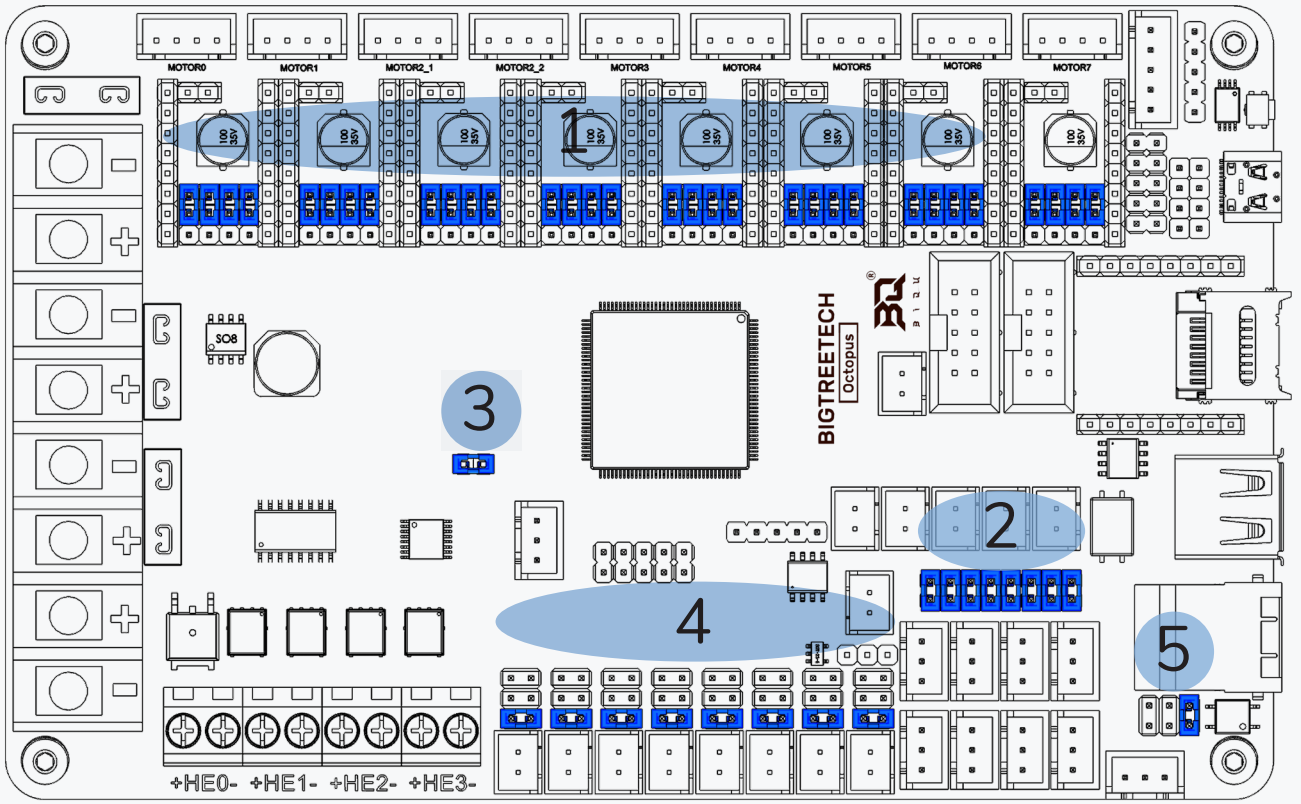
JUMPERS

Several jumpers need to be configured on the controller board. We will begin by removing all the JUMPERS from the controller board (MCU).

1) Remove the jumpers in the “driver sockets”.

2) Remove all the jumpers in the “DIAG” header when using microswitch or Hall Effect endstops.

3) Remove the “USB 5V power supply” jumper to avoid the interaction between the USB 5V of Raspberry Pi and the 5V of the MCU.



4) Remove all the jumpers on the “Fan Voltage Selection” headers so that you can set the correct supply voltage.

5) Remove the jumper in “Probe Voltage Selection” header so that you can set it to the correct supply voltage.

Diagram courtesy of @GadgetAngel

JUMPERS

Several jumpers need to be set on the MCU.

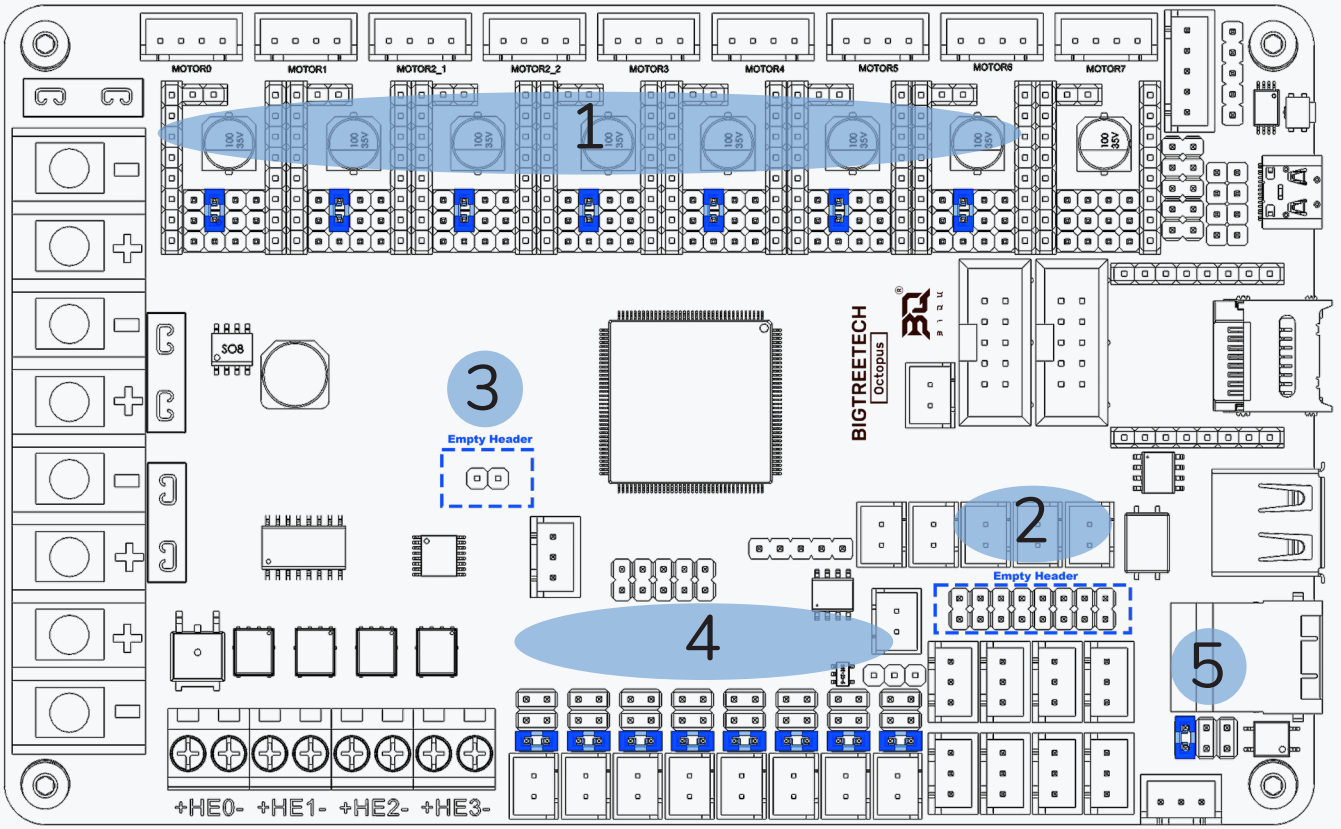
Add the following JUMPERS to the controller board (MCU).

1) Set the jumpers in the "driver sockets" as shown to set TMC2209 UART mode.

2) Ensure all the jumpers in the "DIAG" header are removed.

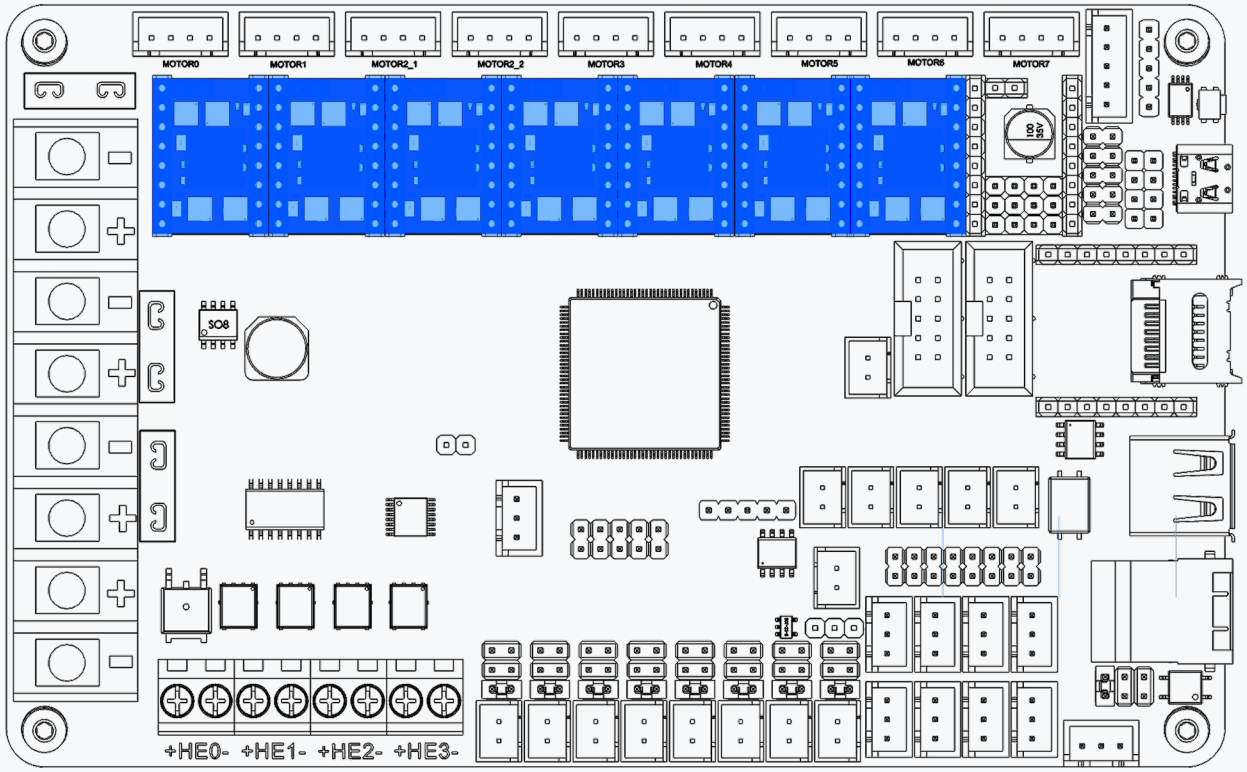
3) Ensure the Power Selection header is empty.

4) Set the Jumpers for the "Fan Voltage Selection" header so they match your fan's voltage. Shown here are the settings for 24VDC.



5) Set the jumper in "Probe Voltage Selection" header to 24VDC.

Diagram courtesy of @GadgetAngel



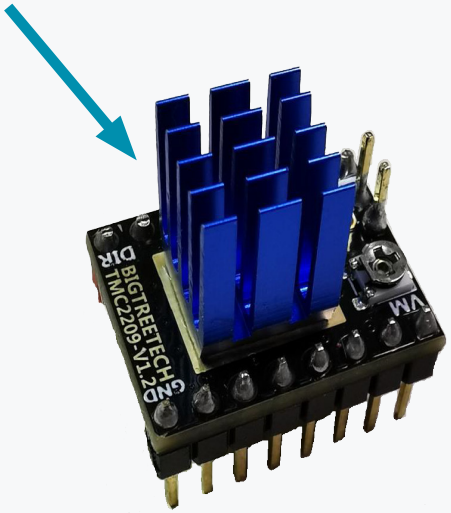
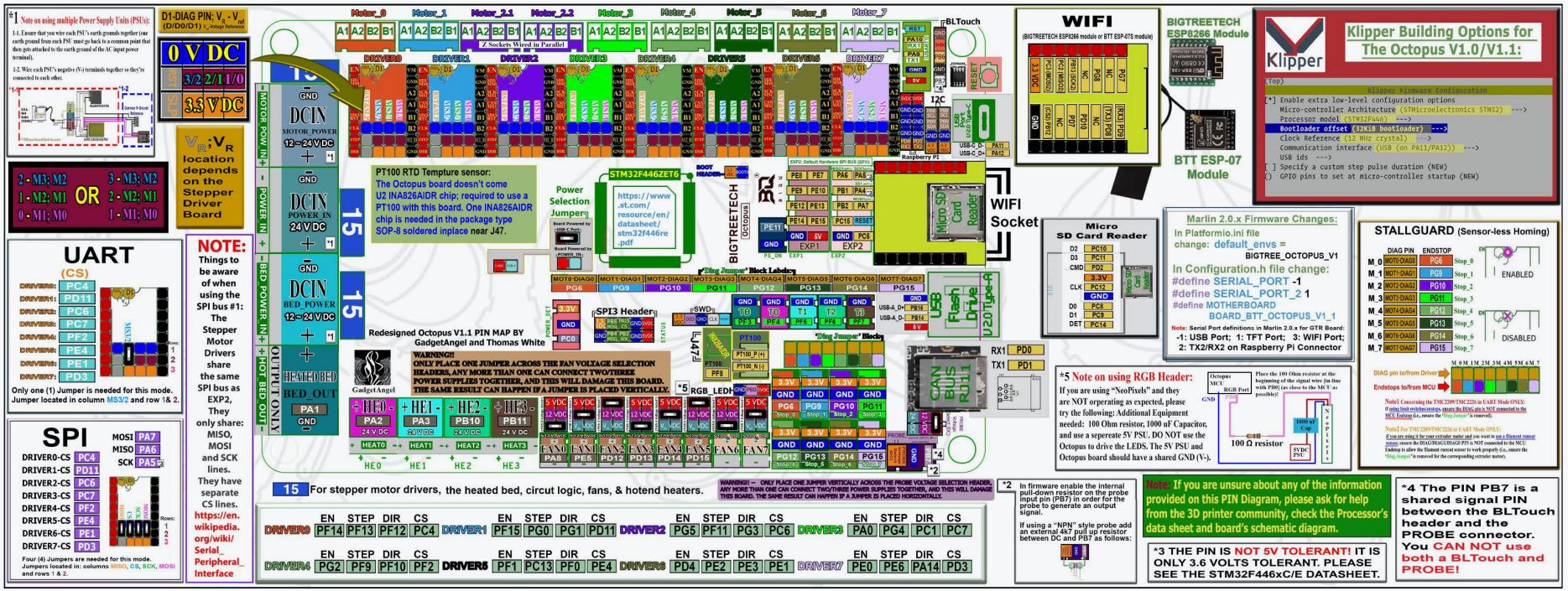


Diagram courtesy of @GadgetAngel

OCTOPUS PINOUT REFERENCE

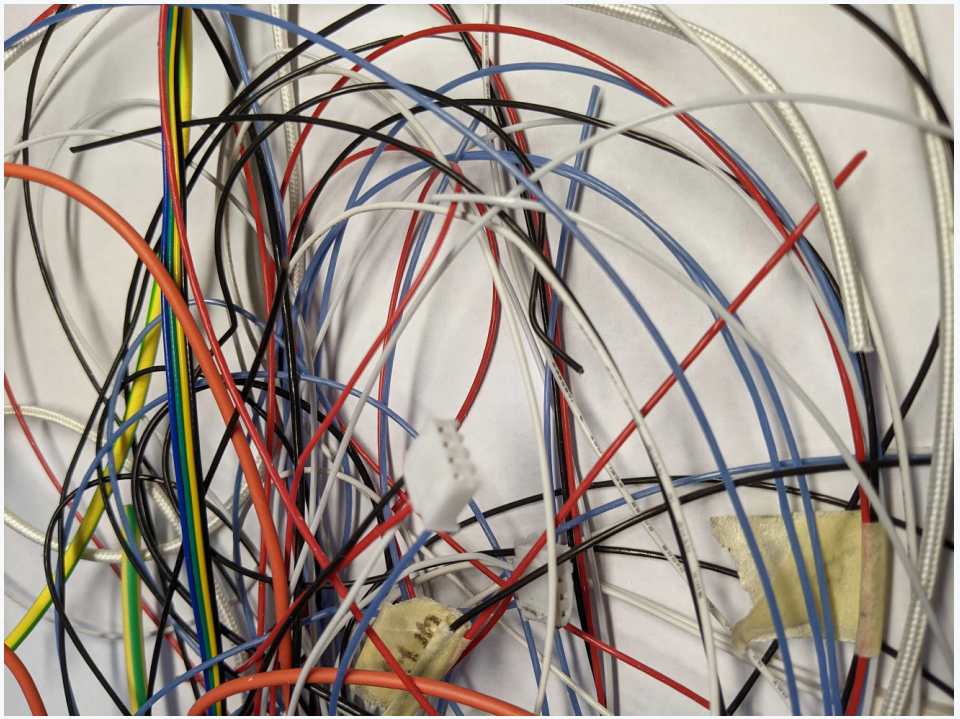
This Coloured PIN diagram can be found on GadgetAngel's GitHub repository for the Octopus V1.1

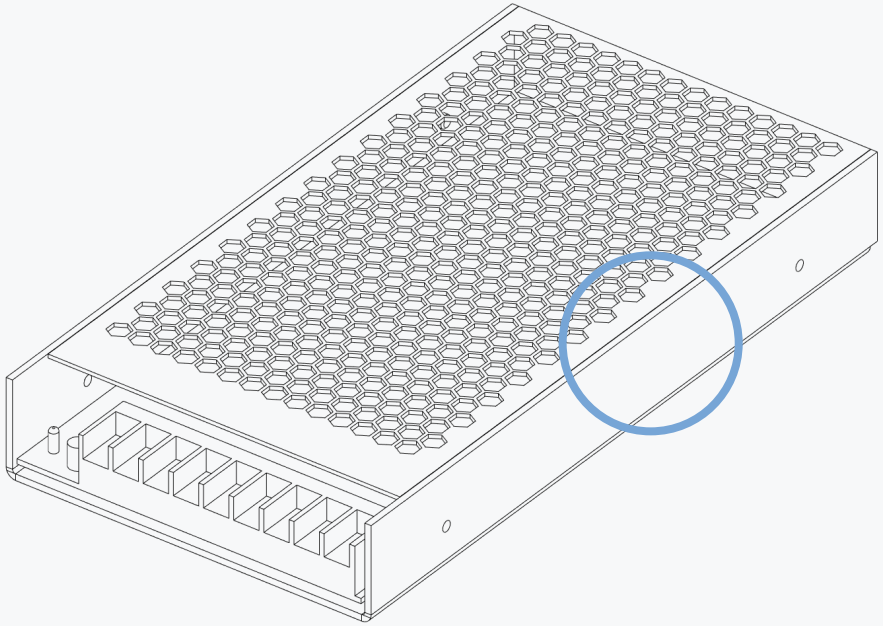


The original PIN diagram can be found on Bigtreetech's GitHub repository for Octopus V1.1 (preview friendly version)

Diagram courtesy of @GadgetAngel

A year later this figure grew to 350 Voron2 printers.

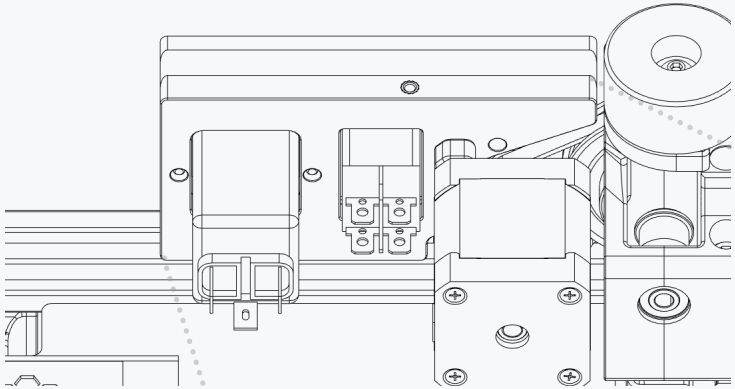




INPUT VOLTAGE SWITCH

Check the input voltage switch of the power supply. It is located in the highlighted area.

Make sure the selection matches your local mains voltage. Refer to the Mean Well LRS-200 datasheet for possible settings (voron.link/e0szdyh).



ATTACH 250MM OF WIRE

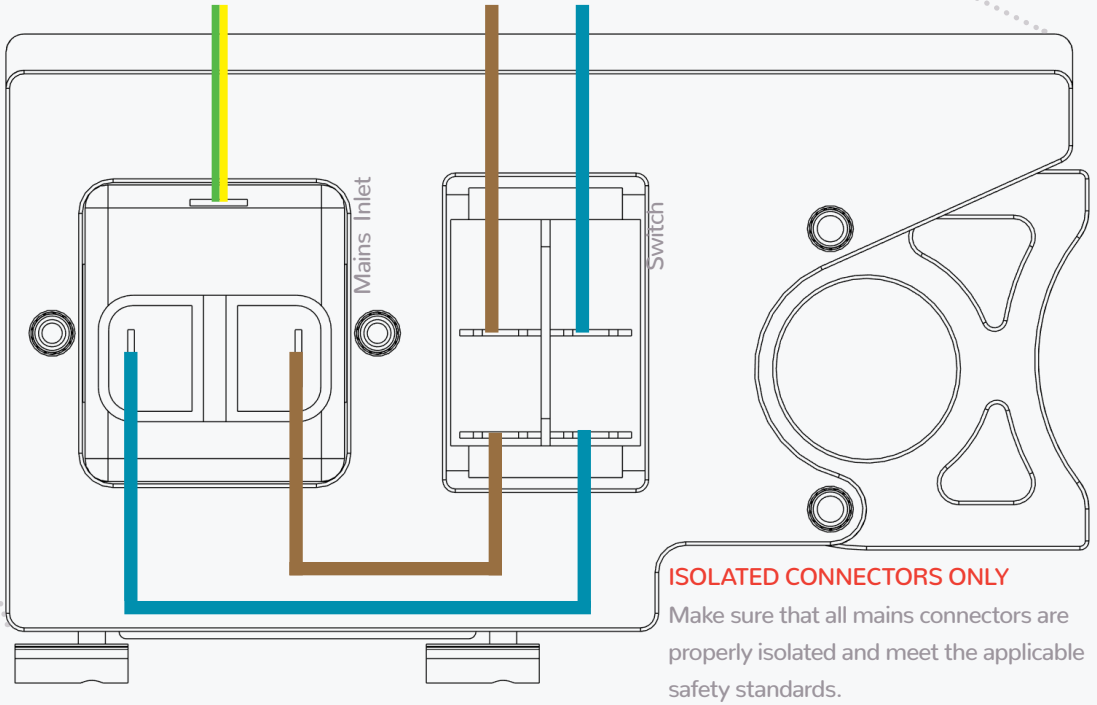
Cables should be at least 1mm² (AWG18) or thicker depending on local regulations.

MAINS INLET WIRING

We show the wiring in the IEC colour scheme. Depending on your region the colour scheme and wiring standards will differ.

Mains wiring should only be done by qualified personnel trained in local regulations and safety standards. Depending on your local regulations you may be forbidden from wiring the mains side and/or putting the printer into operation; seek professional assistance.

Failure to observe those could result in bodily harm.



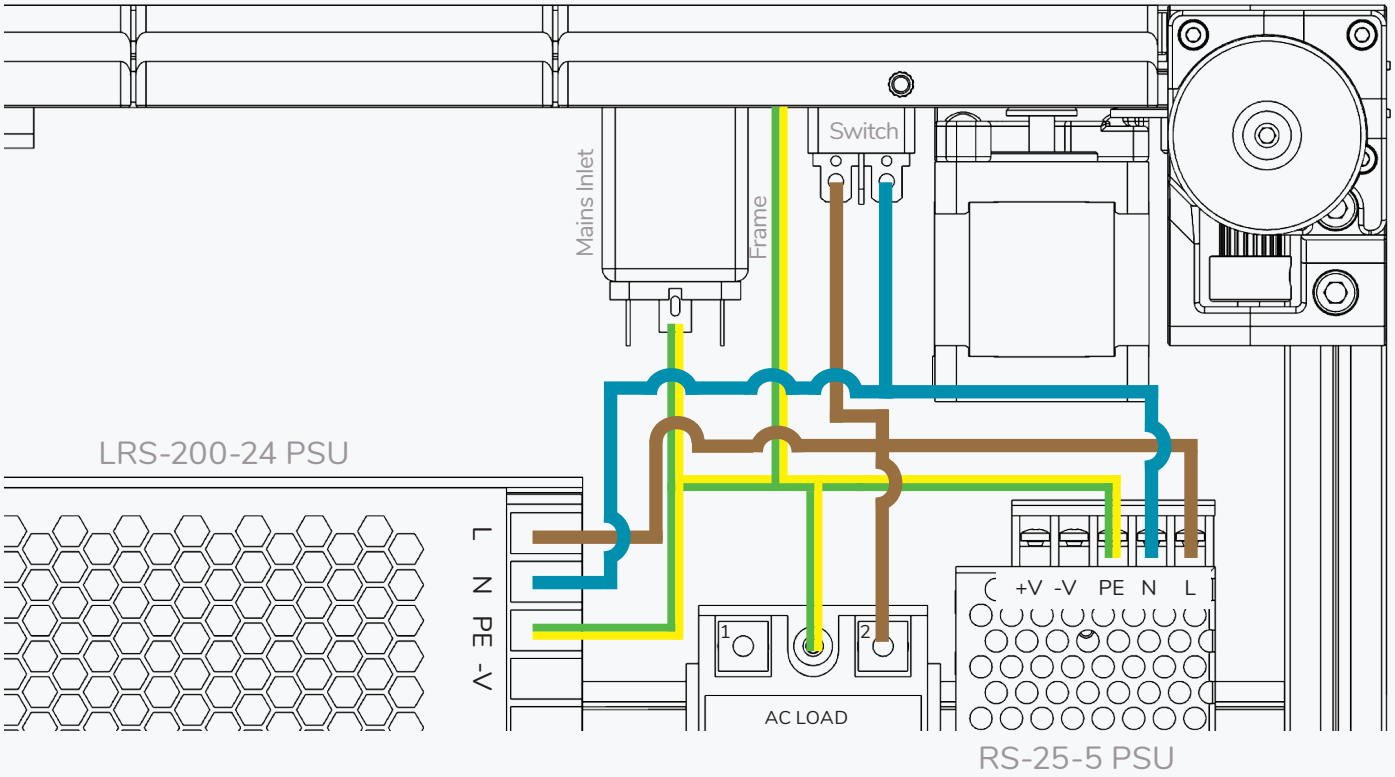
ISOLATED CONNECTORS ONLY

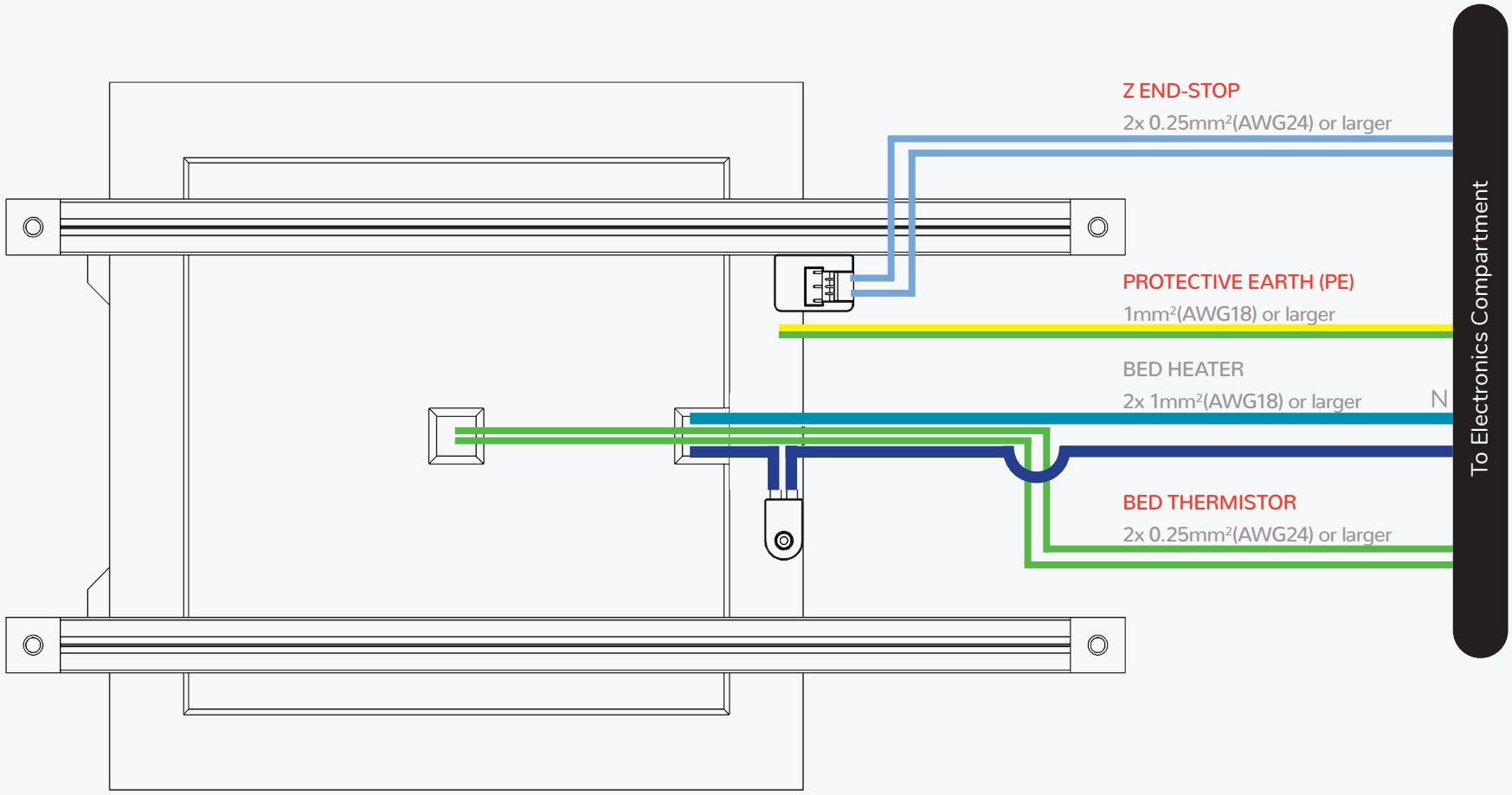
Make sure that all mains connectors are properly isolated and meet the applicable safety standards.

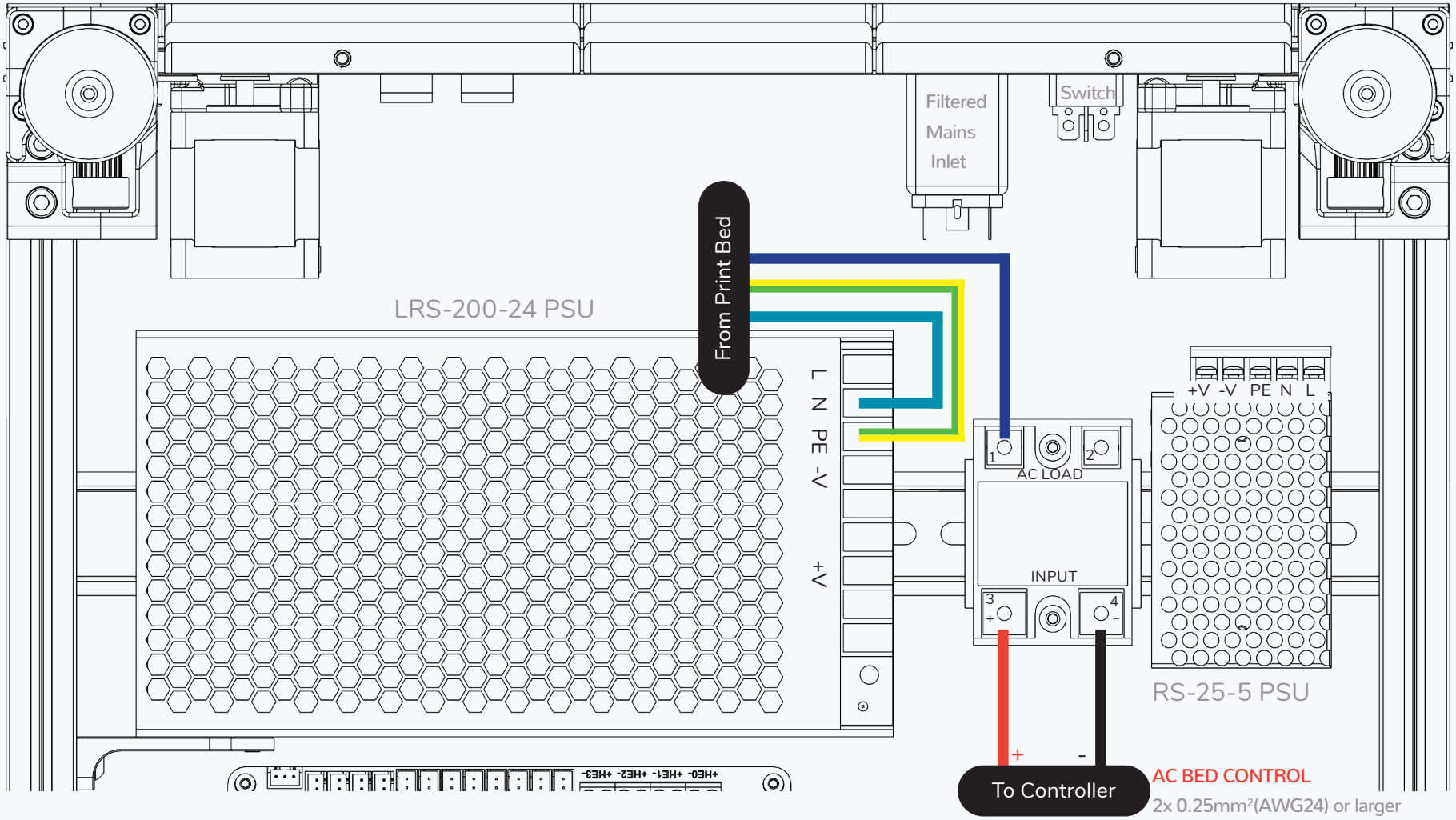
MAINS WIRING CONTINUED

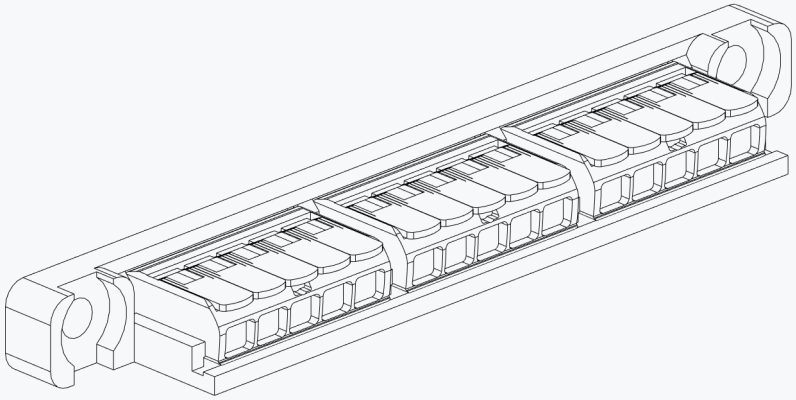
Secure the wires with cable clips / cable tie anchors.

The bed heater is powered by AC voltage and receives its PE in a later step.
Observe your local regulations in regards to the Protective Earth connections for the frame/other components.




Z END-STOP
2x 0.25mm²(AWG24) or larger
PROTECTIVE EARTH (PE)
1mm²(AWG18) or larger
BED HEATER
2x 1mm²(AWG18) or larger
N
BED THERMISTOR
2x 0.25mm²(AWG24) or larger
To Electronics Compartment

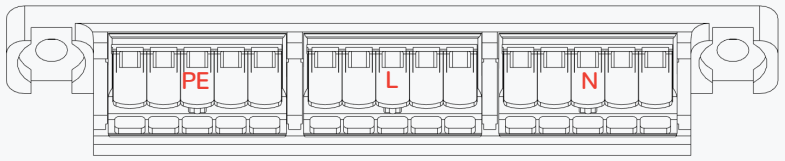

Filtered
Mains
Inlet
Switch
From Print Bed
LRS-200-24 PSU
L N PE -V +V
AC LOAD
INPUT
1
2
3
4
+V -V PE N L
RS-25-5 PSU
+
-
To Controller
AC BED CONTROL
2x 0.25mm²(AWG24) or larger

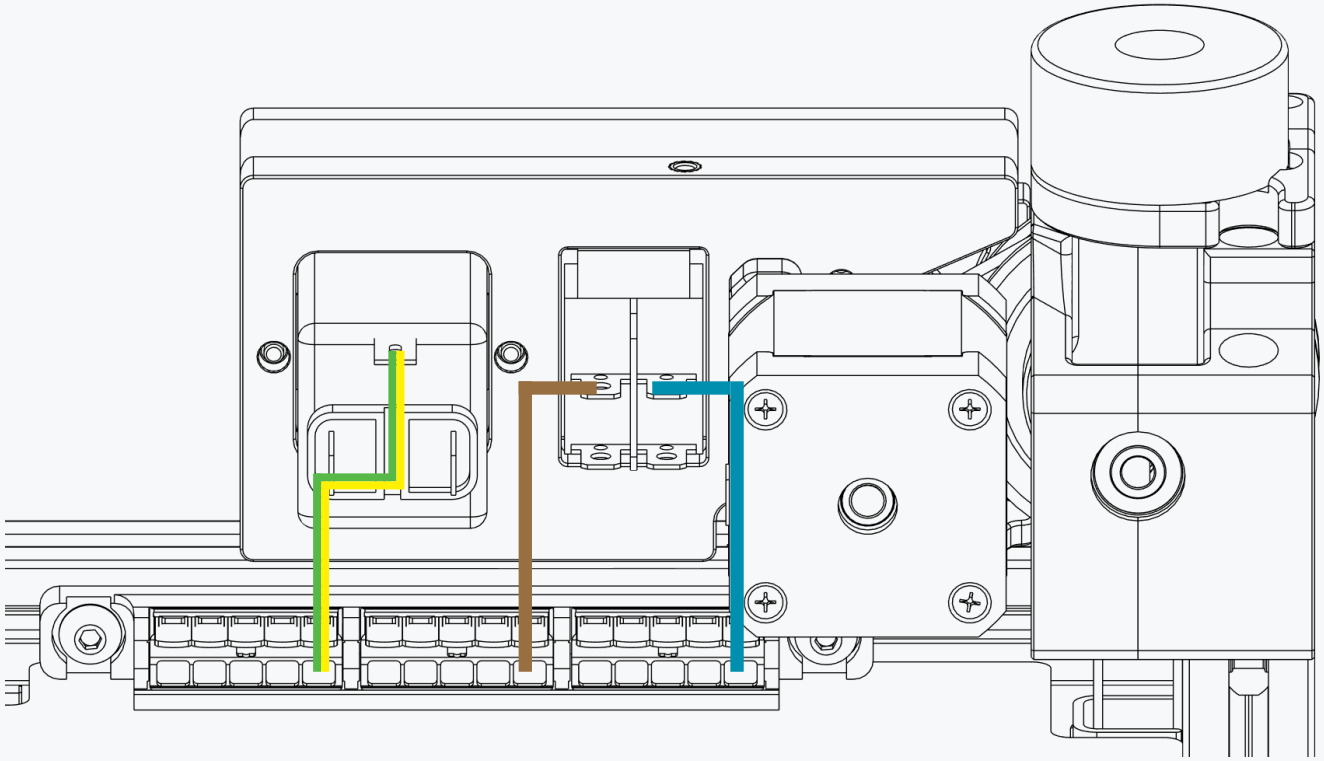


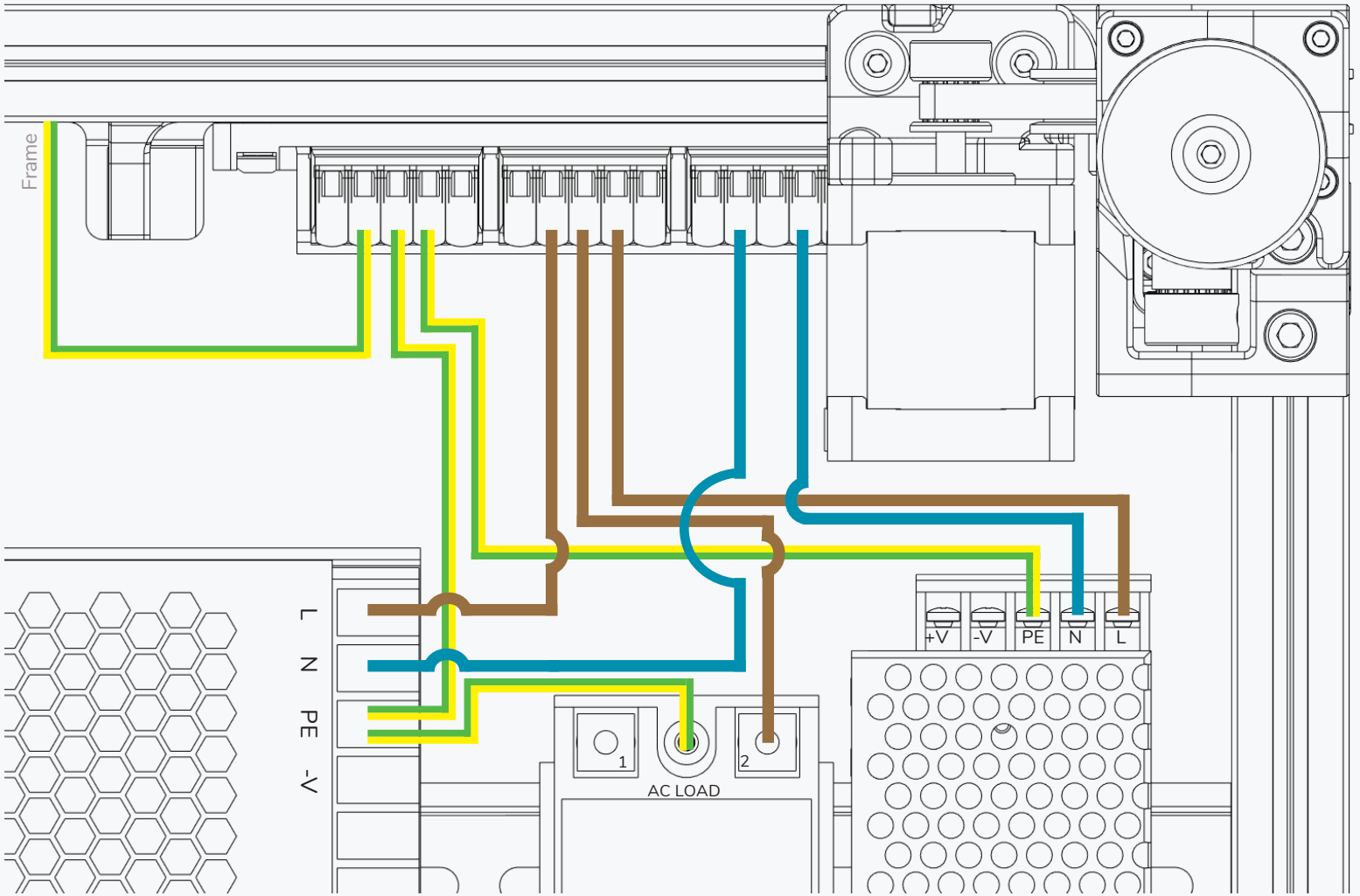
OPTION: WAGO CLAMPS FOR MAINS

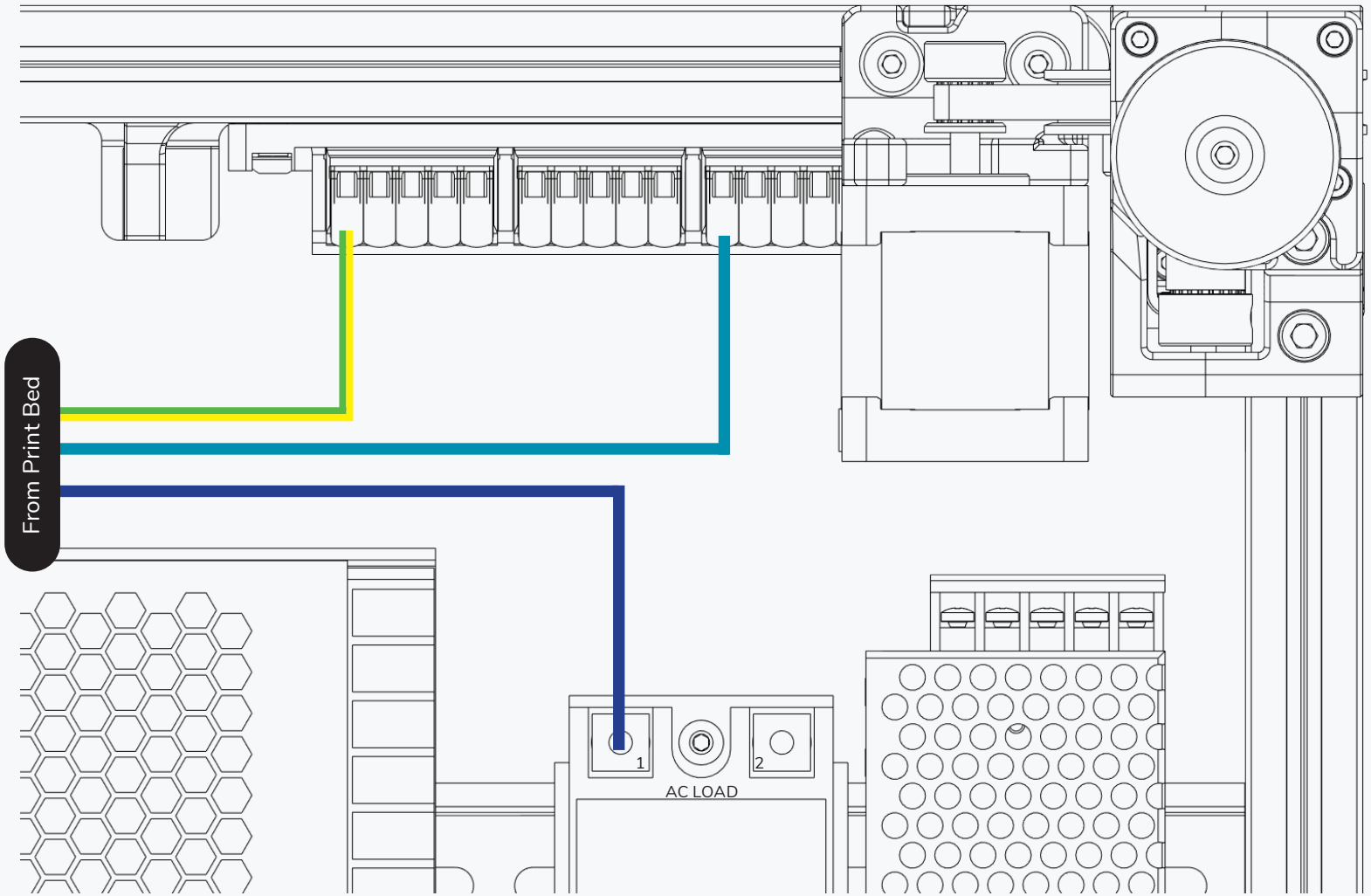
WAGO wire clamps allow for a clean and easy wiring of the mains side.

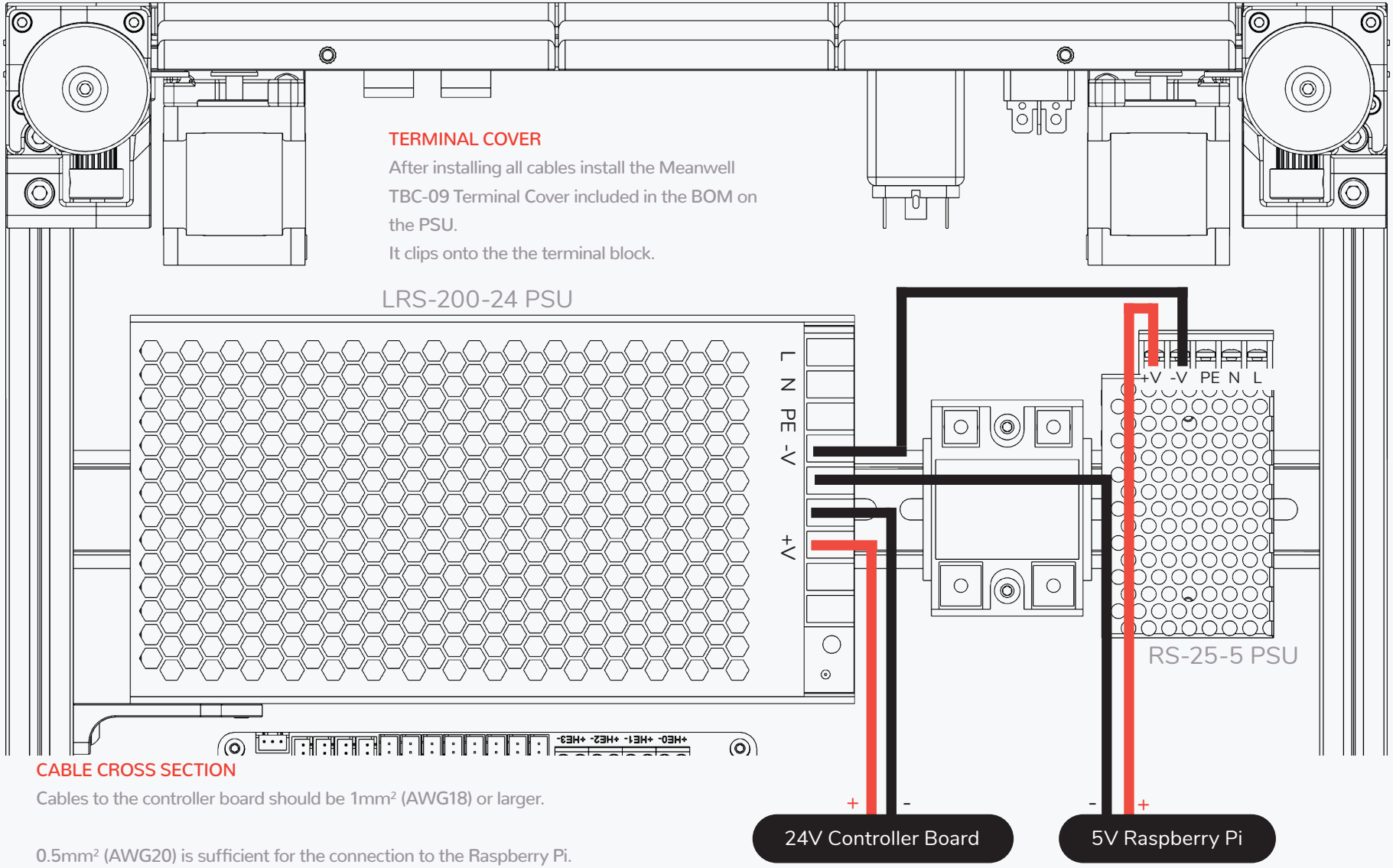
You may want to label your clamps as shown below.






Frame
L
N
PE
-V
1
2
AC LOAD
+V
-V
PE
N
L


From Print Bed
1
2
AC LOAD



TERMINAL COVER

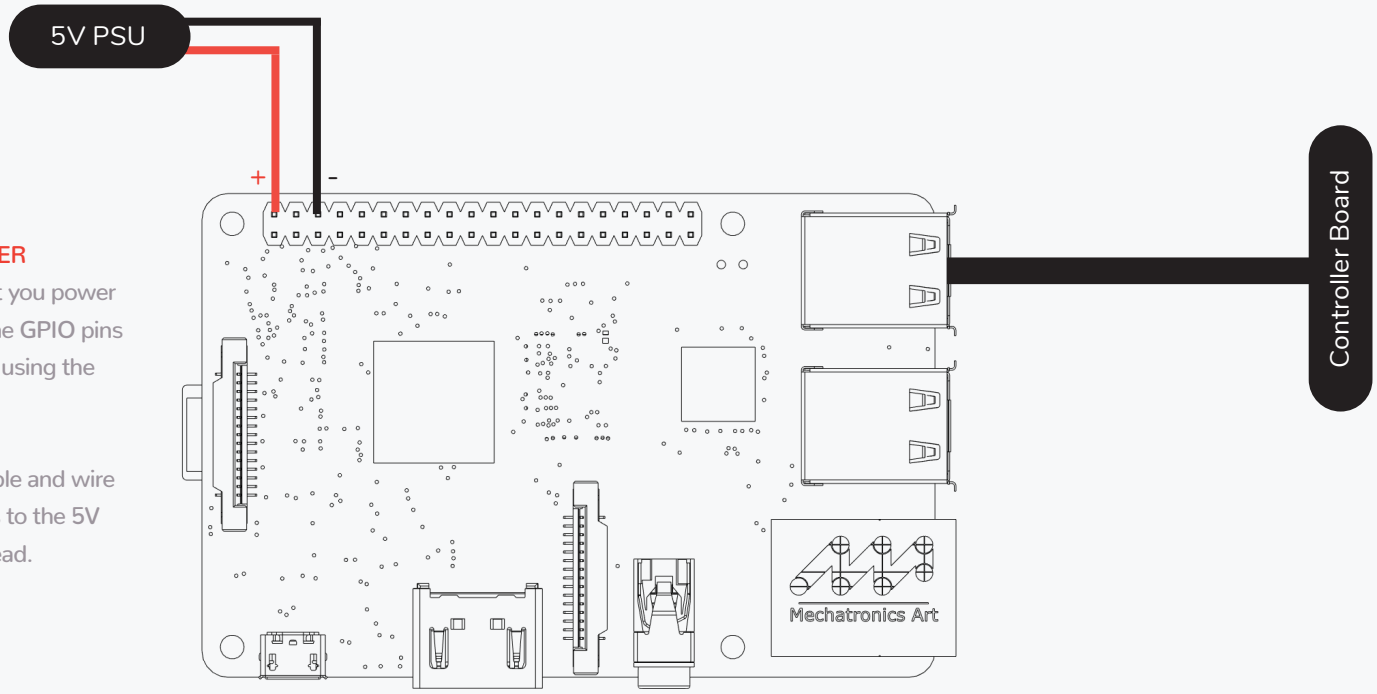
After installing all cables install the Meanwell TBC-09 Terminal Cover included in the BOM on the PSU.

It clips onto the the terminal block.

CABLE CROSS SECTION

Cables to the controller board should be 1mm² (AWG18) or larger.

0.5mm² (AWG20) is sufficient for the connection to the Raspberry Pi.



RASPBERRY PI POWER

While we suggest that you power the Raspberry Pi via the GPIO pins you may also power it using the "Power-In" USB port.

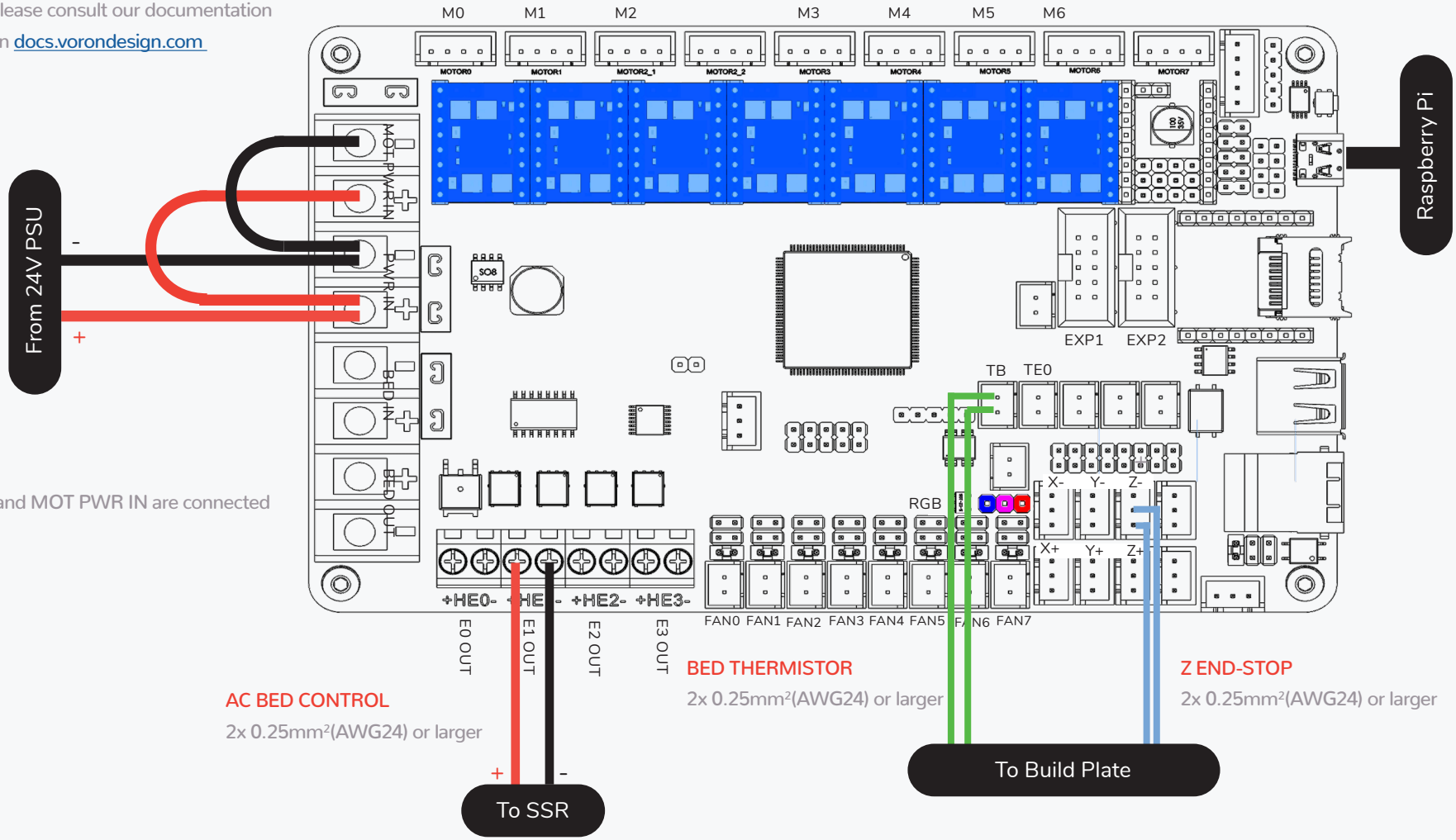
Cut a suitable USB cable and wire the + and ground lines to the 5V DC/DC converter instead.

JUMPERS

Several jumpers may need to be configured on the controller board. Please consult our documentation on docs.vorondesign.com

CONTROLLER BOARD

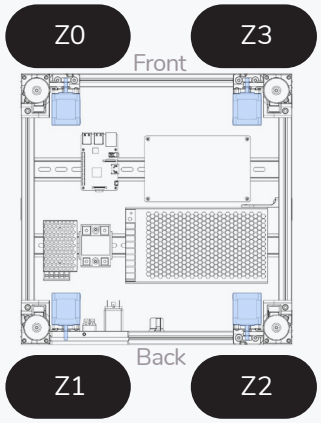
The assembly manual will outline the wiring for a Bigtreetech Octopus V1.1. You can find additional documentation and alternative configurations on docs.vorondesign.com



PWR IN

PWR IN and MOT PWR IN are connected to 24V.

CONTROLLER BOARD

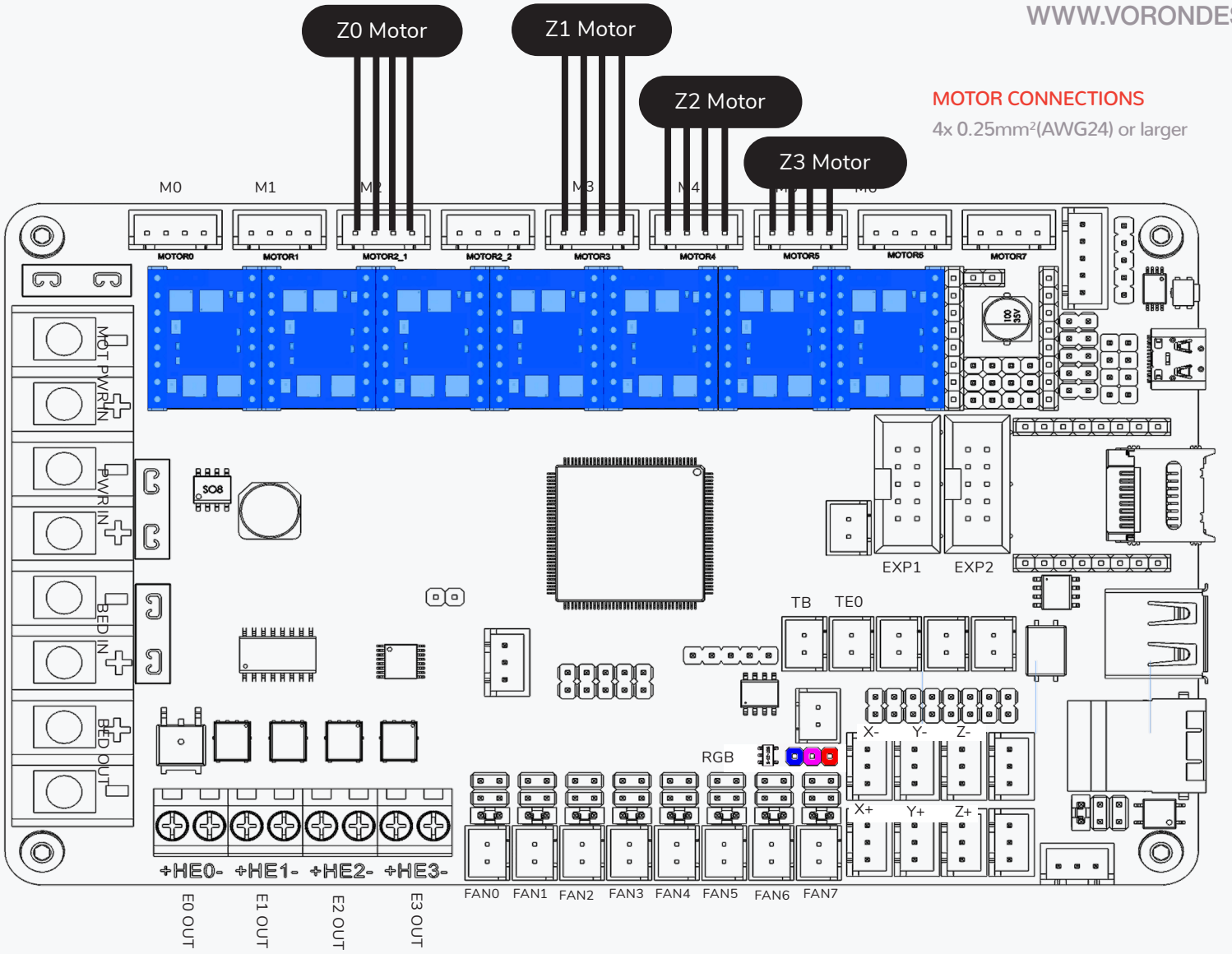


BLACK MOTOR WIRES?

There is no standardized stepper wire colouring scheme. Each manufacturer implements their wires colours slightly different.

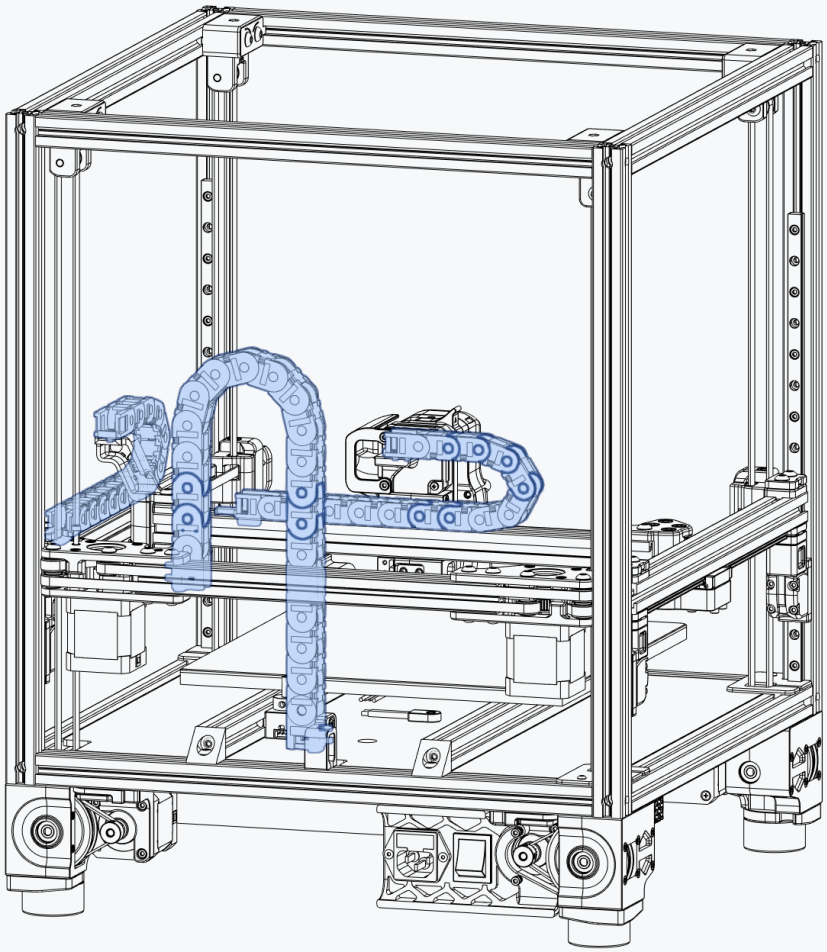
Please consult the datasheet of your stepper motors for the correct order.

If your motors came with plugs it's usually safe to assume that this order is correct.



MOTOR CONNECTIONS

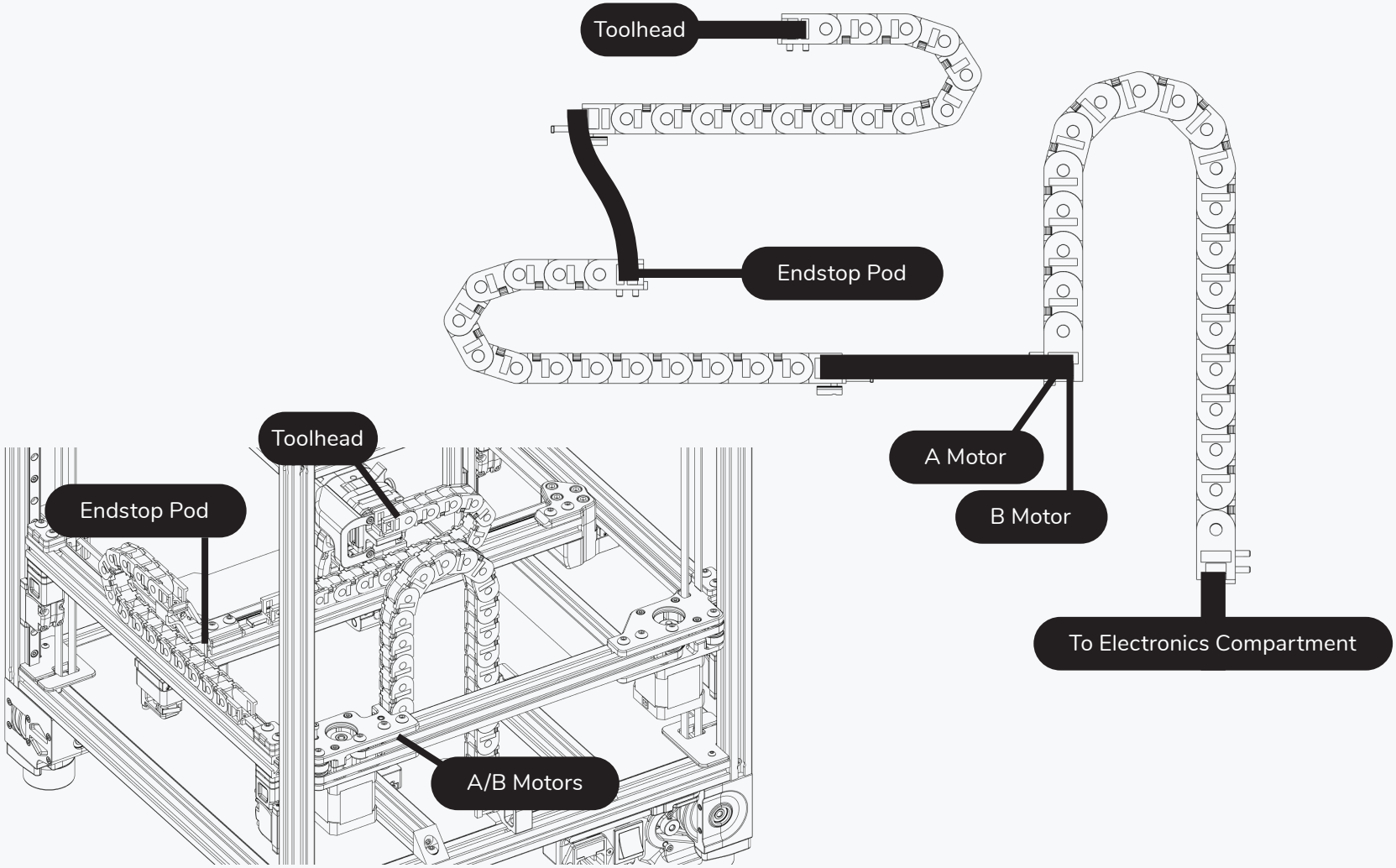
4x 0.25mm²(AWG24) or larger

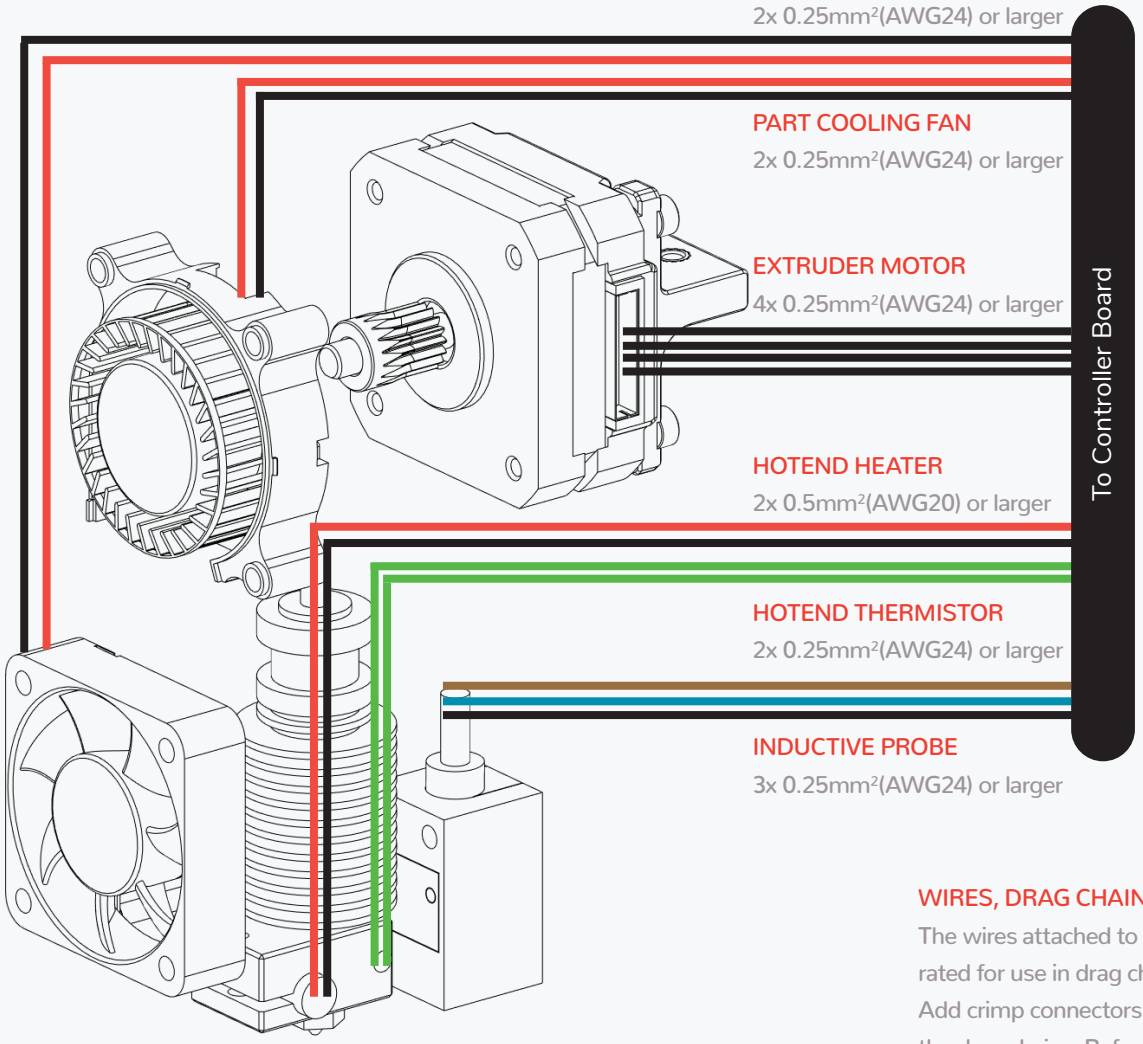


CABLE CHAINS INSTALL

You can opt to install the chains now and fish the wires through the chains or build the complete harness outside of the printer and install it in one go. Either approach does work.

If you sourced a pre-built wire harness completing the harness outside of the printer is recommended.

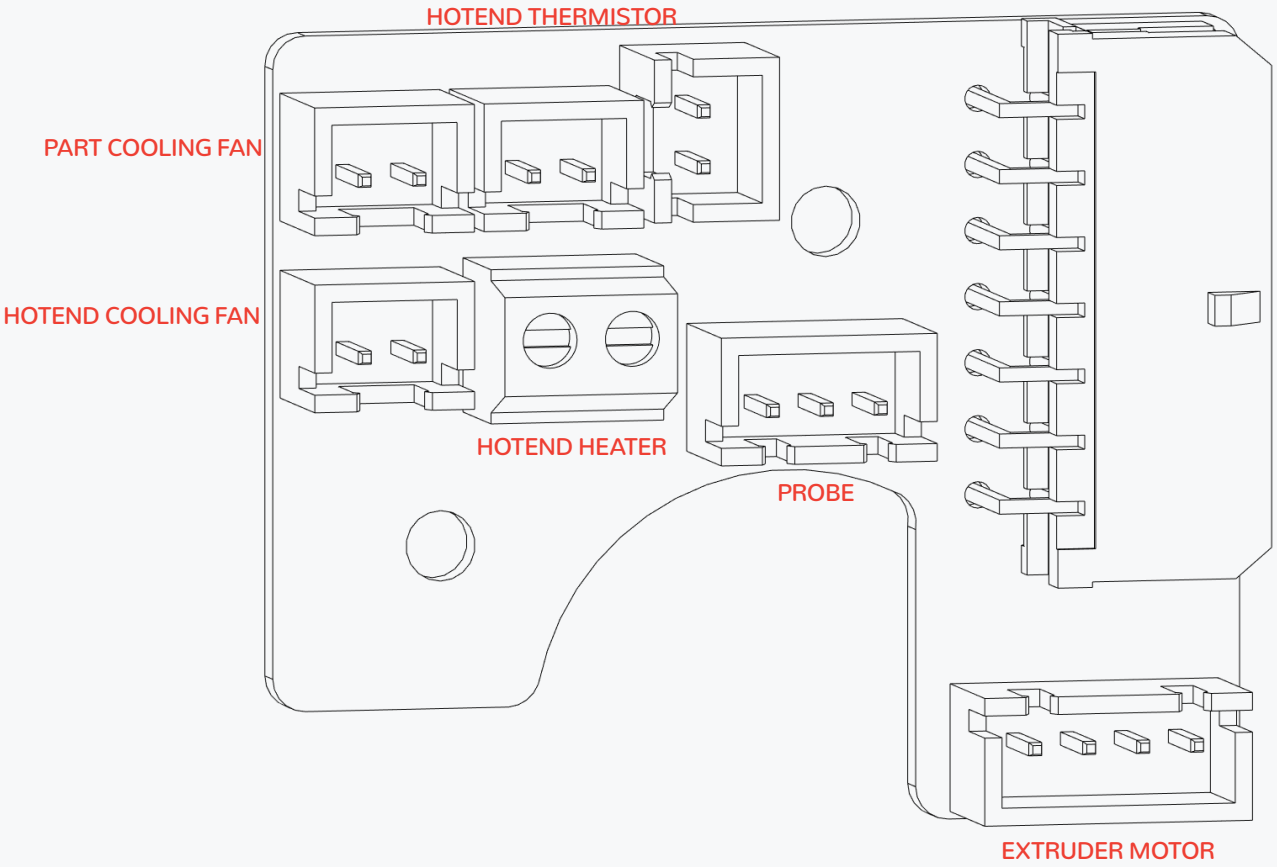

Toolhead
Endstop Pod
A Motor
B Motor
To Electronics Compartment
Toolhead
Endstop Pod
A/B Motors



WIRES, DRAG CHAINS AND CRIMPS

The wires attached to the probe, fans, heater, etc. are usually not rated for use in drag chains.

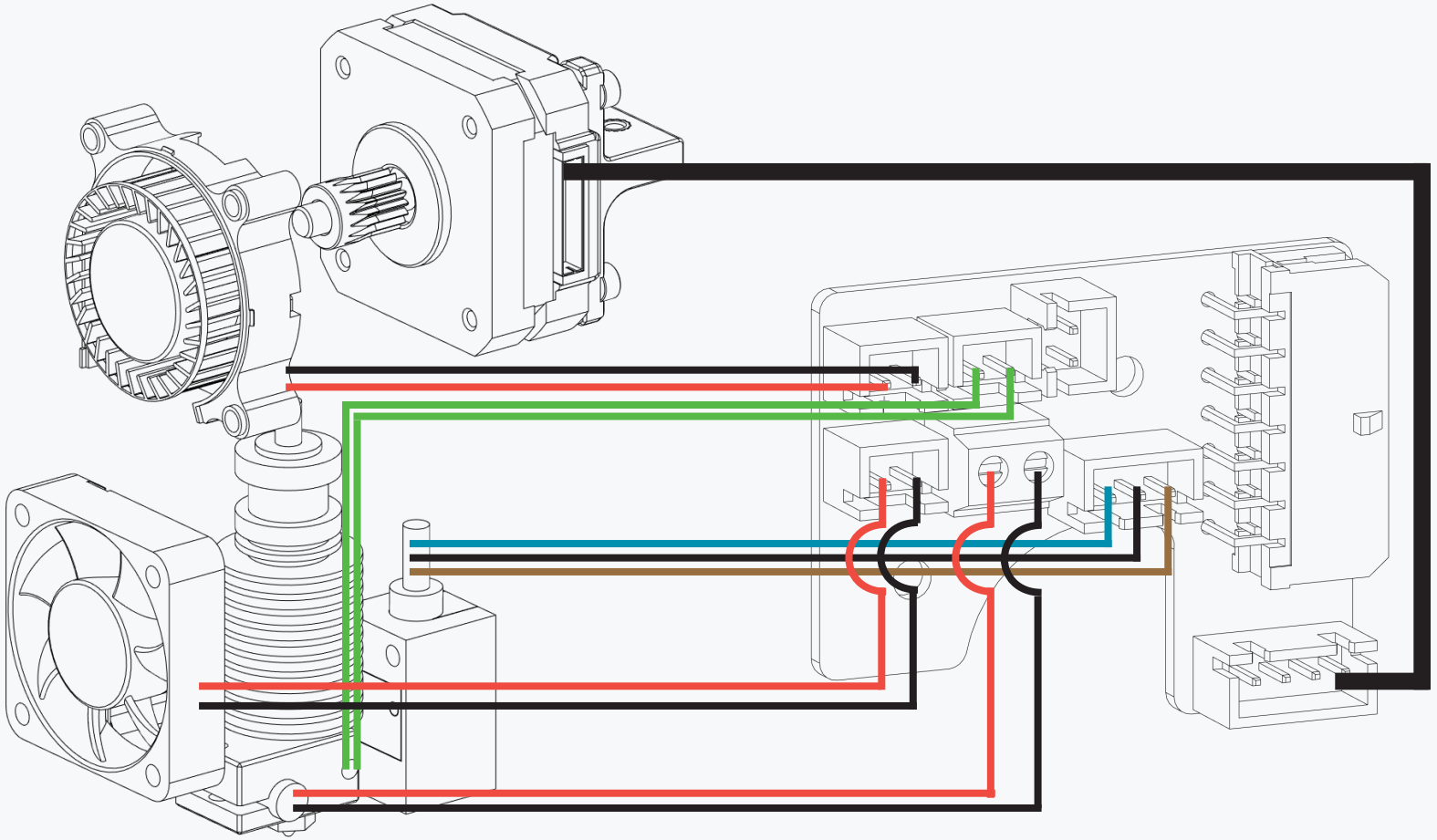
Add crimp connectors at the toolhead and run suitable wire down the drag chains. Refer to the sourcing guide for options.

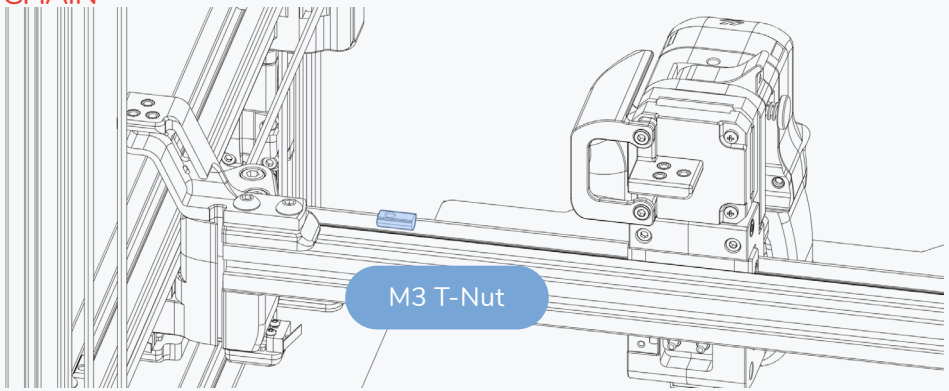


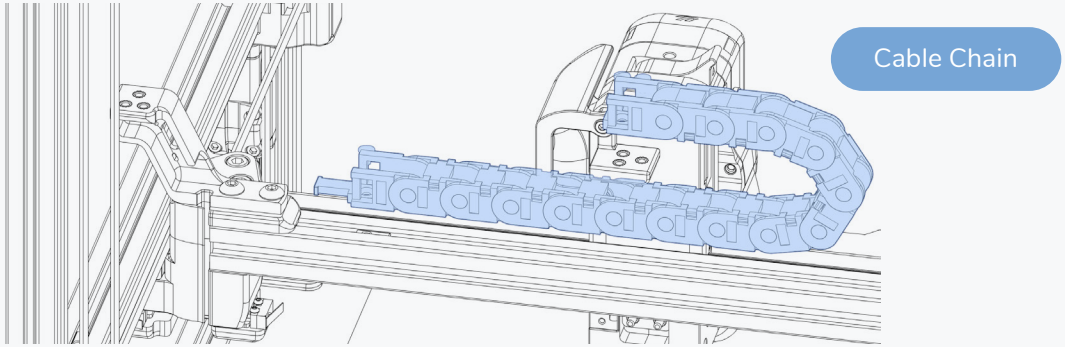
OPTION: TOOLHEAD PCB

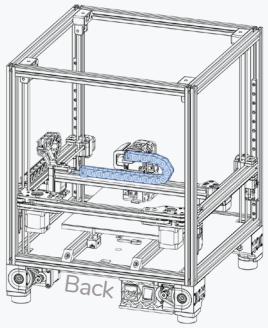
The layout of the toolhead pcb changed over the versions. For a full breakdown visit the link below.

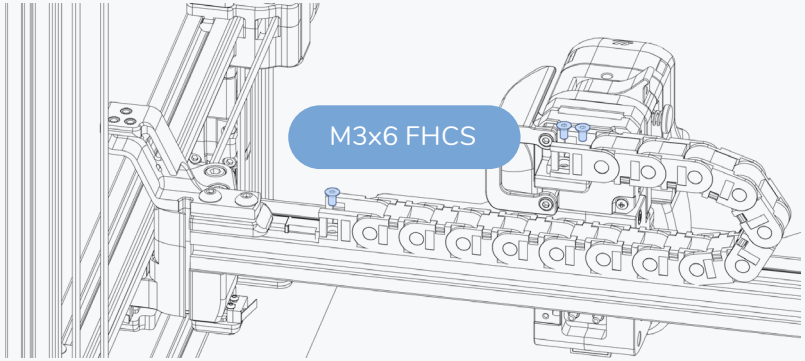
https://voron.link/zopduze

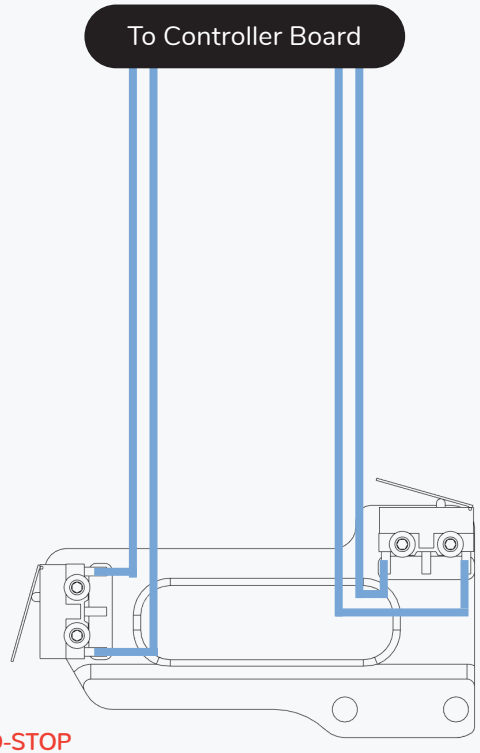


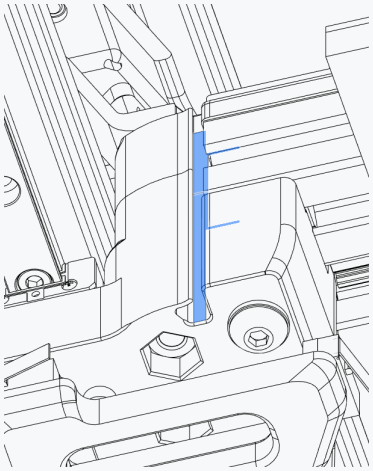

M3 T-Nut


Cable Chain


Back


M3x6 FHCS



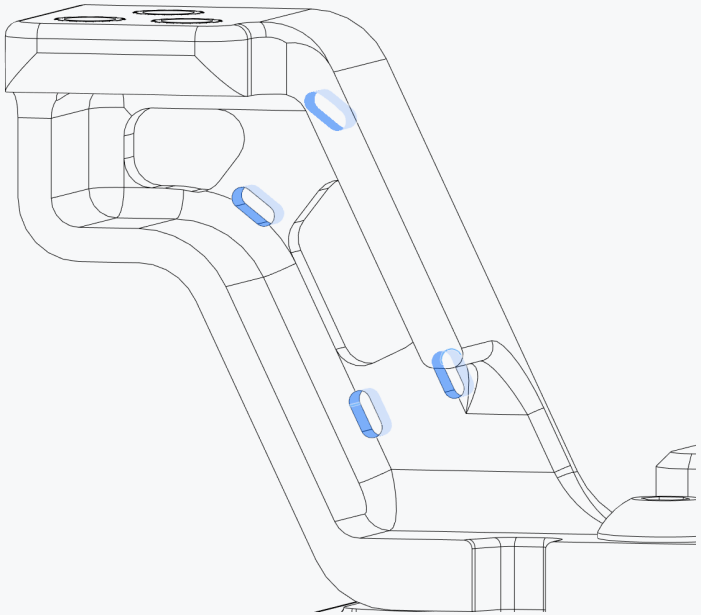


X END-STOP

2x 0.25mm²(AWG24) or larger

Y END-STOP

2x 0.25mm²(AWG24) or larger

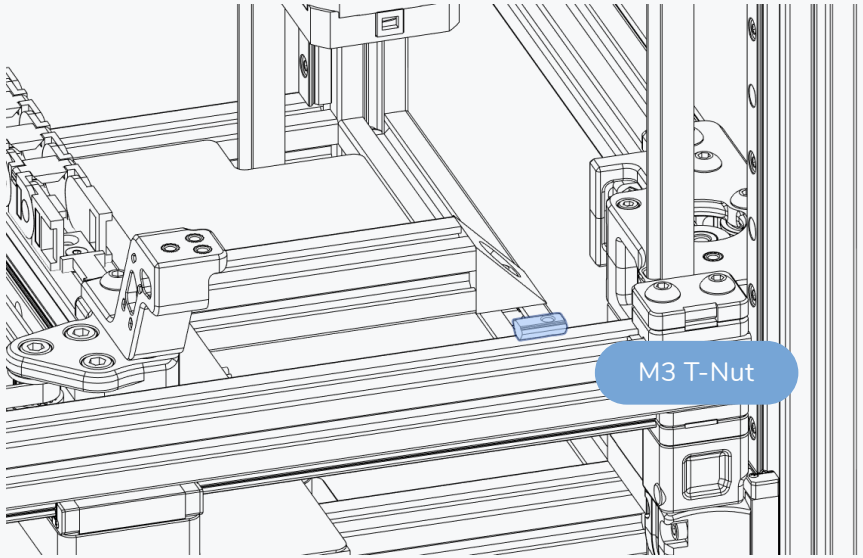


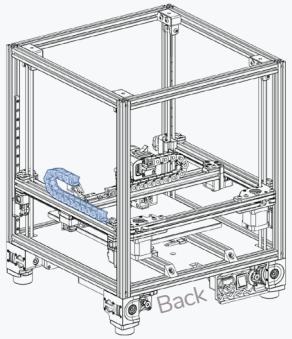
ZIP TIE LOOPS

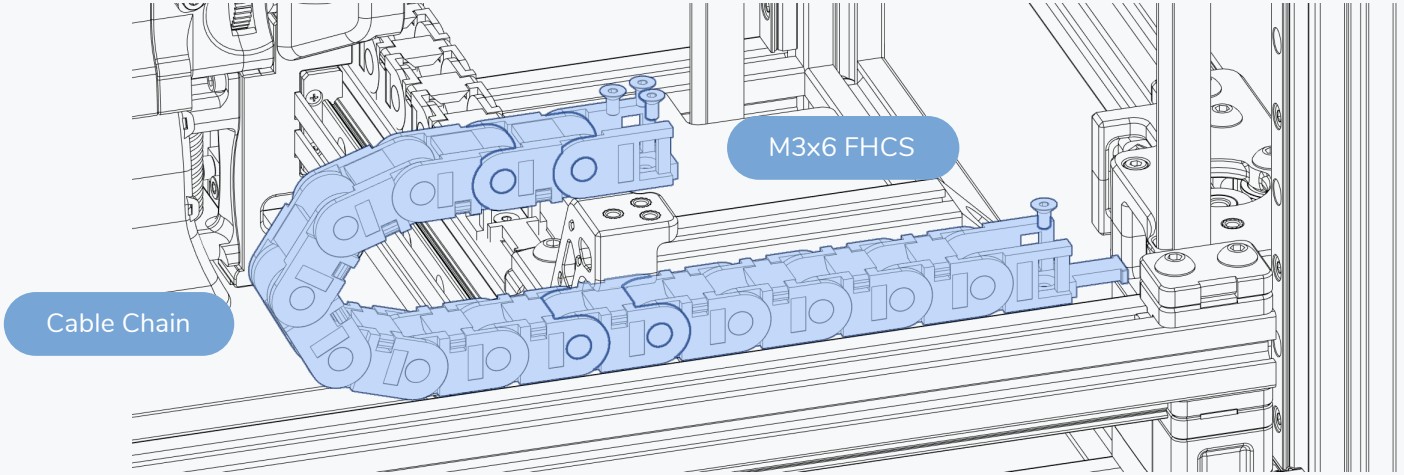
Secure the wire bundle to the strain relief using small zip ties.

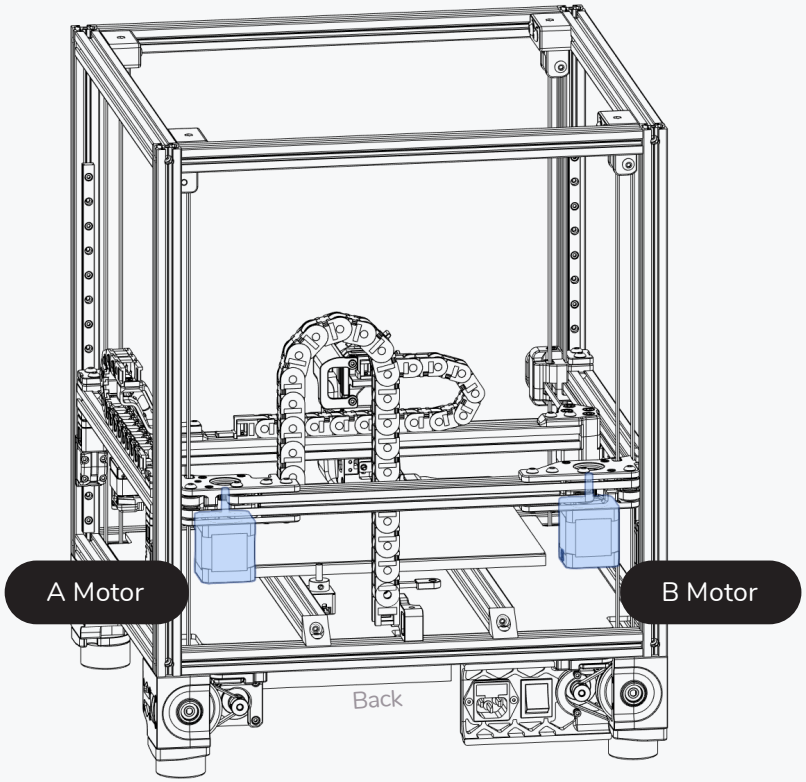
OPTION: ENDSTOP BOARD/HALL EFFECT BOARD

Those boards utilize a 4 pin connector instead. Please refer to https://voron.link/djhyygu and https://voron.link/d6qb7o6 for details.


M3 T-Nut

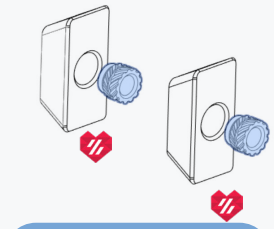

Back


M3x6 FHCS
Cable Chain

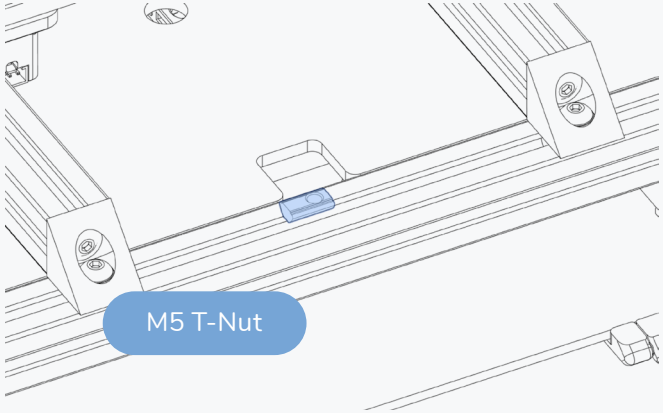


SECURING MOTOR CABLES

Secure the wire bundles along the small extrusion that sits between the drives with small zip ties.

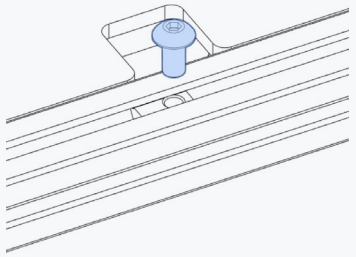


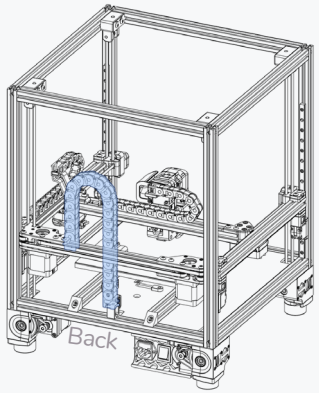
Heat Set Insert

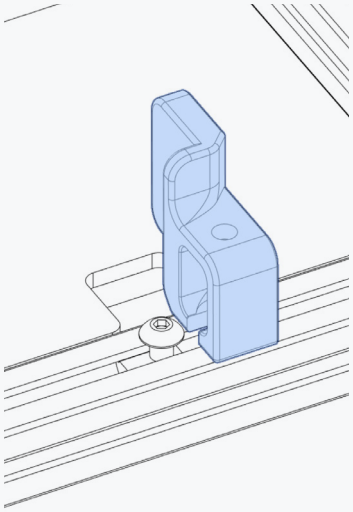


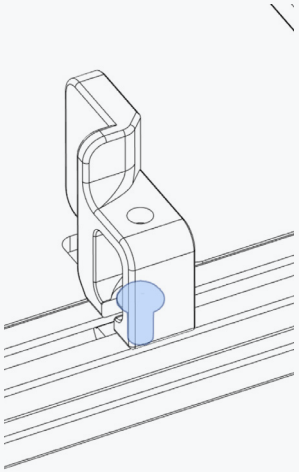
M5 T-Nut

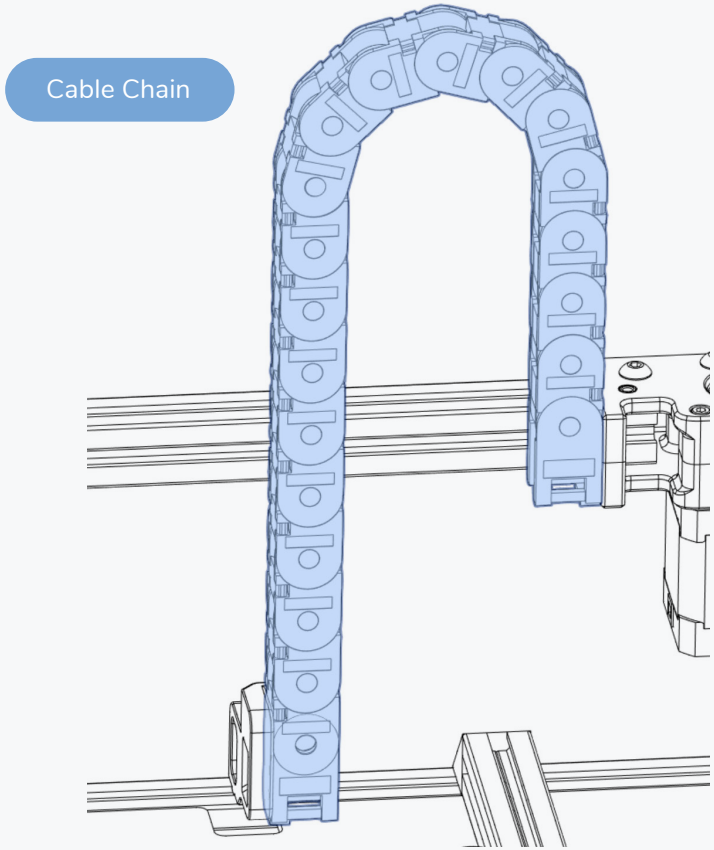
M5x10 BHCS

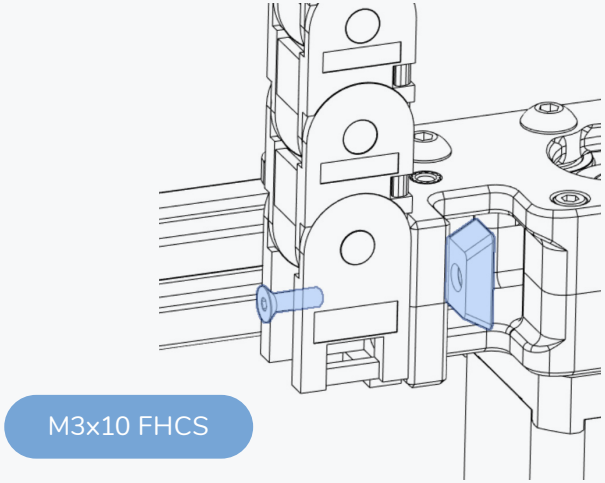


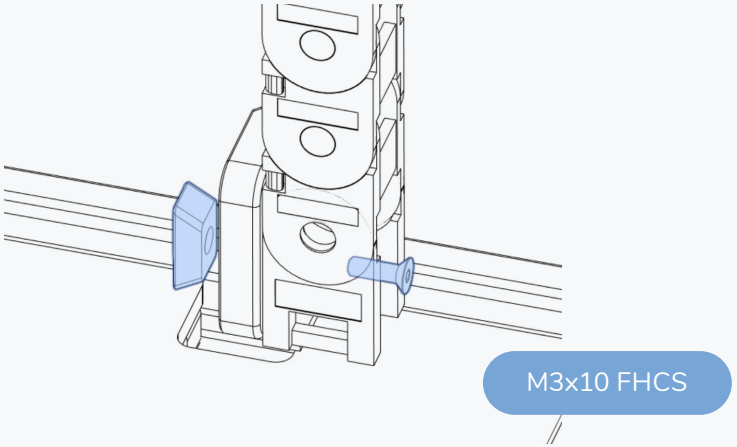


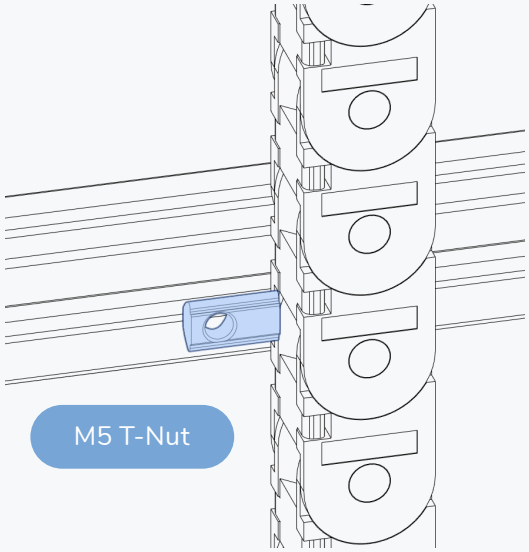


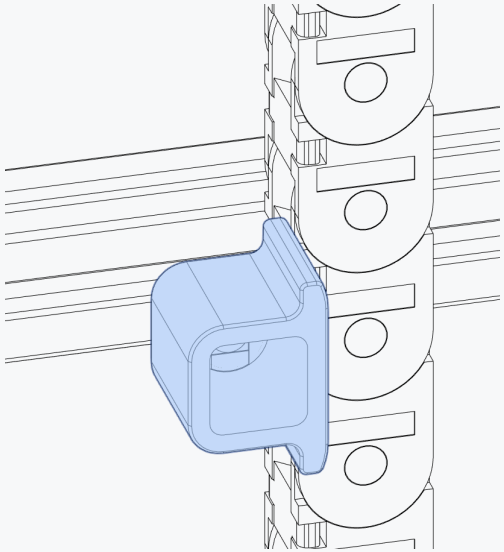


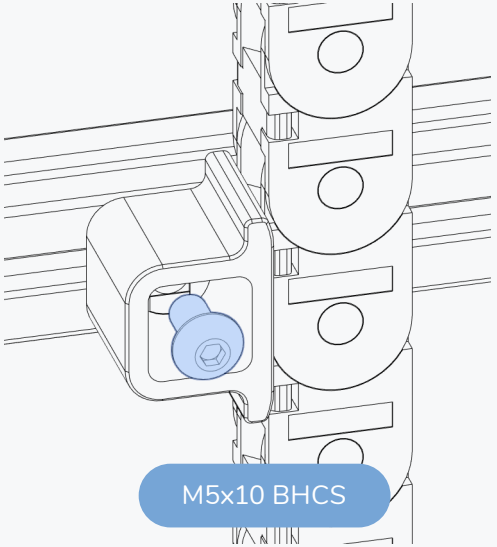

Cable Chain

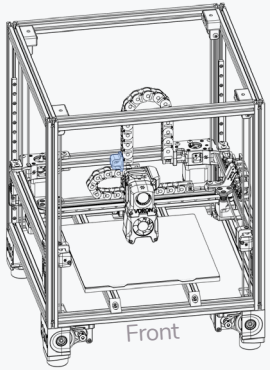

M3x10 FHCS

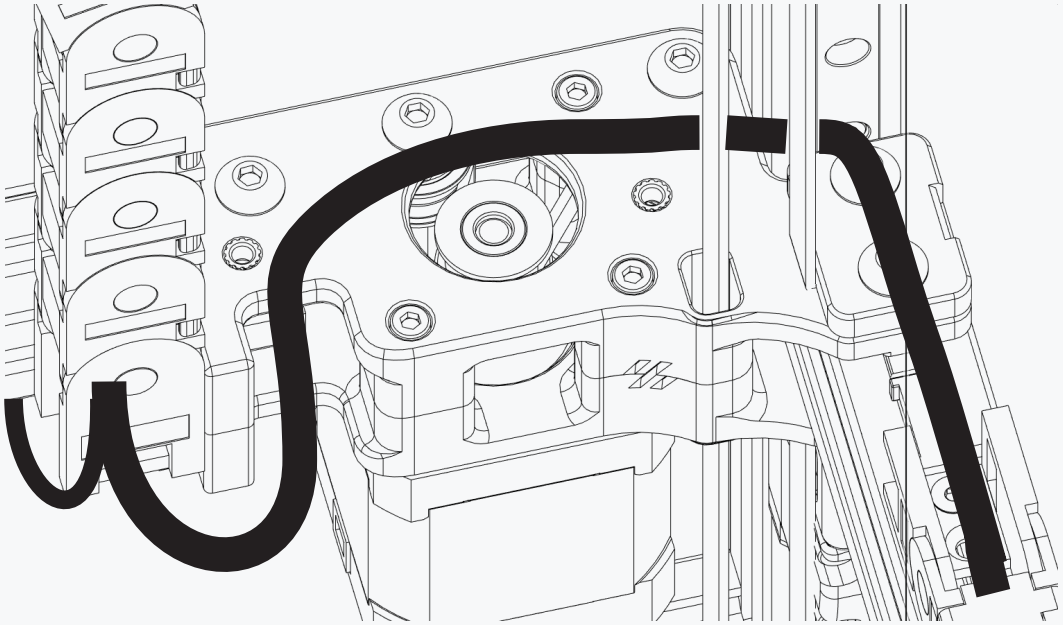

M3x10 FHCS

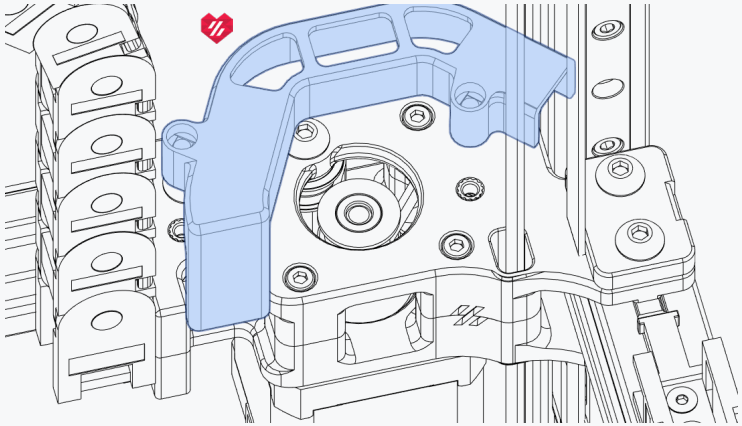

M5 T-Nut

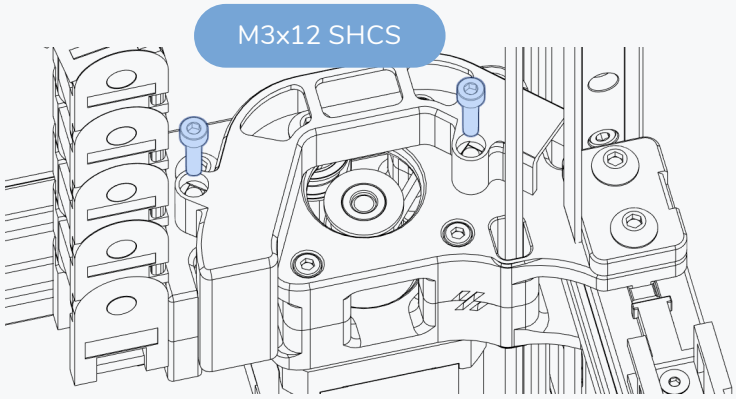



M5x10 BHCS


Front







WIRE PATH

Guide the wire bundle behind the Z belt and over the A drive as shown above. Secure it with zip ties on the strain relief of the cable chains.

B Motor

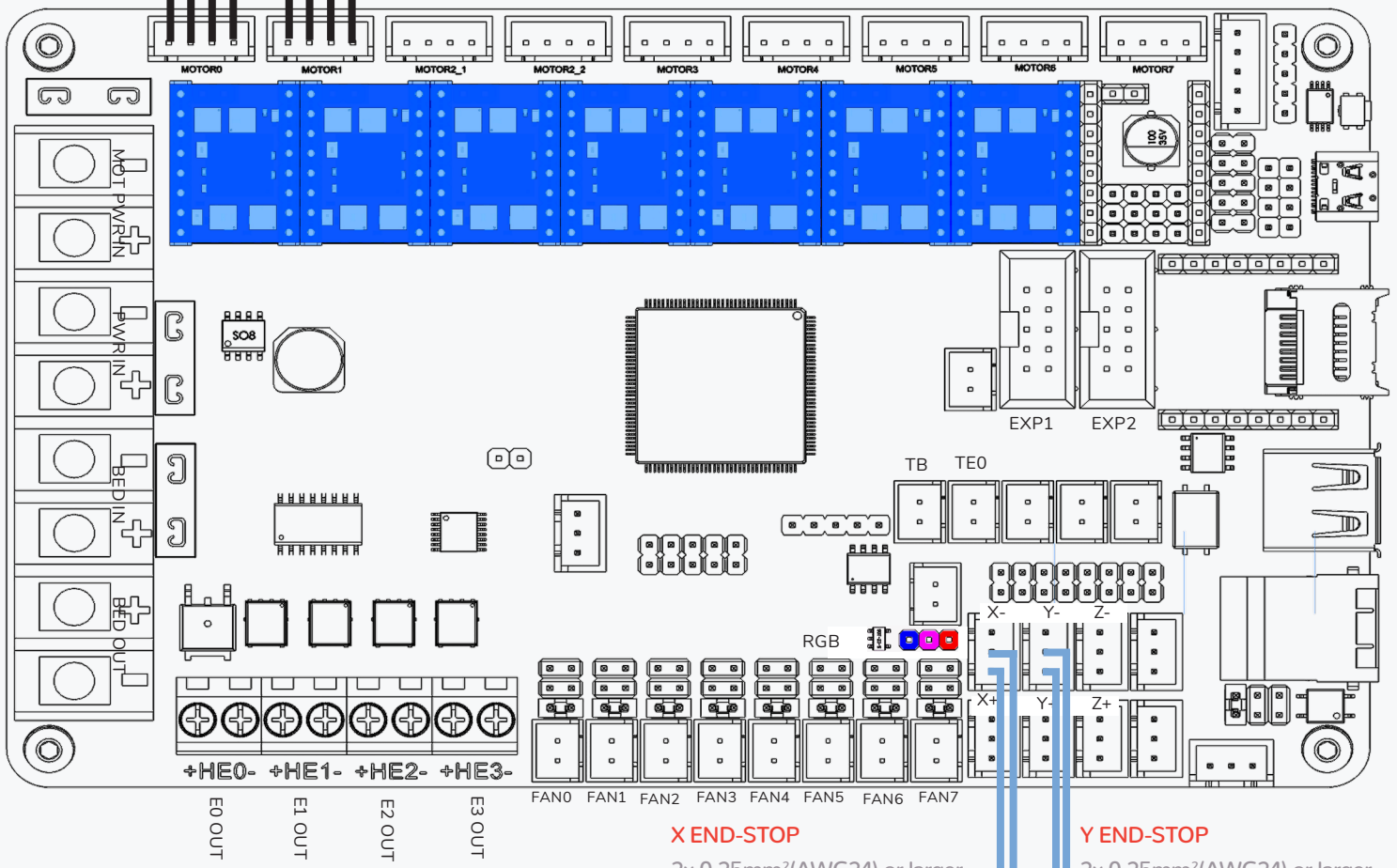
A Motor

B MOTOR

4x 0.25mm²(AWG24) or larger

A MOTOR

4x 0.25mm²(AWG24) or larger



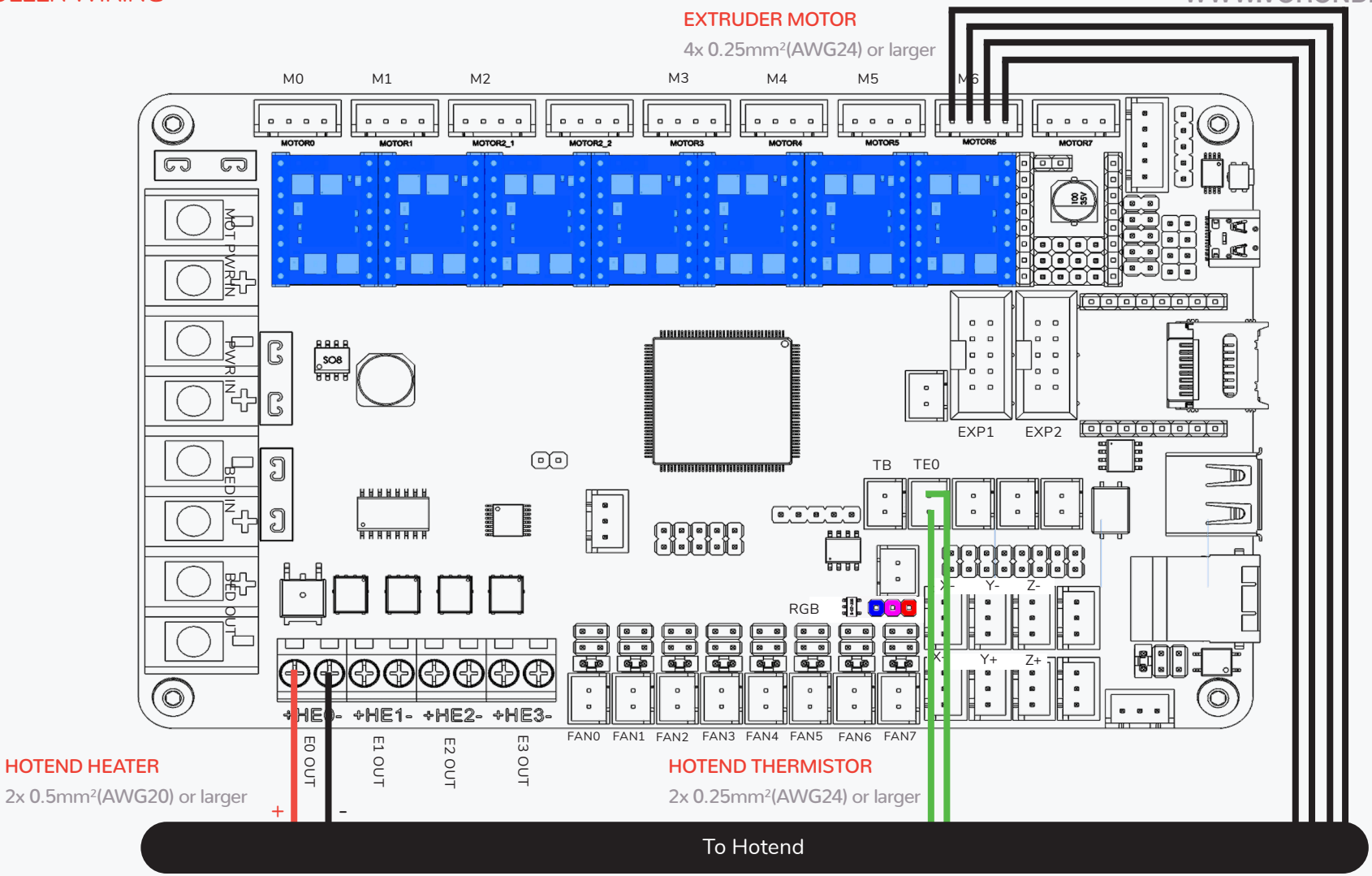
X END-STOP

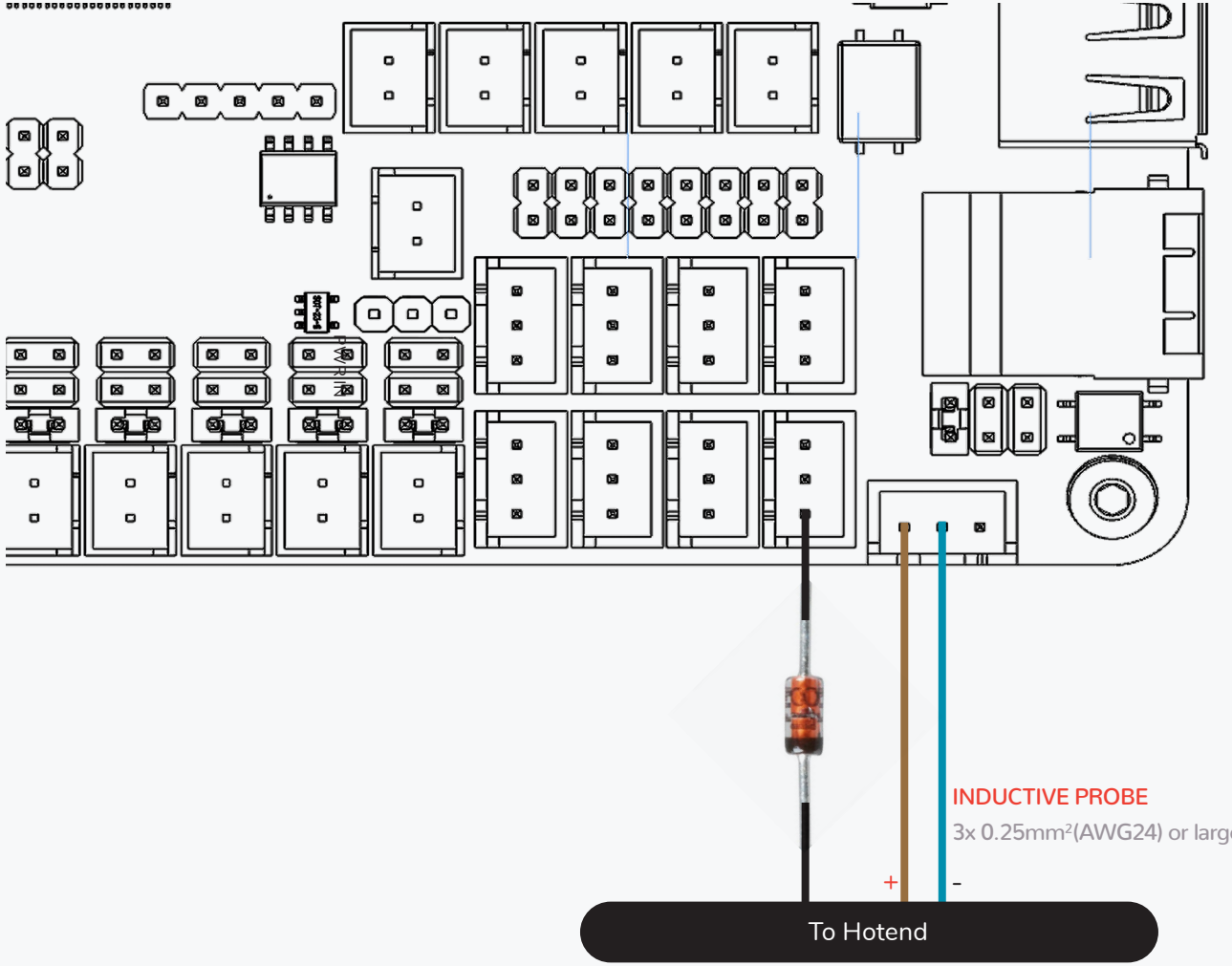
2x 0.25mm²(AWG24) or larger

Y END-STOP

2x 0.25mm²(AWG24) or larger

To End-Stop Pod


EXTRUDER MOTOR
4x 0.25mm²(AWG24) or larger
M0
M1
M2
M3
M4
M5
M6
MOTOR0
MOTOR1
MOTOR2_1
MOTOR2_2
MOTOR3
MOTOR4
MOTOR5
MOTOR6
MOTOR7
MOT PWR IN
PWR IN
BED IN
BED OUT
EXP1
EXP2
TB
TE0
RGB
X-
Y-
Z-
X+
Y+
Z+
+HE0-
+HE1-
+HE2-
+HE3-
FAN0
FAN1
FAN2
FAN3
FAN4
FAN5
FAN6
FAN7
E0 OUT
E1 OUT
E2 OUT
E3 OUT
+
-
HOTEND HEATER
2x 0.5mm²(AWG20) or larger
HOTEND THERMISTOR
2x 0.25mm²(AWG24) or larger
To Hotend

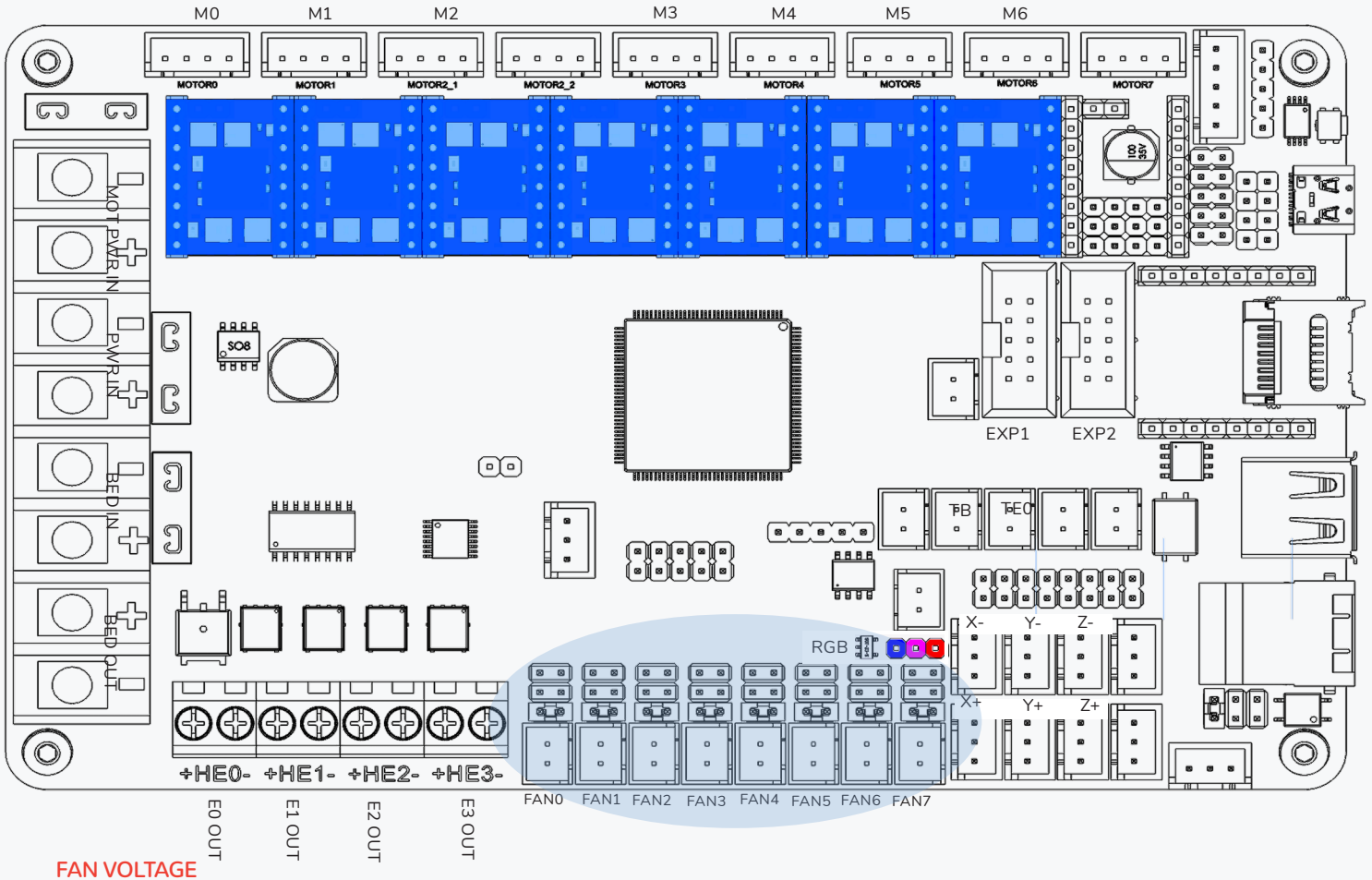


PROBE HOOKUP

Instead of using the dedicated probe input of the BTT Octopus we recommend wiring the probe's signal line to an endstop input using a BAT85 diode as protection.

The black ring on the diode "points" toward the toolhead.

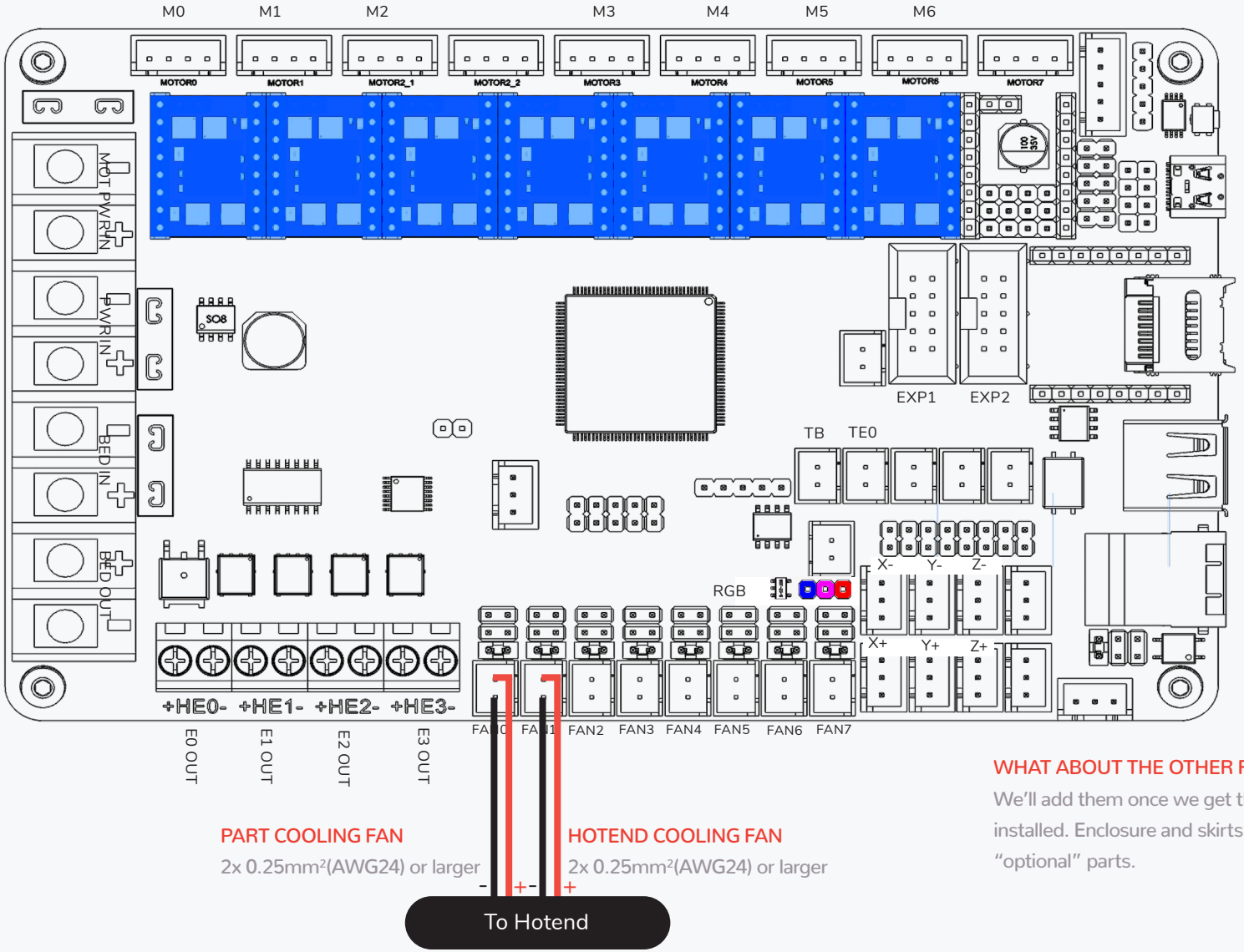
For technical details please refer to https://voron.link/n9i7lss.



FAN VOLTAGE

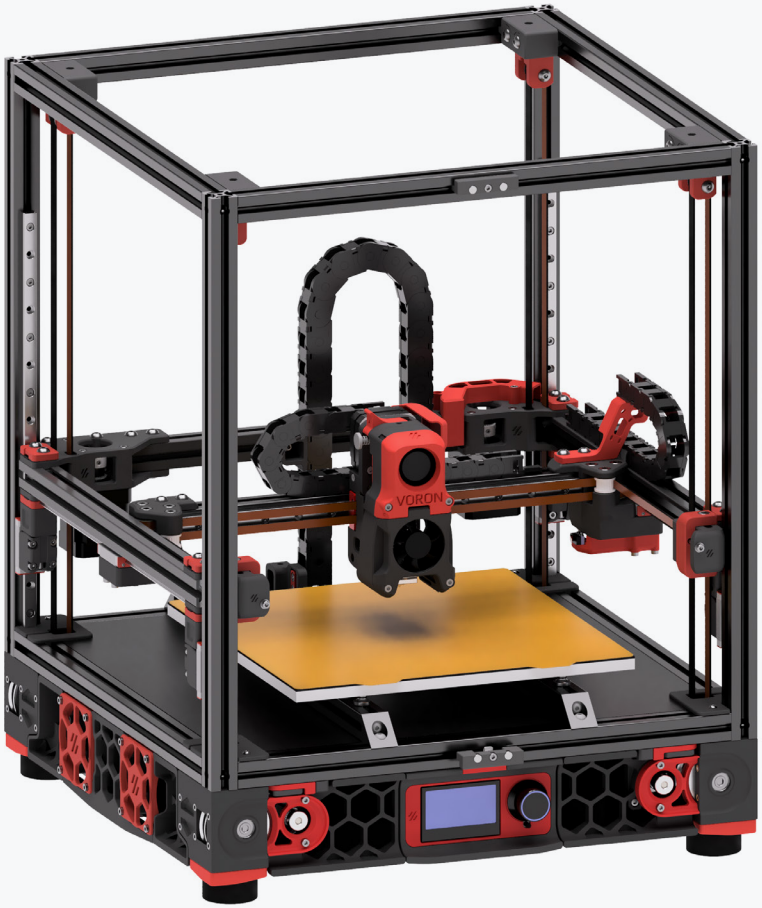
The fans recommended in the sourcing guide are 24V fans.

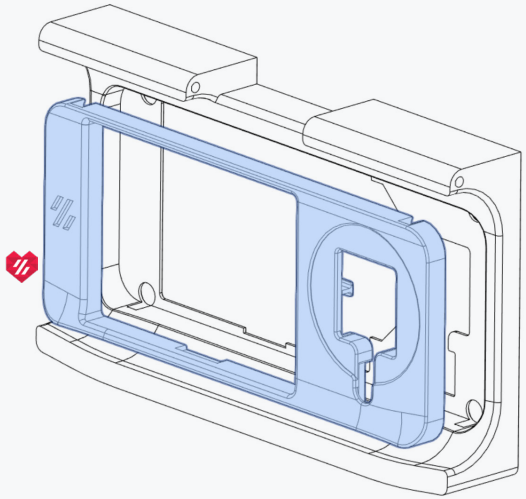
Please check your hotend cooling (40x40x10 axial), part cooling (40x40x20 blower) and exhaust/electronics (60x60x20 axial) fans for their voltage rating and jumper the voltage selection accordingly. Refer to the Bigtreetech Octopus V1.1 manual for possible settings.

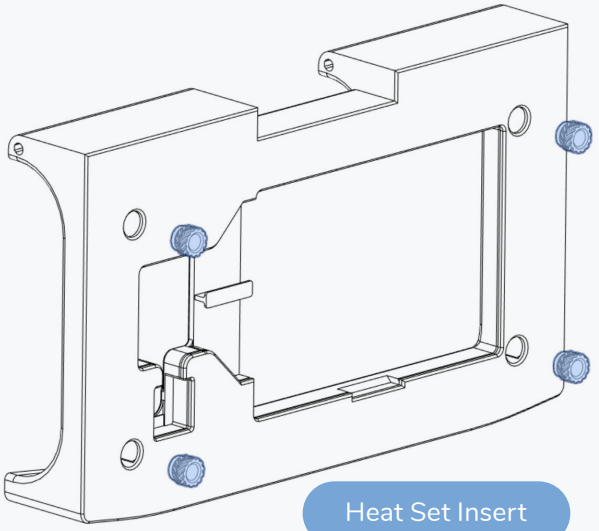


WHAT ABOUT THE OTHER FANS?

We'll add them once we get them installed. Enclosure and skirts are "optional" parts.

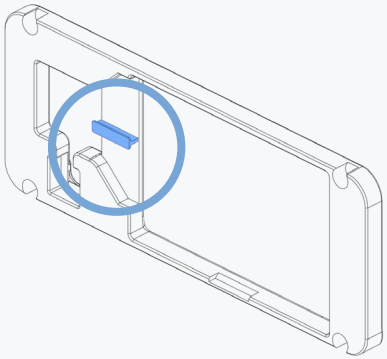

VORON





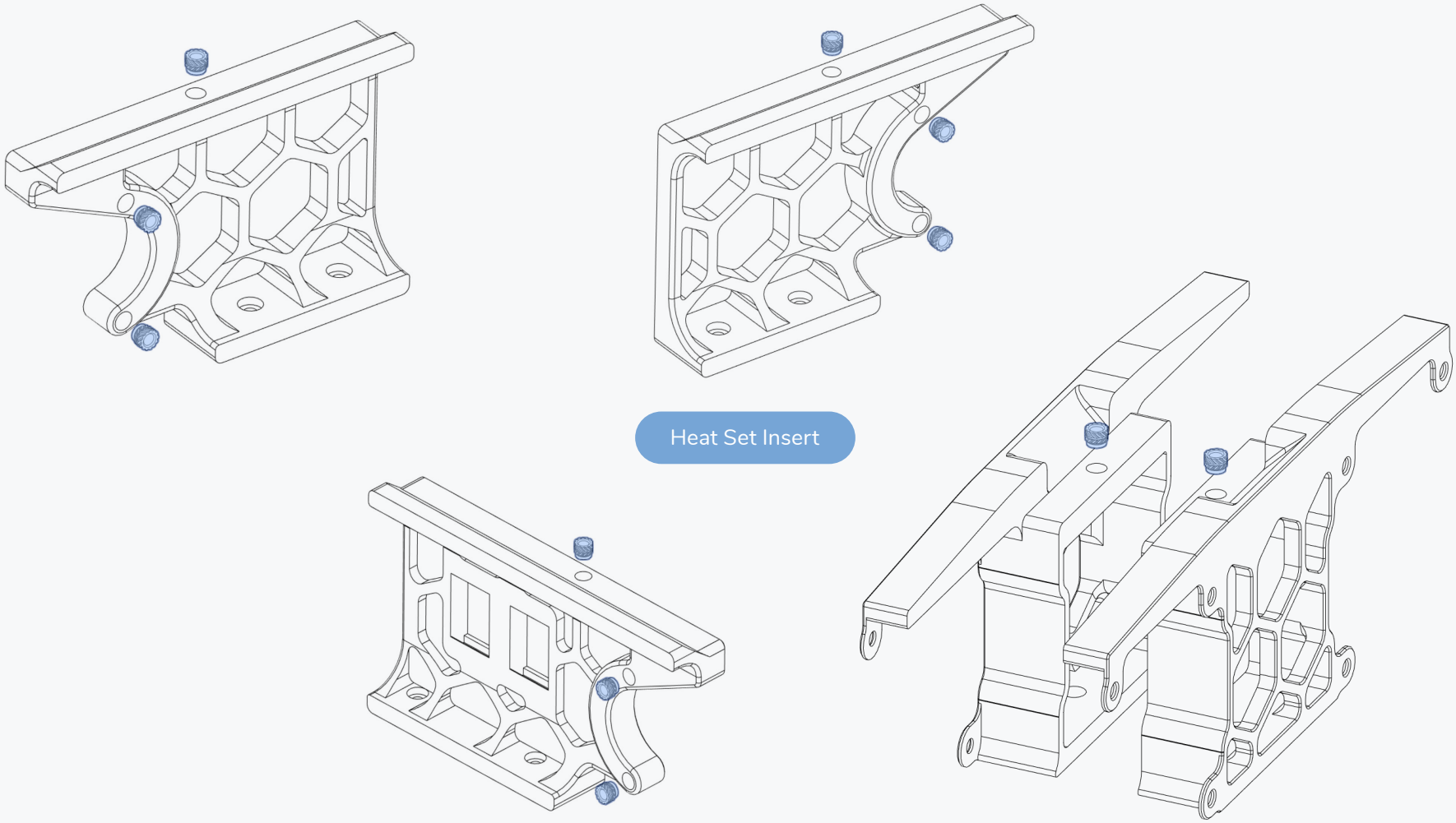
FRONT COVER

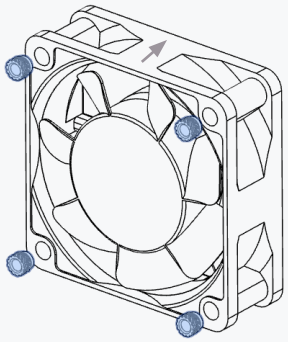
The front cover is held in place by the heat set inserts. Hold the front face firmly in place while inserting the heat set inserts.



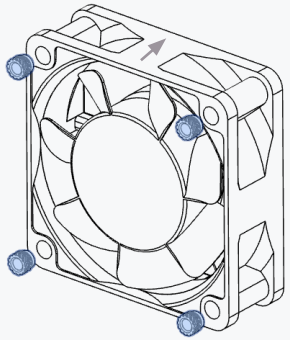
BUILT-IN SUPPORT

Remove the highlighted section. It's a built-in support for printability.

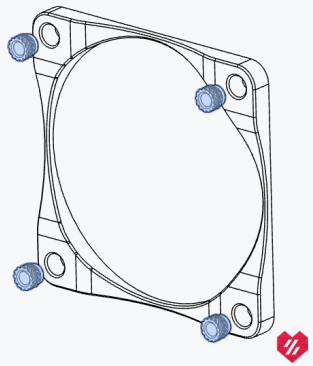

Heat Set Insert

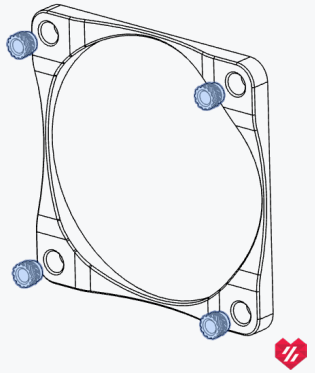


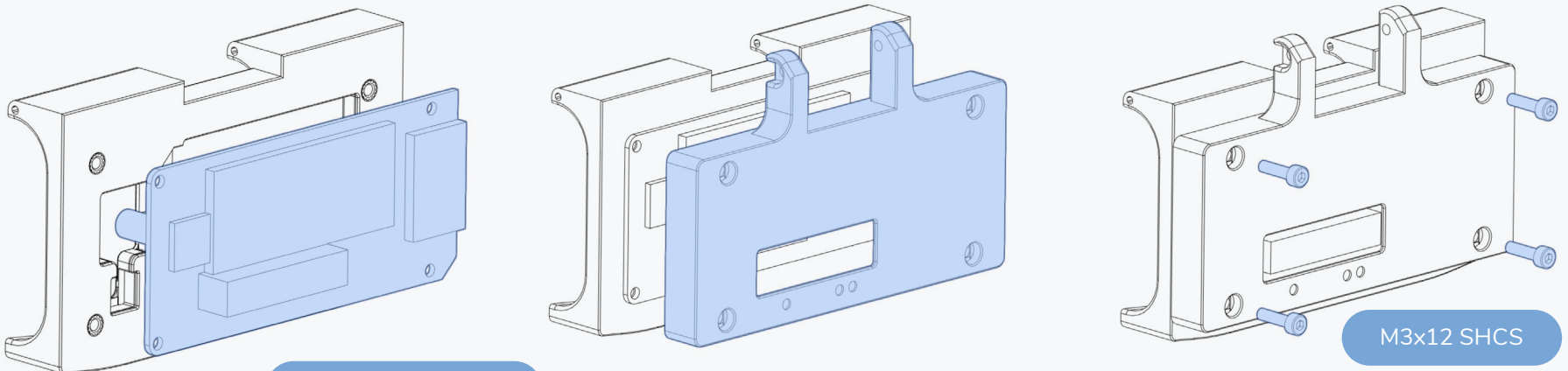
60x20 Fan

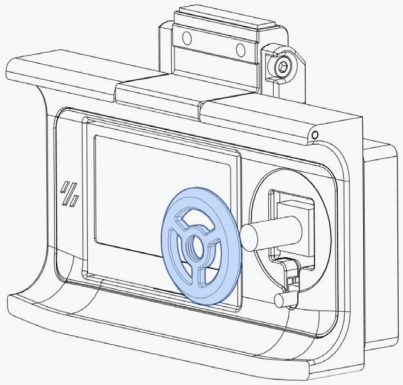


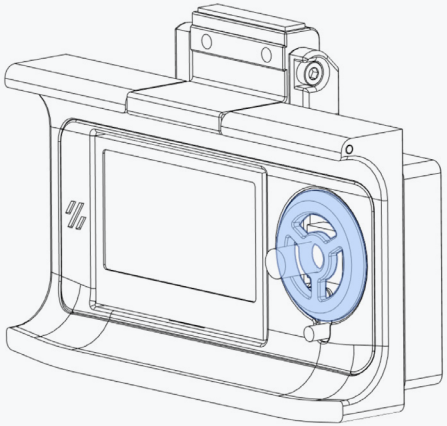
Heat Set Insert

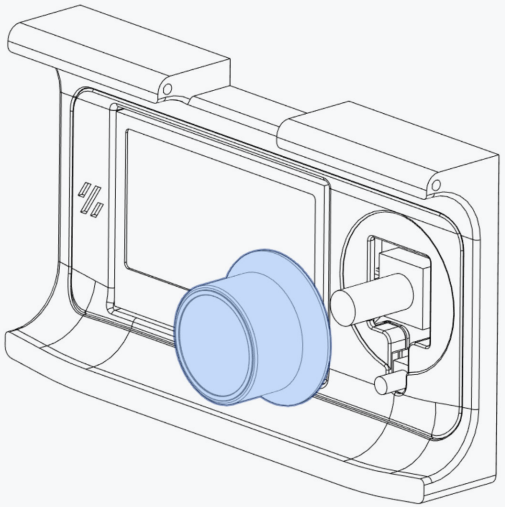





Mini 12864 Screen
M3x12 SHCS

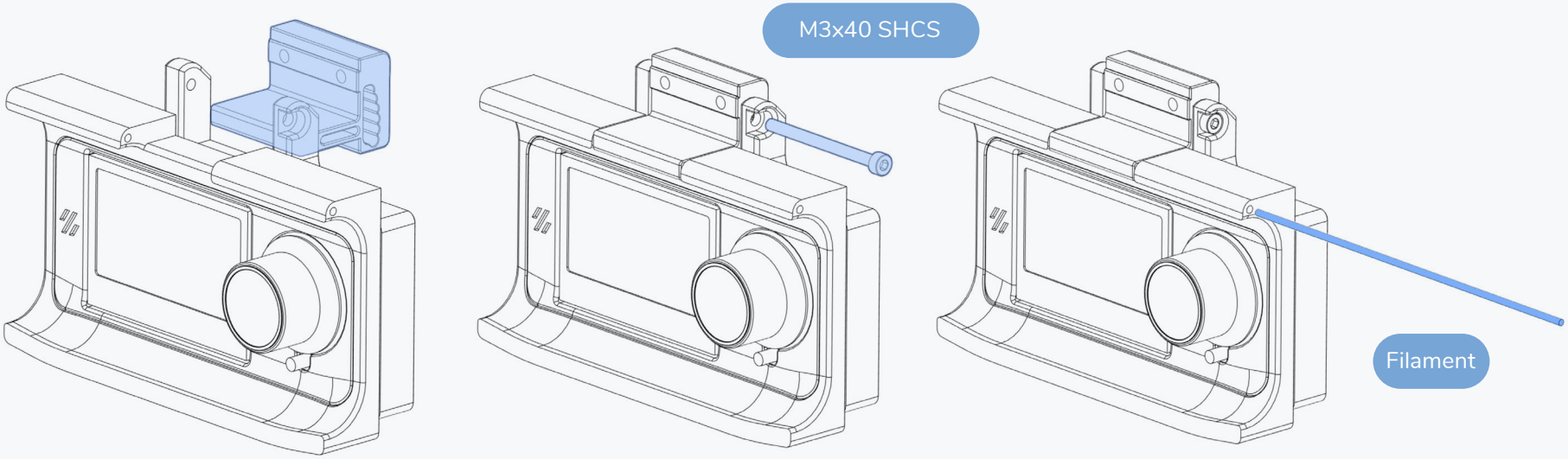


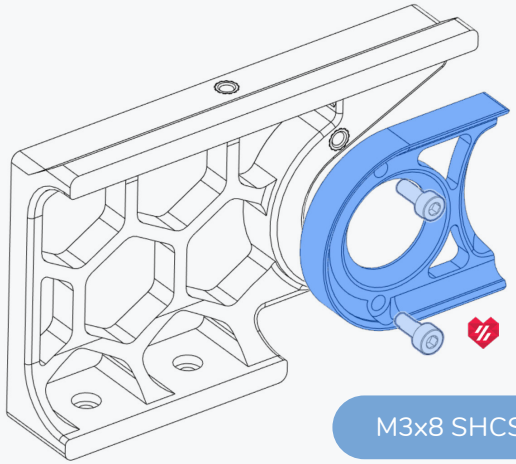


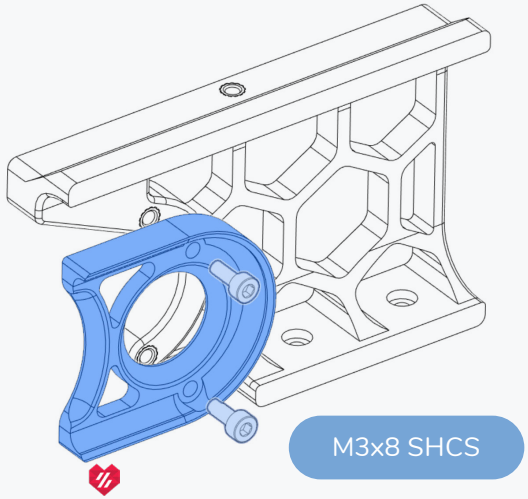


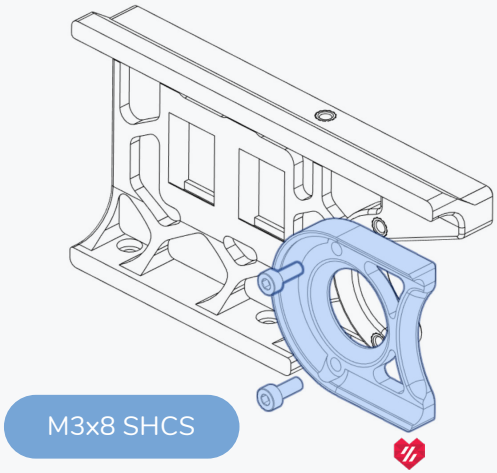
OPTION: LIGHT BLOCKER

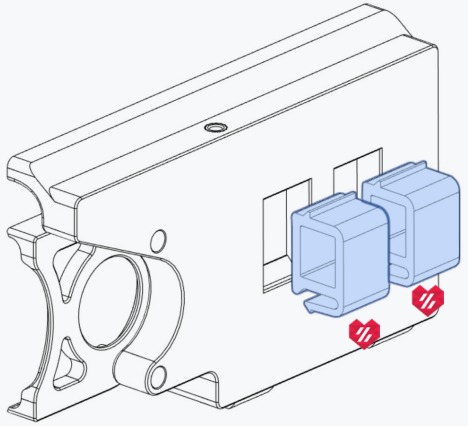
Some LCDs come with a smaller encoder knob. This extra piece prevents excess light bleed. Threads onto the encoder before the knob is pressed on.


M3x40 SHCS
Filament





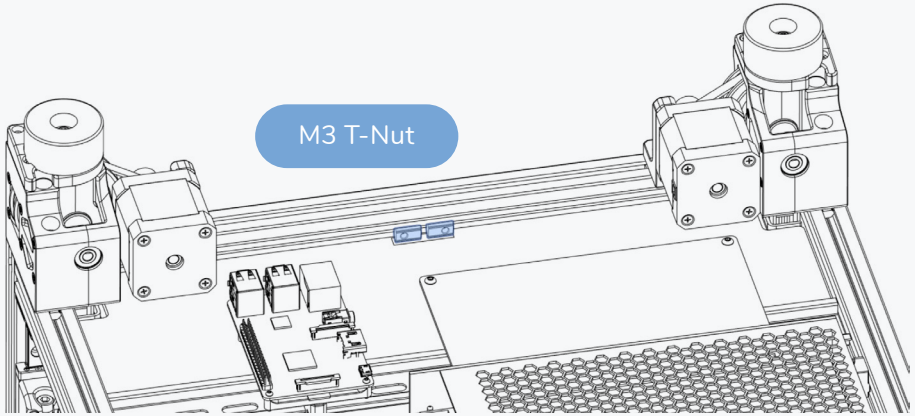


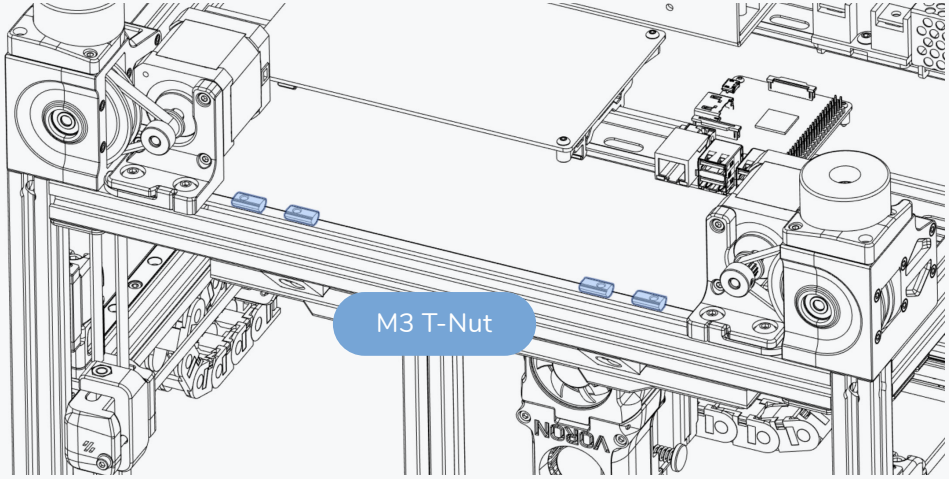


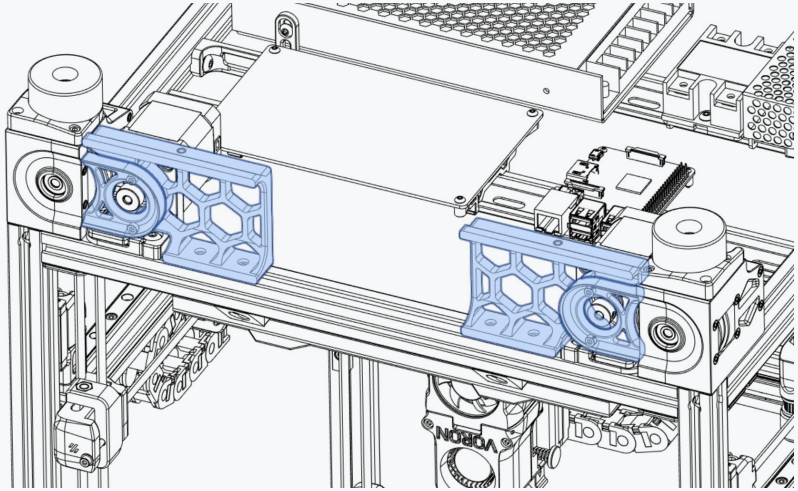
OPTION: KEYSTONE INSERTS

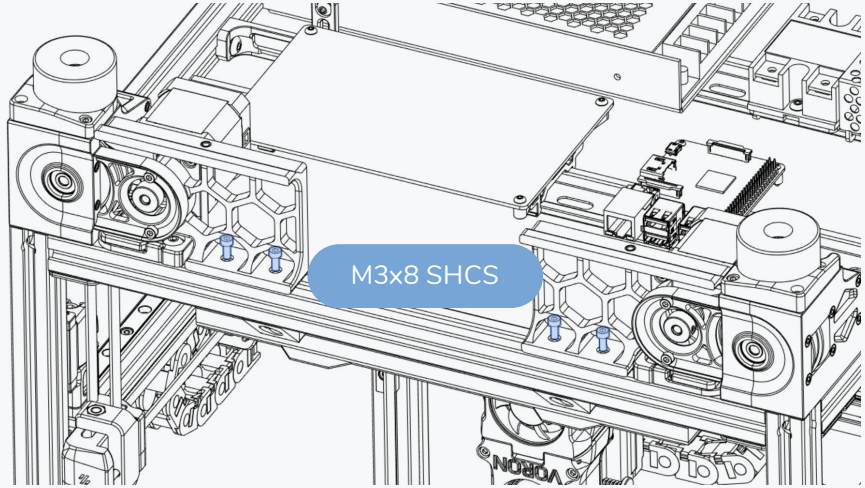
The picture is showing blanks for the keystone slots.

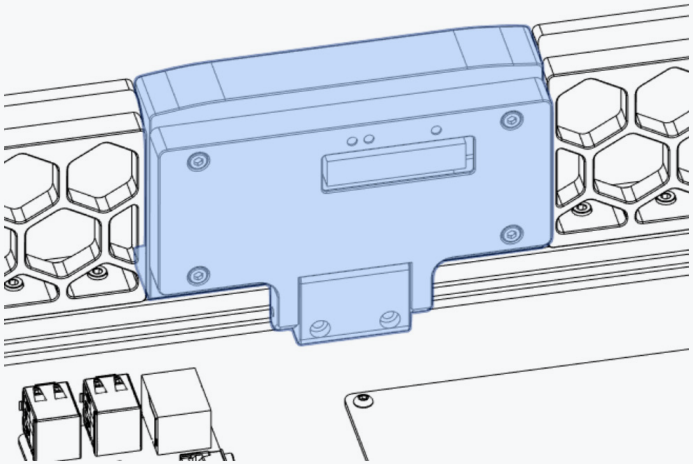
Alternatively you can add modules for USB or ethernet and expose ports of the Raspberry PI on the back of the printer.

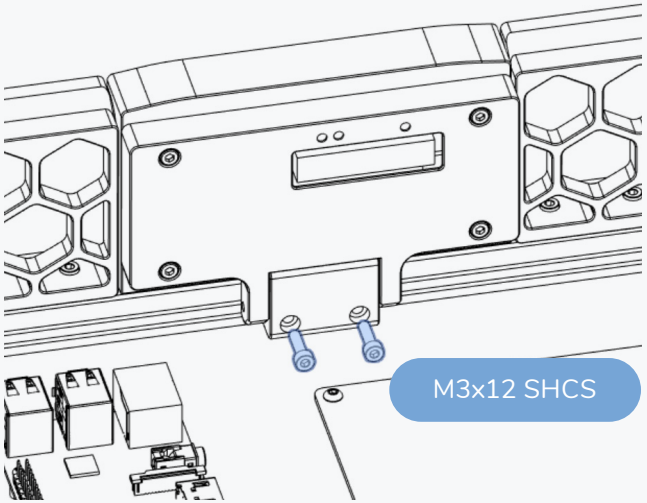

M3 T-Nut

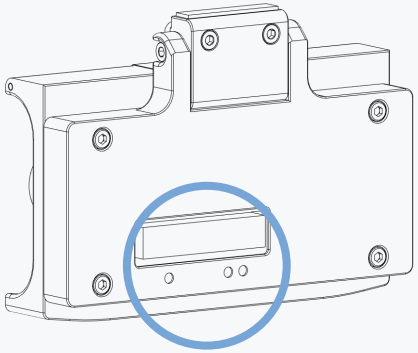

M3 T-Nut




M3x8 SHCS

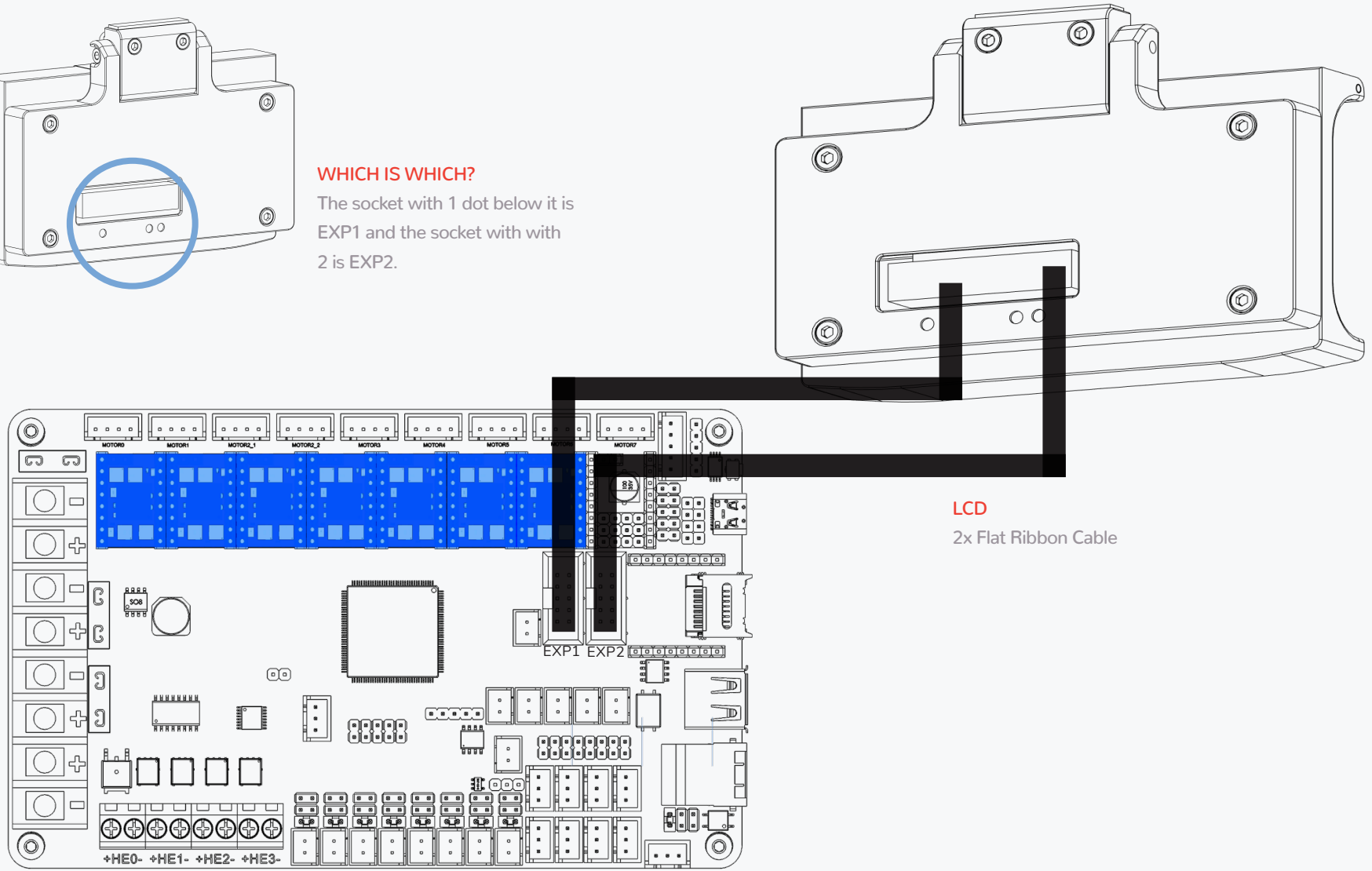



M3x12 SHCS



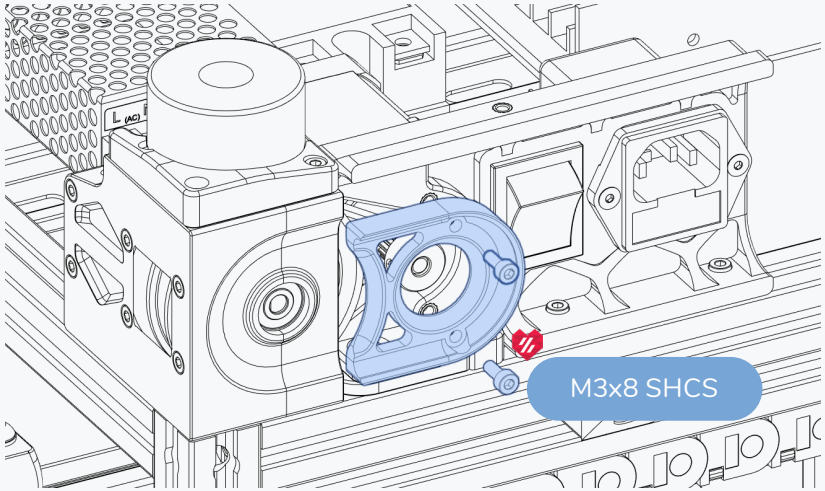
WHICH IS WHICH?

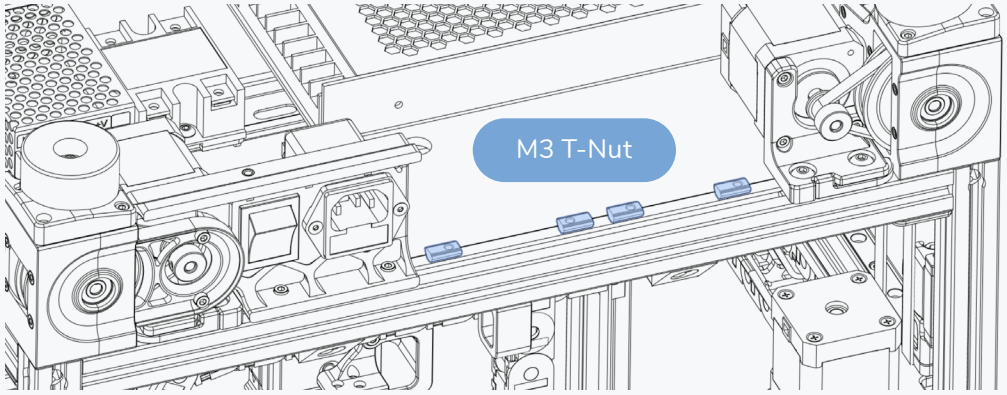
The socket with 1 dot below it is EXP1 and the socket with with 2 is EXP2.

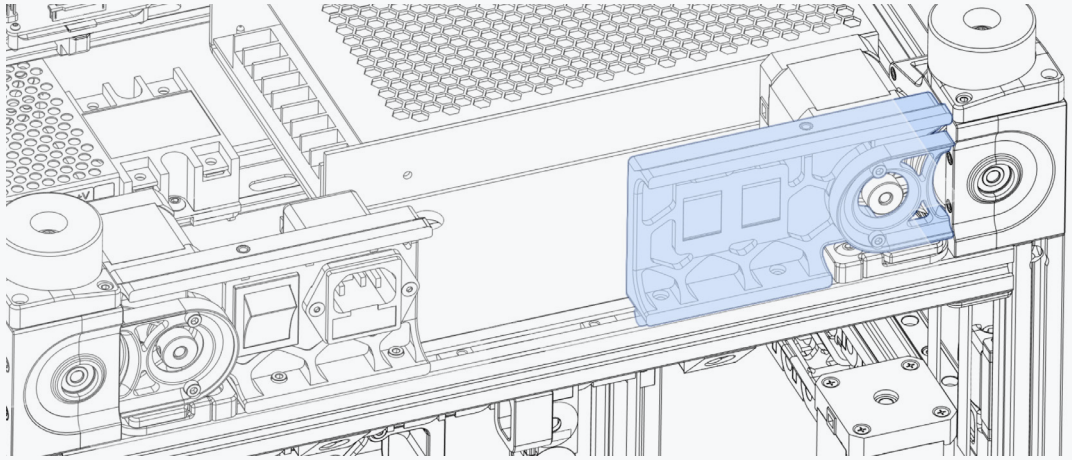


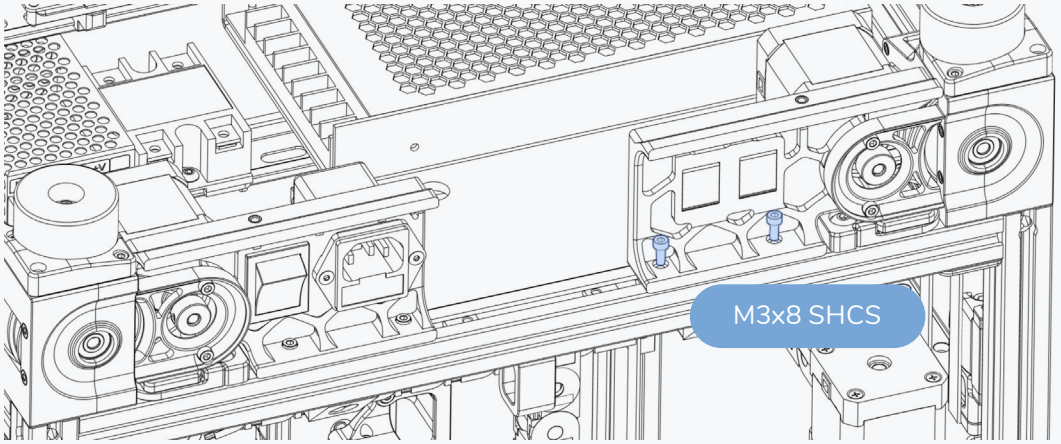
LCD

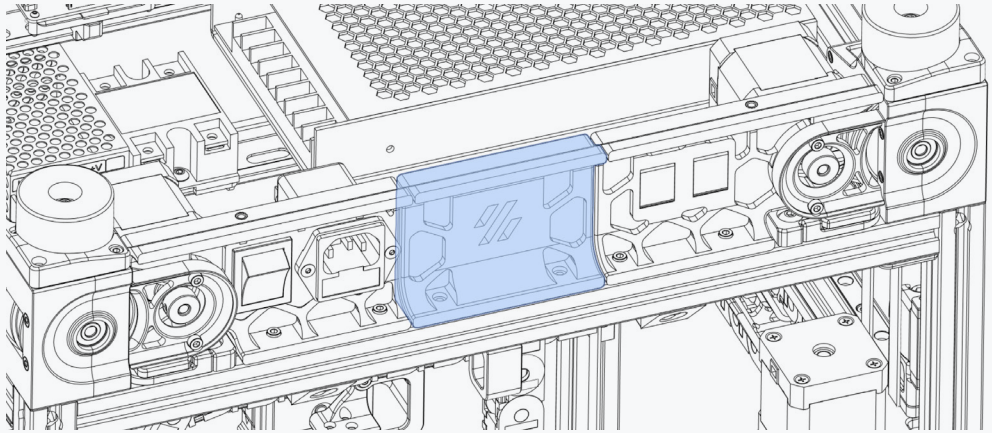
2x Flat Ribbon Cable

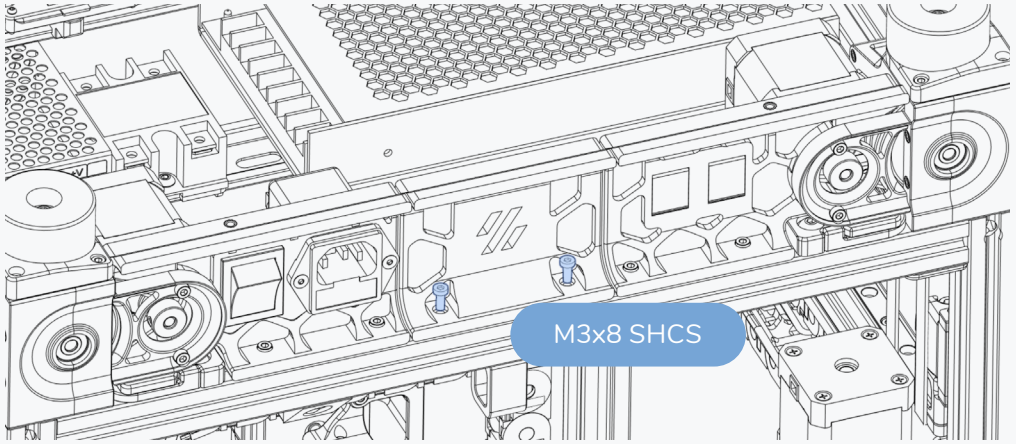

M3x8 SHCS


M3 T-Nut




M3x8 SHCS

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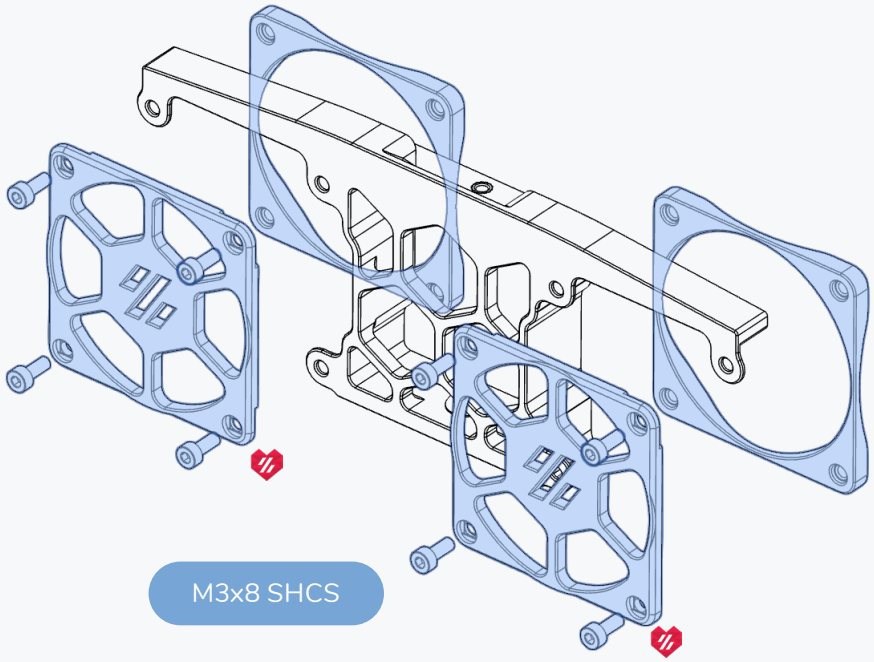
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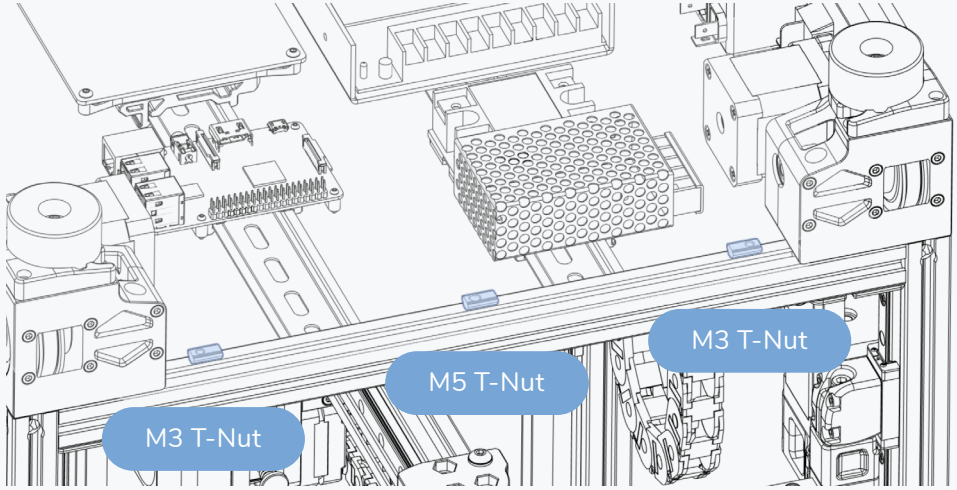
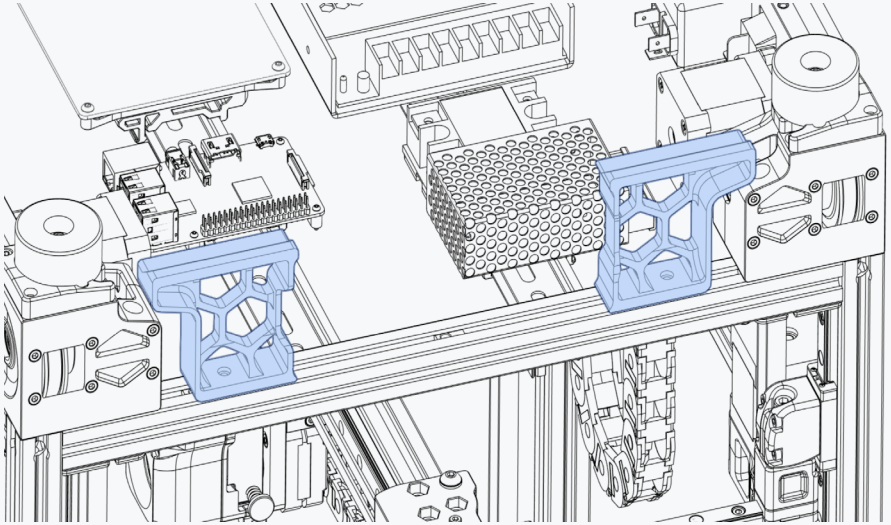
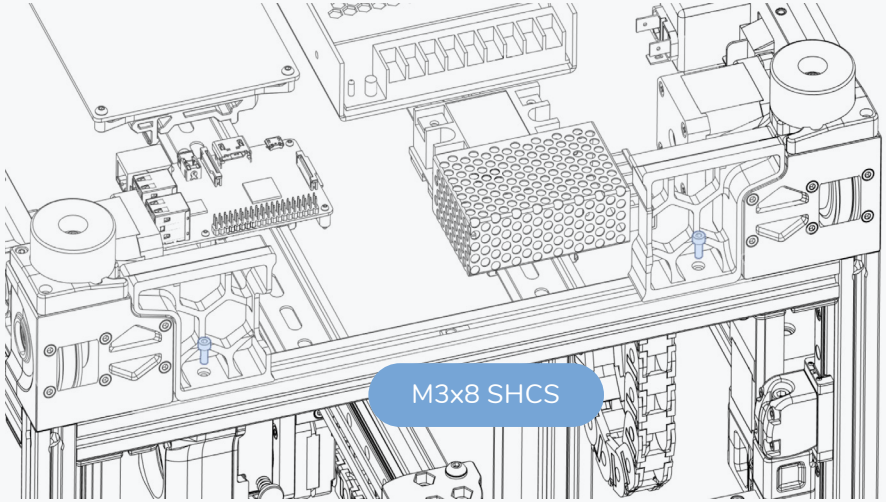
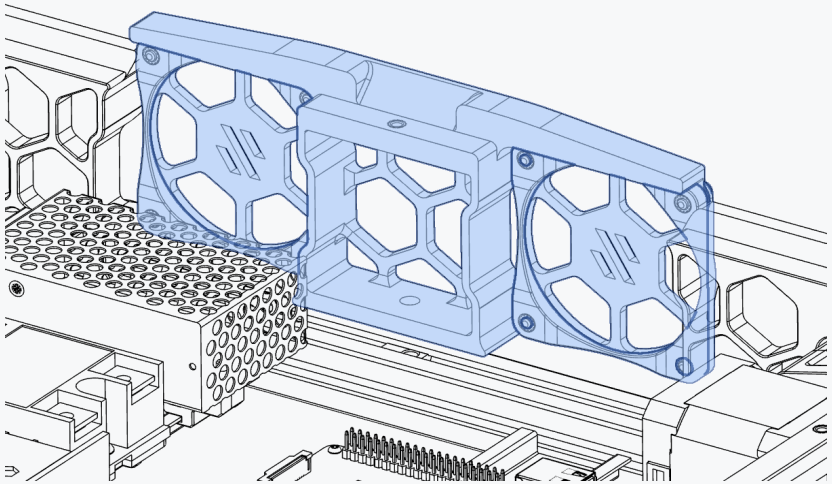
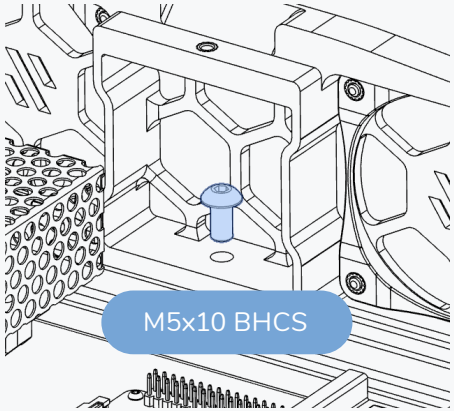
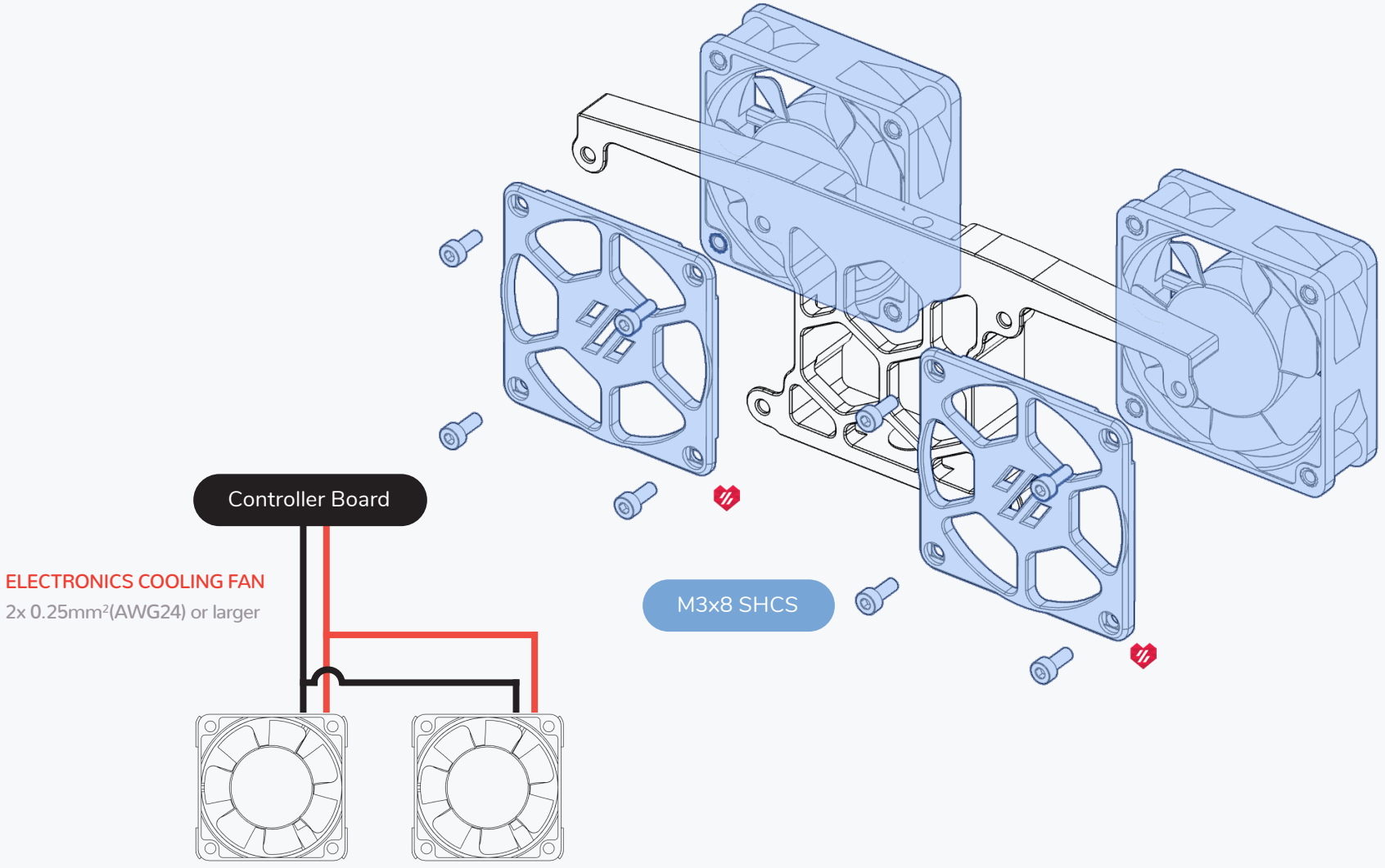

M3 T-Nut
M5 T-Nut
M3 T-Nut

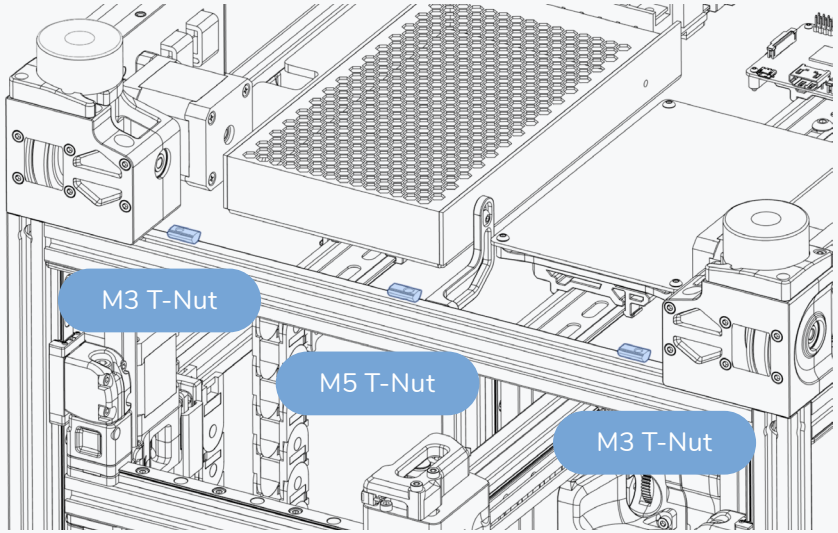


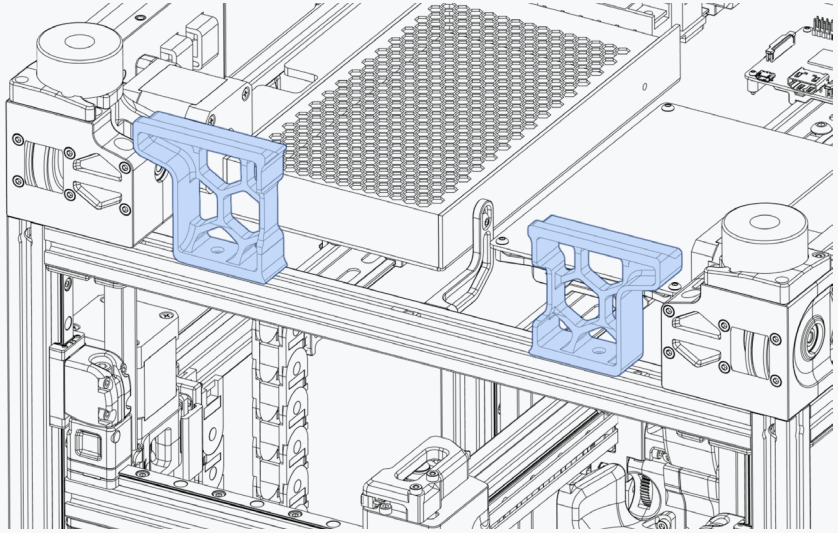

M3x8 SHCS

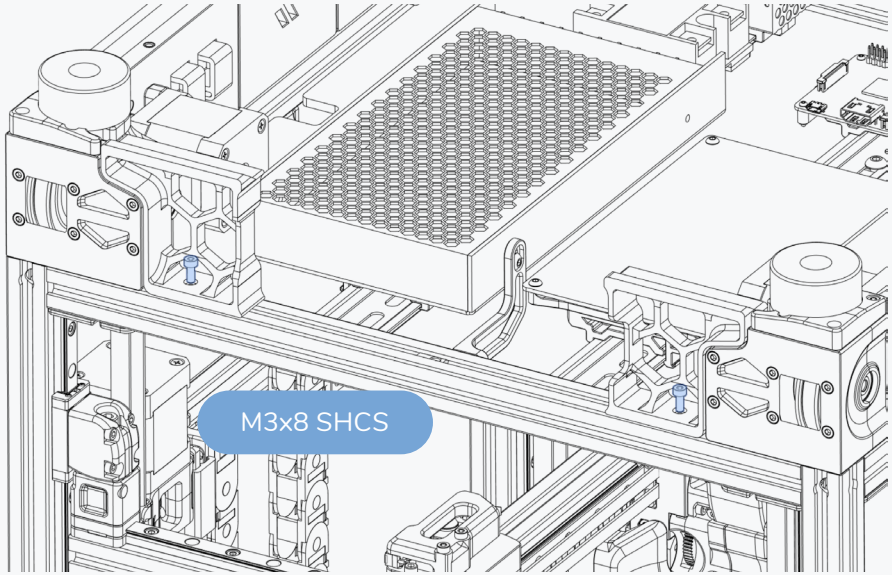


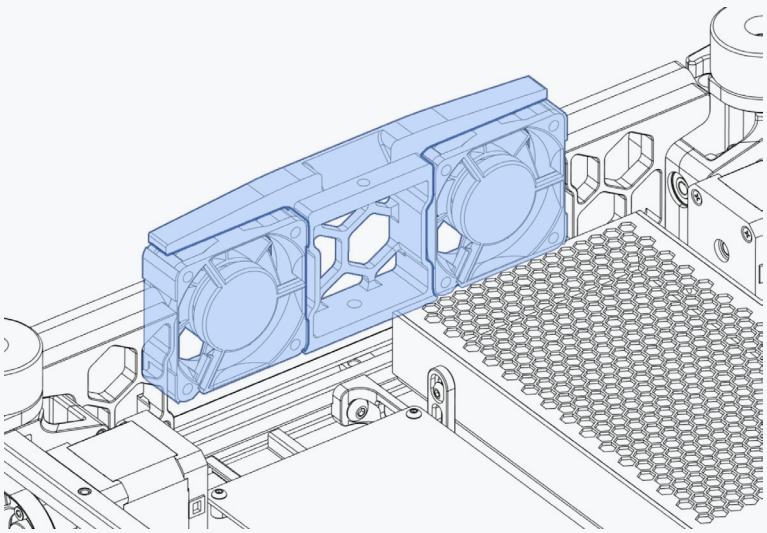

M5x10 BHCS

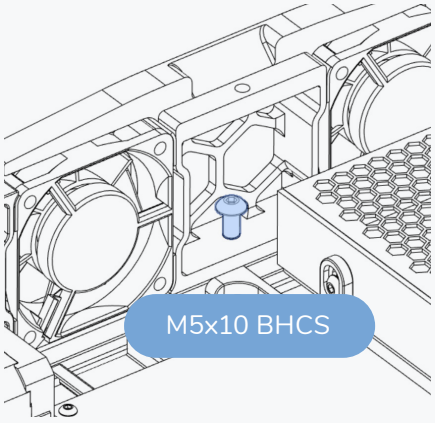

Controller Board
ELECTRONICS COOLING FAN
2x 0.25mm²(AWG24) or larger
M3x8 SHCS

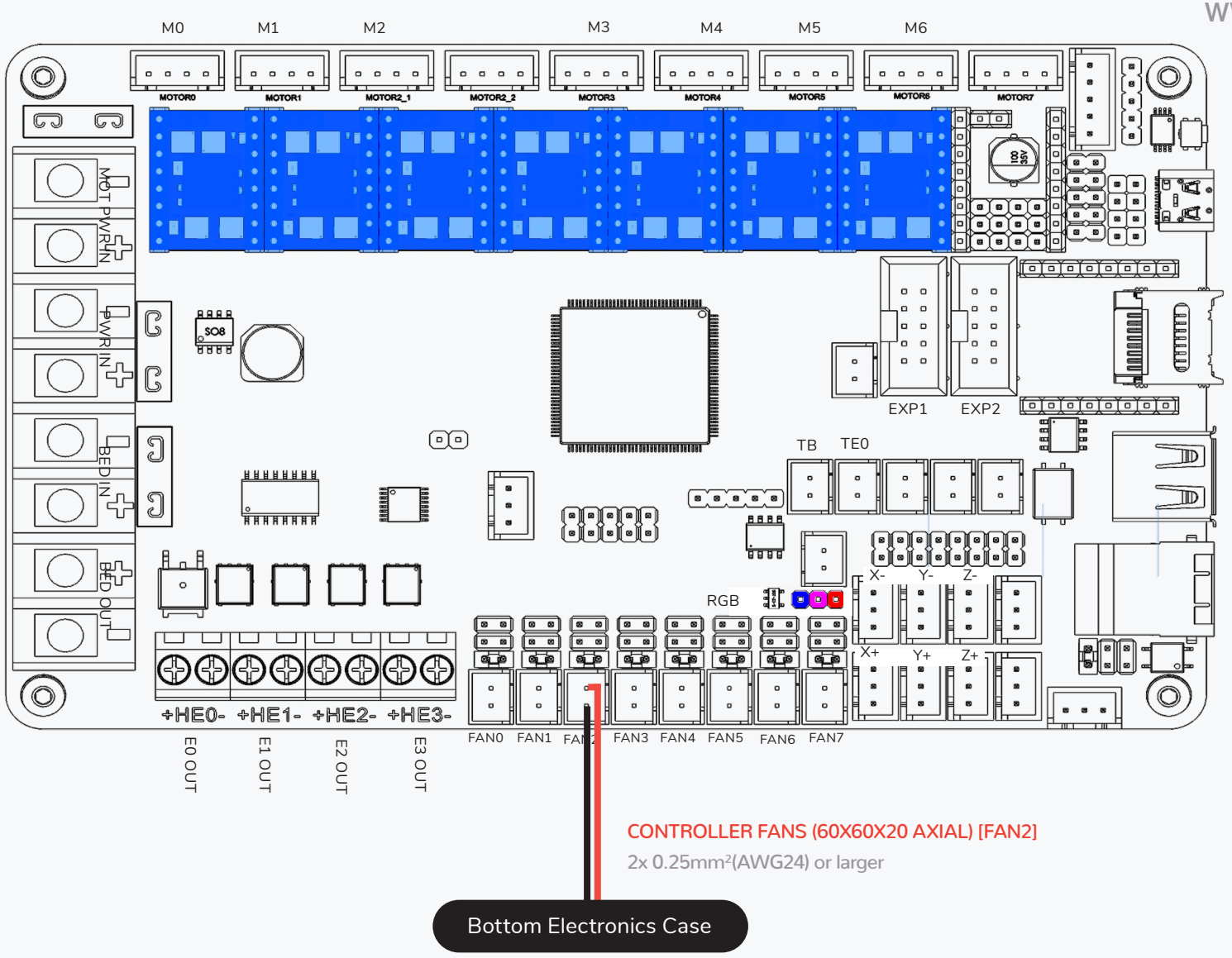

M3 T-Nut
M5 T-Nut
M3 T-Nut




M3x8 SHCS

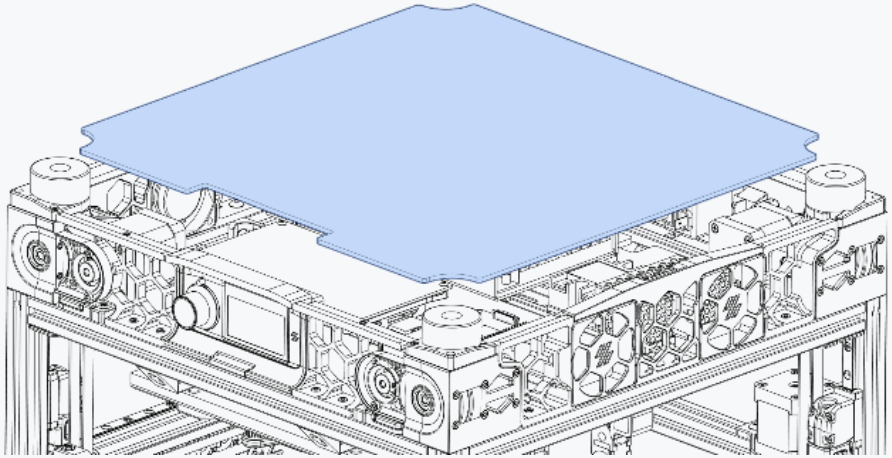


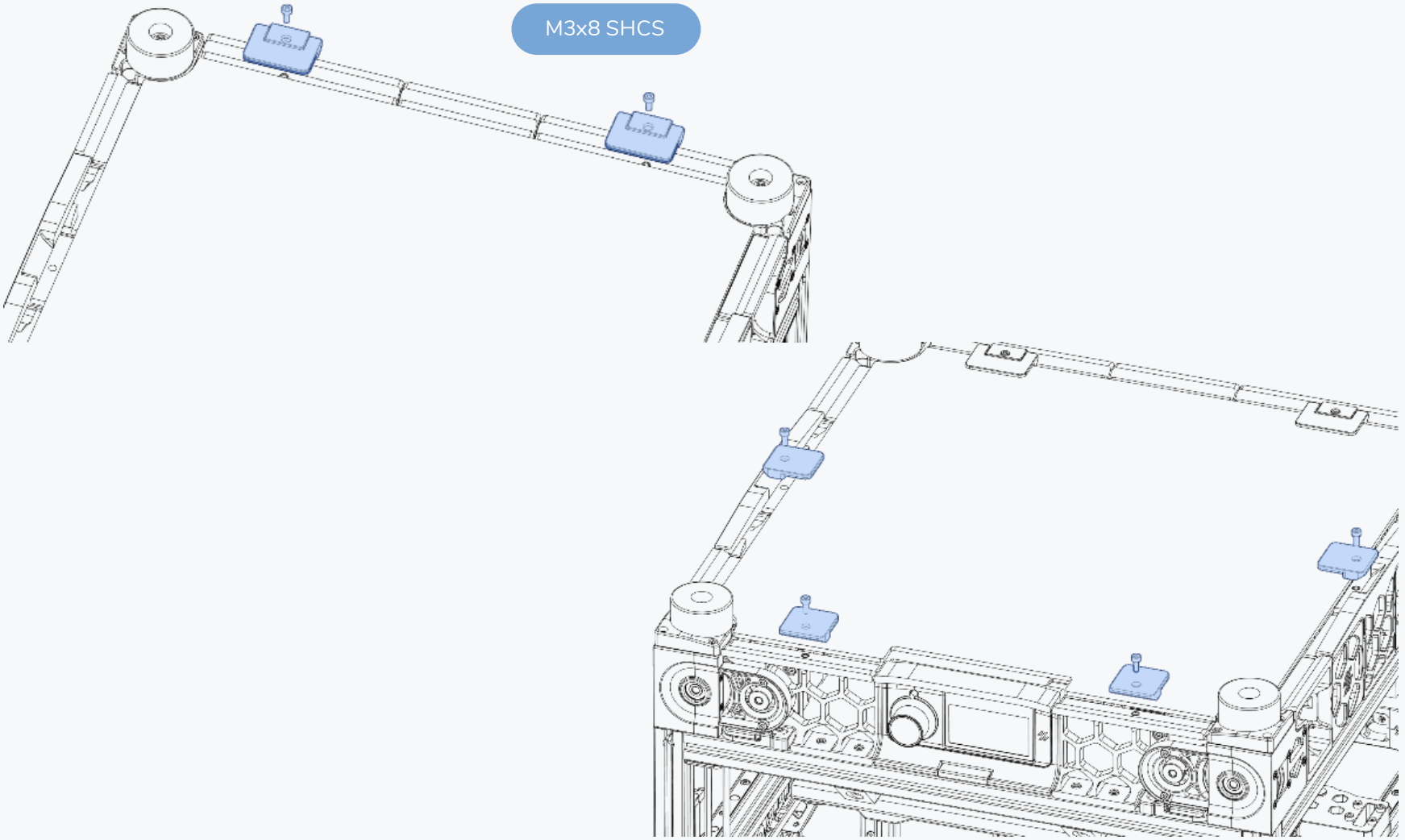

M5x10 BHCS

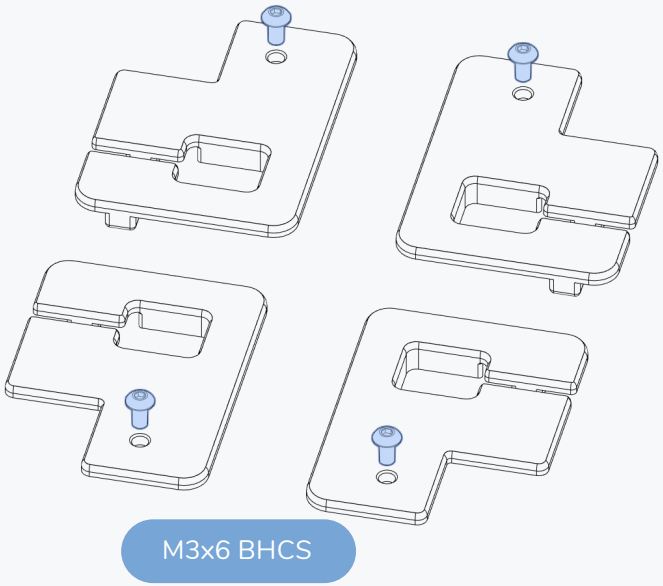

M0
M1
M2
M3
M4
M5
M6
MOTOR0
MOTOR1
MOTOR2_1
MOTOR2_2
MOTOR3
MOTOR4
MOTOR5
MOTOR6
MOTOR7
MOT PWR IN
PWR IN
BED IN
BED OUT
SO8
EXP1
EXP2
TB
TE0
RGB
X-
Y-
Z-
X+
Y+
Z+
+HE0-
+HE1-
+HE2-
+HE3-
FAN0
FAN1
FAN2
FAN3
FAN4
FAN5
FAN6
FAN7
E0 OUT
E1 OUT
E2 OUT
E3 OUT
CONTROLLER FANS (60X60X20 AXIAL) [FAN2]
2x 0.25mm²(AWG24) or larger
Bottom Electronics Case

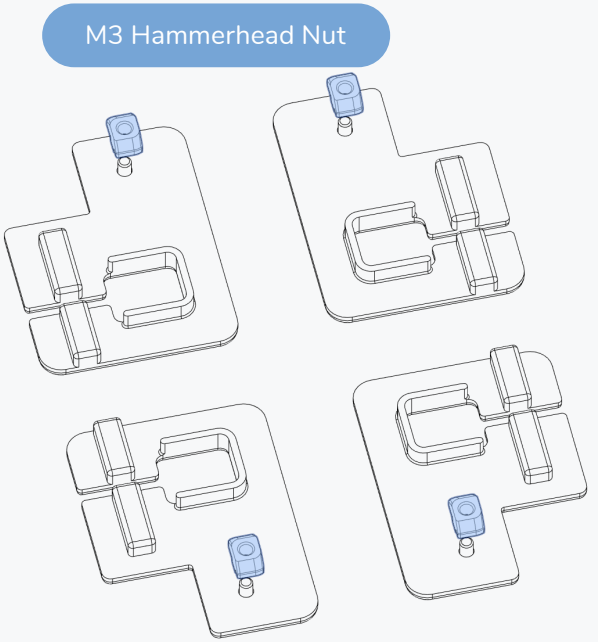
APPLY VHB TAPE

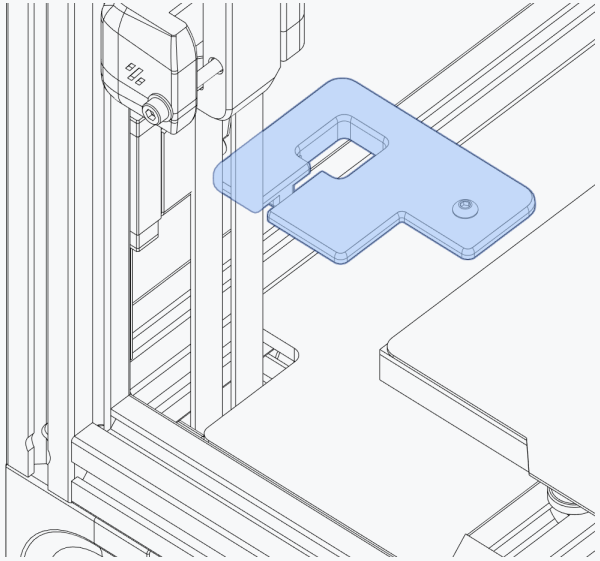
VHB Tape is a double sided adhesive tape.

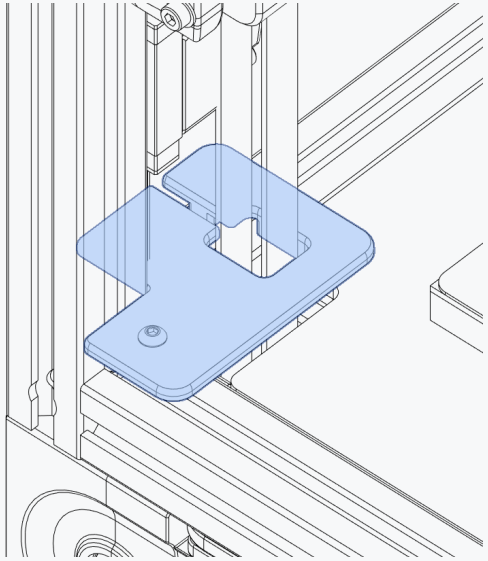


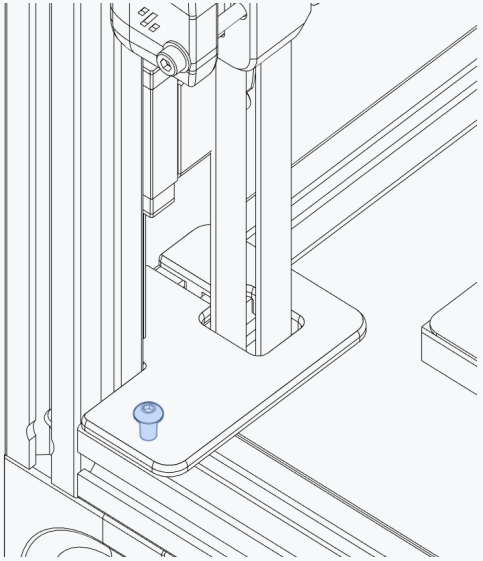

M3x8 SHCS


M3x6 BHCS


M3 Hammerhead Nut





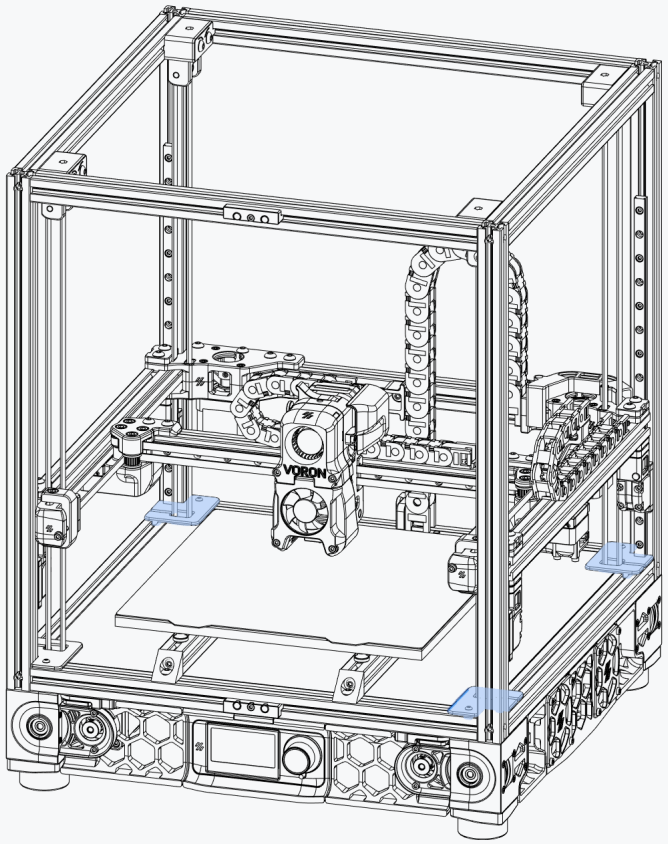


PINCH BELT

Pinch the Z belt loop flat and slide the cover in place.

TURN TO FASTEN

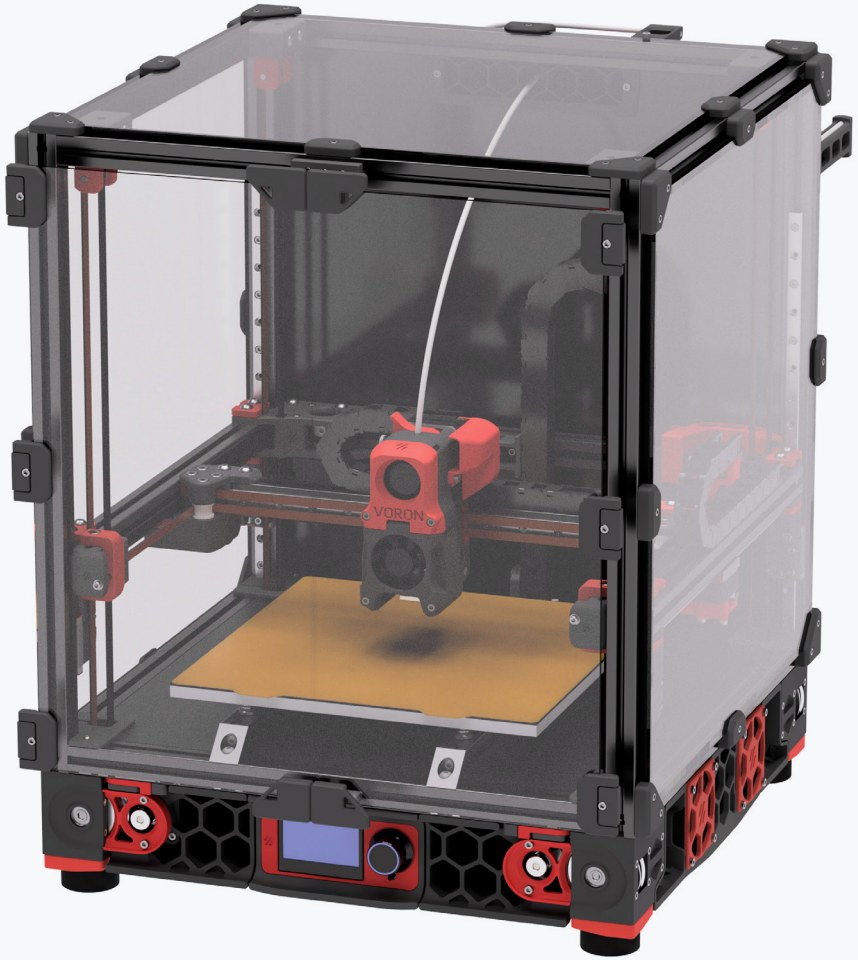
The hammerhead nut will rotate and lock into place when you fasten the screw. At least that's the theory.

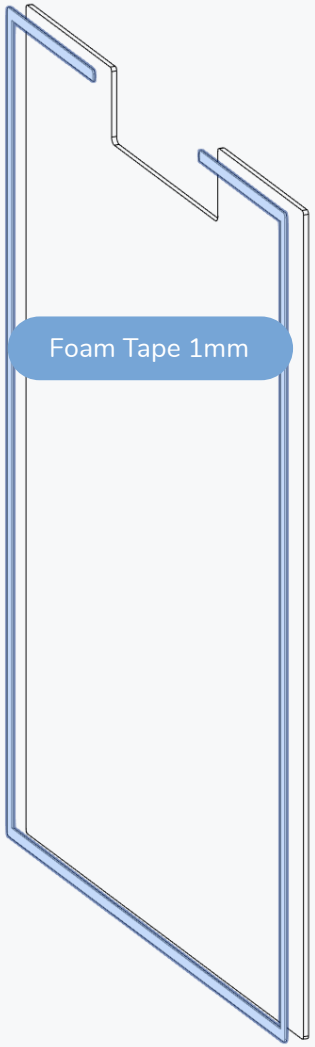


REPEAT FOR REMAINING COVERS

Repeat the assembly steps and install the remaining 3 covers.

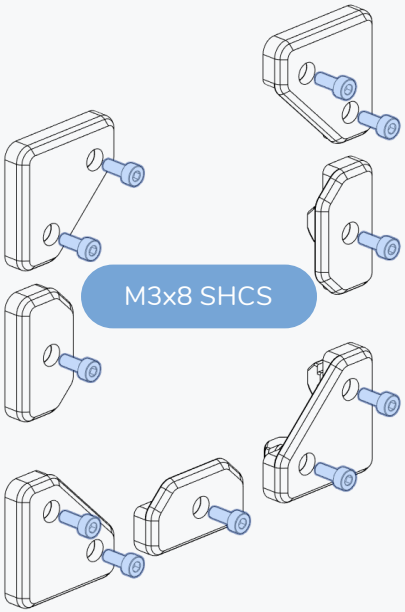
Voron2.4 was released on May 13 2020. Between the releases of 2.4 and 2.4R2 over 2500 Voron2 printers have been build and serialized.


VORON



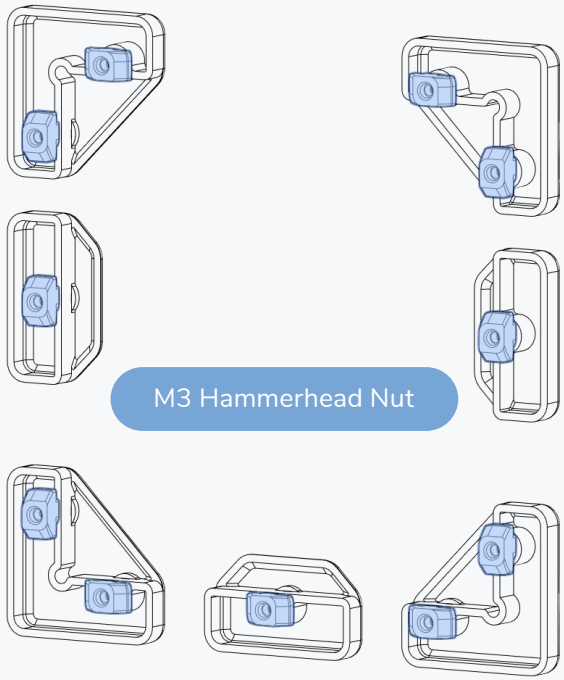
APPLY FOAM TAPE

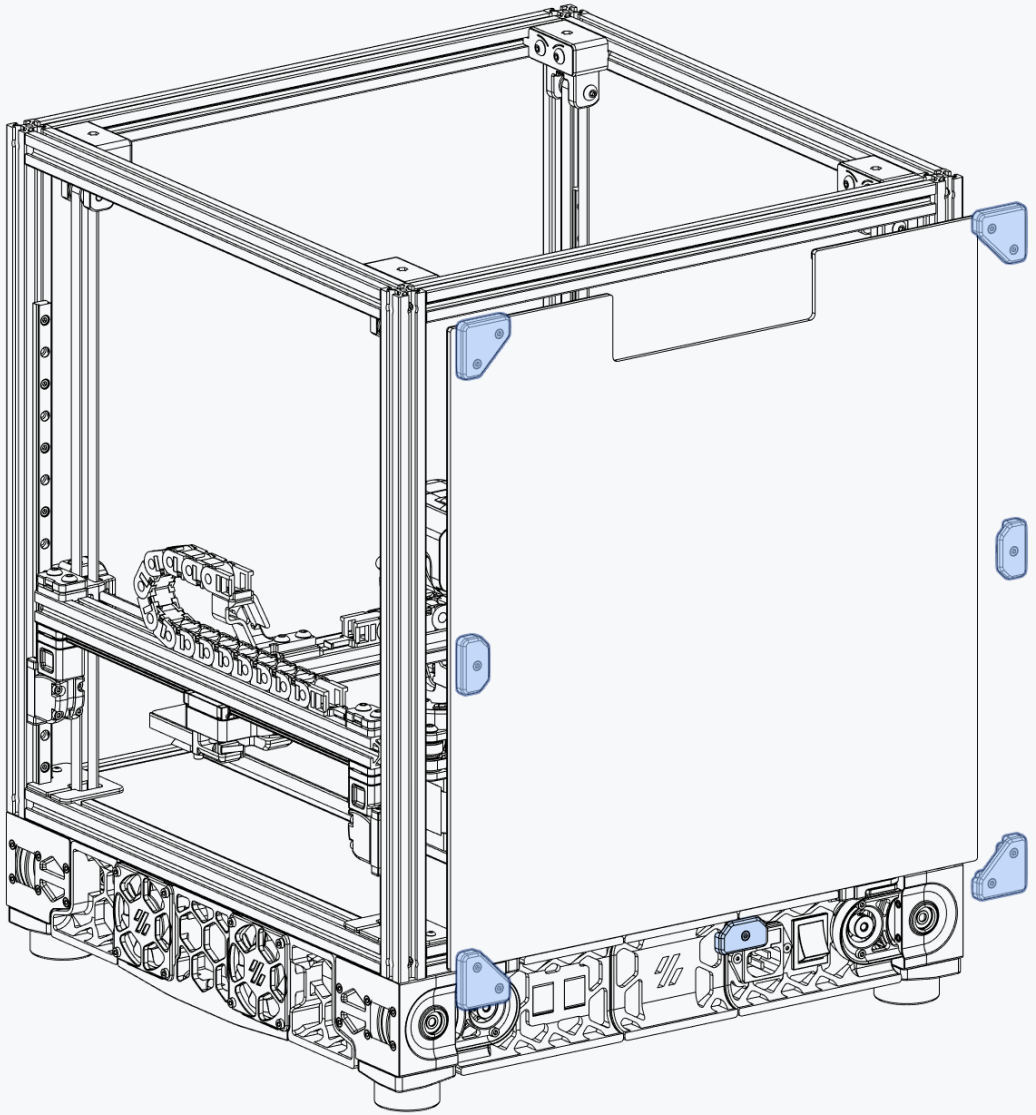
Use foam tape on the contact areas between the panels and the frame to mitigate noise from vibrations.

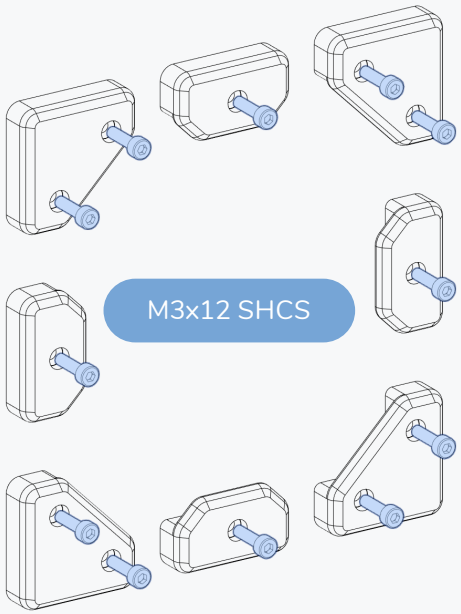


HAMMERHEAD NUTS?

A drop of thread locker will turn the hammerhead nuts into a 1/4 turn quick release for the panels. Best done once the assembly is finished.

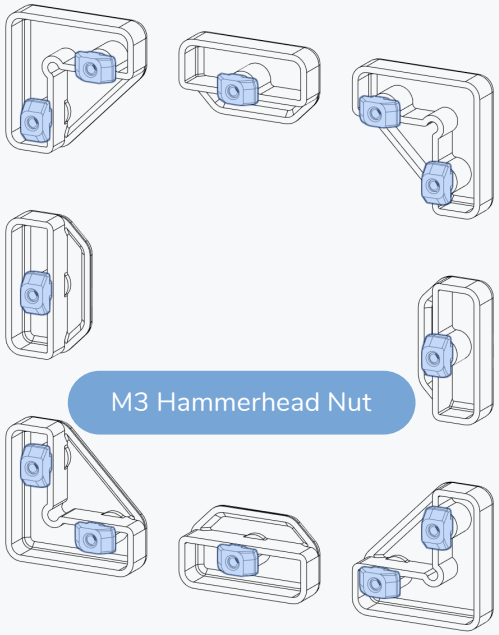


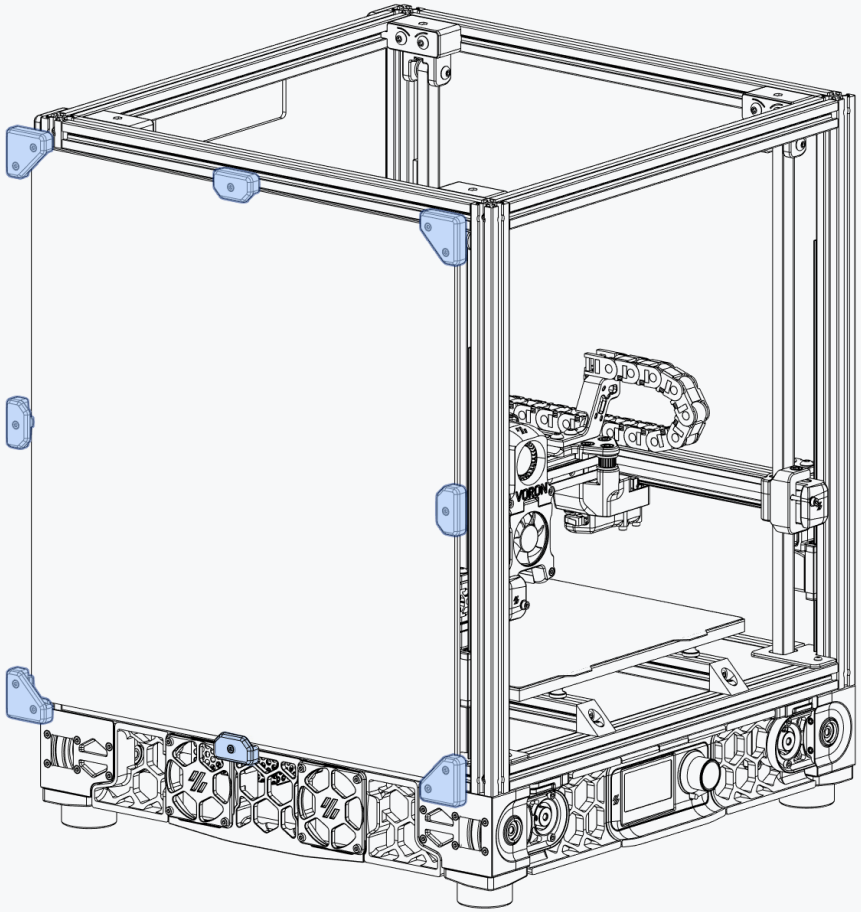


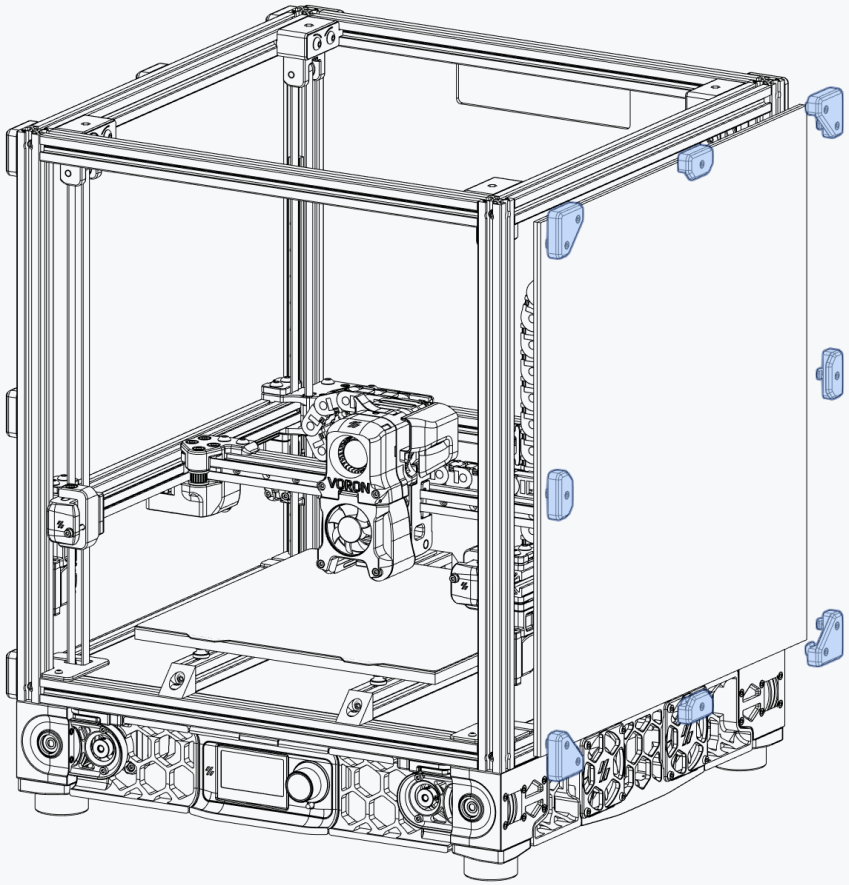


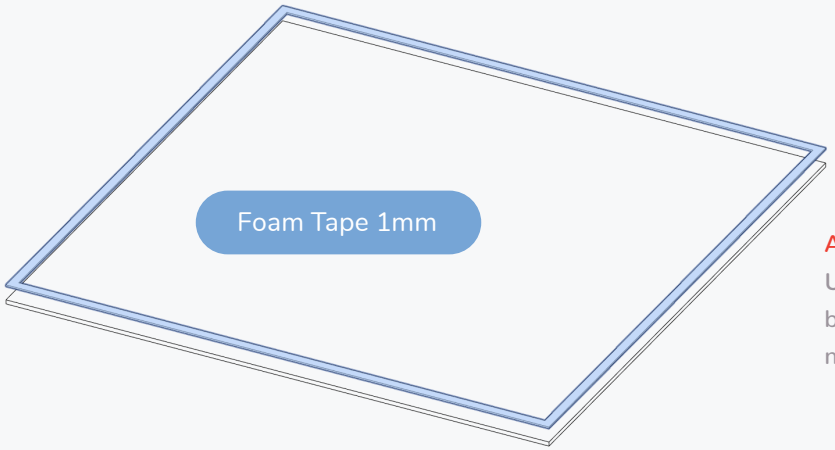
APPLY 3MM FOAM TAPE

Use foam tape on the contact areas between the panels and the frame to mitigate noise from vibrations.
The 3mm foam tape is used on the side panels to prevent the gantry from rubbing on the panels.



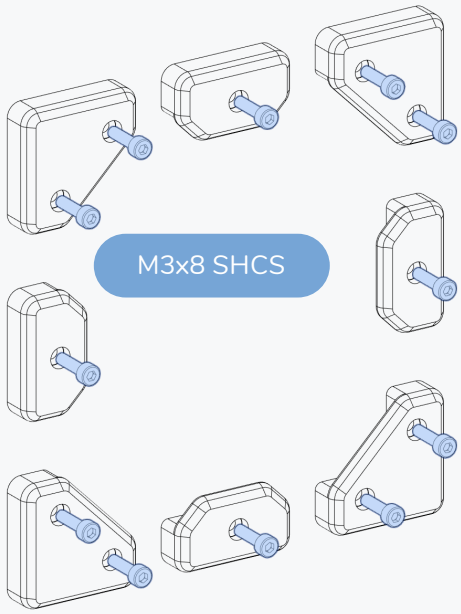


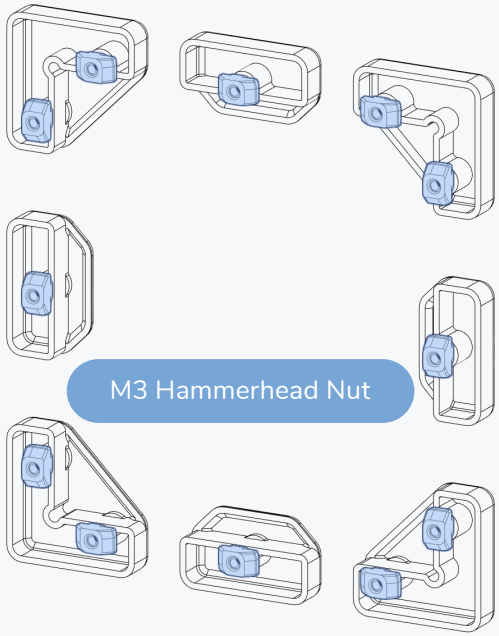


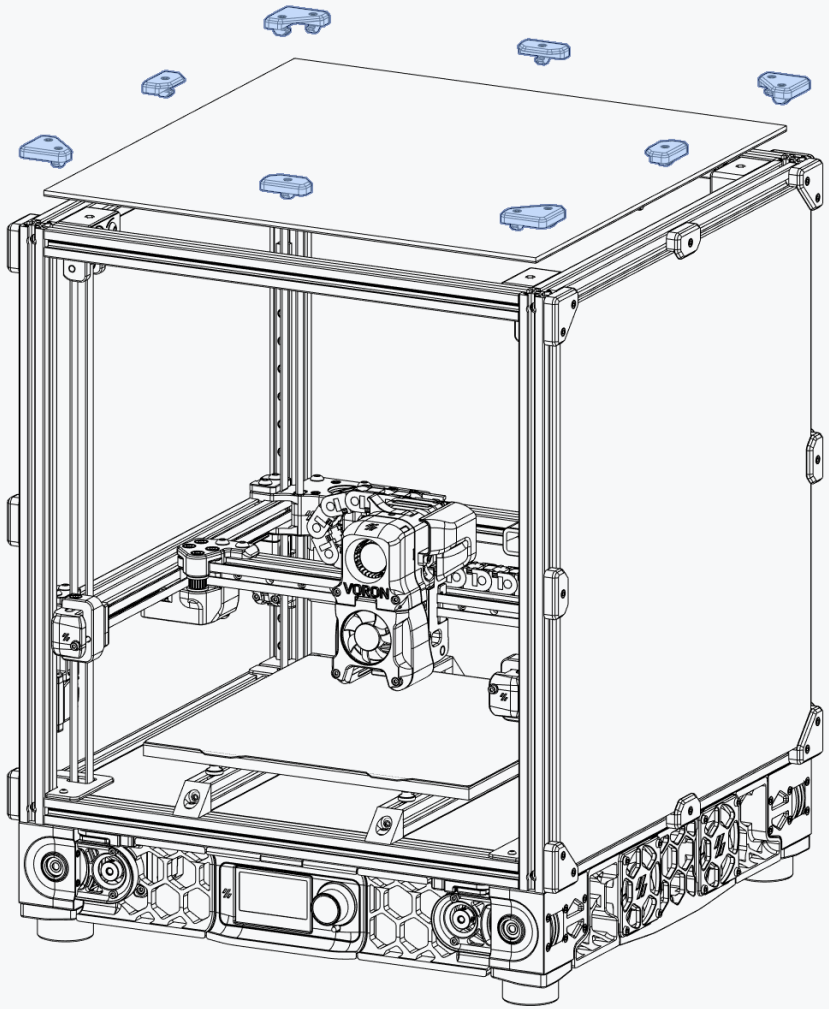


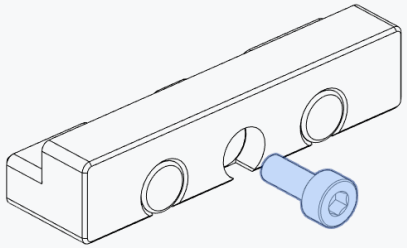
APPLY FOAM TAPE

Use foam tape on the contact areas between the panels and the frame to mitigate noise from vibrations.

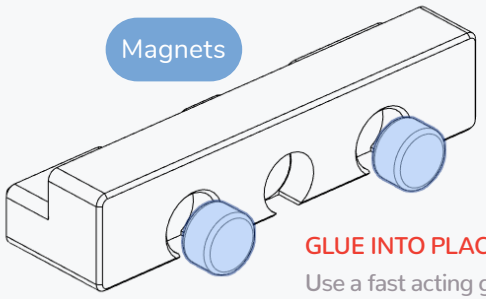








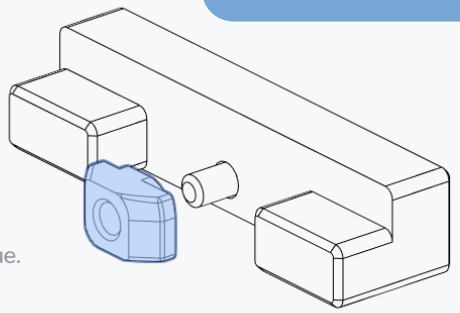
M3x8 SHCS



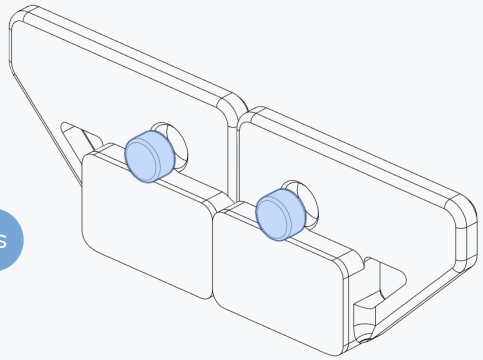
Magnets

GLUE INTO PLACE

Use a fast acting glue like super-glue.



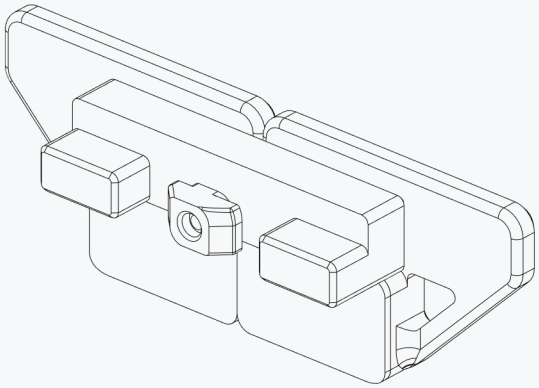
M3 Hammerhead Nut

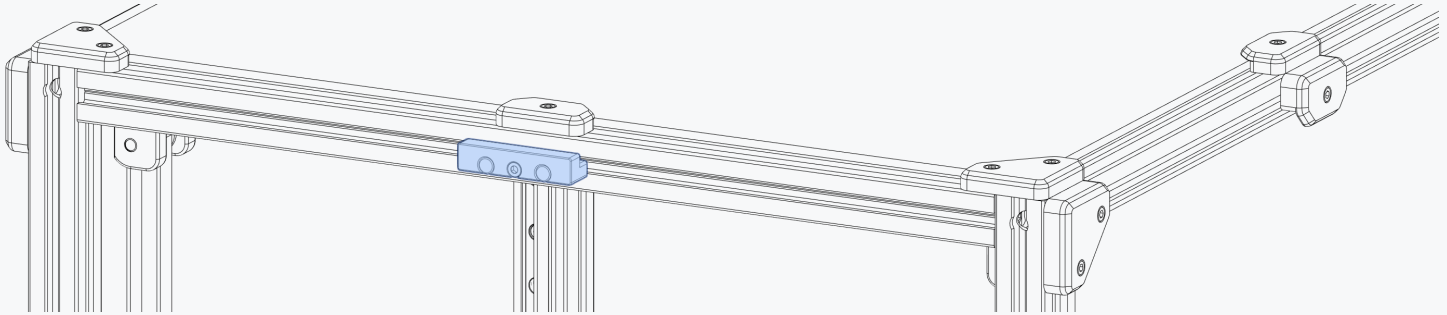


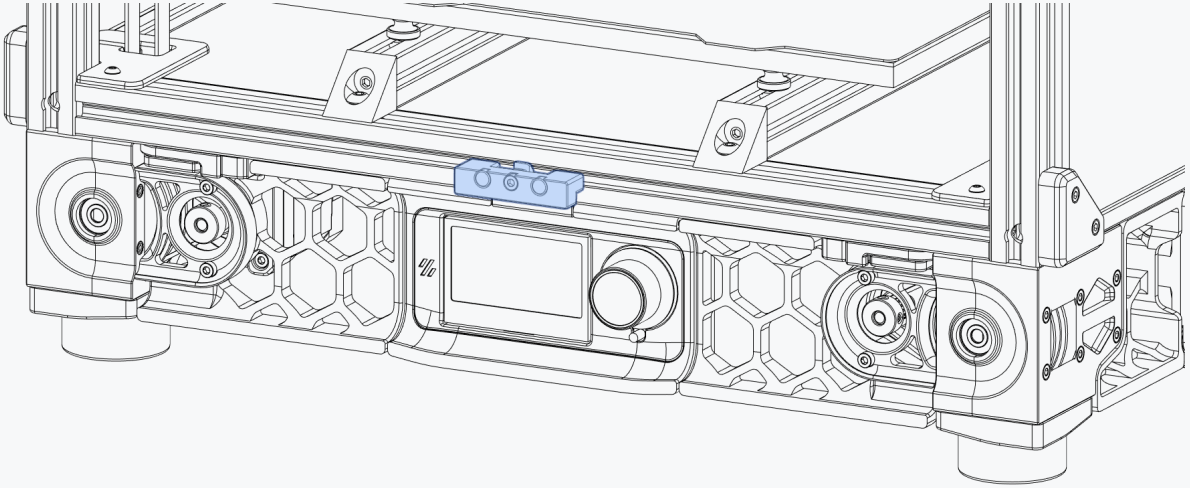
Magnets

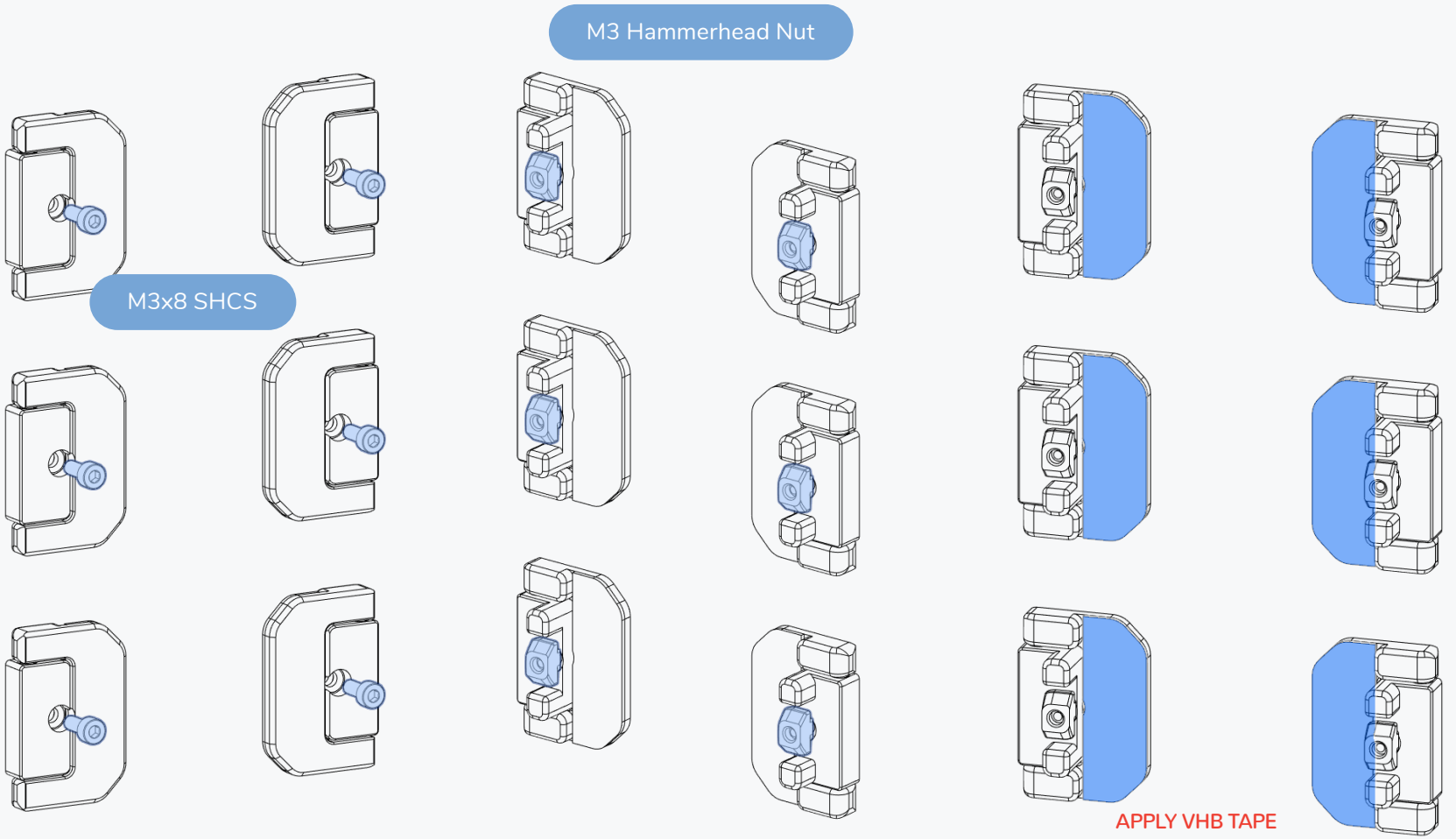
MIND THE MAGNET POLARITY

Ensure that the magnets are facing in the right direction prior to gluing them into place.



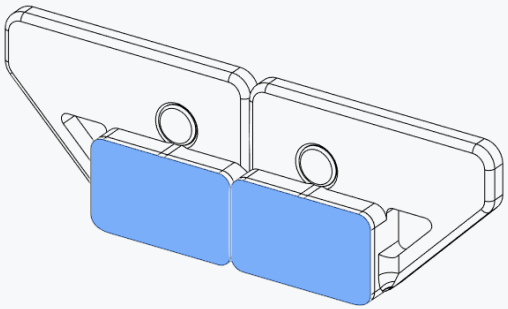






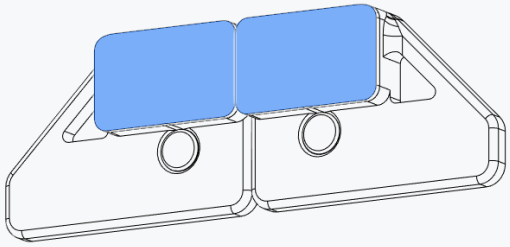
APPLY VHB TAPE

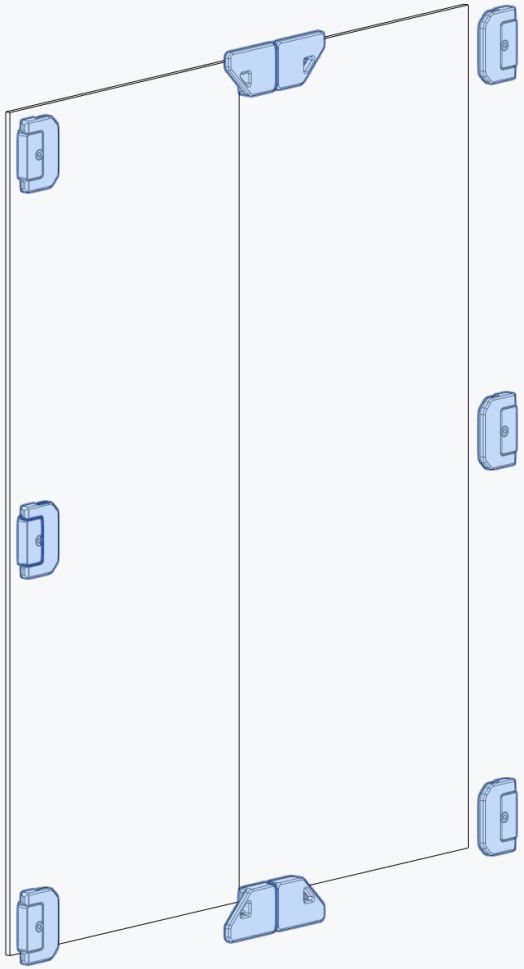
VHB Tape is a double sided adhesive tape.

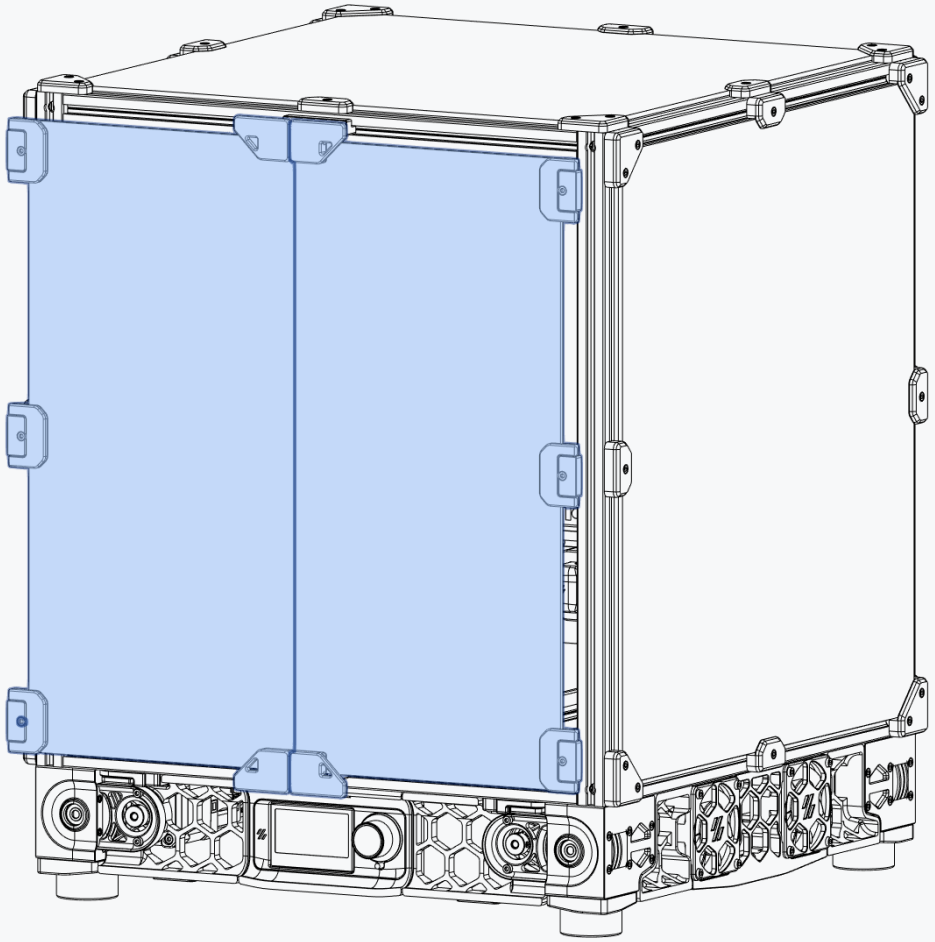


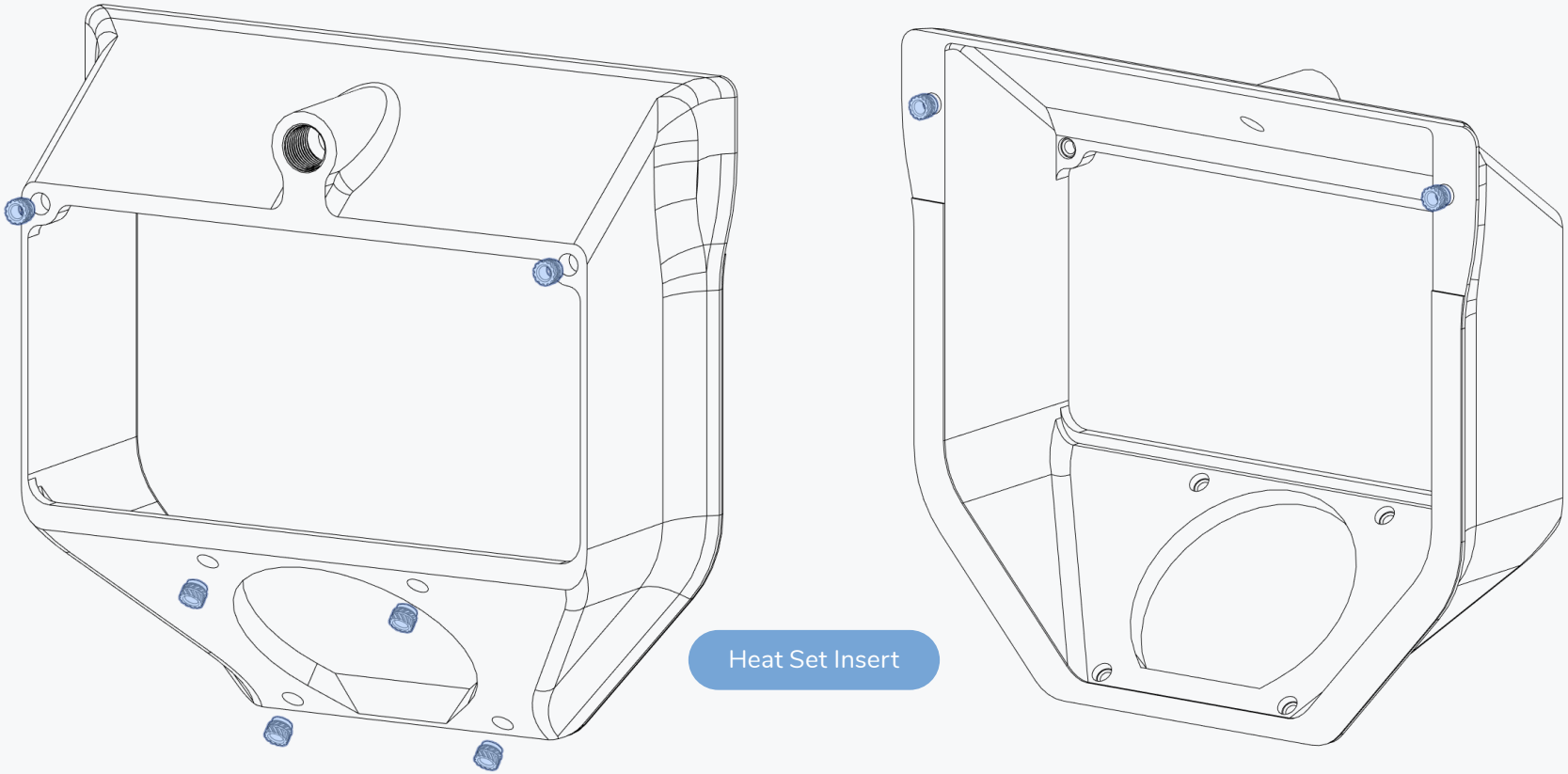
APPLY VHB TAPE

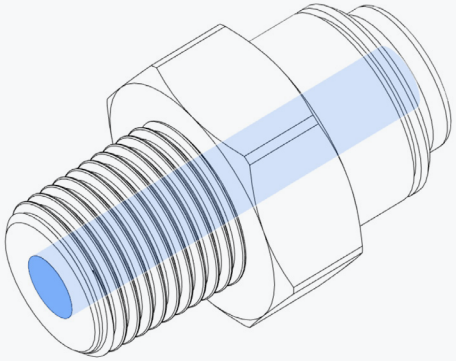
VHB Tape is a double sided adhesive tape.

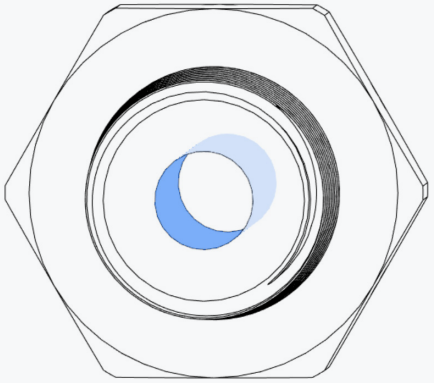







Heat Set Insert

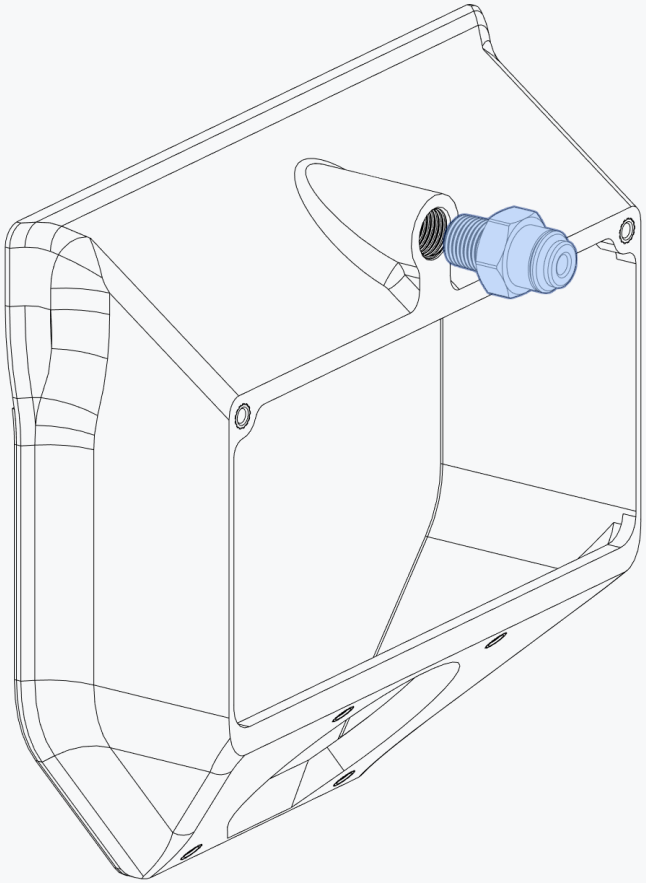


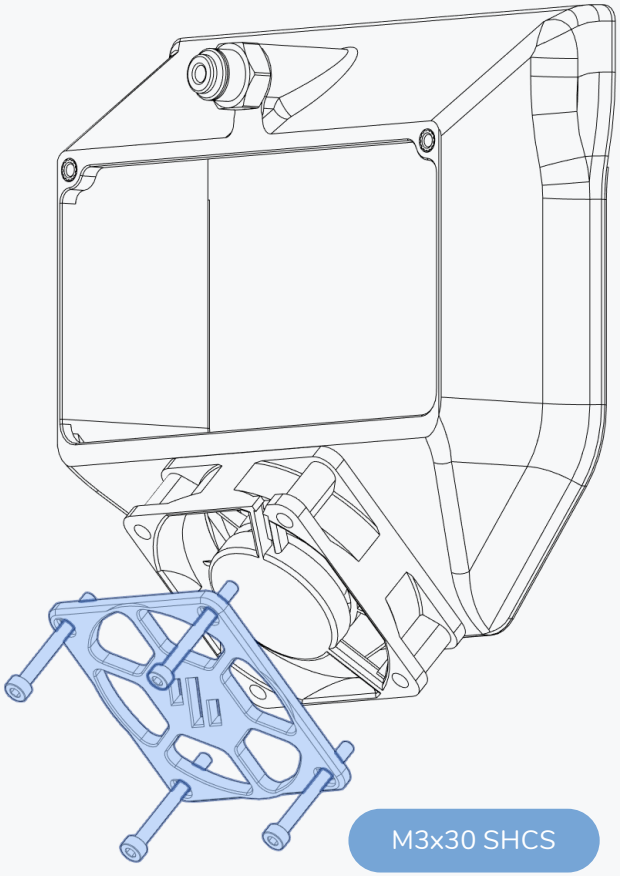


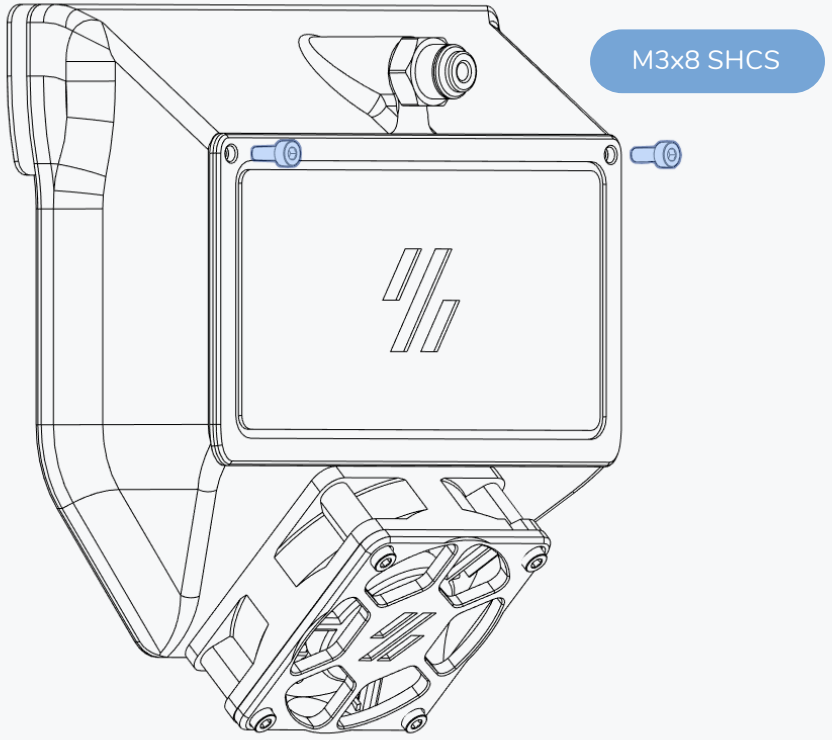
BSPP ADAPTER

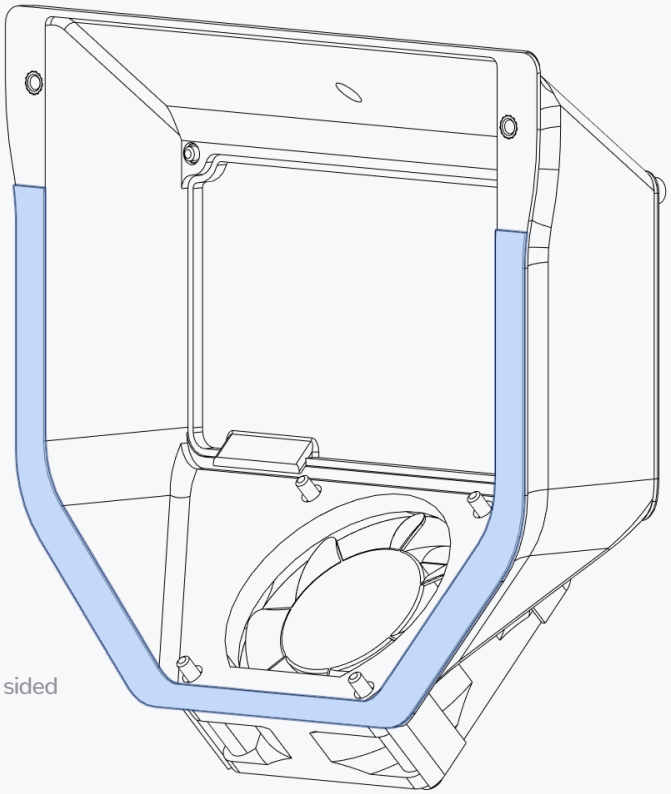
Some adapters have a small lip that prevents the PTFE tube from passing through.

Inspect the adapter and if necessary use a drill to carefully remove the lip.



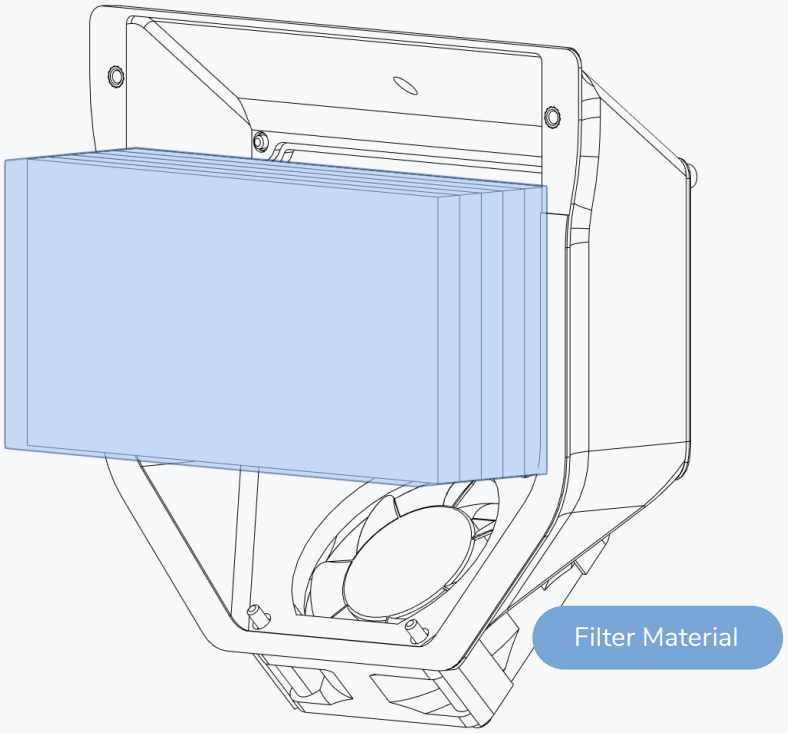

M3x30 SHCS

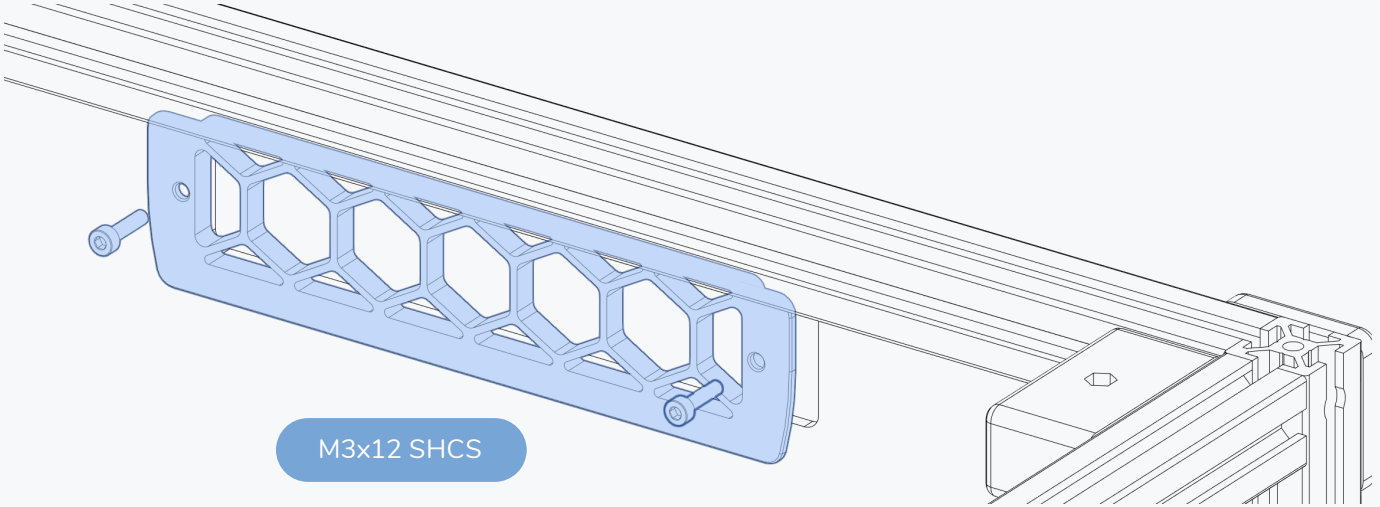

M3x8 SHCS

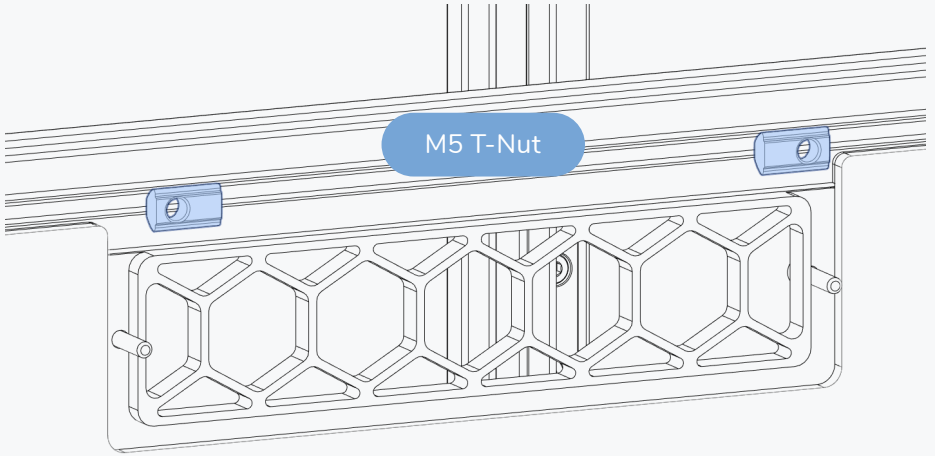


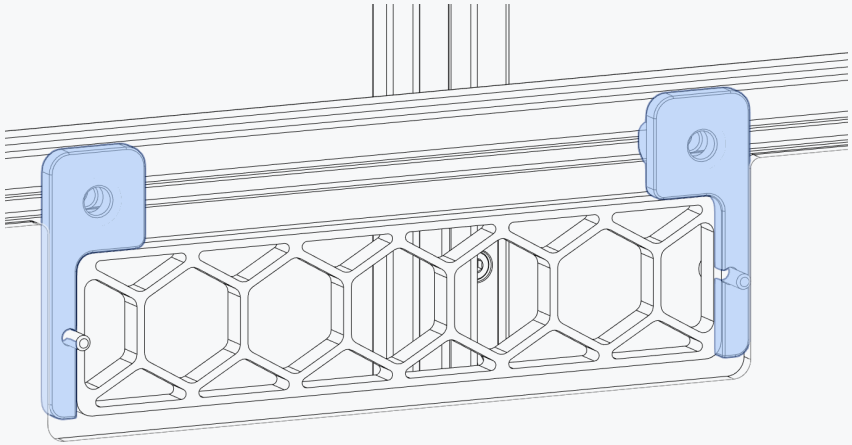
APPLY VHB TAPE

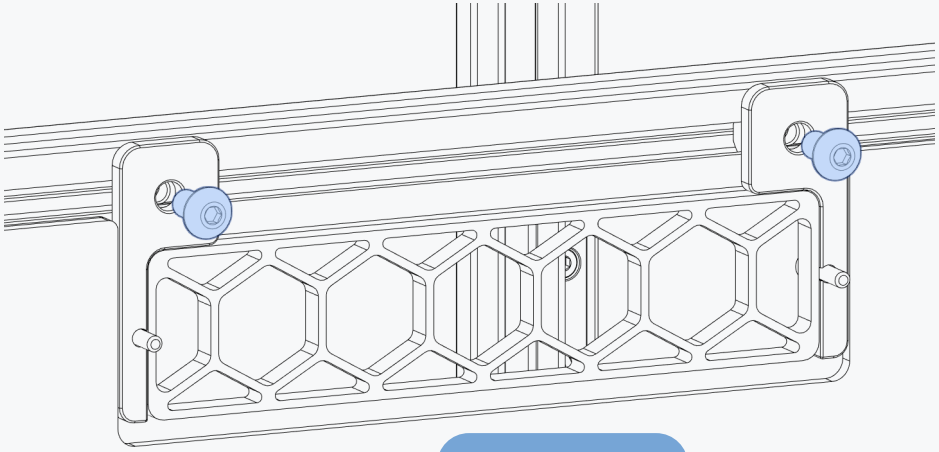
VHB Tape is a double sided adhesive tape.



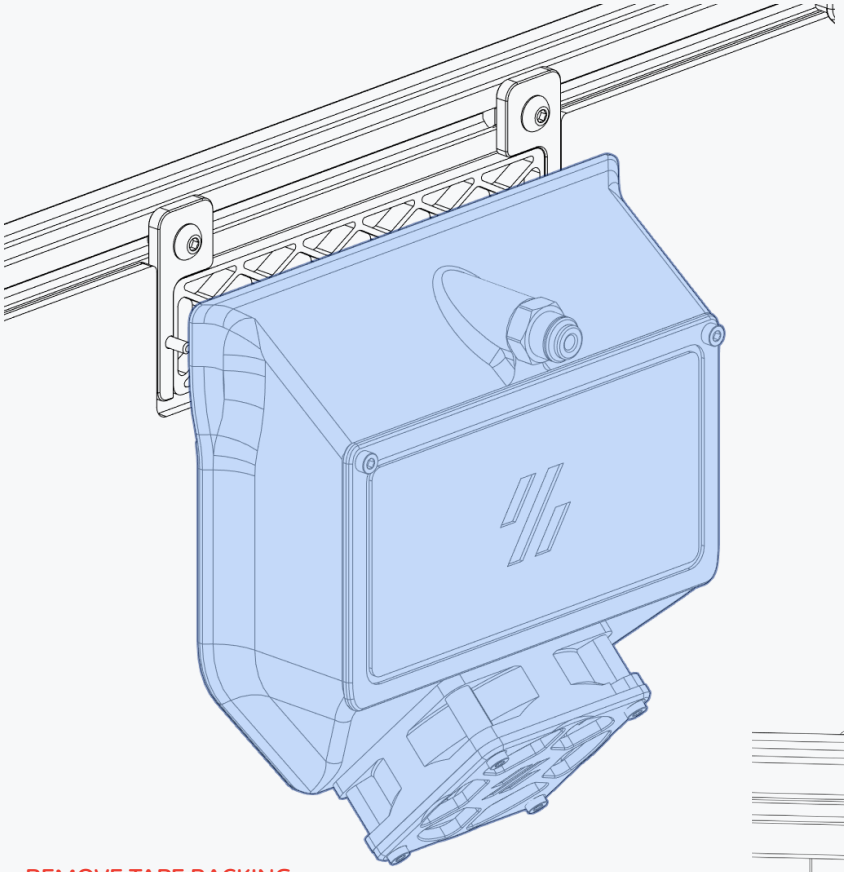

M3x12 SHCS


M5 T-Nut





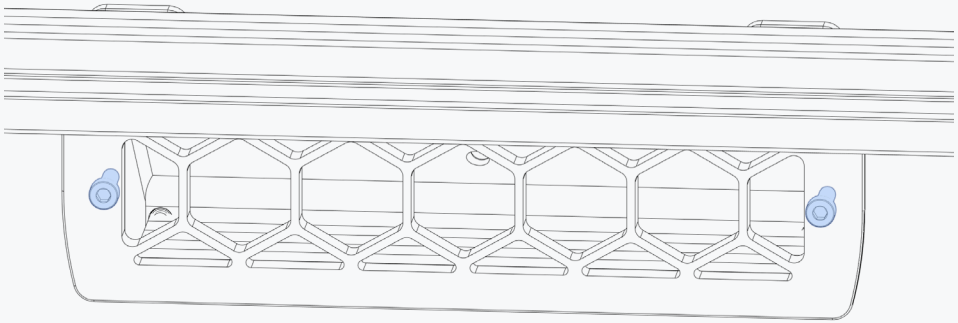
M5x10 BHCS



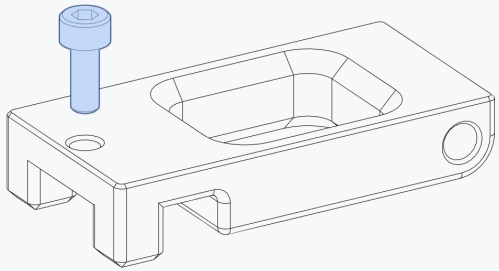
REMOVE TAPE BACKING

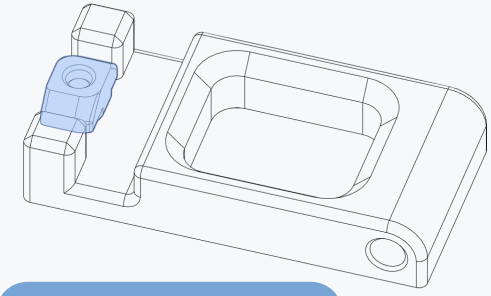
Attach the exhaust assembly to the back panel and secure it with the bolts on the other side of the exhaust gril.

TIGHTEN BOLTS

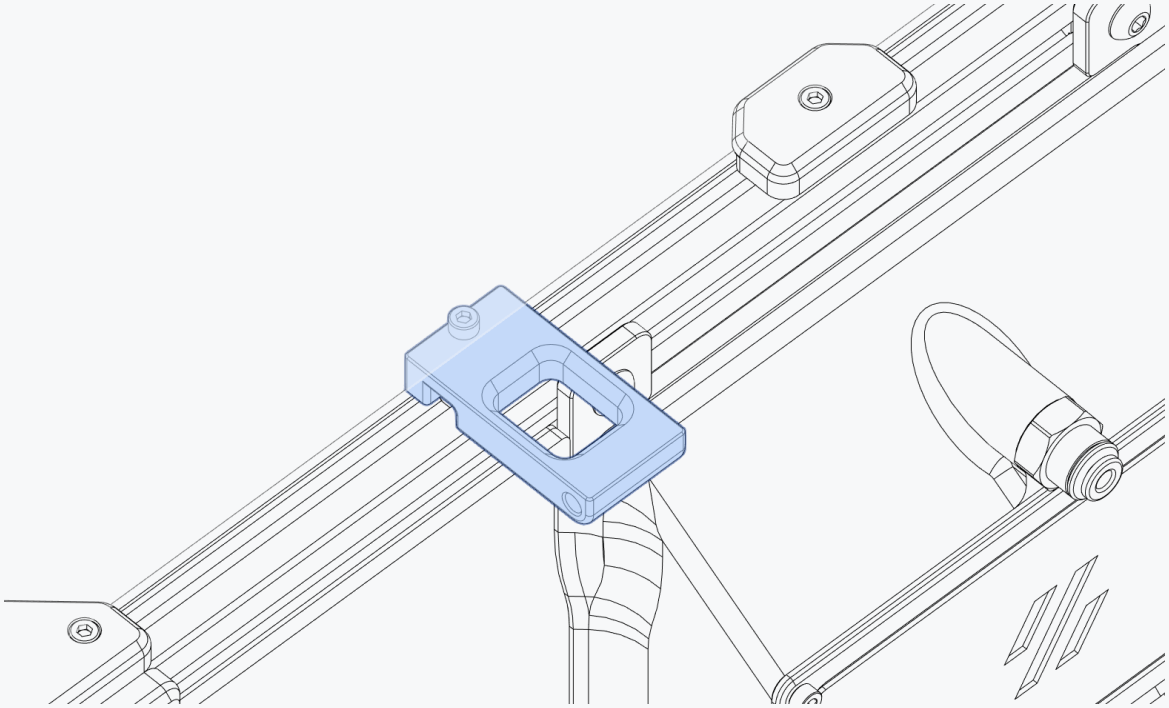


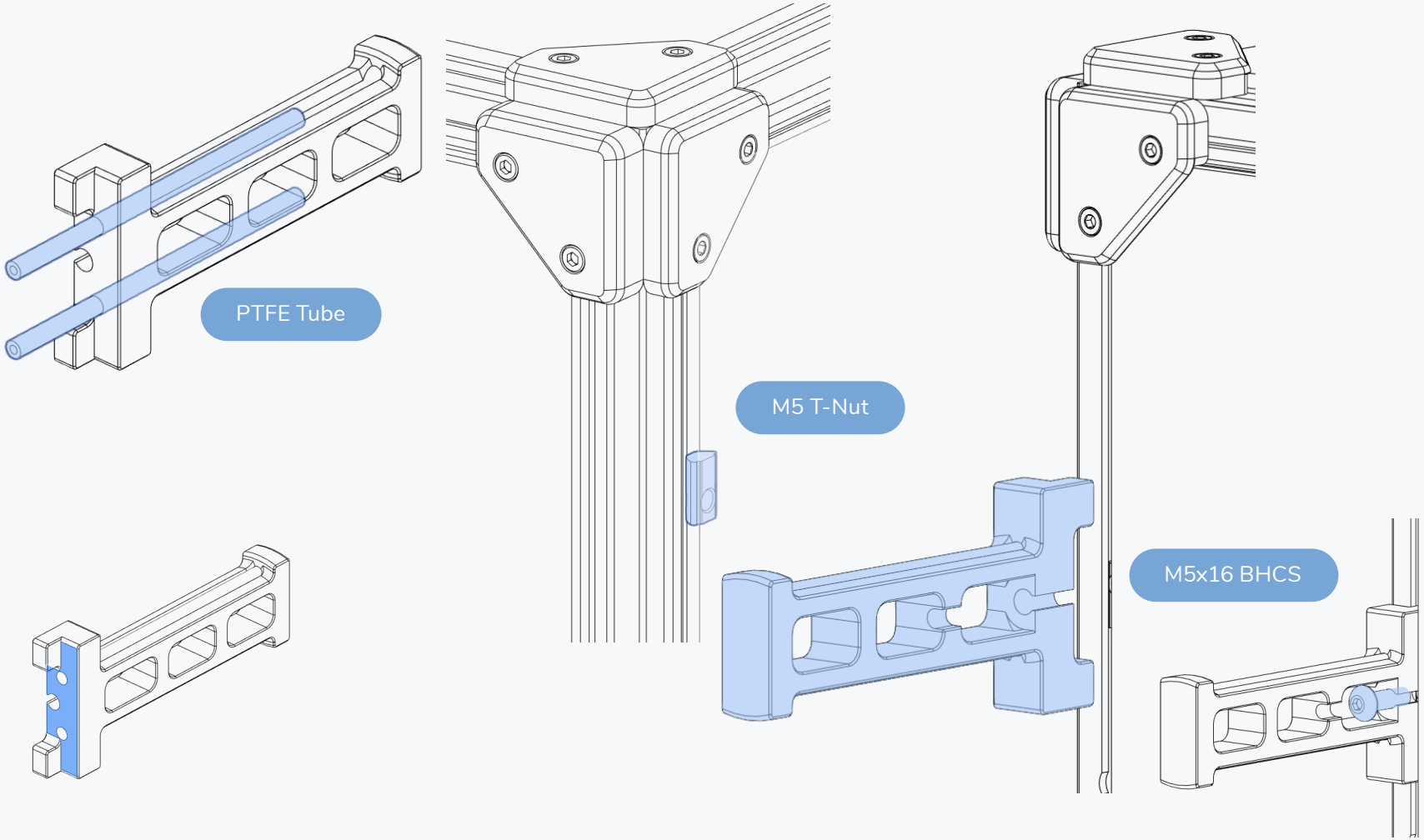
M3x8 SHCS





M3 Hammerhead Nut




PTFE Tube
M5 T-Nut
M5x16 BHCS

ASSEMBLY COMPLETED! ... NEXT STEP: SETUP & CALIBRATION

This manual is designed to be a reference manual for the build process of a Voron2 printer. Additional details about the build and background on advanced topics can be found on our documentation page linked below.

The software setup and other initial setup steps with your new printer can also be found on our documentation page. We recommend starting here.

https://docs.vorondesign.com/

https://github.com/VoronDesign/Voron-2

HOW TO GET HELP

If you need assistance with your build, we're here to help. Head on over to our Discord group and post your questions. This is our primary medium to help VORON Users and we have a great community that can help you out if you get stuck. Alternativly, you can use our subreddit.

https://discord.gg/voron

https://www.reddit.com/r/VORONDesign

REPORTING ISSUES

Should you find an issue in this document or have a suggestion for an improvement please consider opening an issue on GitHub (https://github.com/VoronDesign/Voron-2/issues).
When raising an issue please include the relevant page numbers and a short description; annotated screenshots are also very welcome.
We periodically update the manual based on the feedback we get.

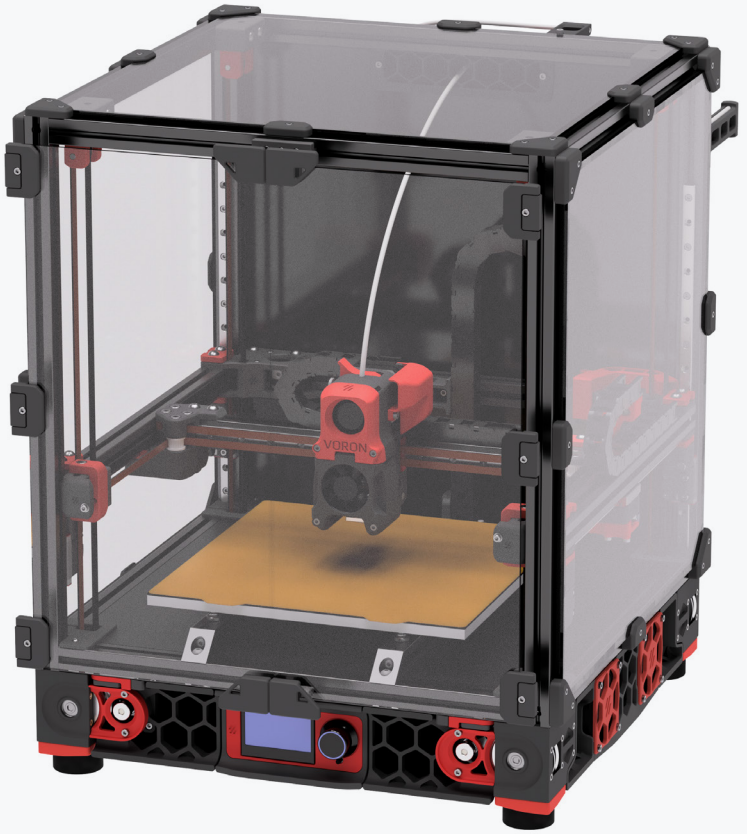
Enjoy your printer.

Website
www.vorondesign.com

Github
github.com/vorondesign

Docs
docs.vorondesign.com

Discord
discord.gg/voron


VORON