

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

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.



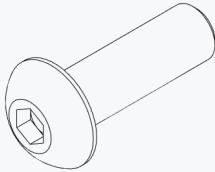
<https://github.com/vorondesign>



<https://docs.vorondesign.com/>

HARDWARE REFERENCE

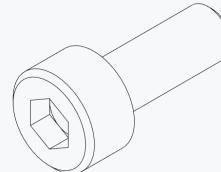
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BUTTON HEAD CAP SCREW (BHCS)

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.

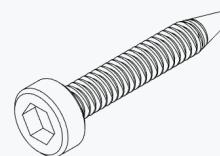
ISO 4762



FLAT HEAD COUNTERSUNK SCREW (FHCS)

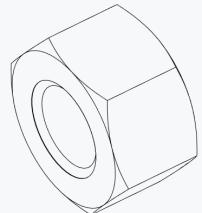
Metric fastener with a cone shaped head and a flat top.

ISO 10642



SELF TAPPING SCREW

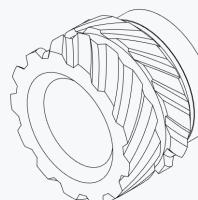
Fastener with a pronounced thread profile that is screwed directly into plastic.



HEX NUT

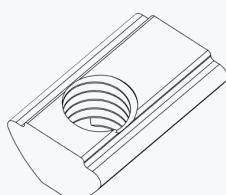
Hex nuts couple with bolts to create a tight, secure joint. You'll see these used in both M3 and M5 variants throughout this guide.

ISO 4032



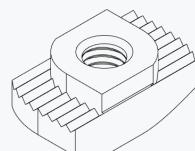
HEAT SET INSERT

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".

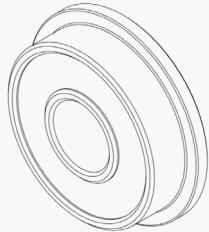


HAMMERHEAD NUT

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

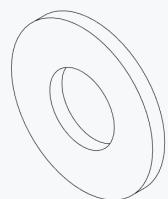
HARDWARE REFERENCE

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F695 BEARING

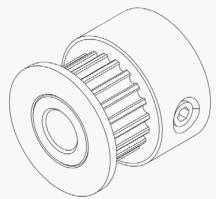
A ball bearing with a flange used in various gantry locations.



SHIM

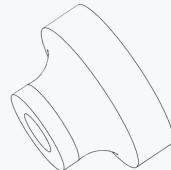
Not to be confused with stamped washers. These are used in all M5 call-out locations in this manual.

DIN 988



PULLEY

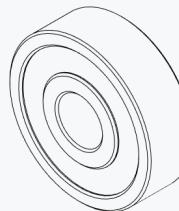
GT2 pulley used on the motion system of the Voron.



THUMB NUT

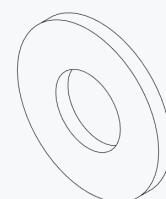
Used in the print bed as a spacer.

DIN 466-B



625 BEARING

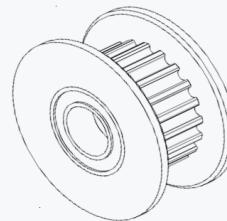
A ball bearing used on the Voron Z drives.



WASHER

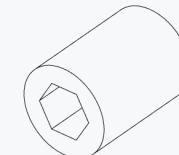
Usually stamped from sheet metal this type of spacer is not as consistent in thickness as the shims are. Only used in M3 size.

DIN 125



IDLER

GT2 idler used in the motion system of the Voron.



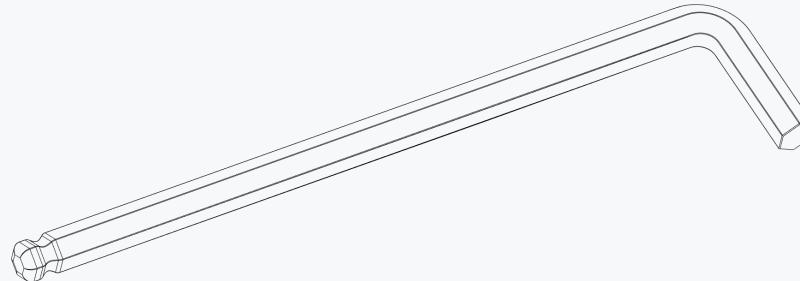
SET SCREW

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.



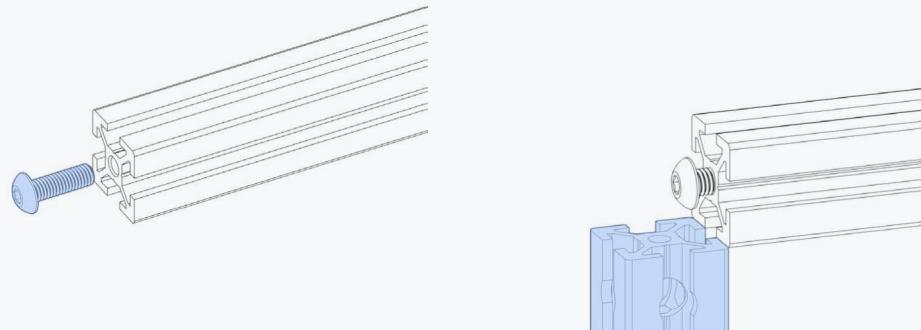
2.5MM HEX DRIVER

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

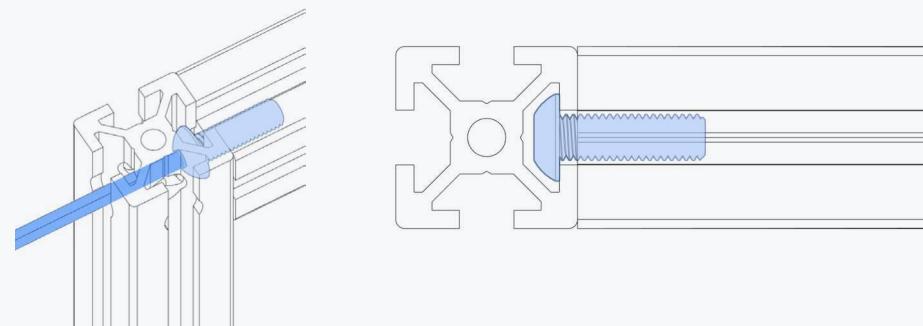
Blind Joints provide a cost effective and rigid assembly method.

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>

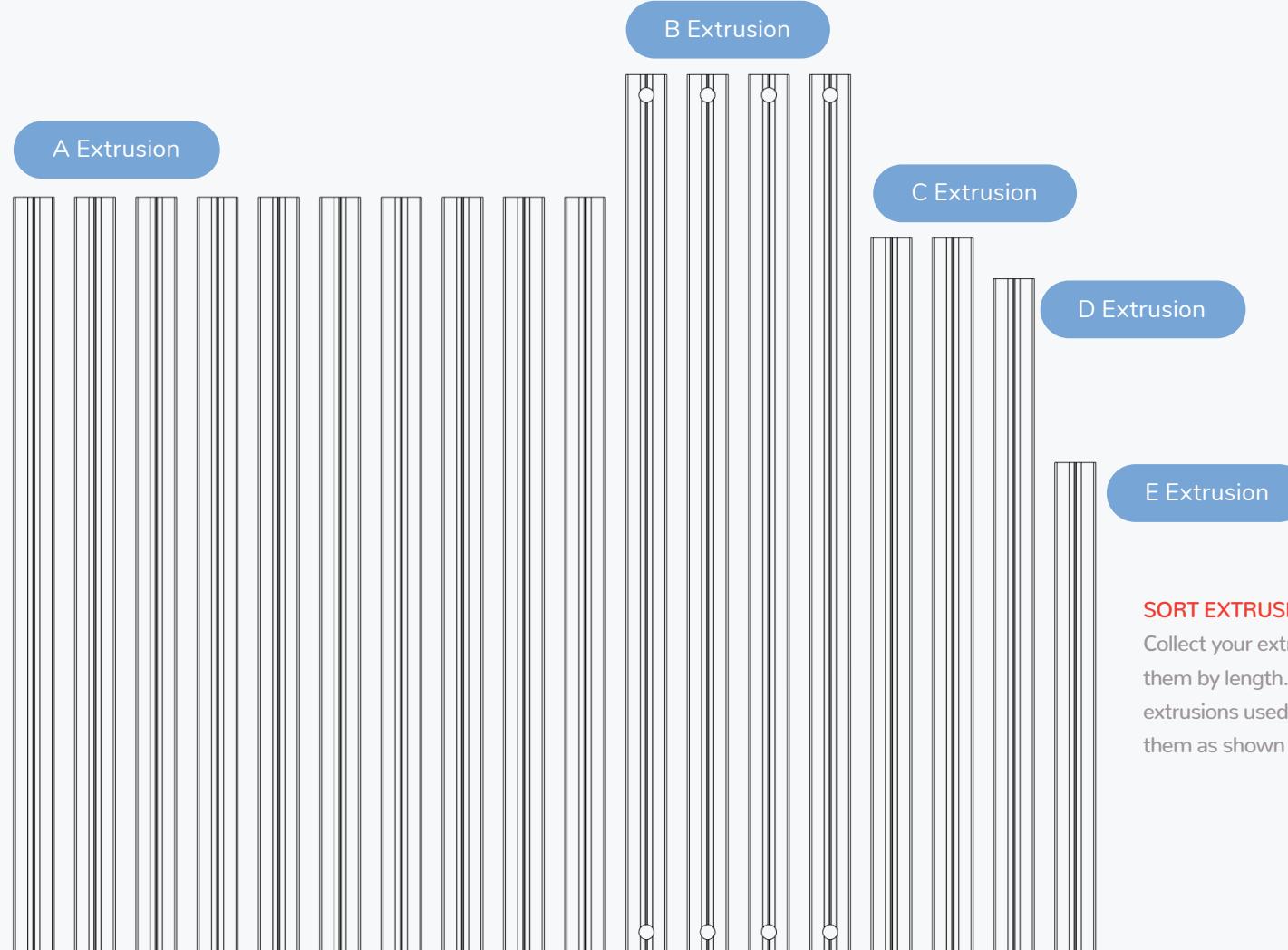


The first Voron printer was released to the public on March 10 2016.

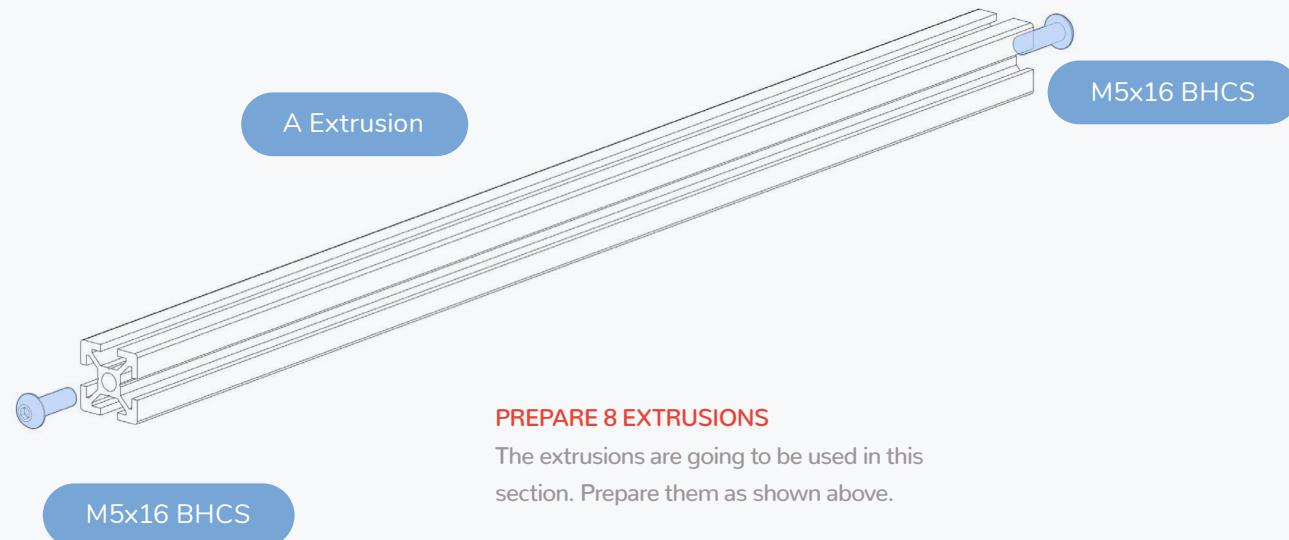
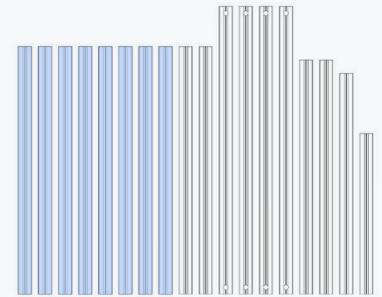
FRAME

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**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.



FRAME

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FRAME ASSEMBLY

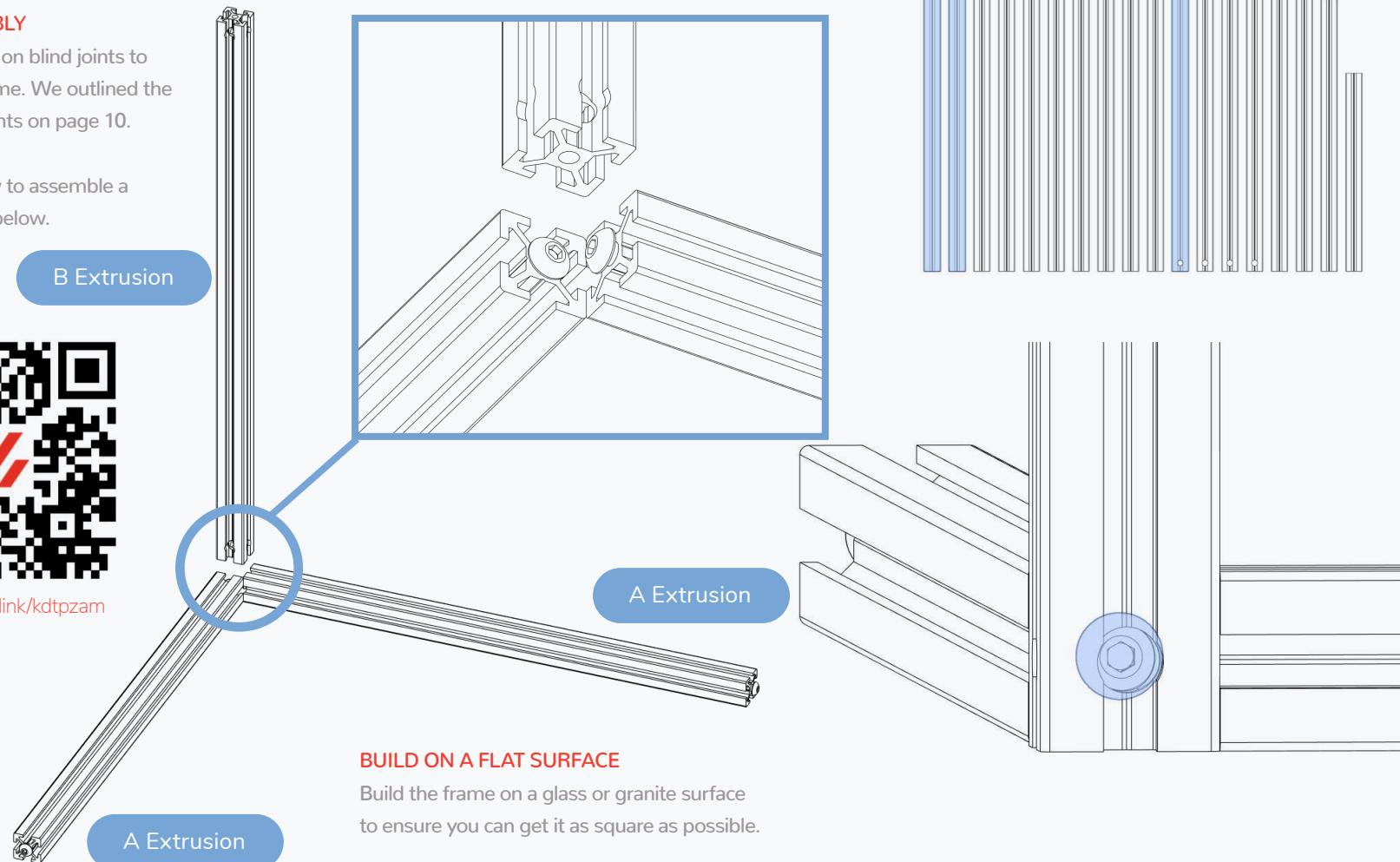
This design relies on blind joints to assemble the frame. We outlined the basics of blind joints on page 10.

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

B Extrusion



<https://voron.link/kdtpzam>



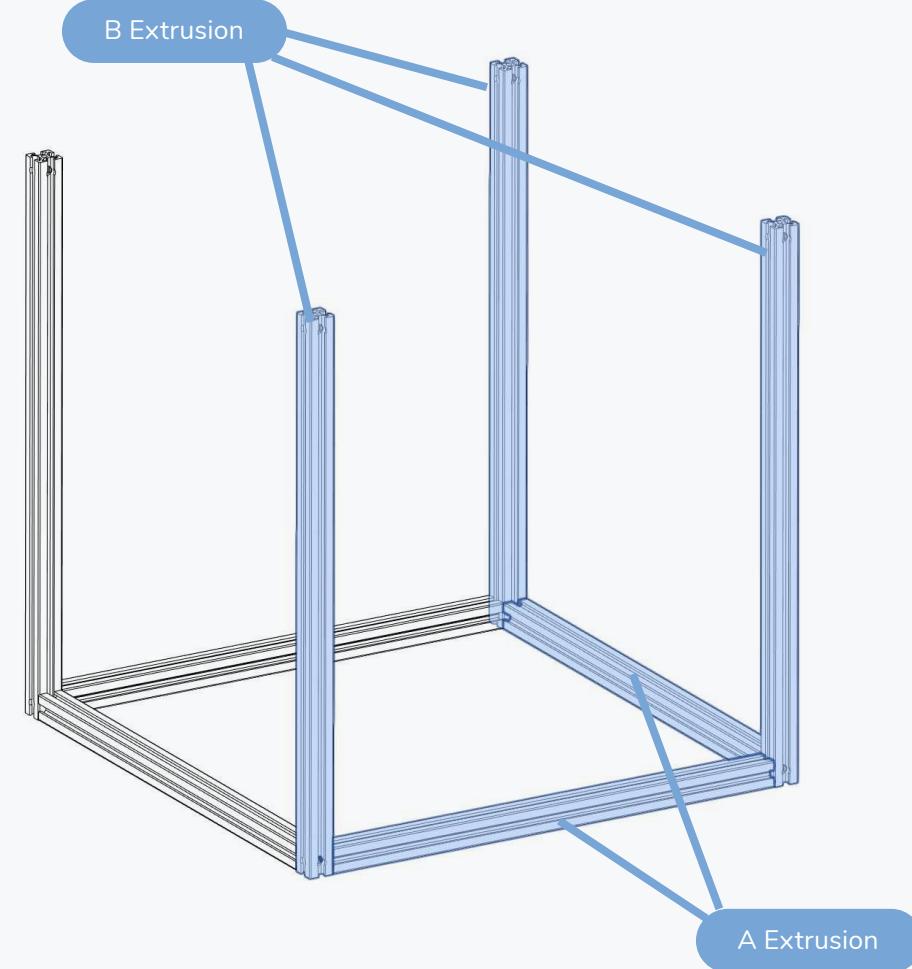
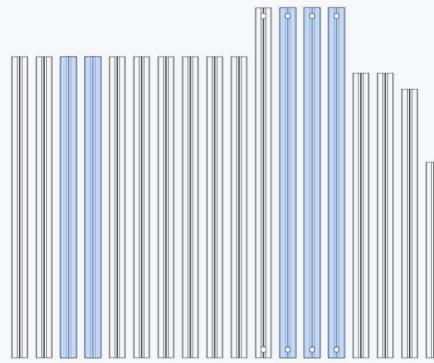
A Extrusion

BUILD ON A FLAT SURFACE

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

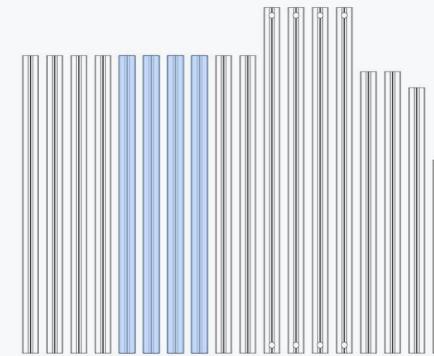
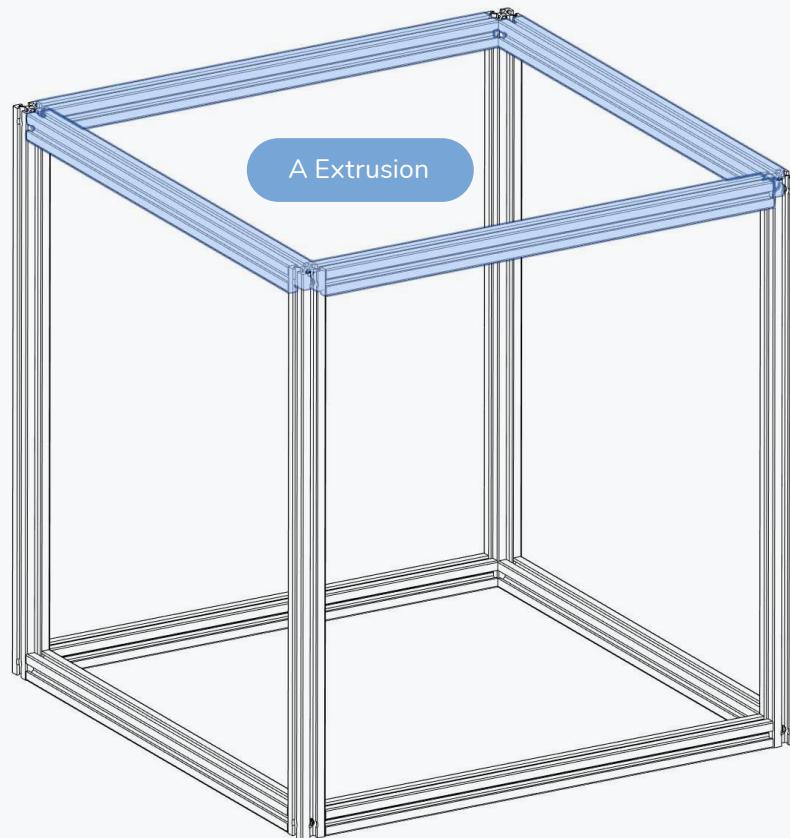
FRAME

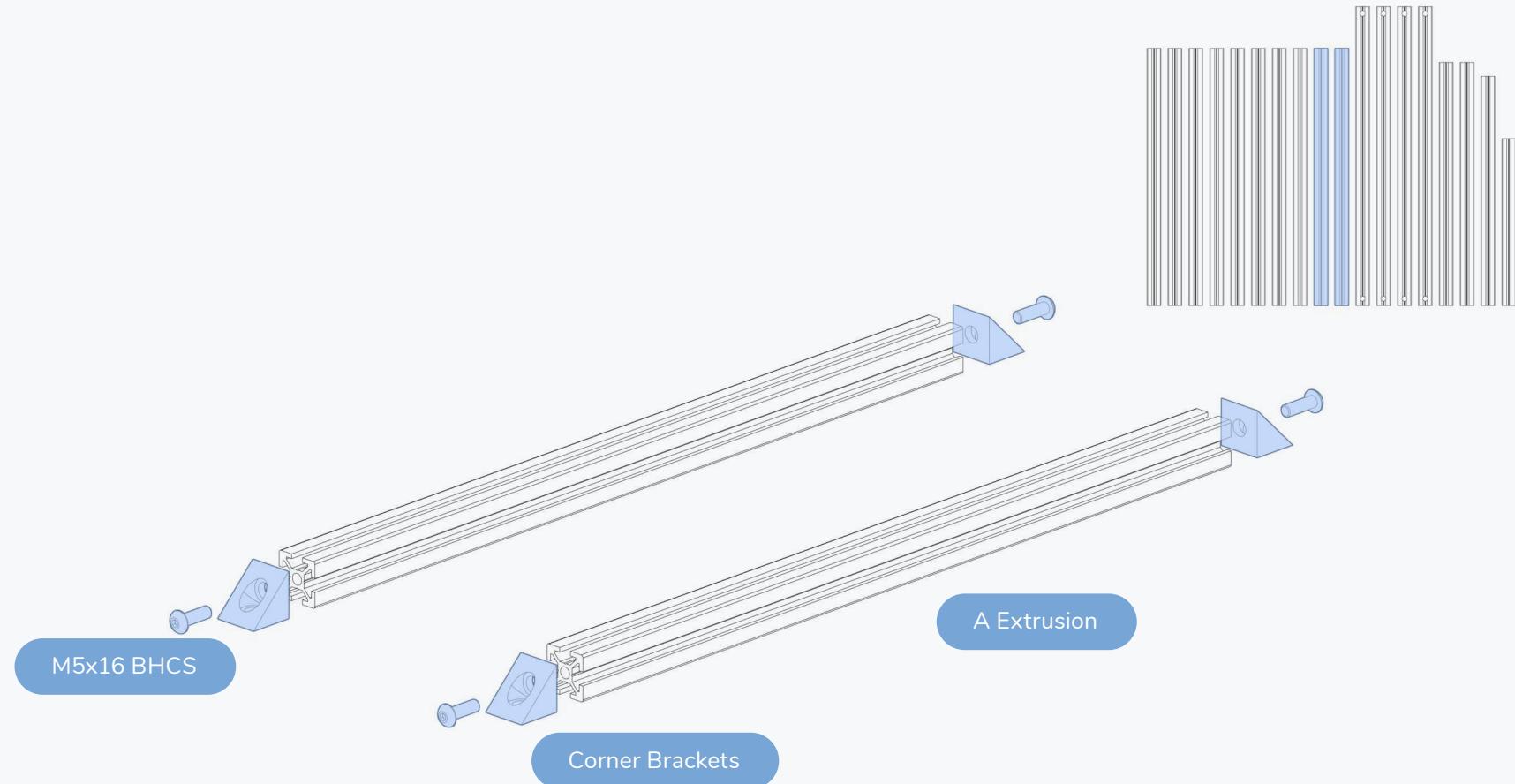
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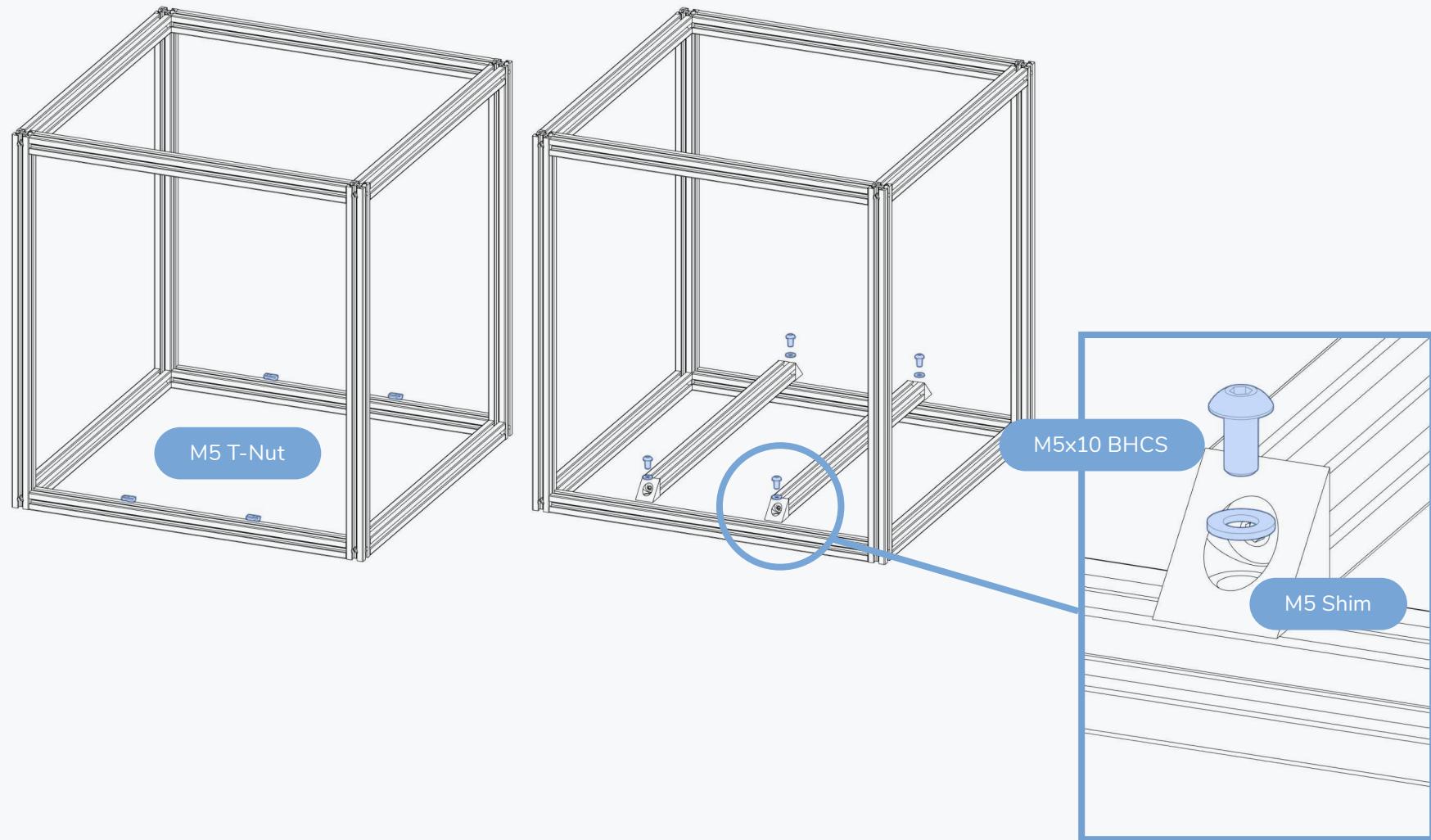


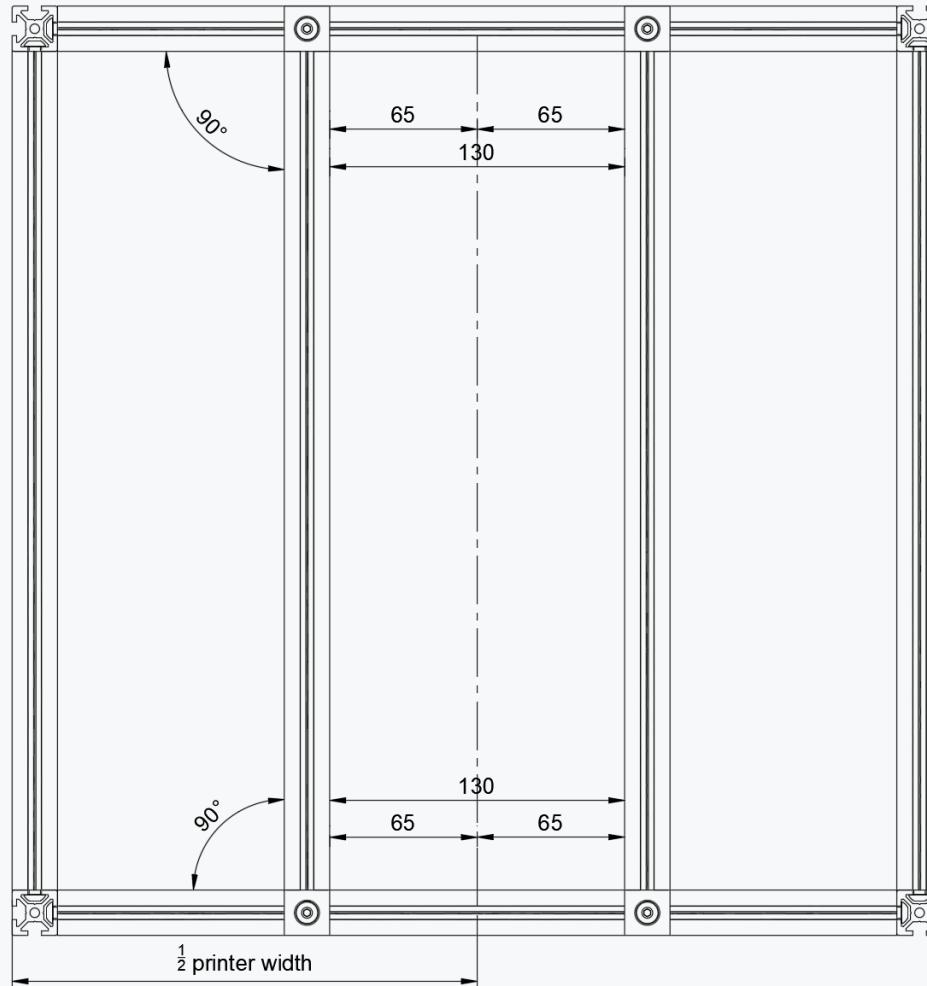
FRAME

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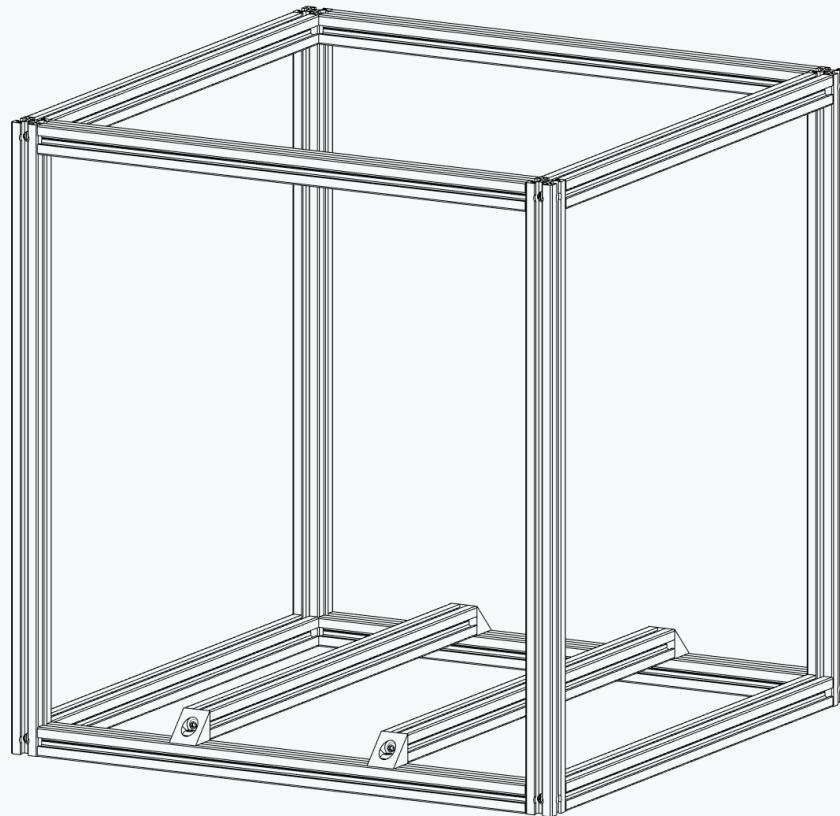
POSITION BED EXTRUSIONS

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.

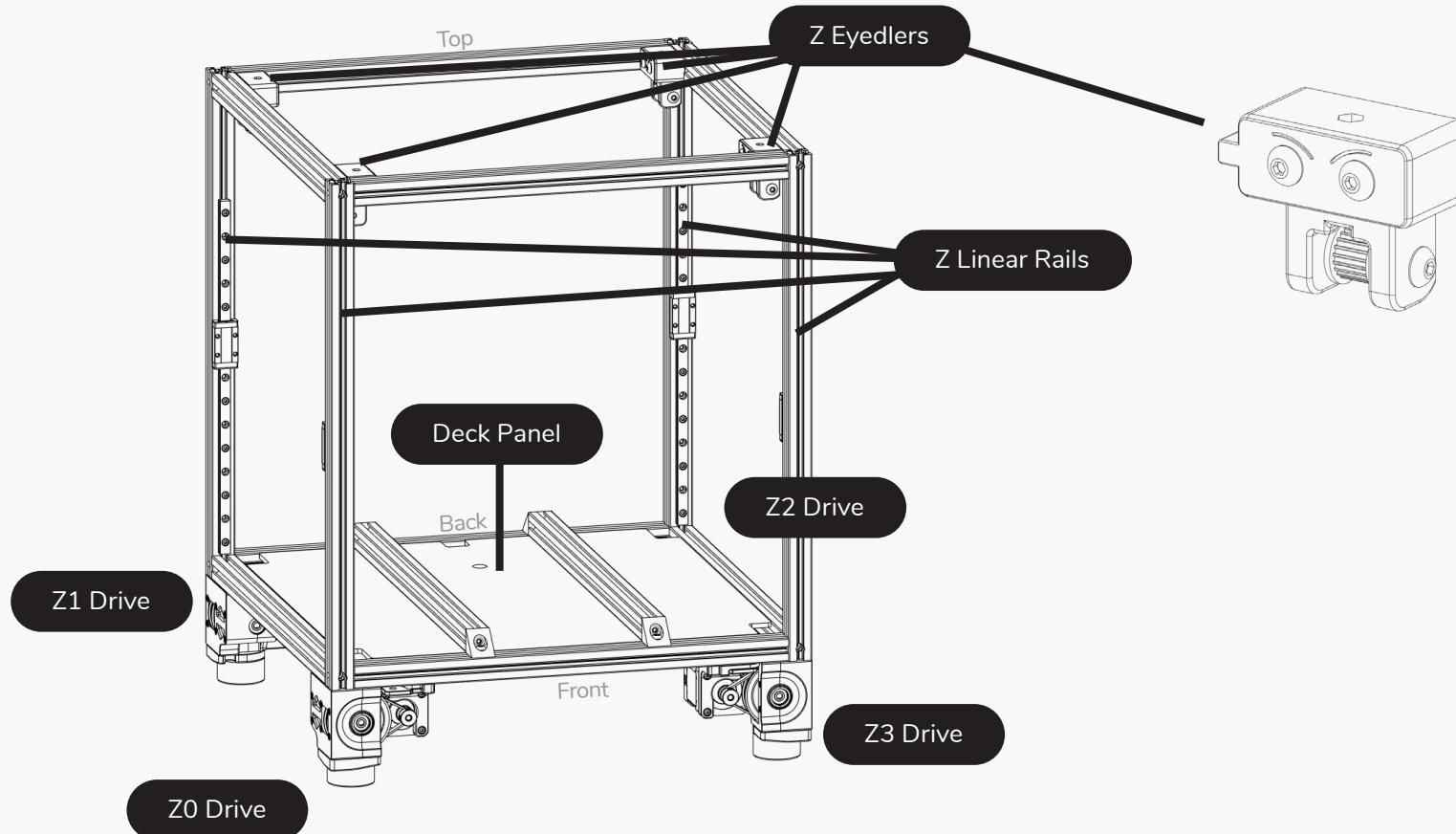


<https://voron.link/kdtpzam>

Z DRIVES

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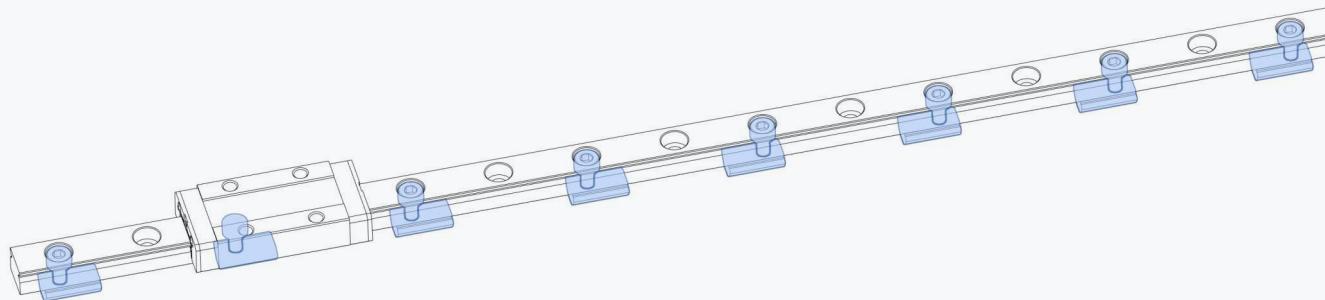
OVERVIEW

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.

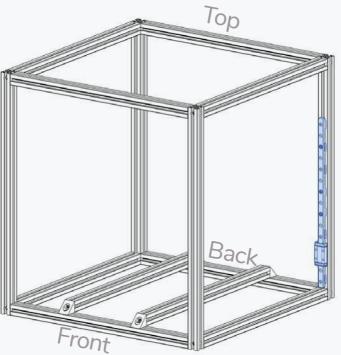
When tightening the bolts tighten them from the center outward to ensure that the rail sits flush on the extrusion.



<https://voron.link/aguOnes>

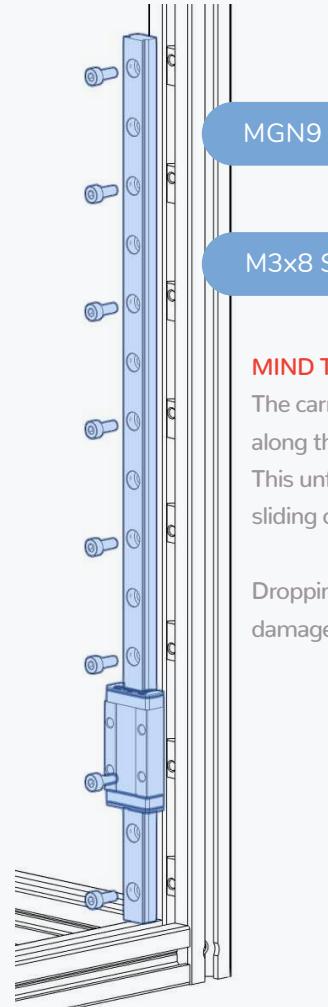
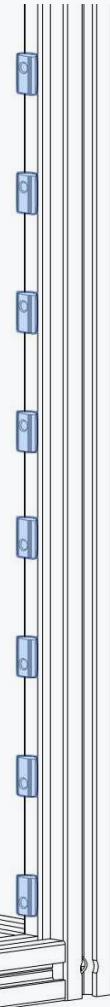
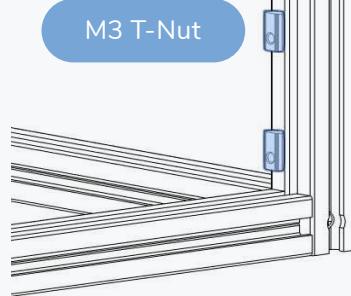
Z RAILS

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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

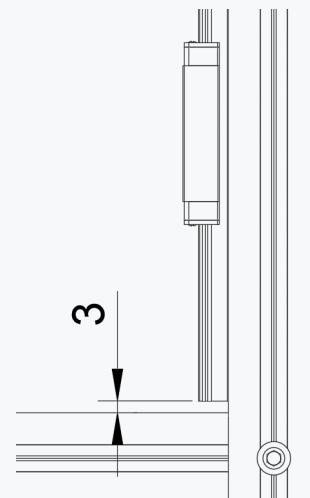
The carriages are designed to slide along the rail easily. This unfortunately also includes sliding off the rails.

Dropping the carriage will likely damage it.



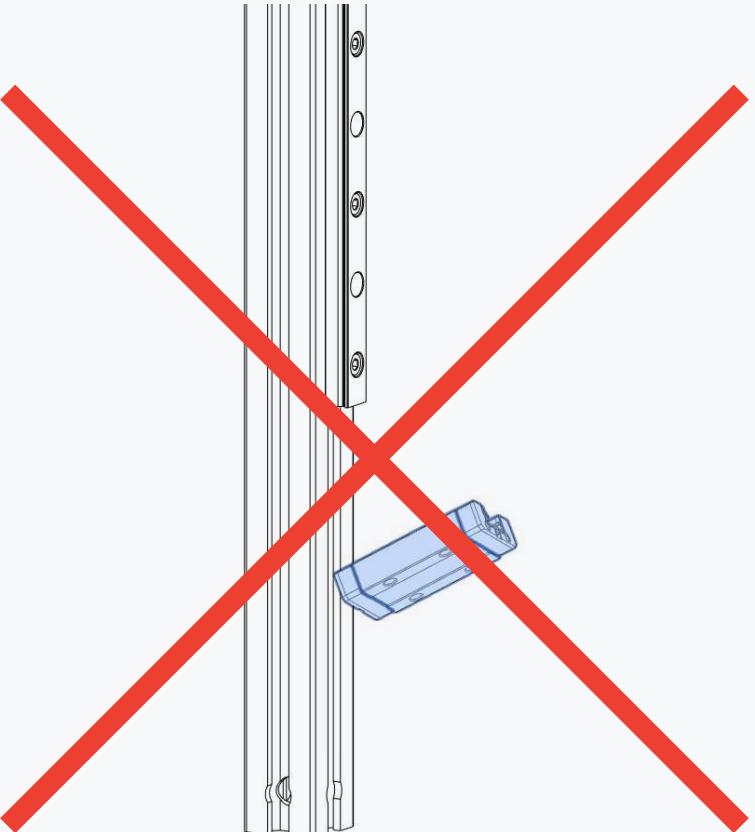
CENTRED RAIL INSTALLATION GUIDE

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.



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.

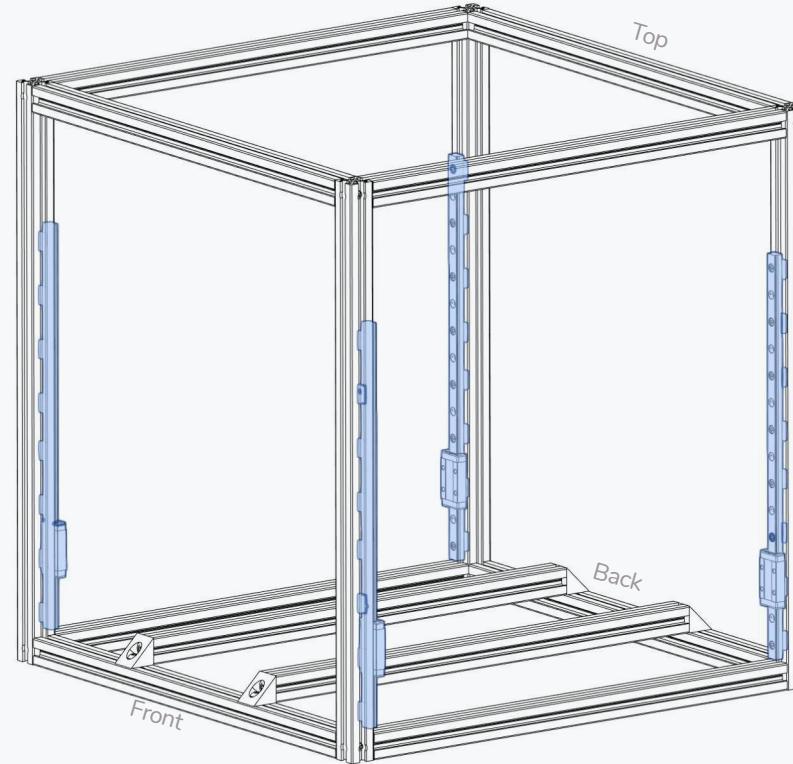
If your rails were delivered with plastic stoppers you can also temporarily reinstall them to prevent carriages from falling off their rails and spilling their bearing balls..

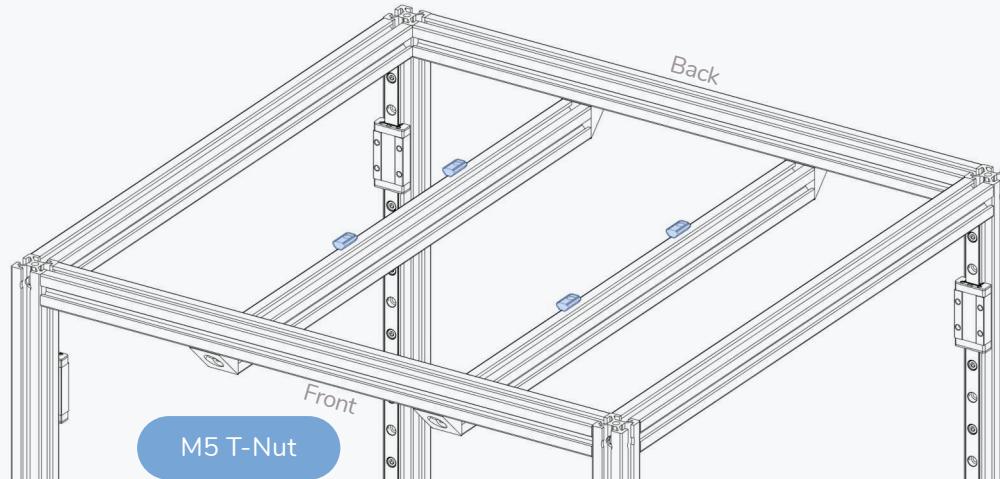
For illustration purposes only. Do not attempt to replicate.

INSTALL REMAINING Z RAILS

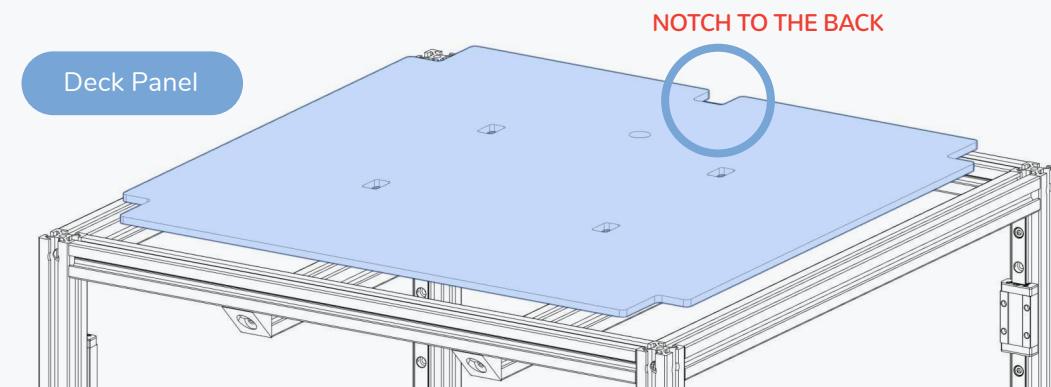
Add the remaining Z rails following the same instructions.

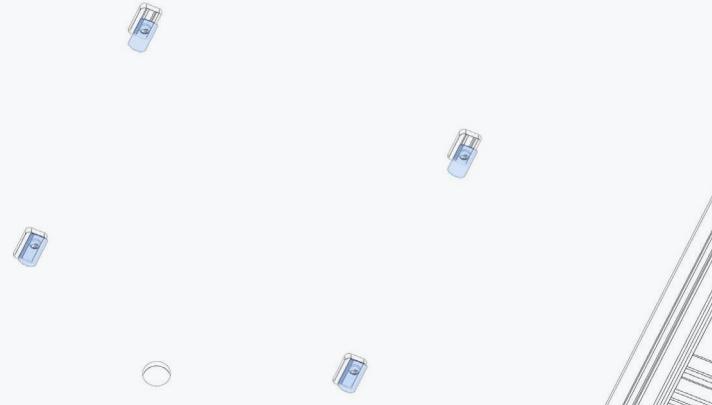
Make sure the rails face each other as shown in the graphic.



**FLIP PRINTER UPSIDE DOWN**

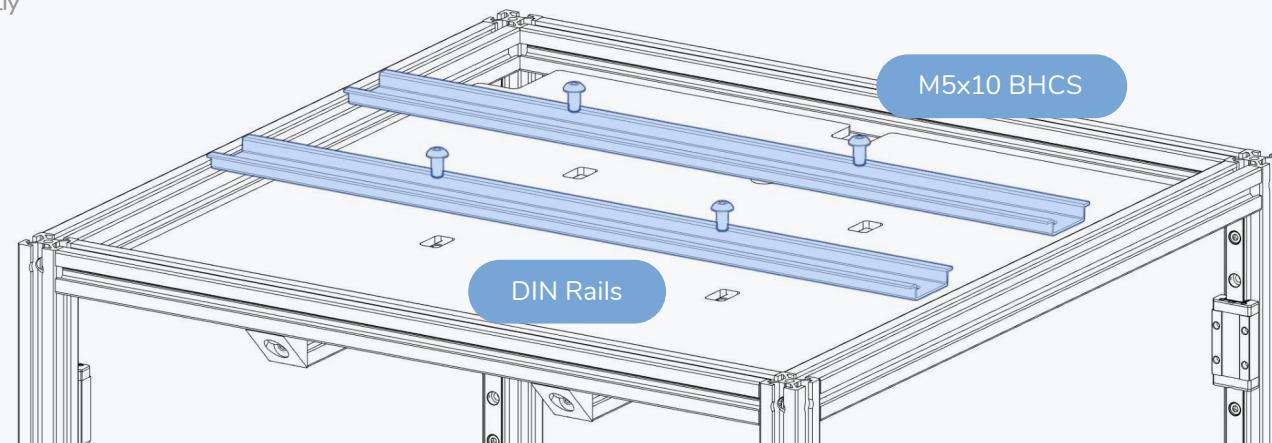
It's easier working with gravity than against it. But make sure the rail carriages are secure before doing so.





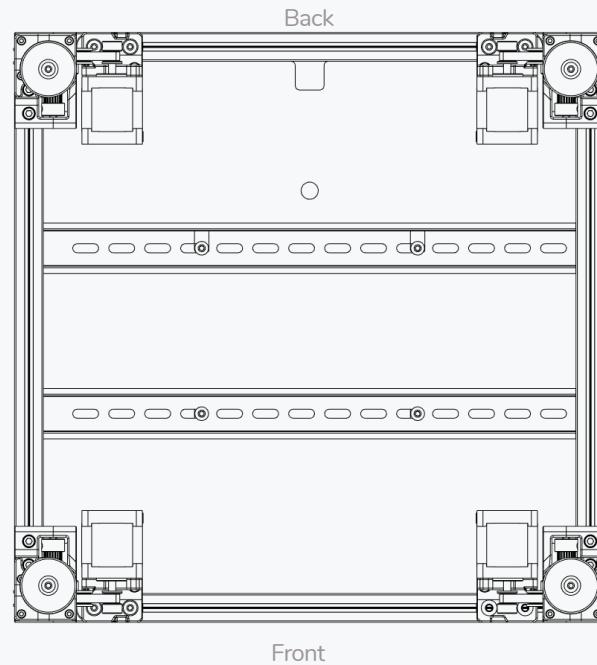
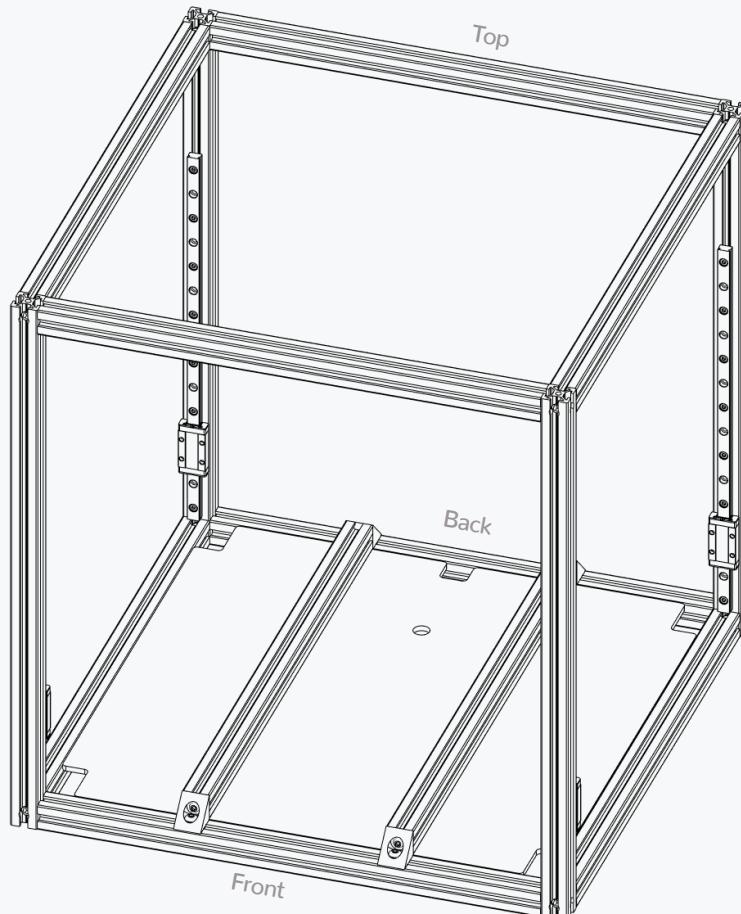
ALIGN T-NUTS WITH HOLES

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



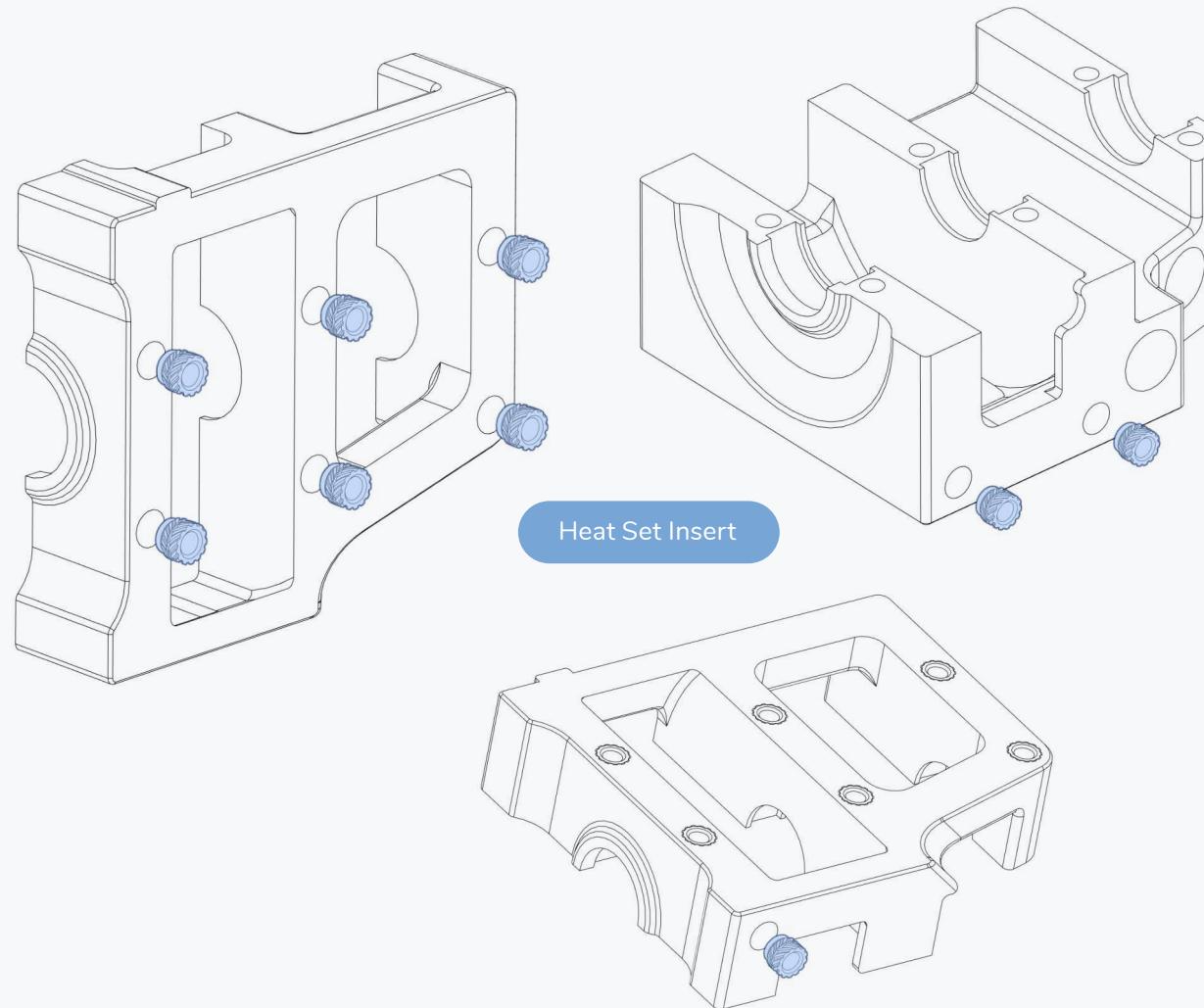
DIN RAIL SLOTS

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.



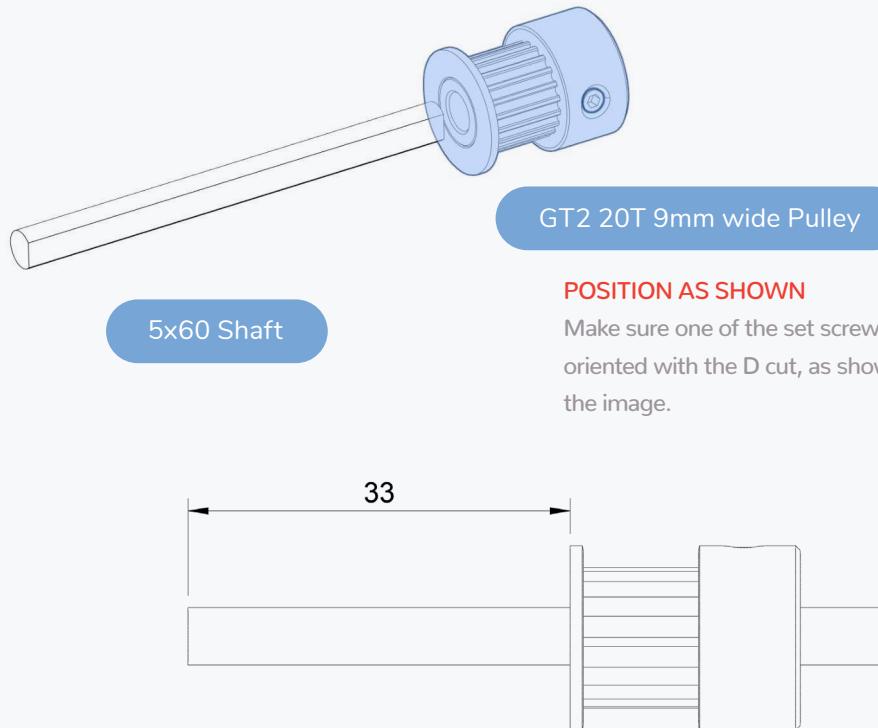
HEAT SET INSERTS

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.



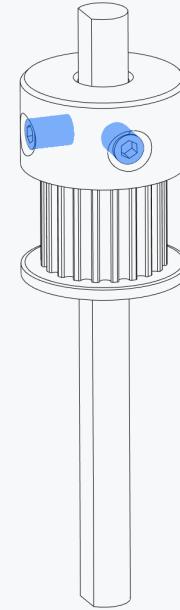
<https://voron.link/m5ybt4d>



GT2 20T 9mm wide Pulley

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.

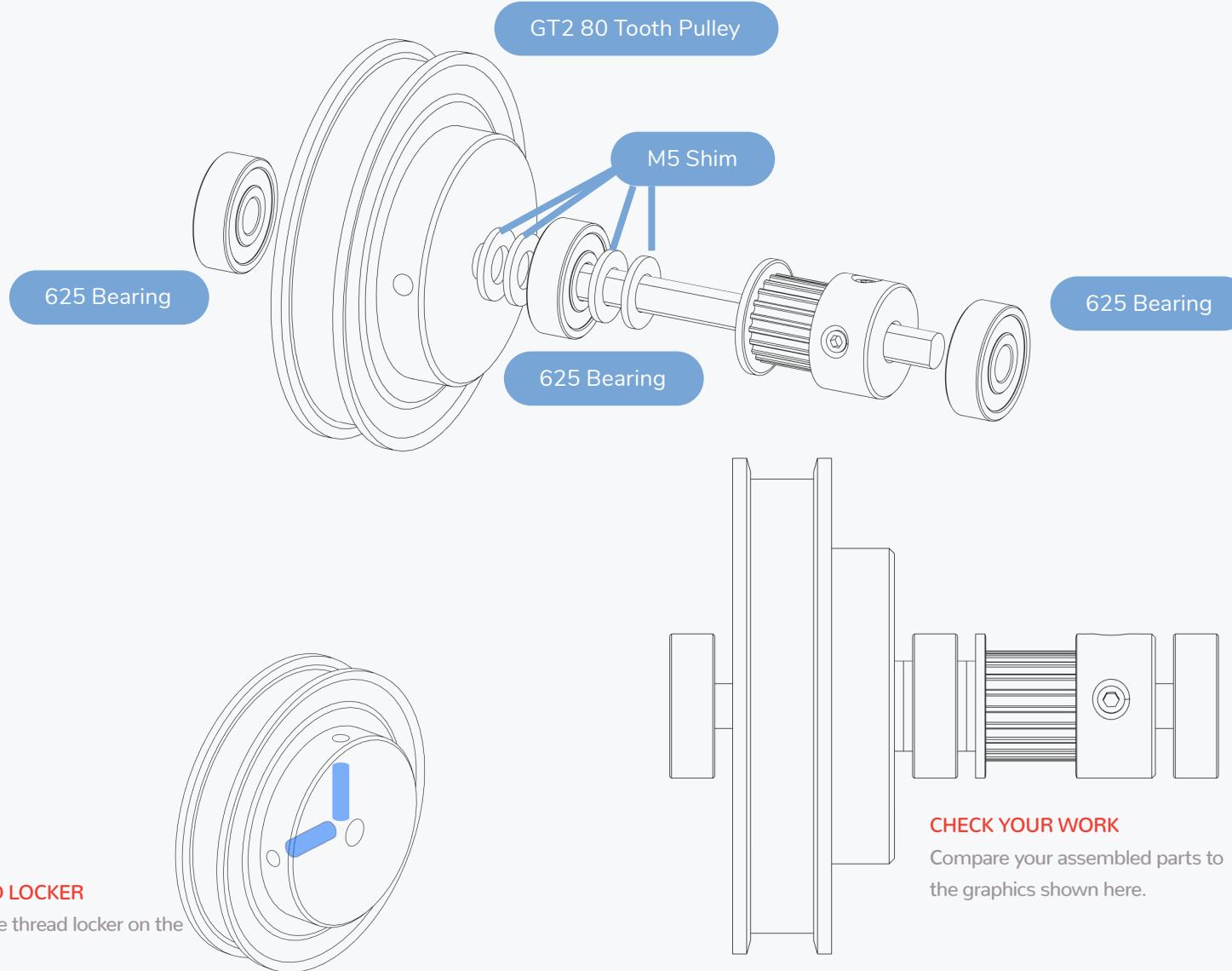
Use a high quality hex driver to prevent the hex profile from stripping. Ball-end drivers are not recommended.

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.

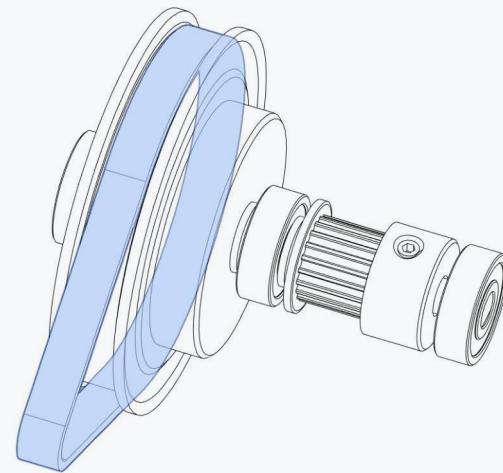
BELT DRIVE ASSEMBLY

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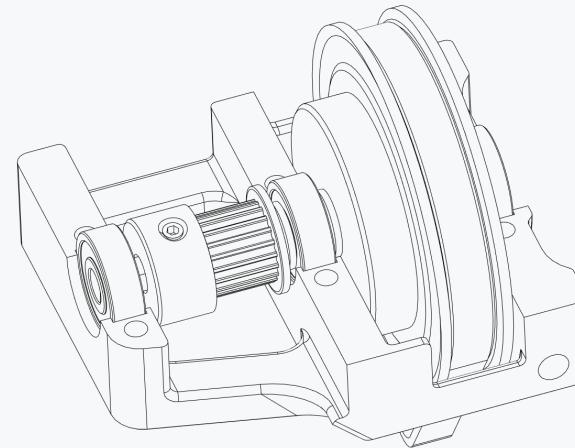
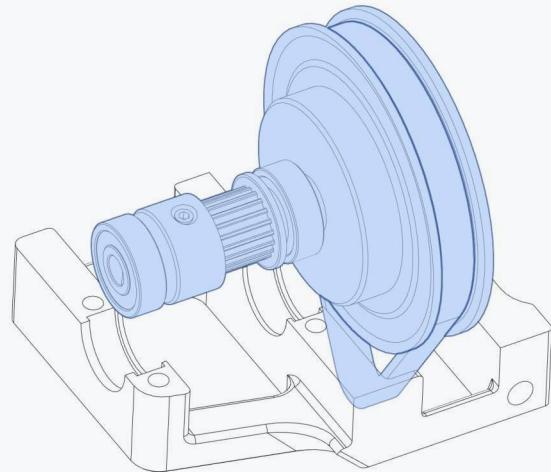


Z DRIVE

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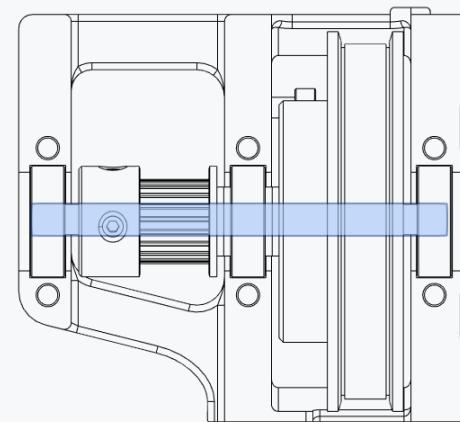


GT2 188mm Belt Loop



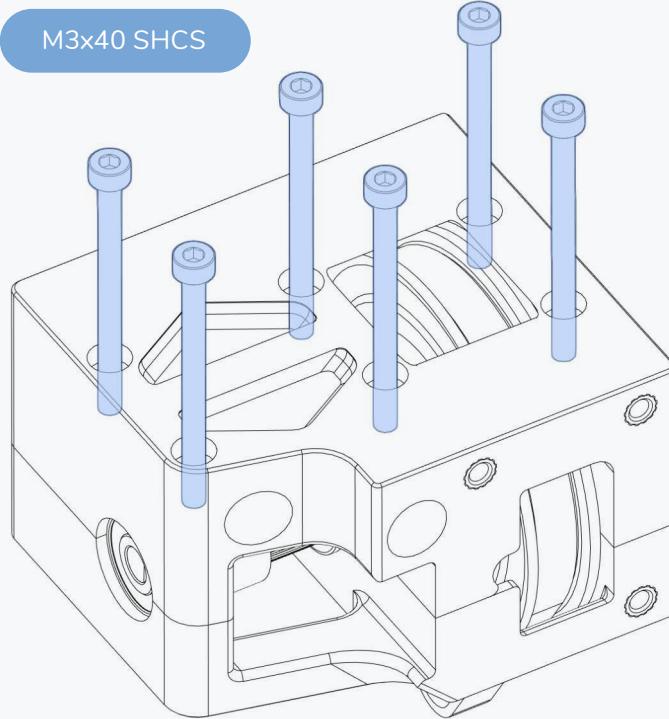
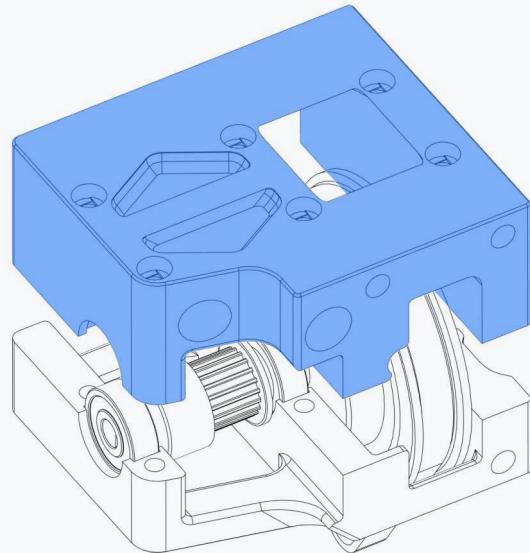
CHECK SHAFT POSITION

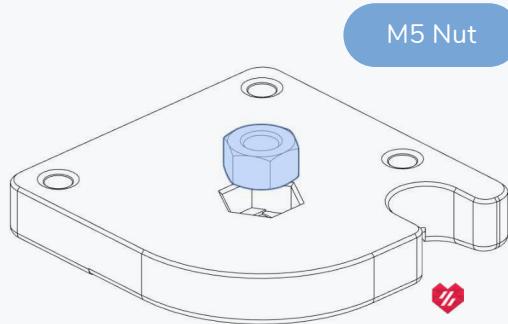
Compare your assembled parts to
the graphics shown here.



Z DRIVE

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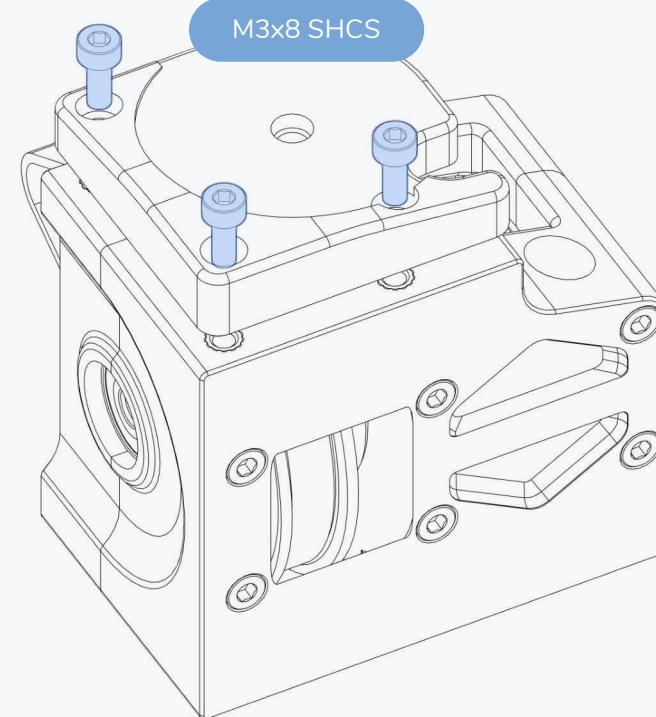




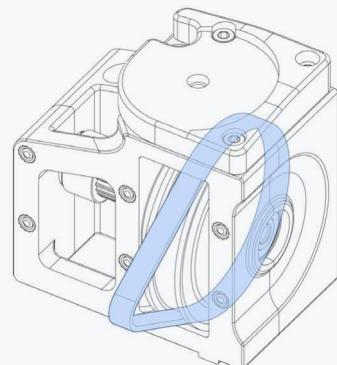
M5 Nut

ACCENT PART?

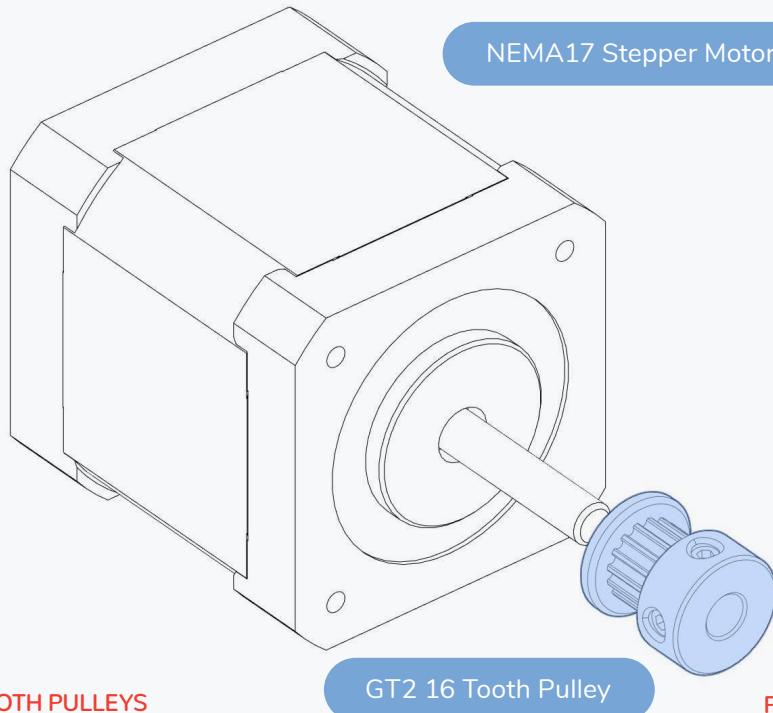
Look for Voron heart next to the part.
It indicates that this is an accent part.



M3x8 SHCS

**CHECK FOR BELT**

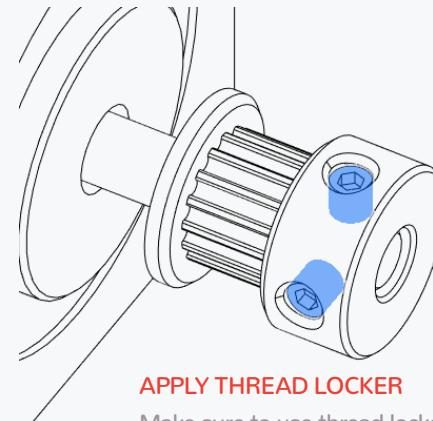
Make sure the closed belt loop is in
the part.



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.

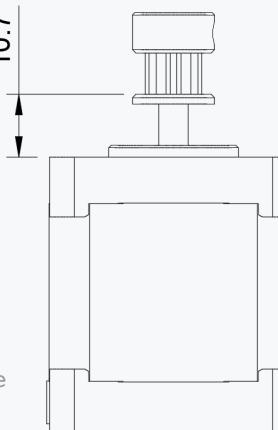


APPLY THREAD LOCKER

Make sure to use thread locker on the set screws.

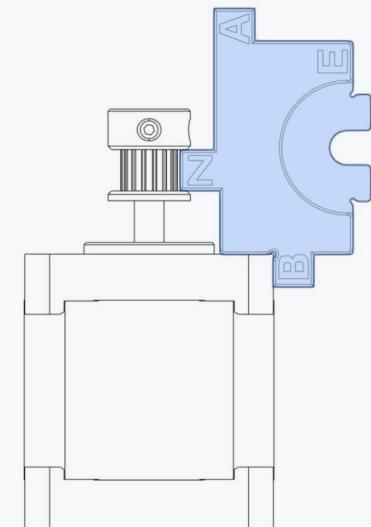


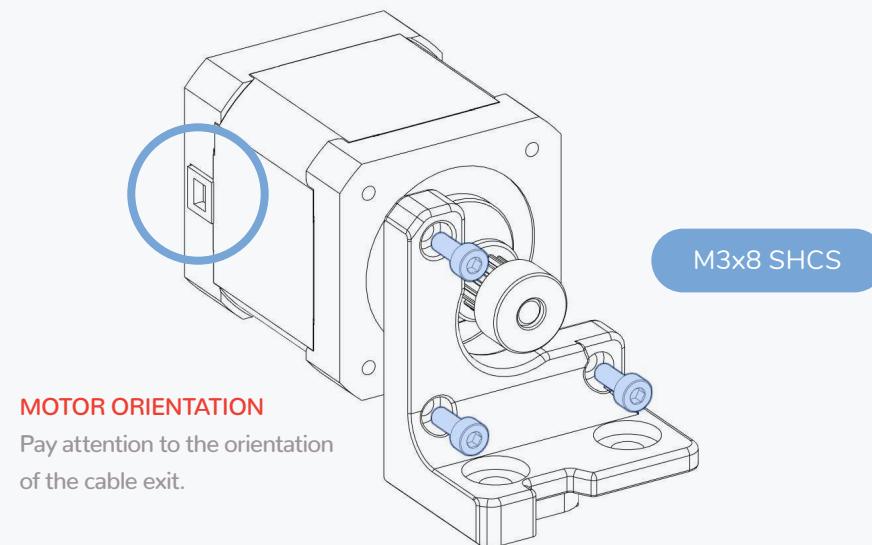
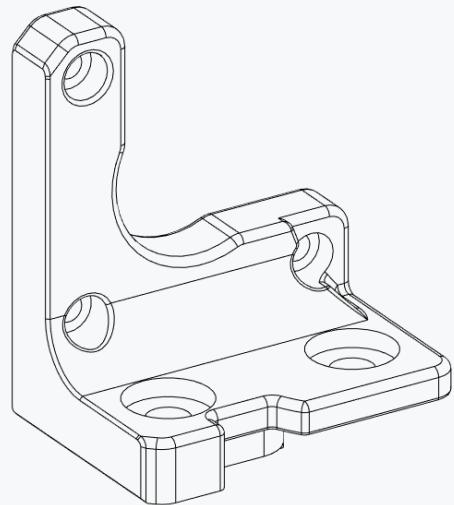
<https://voron.link/fx10m8e>



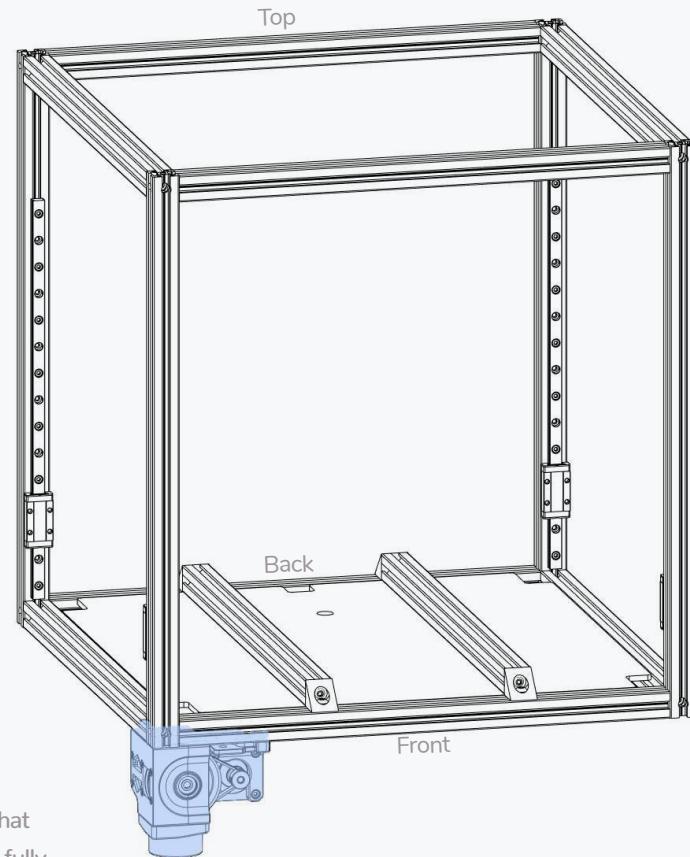
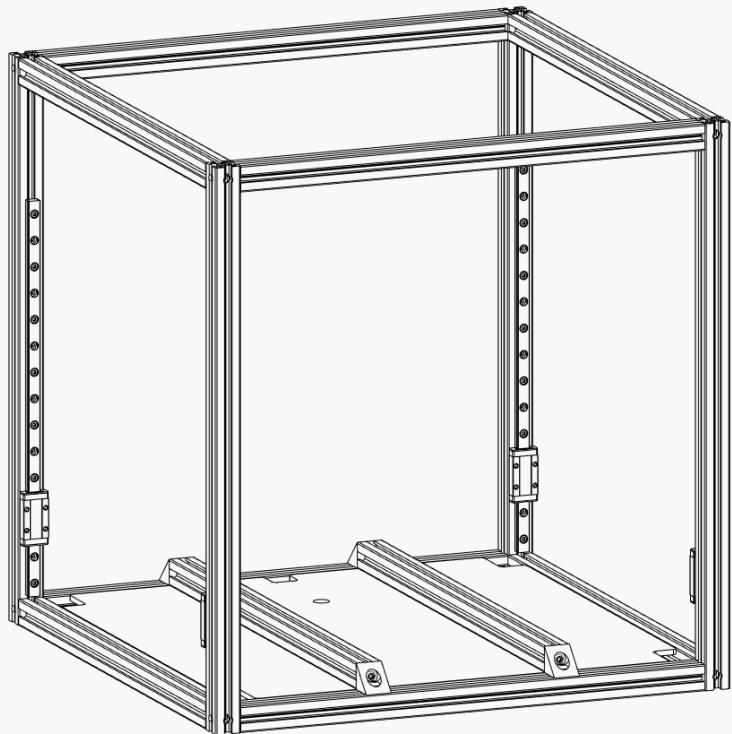
PULLEY POSITION

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.

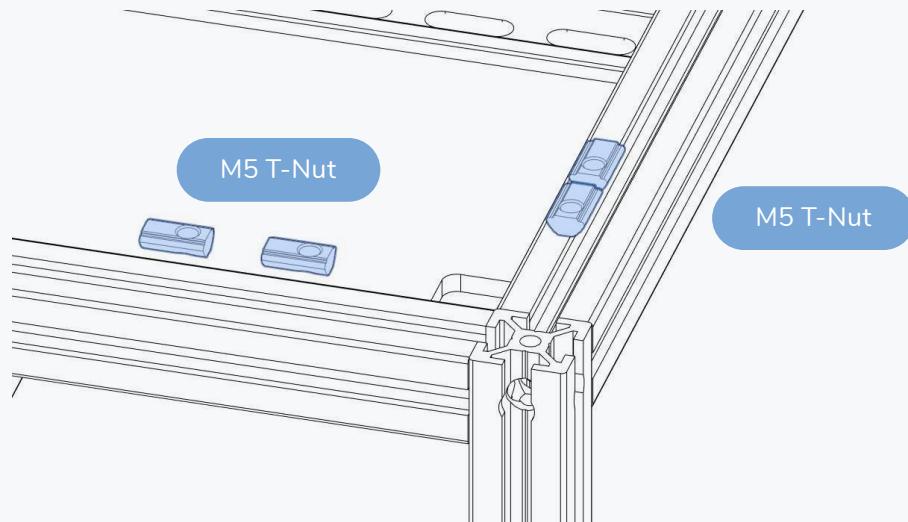


**MOTOR ORIENTATION**

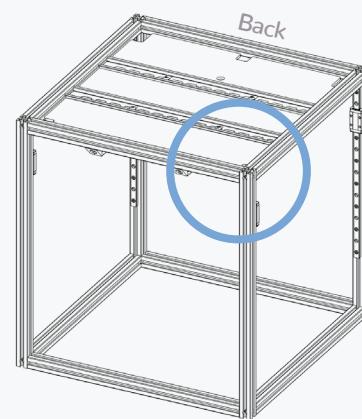
Pay attention to the orientation
of the cable exit.

**PICTURE FOR ORIENTATION**

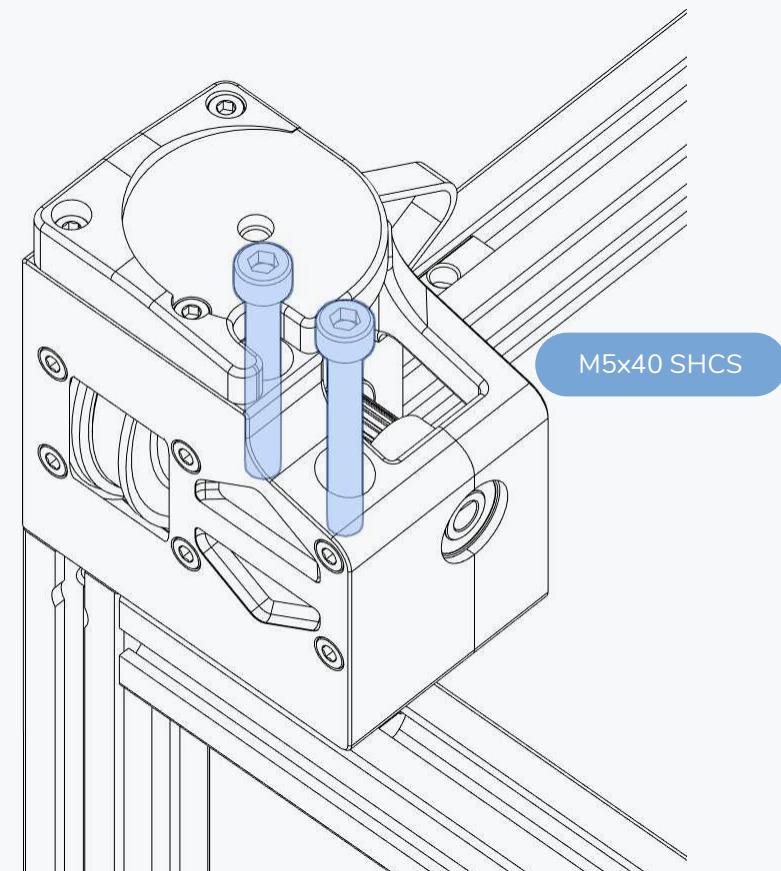
The Z0 drive is the first Z drive that will be added to the printer. The fully assembled Z Drive is highlighted in blue.

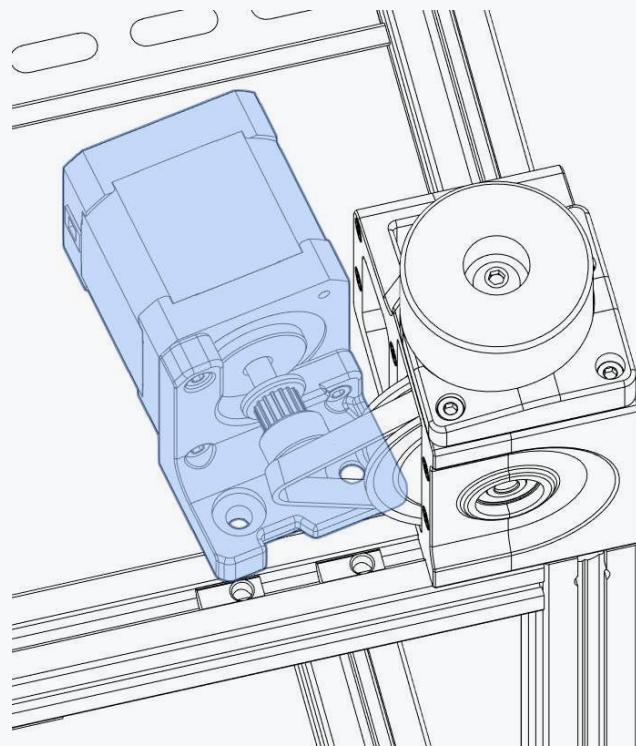
**WHICH CORNER IS THIS?**

We highlighted the corner with a circle.

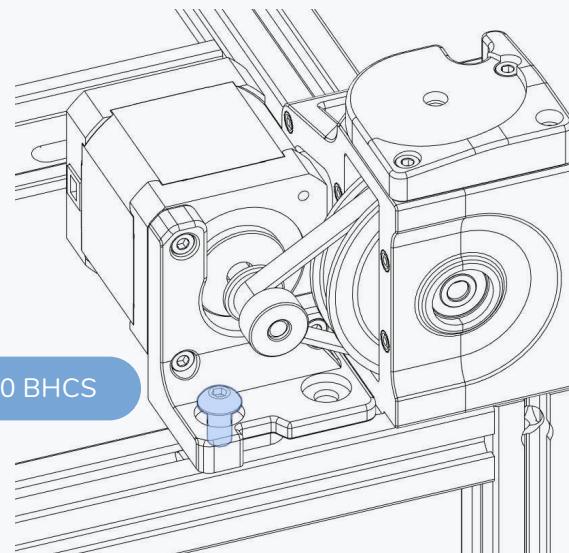
**UPSIDE DOWN ASSEMBLY**

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

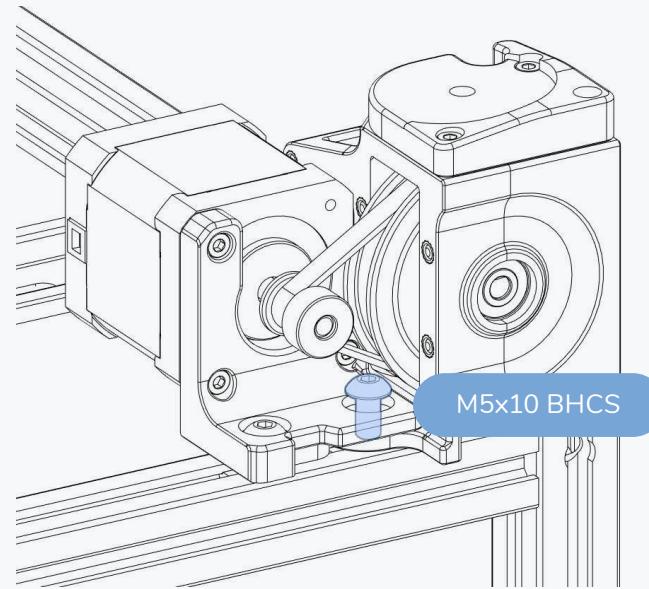
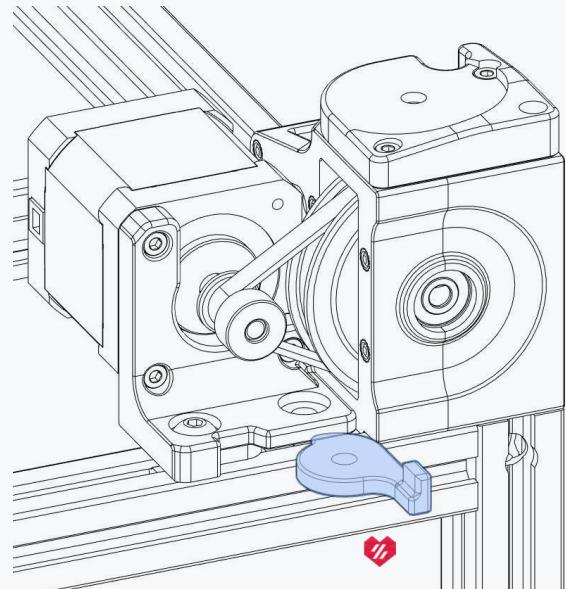


**SLIDE INTO PLACE**

Insert at an angle and slide into place.

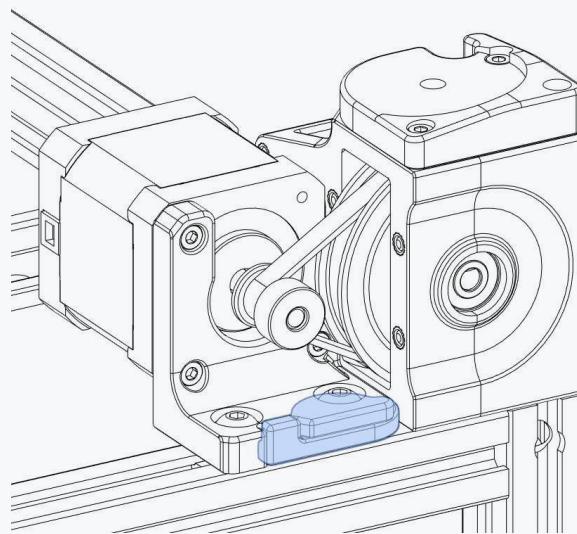
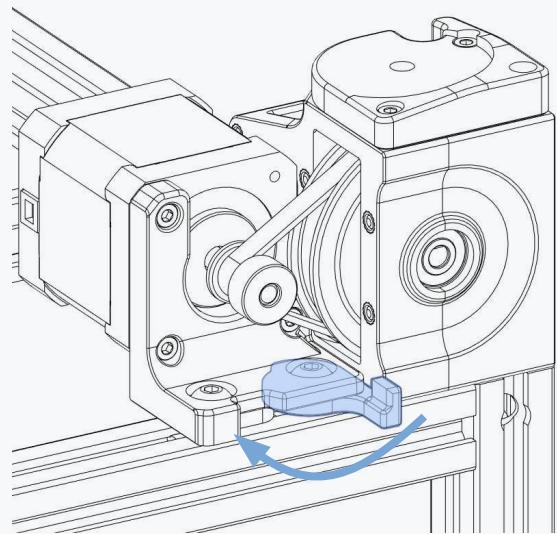
**DON'T TIGHTEN**

Leave the bolt loose for the next step.



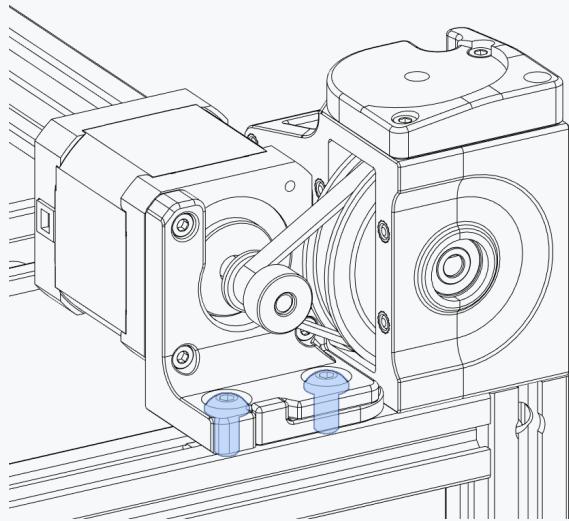
DON'T TIGHTEN

Leave the bolt loose for the next step.

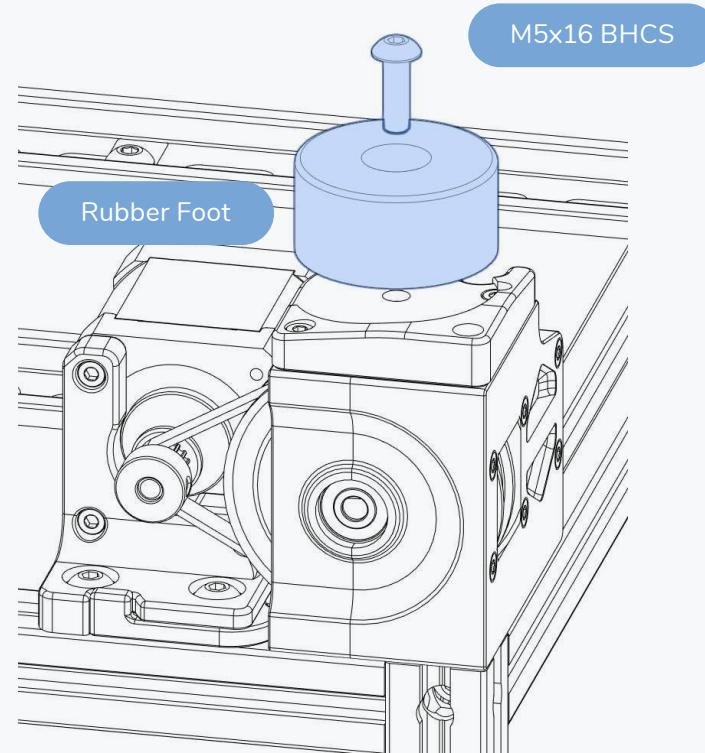


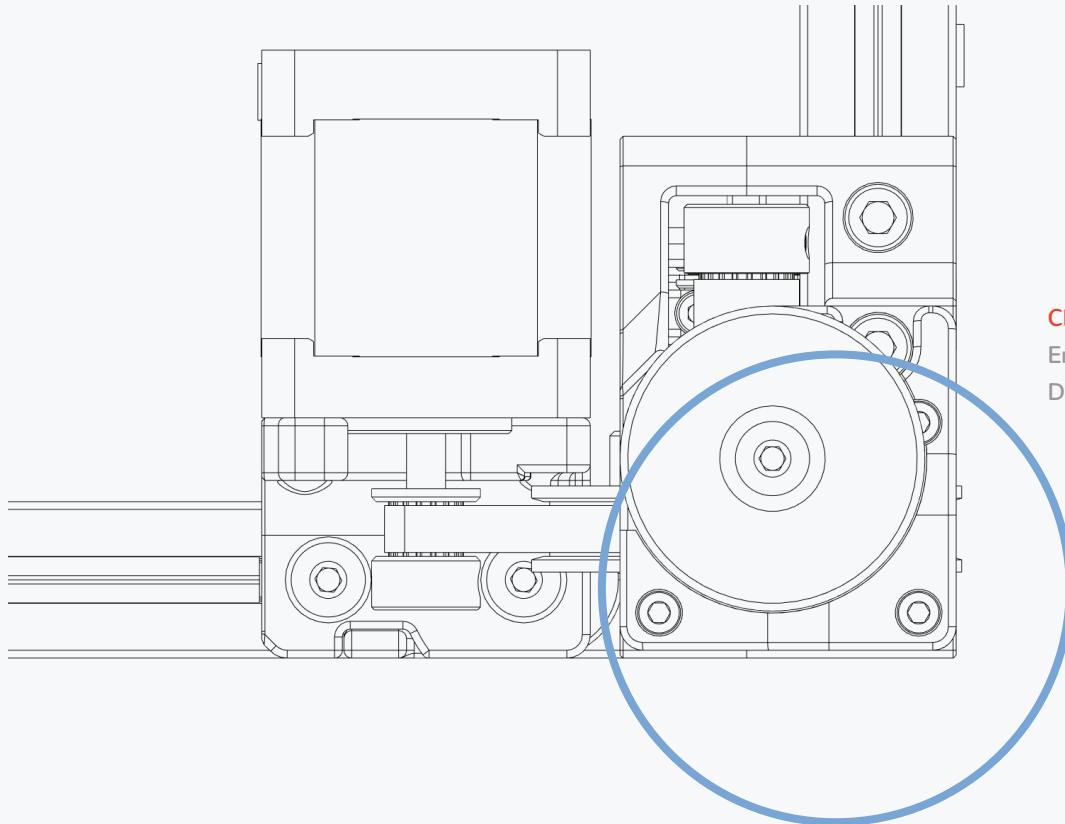
CLOSE THE BELT TENSIONER

Flip the belt tensioner latch closed.

**TIGHTEN BOLTS**

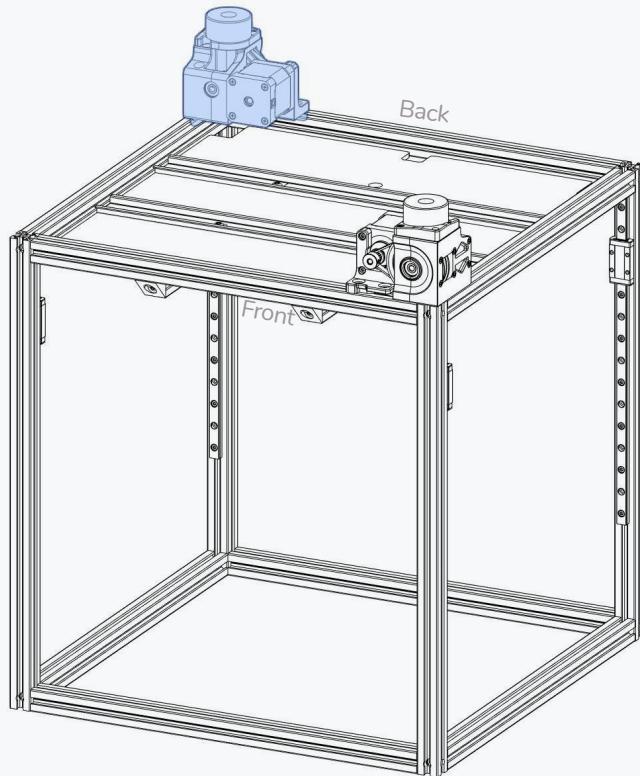
After closing the tensioner the M5 bolts can be properly fastened.





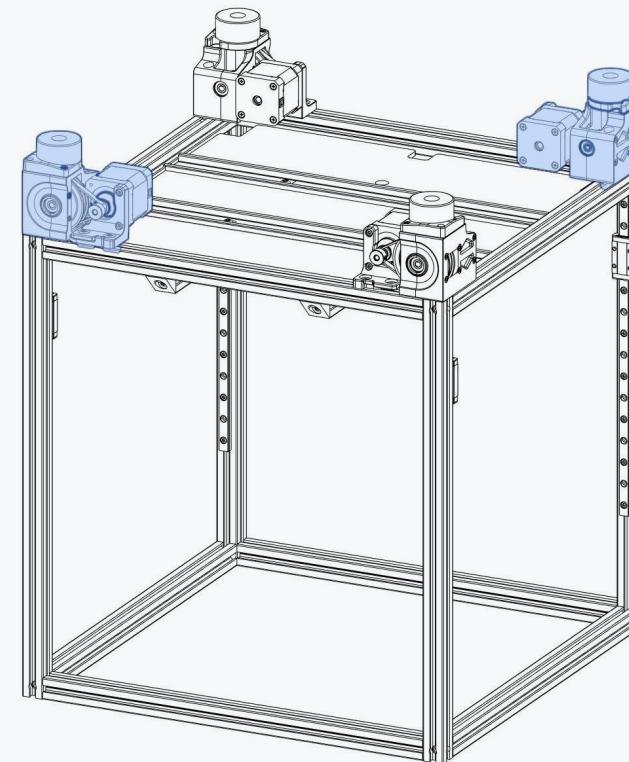
CHECK POSITION

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



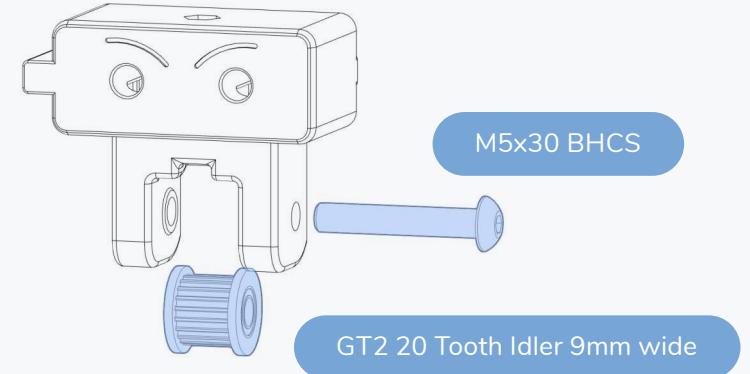
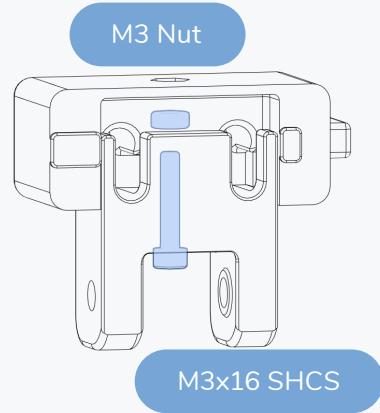
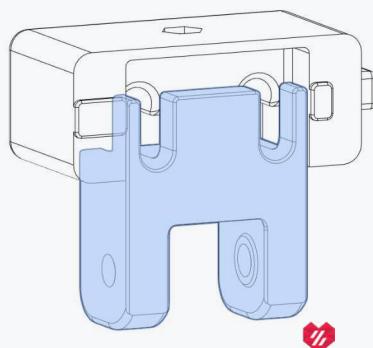
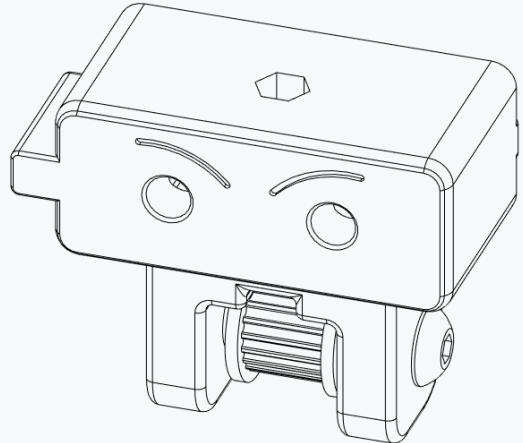
REPEAT INSTRUCTIONS FOR OPPOSING CORNER

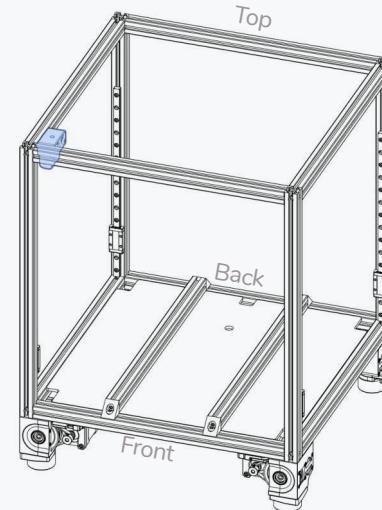
Build another Z drive, following the same instructions.



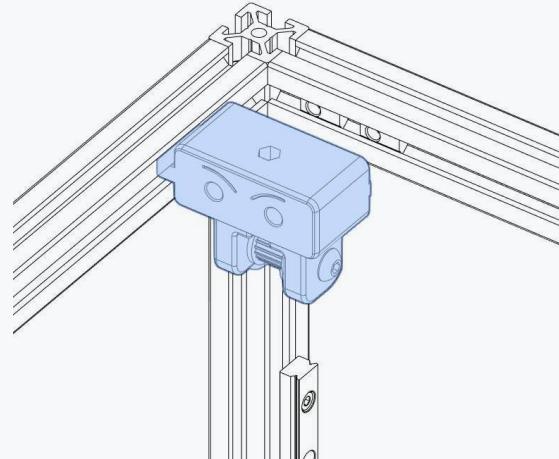
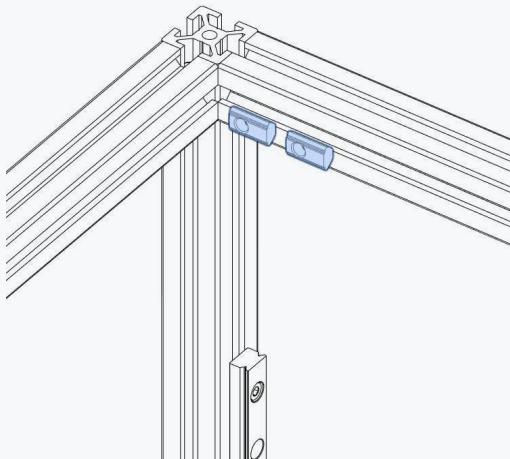
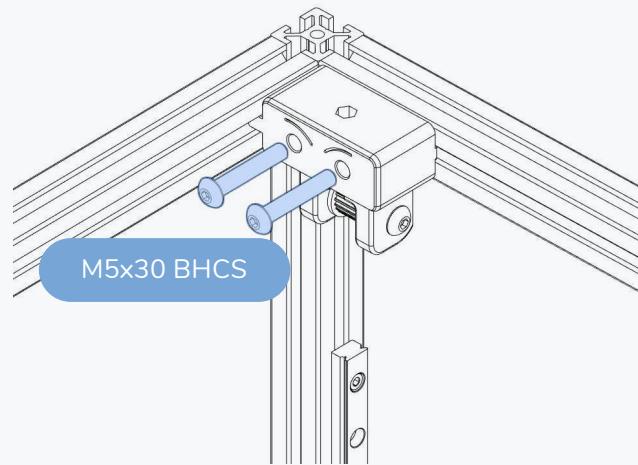
REPEAT INSTRUCTIONS FOR THE MIRRORED DRIVES

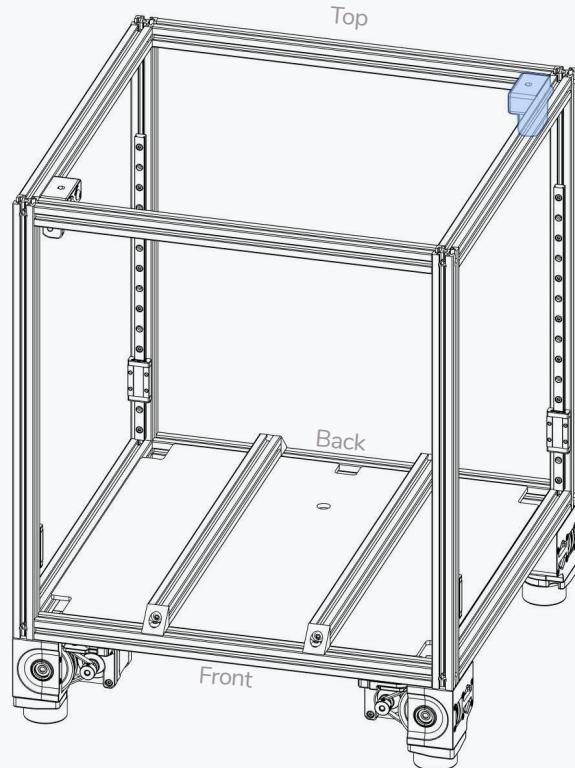
Build two more Z drives following the instructions that came before. The printed parts are mirrored.



**IDLER ORIENTATION**

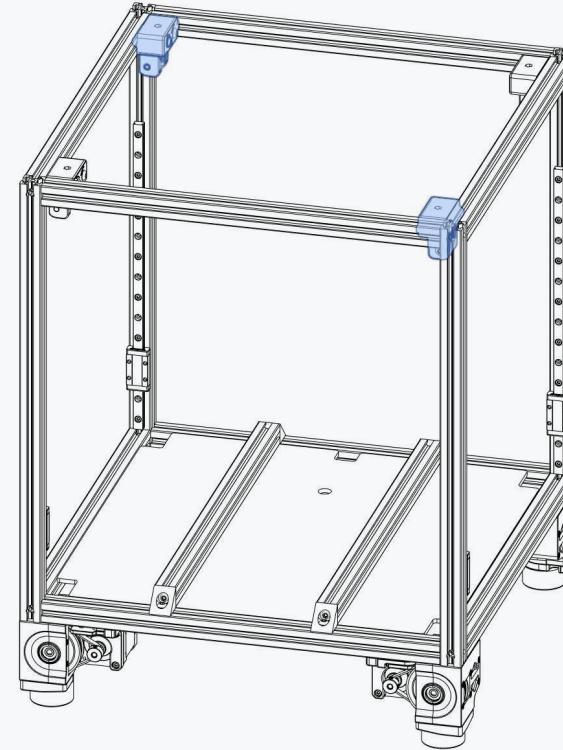
Mind the idler orientation. The idler must face in the same orientation as the pulley in the drive below it.

M5 T-Nut**M5x30 BHCS**



REPEAT INSTRUCTIONS FOR OPPOSING CORNER

Build another Z idler following the same instructions.



REPEAT INSTRUCTIONS FOR THE MIRRORED DRIVES

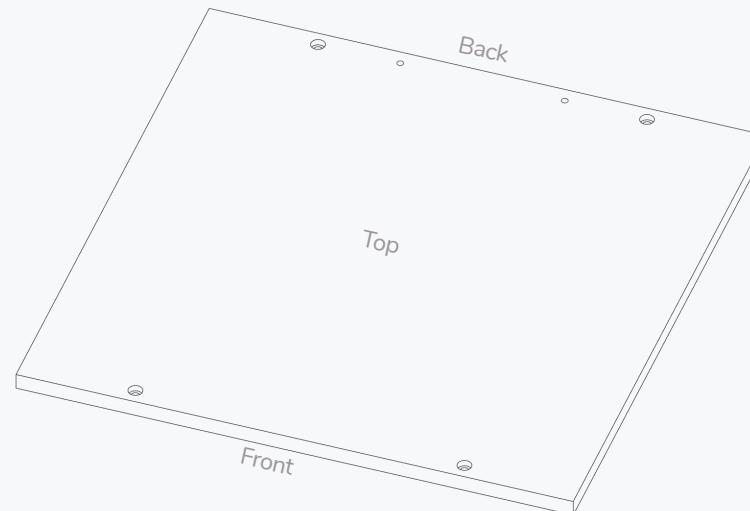
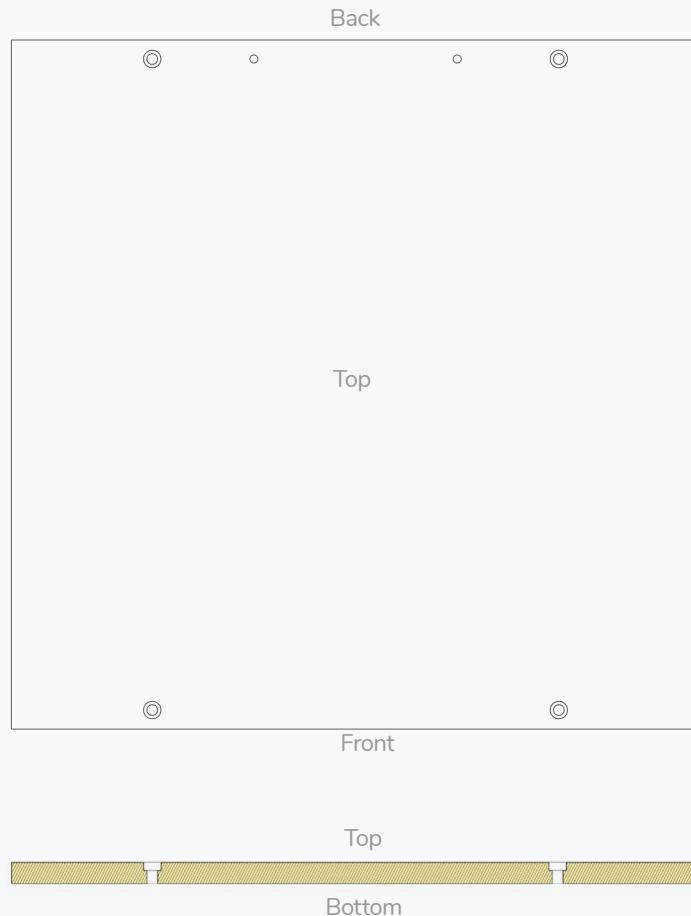
Build two more Z idlers following the instructions that came before. The printed parts are mirrored.

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

PRINT BED

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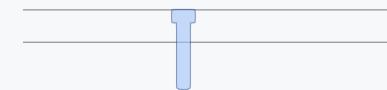


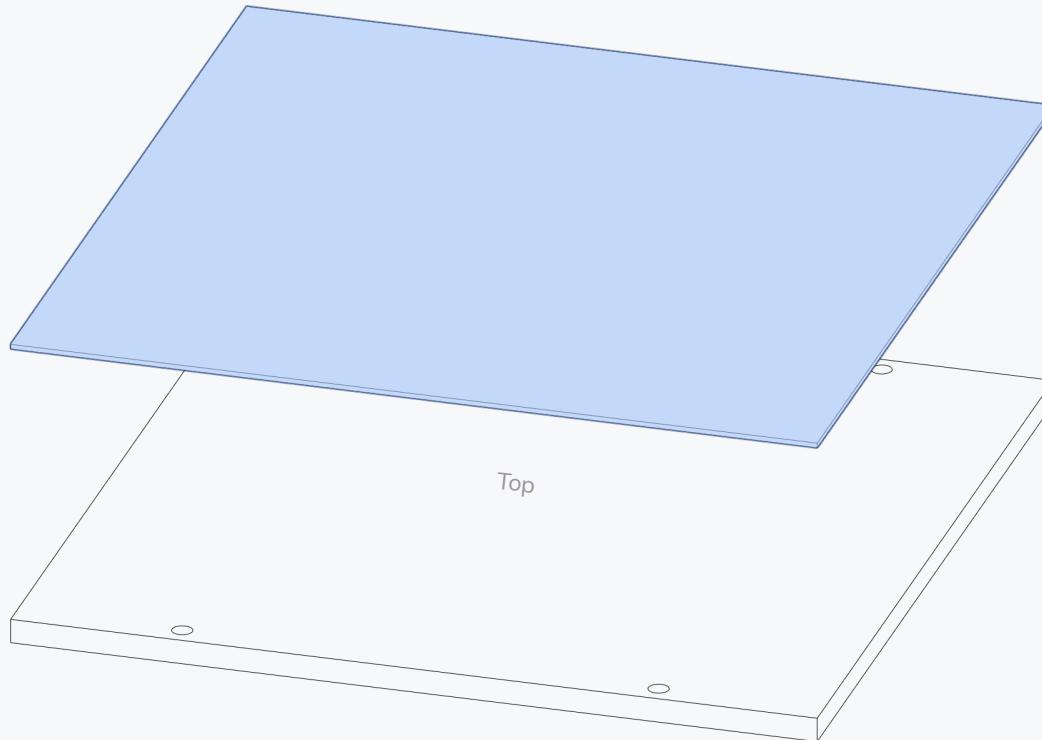


WHICH SIDE IS WHICH?

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**

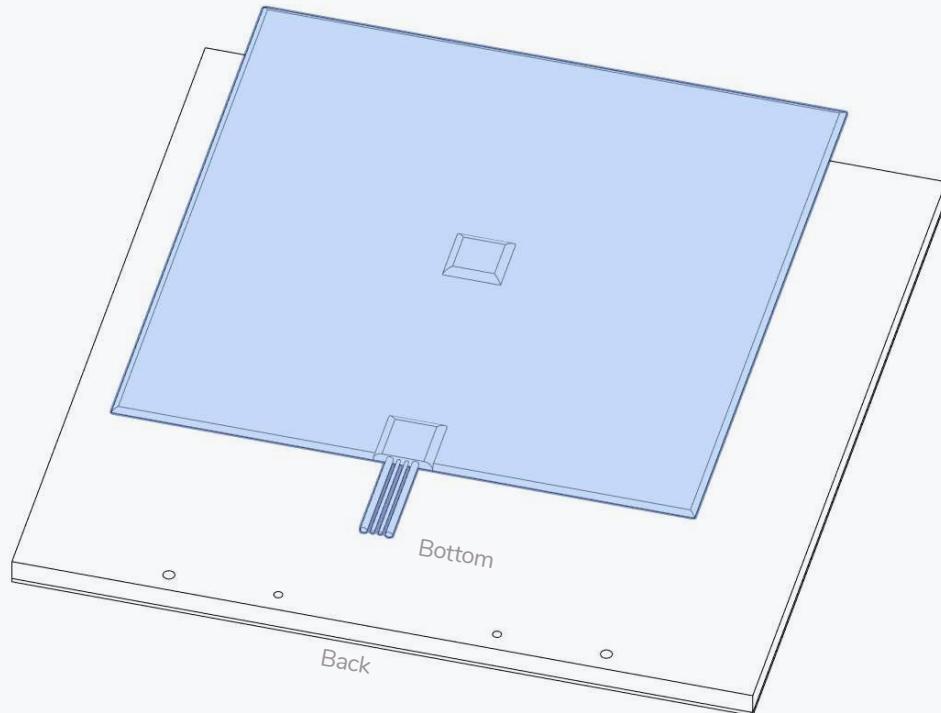
Clean the plate with isopropyl alcohol or similar cleaner prior to applying the magnet.

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.



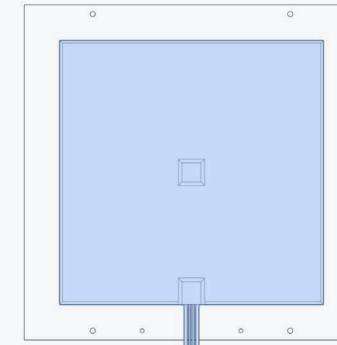
<https://voron.link/rm6tpIld>

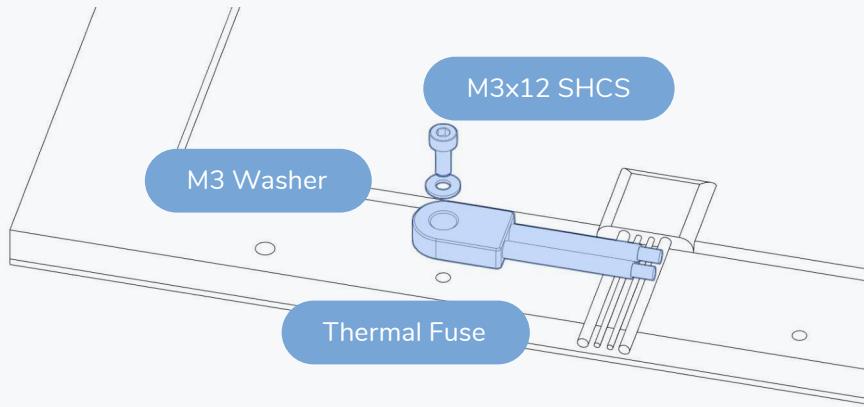


HEATER APPLICATION

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.



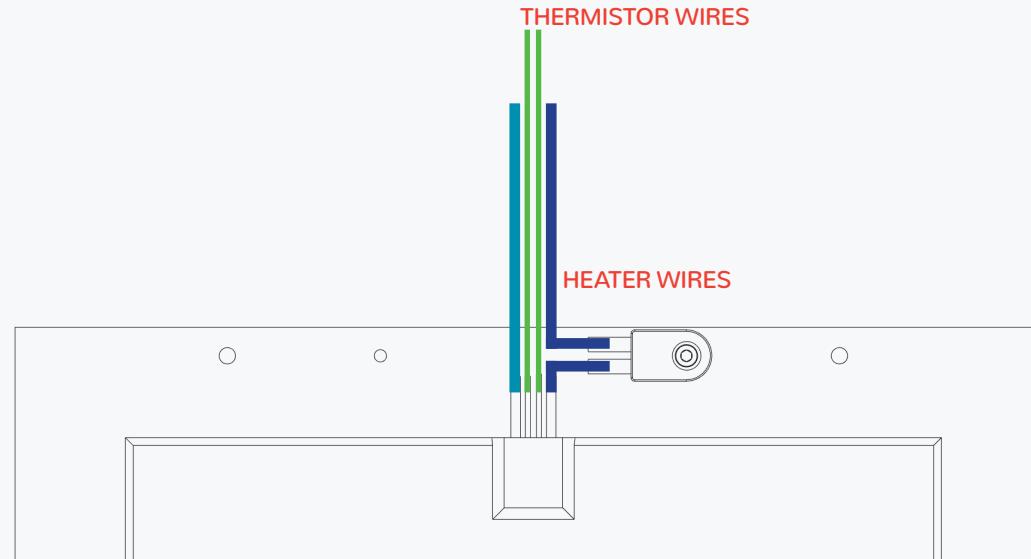


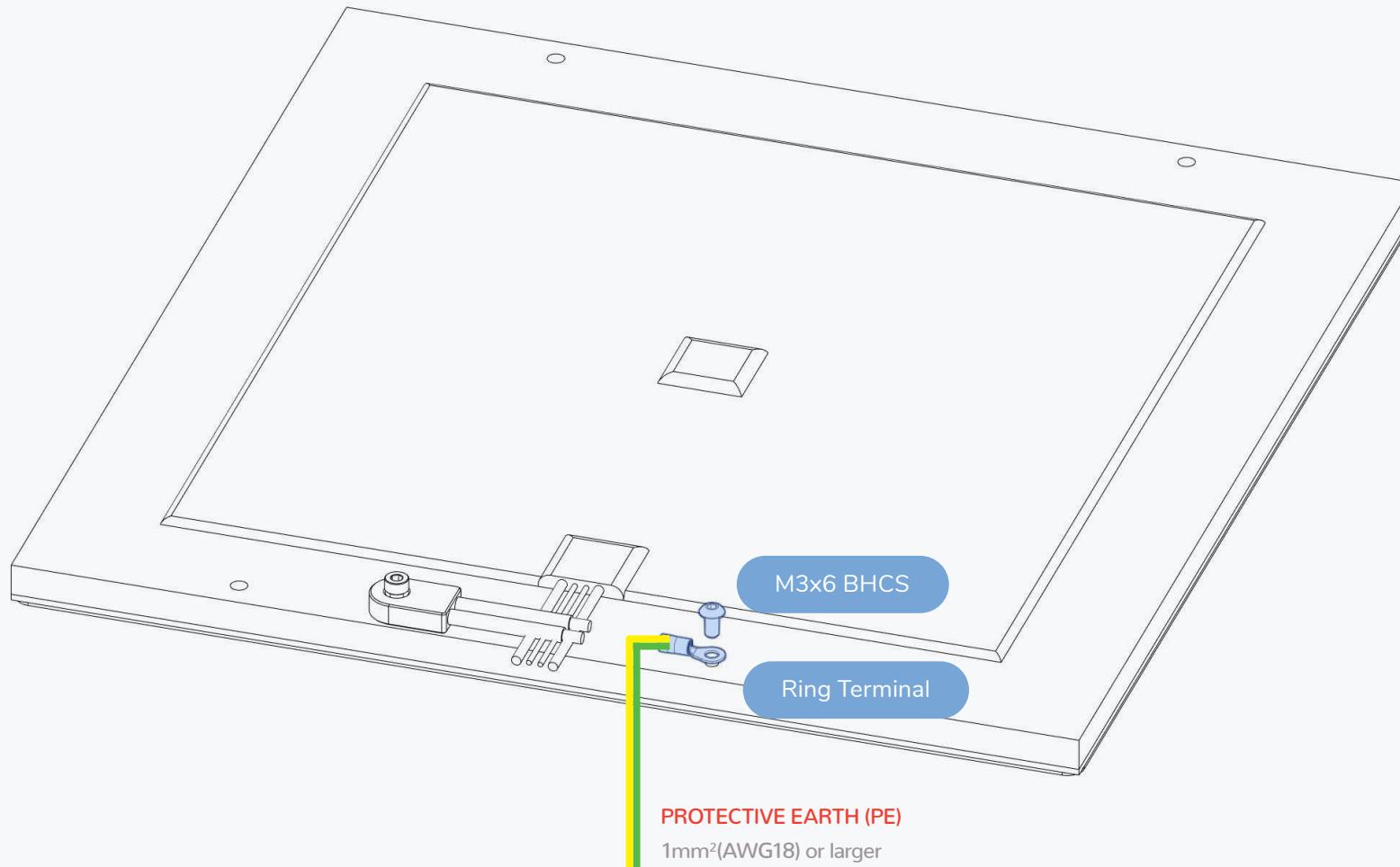
THERMAL FUSE

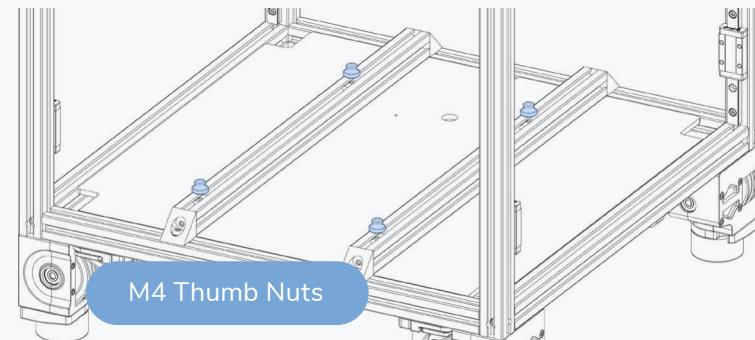
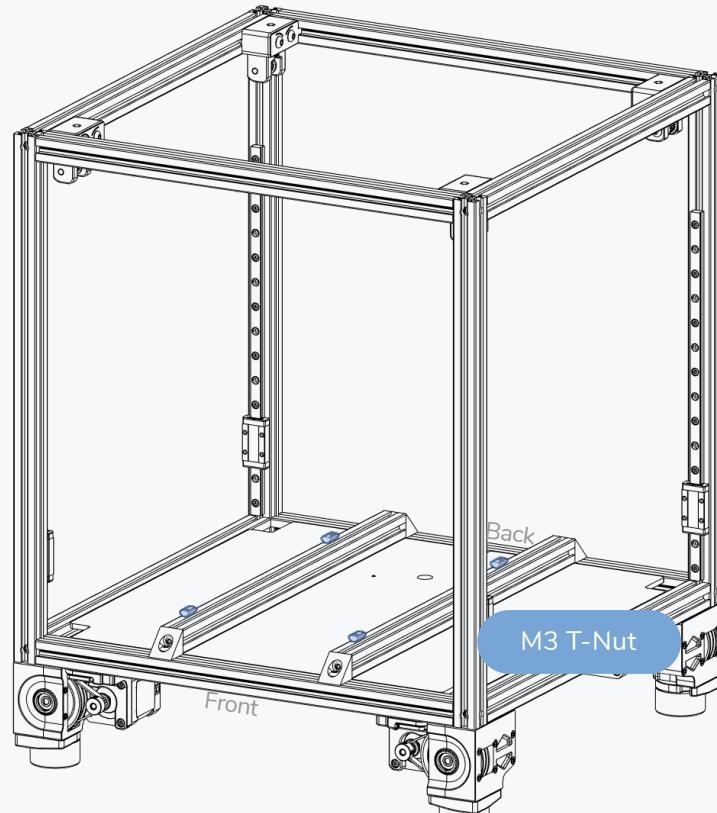
While not required to operate the printer, a thermal fuse attached to the build plate adds an additional layer of protection against potentially dangerous malfunctions.

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.

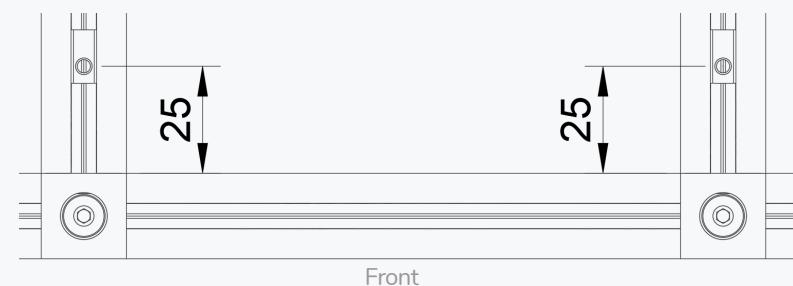


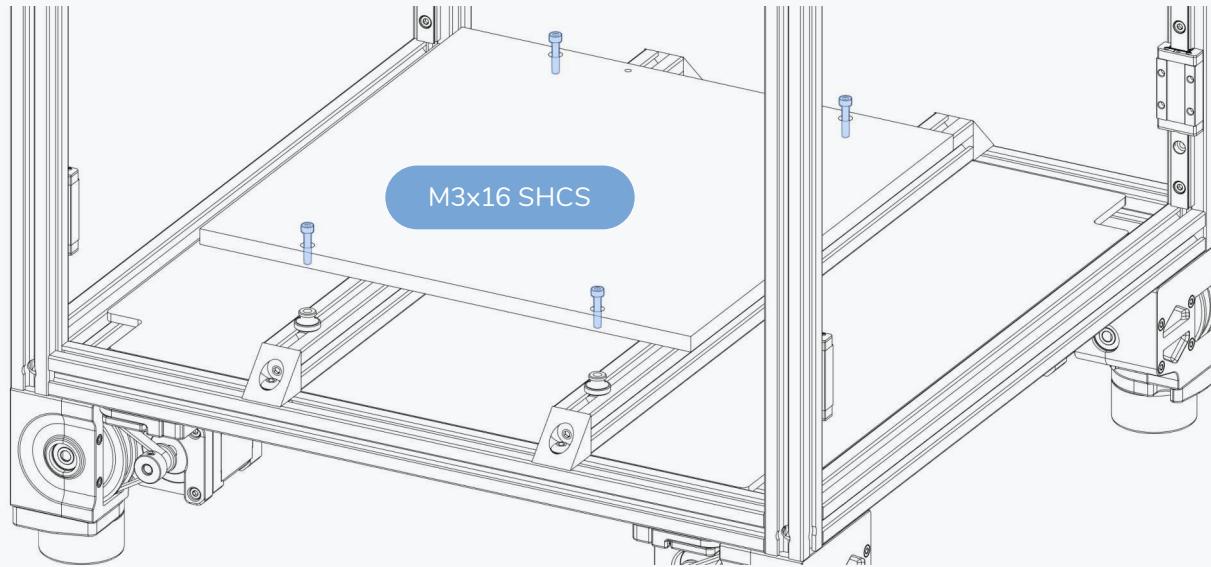




M4 NUT FOR A M3 BOLT?

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





M3x16 SHCS

BED AND SPACER THICKNESS

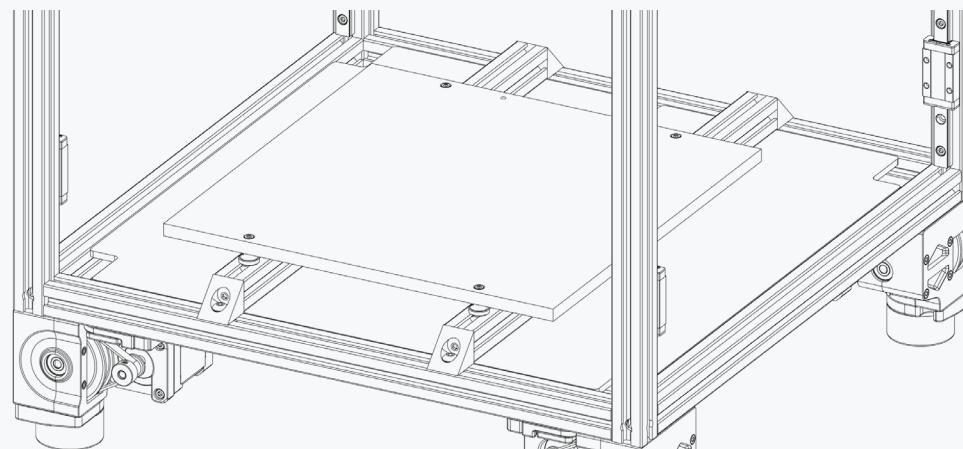
Depending on the combination of bed and spacer thickness you may need to use longer bolts to secure the bed.

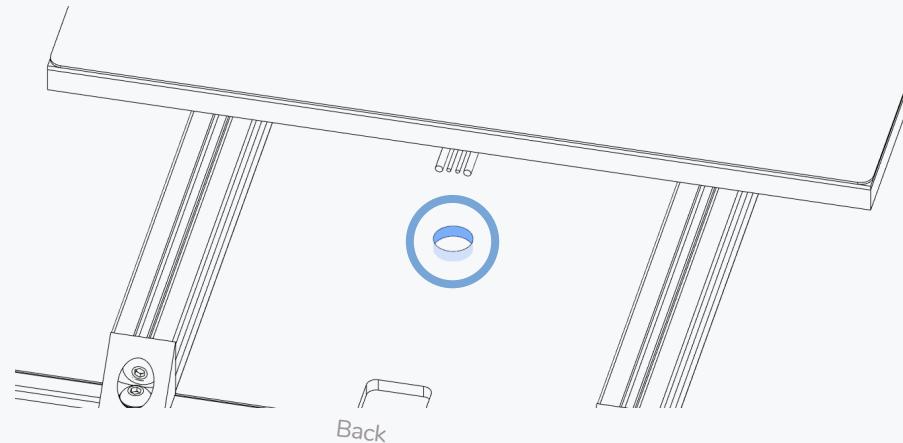
DON'T TIGHTEN

Only tighten one bolt fully.

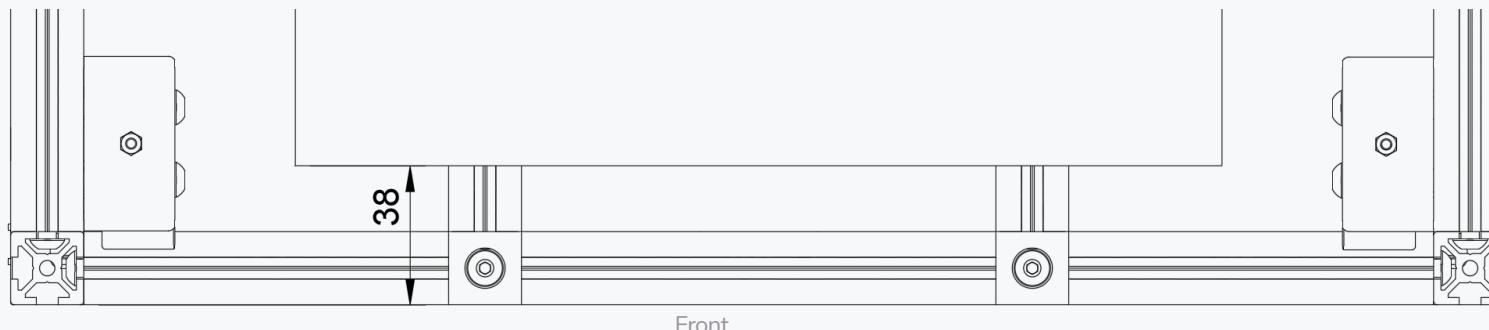
Leave the remaining bolts slightly loose.

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.

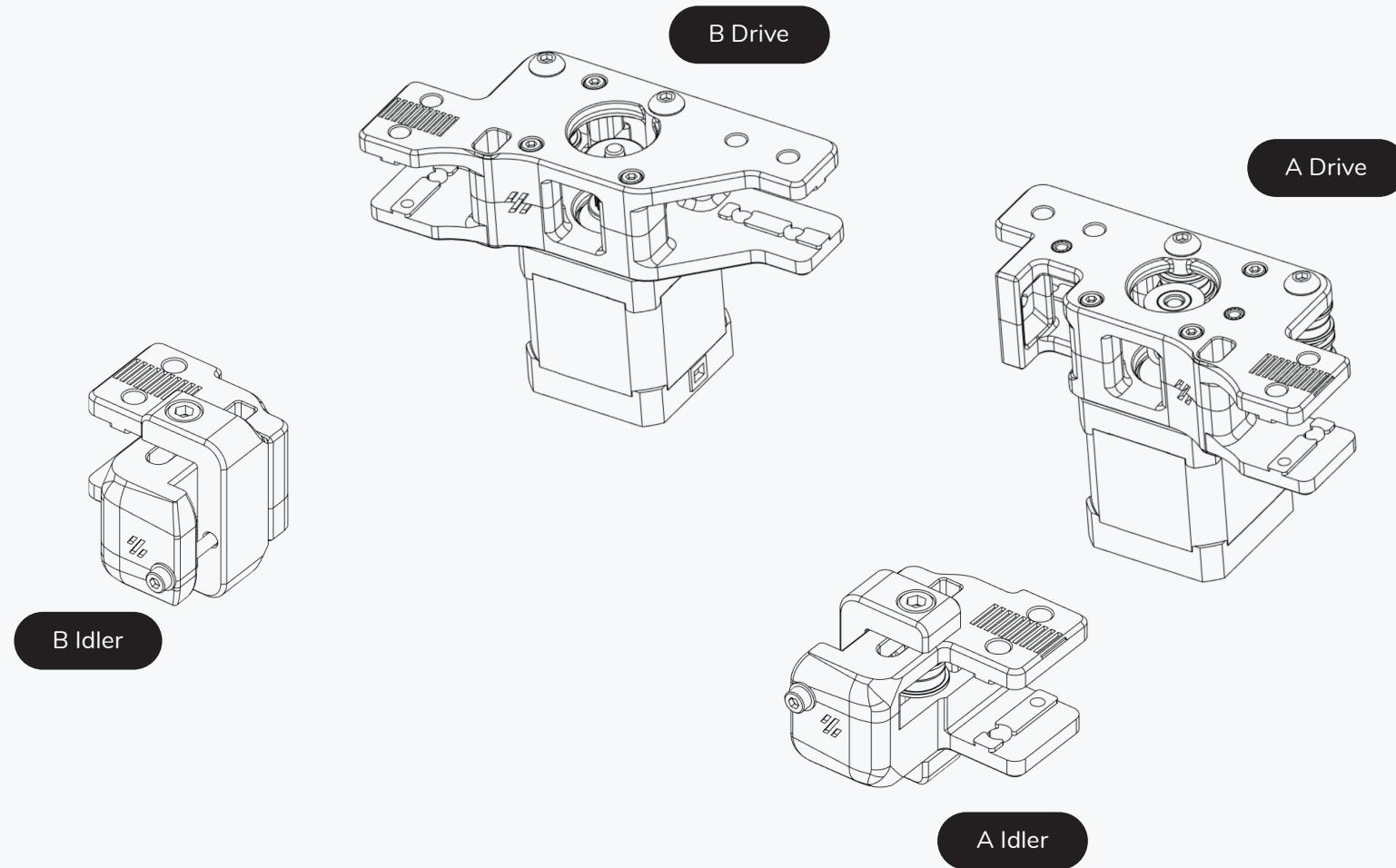
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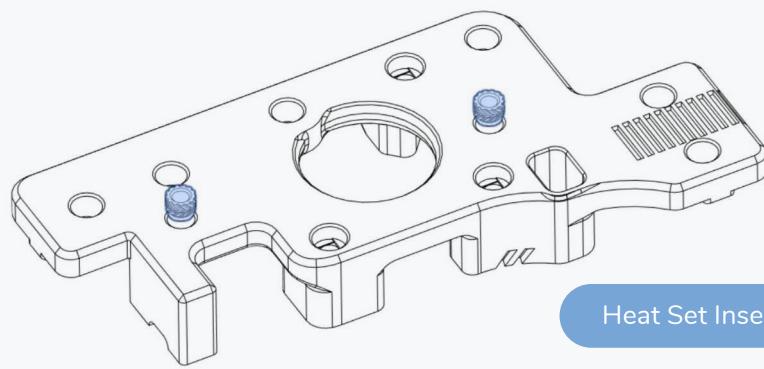
The Voron Legacy is a modernized design true to the spirit of the original Voron 1.0.

A/B DRIVES AND IDLERS

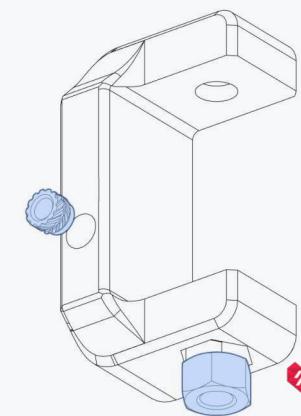
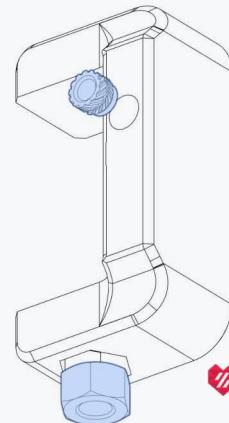
WWW.VORONDESIGN.COM



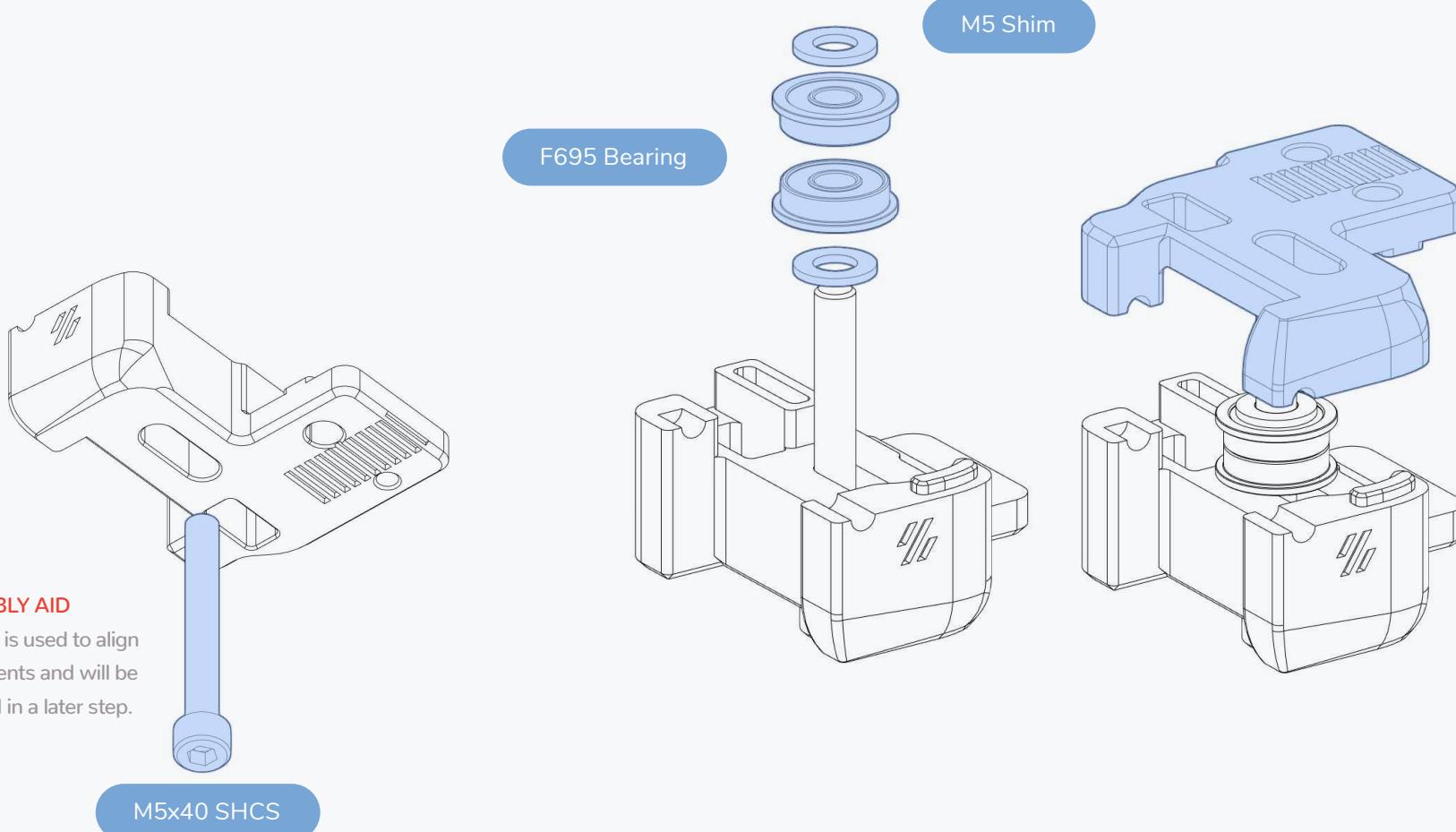


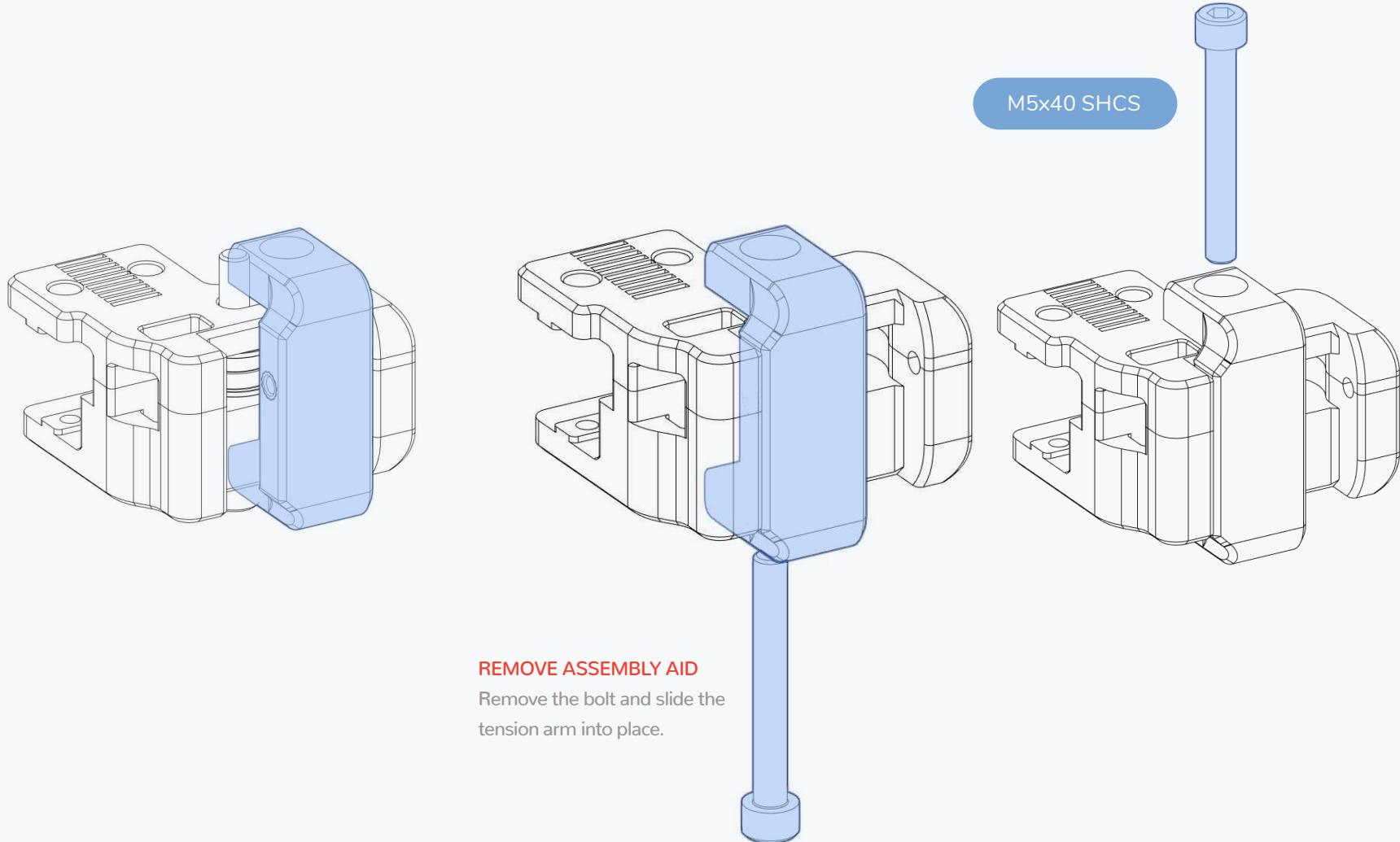


Heat Set Insert



M5 Nut

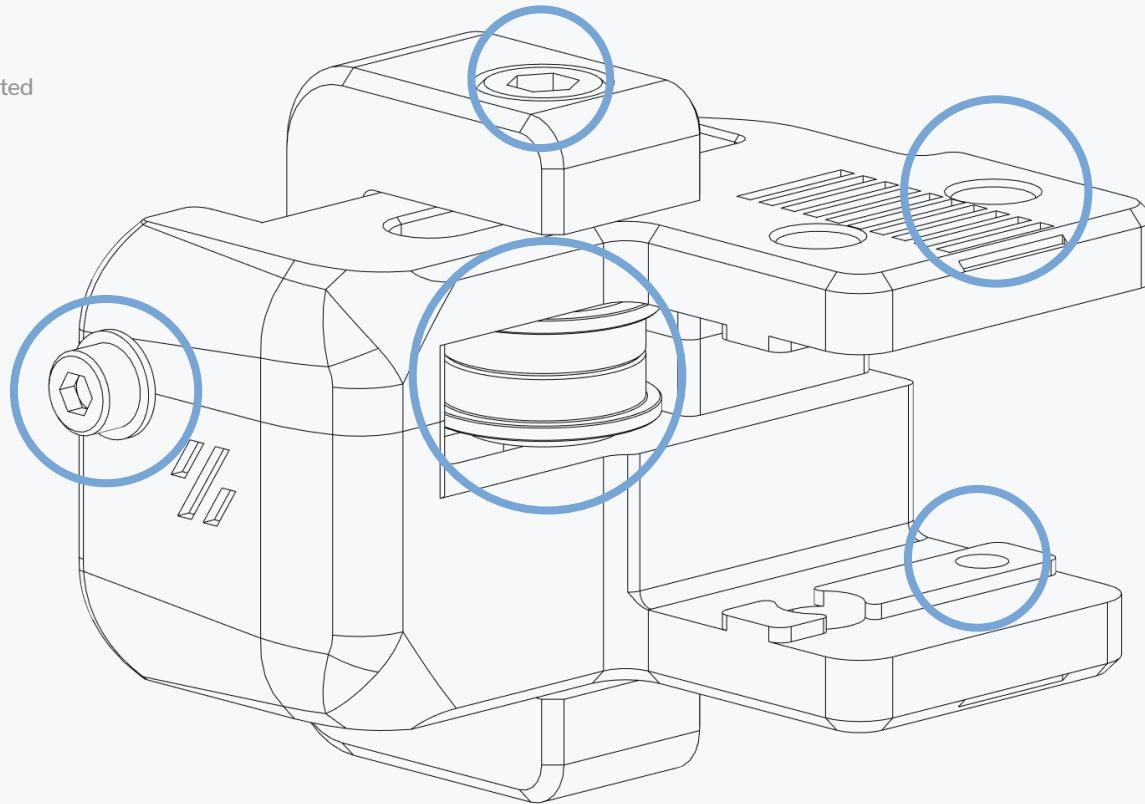






CHECK YOUR WORK

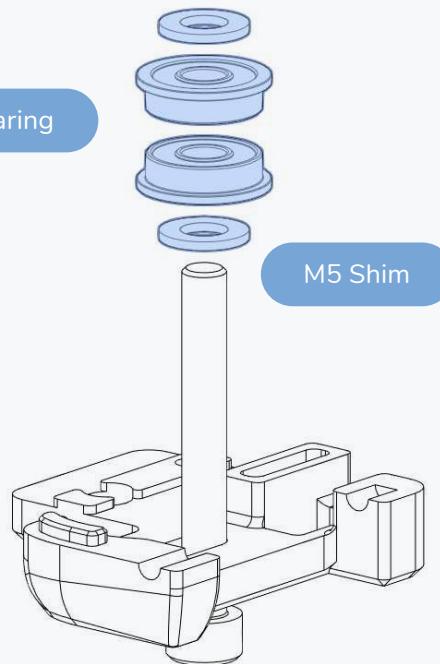
Compare your assembled parts to the graphics shown here. Pay attention to the features highlighted by the circles.



**ASSEMBLY AID**

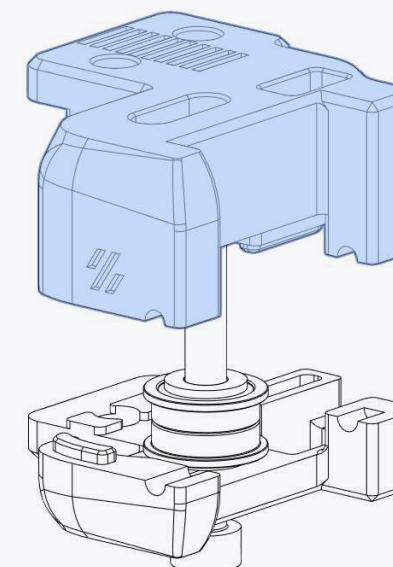
This bolt is used to align components and will be removed in a later step.

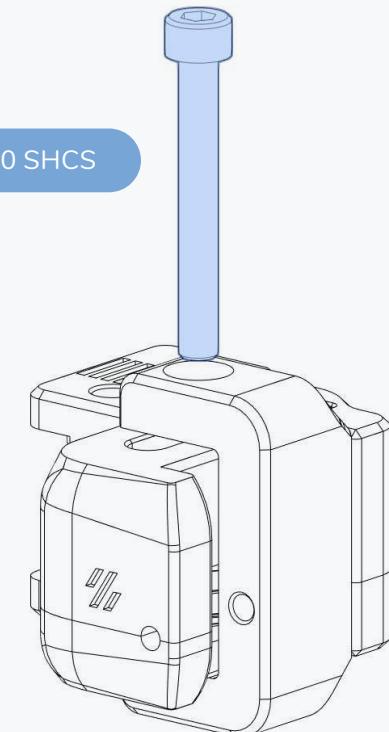
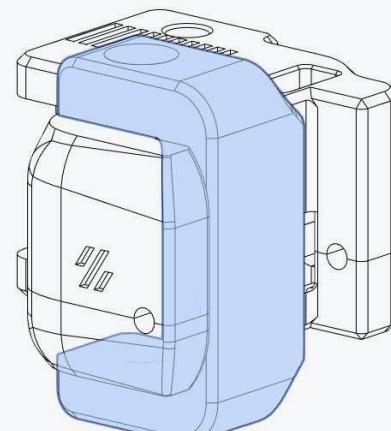
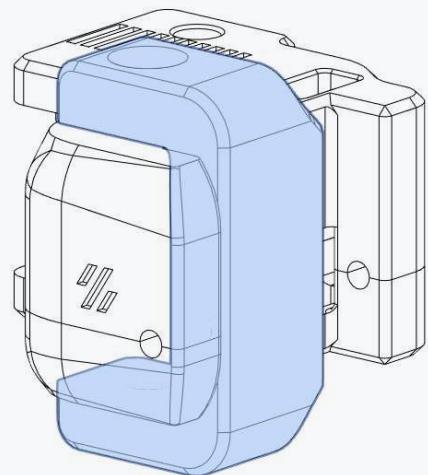
F695 Bearing



M5 Shim

M5x40 SHCS



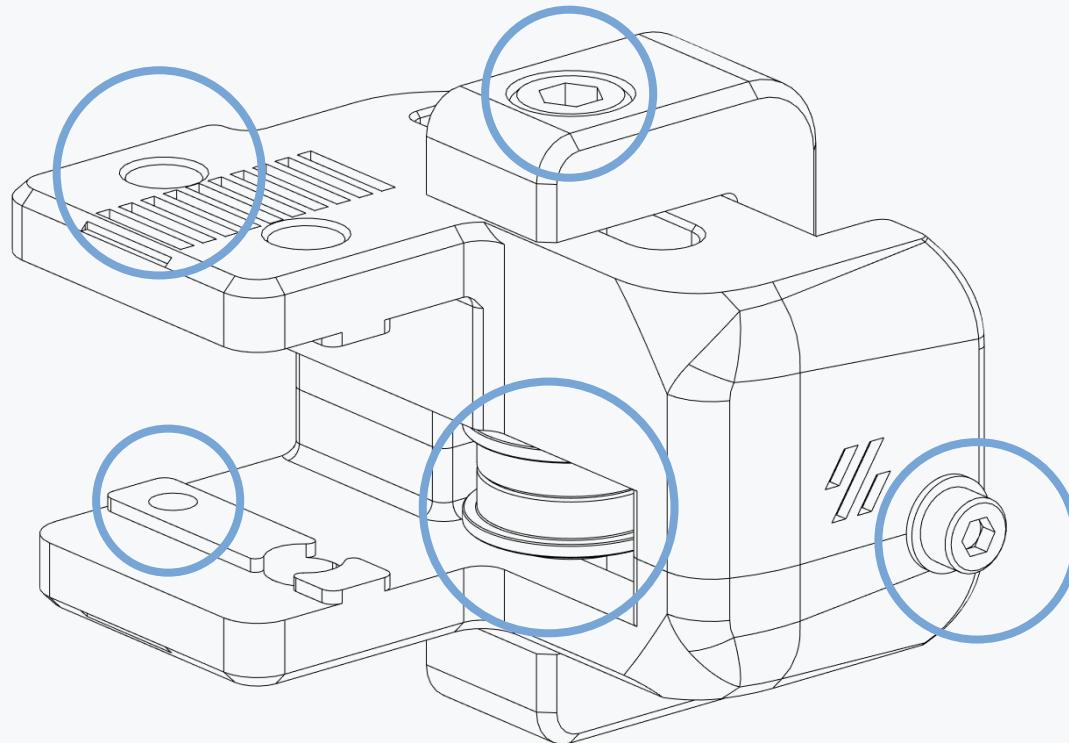
**REMOVE ASSEMBLY AID**

Remove the bolt and slide the tension arm into place.

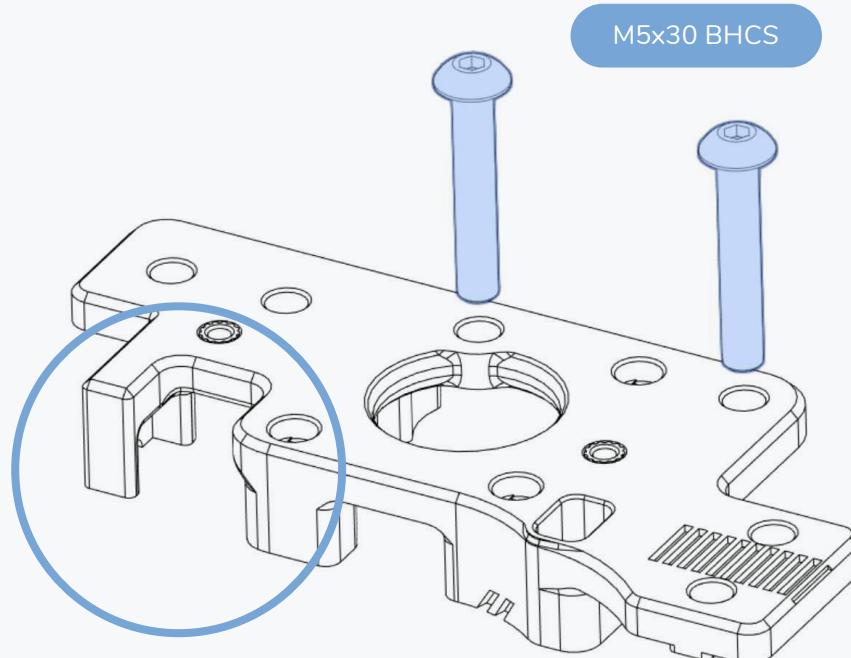
B IDLER

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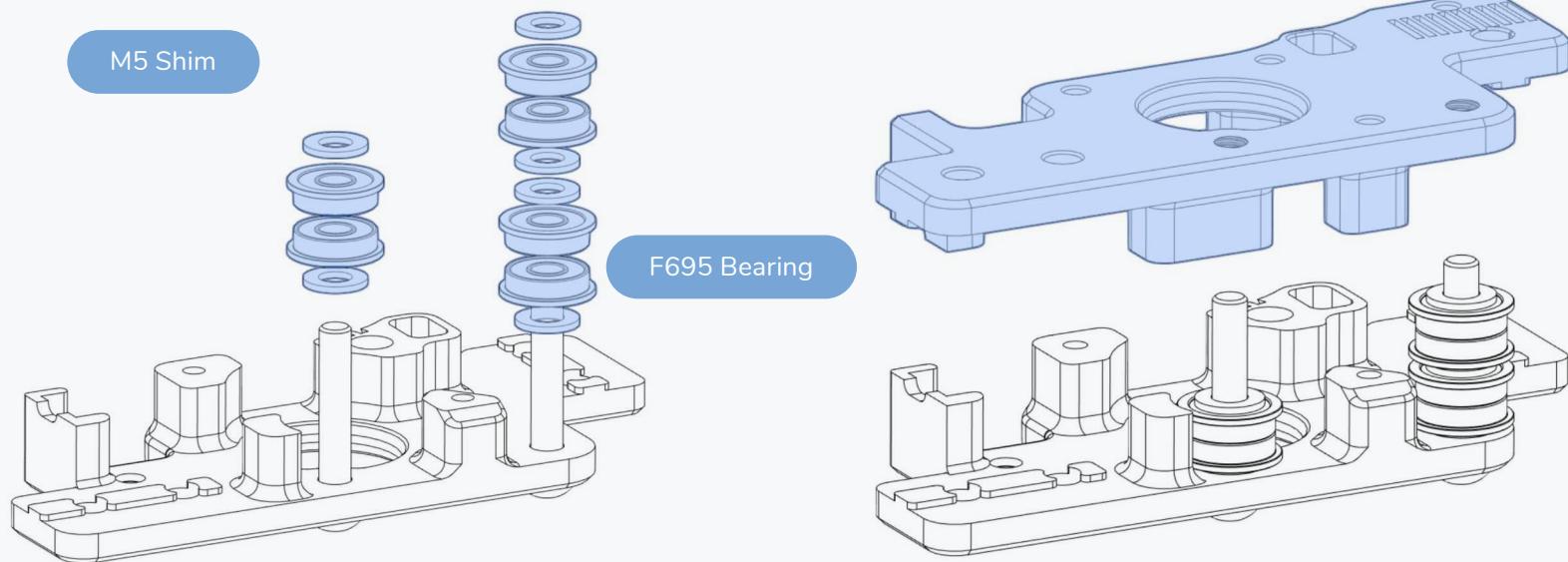


**CHECK YOUR WORK**

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

**CUTOUT**

The printed parts for the A drive have a cutout.

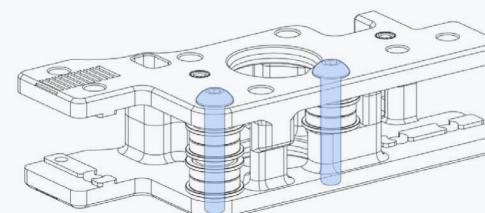


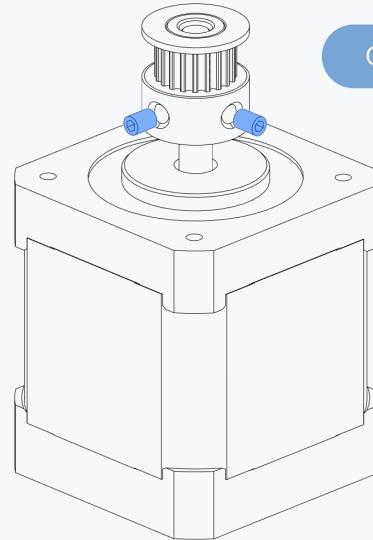
UPSIDE DOWN ASSEMBLY

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

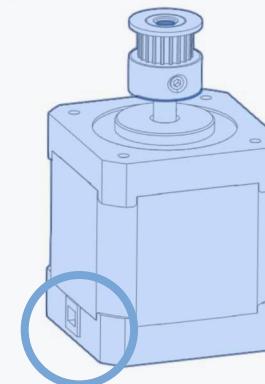
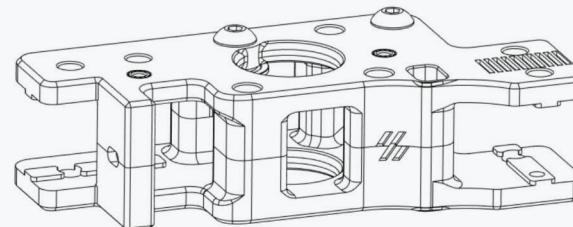
DON'T OVER TIGHTEN

The M5 bolts are threaded directly into plastic.

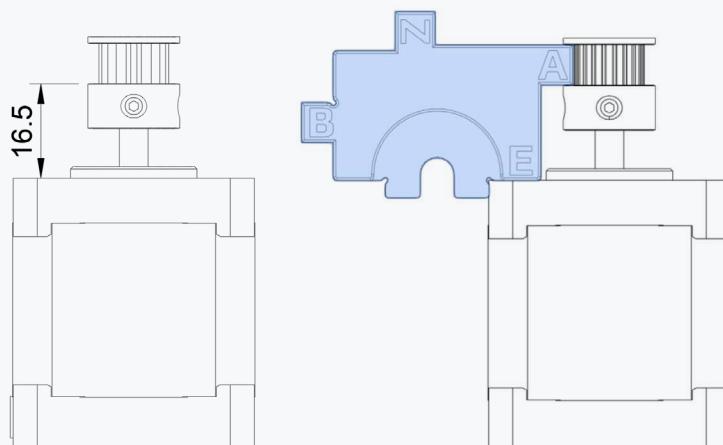


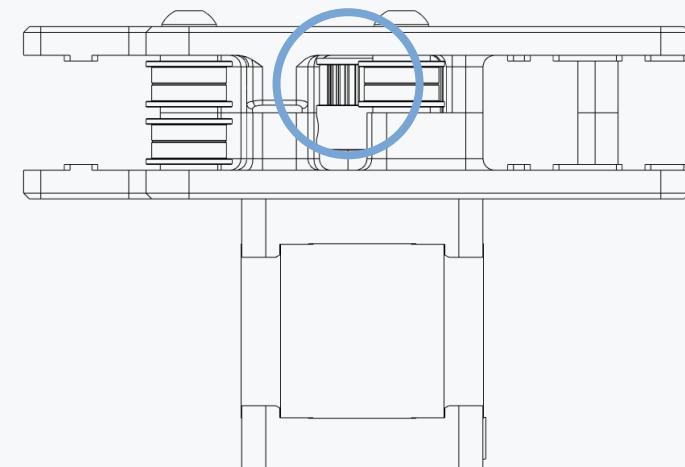
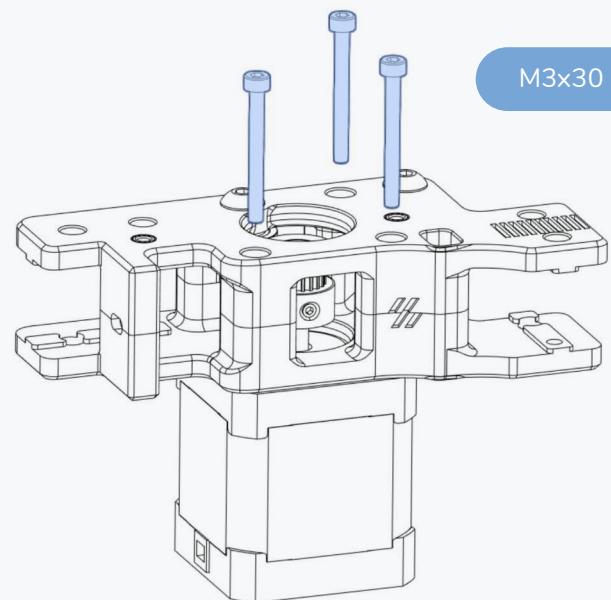
**APPLY THREAD LOCKER**

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.

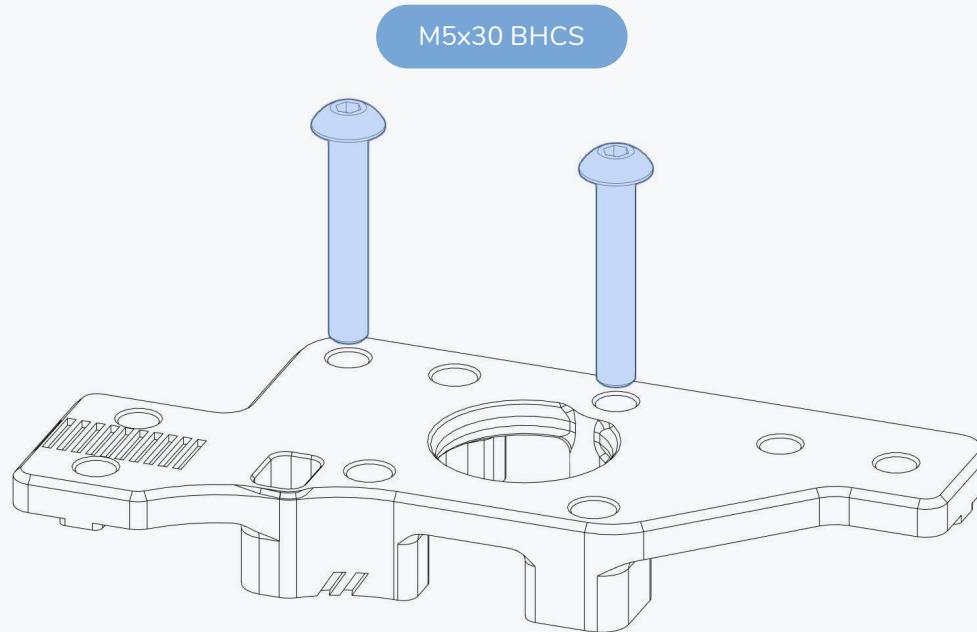


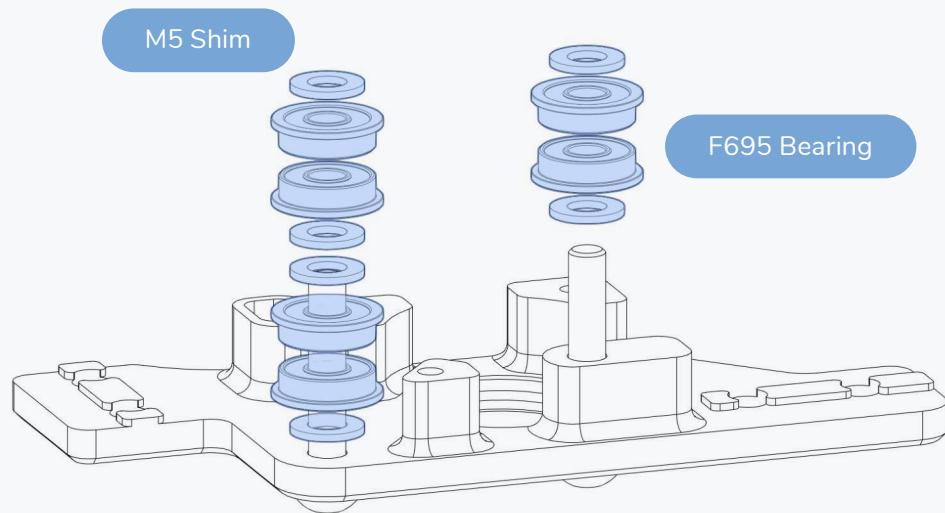


CHECK YOUR WORK

Compare your assembled part to the graphic shown here.

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



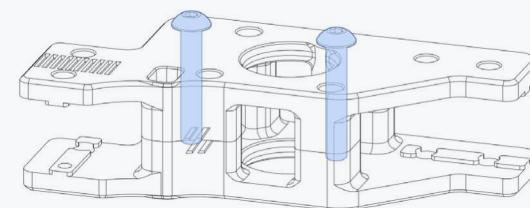
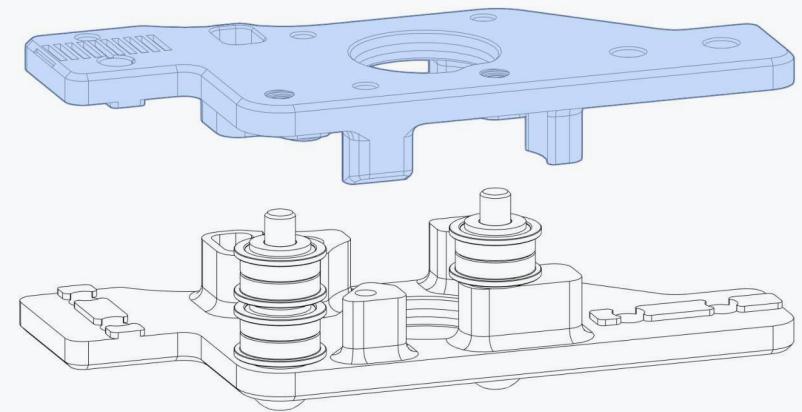


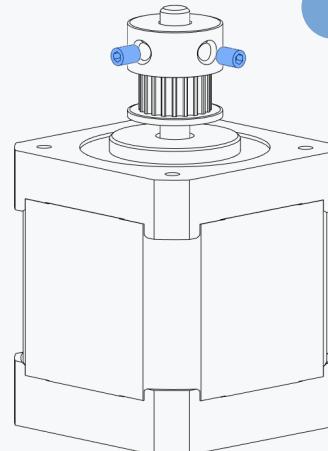
UPSIDE DOWN ASSEMBLY

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.

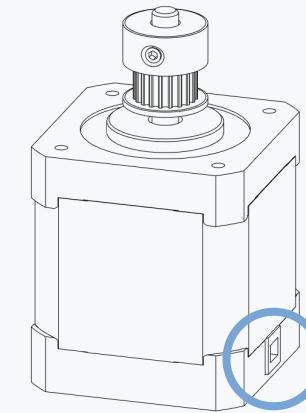
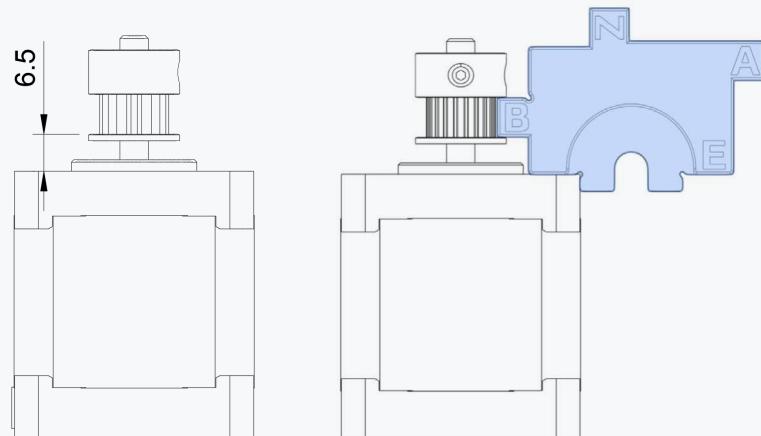
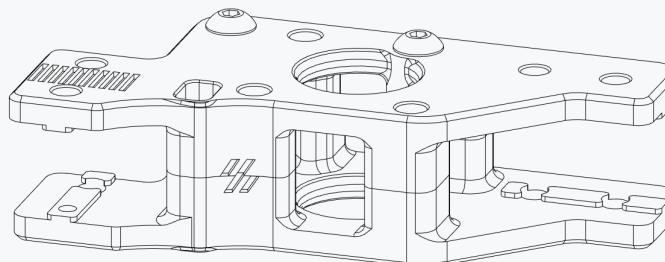




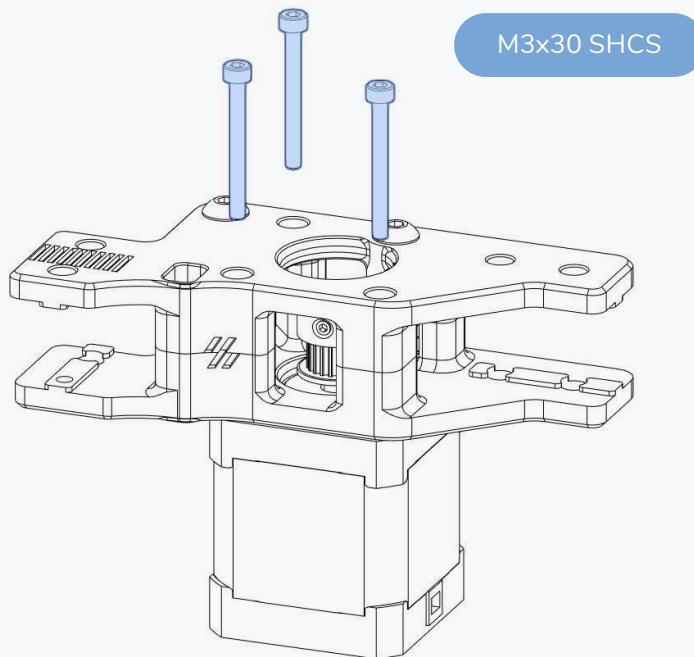
GT2 20 Tooth Pulley

APPLY THREAD LOCKER

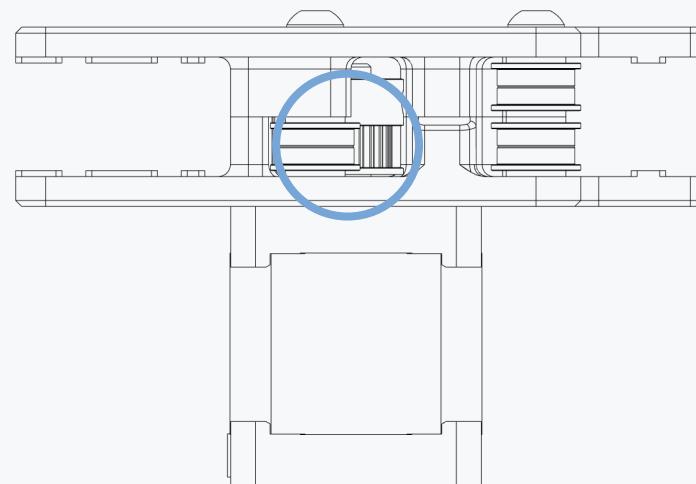
Make sure to use thread locker on the set screws.

**MOTOR ORIENTATION**

Pay attention to the orientation of the cable exit.



M3x30 SHCS



CHECK YOUR WORK

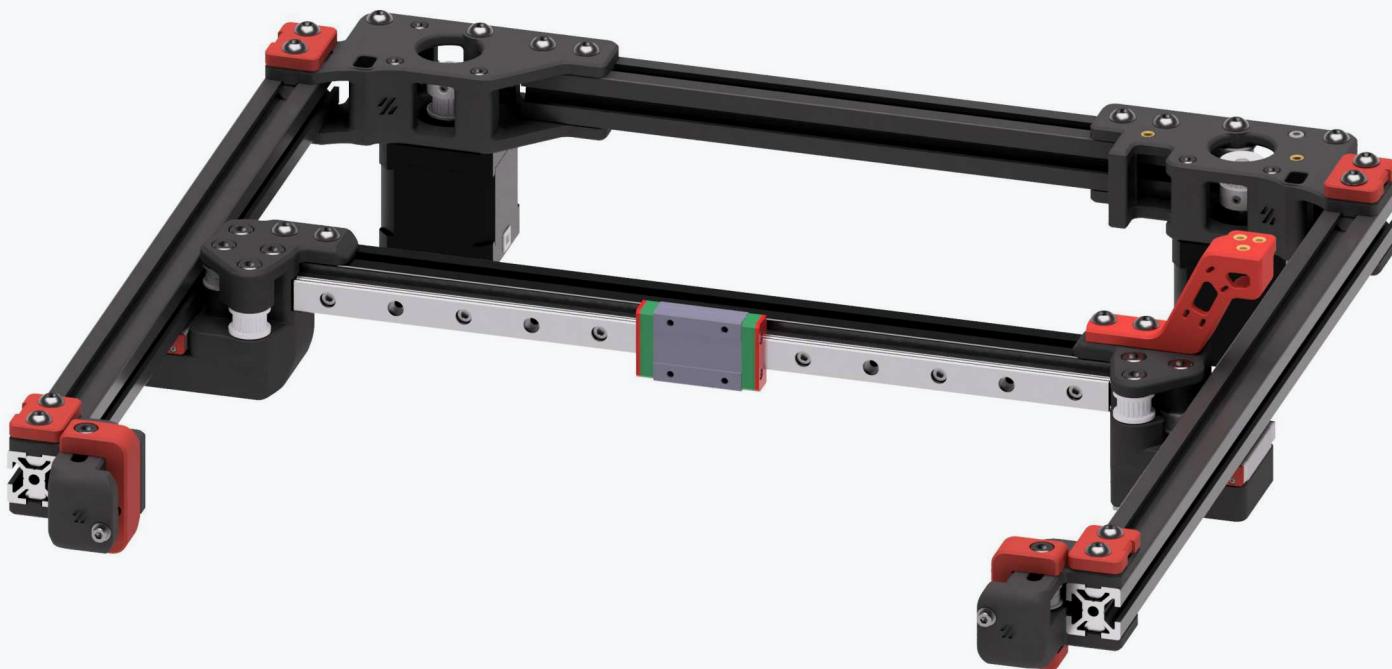
Compare your assembled part to the graphic shown here.

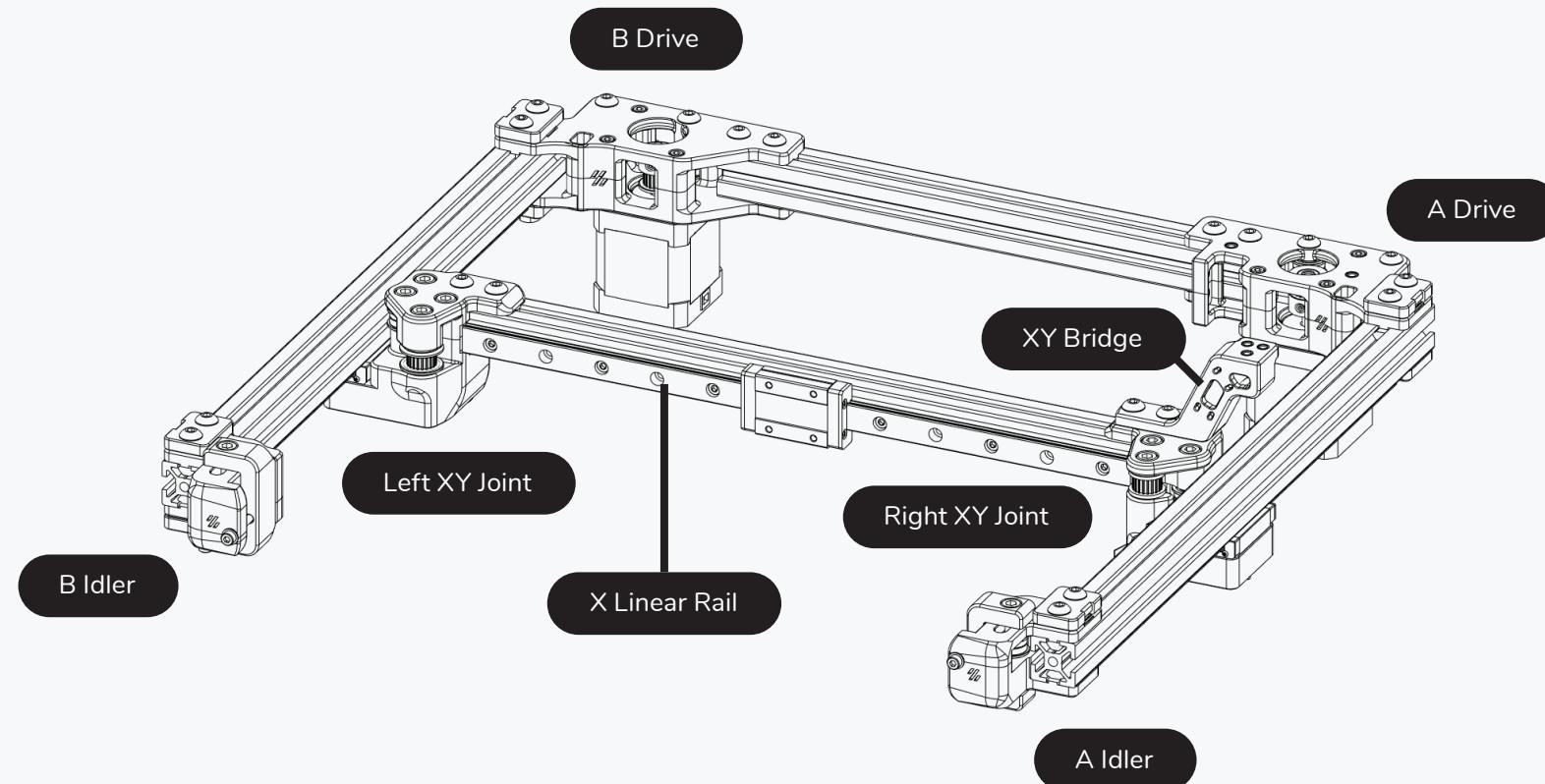
Pay attention to the pulley orientation and alignment with the bearing stacks.

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

GANTRY

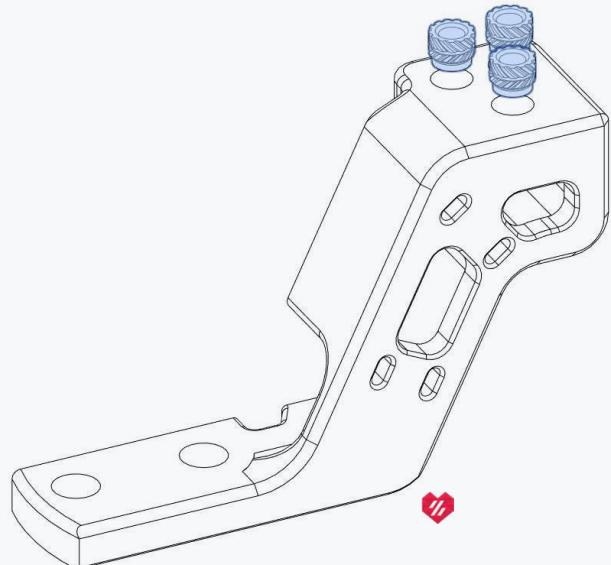
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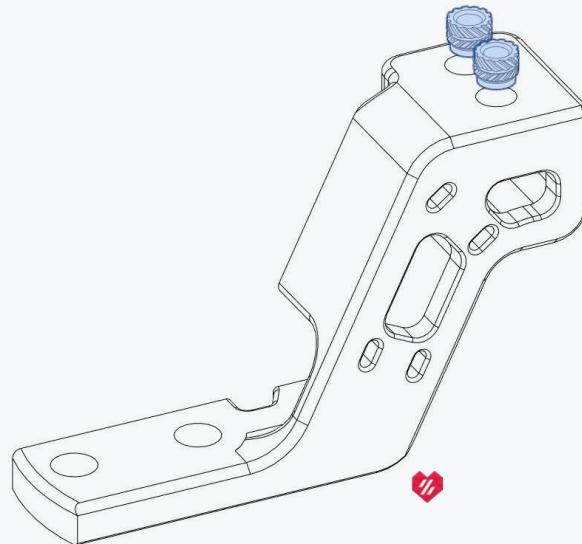


GENERIC CABLE CHAINS

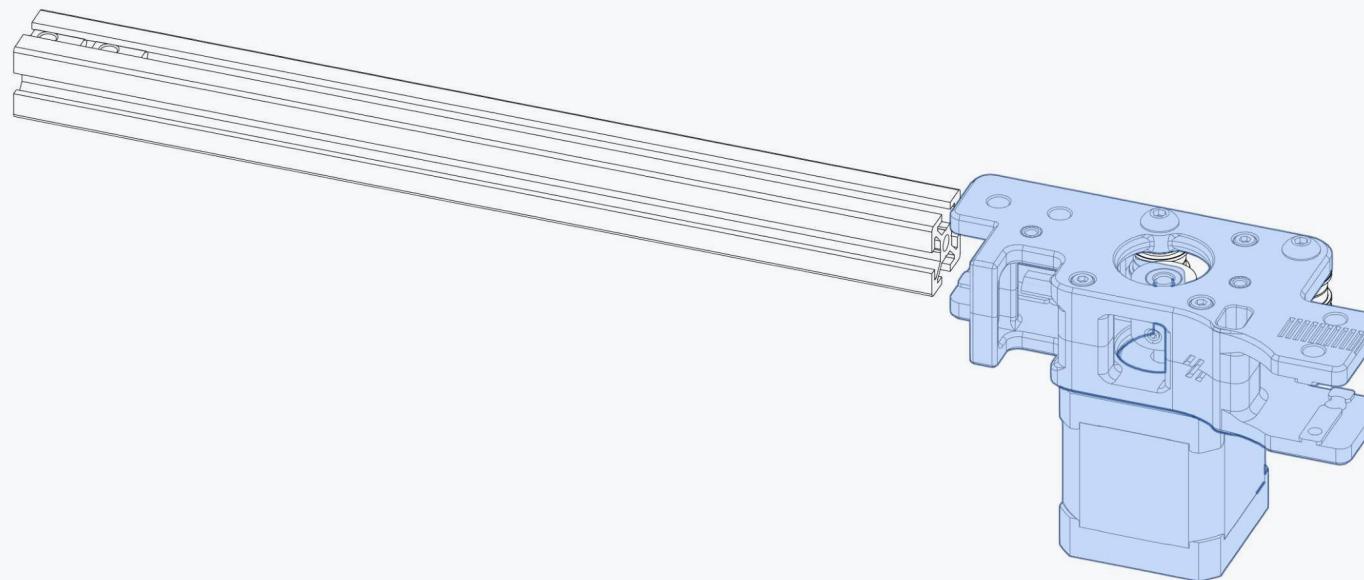
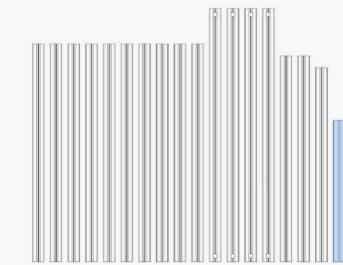
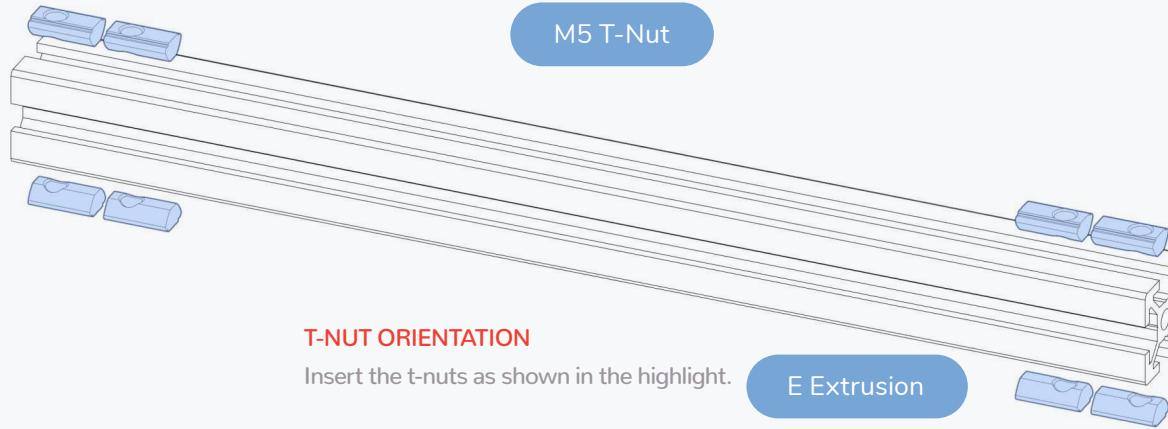
The 3 hole pattern is usually found on generic cable chains.

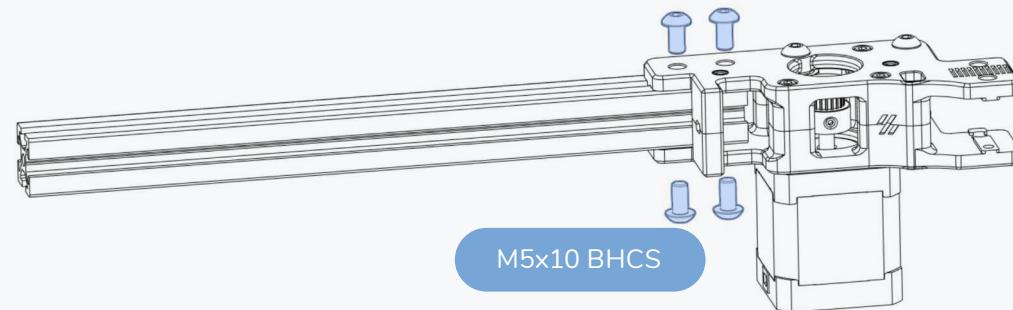
**IGUS CABLE CHAINS**

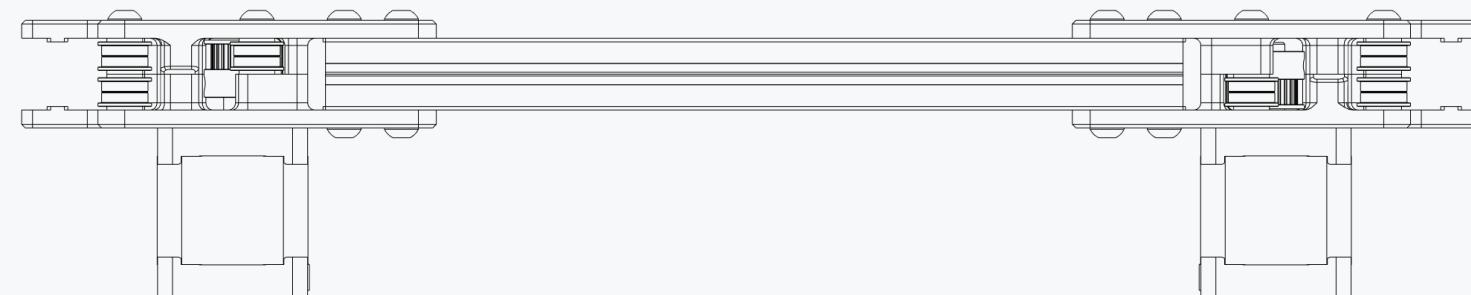
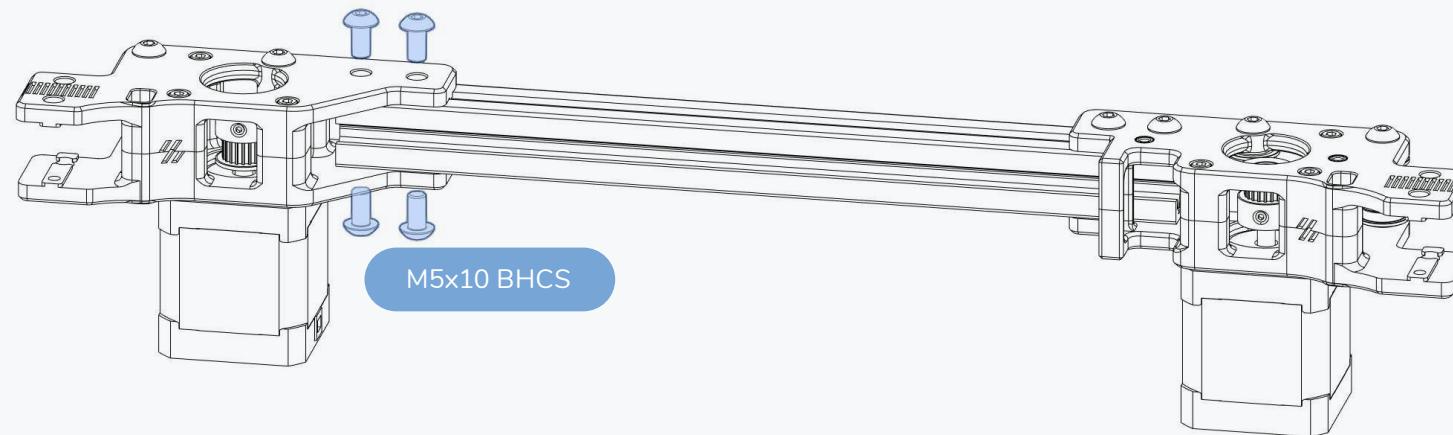
IGUS chains have 2 mounting holes.

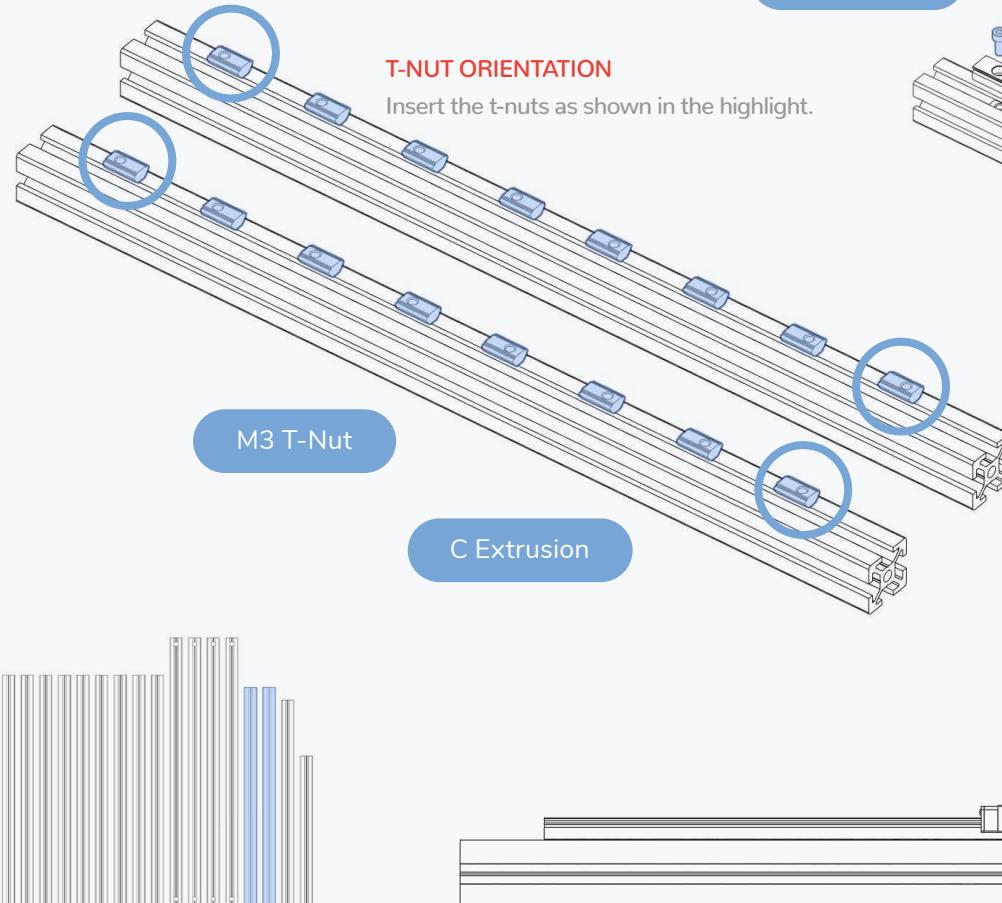
**WHICH TO CHOOSE?**

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









CENTRED RAIL INSTALLATION GUIDE

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



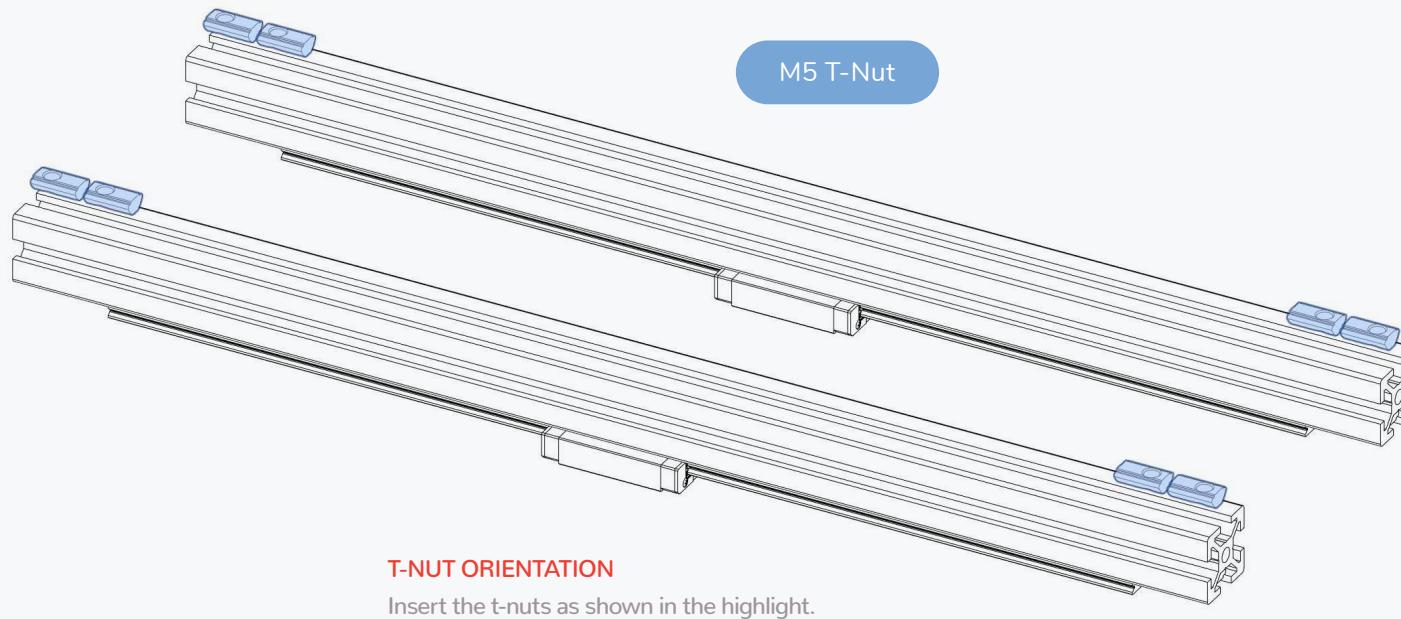
M3x8 SHCS

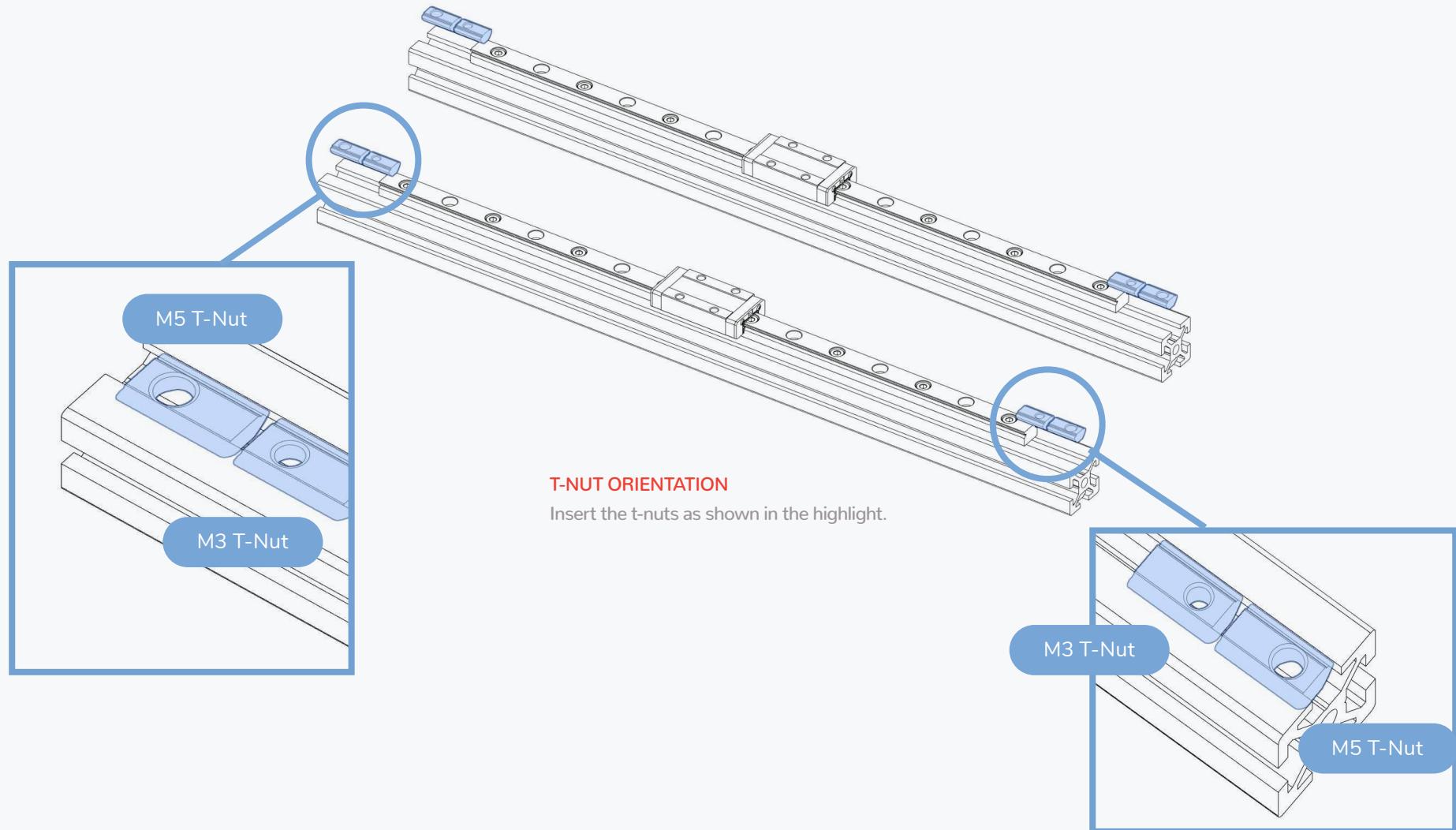
MIND THE CARRIAGE

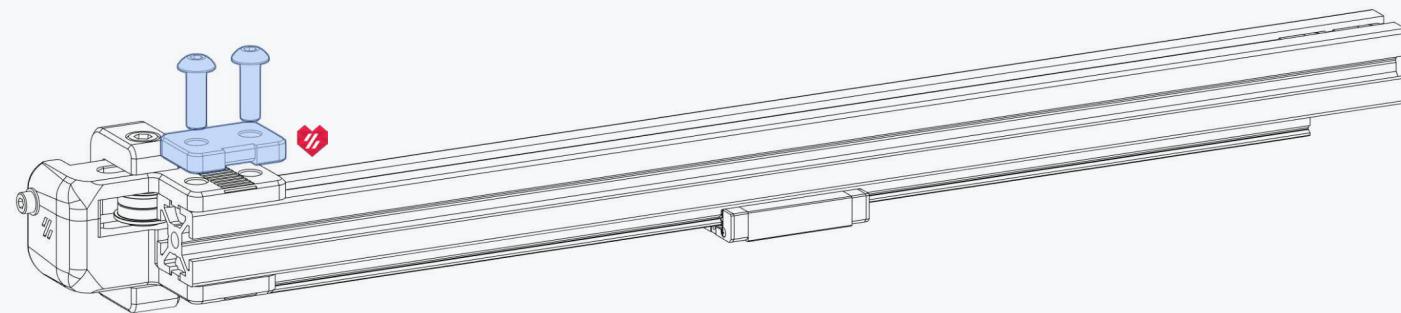
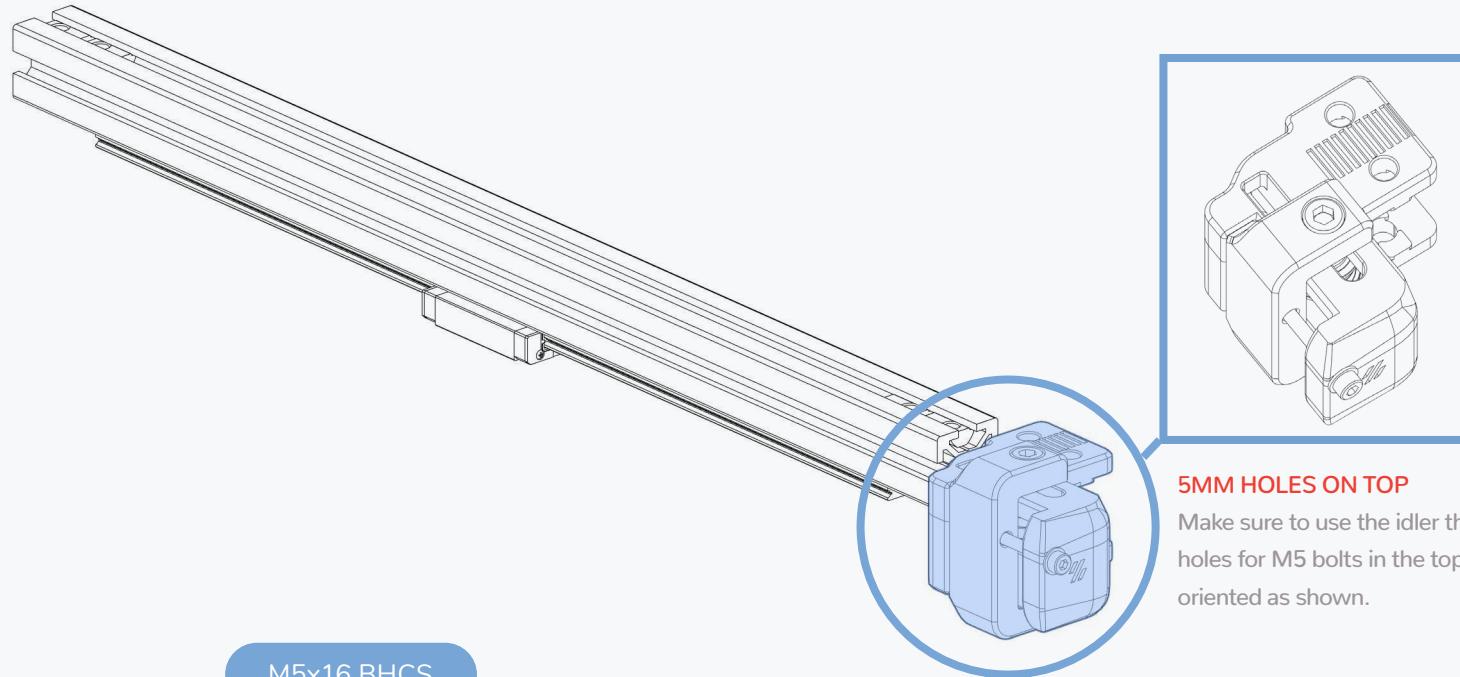
The carriages are designed to slide along the rail easily. This unfortunately also includes sliding off the rails.

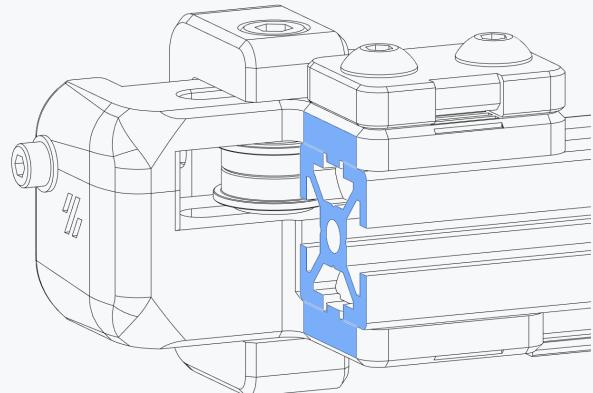
Dropping the carriage likely irreparably damages it.







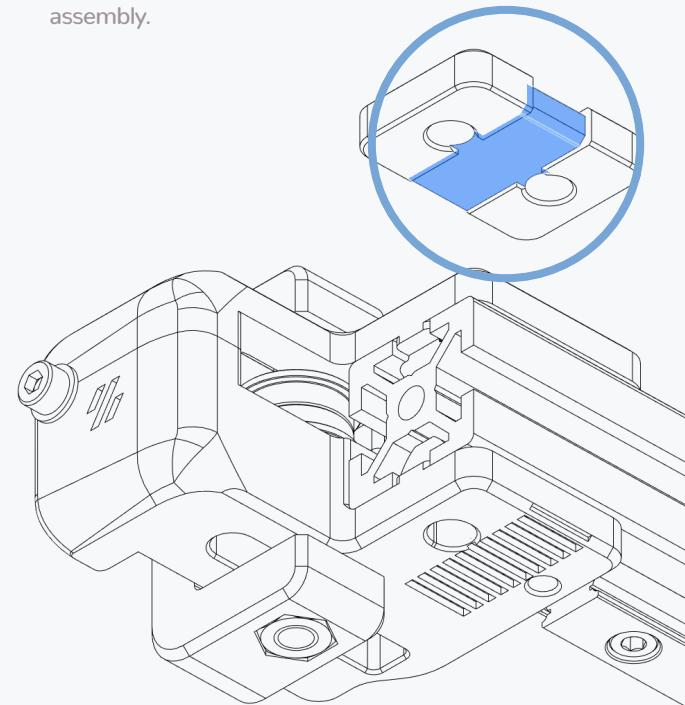


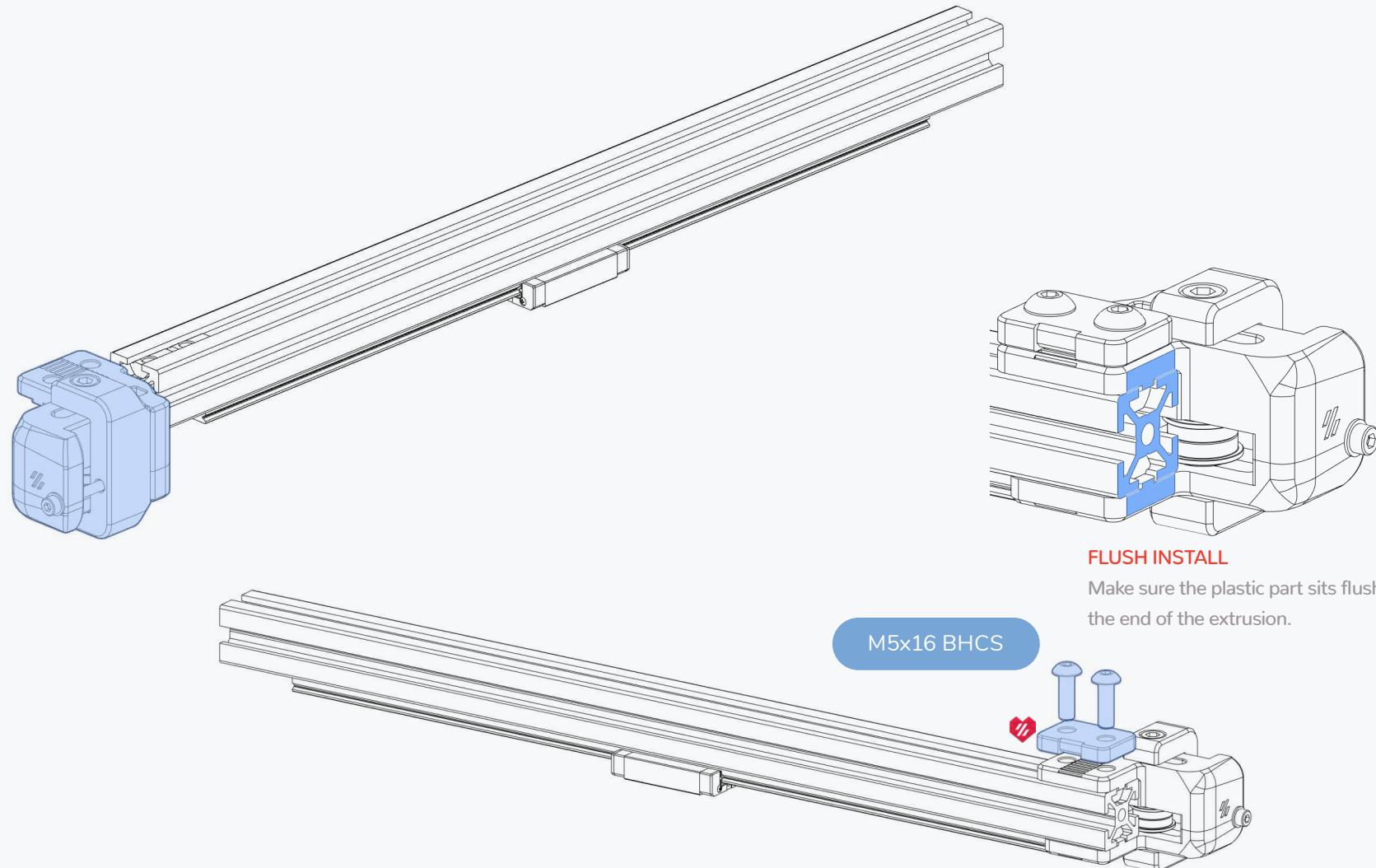
**FLUSH INSTALL**

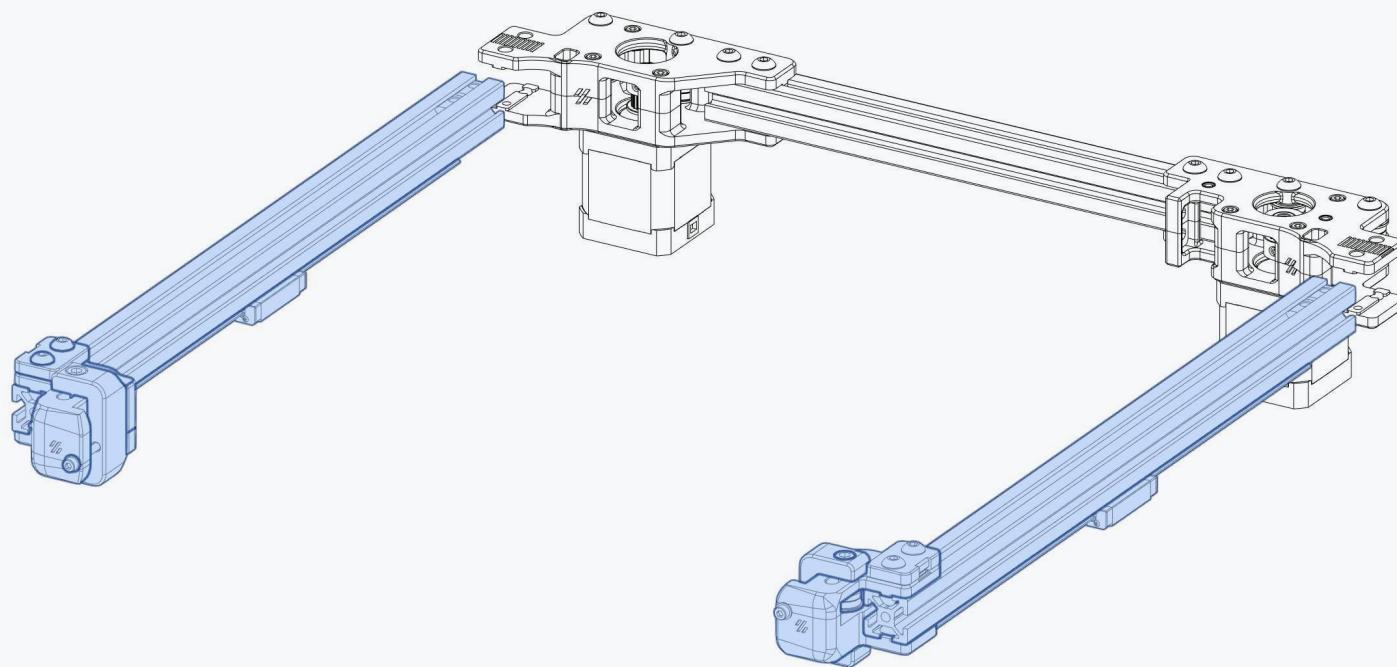
Make sure the plastic part sits flush with the end of the extrusion. If not flush check if you installed the correct idler.

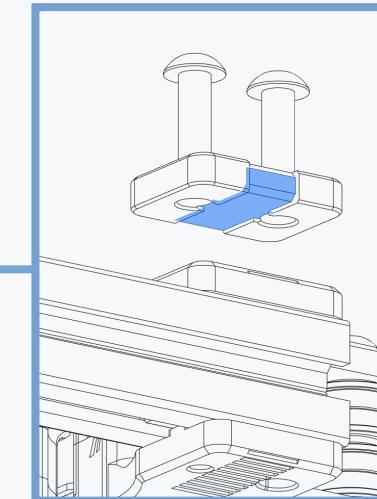
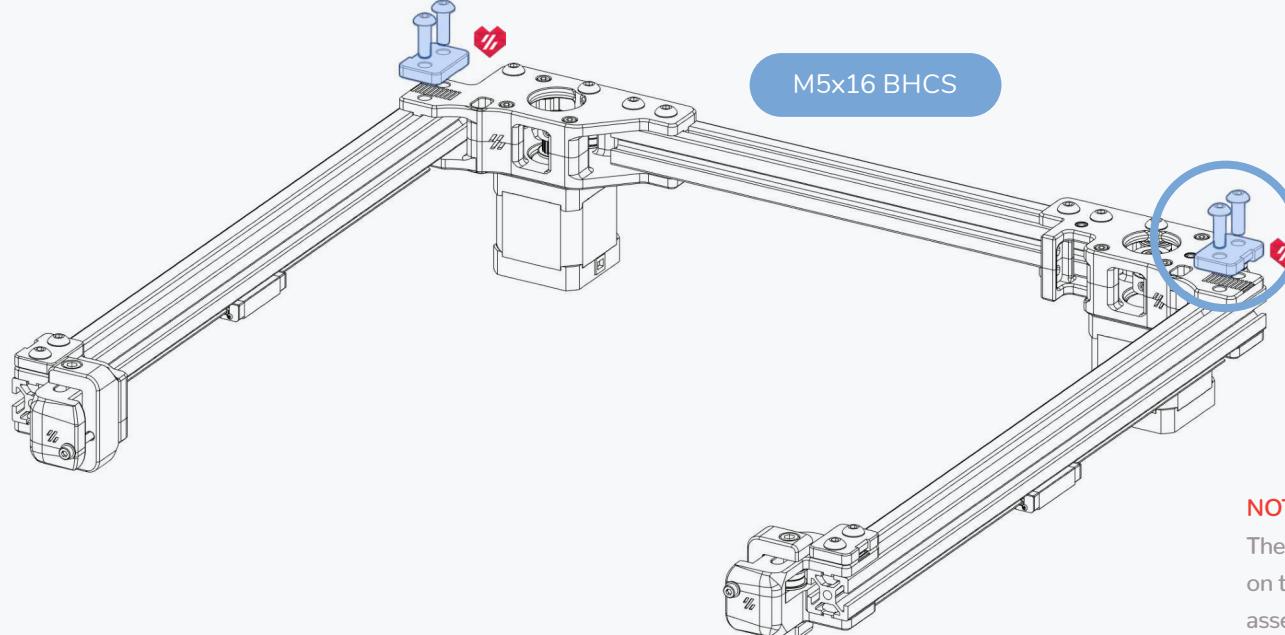
NOTCH ORIENTATION

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







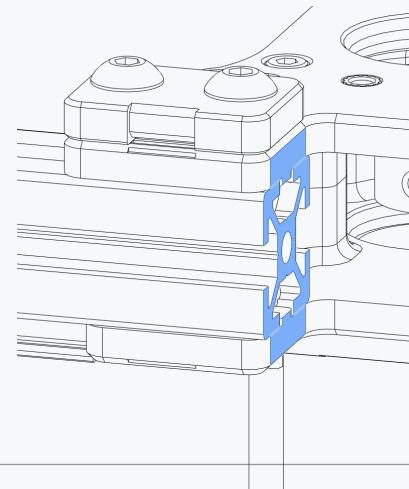


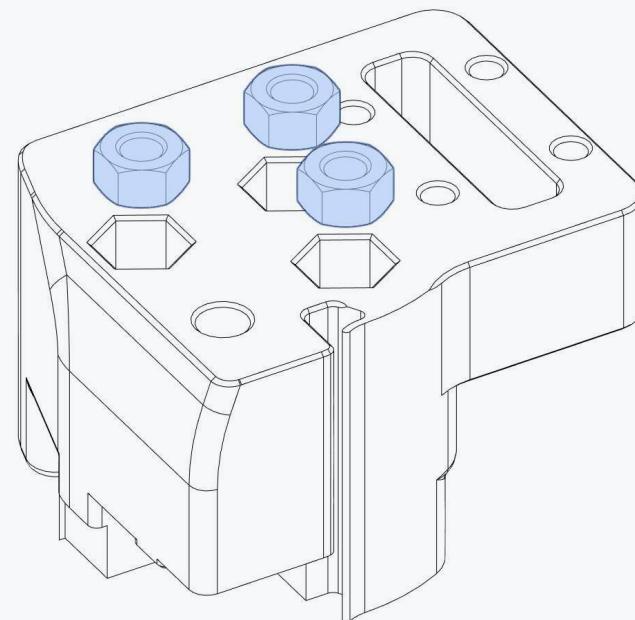
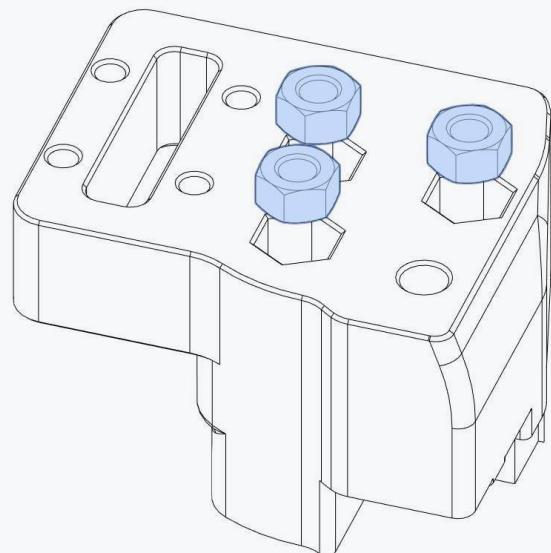
NOTCH ORIENTATION

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

FLUSH INSTALL

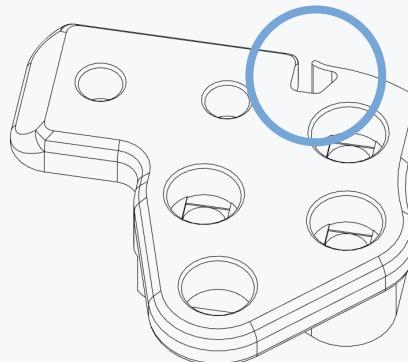
Make sure the plastic part sits flush with the end of the extrusion.





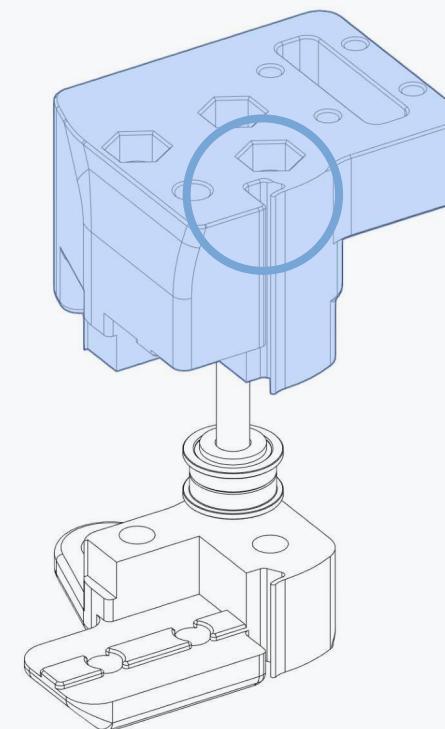
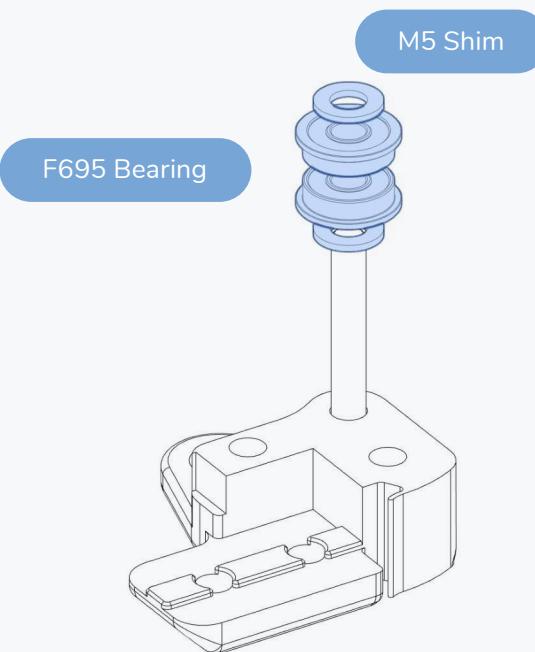
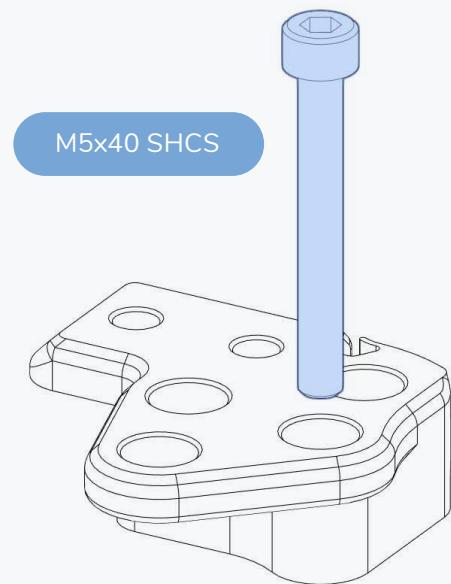
RIGHT XY JOINT

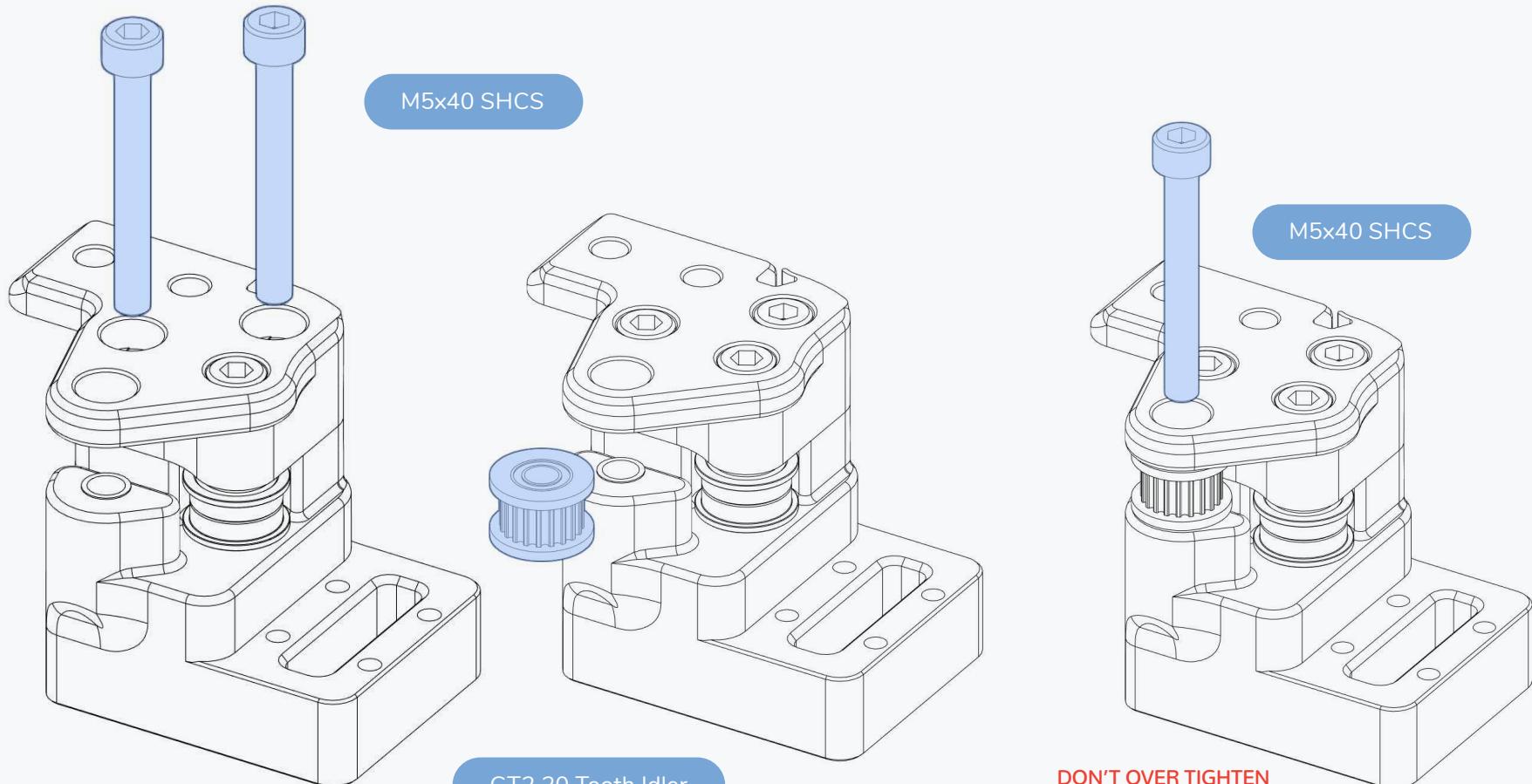
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CABLE PATH

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

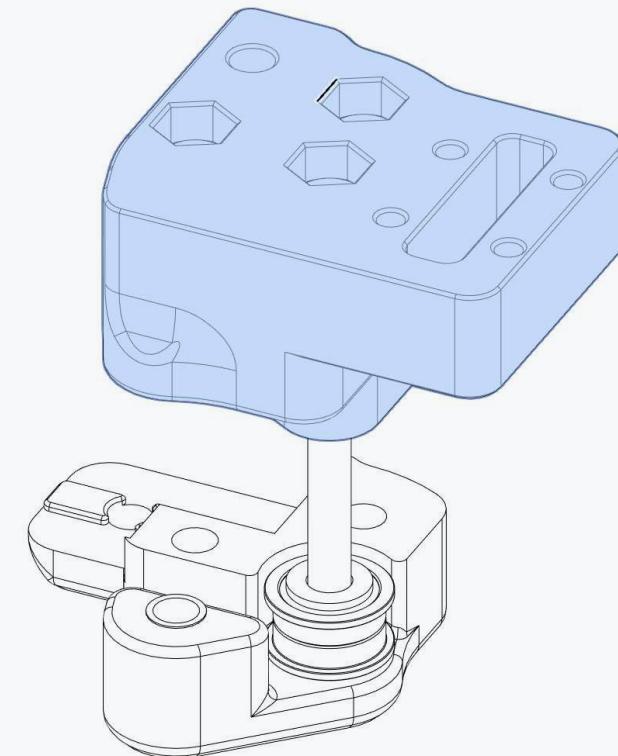
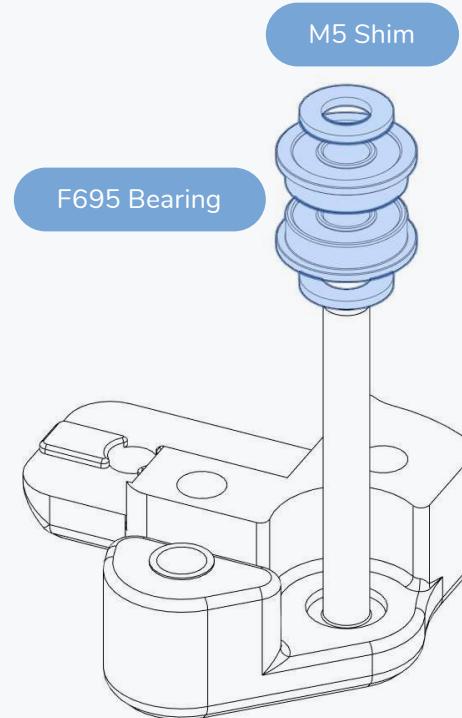
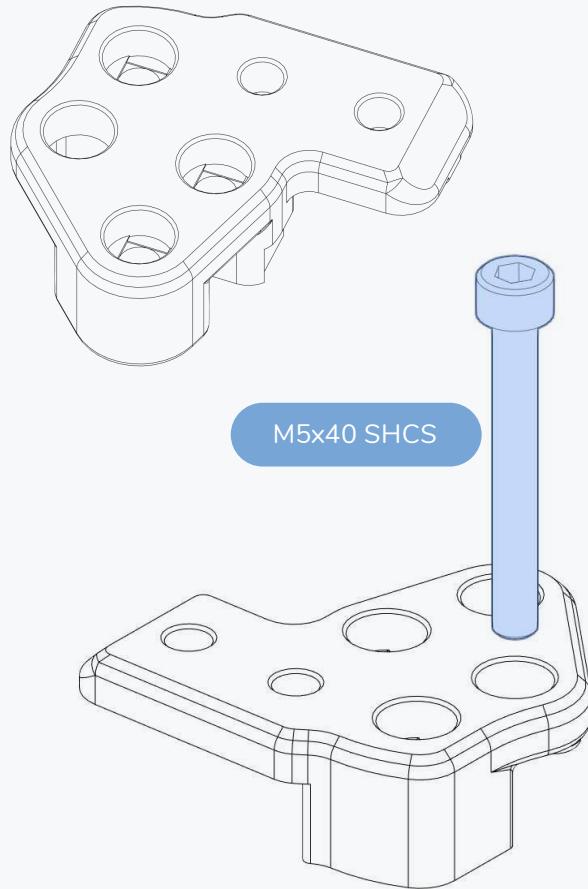


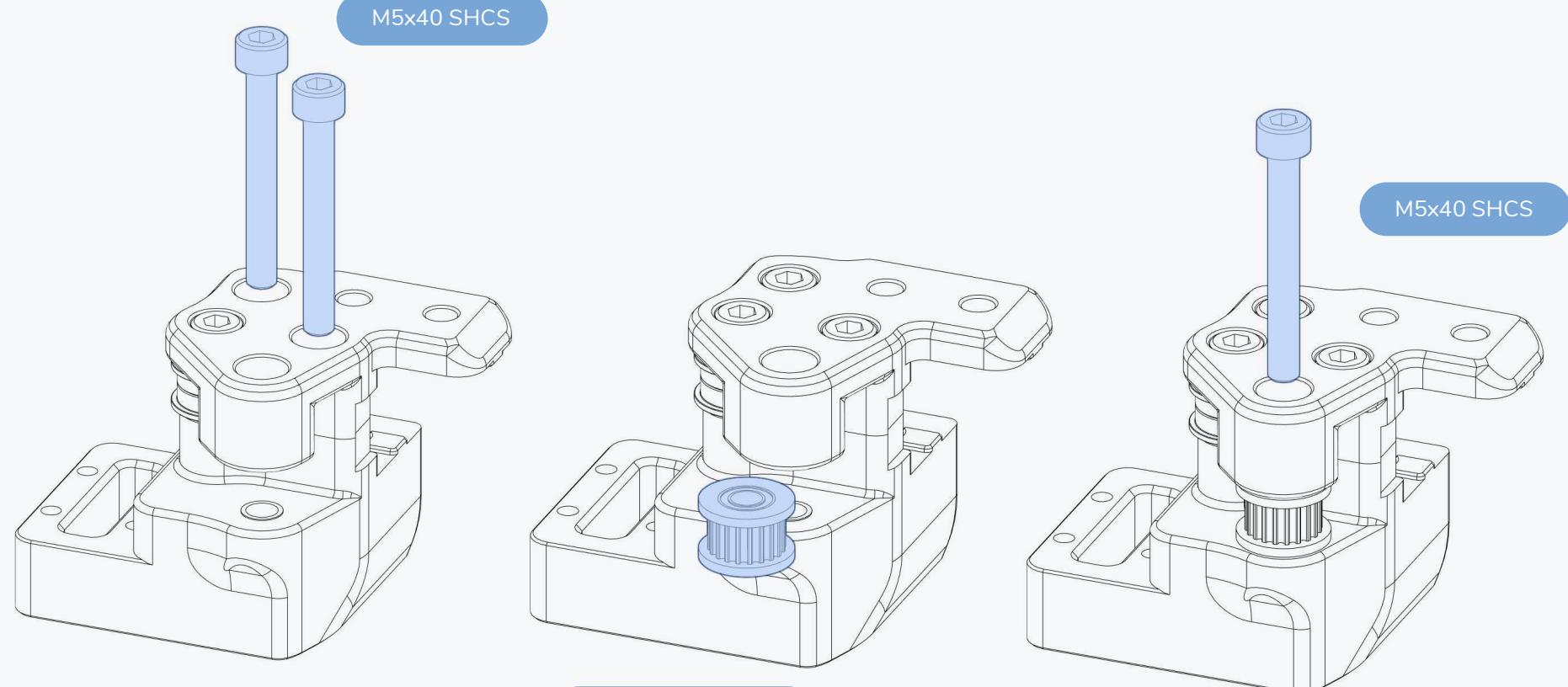
**DON'T OVER TIGHTEN**

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

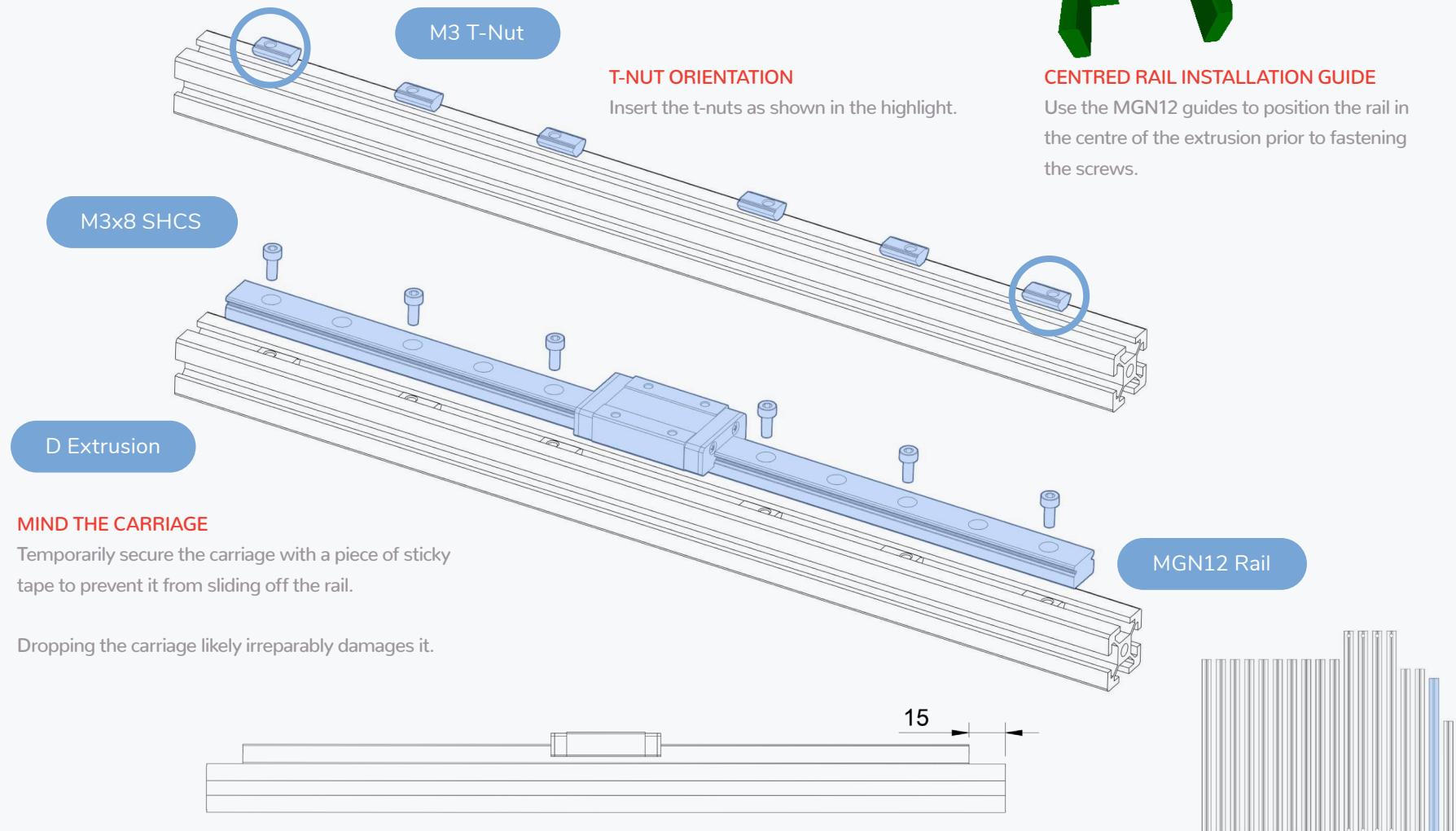
LEFT XY JOINT

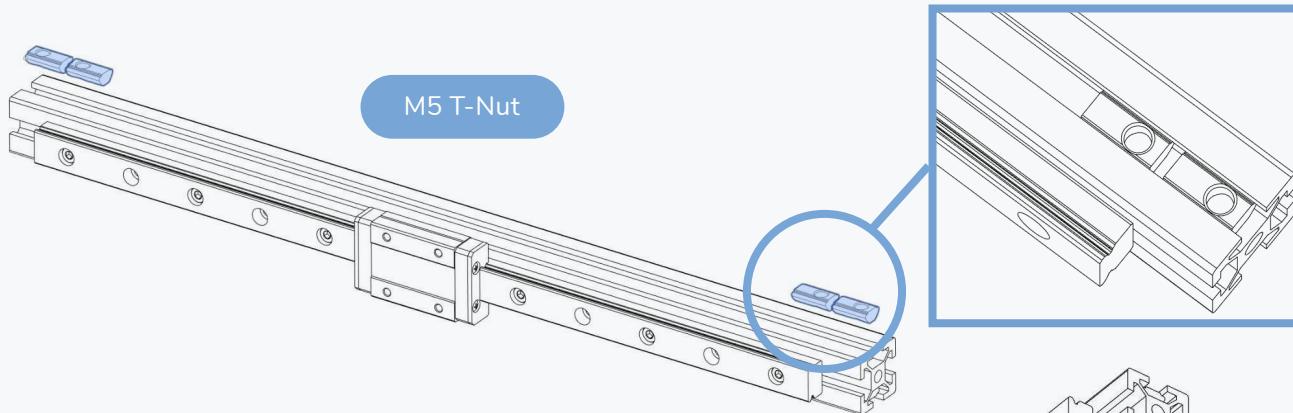
WWW.VORONDESIGN.COM



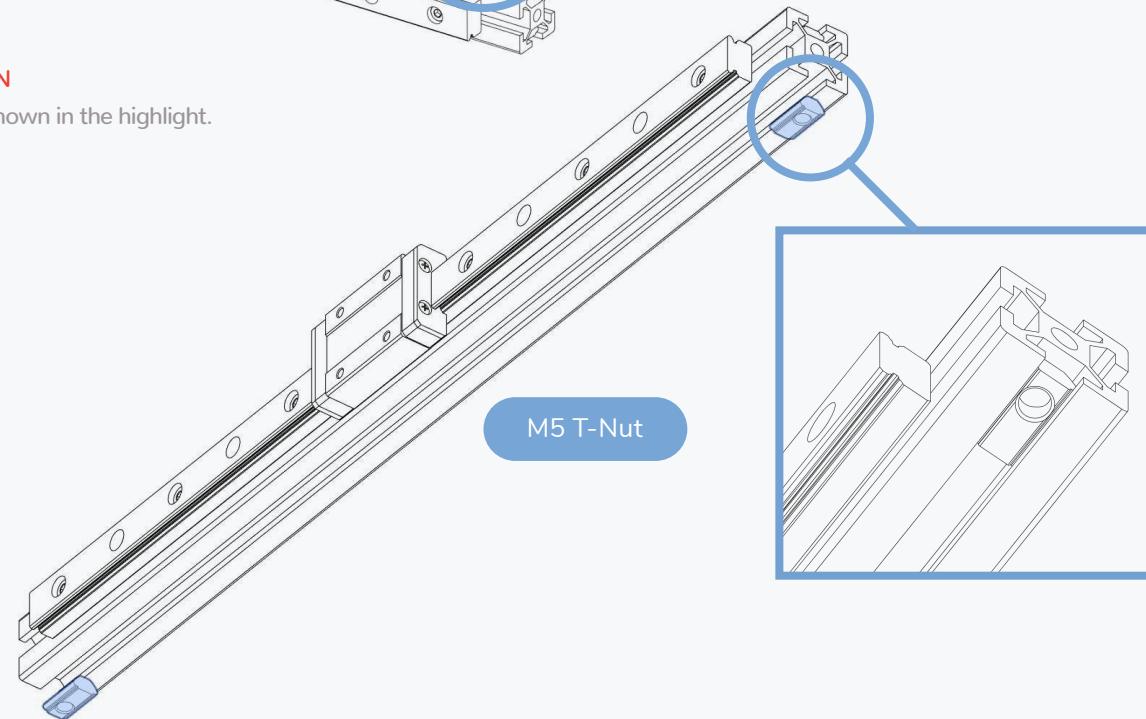
**DON'T OVER TIGHTEN**

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



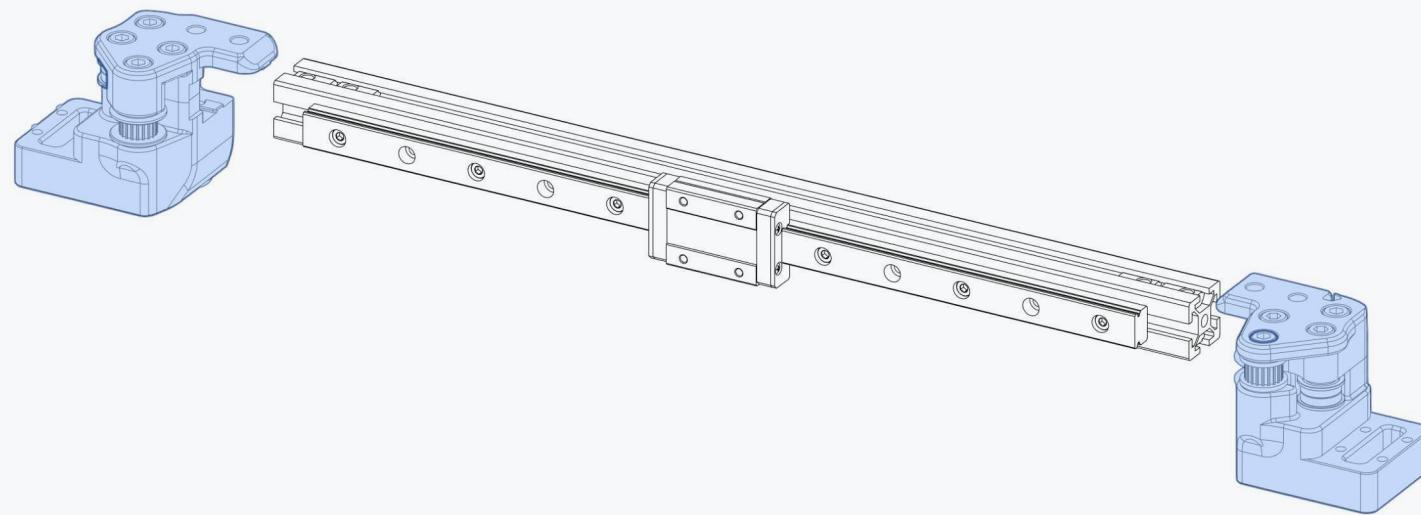
**T-NUT ORIENTATION**

Insert the t-nuts as shown in the highlight.



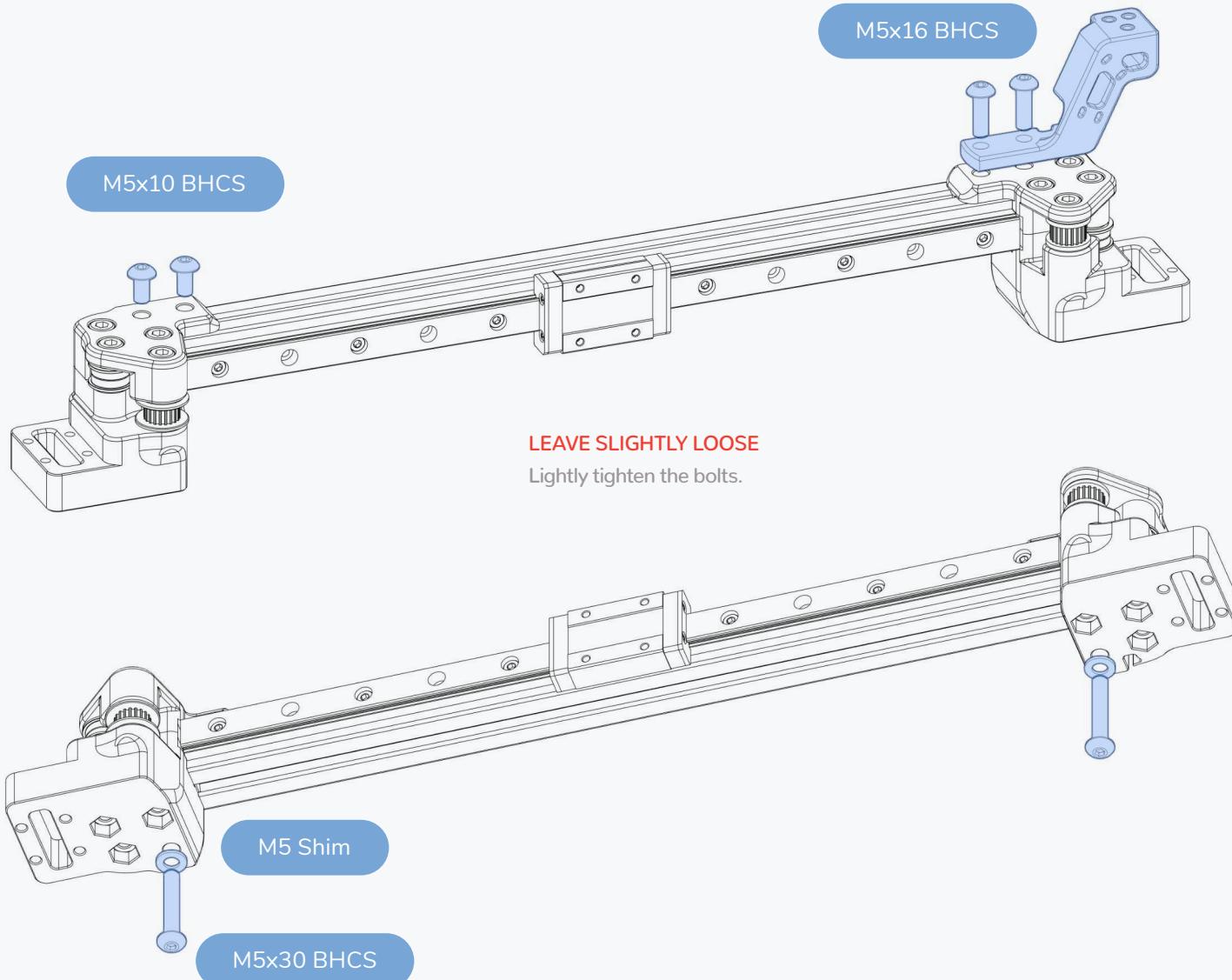
X AXIS

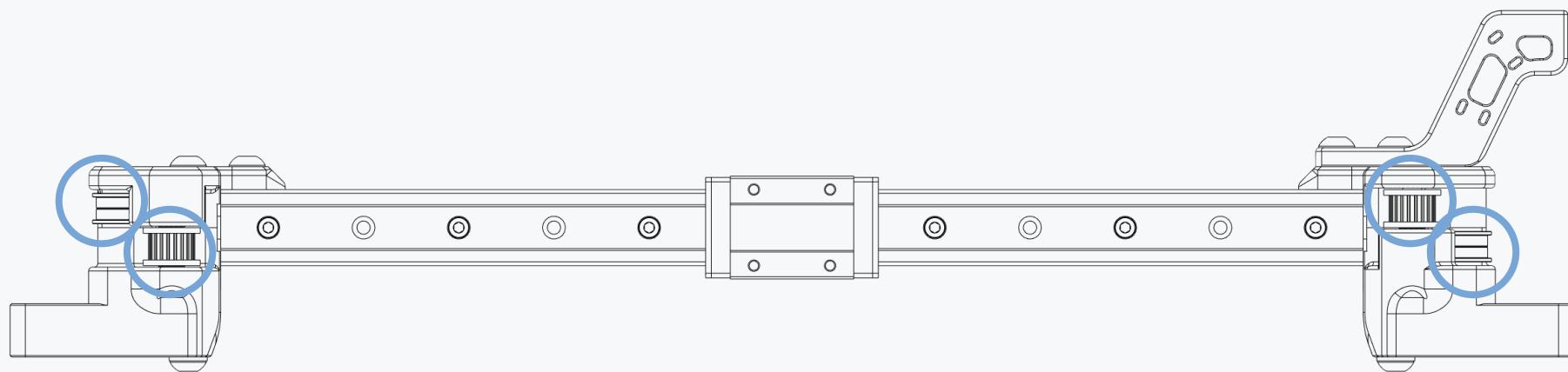
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X AXIS

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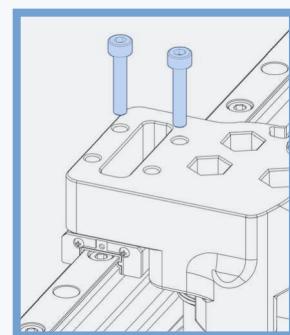
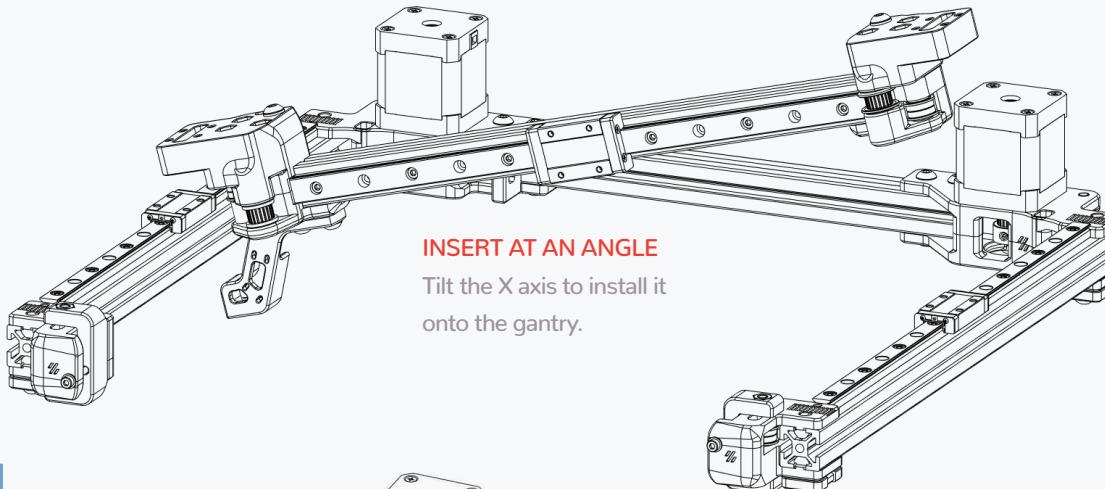
**CHECK YOUR WORK**

Compare your assembled part to the graphic shown here.

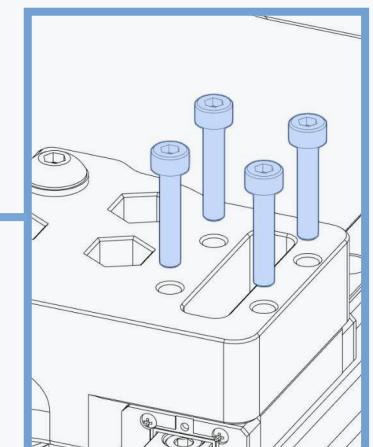
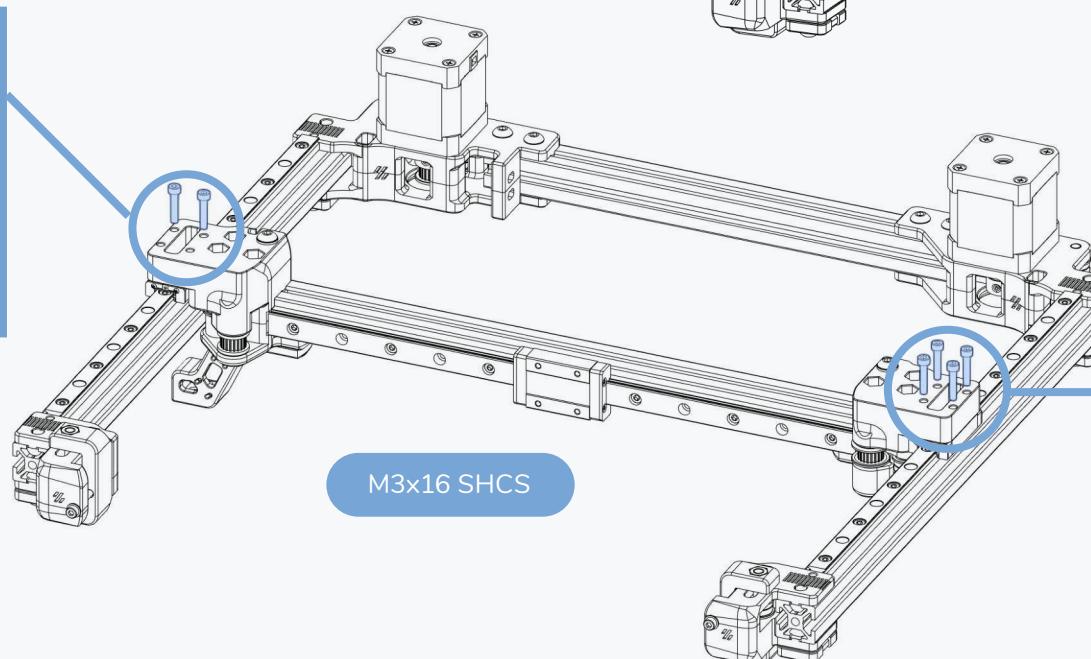
Pay attention to the pulley orientation and alignment with the bearing stack ups.

FLIP GANTRY

Turn the gantry around for the next step.

**2X BOLT ONLY**

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

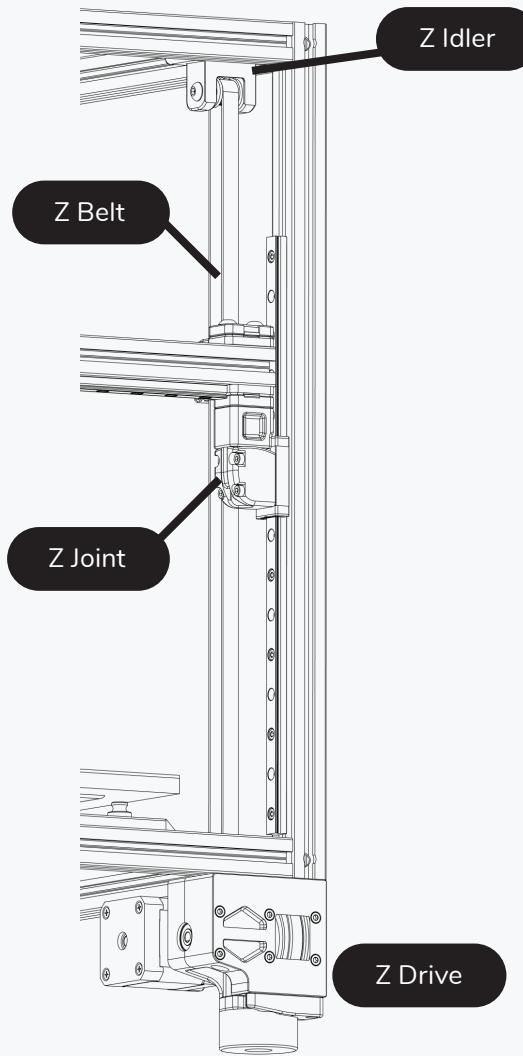


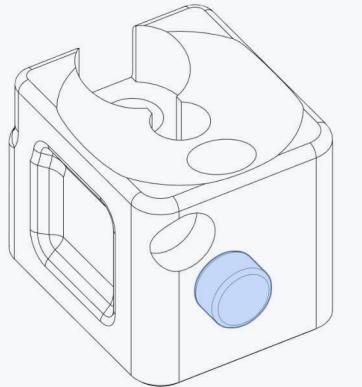
V1 and V2 are not version numbers but the printer models/lines. We renamed the V1 to Voron Trident to address the confusion this caused.

Z AXIS

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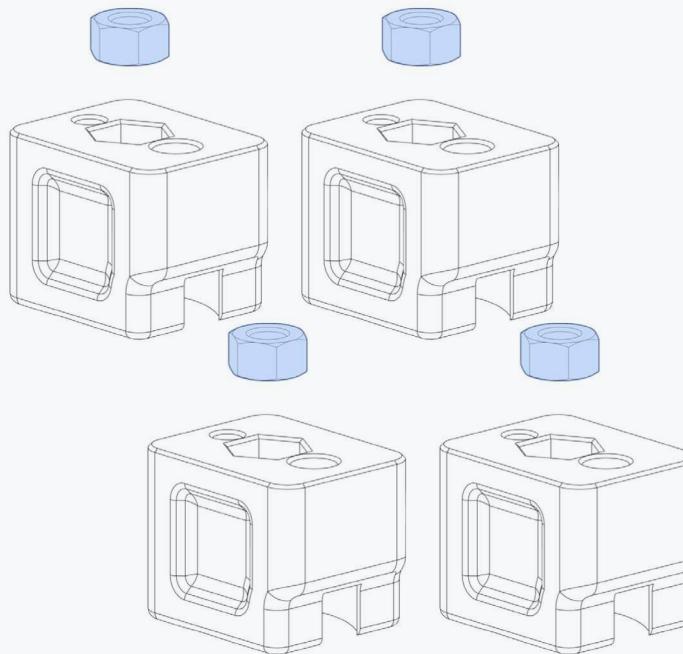


6x3 Magnet

OPTION: HALL EFFECT ENDSTOP

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

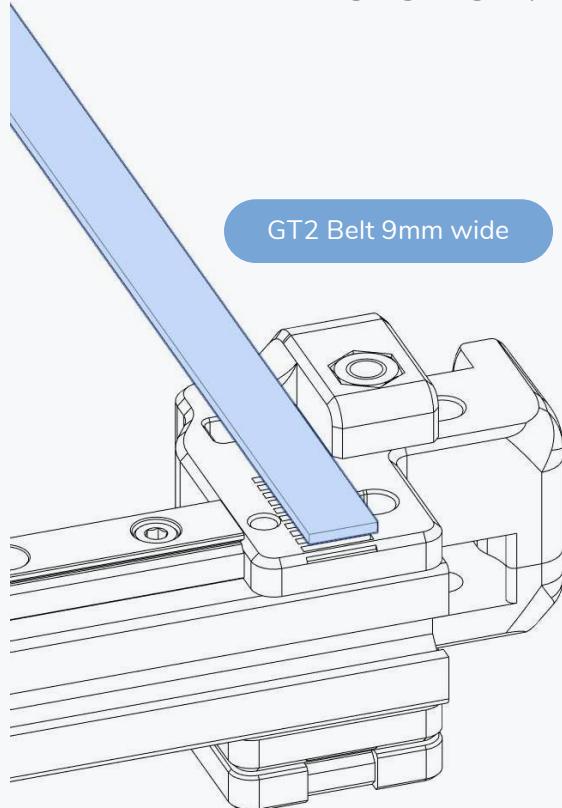
M5 Nut



Z BEARING BLOCKS

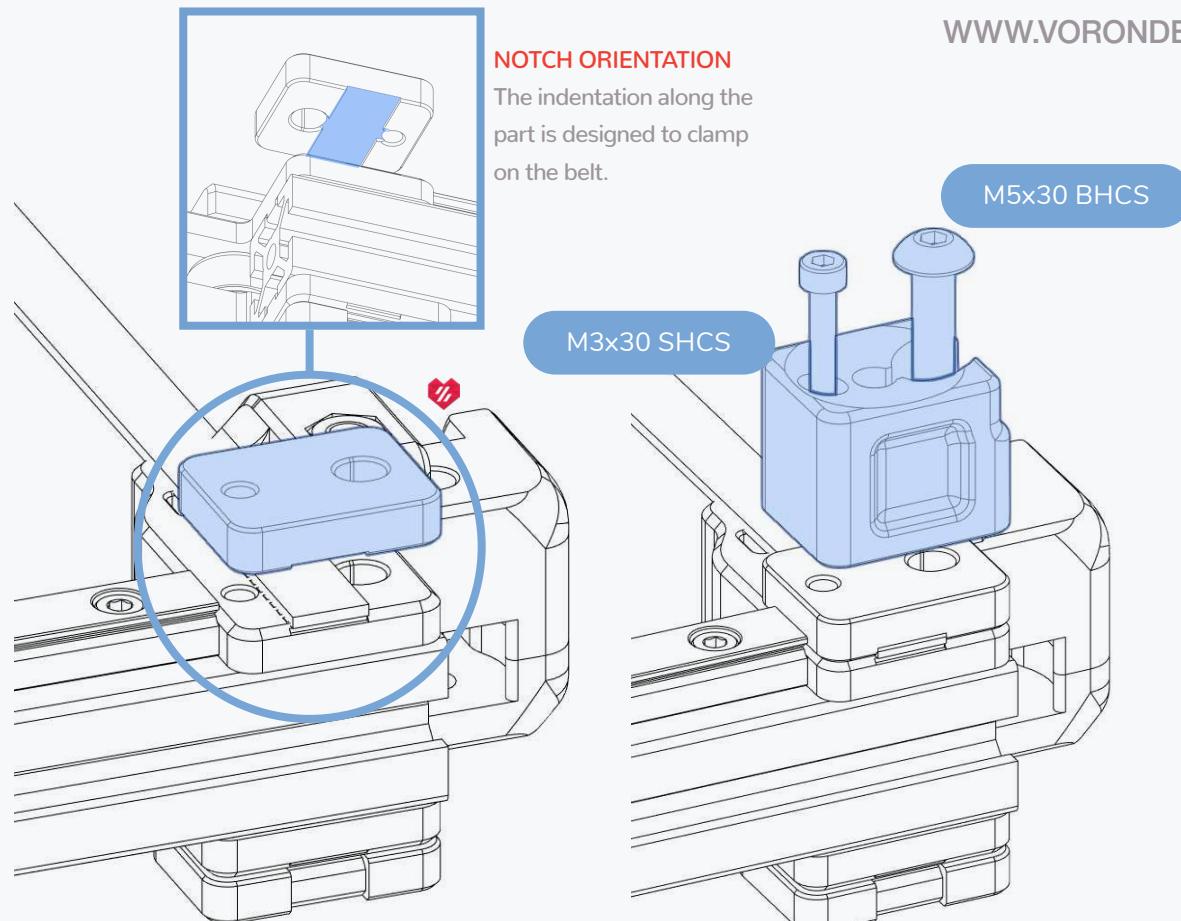
GANTRY IS STILL UPSIDE DOWN

It's a lot easier than fighting with gravity.



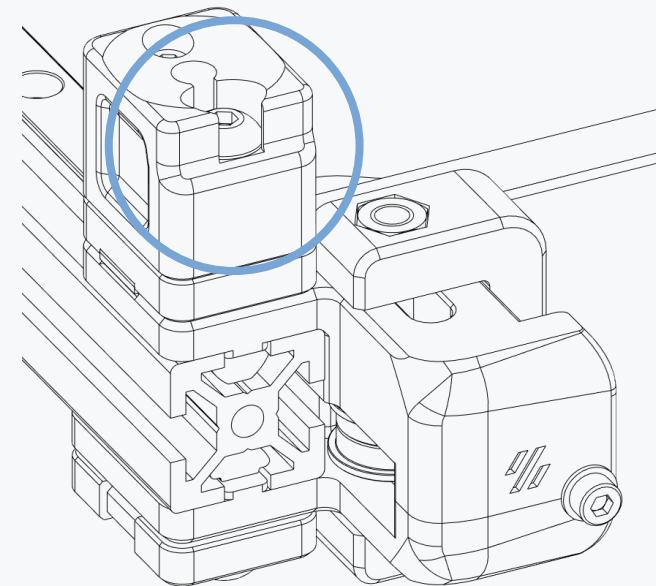
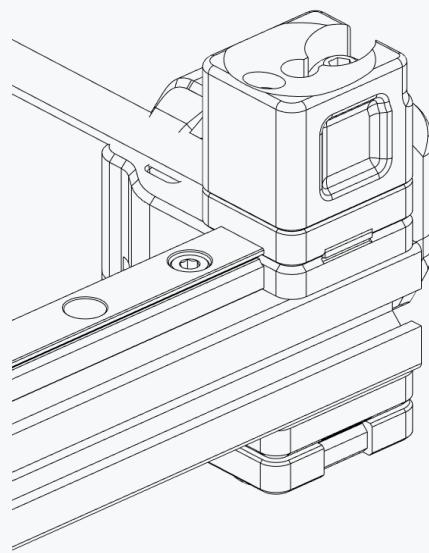
TEETH DOWN

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



MINIMUM RECOMMENDED BELT CUT LENGTH

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

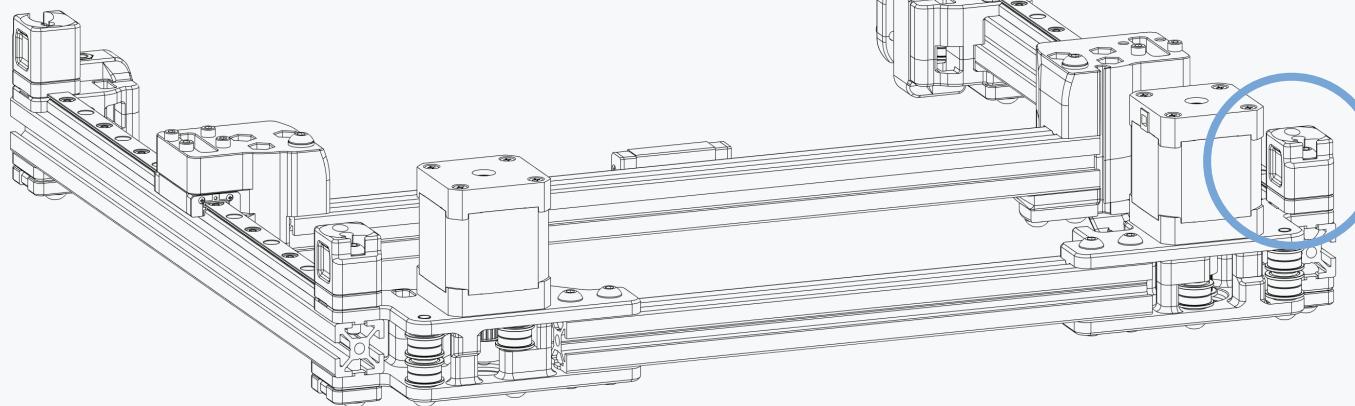
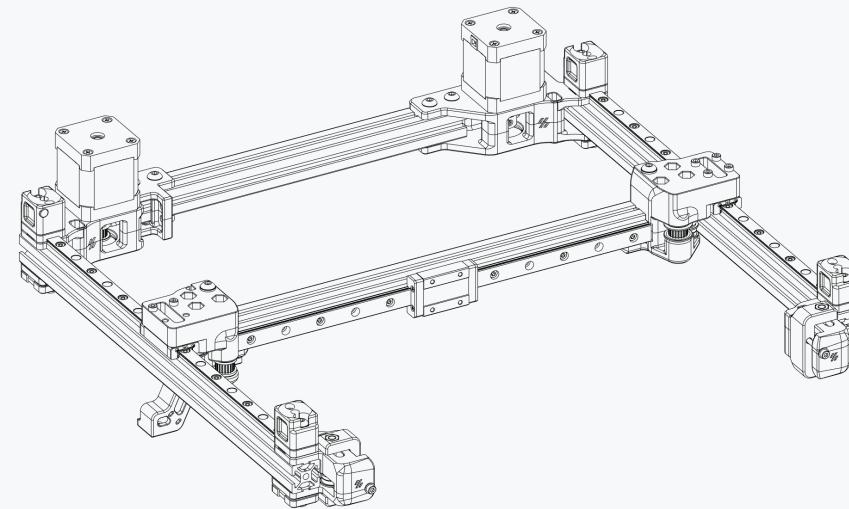


MIND THE PART ORIENTATION

The cutout goes towards the outside.

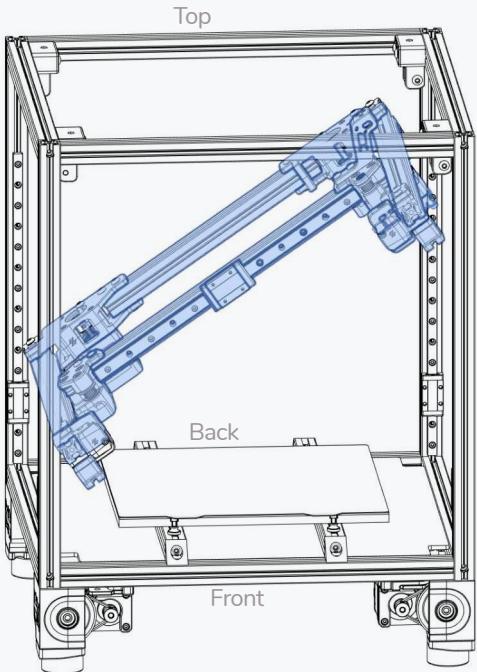
REPEAT BELT INSTALL FOR ALL 4 BLOCKS

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

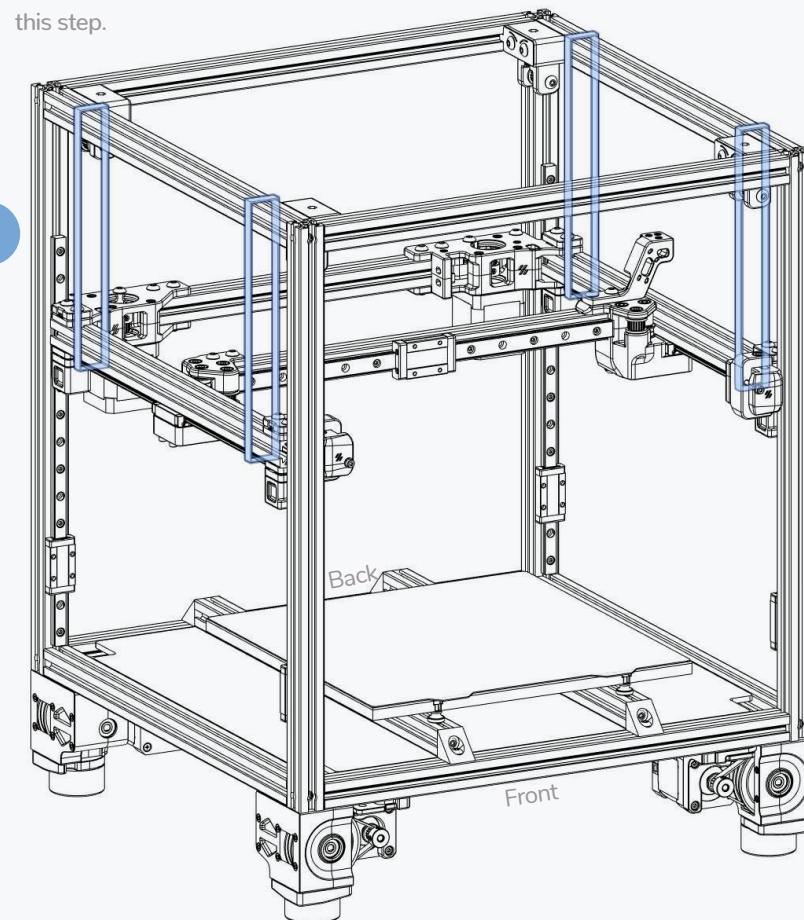


OPTION: HALL ENDSTOP

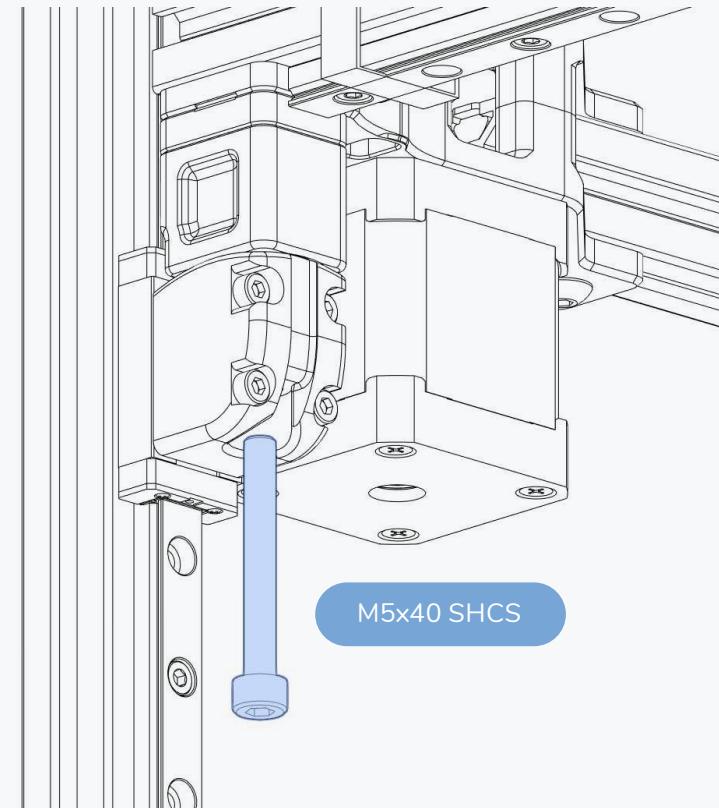
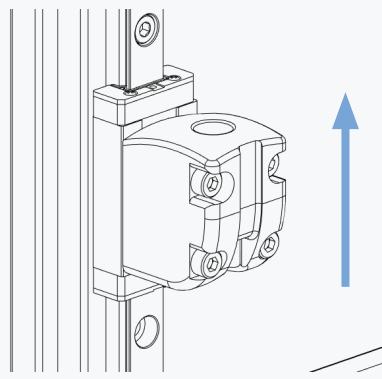
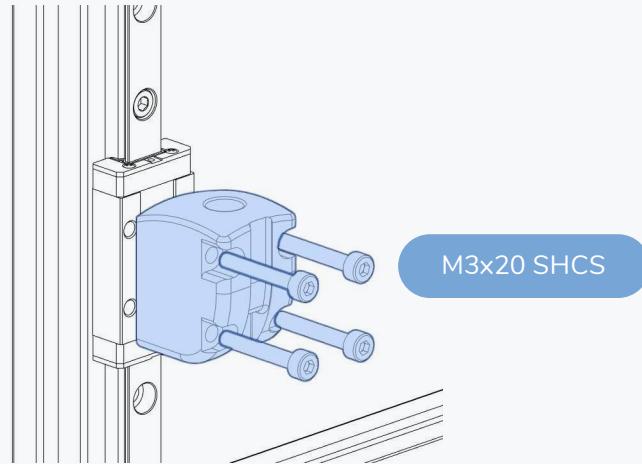
Install the block with the magnet in this position. The magnet faces the XY joint.

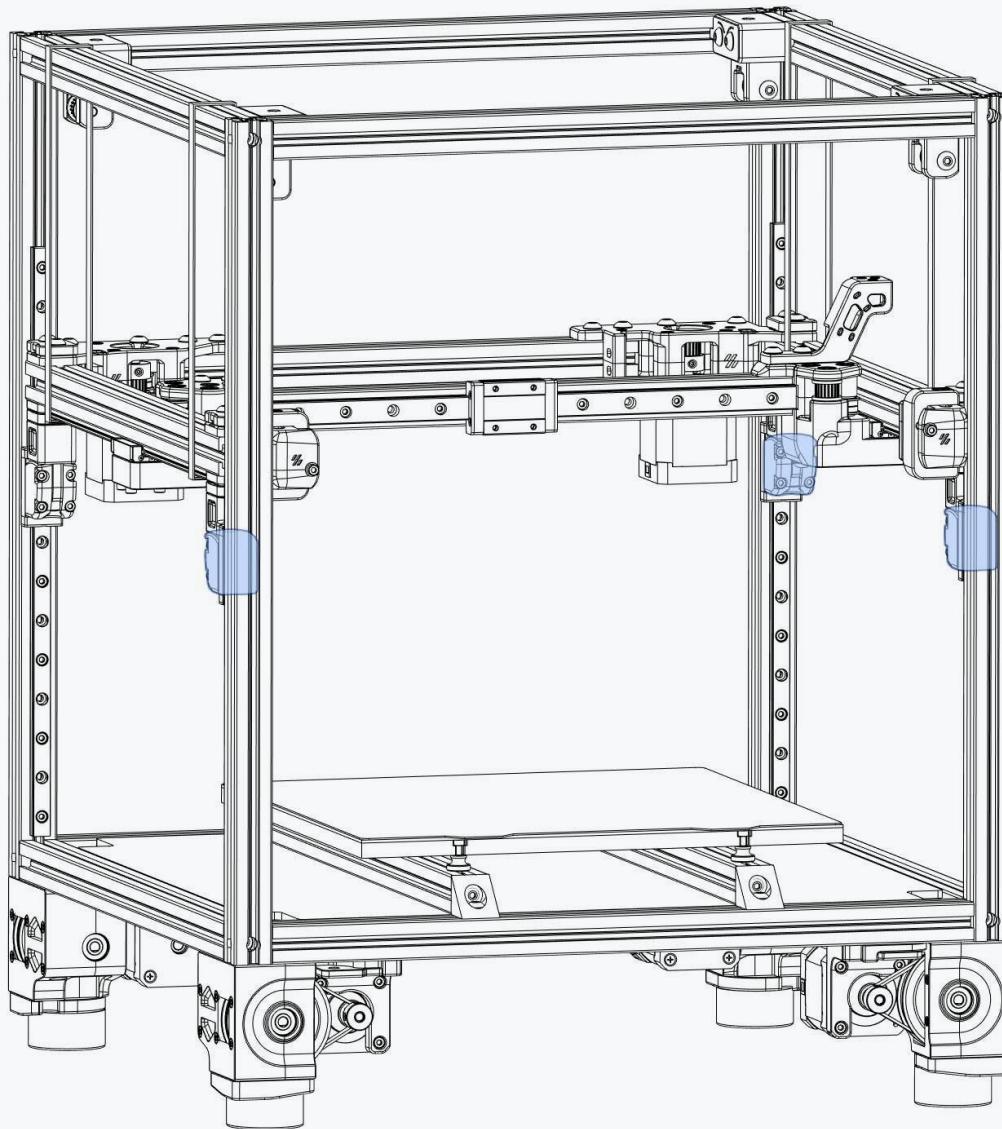
**INSERT AT AN ANGLE**

Tilt the gantry to move it past the uprights.

Long Zipties**A HELPING HAND**

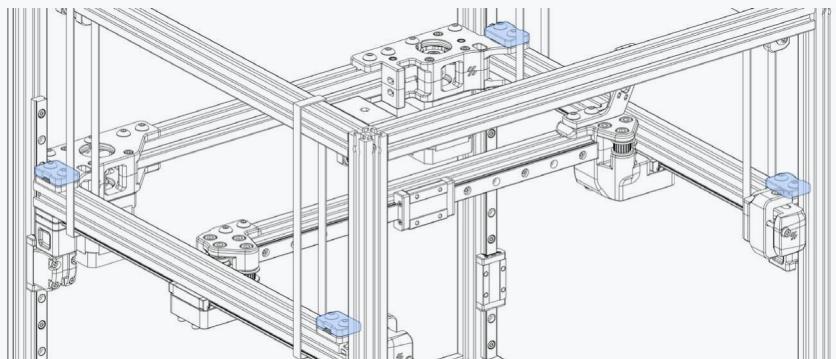
Secure the gantry with long zipties or similar while the gantry is being installed. An extra pair of hands helps with this step.



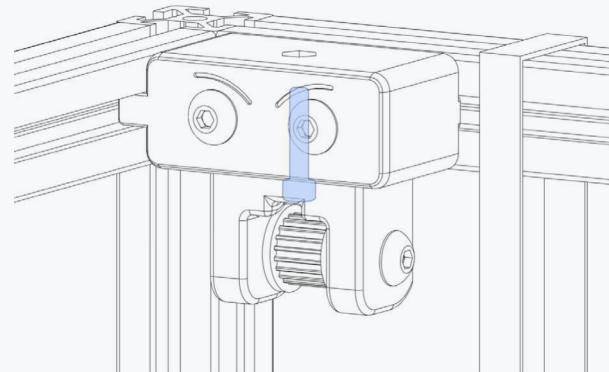


INSTALL REMAINING JOINTS

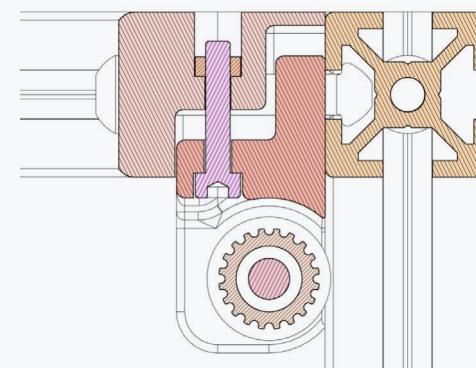
Add the other 3 joints repeating the same steps.

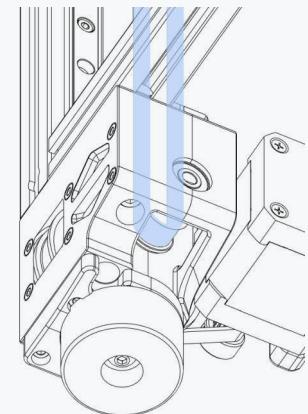
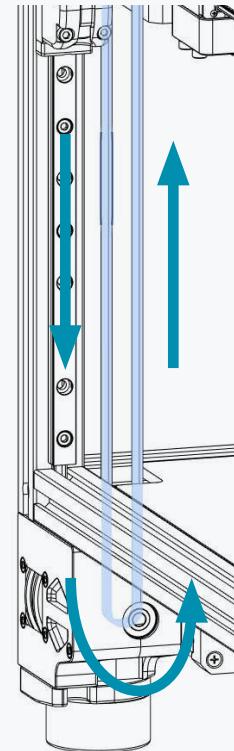
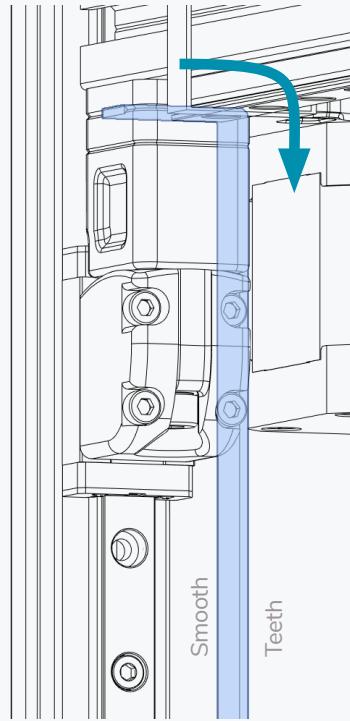
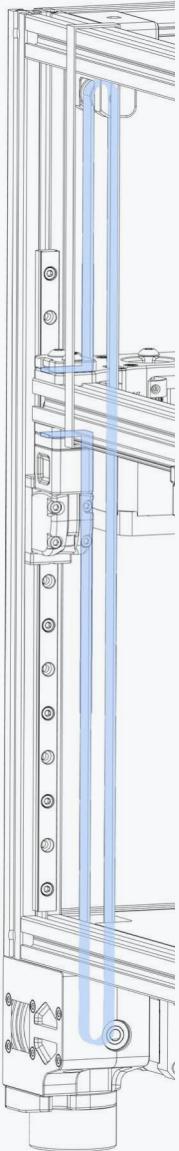
**LOOSEN TOP BELT CLAMPS**

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.

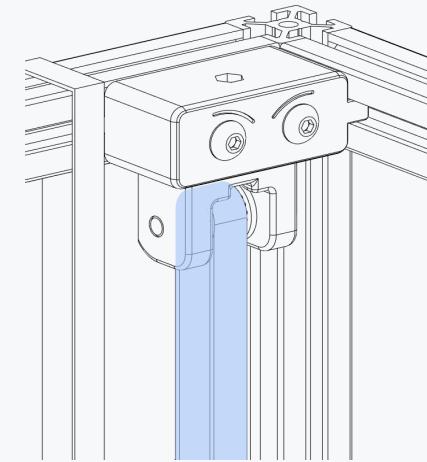
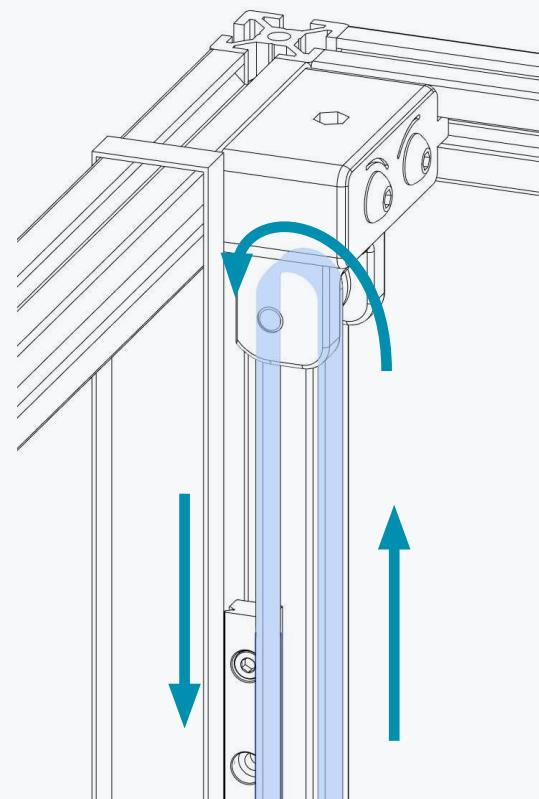
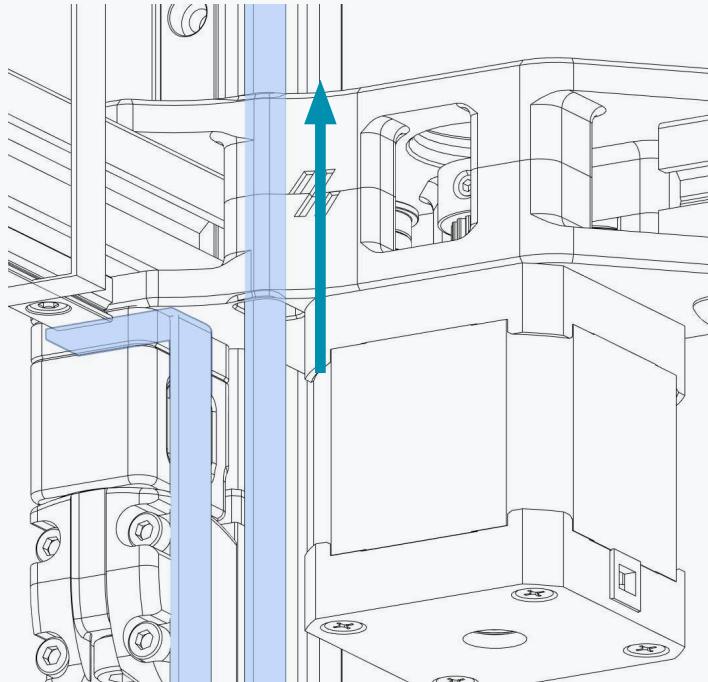


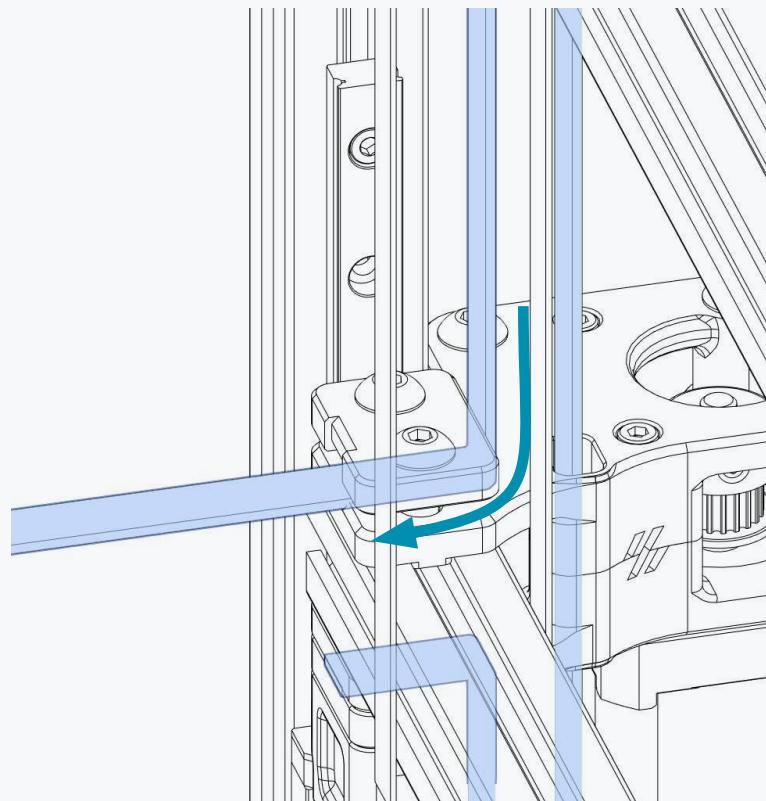


Z BELT ROUTING

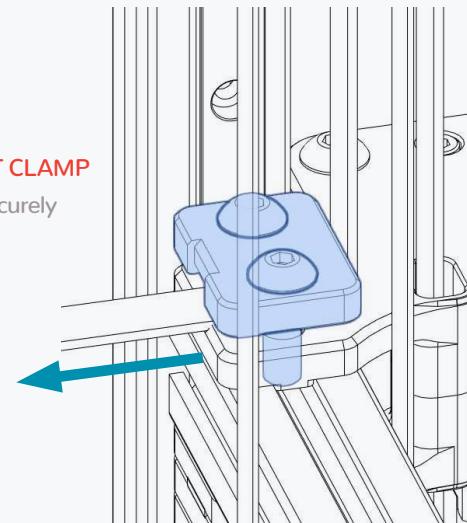
Follow the path pointed out by the arrows.
Needle nose pliers, tweezers or similar tools
can help in this step.

The belt teeth are on the inside of the loop.

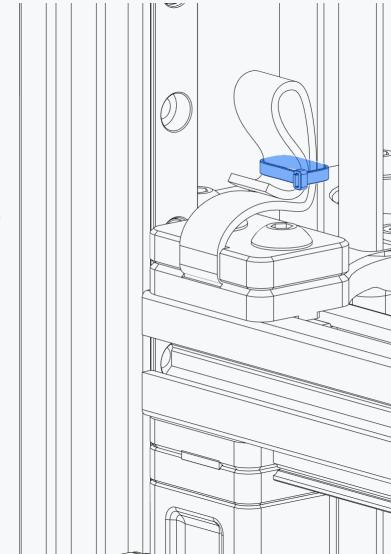


**PULL TIGHT AND SECURE BELT CLAMP**

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

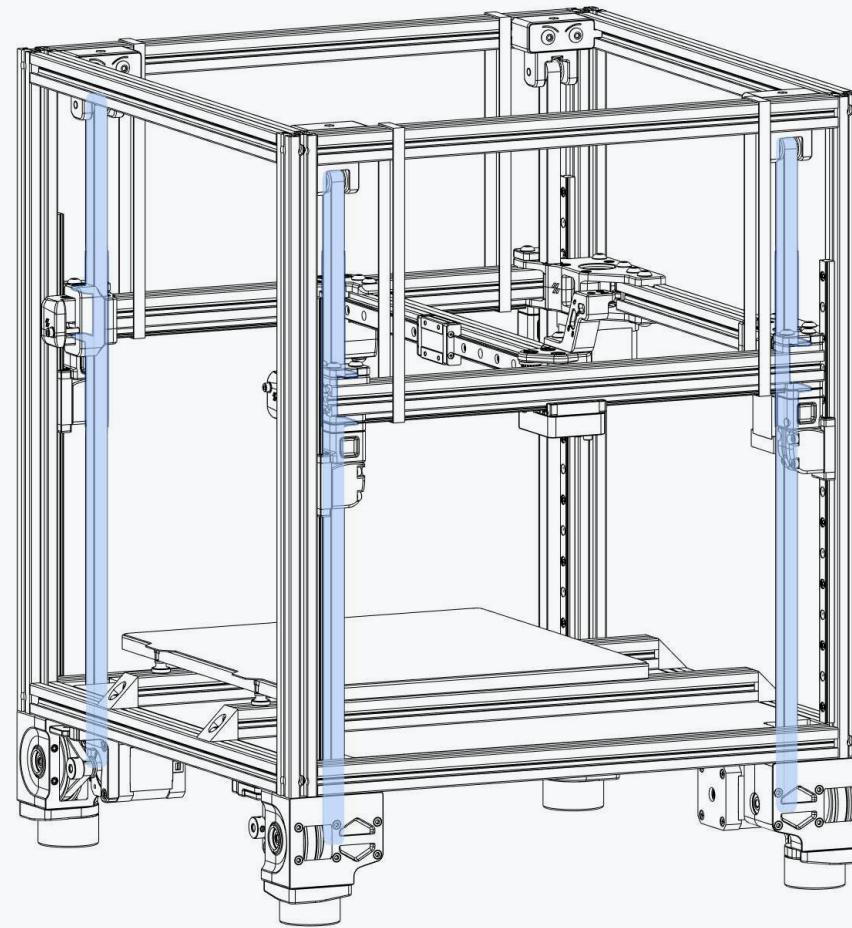
**EXCESS BELT**

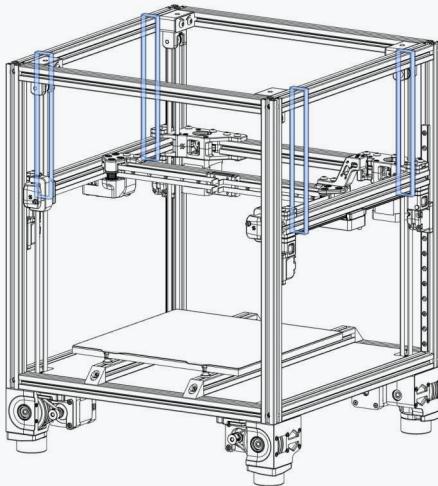
Fold the excess belt over and use a small ziptie to secure the end.



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

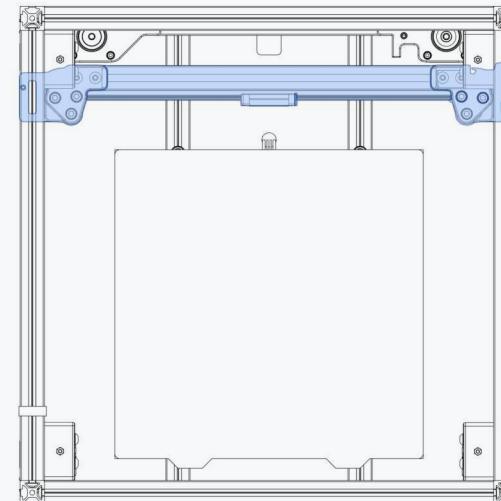
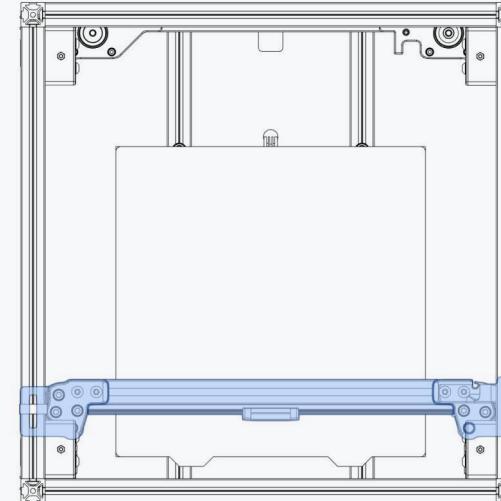
Move the gantry all the way back until it hits the A and B drive on both sides.

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/cekh81>



Voron2.0 was never officially released.

A/B BELTS

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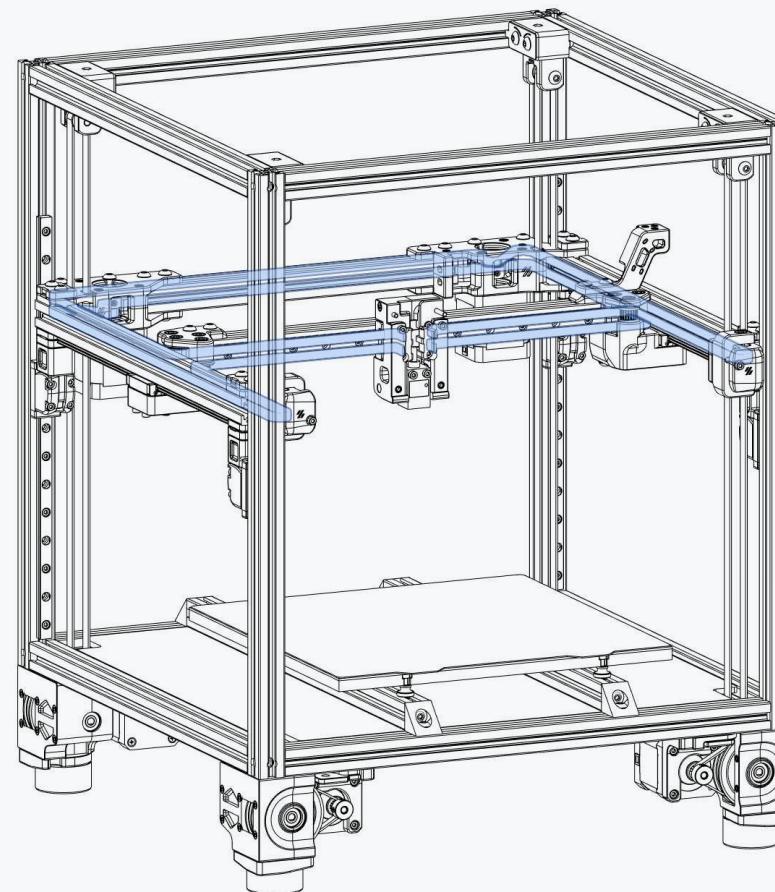
THE VORON BELT PATH

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>

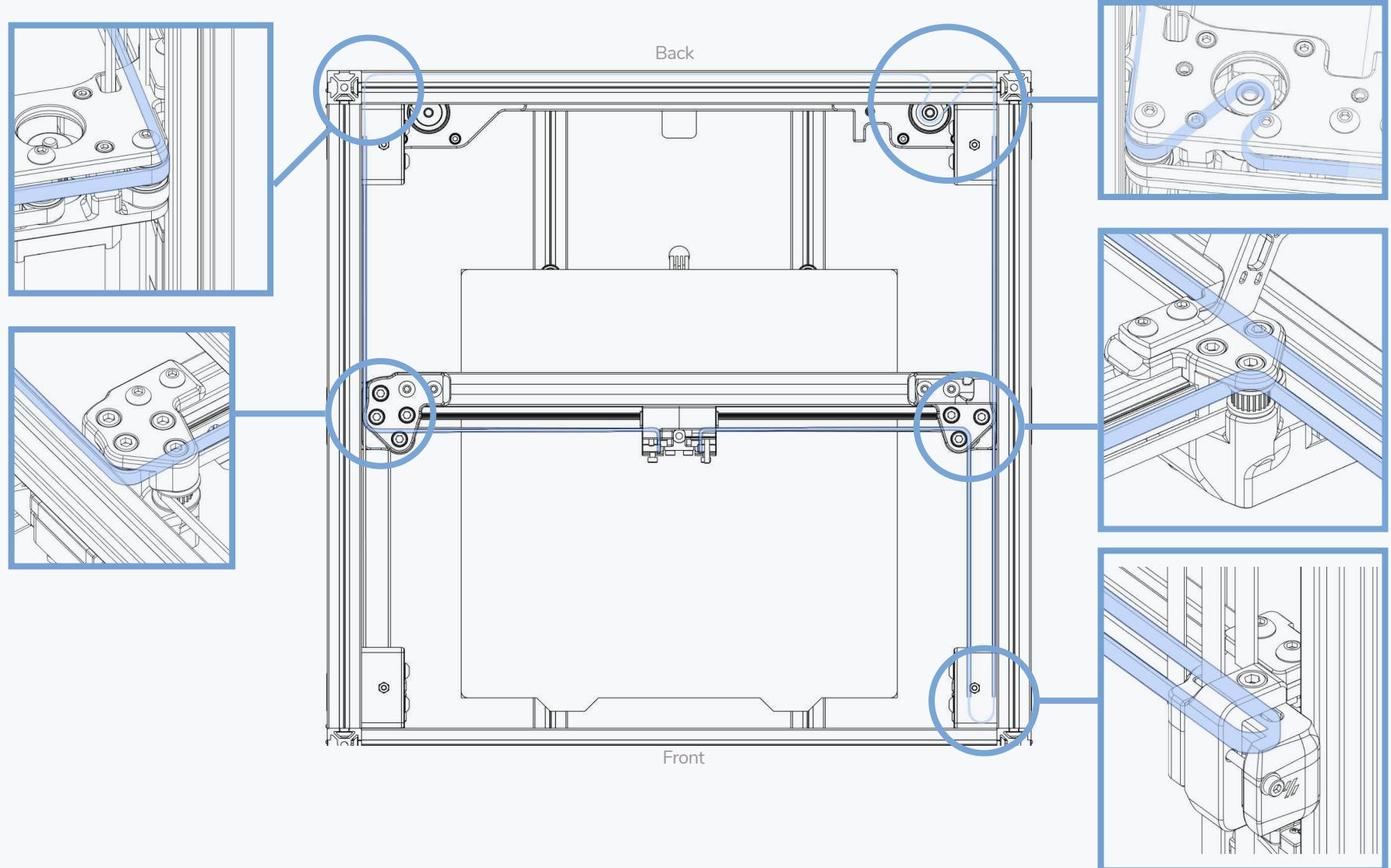
Equal belt tension is important to the proper function of a CoreXY motion system.

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.



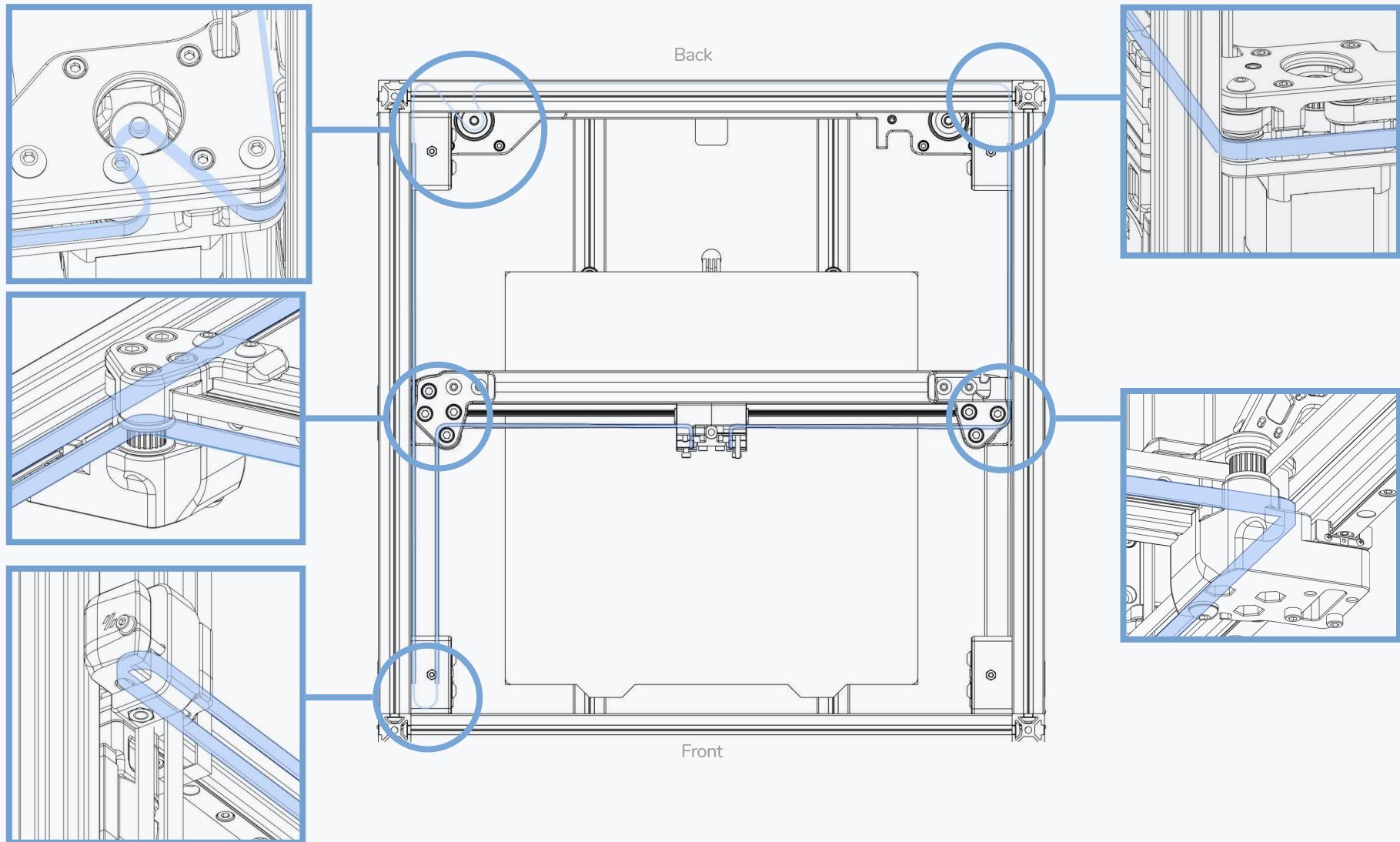
OVERVIEW - A BELT

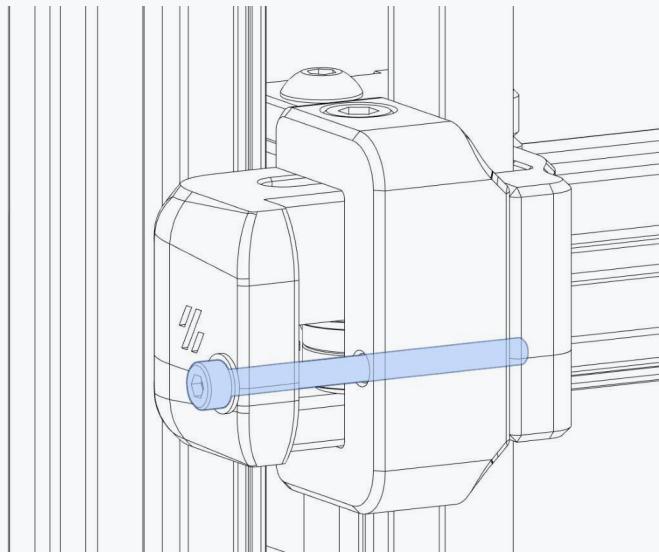
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OVERVIEW - B BELT

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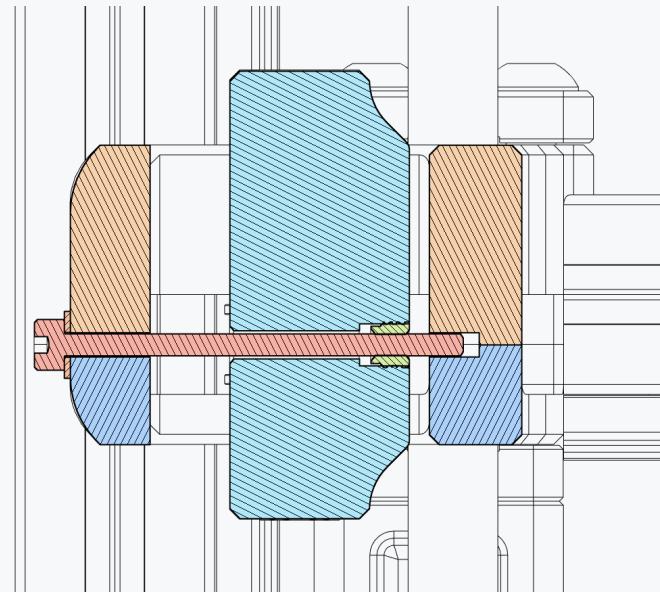


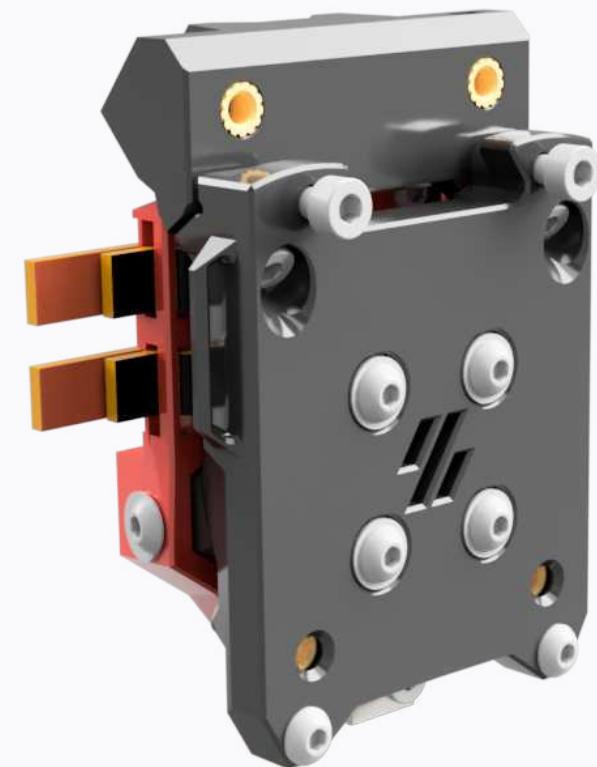
EXTEND IDLER

Loosen the idler bolt to extend the idler.

Once extended to the maximum tighten 4 turns.

Repeat for the second idler.





VORON TAP

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

VERSION 2022-12-16

INTRODUCTION

Jonklik
Jon Frank AF
Jon Corvinus
DragonKitty
Rastafire
MAZ
Zwncho
Shenz
Tunnt99
Hagbard
Wthomasforsius



Before you begin this 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. This machine can start a fire.

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!

Badnoob.

Hawt

lifisah

Lolmodule
Thebrakshow
Takuya
ByThorsThunder

Blammo
ToxGunn
DarkNeutrino
Trippinonaduck
Deutherius
yosdn
Neri
Clee

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Printed Parts Diagram	14
BOM	15
Hardware and Tools	16
Assembly	18
Toolhead Install	34
Release the Magnets!	36

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)

INFILL TYPE

Grid, Gyroid, Honeycomb, Triangle or Cubic

MATERIAL

ABS or ABS+

INFILL PERCENTAGE

Recommended: 40%

LAYER HEIGHT

Recommended: 0.2mm

WALL COUNT

Recommended: 4

EXTRUSION WIDTH

Recommended: Forced 0.4mm

SOLID TOP/BOTTOM LAYERS

Recommended: 5

FILE NAMING

The STL files for our parts are available in our [Github repository](#). The parts use this naming convention:

PRIMARY COLOR

Example `Tap_Front.r1.stl`

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

ACCENT COLOR



Example `[a]Tap_Center_r1.stl`

We have added “[a]” to the front of any STL file that is intended to be printed with accent color. The parts are marked with a heart in the manual.

PART VERSIONING

Example `Tap_Front_r1.stl`

Part names will have a revision number at the end (e.g., “r1”). It is normal for revision numbers to not match up: not all parts are changed for every revision. Always see the Github repository for the latest parts.

HOW TO GET HELP

If you need assistance with your build, we’re here to help. Head on over to our Discord group, Forum, or to Reddit and post your questions. We have a great community that can help you if you get stuck.



<https://discord.gg/voron>



<https://forum.vorondesign.com/>



<https://www.reddit.com/r/VORONDDesign>

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-Tap/issues>). When raising an issue, please include the relevant page numbers and a short description. Annotated screenshots are also very welcome and helpful. 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. For additional information, we recommend downloading the CAD file from our [Github repository](#). It can sometimes be easier to follow along when you have the whole assembly in front of you.



<https://github.com/vorondesign>

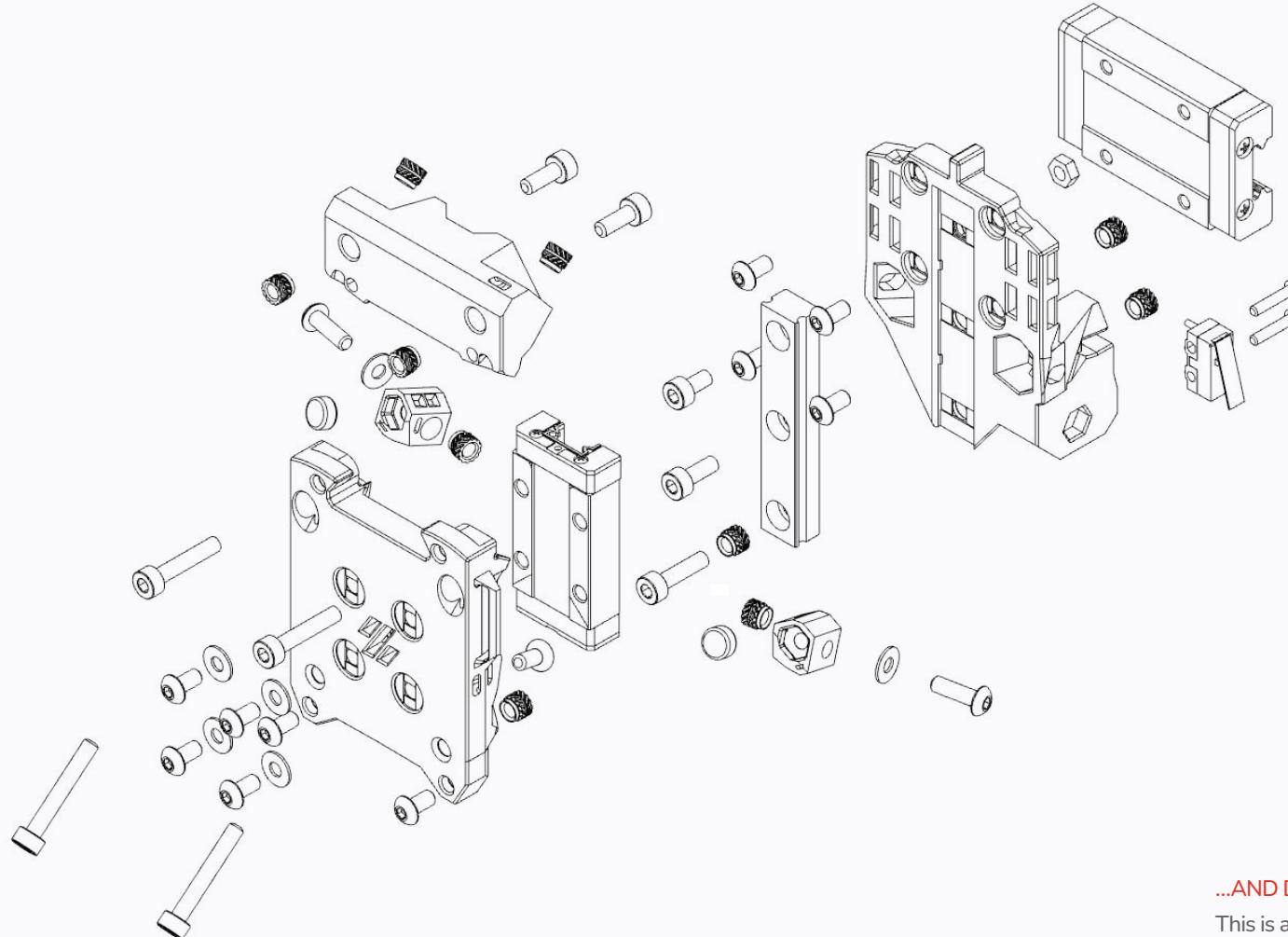


<https://docs.vorondesign.com>

AN ASSEMBLY MANUAL?

We need to write an assembly manual?

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...AND DONE.

This is all you need to see, really.
But, just in case though, read
through this document carefully.

WHAT IS TAP?

Tap is a nozzle-based z-probe for the V2 and Trident printer designs. The entire toolhead moves to trigger an optical switch.

Tap offers many advantages over other z-probes; Here are a few examples:

EXTREME PRECISION

A well constructed Tap, when in service on a well-constructed printer, will be able to measure your Z position reliably with a precision of 0.4 µm (0.0004 mm). This precision will help you better use and maintain your printer.

ANY BUILD SURFACE, CHANGE AT WILL

Tap can measure any securely mounted build surface. Print on Glass, Garolite, Alumina, Moon dust...it no longer matters. Textured plates are ideal for Tap, but adhesive PEI sheets may also be used. Tap is unaffected by beds with magnetic fluctuations (note: magnets may affect the build surface Tap is sensing, such as pulling the plate tighter over the magnet). Once Tap is setup, you should not need to recalibrate after changing nozzles or build plates.

VORON DURABILITY, HIGH TEMPERATURE OPERATIONS (OPTICAL SENSOR VERSIONS)

Tap uses light to detect movement and will never wear out. The sensor in Tap is rated to operate at 70C to 100C and will not degrade over time the way a contact switch or inductive probe can. Even if you brought your chamber temperature to 100C, it will accurately and reliably record your printer melting (assuming you printed in ABS). We tested dozens of printers and thousands of print hours. Hundreds of PIF quality kits were printed using Tap. Some test printers had over 1,000,000 probe cycles to test durability.

NO COMPLICATED MACROS

For consistent probing temperatures, Tap uses a single 'activate_gcode' macro in the [probe] config. Tap is always ready to probe and requires no docking or undocking moves.

Z ENDSTOP ELIMINATION

There is no need for a separate Z endstop. Once the offset is configured, it will hold without appreciable drift. It is normal to need slightly different offsets when switching between filament types.

CRASH PROTECTION

With Tap installed, the nozzle and bed are protected from minor crashes (such as accidentally setting your Z to 1 mm below the build surface, or running into a curled up print). In extreme crashes, Tap can break away completely, saving you from a hidden break elsewhere in your printer.

SPECIAL WARNING ON Y POSITION:

Tap is ~3 mm thicker than the stock 2.4R2 and Trident X carriages. This places the toolhead closer to your doors. Make sure you have clearance, and you may need to adjust your bed position on V2 or Y travel on Trident.

HARDWARE REQUIREMENTS:**YOU MUST USE THE MGN12H X-AXIS**

You must already be using the MGN12 based X-Axis. Tap does not fit on the older MGN9 based X-axis.

CW2 STYLE MOUNTED EXTRUDER REQUIRED

Tap replaces the X-carriage mount, and requires that the mounting screws come in from the front of the carriage like CW2, not the back like CW1. There are mounts for LGX and Galileo available.

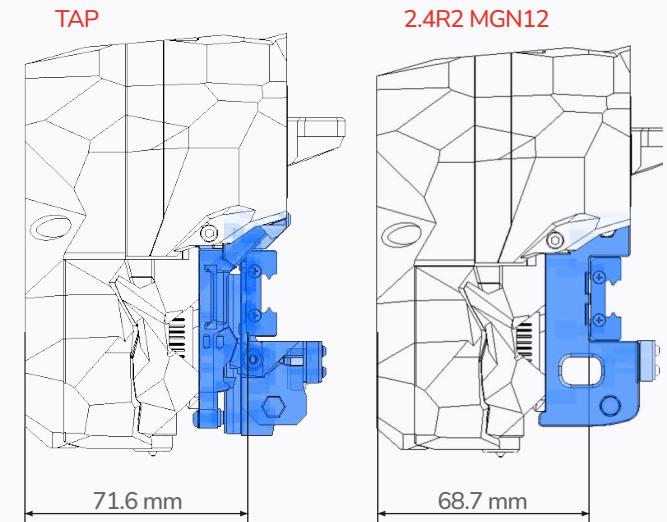
BED MOUNT MUST BE SECURE

When Tap is probing, the nozzle will contact the bed with a force of approximately 500-800 grams. Your bed should not move during this. Bed motion compromises the accuracy of Tap, so it is not recommended for Voron 1.8, Legacy, or Switchwire designs.

If you want to know if Tap is right for you, tap your finger on the bed firmly. If the bed moves, Tap is not right for you.

GOOD MECHANICAL CONDITION

Tap is far more precise than previous Z sensing systems, and we have found it can reveal previously unnoticed problems in a printer. If your printer has known mechanical issues (such as cracked components) fix them before attempting Tap.



TOOLHEAD ON A RAIL

With Tap, the entire toolhead (including Extruder) can move in the Z direction on a short MGN9 rail with a MGN9H carriage. In normal printing operation, the toolhead is held in place by a pair of magnets, acting on a pair of screws. During probing the toolhead lifts up slightly, activating a photointerrupter switch concealed in the mechanism.

OPTICAL SENSOR OR MECHANICAL SWITCH

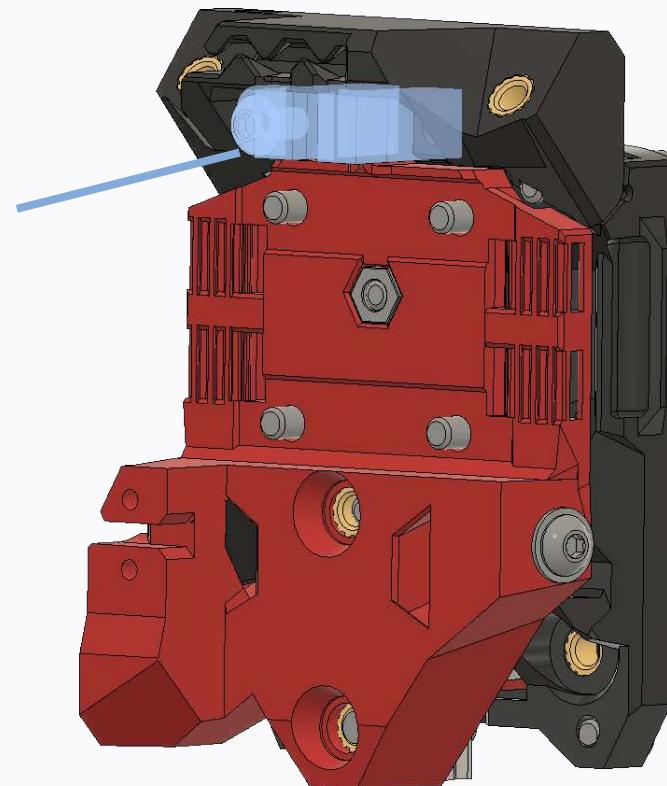
See the BOM for the sensor part numbers.

These are all tested and are known to work. If you ignore this advice and buy a random sensor off Amazon, it may not work.

The mechanical switch option is provided in case you cannot find the optical sensors.

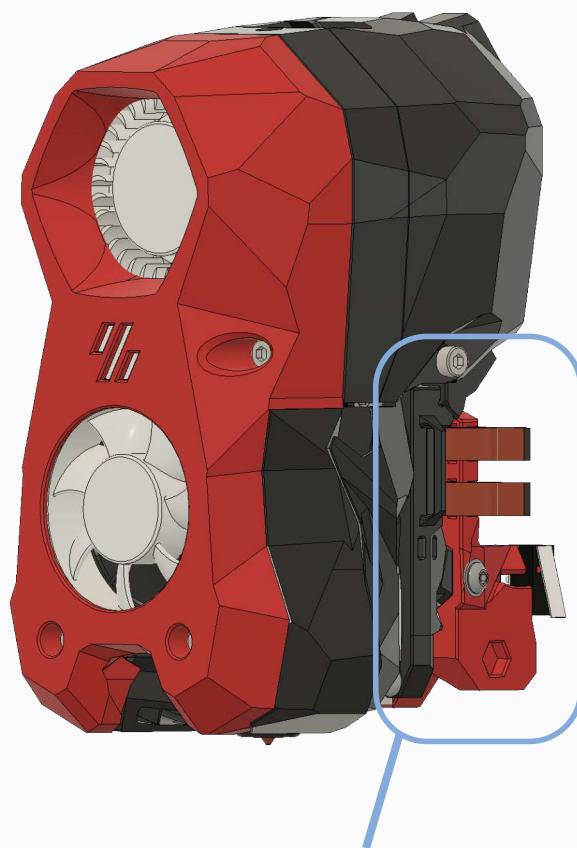
CENTER (RED)

Houses magnets, retains belts, and is connected to the MGN12H X-axis. Up top, there's a plastic tab that triggers the optical sensor.



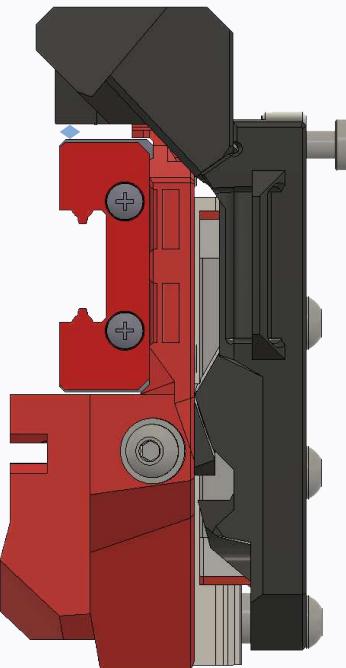
FRONT (BLACK)

Connects to the toolhead and extruder, rides on a MGN9 Rail, and houses the sensor.

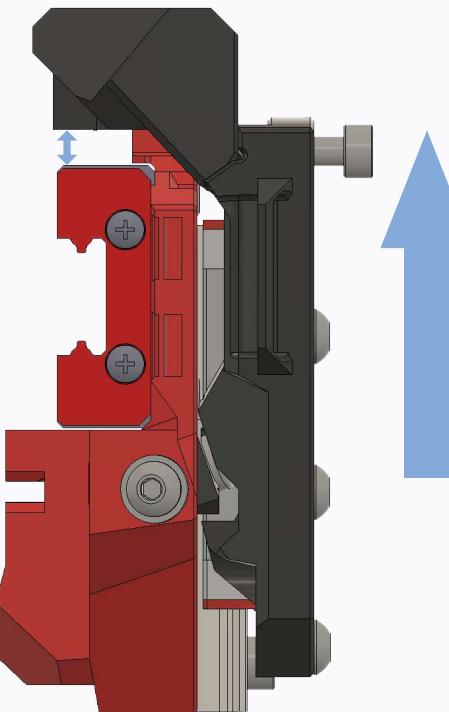
**TAP REPLACES THE X CARRIAGE**

Tap is a drop-in replacement for the X Carriage. The toolhead and extruder mount to Tap, which is mounted to the MGN12 X axis.

NORMAL OPERATING POSITION



TRIGGERED



Magnetic and gravitational forces keep the toolhead from shifting during printing. If the nozzle contacts something solid (like the bed), the black section of Tap and toolhead move up, and the optical sensor will trigger. There are stops built in to prevent it from moving too far, unless you really want the front to fall off.

CHOOSE TO USE EITHER THE WIRED OPTICAL SENSOR OR THE PCB-BASED SENSOR**WIRED OPTICAL SENSOR:**

Tap was designed to use an Optek OPB991 sensor (see BOM for part numbers)

Pre-release versions of Tap used OPB990 sensors. We switched to 991 because some MCU's were shown to be sensitive to having +5v on a signal pin.

These sensors are pre-wired, but you will have to add a 220 Ohm resistor to the wiring as a current limiter. The exact resistance is not critical, it can be +/- 10% of 220 Ohms, and should be rated for 1/4 watt or higher. Soldering this resistor is no harder than adding the diode for the old inductive sensors...but soldering isn't for everyone. See next page for details on soldering this together.

PCB-BASED SENSOR:

Recognizing that soldering is difficult for some builders, Voron engineers designed a PCB-based sensor. This mounts an Optek OPB666N or OPB971N sensor. This PCB has the advantage of having an indicator light on the board. The files for making this may be found on the Voron Github. <https://github.com/VoronDesign/Voron-Tap/tree/main/OptoTap>

MECHANICAL SWITCH D2HW-C203MR

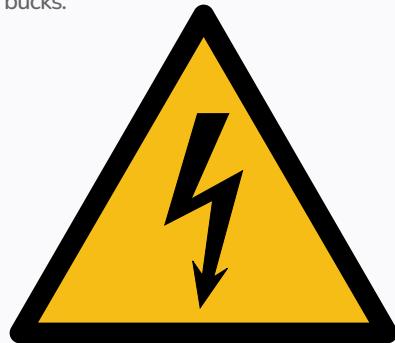
We've had a lot of supply issues with the optical switches. The mechanical switch is inferior to the optical choices, but still better than staying with a non-tap sensor. The only mechanical switch I can recommend is the Omron D2HW-C203MR (D2HW-C203MRS is identical for our purposes)

WHICH ONE IS BETTER?

Both optics and the mechanical are capable of 0.4 µm accuracy (assuming the rest of the printer is in good condition). If you can, get the optical PCB-based sensor. Having an indicator light is a big plus, and the OPB666N sensor is good to 100° Celsius operating temperature. The OPB991 and OPB971 sensors are rated to 70° Celsius which should be fine for most Voron printers. The sensor is away from significant sources of heat.

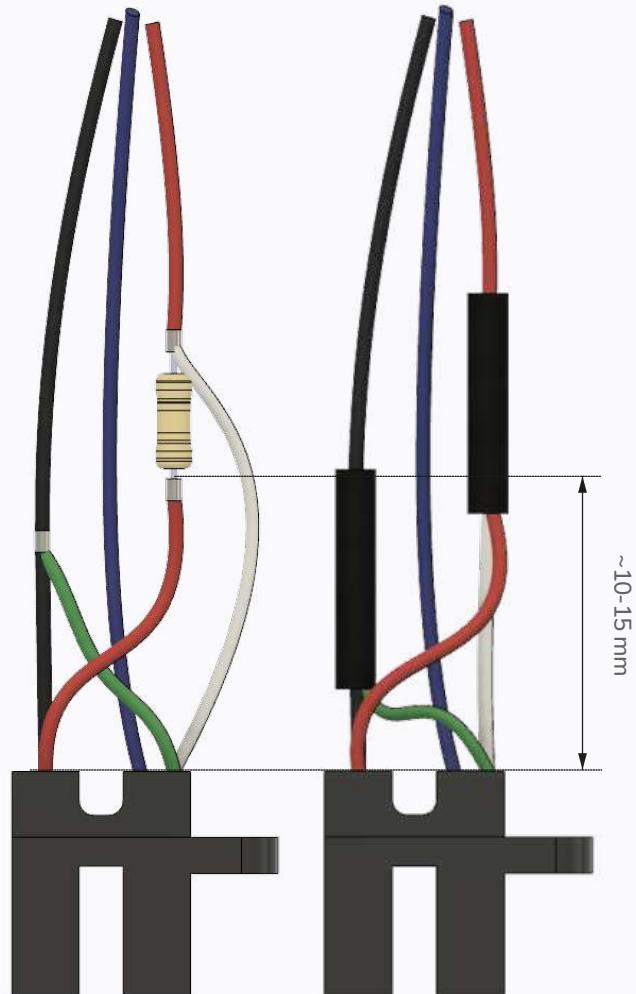
IF YOU PURCHASE A PREBUILT PCB-BASED SENSOR

Make sure it's based on either an Optek 971N51 or OPB666N sensor, and it's designed to work with Tap. Don't buy a generic sensor and expect it to work, this is not the place to save a couple of bucks.

**MAKE SURE YOUR SENSOR CAN HANDLE YOUR VOLTAGE**

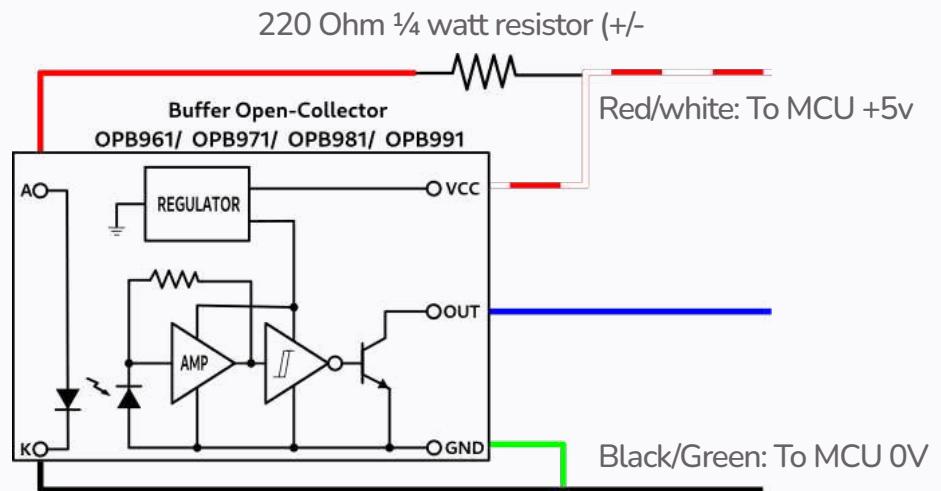
V1 PCBs and the wired optical sensors were designed for 5 volts, 24 volts is more than 5 volts.

Connecting to 24 volts may appear to work at first, but the sensor will burn out.



HOW TO CONNECT THE WIRED OPTICAL SENSOR

1. Solder the red wire to one side of resistor.
(Approx. 10-15 mm away from the sensor body)
2. Solder the white wire to the other side of resistor.
3. Solder the black and green wires together.
4. Cover all solder joints and the resistor with shrink tube.
5. Connect the red wire to +5 volts, blue wire to the signal pin of your MCU, and the black wire to ground (0 volts).

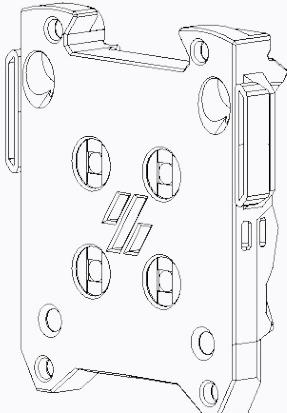


PRINT THESE FOUR PARTS

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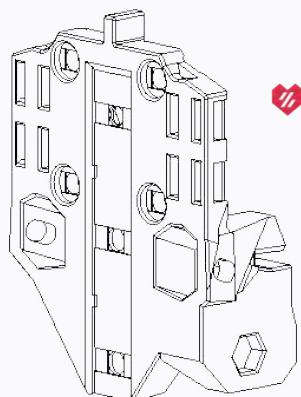
FRONT

Tap_Front_r1.stl



CENTER

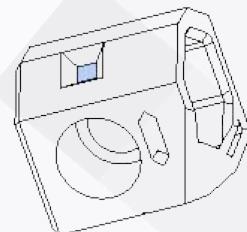
[a]Tap_Center_r1.stl



RIGHT MAGNET HOLDER

Tap_Magnet_Right_r1.stl.

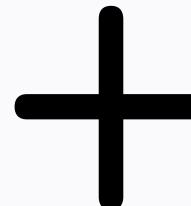
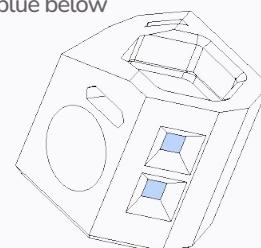
Notice one dot (blue) on the right.



LEFT MAGNET HOLDER

Tap_Magnet_Left_r1.stl. Note

the left has 2 dots marked in blue below

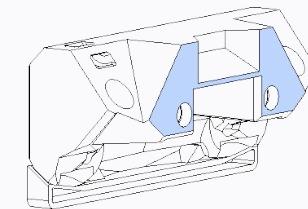


PRINT ONE UPPER

Which upper to print depends on the sensor choice:

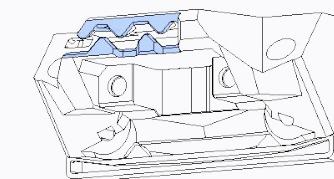
PCB-BASED SENSOR:

Use **Tap_Upper_PCB_r1.stl** if you use the PCB-based sensor.



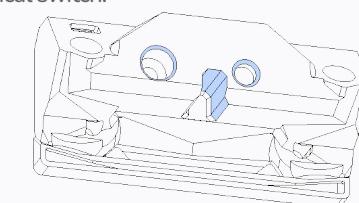
WIRED SENSOR:

Use **Tap_Upper_Wired_r1.stl** if you use the wired sensor. Notice the wiring channel in blue.



D2HW-C203MR SWITCH

Use **Tap_Upper_D2HW_r1.stl** if you use the mechanical switch.



BILL OF MATERIALS (BOM)

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Qty	Description	Notes
1	50 mm MGN9 rail	See cutting guide in this manual for details.
1	MGN 9H carriage	Medium preload (Z1) is preferred, light or no preload will also work. Carriage must be removable from rail.
2	6 mm x 3 mm magnet	6 mm diameter by 3 mm tall cylinder. N52 strength is preferred , N35 or higher strength is required.
11-12	M3 heat-set insert	These are standard Voron inserts, 5 mm diameter 4 mm long. 11 for optical versions, 12 for the D2HW version.
1	M3 hex nut	ISO 4032 / DIN 934
6	M3 washer	ISO 7089 / DIN 125 7 mm outer diameter, 0.5 mm thickness
2	M3 x 20 SHCS	ISO 4762 / DIN 912 socket head cap screw
2	M3 x 16 SHCS	ISO 4762 / DIN 912 socket head cap screw
1	M3 x 12 SHCS	ISO 4762 / DIN 912 socket head cap screw
3	M3 x 8 SHCS	ISO 4762 / DIN 912 socket head cap screw
1	M3 x 6 SHCS	ISO 4762 / DIN 912 socket head cap screw
2	M3 x 6 FHCS	ISO 10642 / DIN 7991 flat head cap screw MUST BE MAGNETIC, NO STAINLESS!
2	M3 x 10 BHCS	ISO 7380-1 button head cap screw
10	M3 x 6 BHCS	ISO 7380-1 button head cap screw

PCB-Based Sensor option

1	OptoTap PCB	See Github repository https://github.com/VoronDesign/Voron-Tap/tree/main/OptoTap
1	OPB Sensor	Two known good part numbers: OPB 666 N, OPB 971 N51

Wired Sensor option

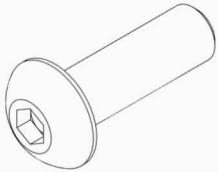
1	220 Ohm resistor	¼ Watt, +/- 10% (or better) tolerance resistor. For example, CFR-25JB-52-220R
1	OPB Sensor	Four known good part numbers: OPB 991 P51Z , OPB 991 L51Z, OPB 991 T51Z, OPB 991 T11Z

OMRON D2HW-C203MR Switch option

1	D2HW-C203MR	Can substitute D2HW-C203MRS, they are identical except the "S "has a UL rating. Digikey US link
1	M3x8 BHCS	If you have sufficient clearance to the cable chain, a SHCS can be used here instead

HARDWARE REFERENCE

WWW.VORONDESIGN.COM



BUTTON HEAD CAP SCREW (BHCS)

Metric fastener with a domed shape head and hex drive.

ISO 7380-1



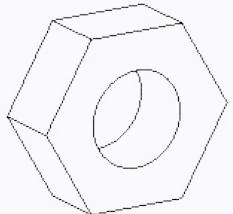
FLAT HEAD COUNTERSUNK SCREW

(FHCS)

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

MUST BE MAGNETIC, NO STAINLESS!

ISO 10642



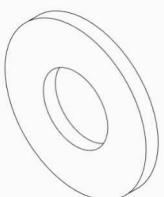
AW, NUTS!

Actually, its just the one nut.

We don't like nut pockets either, but sometimes its the right move.

Metric fastener. Only used in M3 size.

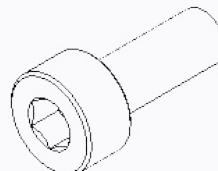
ISO 4032



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.

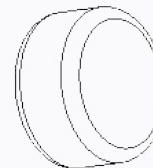
DIN 125



SOCKET HEAD CAP SCREW (SHCS)

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

ISO 4762

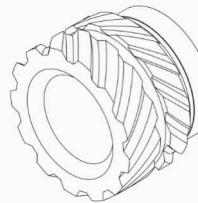


MAGNETS

How do they work?

These are round 6mm in diameter by 3 mm tall. Shorter ones are OK.
(down to 2.7 mm)

N52 are preferred, but N35 can work
Lower strength might cause ringing
at high acceleration.



HEAT-SET INSERT

These are made of brass , threaded on the inside and has ridges on the outside. Heat them up to approx 250C with a soldering iron and push them into the plastic.

As the plastic cools, it solidifies around the knurls and ridges on the insert for excellent resistance to both torque and pull-out.

SOLDERING IRON

We use this for setting heat-set inserts into parts. Depending on your sensor choice, you might be soldering some wires together.

ANGLE GRINDER/DREMEL

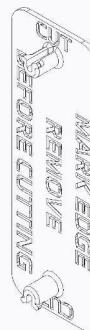
If you can't find a pre-cut 50 mm MGN9 rail, you'll need to cut down a longer one. Leave your grandfather's trusty hacksaw in the toolbox: rails are usually hardened steel.

VISE

A vise is handy if you have to cut your MGN9 rail. A vise may also be helpful when putting magnets in their holders.

WIRING CRIMPER

You'll need this to wire up the sensor. Or maybe theres a turnkey solution out there you can buy, check Discord. If you got this far without learning how to crimp, we don't judge.



PRINTED CUT GUIDE

If you have to cut your MGN9 yourself, this can help you mark the places to cut. Remove the tool before cutting, or you will melt it to the rail.

SUPERGLUE

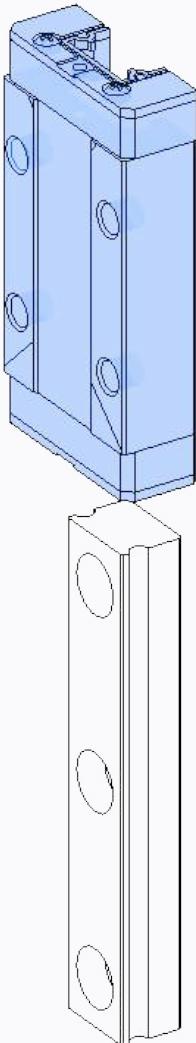
Yes, we consider this a tool. Superglue is useful as a plastic safe threadlock, and magnet glue. Cheap, single-use gel tubes are fine.



MGN9 ASSEMBLY TOOL

We love this thing. Print it. You will need it.

Marvel at its simplicity and wonder why you never thought of it before.



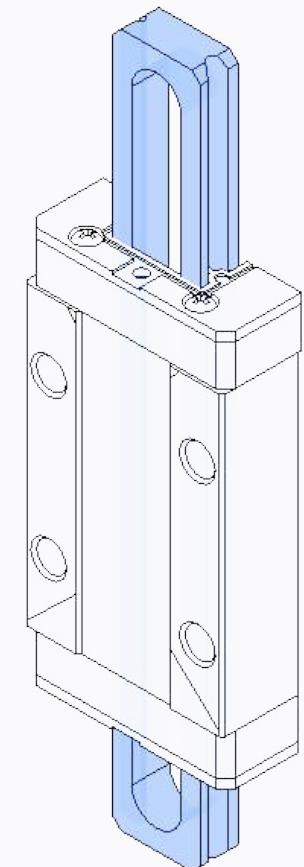
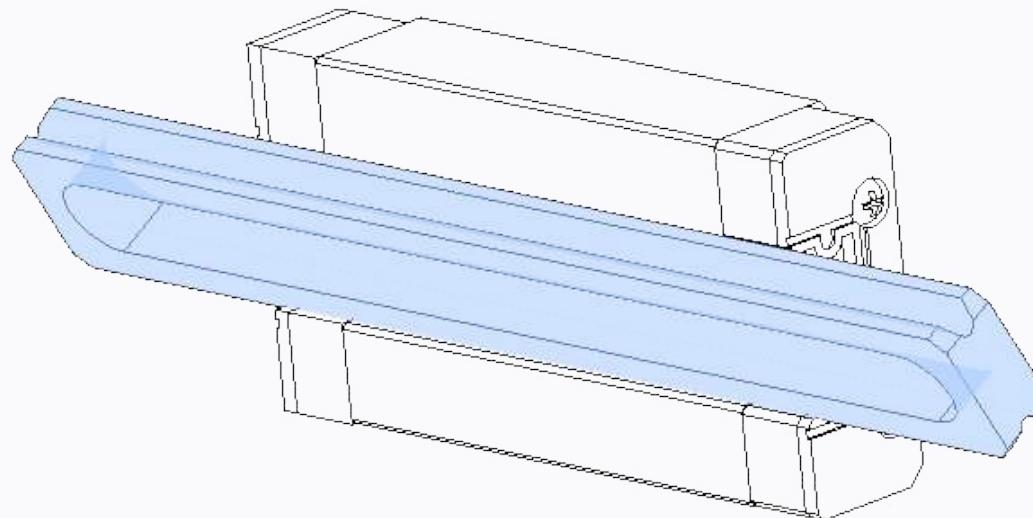
CAREFULLY REMOVE THE CARRIAGE

Do this over a bowl or other container, just in case a ball drops out. If some do, don't panic! They can be pushed back in, just add the balls back to the middle of the carriage.

MGN9 ASSEMBLY TOOL

Fit the tool over the bearings on one side. Squeeze the sides of the tool and rotate it to fit it over the other side's bearings, then release pressure.

The tool serves to hold the balls in place when not installed on a rail, and will help you reinstall the carriage later. Not bad for a 7 minute print, right?

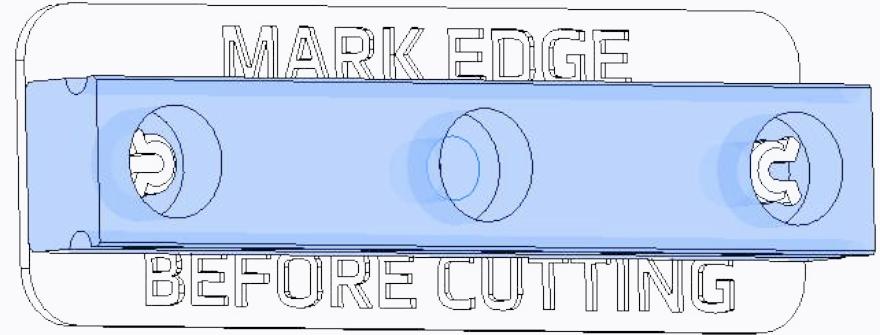
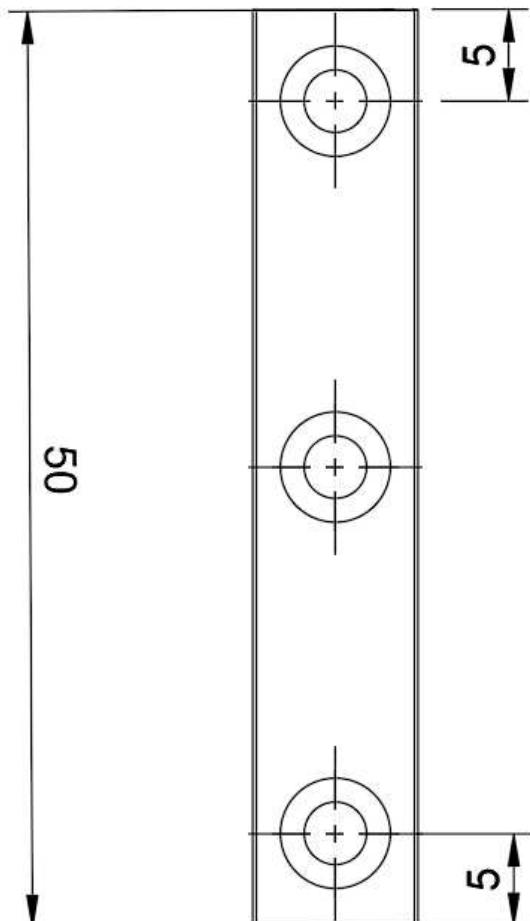


MGN9 CUTTING GUIDE

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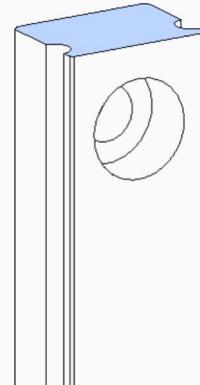
ENDS CAN BE +/- 1 MM OFF FROM THIS
DRAWING

Just make sure you have 3 holes spaced
like so. One in the center, and the other
two ~ 5 mm from the ends.



USE THE GUIDE TO MARK WHERE TO CUT

If you have a longer rail you are cutting. Install this guide on the rail,
mark the ends where you will cut.
Don't forget to remove the guide before cutting, it will melt.



DEBURR AND CLEAN AFTER CUTTING

Smooth over any sharp edges on the cut surfaces
with a file, and clean the rail carefully.

You don't want slivers of metal getting into the
carriage or damaging the ball bearings.

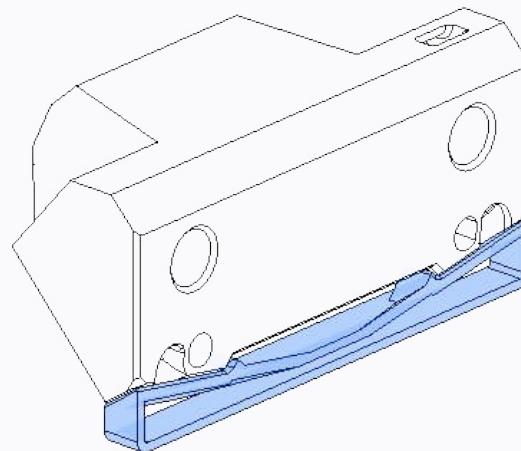
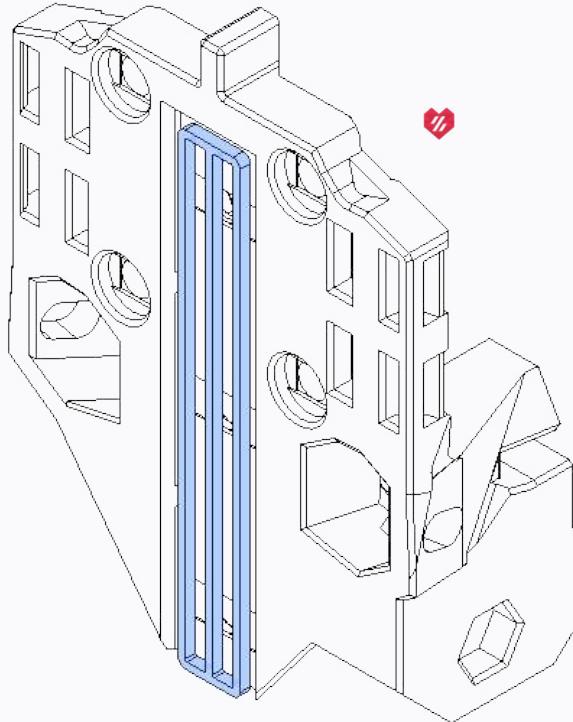
REMOVE SUPPORTS

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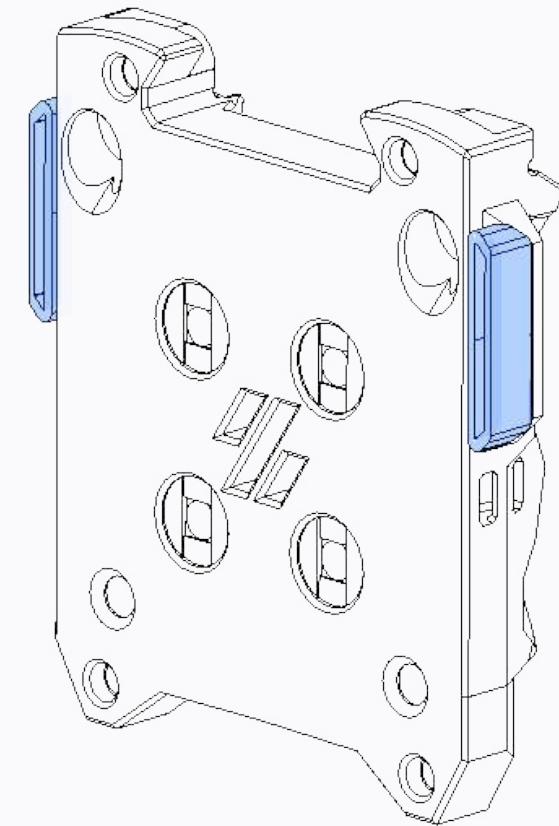
WE DON'T ALWAYS USE SUPPORTS, BUT WHEN WE DO:

...There is a good reason, the support is well designed, and it is easily removable.

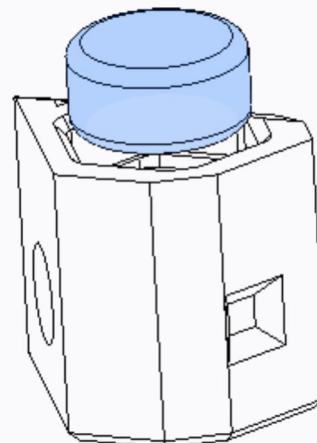
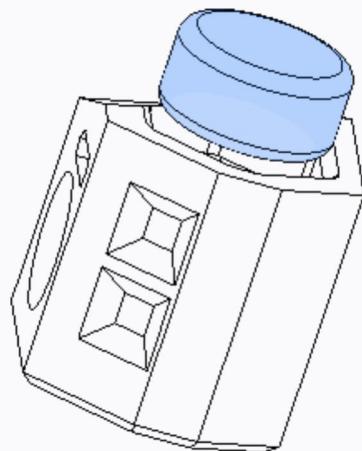
Remove the indicated supports and discard them.



Bonus points if the support makes a face.



(2) 6x3 magnets
2 drops RTV or Superglue



DO YOU SMELL..GLUE?

Yes, yes you do. Specifically superglue, but you could also use RTV silicone, just a drop. Is all that is needed.

Despite our best efforts, the magnets can still come loose without it.

MAGNET PRESS

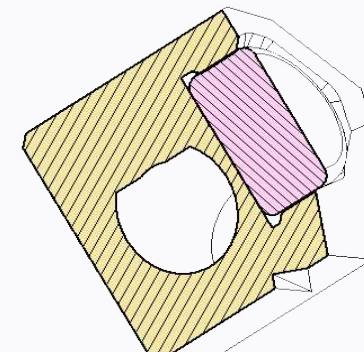
1. Place magnet on a flat surface (polarity doesn't matter)
2. Place a drop of CA glue on top of the magnet
3. Place magnet holder on magnet.
4. Using a strong flat tool, firmly press magnet holder down over magnet.

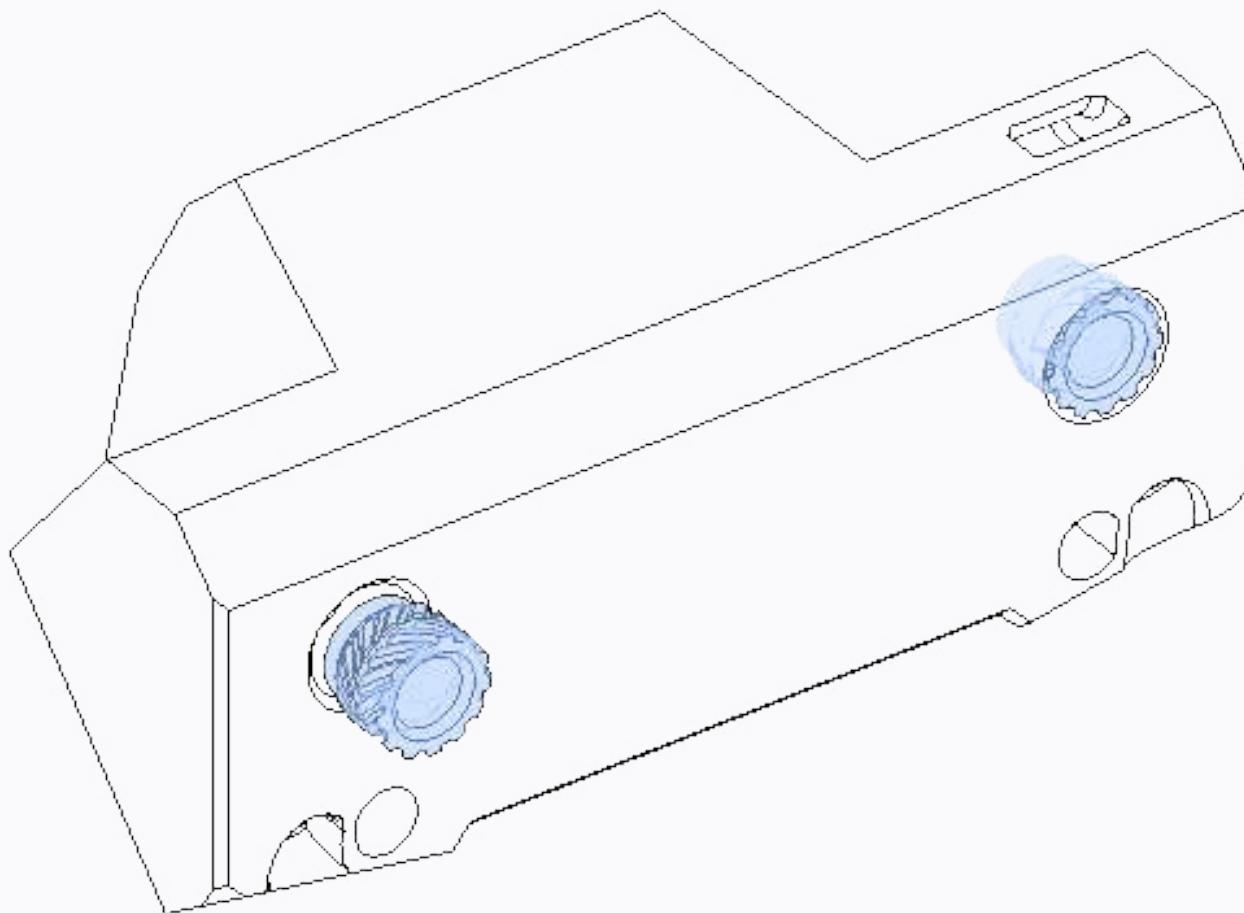
Do this for both left and right magnet holders.

Alternately you can use channel lock pliers (or a vise) for this,. Whatever tool you use please go slow and don't crush the parts or your fingers!

ROUND MAGNET, HEX HOLE

The magnet seats here hold much better than a round hole. The seats have been carefully designed and tested to maximize holding power.





HEAT-SET INSERTS

This design relies 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).

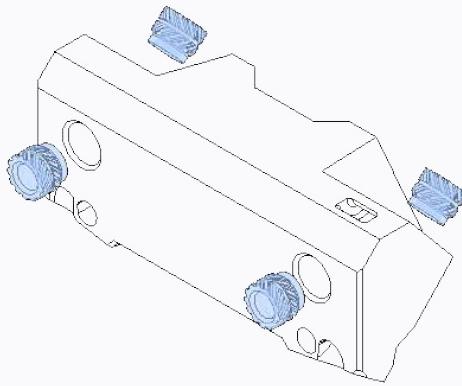
If you've never worked with heat-set inserts before, we recommend you watch the linked guide.



<https://voron.link/m5ybt4d>

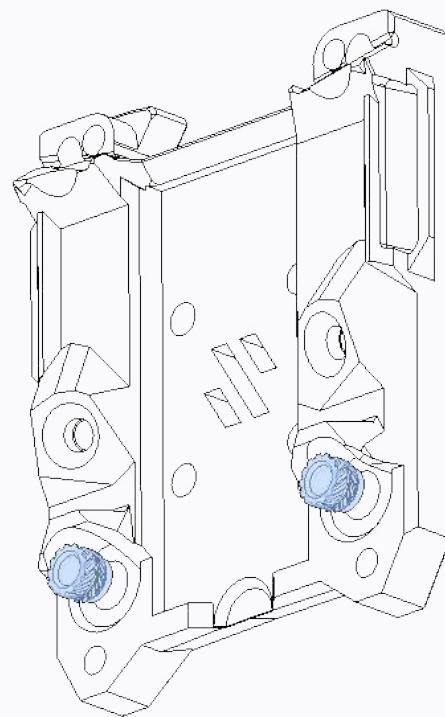
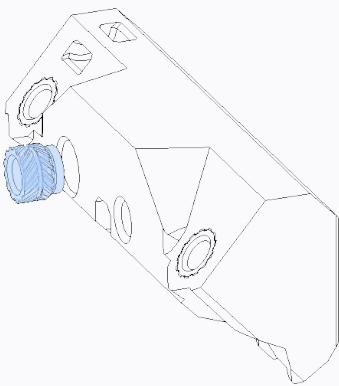
HEAT-SET INSERTS AND M3 NUT

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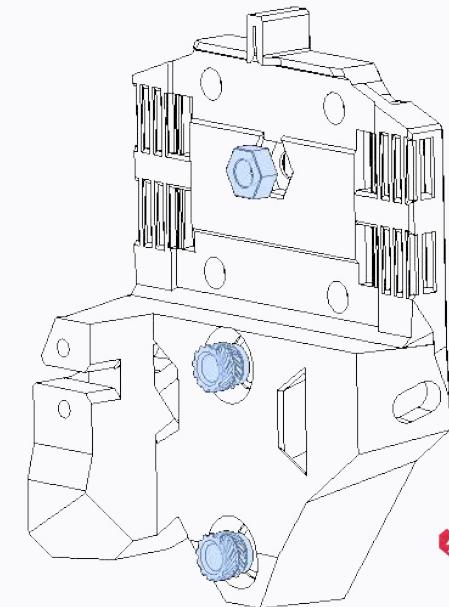
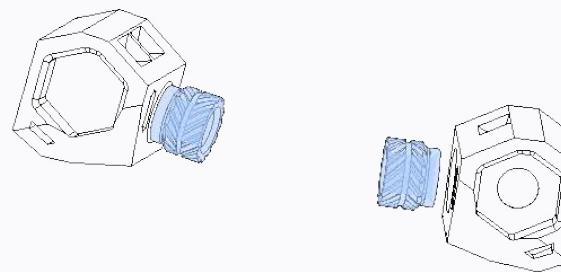


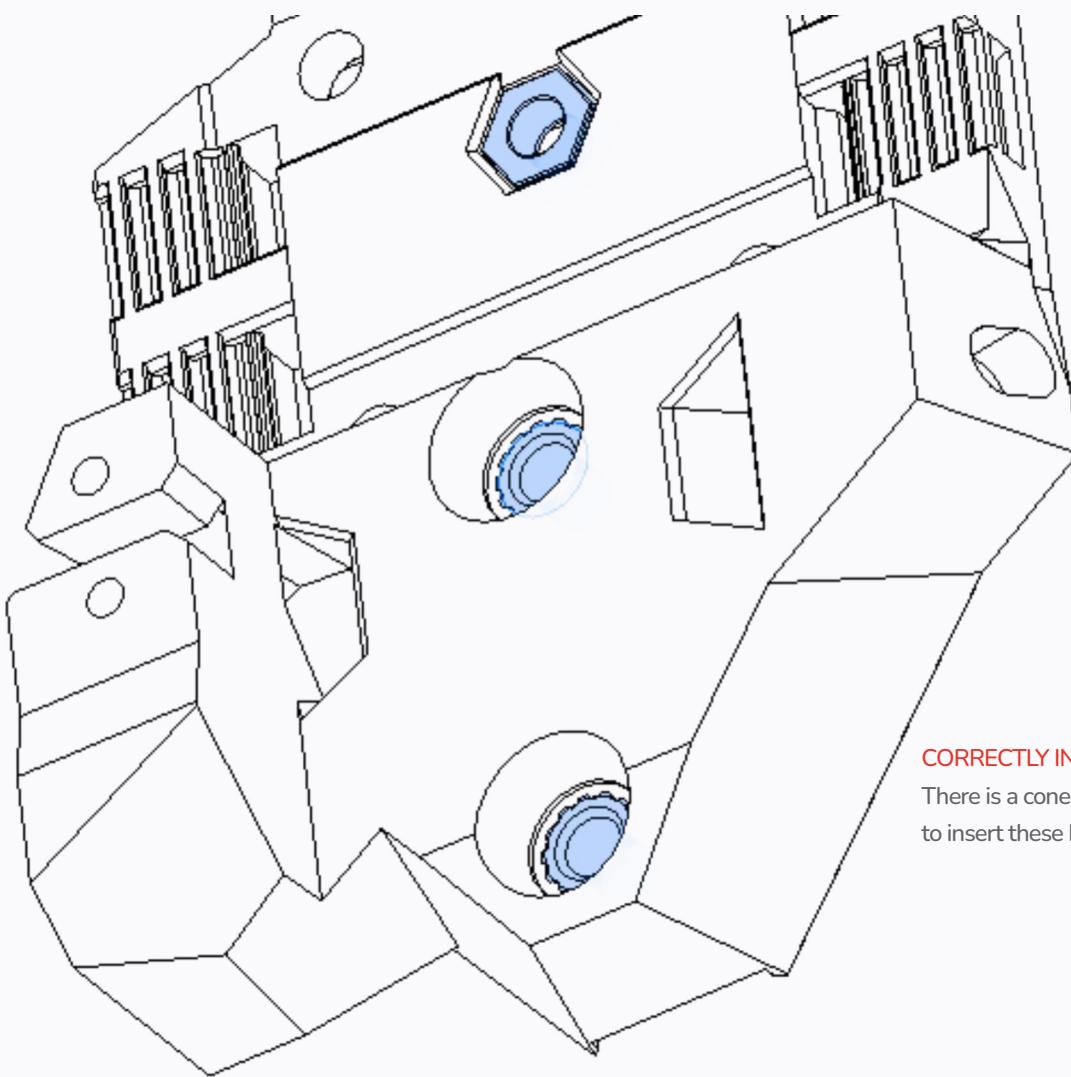
TAP_UPPER_D2HW HAS ONE MORE INSERT

This option (for the mechanical switch version) has one extra heatset insert in the back.

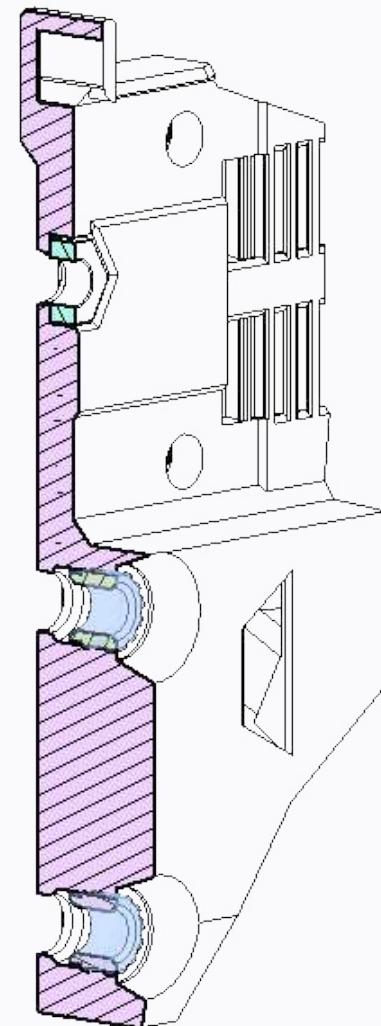


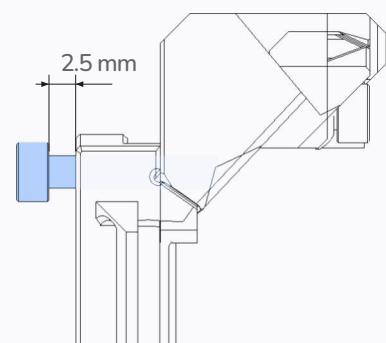
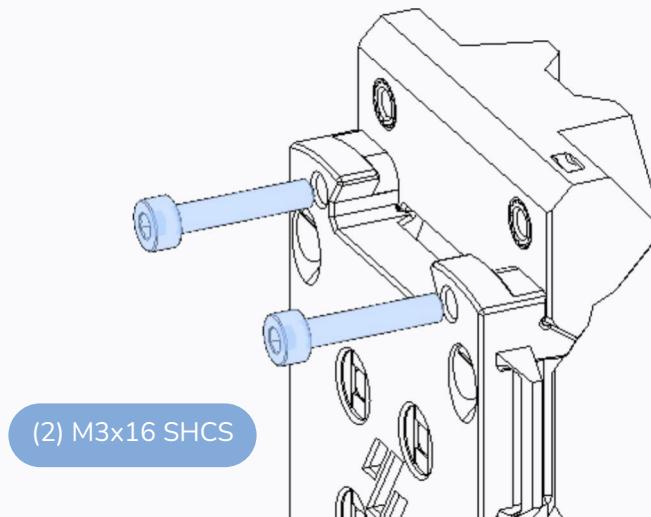
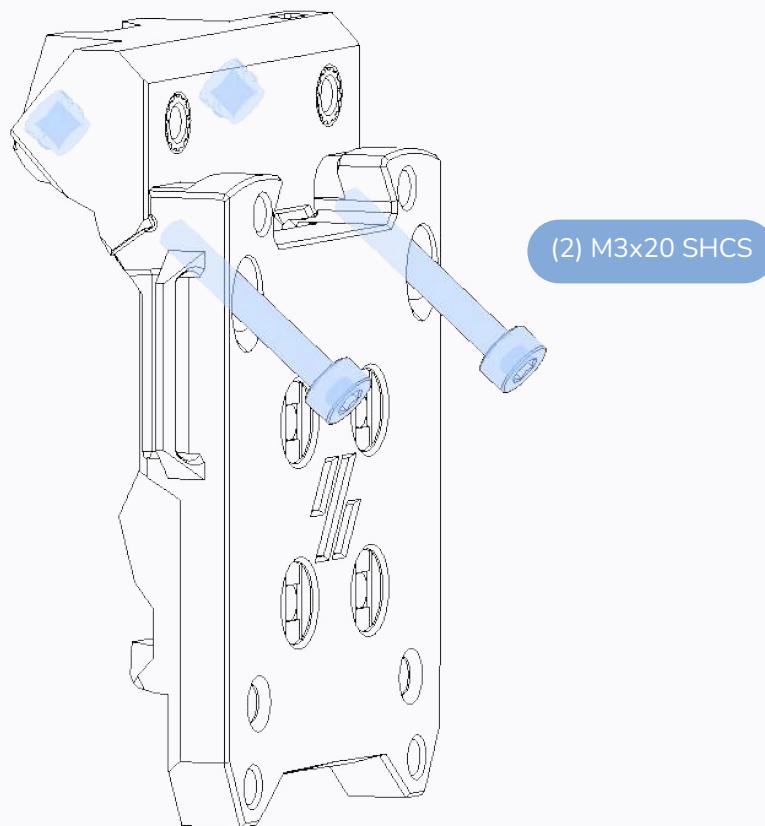
(10) Heat-set Inserts
(1) M3 Hex Nut





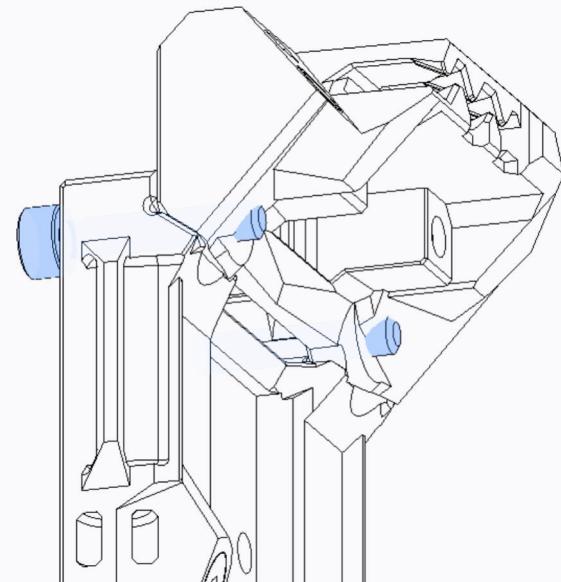
[See here for details from Prusa](#)

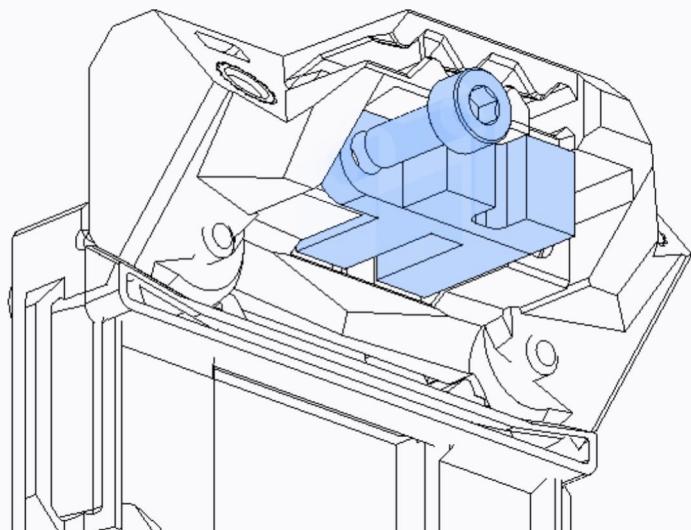




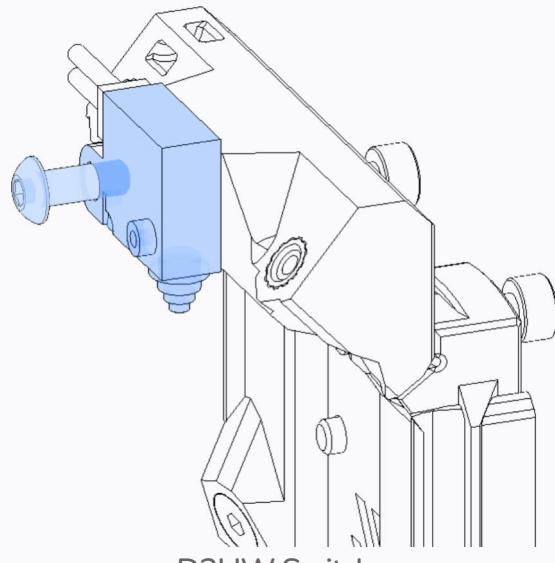
LEAVE ROOM FOR THE TOOLHEAD

The M3x16's thread into the plastic directly.
Don't tighten fully, leave approximately 2.5
mm for the toolhead to mate with them.





Optical Wired

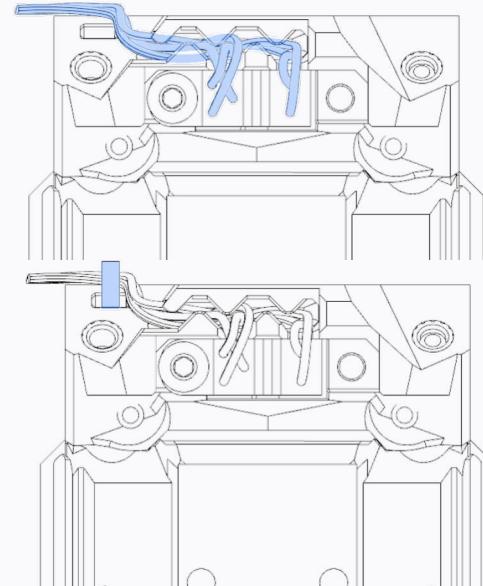


D2HW Switch

OPTICAL SENSOR SCREWS INTO PLASTIC, BE GENTLE

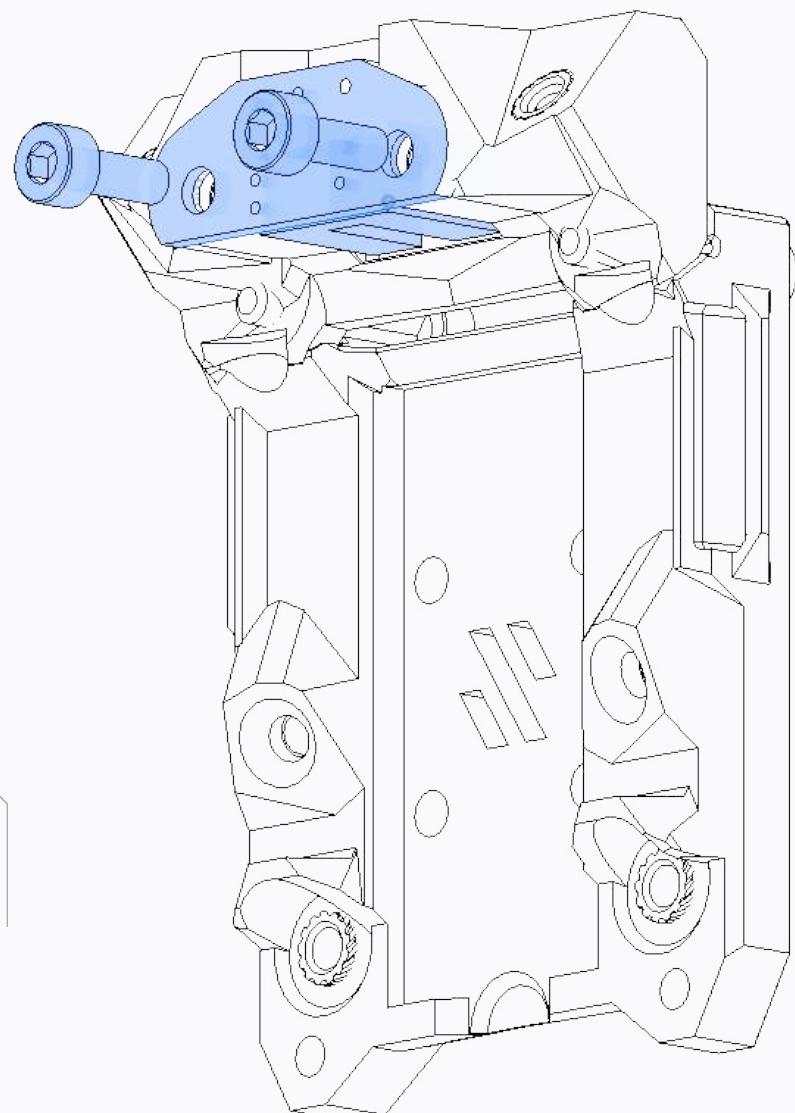
Note that OPB991P or OPB991L wired sensors will only have one M3x8 here, while the wired OPB991T and all PCB-based sensors have two screws.

(1 or 2) M3x8 SHCS

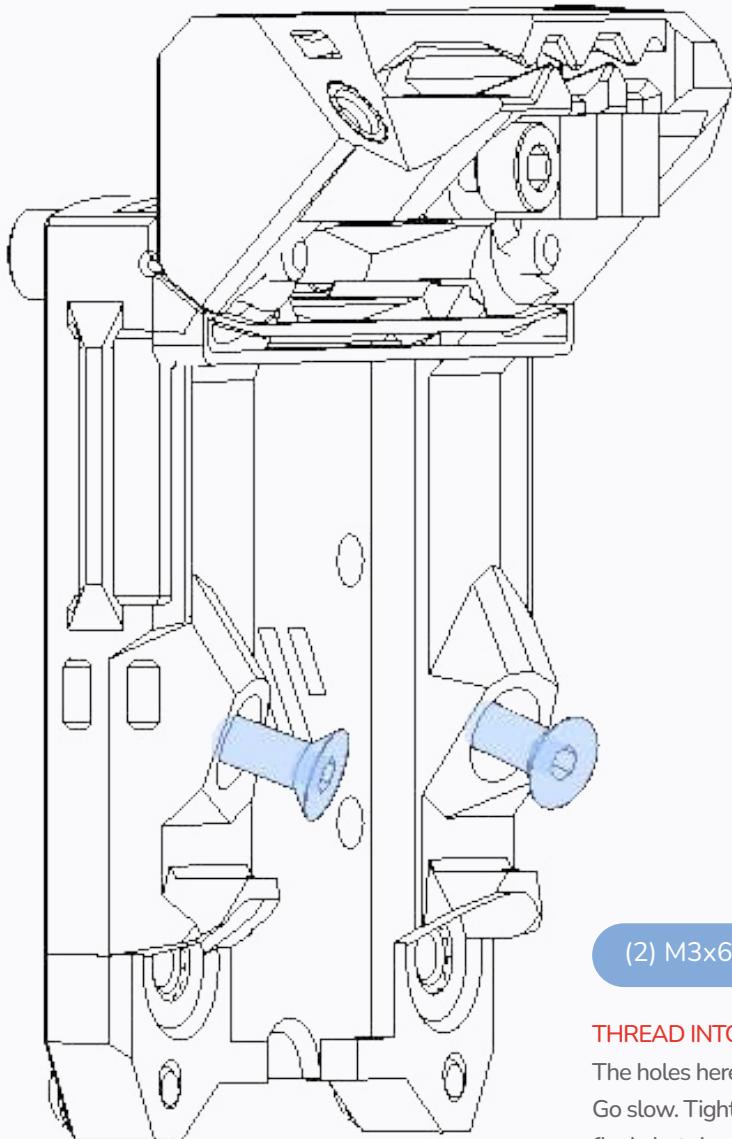


POINTS FOR NEATNESS

Voron takes wiring seriously, and you should too. Use a zip-tie to secure wires to the upper . On the Wired sensor option, use the printed channel to tuck the wires away safely from moving parts.



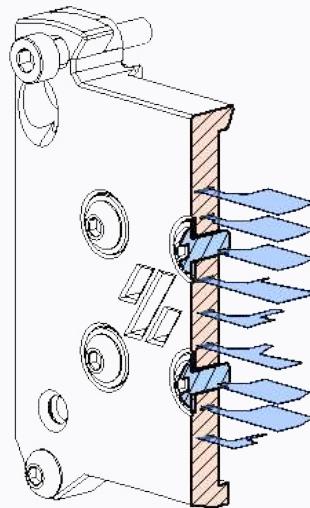
Optical PCB option



(2) M3x6 FHCS

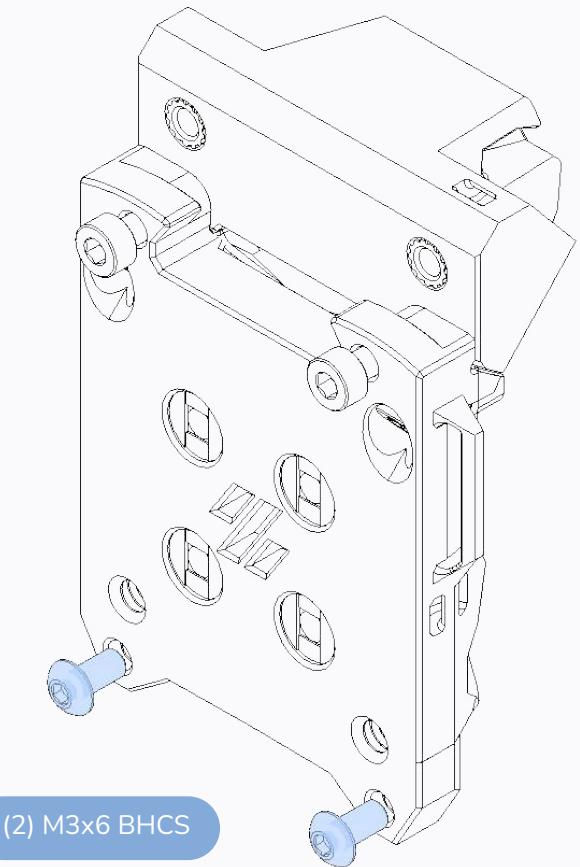
THREAD INTO PLASTIC AT AN ANGLE

The holes here are designed at an angle. Go slow. Tighten the FHCS until they are flush, but do not over tighten.



FUN FACT

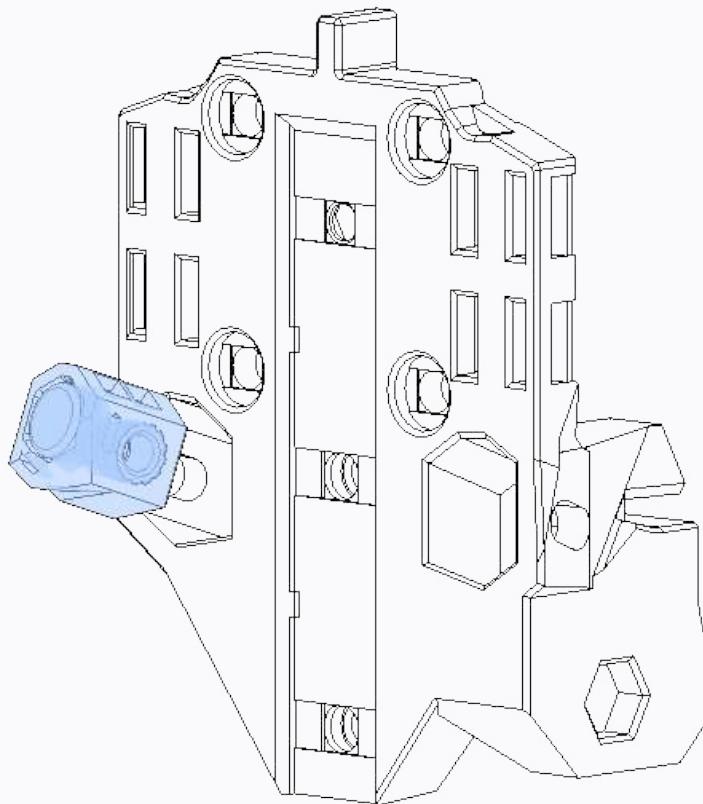
This part has thin voids inside it (blue). When the part is sliced, these produce internal ribs which strengthen the part. If your slicer closes these up, recheck your slicer settings for hole size compensation. Default slicer profiles are available for Voron printers in the github repository.



(2) M3x6 BHCS

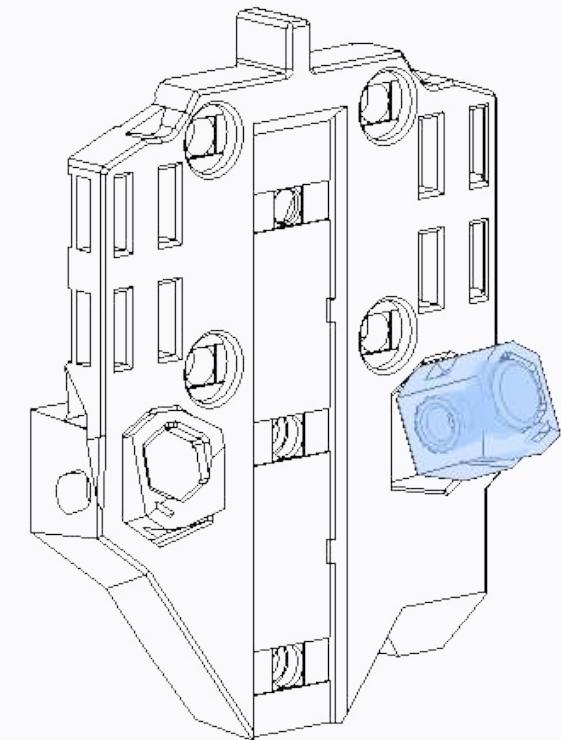
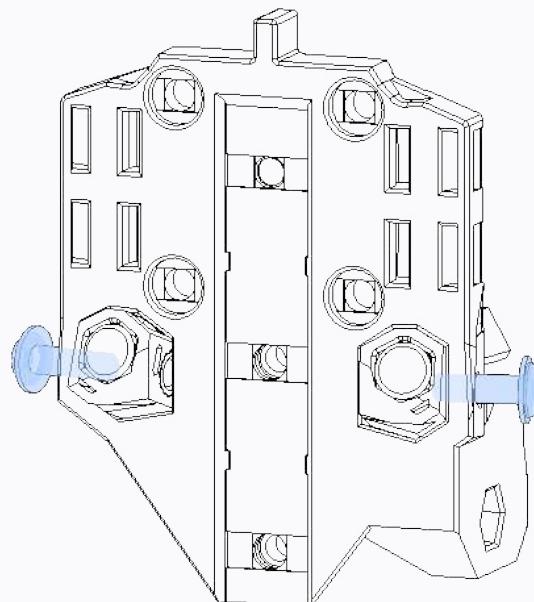
WHAT ARE THESE FOR?

When you install the toolhead, the bottom of the toolhead should rest on these screw heads.

**2 DOTS LEFT, ONE DOT RIGHT**

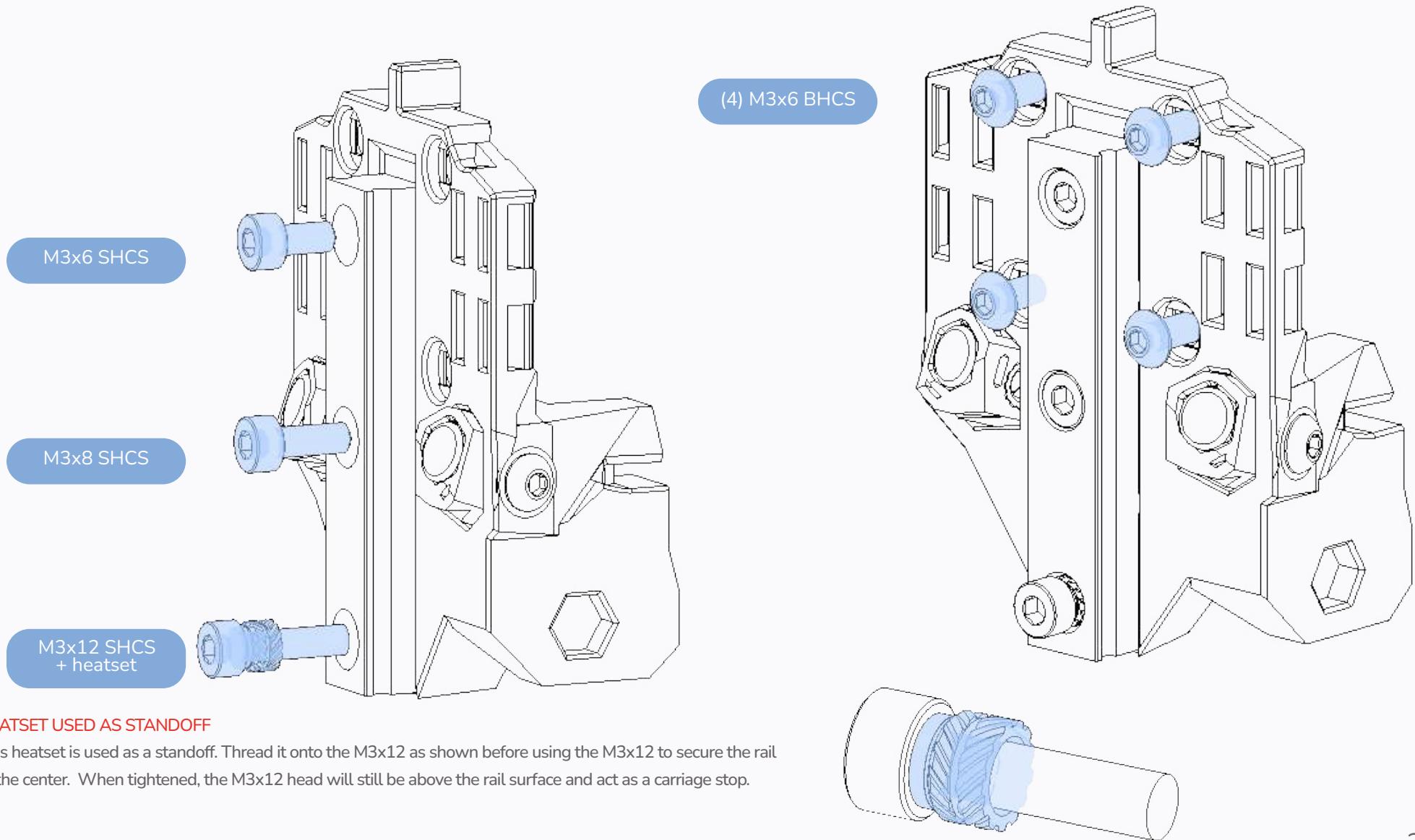
The magnet holders are marked with dots.
The left has two dots, the right has one dot.

We could say that there is only one way they fit, but we don't want to underestimate you.

**SNUG IN FARTHEST BACK POSITION**

These are the magnet adjustment screws. For now, just snug them up with the magnet holders as far back as they will go. We'll adjust them later.

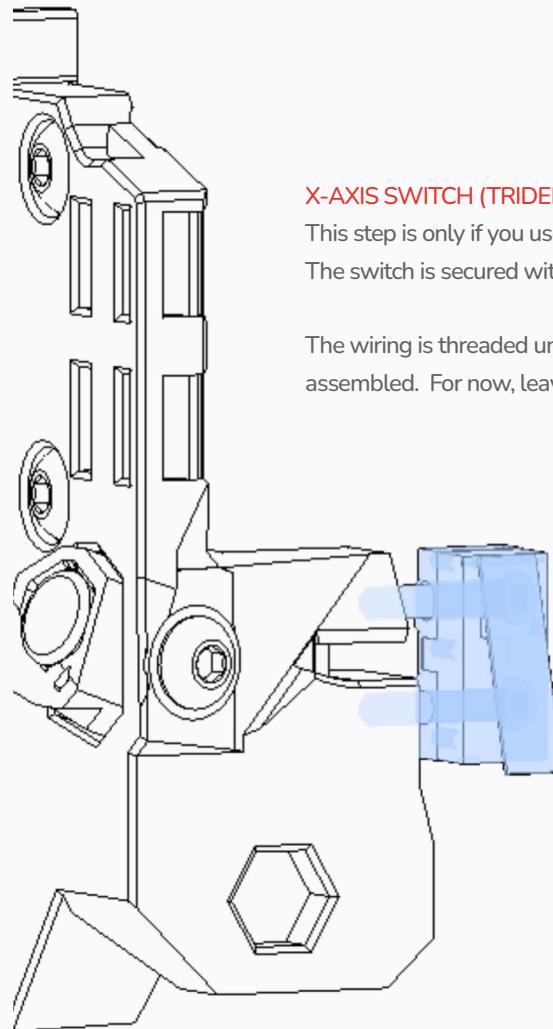
M3x10 BHCS
+ M3 washer

**HEATSET USED AS STANDOFF**

This heatset is used as a standoff. Thread it onto the M3x12 as shown before using the M3x12 to secure the rail to the center. When tightened, the M3x12 head will still be above the rail surface and act as a carriage stop.

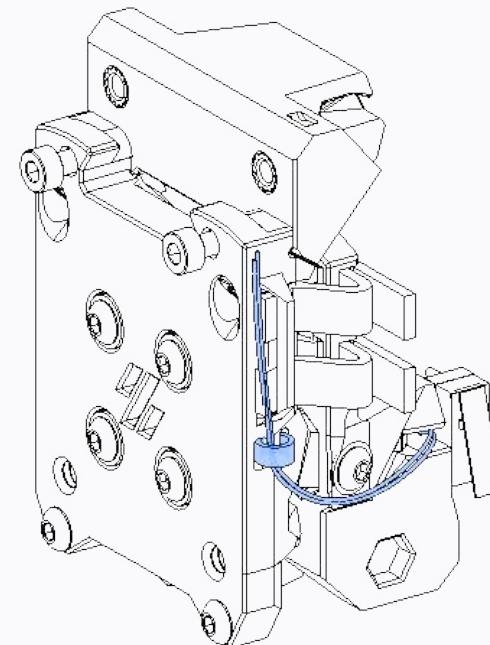
IF YOU USE THE STANDARD XY ENDSTOP POD FROM V2, SKIP THIS PAGE

These steps are only for printers that use either a carriage mounted X switch or need a magnet for the x-axis hall effect endstop

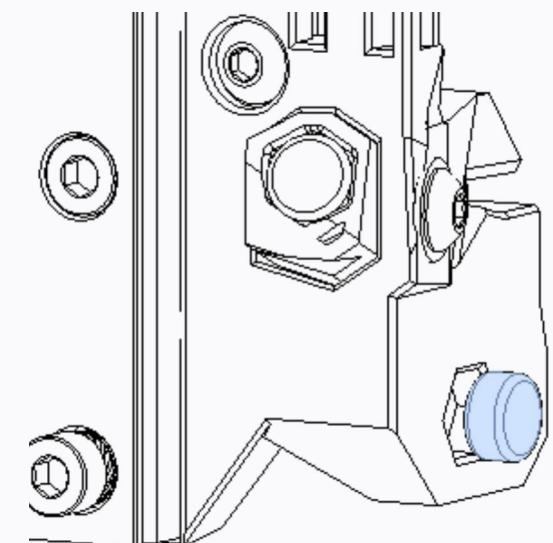
**X-AXIS SWITCH (TRIDENT STYLE)**

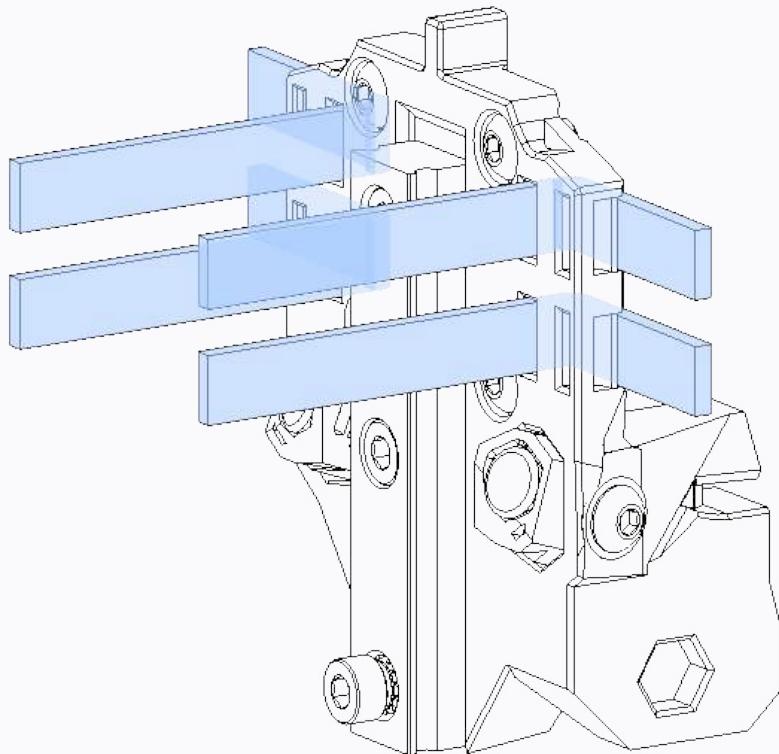
This step is only if you use an X-carriage mounted switch, such as used in the Trident. The switch is secured with 2 screws threaded directly into the plastic.

The wiring is threaded under the switch, and should be zip-tied to the front when fully assembled. For now, leave it loose.

**HALL EFFECT X-AXIS MAGNET INSTALL**

Press the magnet into the hexagon shaped recess here. A hex shape is better at holding round magnets than a round hole because the walls can flex to accommodate slightly different magnets.

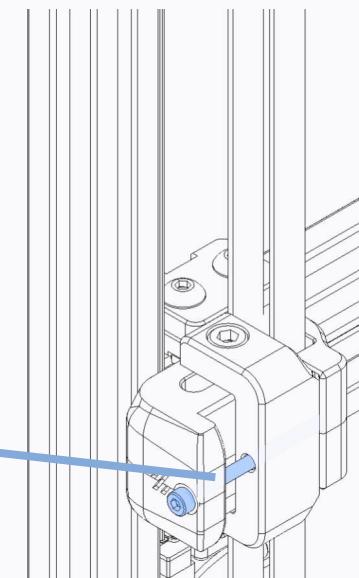




THREAD BELT ENDS THROUGH CENTER

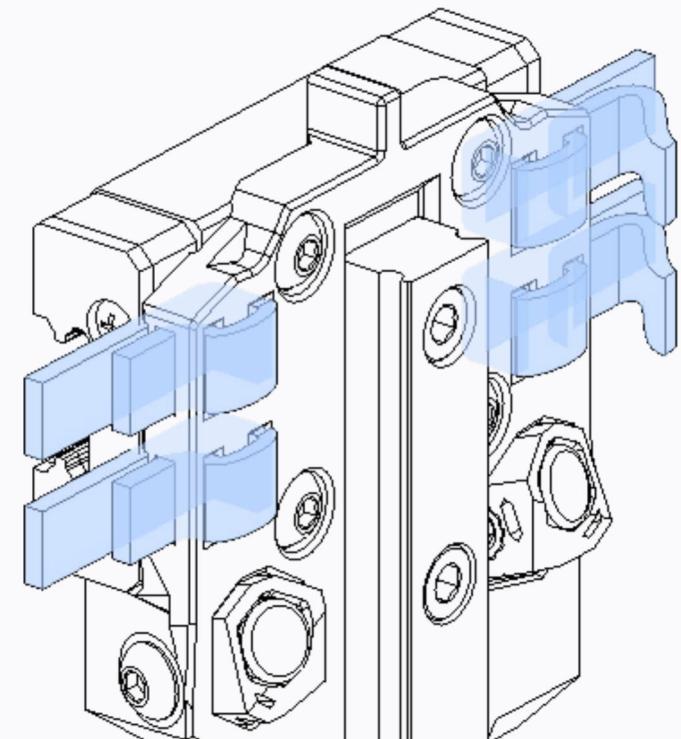
Make sure the belt adjustment screws on the front idlers are loosened completely. Pull the belts taut through the center section of Tap. Secure center to X-Axis MGN 12 using 4 M3x6 BHCS. Retension the belts using the adjustment screws on the front idlers.

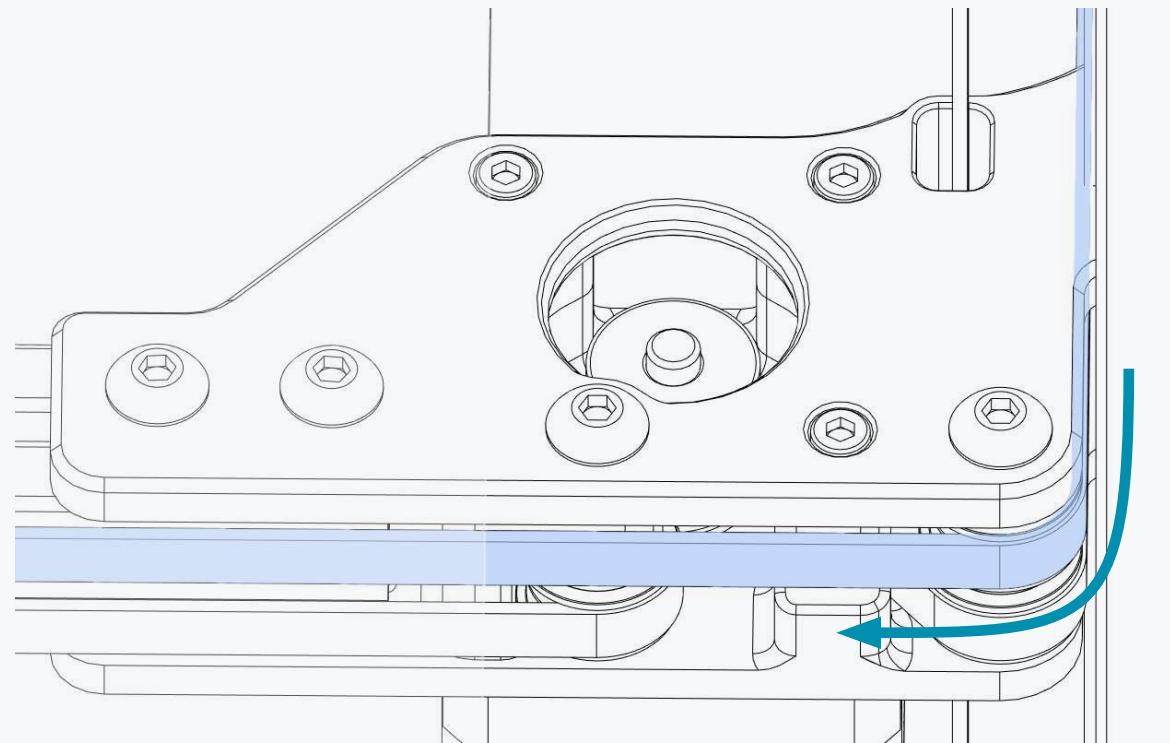
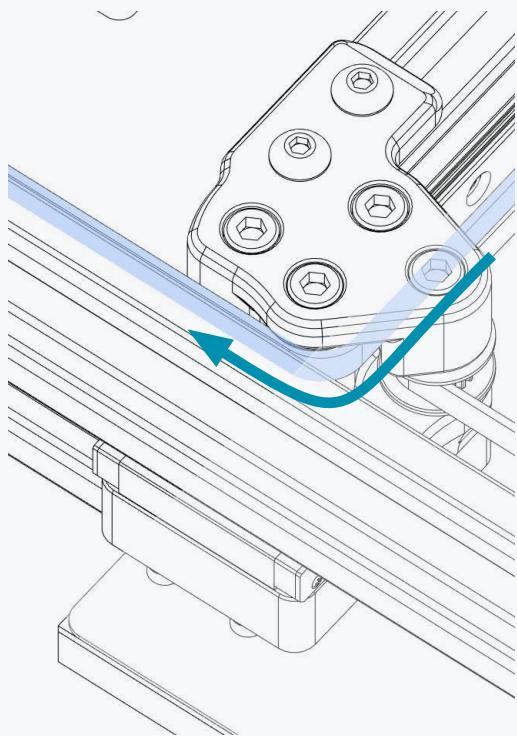
Belt adjustment screw



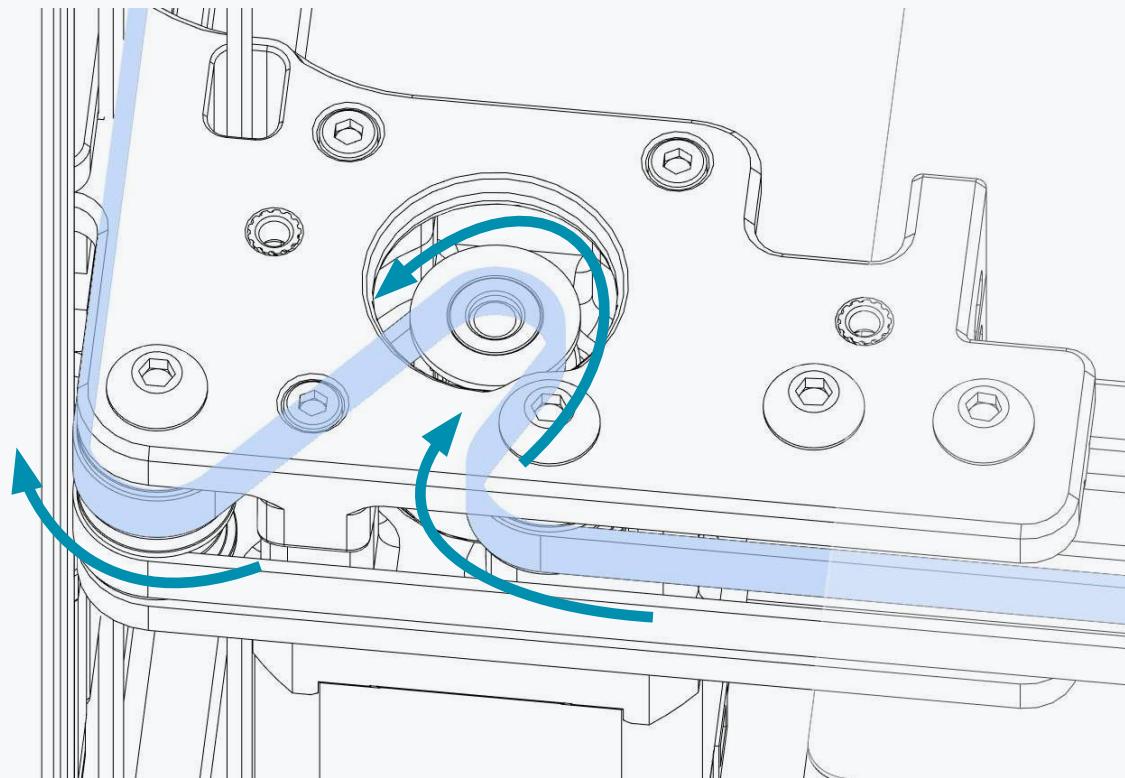
TUCK BELTS BACK THROUGH SLOTS

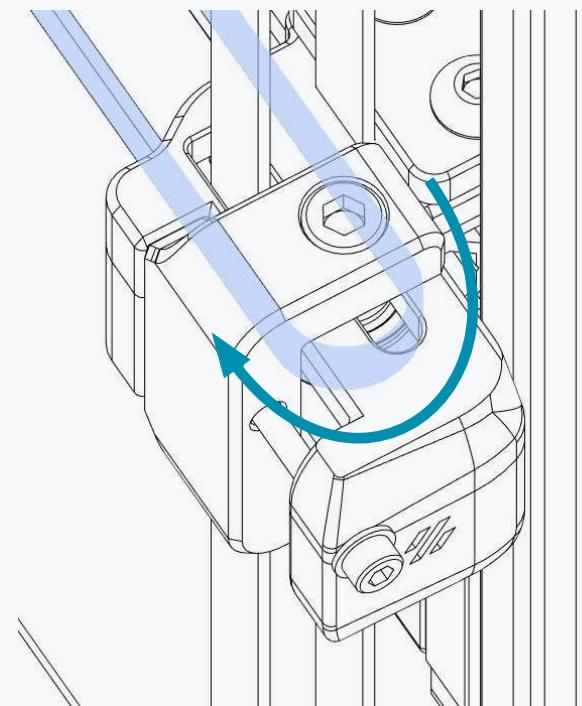
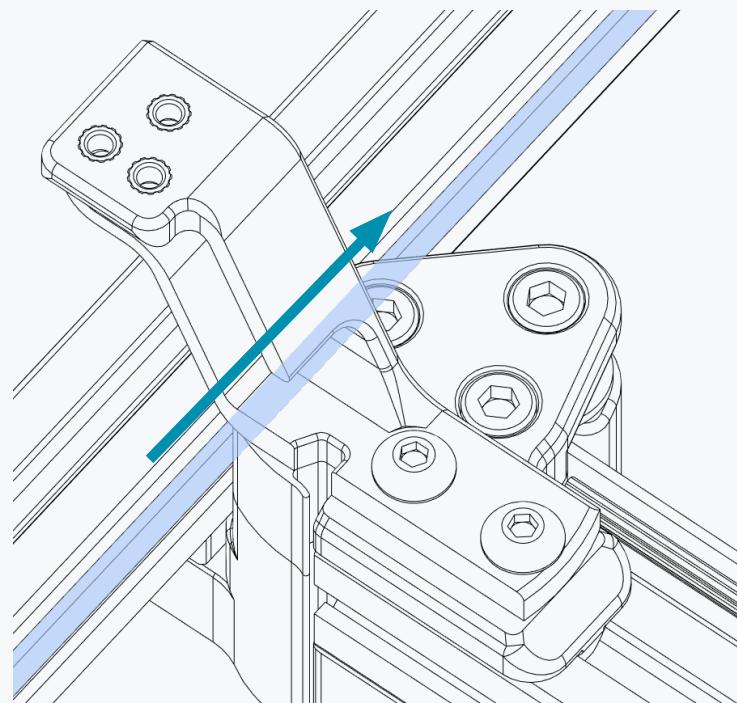
Tuck the belts back into the center and pull them out to sides. Don't worry if they stick out. We'll manage that in a later step when we put the front on.



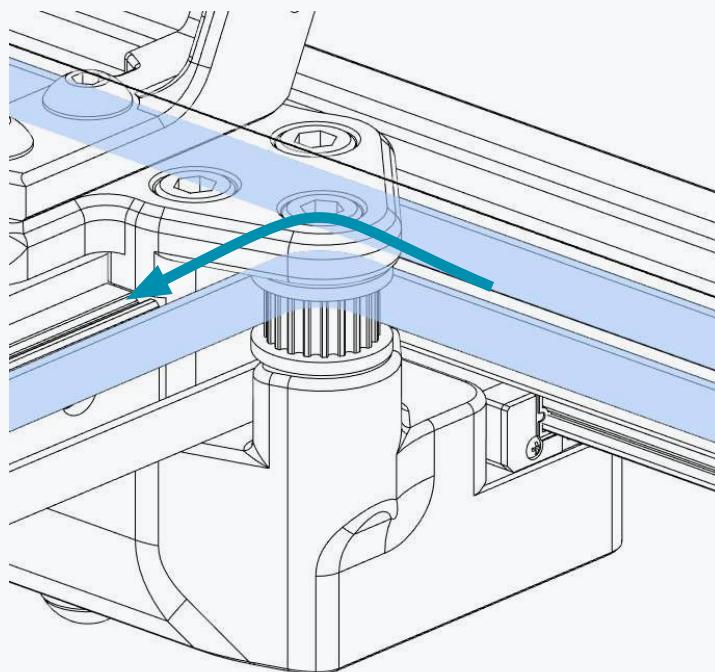
**A BELT ROUTING**

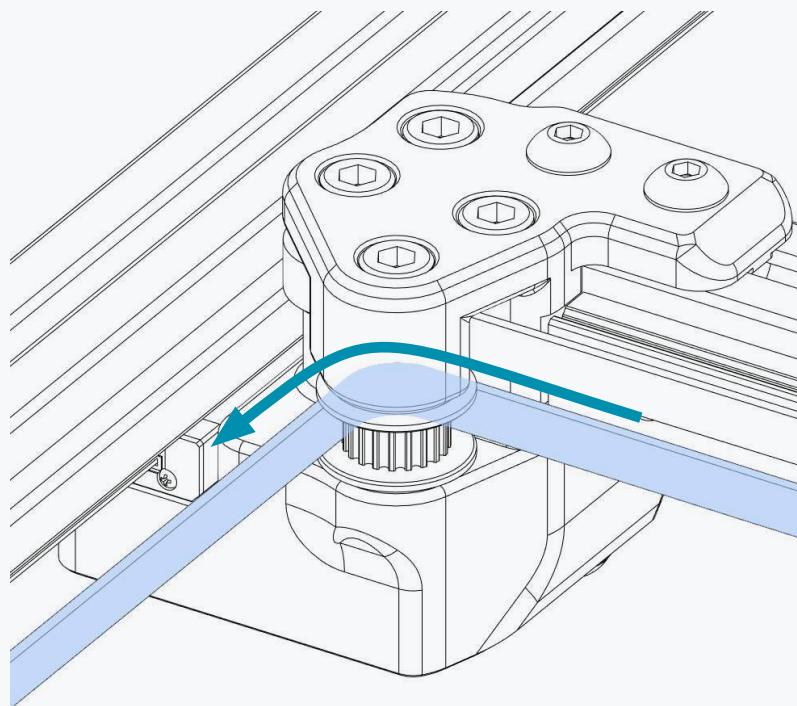
Follow the path pointed out by the arrows.
Needle nose pliers, tweezers or similar tools
can help in this step.



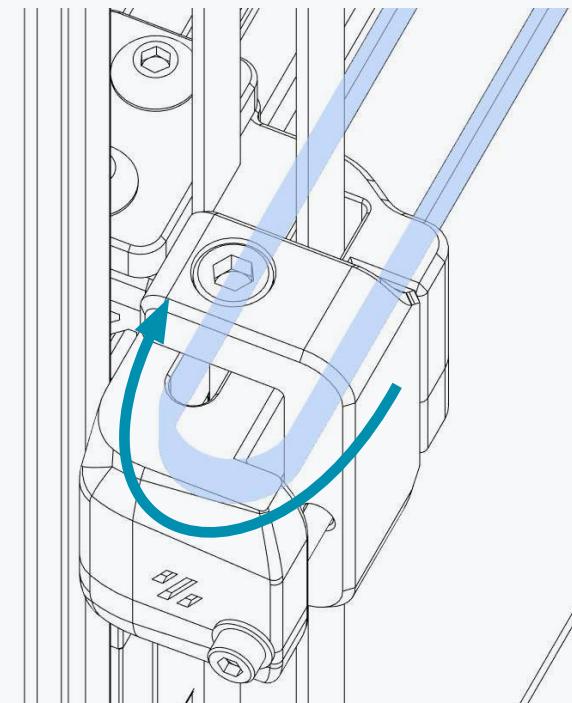
**BELTING IDLERS**

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



**B BELT ROUTING**

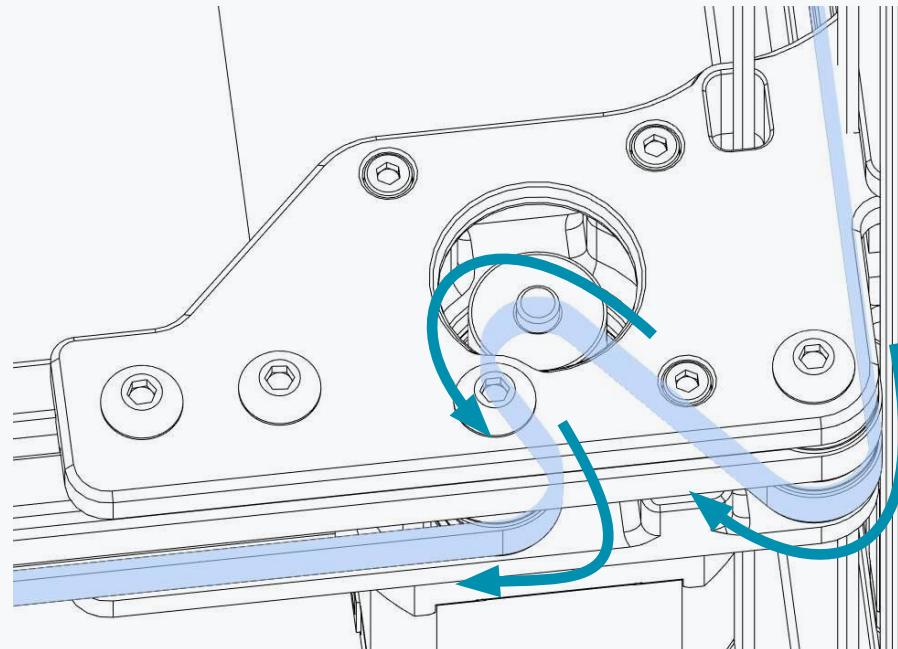
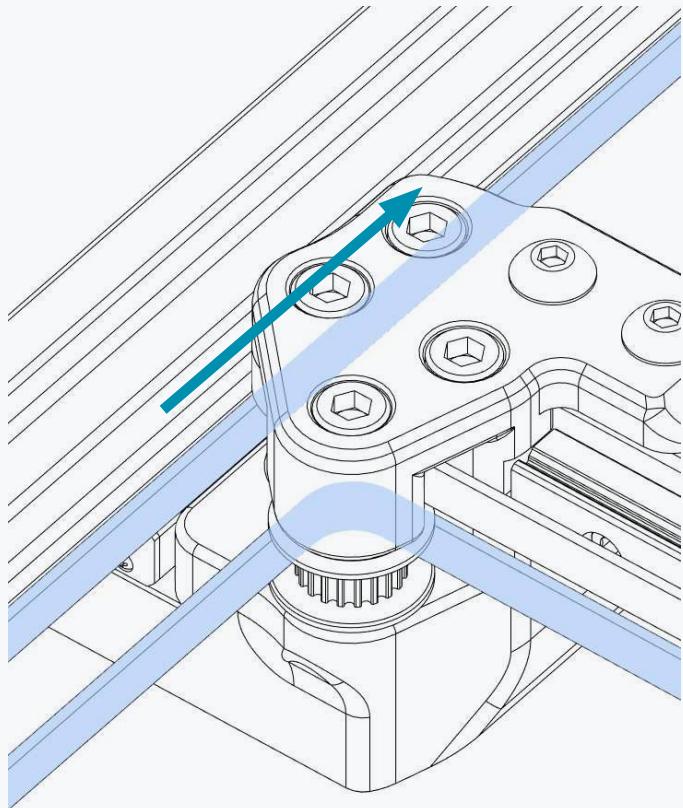
Follow the path pointed out by the arrows.
Needle nose pliers, tweezers or similar tools
can help in this step.

**BELTING IDLERS**

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

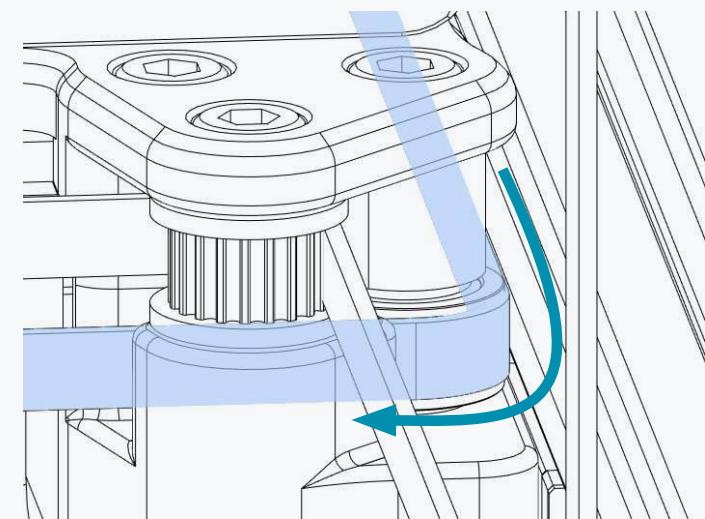
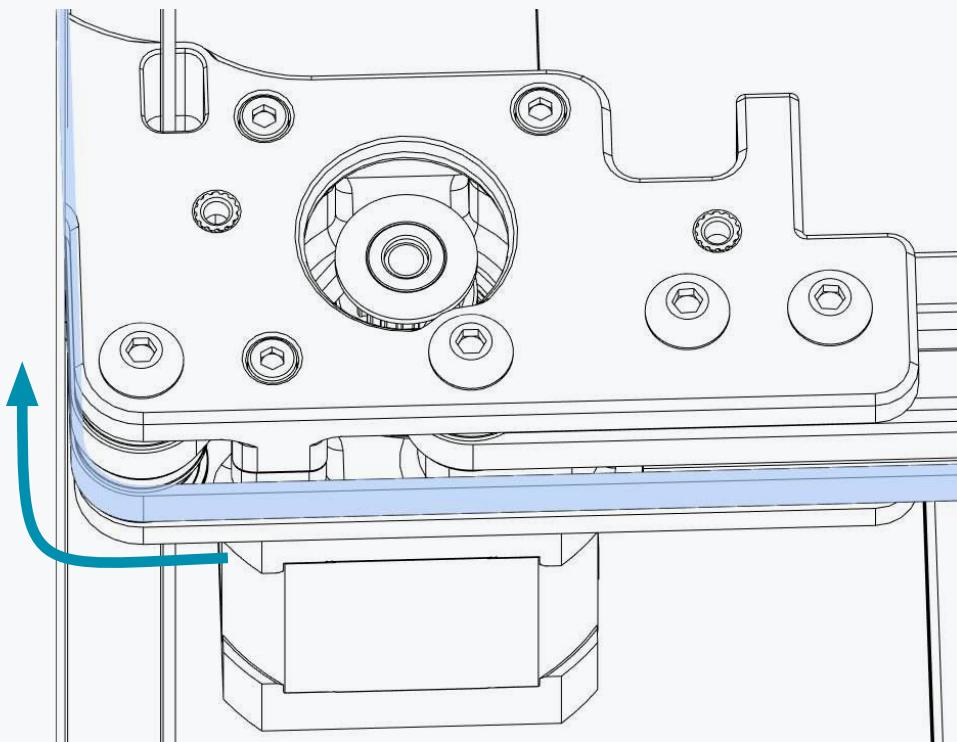
B BELT

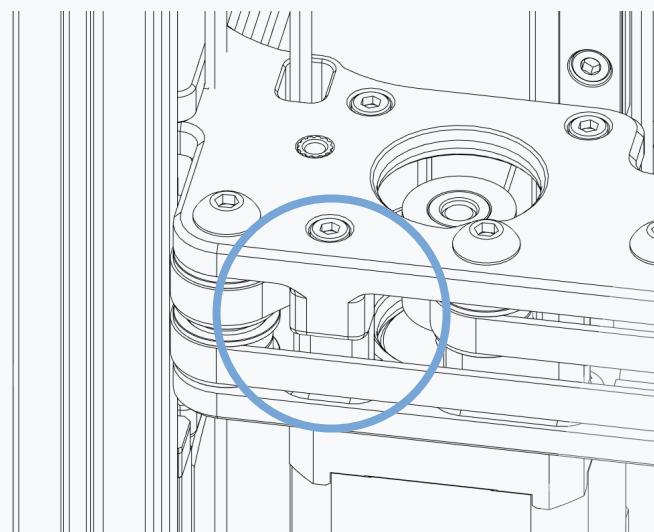
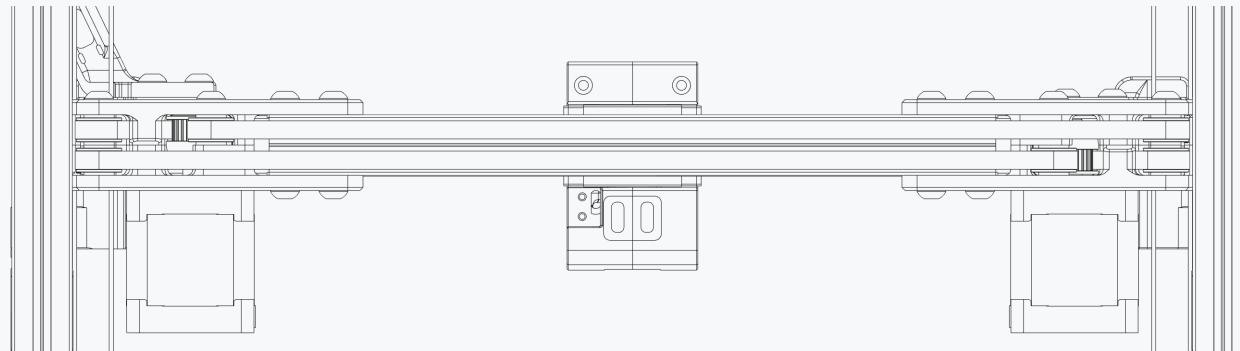
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B BELT

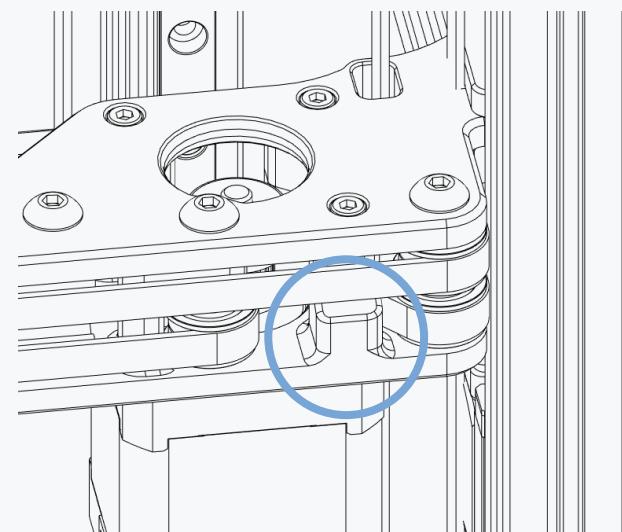
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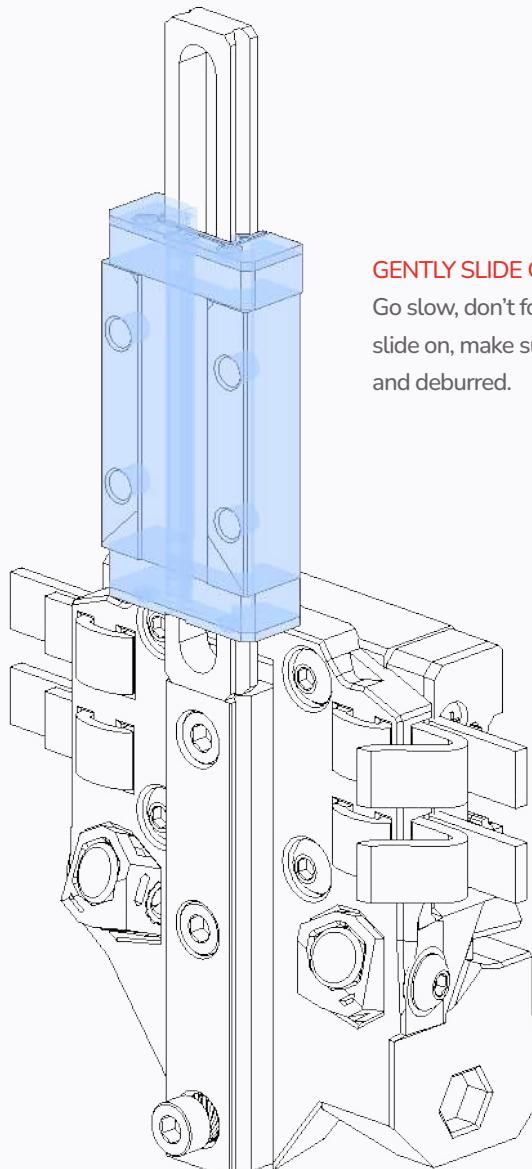
CHECK YOUR WORK

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



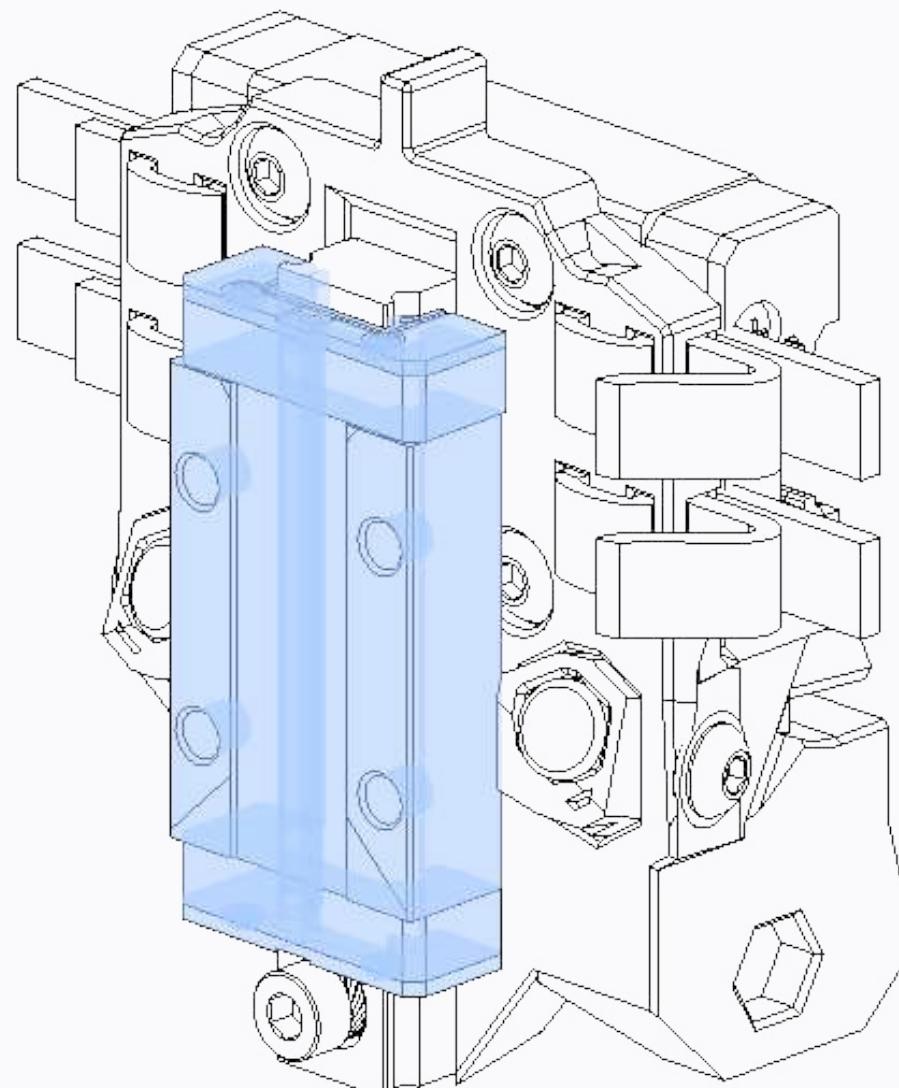
INSTALL MGN9H CARRIAGE

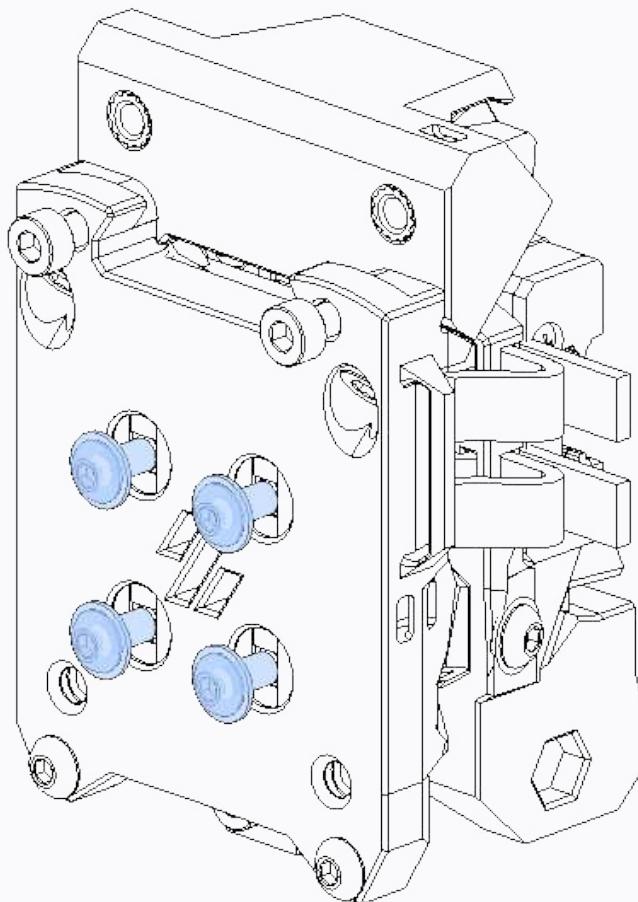
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GENTLY SLIDE CARRIAGE ON TO RAIL

Go slow, don't force it. If it's difficult to slide on, make sure the cut rail is smooth and deburred.



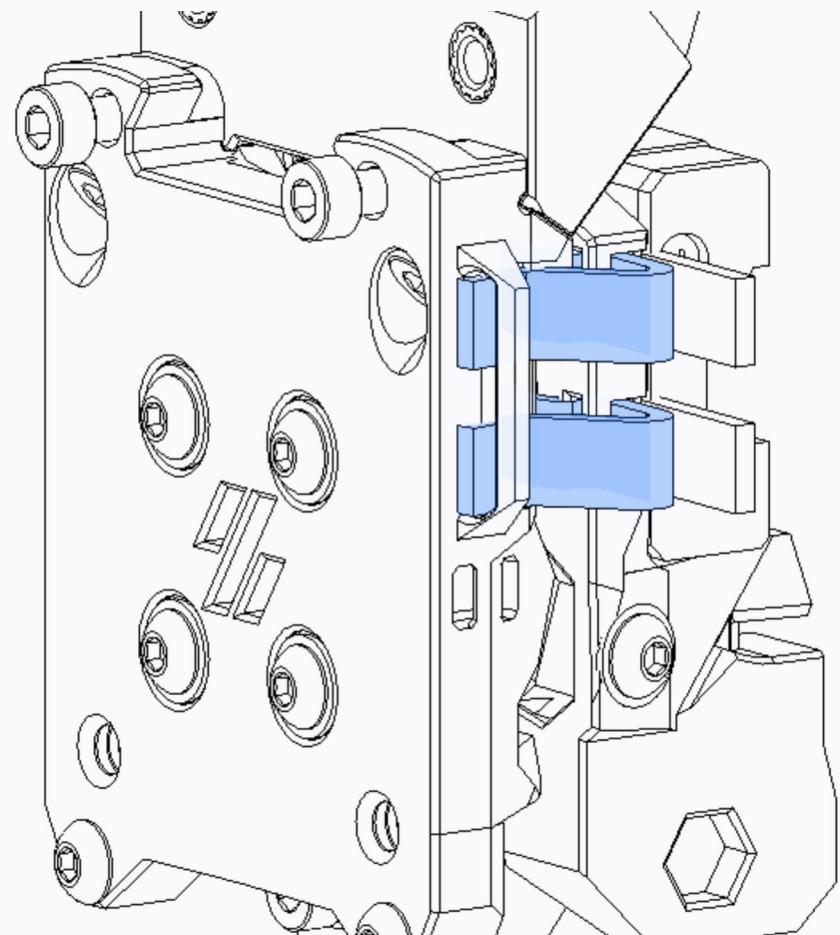


DON'T FORGET THESE WASHERS!

Without them, there is a possibility the carriage won't be tight. Make sure these are tight.

IF YOU HAVE BELT EXCESS, TUCK.

This should be a loose tuck, leave enough of a loop that the mechanism can move. It's just meant to keep the belt out of the way. On both sides, of course.



Voron2.1 was released on November 5 2018.



VORON STEALTHBURNER

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

VERSION 2023-05-05



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

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 COLOUR	ACCENT COLOUR 	CLEAR/TRANSPARENT	OPAQUE	QUANTITY REQUIRED
Example z_joint_lower_x4.stl These files will have nothing at the start of the filename.	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. The parts are marked with a heart in the manual.	Example [c]_led_diffuser.stl We have added “[c]” to the front of any STL file that is intended to be printed with clear or transparent filament (cloudy is better than clear; white or light grey may also work in a pinch).	Example [o]_led_diffuser_mask.stl We have added “[o]” to the front of any STL file that is intended to be printed with an opaque filament (blocks light, dark colours and blacks).	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-Afterburner/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.



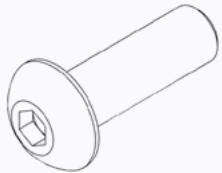
<https://github.com/vorondesign>



<https://docs.vorondesign.com/>

HARDWARE REFERENCE

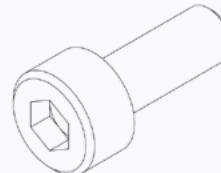
WWW.VORONDESIGN.COM



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 CAP SCREW (FHCS)

Metric fastener with a flat head and hex drive.

ISO 10642



SELF TAPPING SCREW

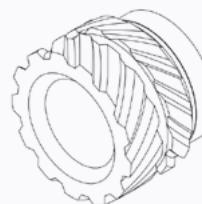
Fastener with a pronounced thread profile that is screwed directly into plastic.



WASHER

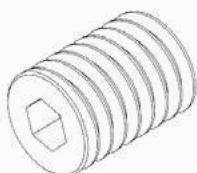
Usually stamped from sheet metal this type of spacer is not as consistent in thickness as the shims are. Only used in M3 size.

DIN 125



HEAT SET INSERT

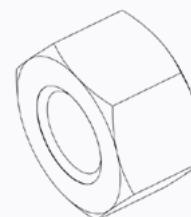
Heat inserts with a soldering tip so that they melt the plastic when installed. As the plastic cools, it solidifies around the knurls and ridges on the insert for excellent resistance to both torque and pull-out.



SET SCREW

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

ISO 4026



HEX NUT

Hex nuts couple with bolts to create a tight, secure joint.

ISO 4032

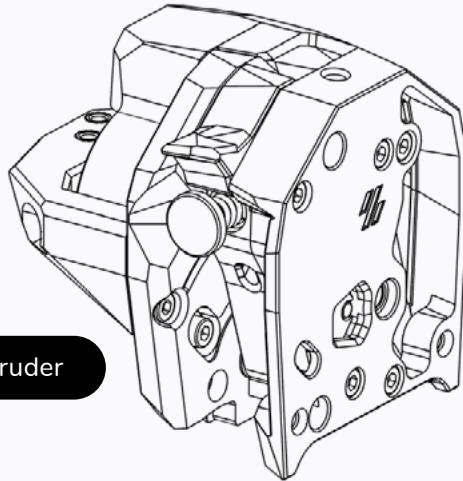
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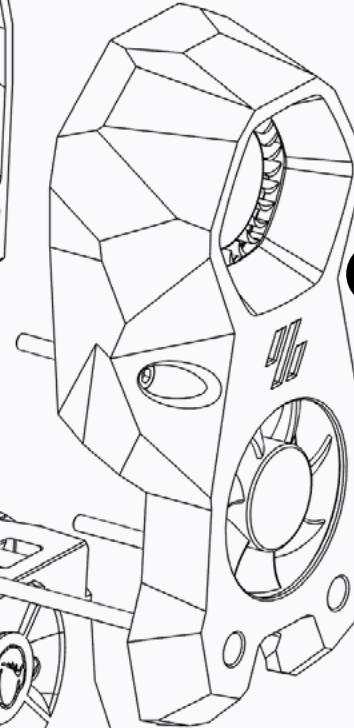
OVERVIEW

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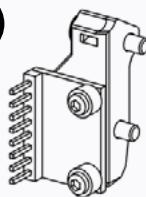
Voron ClockWork2 Extruder



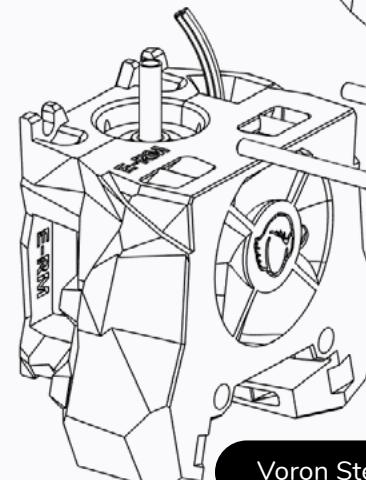
Voron StealthBurner



ADXL Sensor Mount



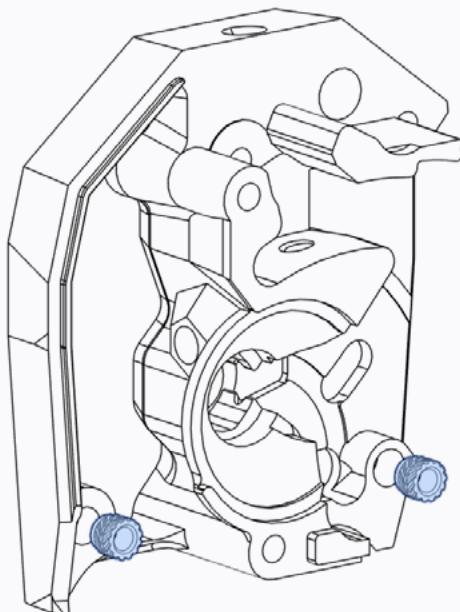
Voron StealthBurner Tool Cartridge



VORON CLOCKWORK2

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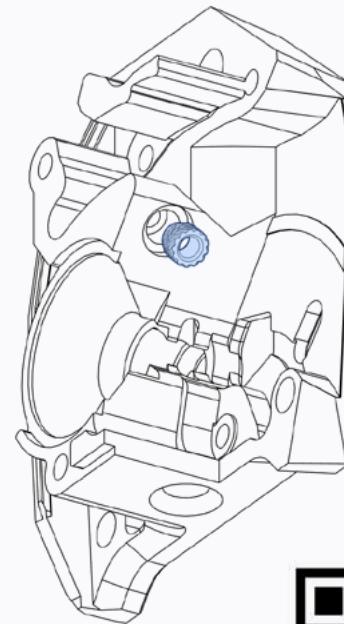


HEAT SET INSERTS

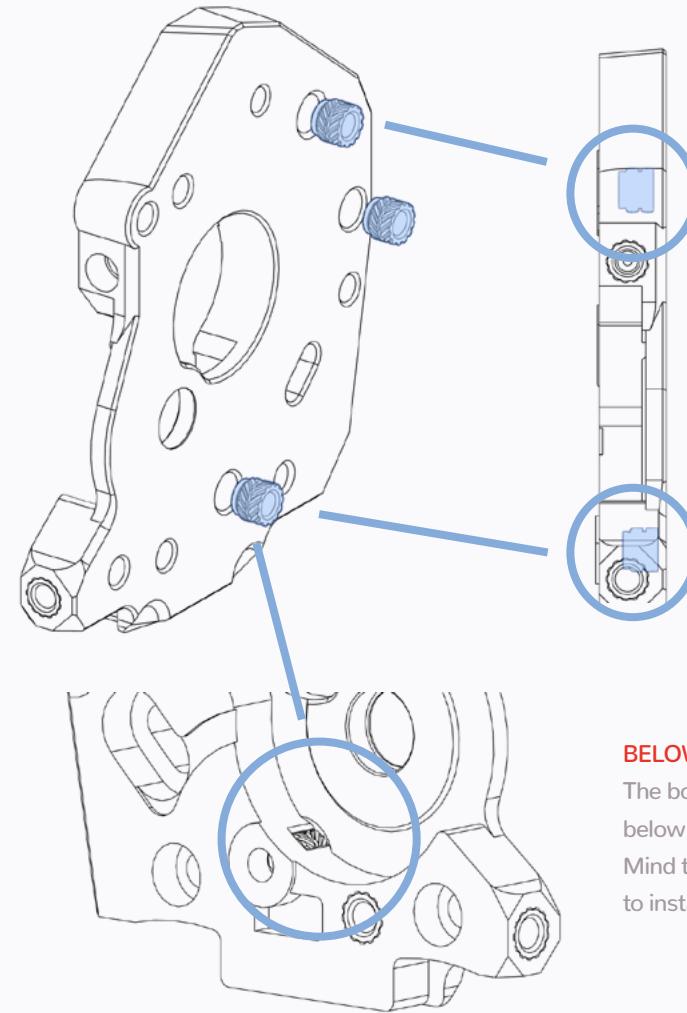
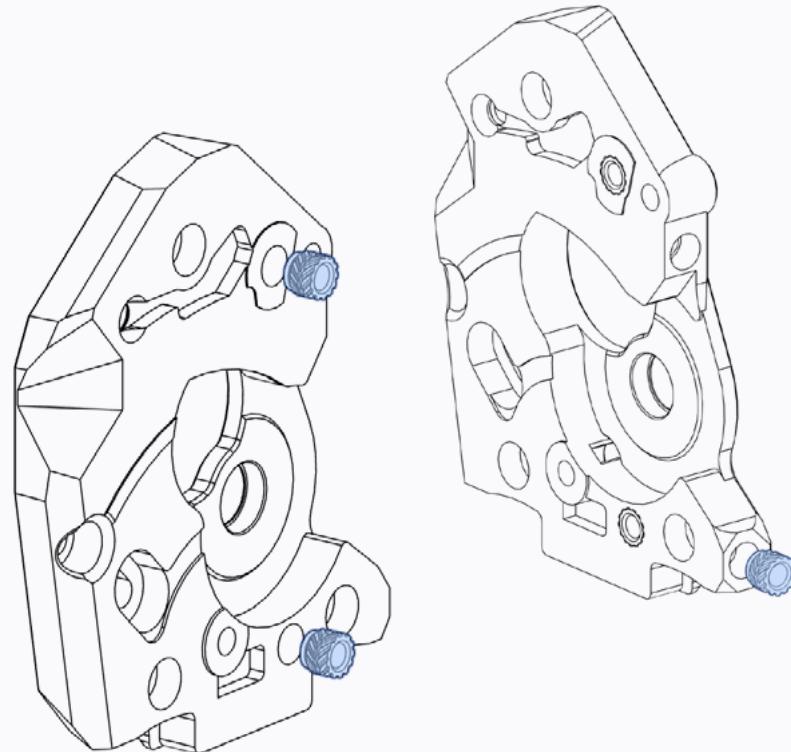
This design relies heavily on heat set inserts. Make sure you have the proper inserts (check the hardware reference for a close-up picture and the [Sourcing Guide](#) for dimensions).

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

Heat Set Insert



<https://voron.link/m5ybt4d>



BELOW SURFACE

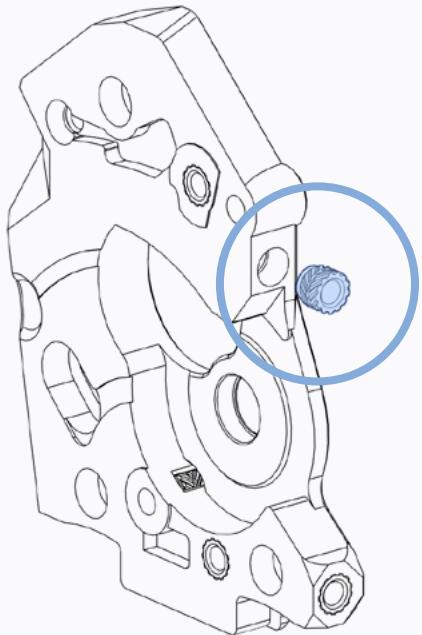
The top heatset insert needs to sit below the surface of the printed part.

BELOW SURFACE

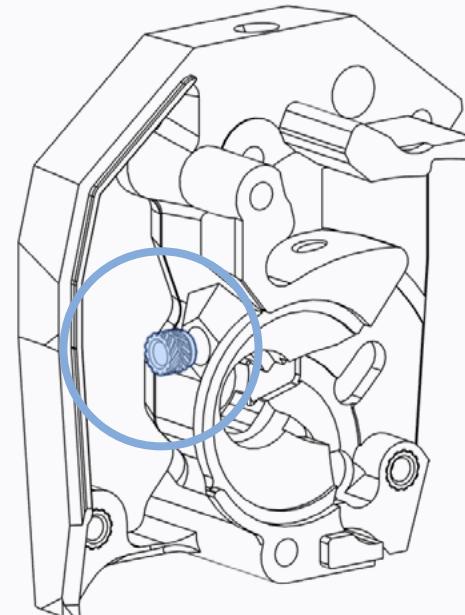
The bottom heatset insert needs to sit below the surface of the printed part.
Mind the cutout in the part and make sure to install it straight.

OPTION: TOOLHEAD PCB

If you opt to use a toolhead PCB, add additional heat set inserts into locations highlighted below.



Heat Set Insert

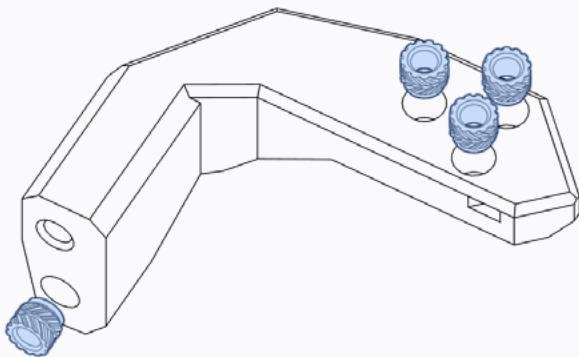


HEAT SET INSERT

Be careful when inserting this heat set insert. It's easy to accidentally touch the left side of the part with the soldering iron.

GENERIC CABLE CHAINS

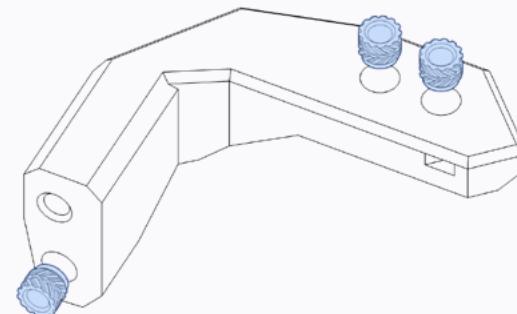
The 3-hole pattern is usually found on generic cable chains.



Heat Set Insert

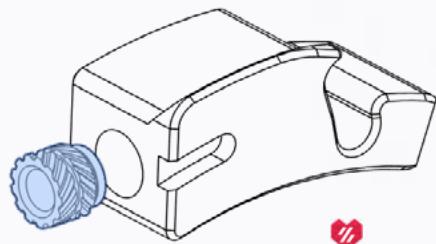
IGUS CABLE CHAINS

IGUS chains have 2 mounting holes.

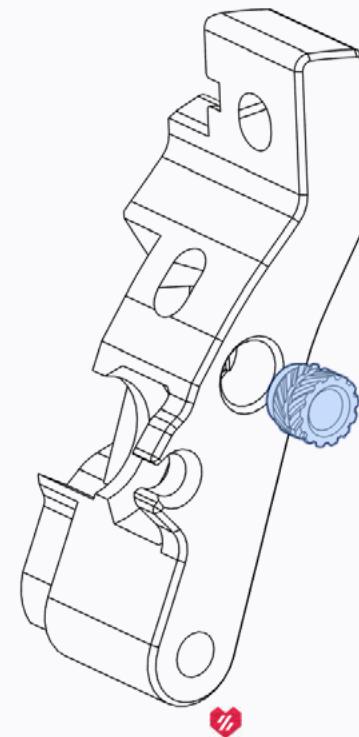
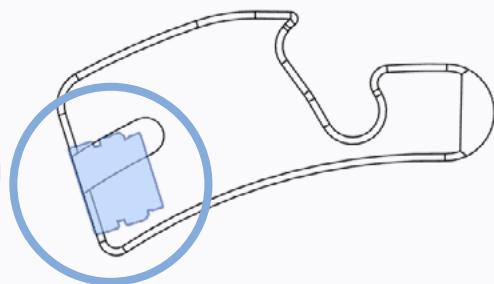


PRINTER SPECIFIC MOUNTS

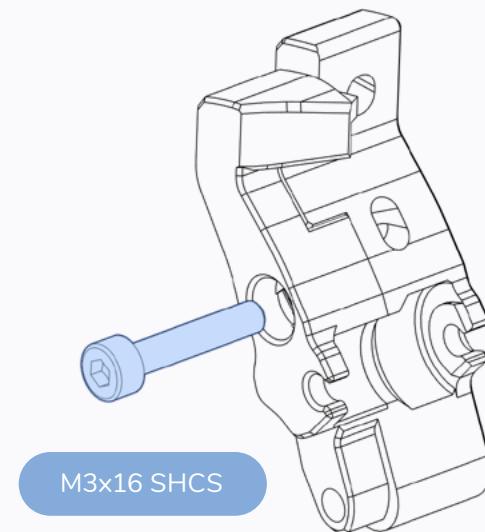
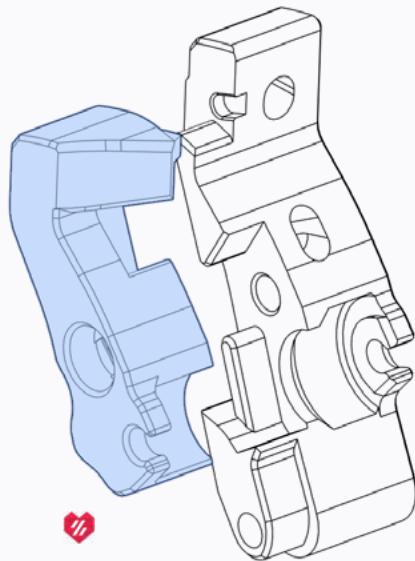
V2, Trident and Legacy use the same printed parts. Extra parts are included for SwitchWire.

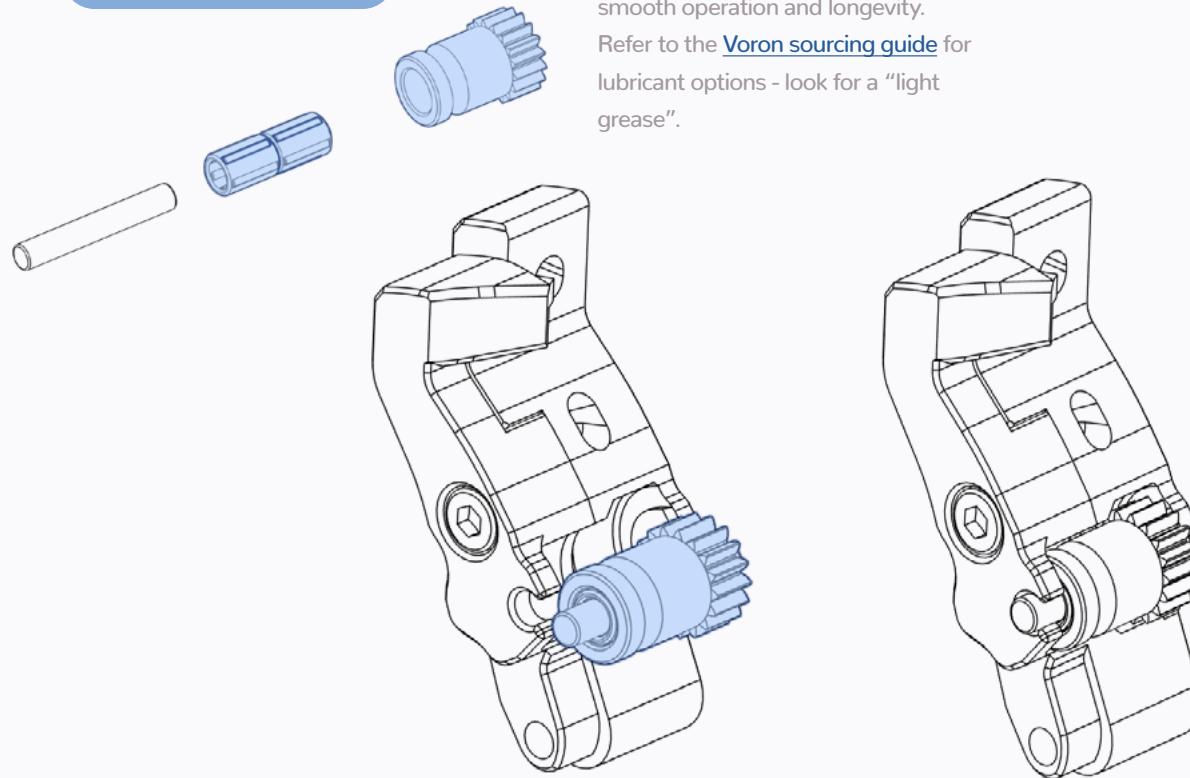
**FLUSH WITH SURFACE**

The heatset insert needs to sit flush or slightly below the surface of the printed part.

**ACCENT PART?**

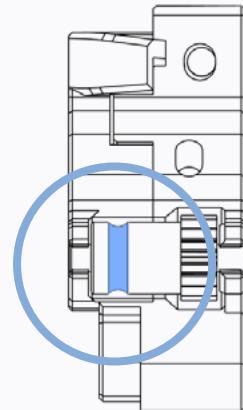
Look for Voron heart next to the part. It indicates that this is a part that is usually printed in the accent color.



BMG Idler Assembly**LUBRICATE BEARINGS**

A lubrication film is required to ensure smooth operation and longevity.

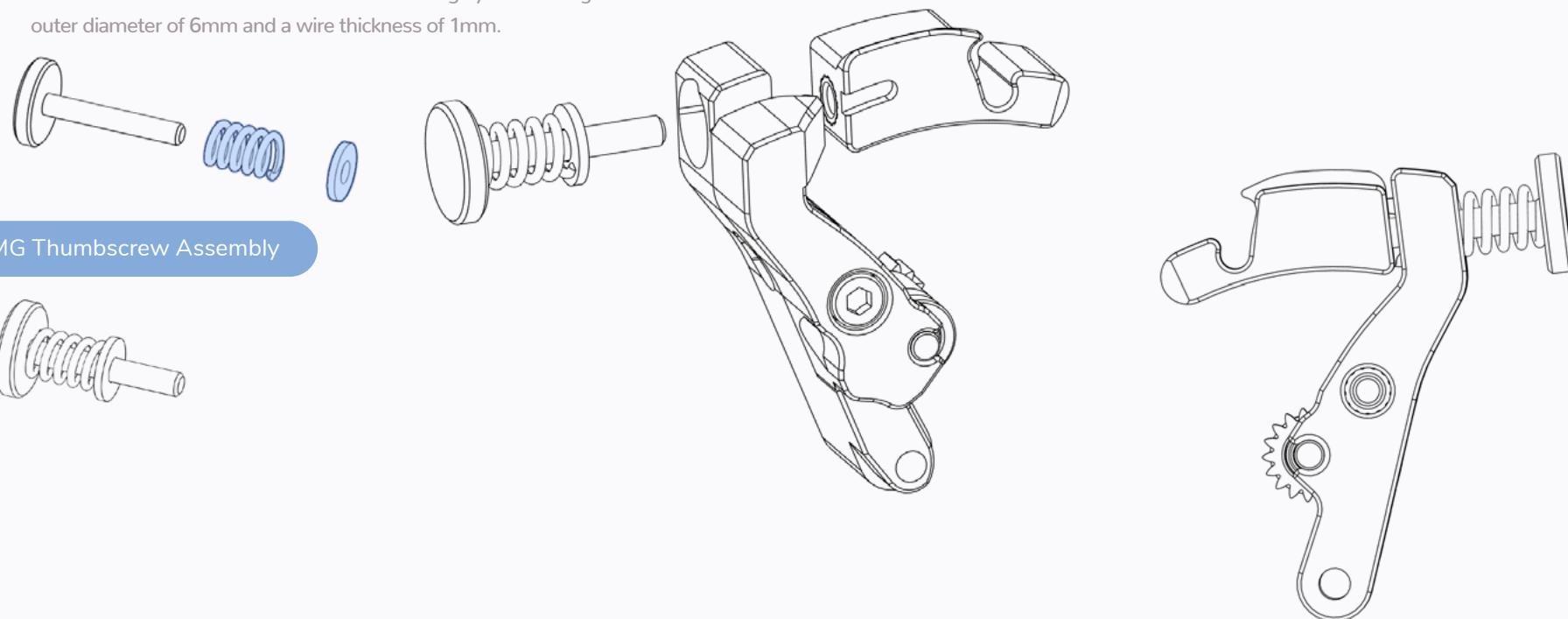
Refer to the [Voron sourcing guide](#) for lubricant options - look for a "light grease".

**MIND ORIENTATION**

Make sure to orient the idler assembly as shown above.

A NOTE ON SPRINGS

Longer/shorter/stiffer springs will change the tension characteristics and have an impact on how well the tension mechanism works. Consider buying the [original Bondtech part](#) as those are known to work well. If sourced from a different vendor check if it's roughly 12mm long with an outer diameter of 6mm and a wire thickness of 1mm.



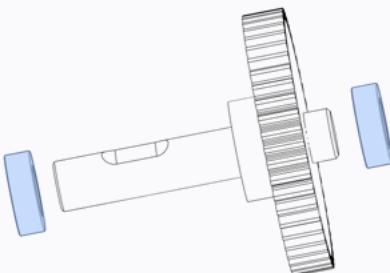
BMG Thumbscrew Assembly

CHECK BEARING FIT

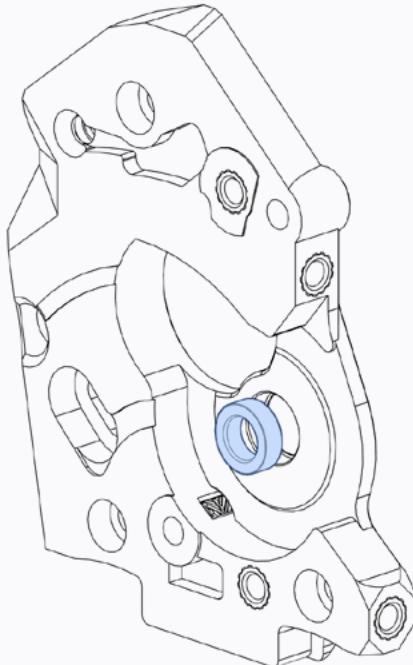
The bearings must slip on and off the shaft easily to allow the gear to self-centre.

Pressing the bearings on the shaft will damage them.

Lightly sand the shaft if required.



MR85 Bearing

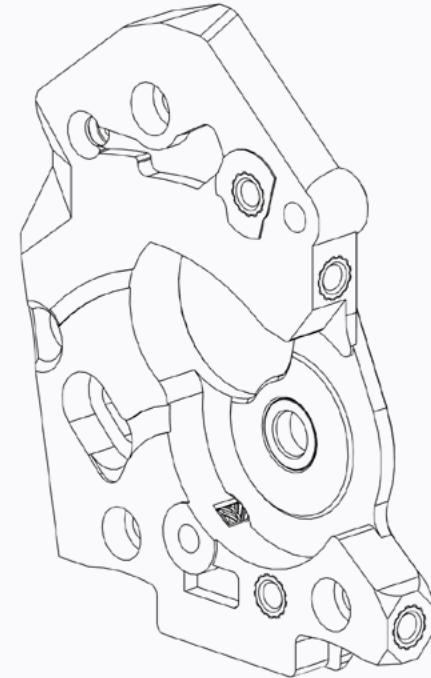


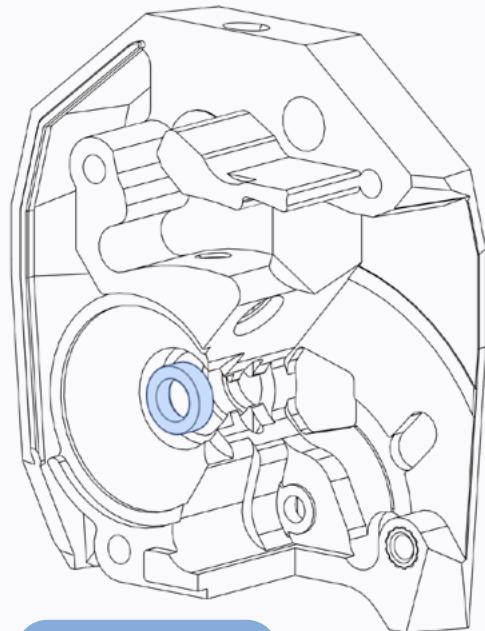
MR85 Bearing

BEARING FIT

Fully seat the bearing into the plastic pocket. Apply even pressure to insert them. Avoid pressing on the inner ring of the bearing.

If the fit is too tight the printed parts are likely over-extruded.

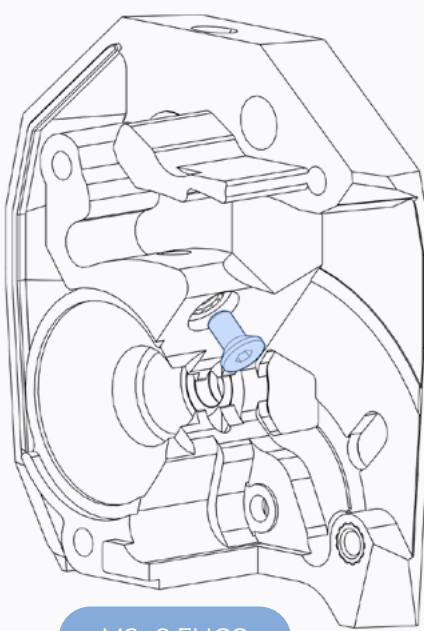




MR85 Bearing

BEARING FIT

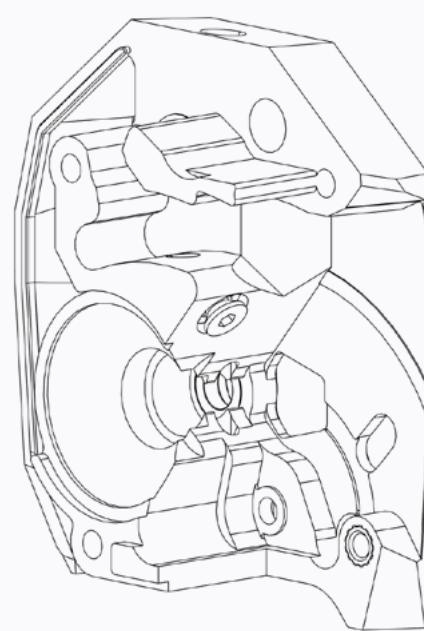
Fully seat the bearing into the plastic pocket.
Apply even pressure to insert them. Avoid
pressing on the inner ring of the bearing.



M3x6 FHCS

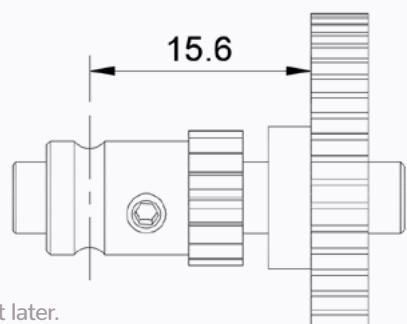
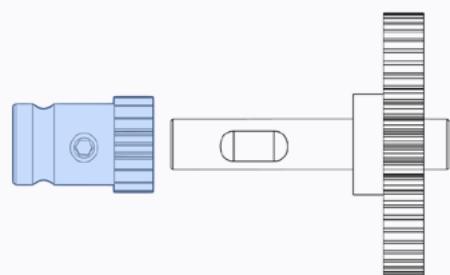
THREAD LOCKER PLEASE

Adding a small amount of medium strength
thread locker to this flat head screw will keep
it from coming loose over time..



A NOTE ON GEARS

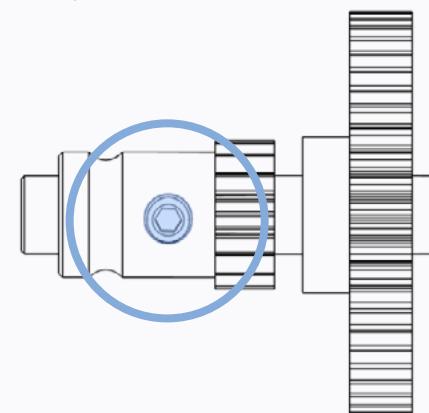
Poorly made gears often cause print quality issues. For best performance consider sourcing the [original Bondtech parts](#).

**INITIAL POSITION**

The final position is set later.

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.

**THREAD LOCKER**

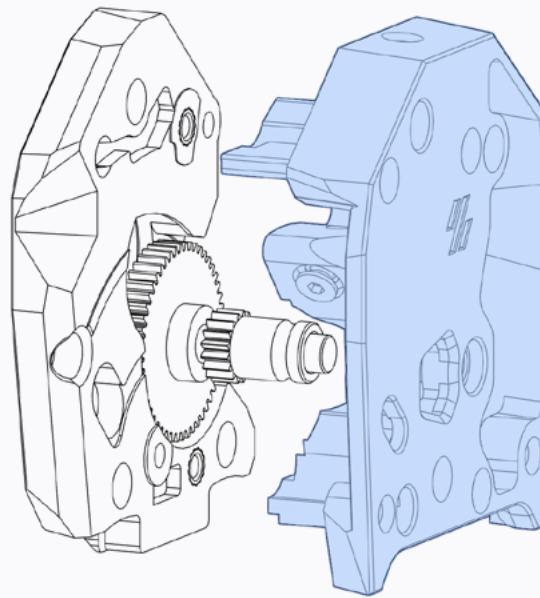
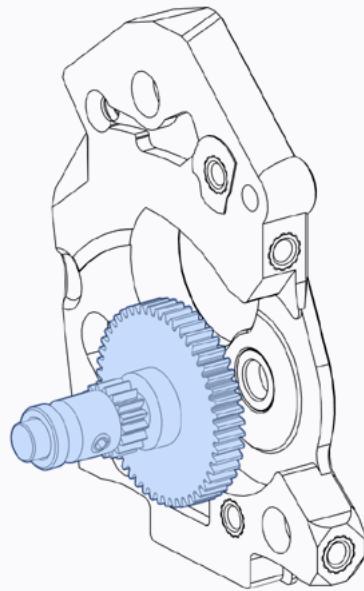
The final position of the drive gear is set in a later step. Common thread lockers have a long enough working time to complete the steps without issues.

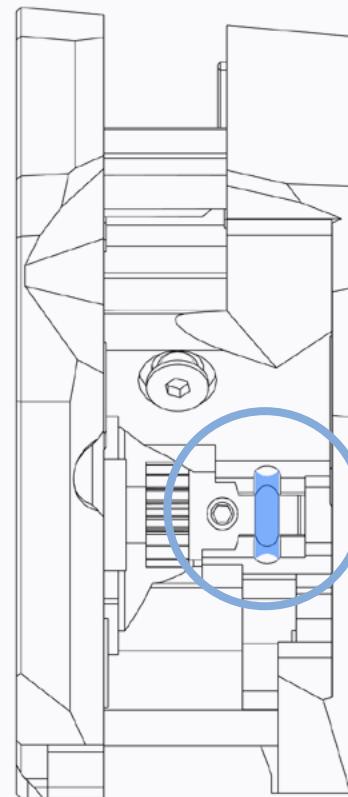
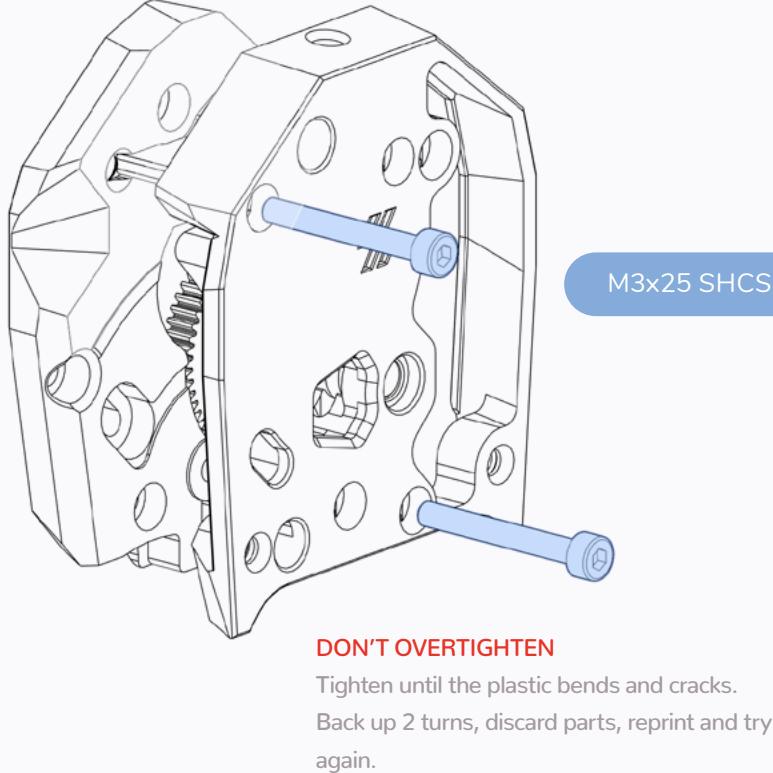
Familiarize yourself with the steps on the next 3 pages before you apply thread locker.

Complete the steps on the next 3 pages after applying the thread locker.

MAIN BODY

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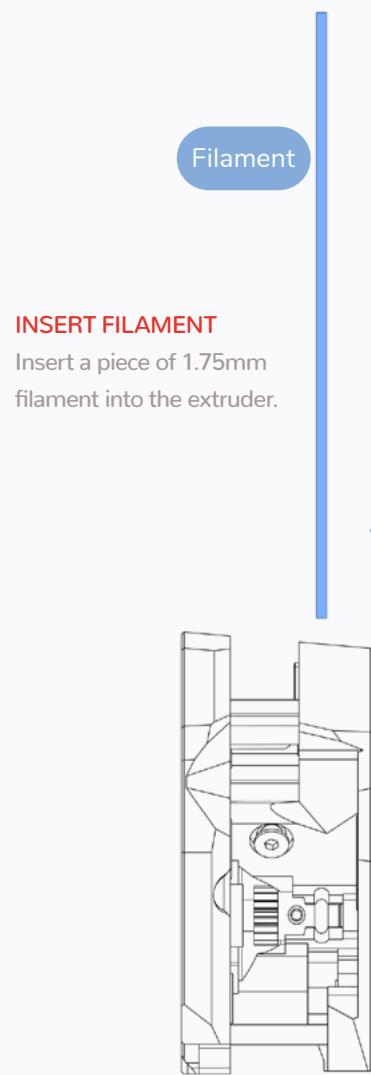


**INITIAL ALIGNMENT CHECK**

Check if the filament path aligns with the toothed section of the drive gear.

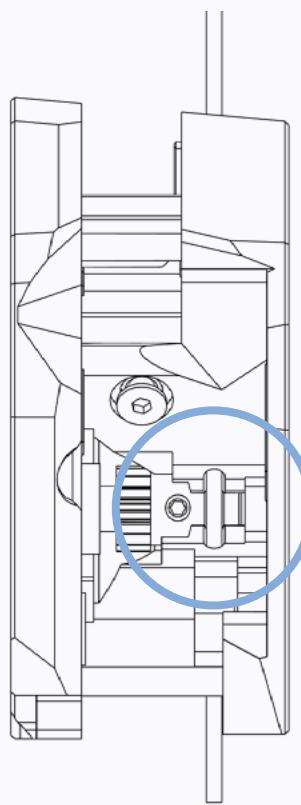
DRIVE ALIGNMENT

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INSERT FILAMENT

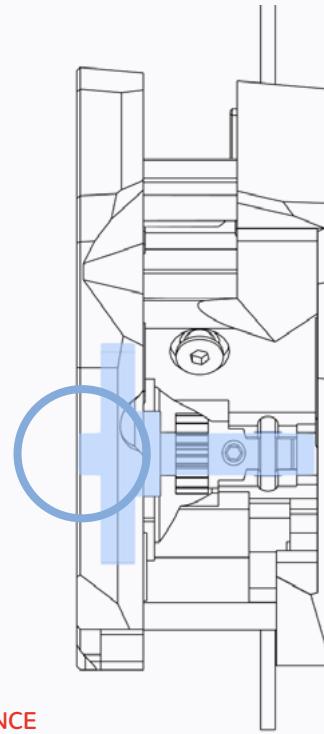
Insert a piece of 1.75mm filament into the extruder.



CHECK ALIGNMENT

With the filament inserted, verify if the filament path and drive gear are aligned.

Loosen the set screw and adjust the position of the drive gear if required.



CHECK FOR CLEARANCE

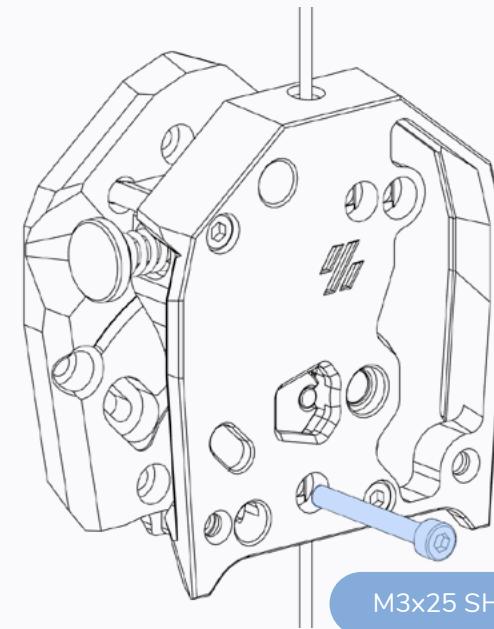
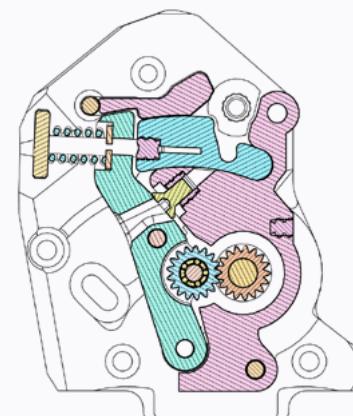
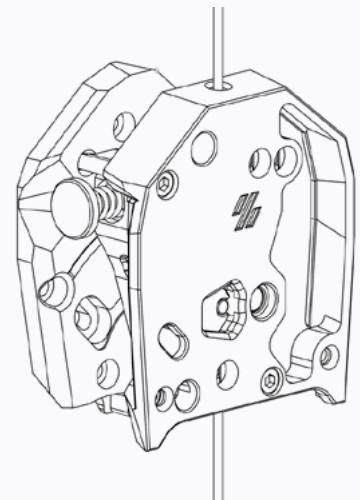
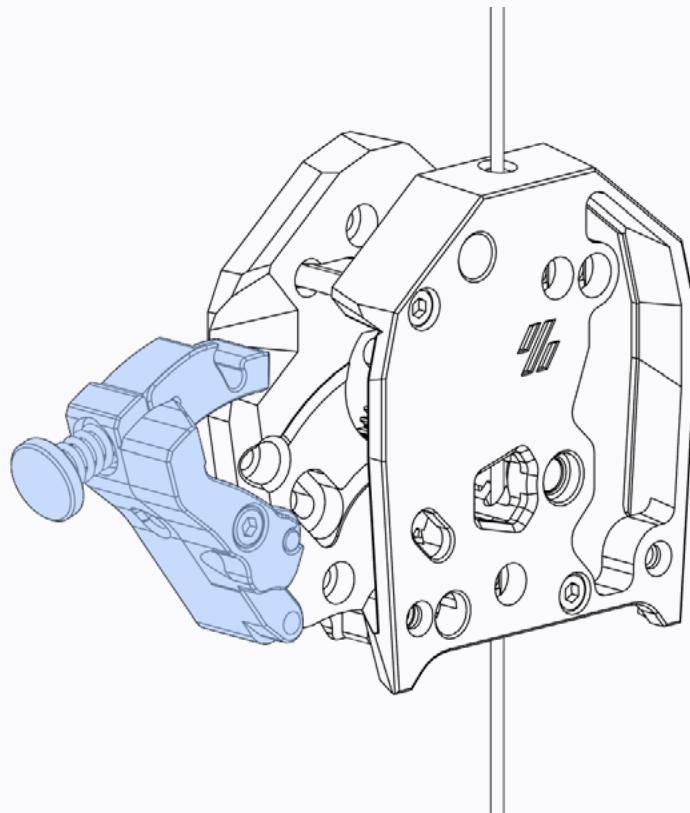
The drive shaft must not touch the motor housing. Make sure it does not sit above the surface of the printed part.

Check if the shaft has sufficient clearance when fully seated.

Depending on the shafts tolerances you may need to adjust the position of the drive gear or sand the face of shaft.

TENSION ARM

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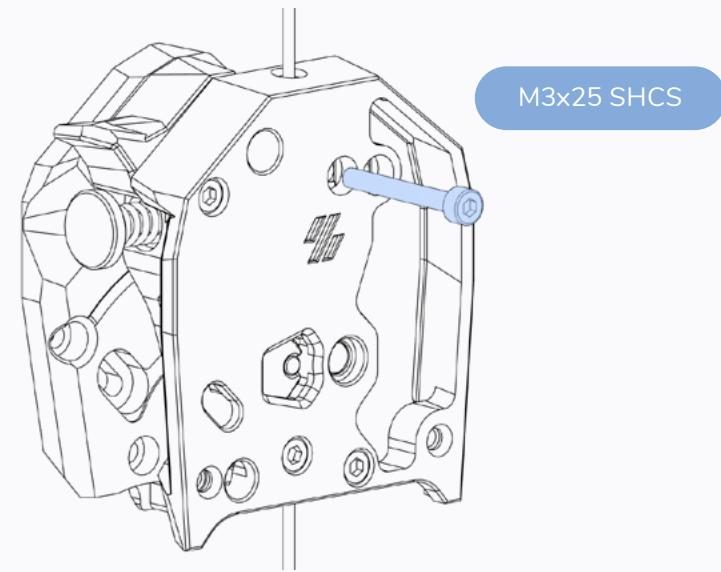
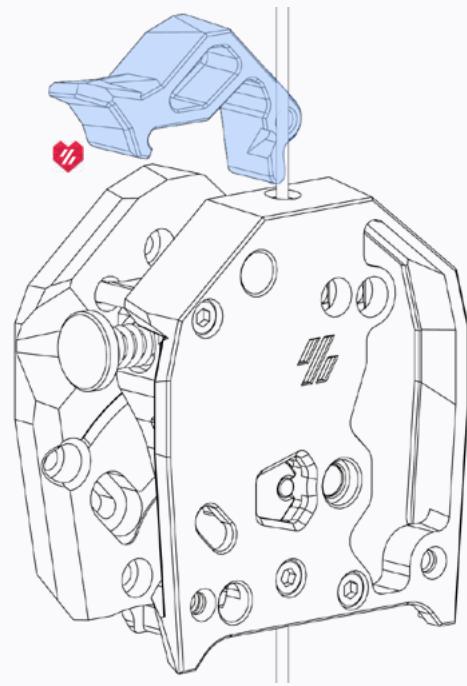
M3x25 SHCS

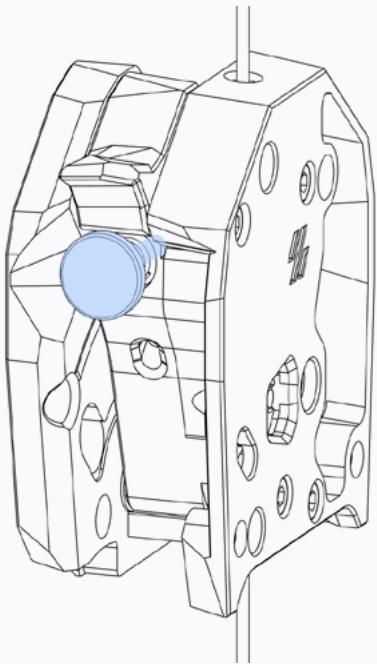
DON'T TIGHTEN

The tensioning arm must move freely. Tightening the bolt may lock it in place.

LATCH

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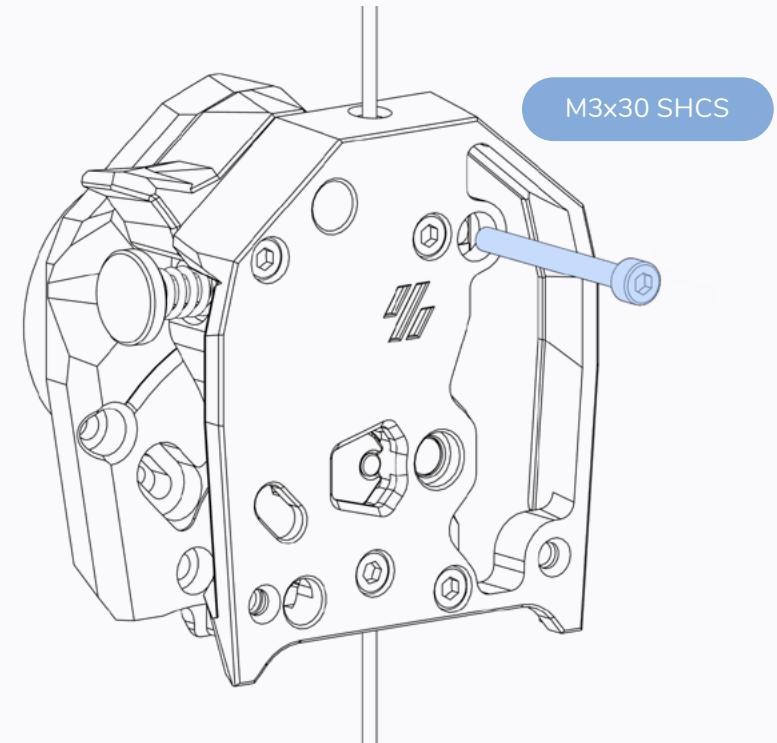
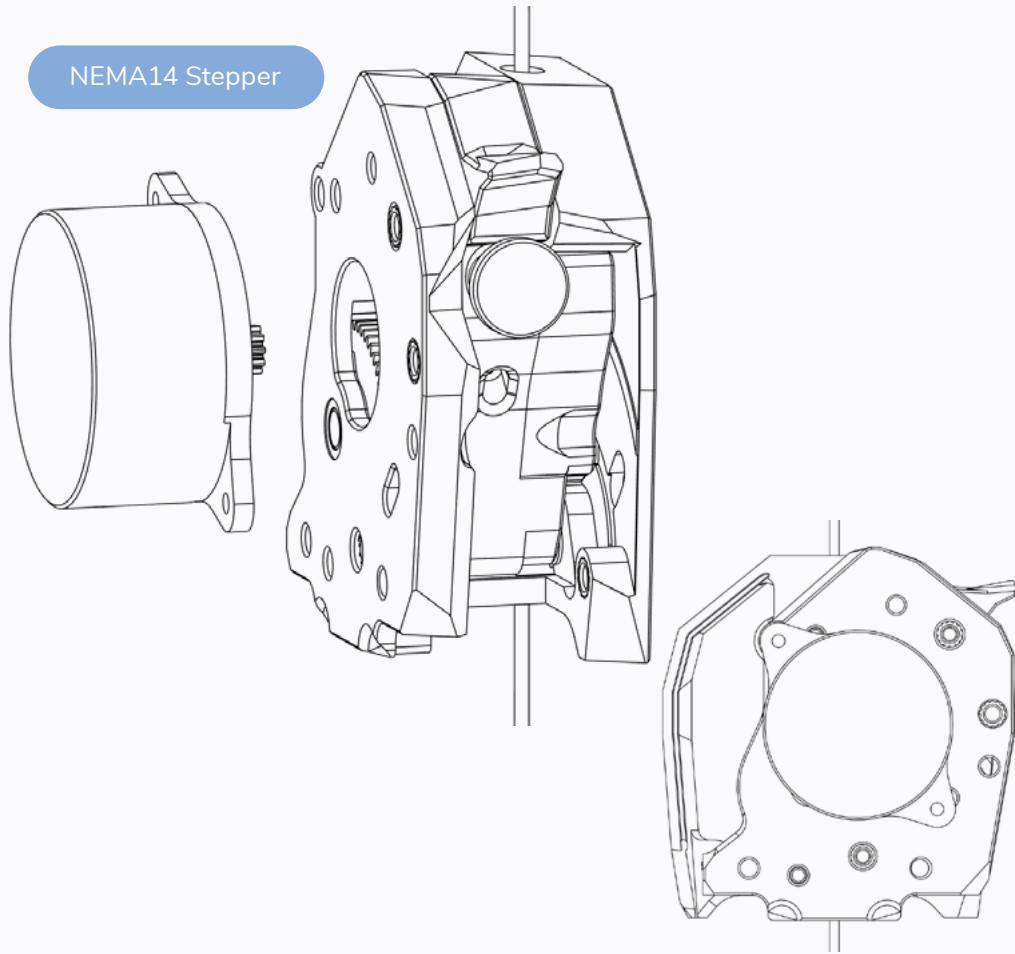


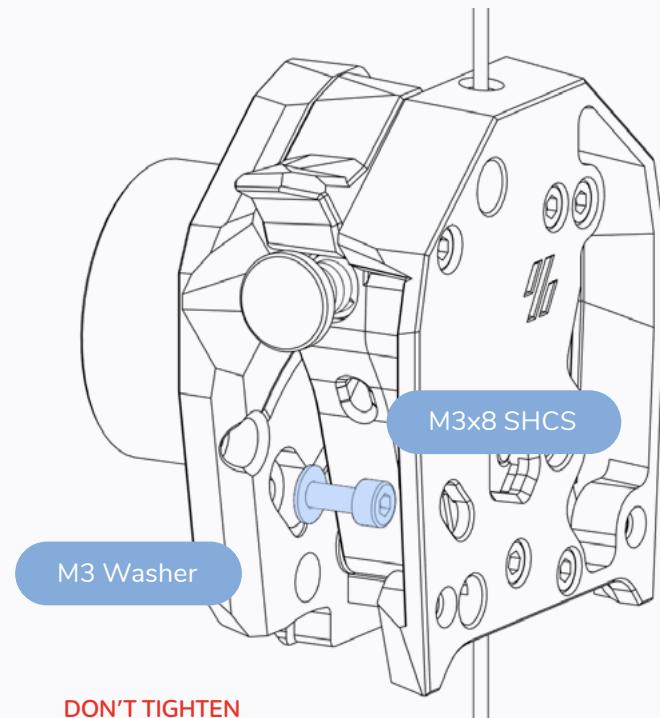
**TENSION KNOB**

Turning the thumb screw clockwise will increase the tension and grip on the filament. Too much tension will result in print issues.

**ANTI SQUISH THINGYMAJIG**

Softer and flexible materials will deform and extrude poorly under too much tension. ClockWork2 adds an adjustment feature to set the minimum distance between the drive gear and the idler, limiting the squish on the filament, and to prevent the gears from meshing too tightly or binding up the extruder.

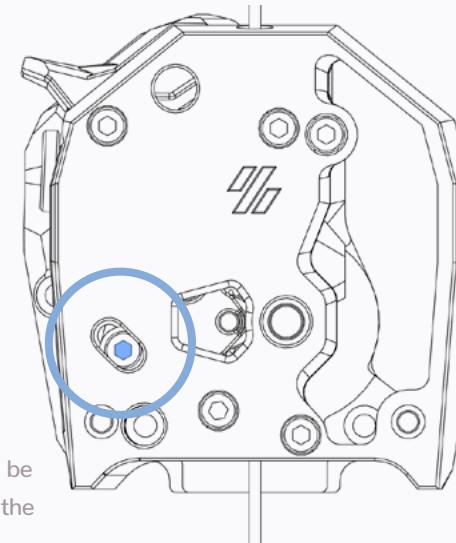


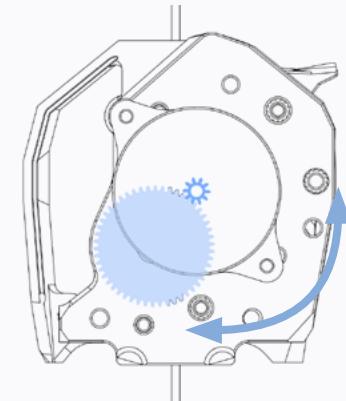
**DON'T TIGHTEN**

The motor position will be adjusted in the next steps. Don't fully tighten just yet.

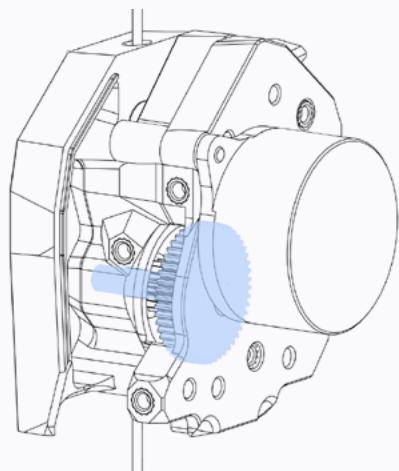
ACCESS HOLE

The second motor bolt can be accessed from the front of the extruder.

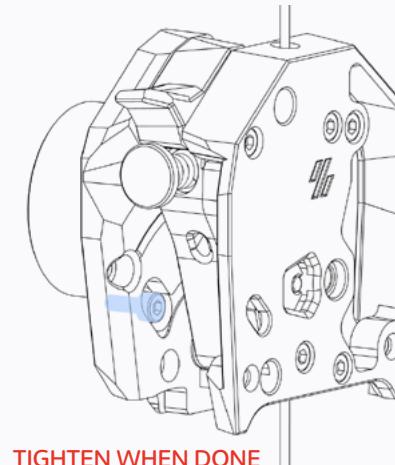


**SET GEAR MESHING**

Adjust the stepper motor position so that the motor and extruder gear teeth fully mesh /overlap with each other. There should be a very small gap between the faces of the gear teeth; the gears must not press tightly against each other.

**CHECK GEAR PLAY**

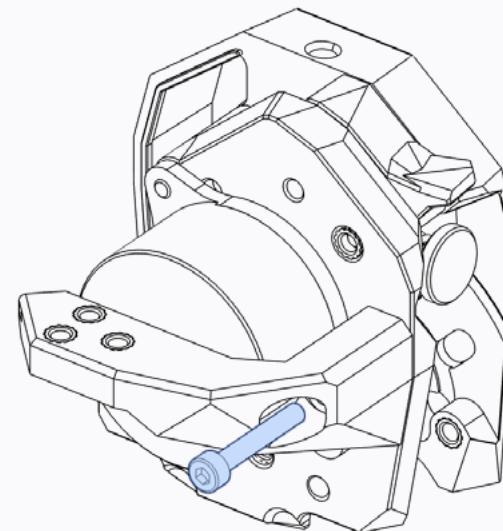
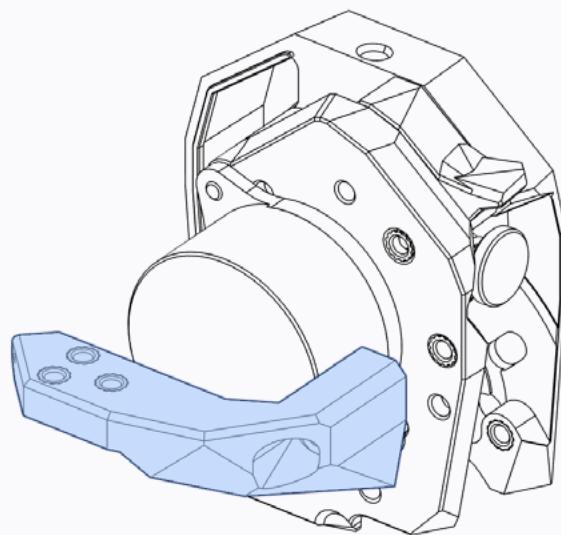
The gear should have a slight play and should not be fully tight against the pinion. Adjust the position of the motor until you have a faint play.

**TIGHTEN WHEN DONE**

Don't forget to tighten the second motor bolt after adjusting.



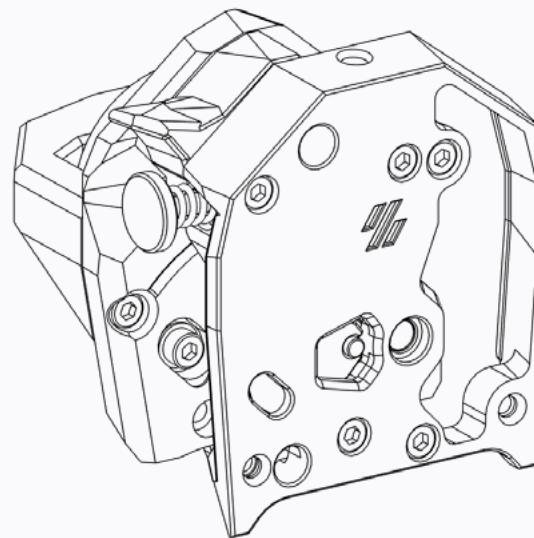
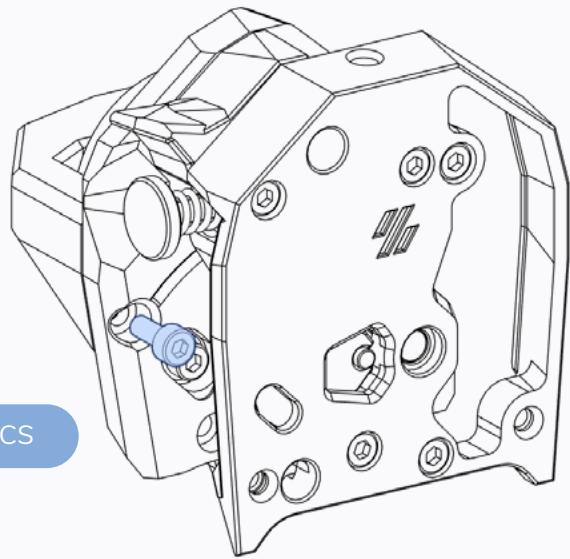
<https://voron.link/u6ehxsw>

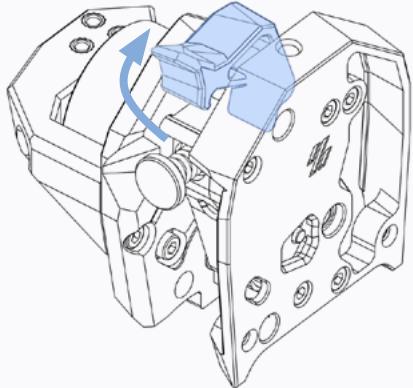


M3x20 SHCS

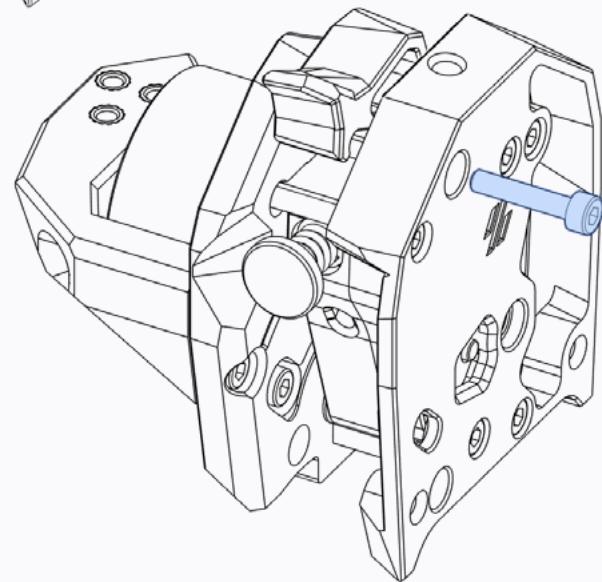
CABLE BRIDGE

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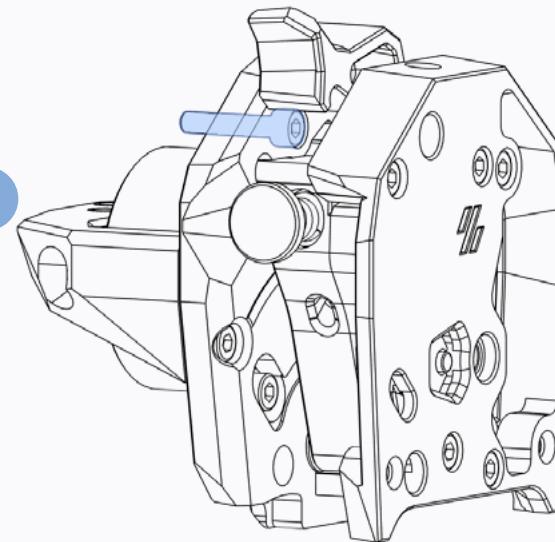


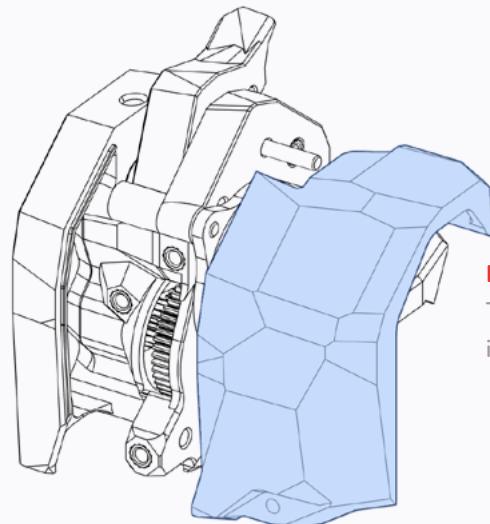
**OPEN LATCH**

Undo the filament latch to expose the bolt pocket for the cable cover.

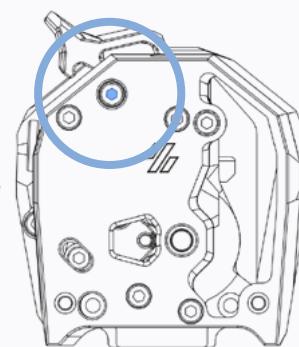


M3x16 SHCS

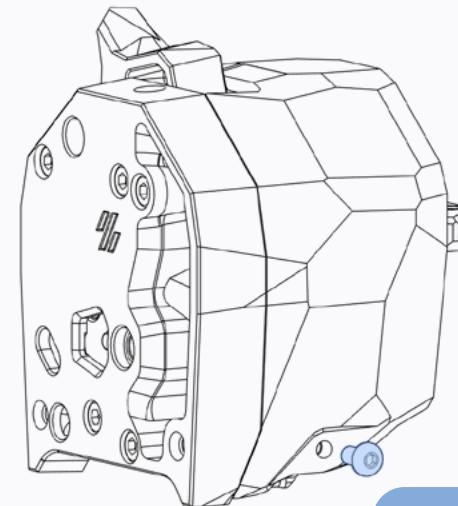


**DON'T OVER-TIGHTEN**

The bolt is threaded directly into plastic.

**ACCESS HOLE**

The bolt drive can be accessed from the front of the extruder.



StealthBurner development started on 2021-04-13 with a simple: "I'm going to regret saying this but, 'How hard could it be?'"

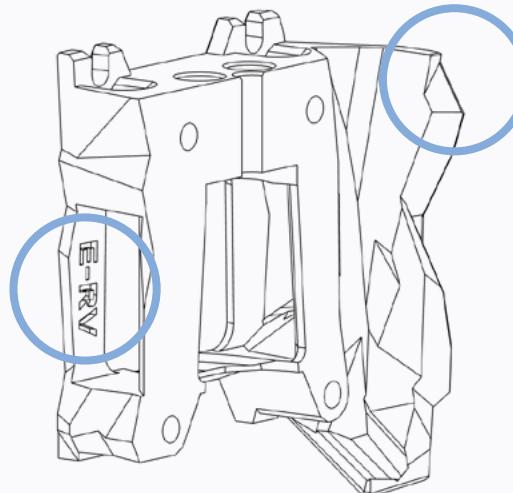
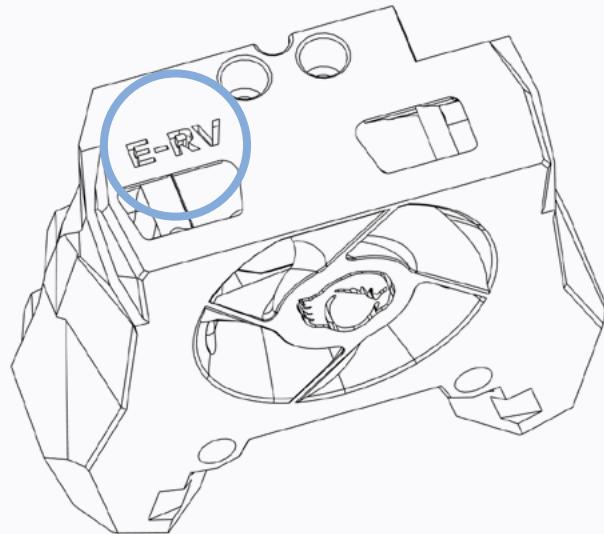
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IDENTIFYING PRINTED PARTS

The hotend type is embossed on the printed parts.

Make sure they match your hotend.

**AVAILABLE MOUNTS**

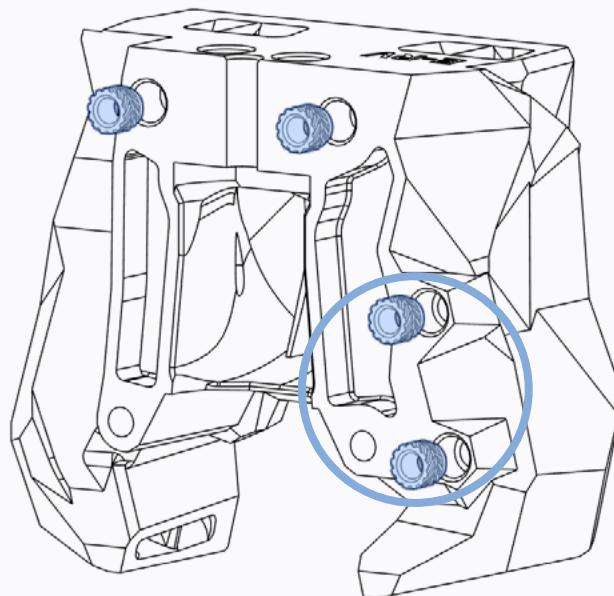
We also provide mounts for other hotends. They are assembled in a similar manner.

For a full list of available mounts and their identification code, see the readme file included in the toolheads folder.

MISSING CORNER? CW1? CW2?

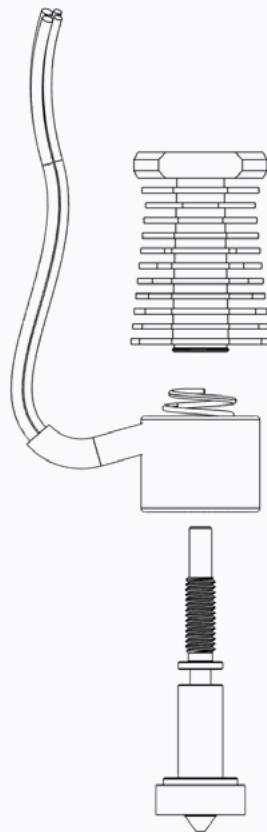
We also provide tool cartridge parts for ClockWork1, and other extruders designed as an alternative to CW1. They are identical except for an opening in the highlighted corner to help with wire routing for those designs.

Heat Set Insert



OPTION: ADXL PCB MOUNT

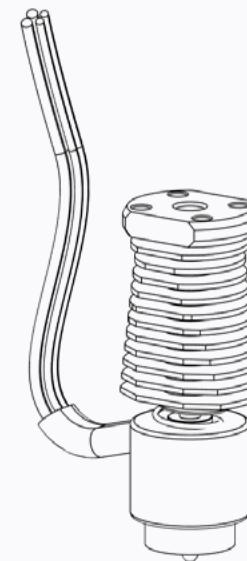
To use the optional ADXL PCB for Klipper's Input Shaper calibration, add additional heat set inserts into the holes in highlighted location.



Revo Voron Heatsink

Revo HeaterCore

Revo Nozzle



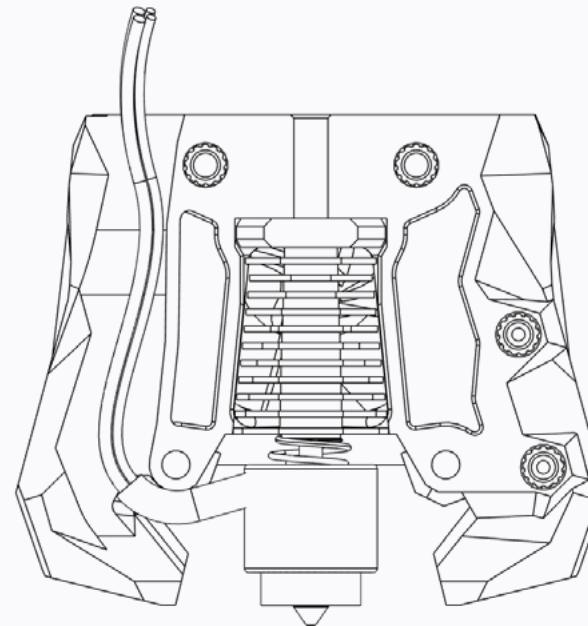
HOTEND WIRE ROUTING

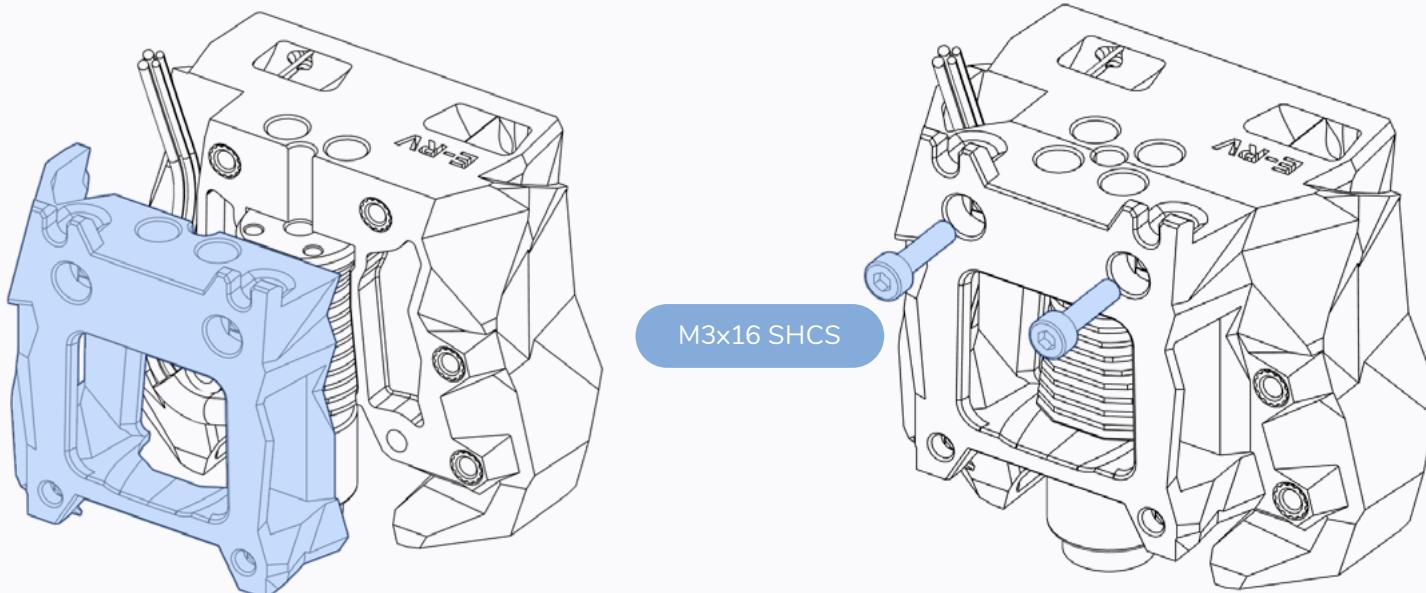
Route the wires as shown to the right. This is universal to all hotend types.

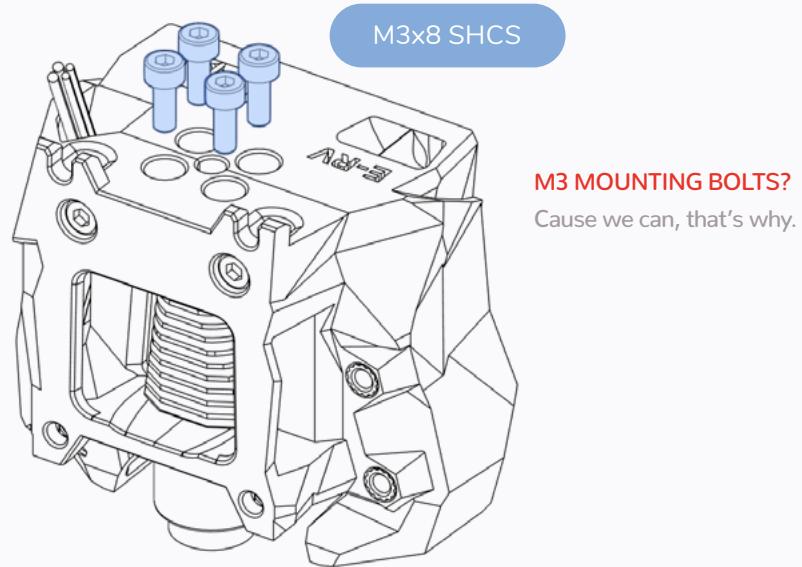
BEND STRAIN RELIEF

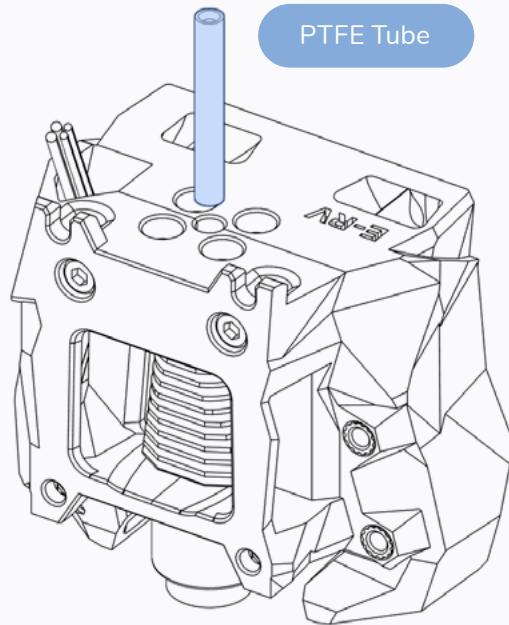
Carefully bend the strain relief to clear the printed part. Firmly hold the HeaterCore to prevent bending the Revo Nozzle.

It is critical that the Revo Nozzle is fully hand tightened into the heatsink. You MUST bend the strain relief to achieve this.







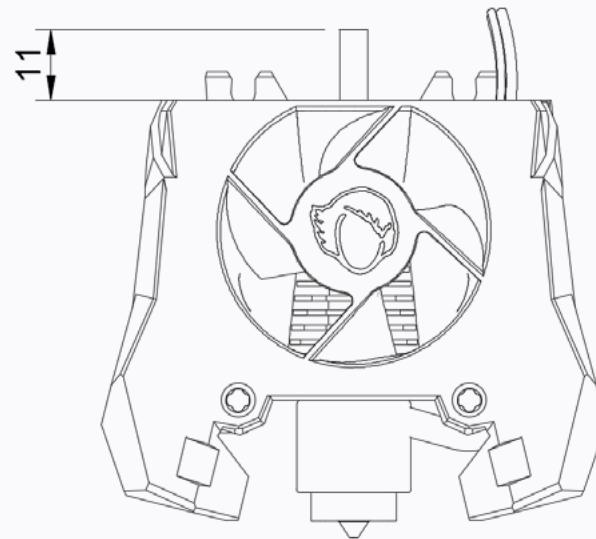


PTFE Tube

PTFE STICKOUT

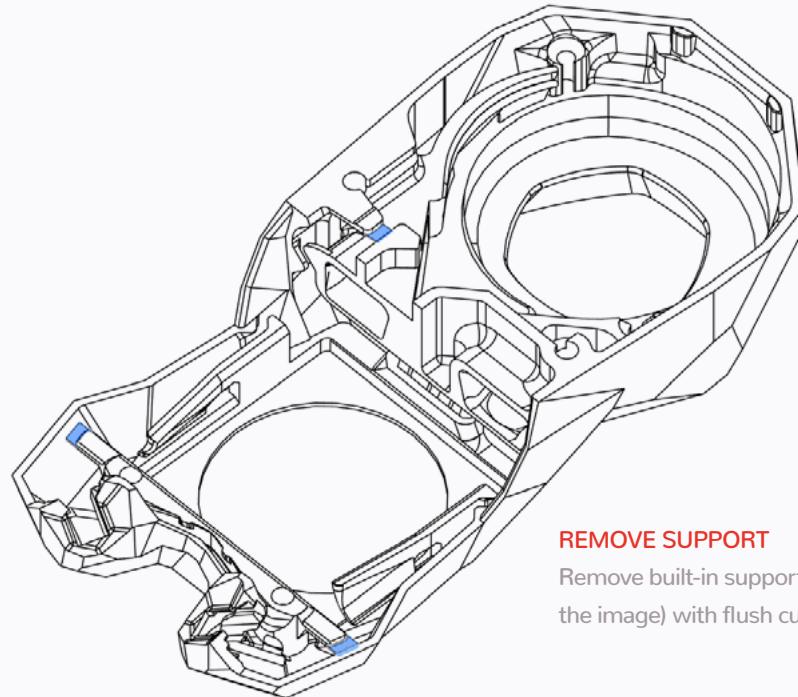
The PTFE tube should stick out 11mm above the surface of the printed part.

The stick out length might vary if you use an extruder other than the ClockWork2.



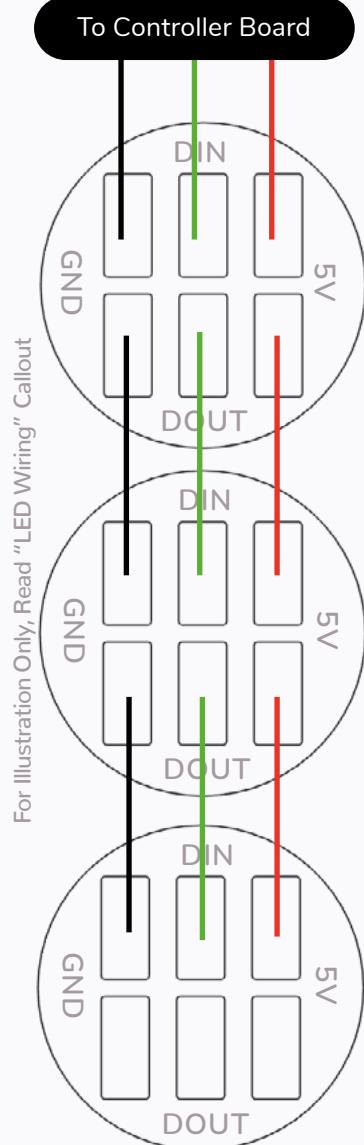
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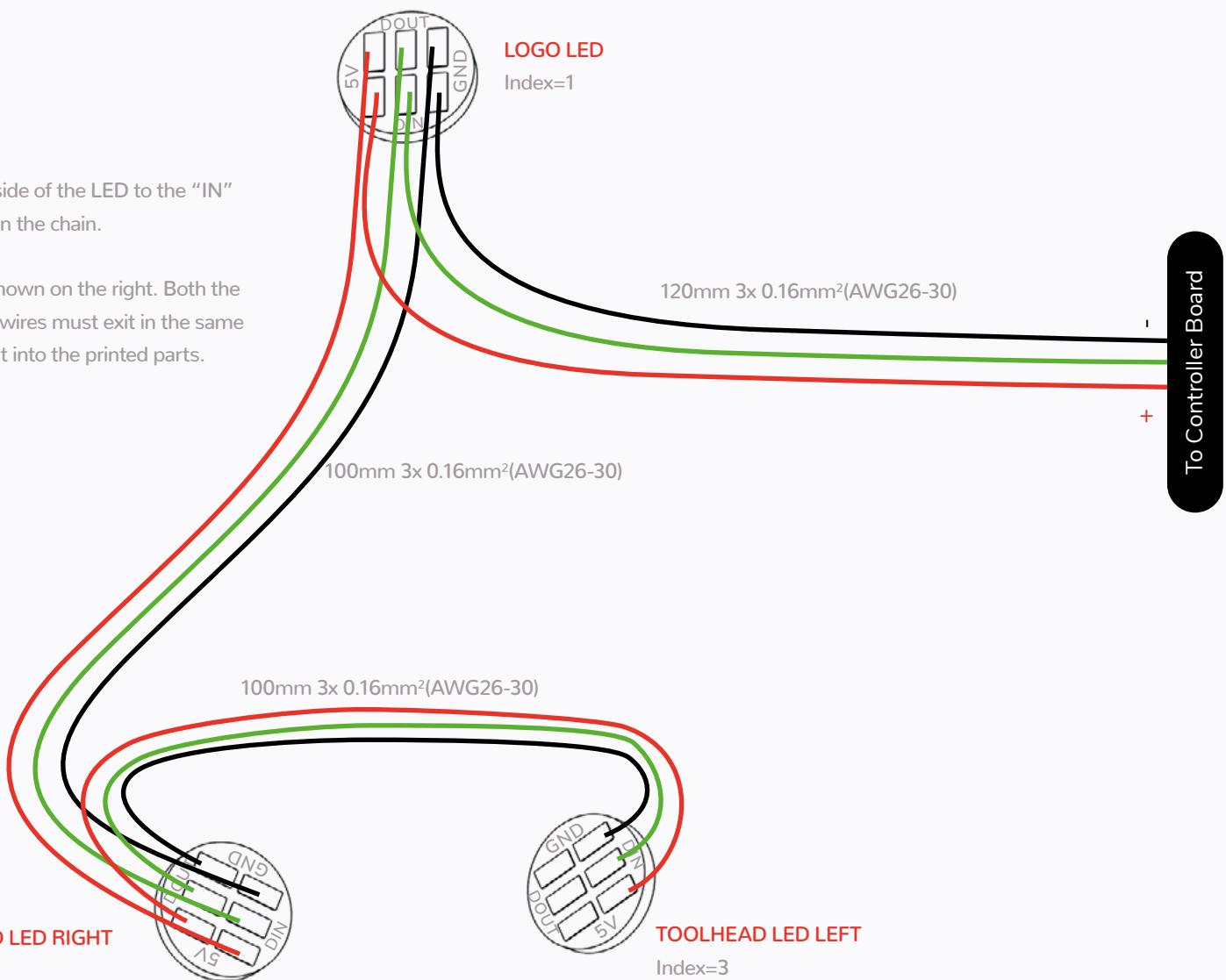
REMOVE SUPPORT

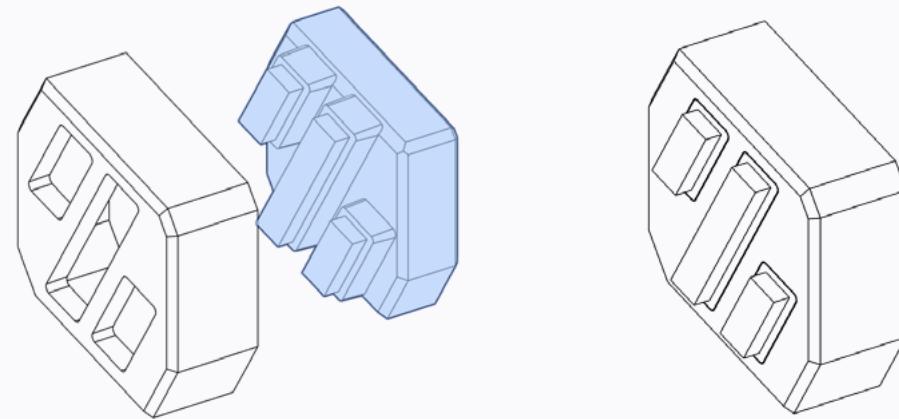
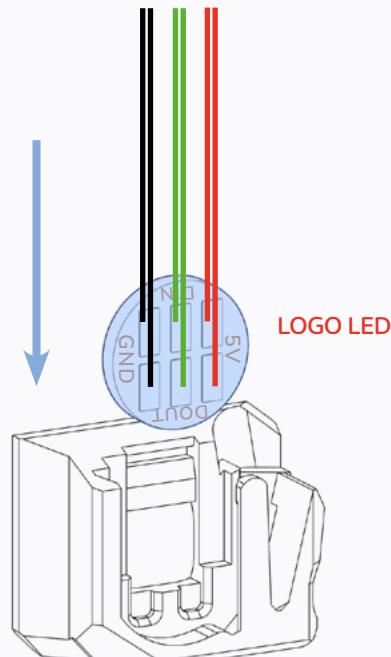
Remove built-in supports (highlighted in the image) with flush cutters.

**LED WIRING**

Connect the "OUT" side of the LED to the "IN" side of the next LED in the chain.

Solder the wires as shown on the right. Both the "IN" and the "OUT" wires must exit in the same direction in order to fit into the printed parts.





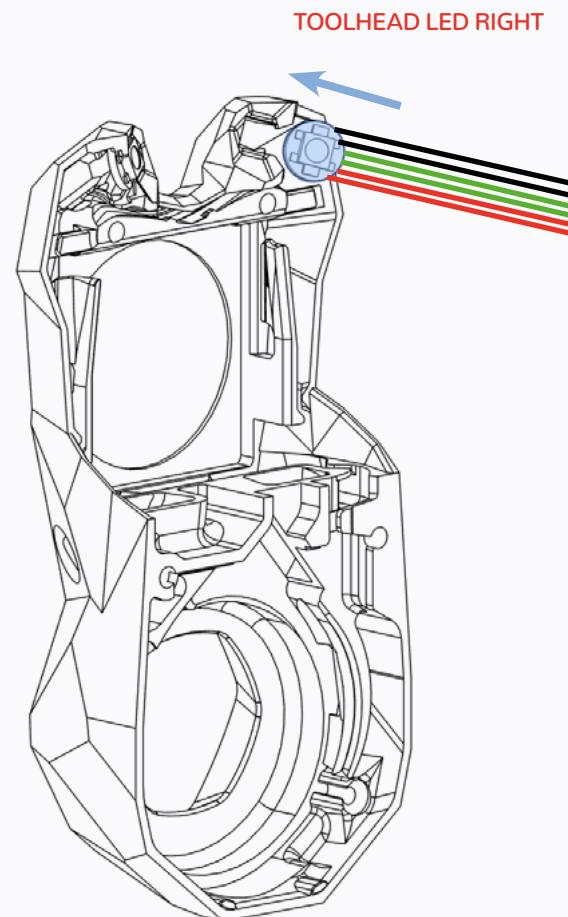
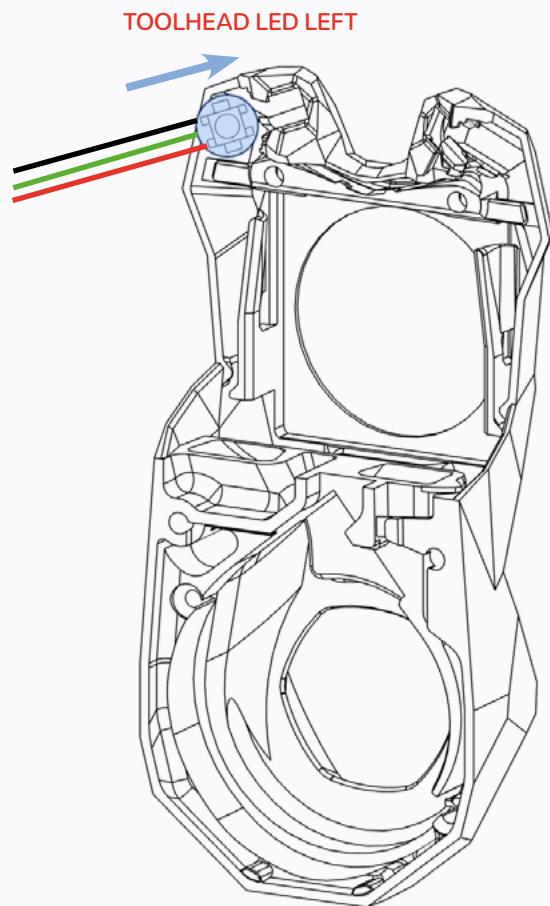
LED DIFFUSER AND MASK

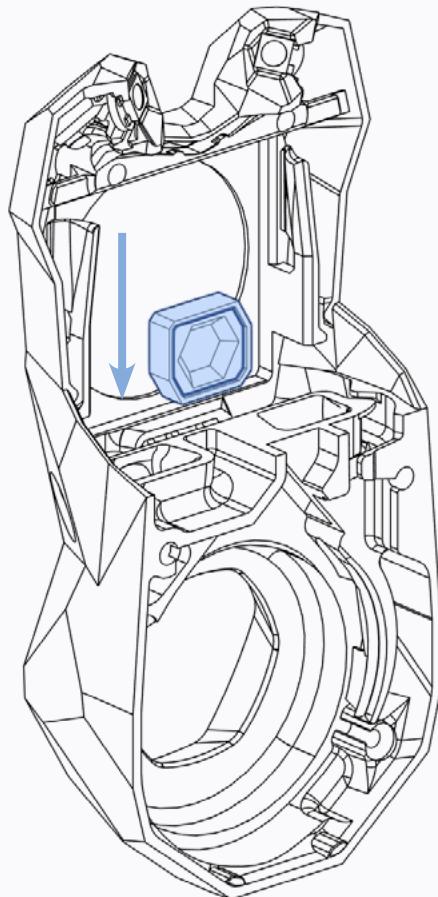
The diffuser (highlighted part) is printed in a translucent filament to evenly spread the light.

The mask (part to the left) is printed in an opaque filament to prevent the light from leaking, resulting in a crisp logo.

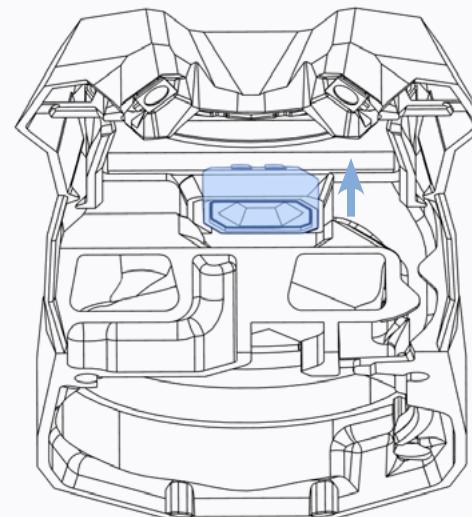
LEDS

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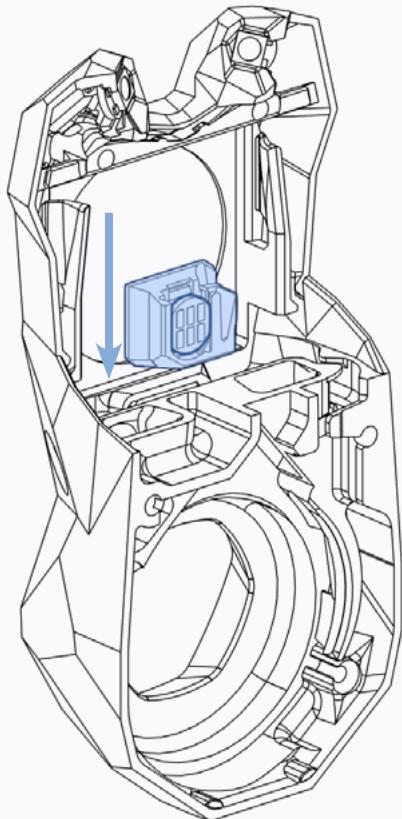
**DIFFUSER INSERTION**

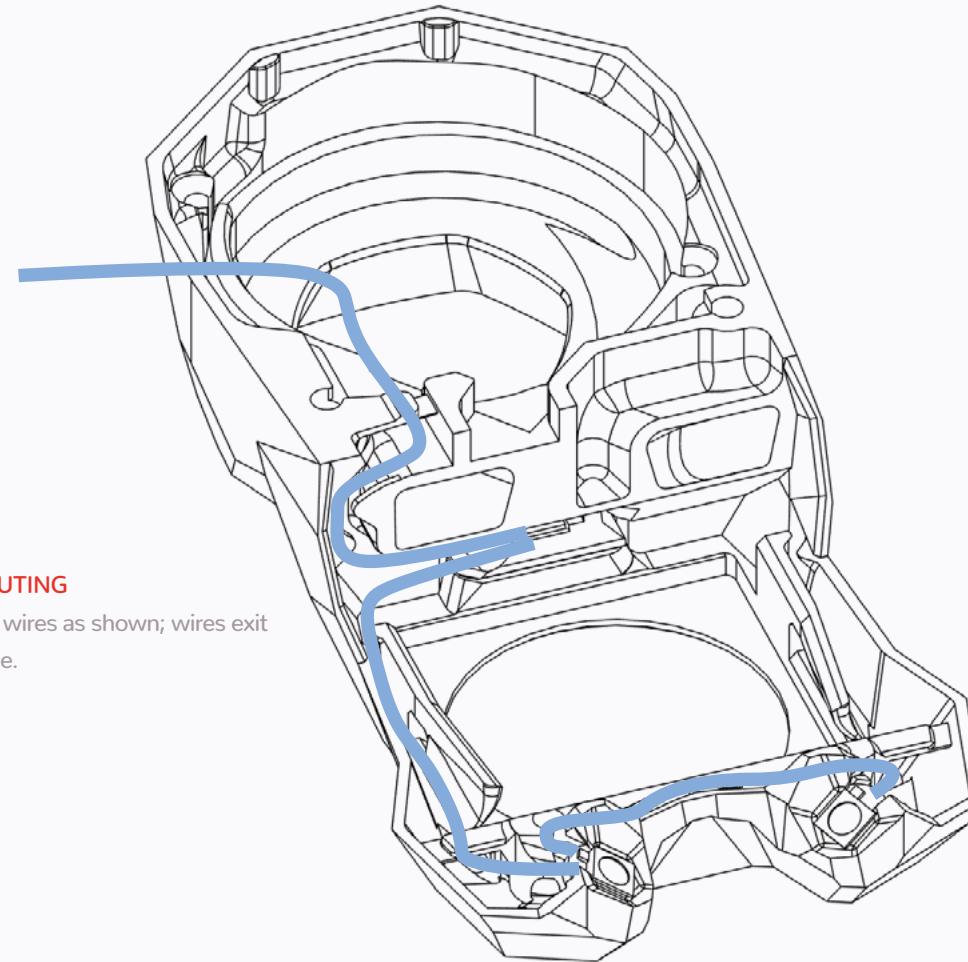
Insert the printed parts and push them towards the front.



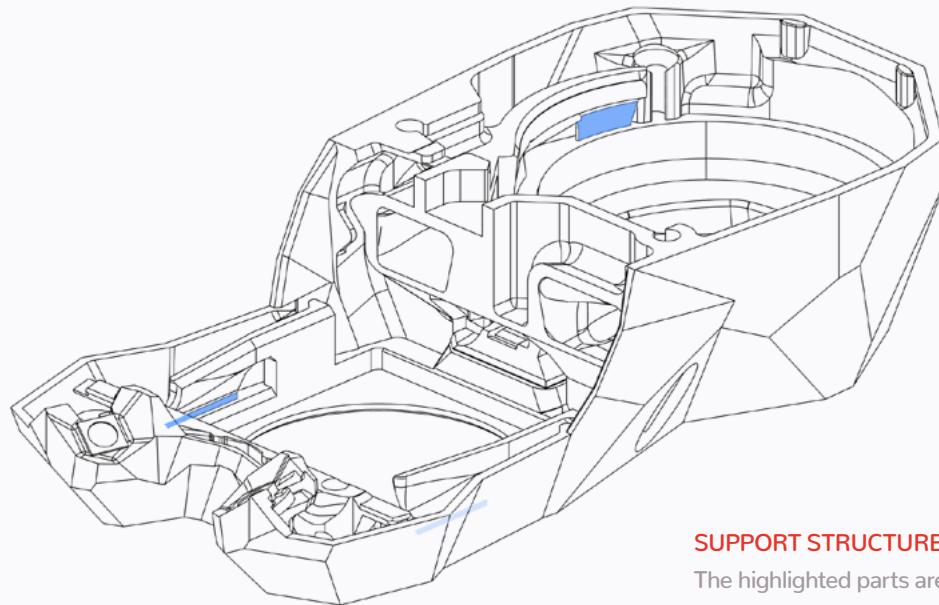
LEDS

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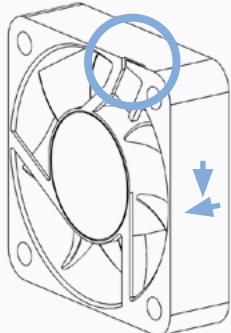
**LED WIRE ROUTING**

Route the LED wires as shown; wires exit on the right side.

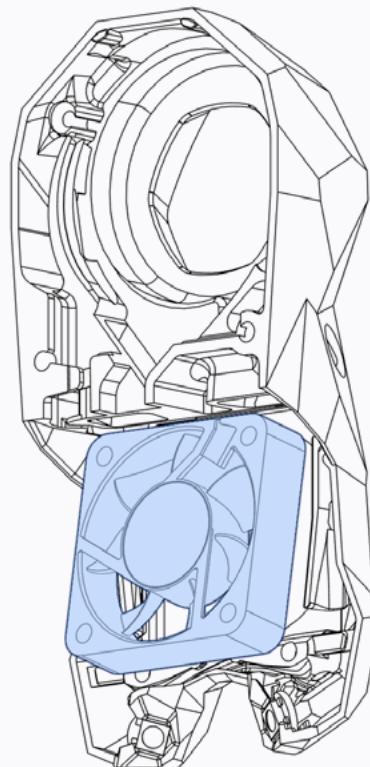


SUPPORT STRUCTURE

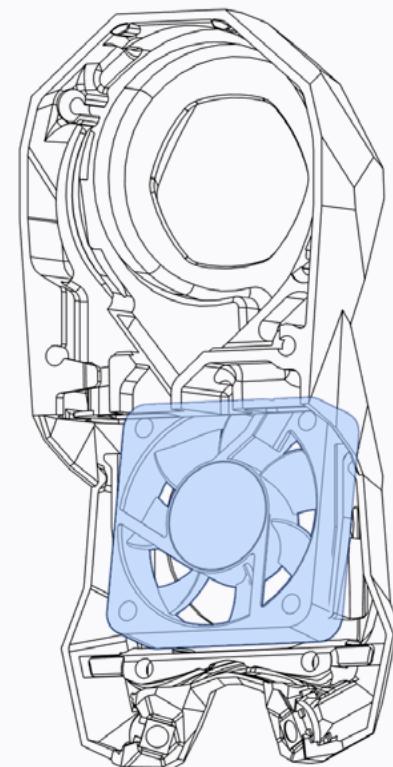
The highlighted parts are build-in support structures. They are designed to break during the fan installation.

**FAN ORIENTATION**

Rotate the fan so that the wires exit on the top and the air is pushed "inwards".

**FAN INSERTION**

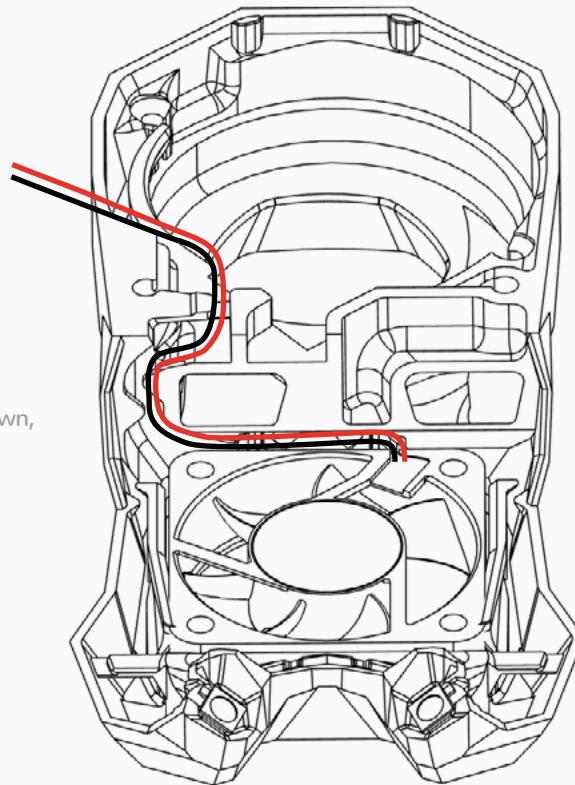
Insert the fan at a slight angle and clip it into place.

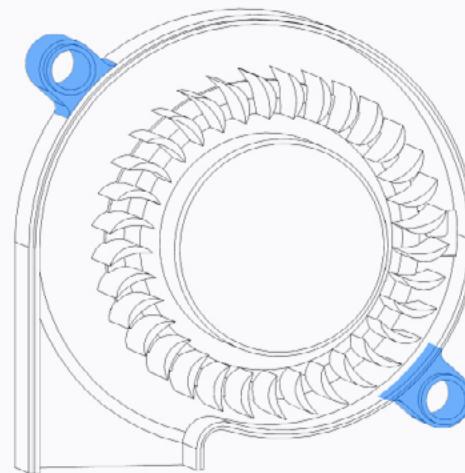
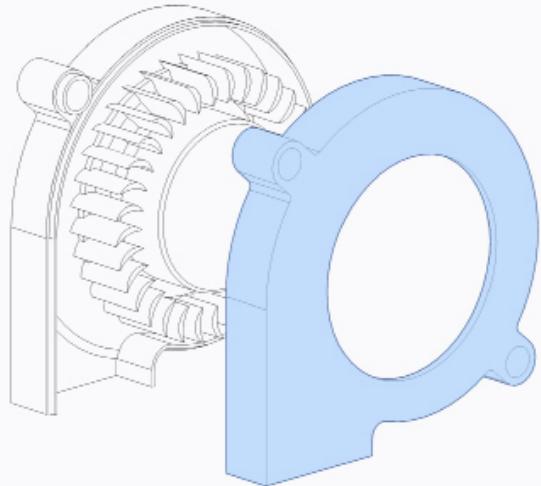


Mind the fan orientation.

FAN WIRE ROUTING

Route the fan wires as shown,
exiting on the right side





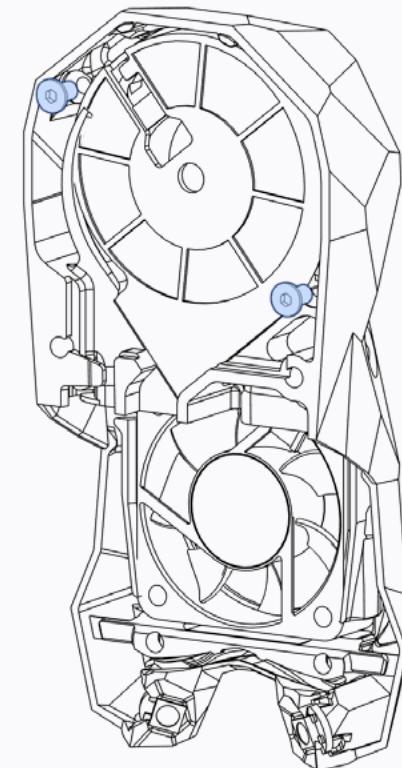
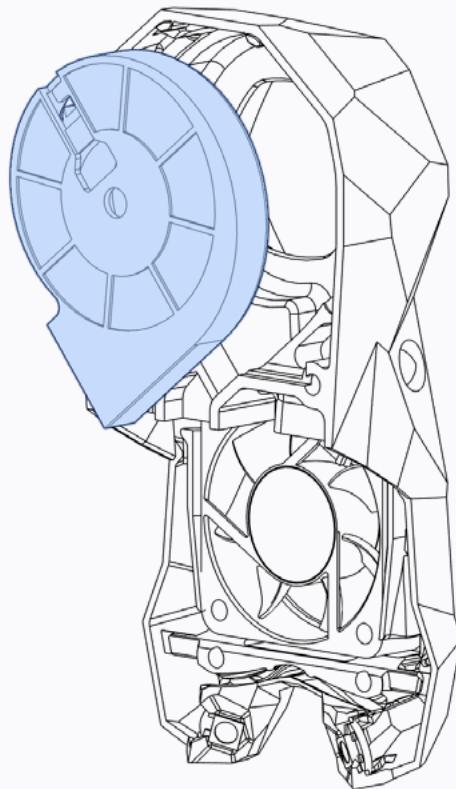
FAN PREPARATION

Remove the front of the 5015 fan. Clip off and file down the stock mounting ears.

There's a trimming jig STL included in the release to make this task easier.

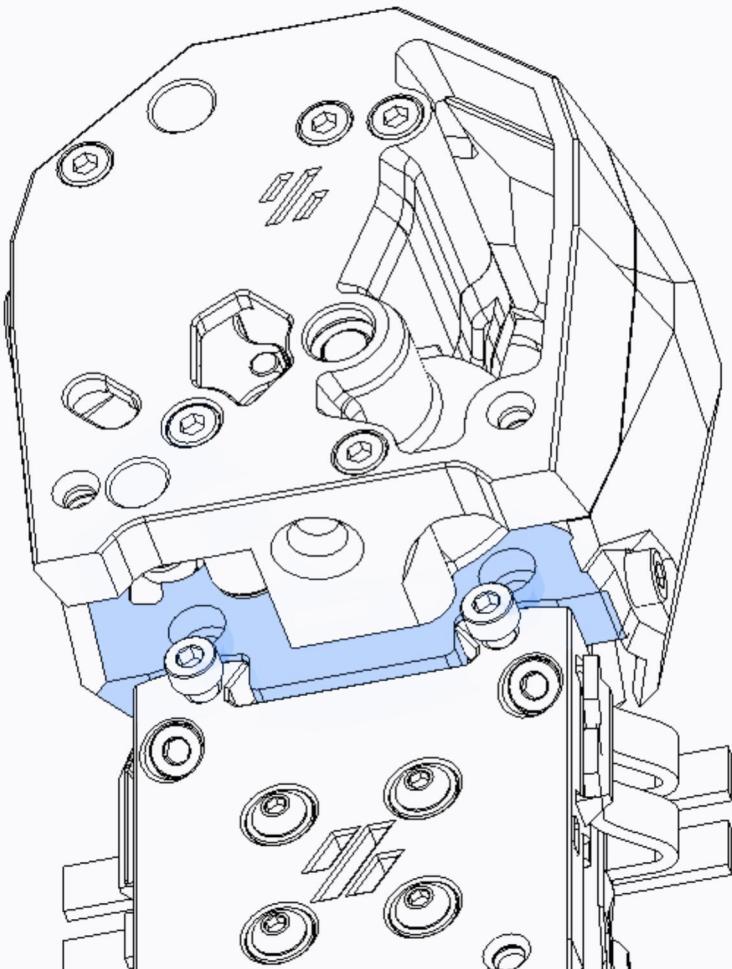
PART COOLING FAN

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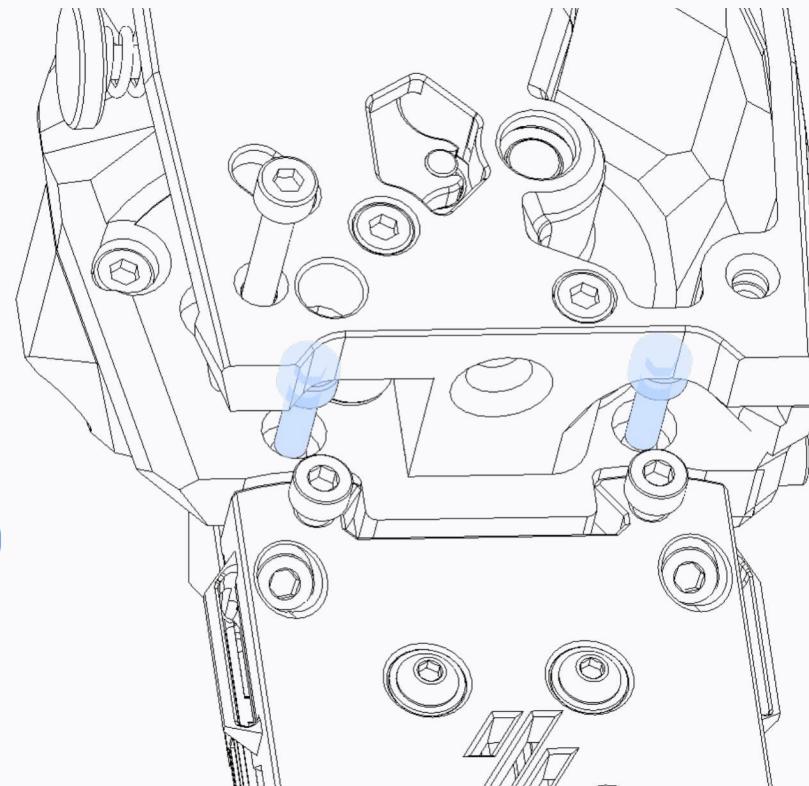


EXTRUDER INSTALL

The extruder motor plate should fit tightly on top of Tap.

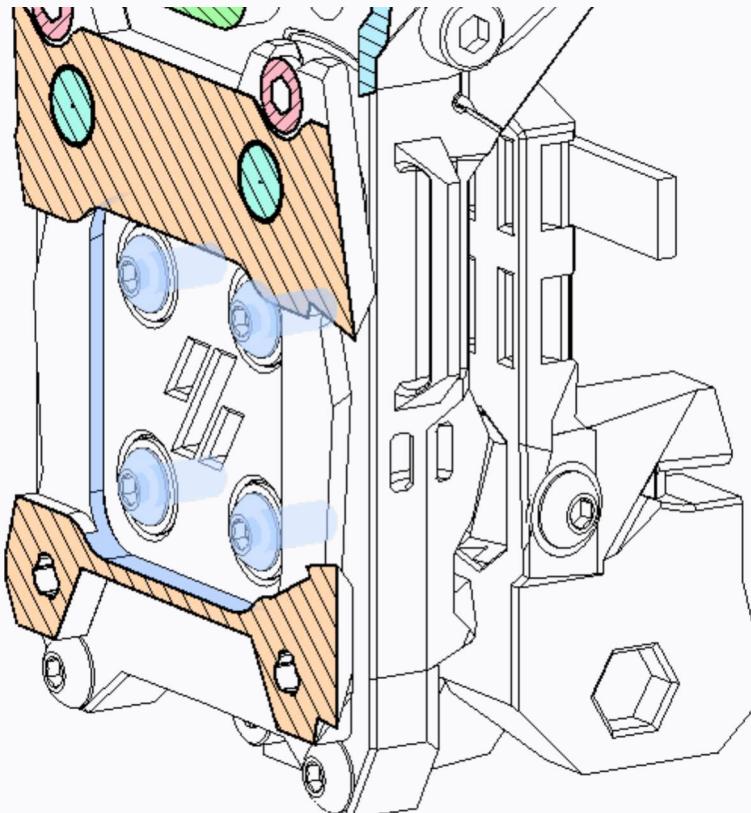


(2) M3x8 SHCS



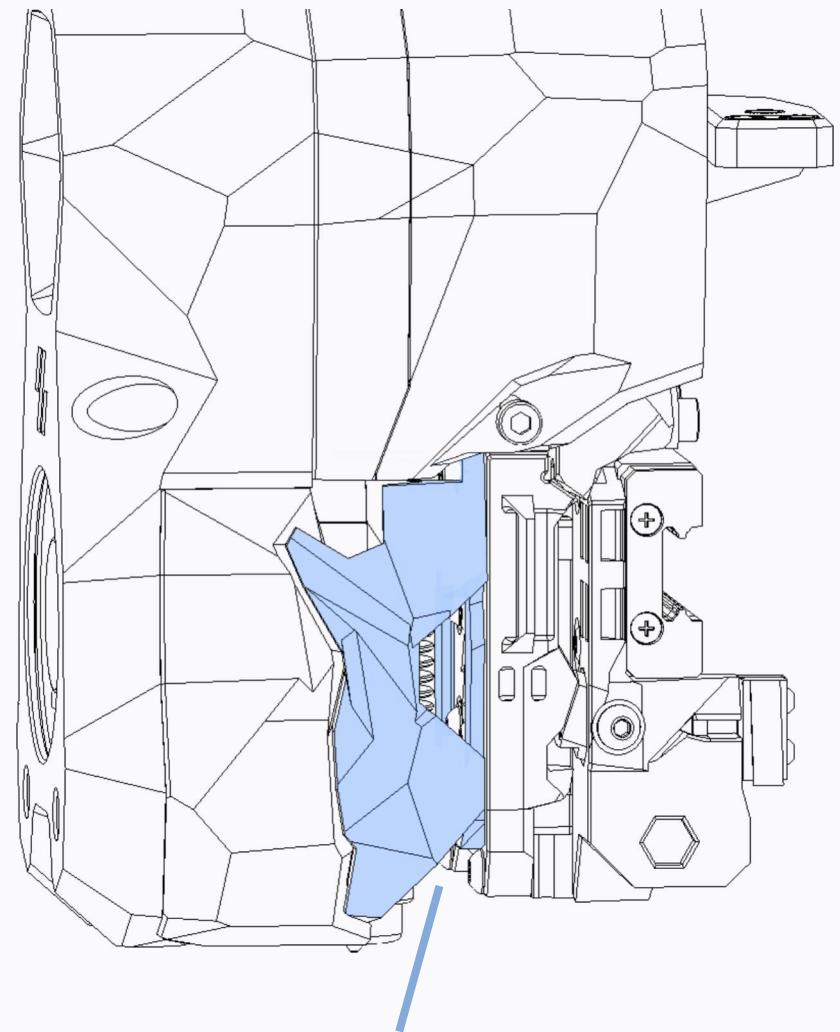
CHECK TOOLHEAD CLEARANCE

The toolhead rear rests on the lowermost 2 screws, but must clear the four screws that secure the front of Tap. Some toolheads may need to be carved back to avoid hitting these screws.



CUTAWAY VIEW

In blue are the four screws and the surface that may need to be trimmed back.

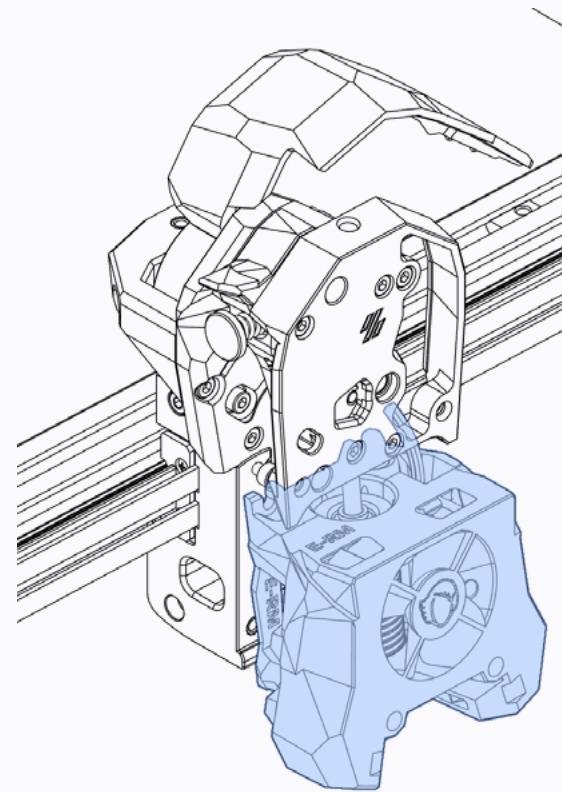


CORRECT INSTALLATION

Toolhead is flat against Tap, and can be firmly secured.

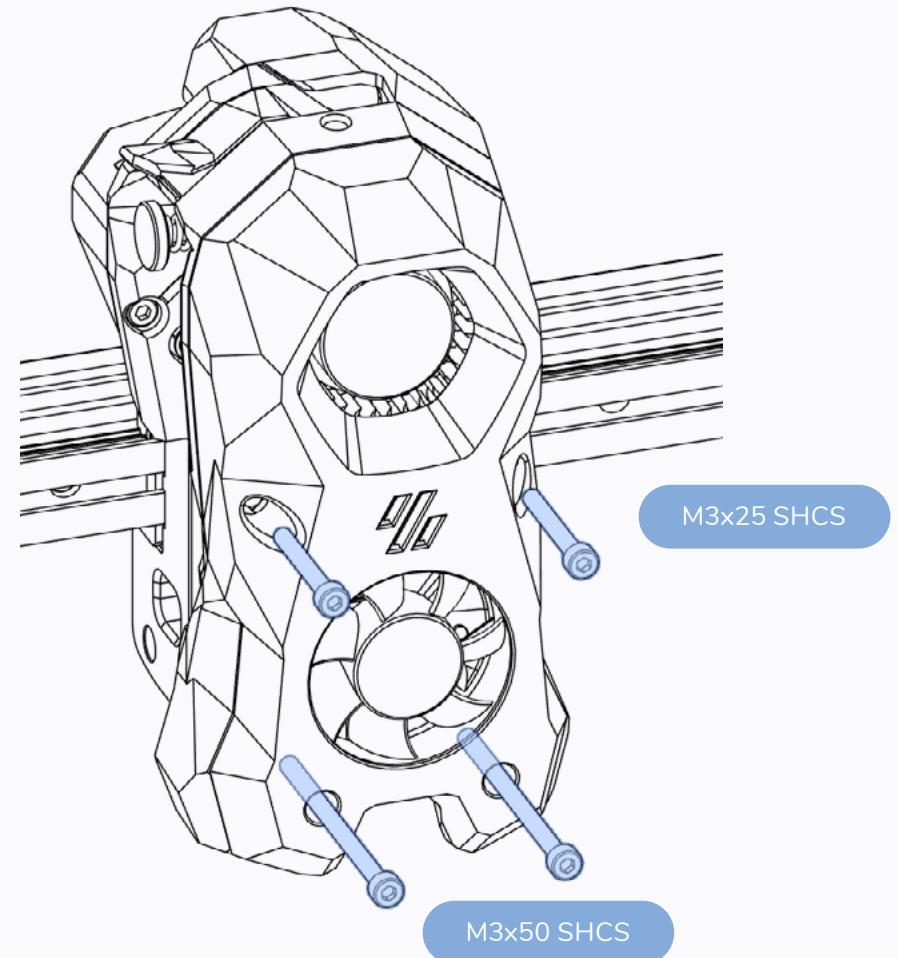
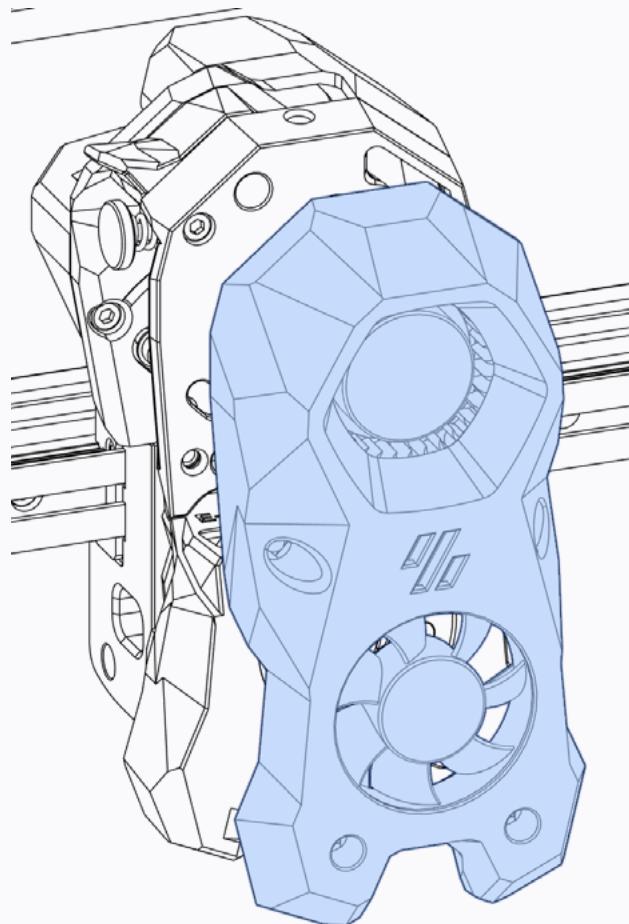
TOOL CARTRIDGE MOUNTING

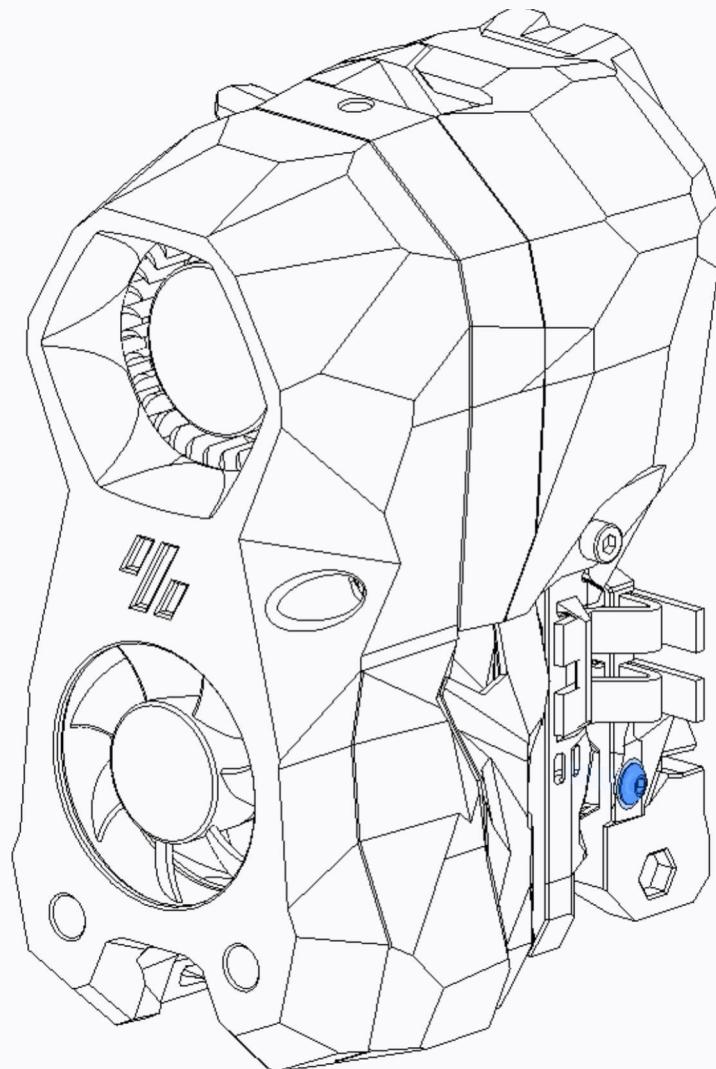
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SB MOUNTING

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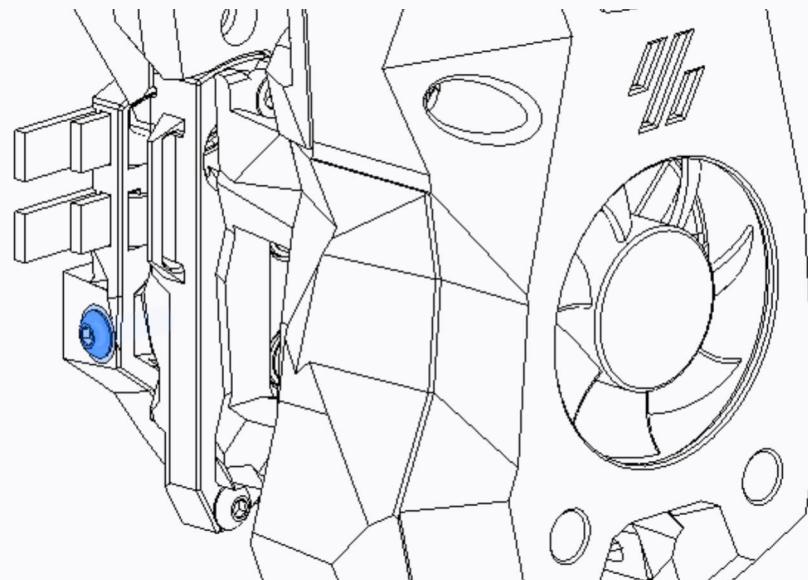


**WITH TOOLHEAD ASSEMBLED**

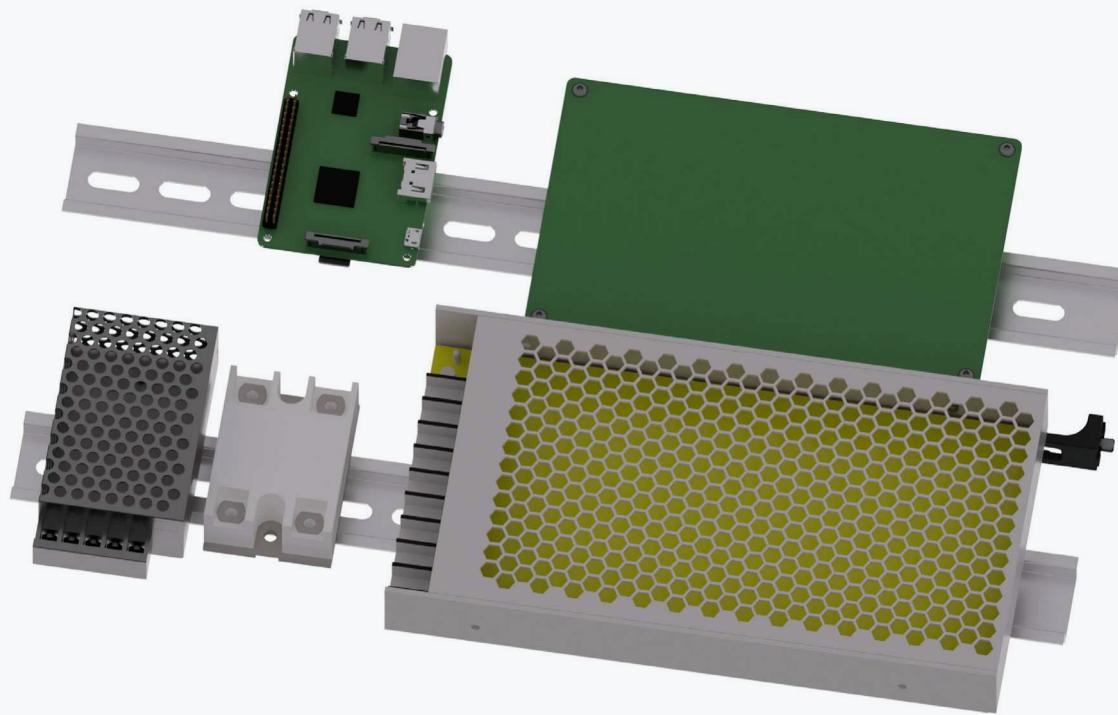
Loosen the 2 magnet alignment screws (one on each side). The magnets will pull themselves into alignment with the FHCS. Give the toolhead a little shake, then tighten these down.

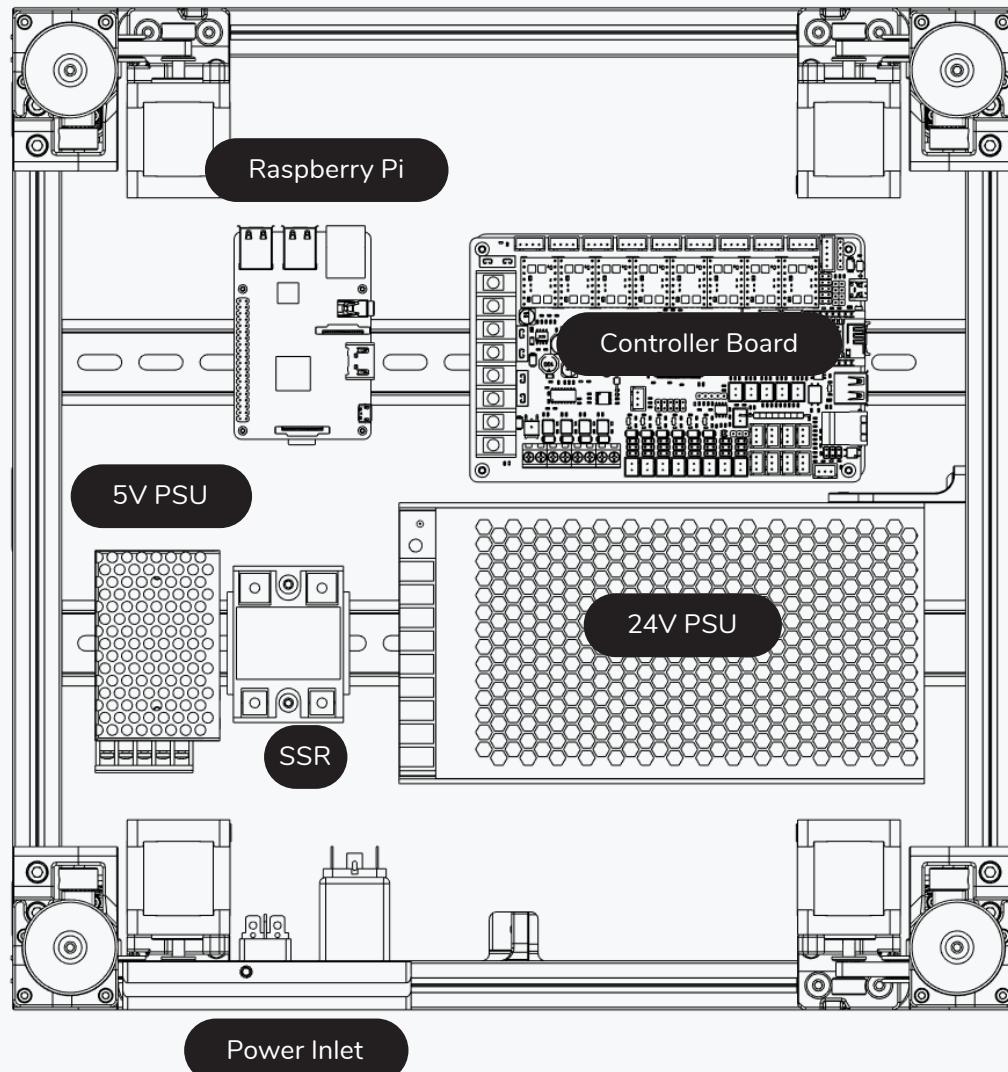
With the magnets aligned and screws tightened, you should be able to push up on the entire toolhead, and it will move 1-2 mm before hitting its stop. If your sensor has an indicator light and is connected, it should change state when you push up on the toolhead by hand.

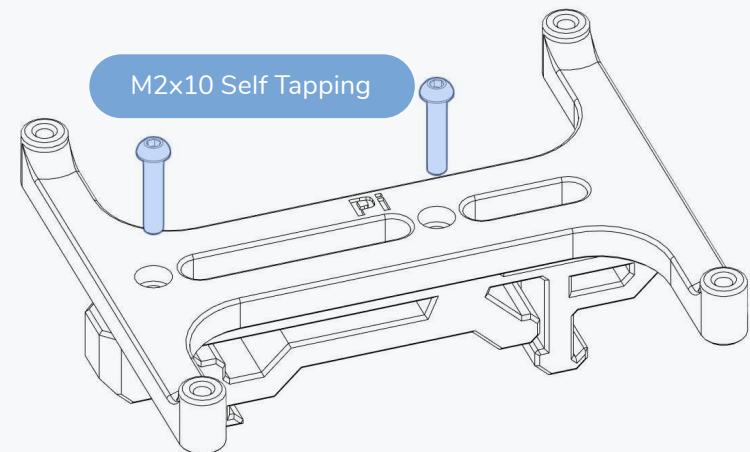
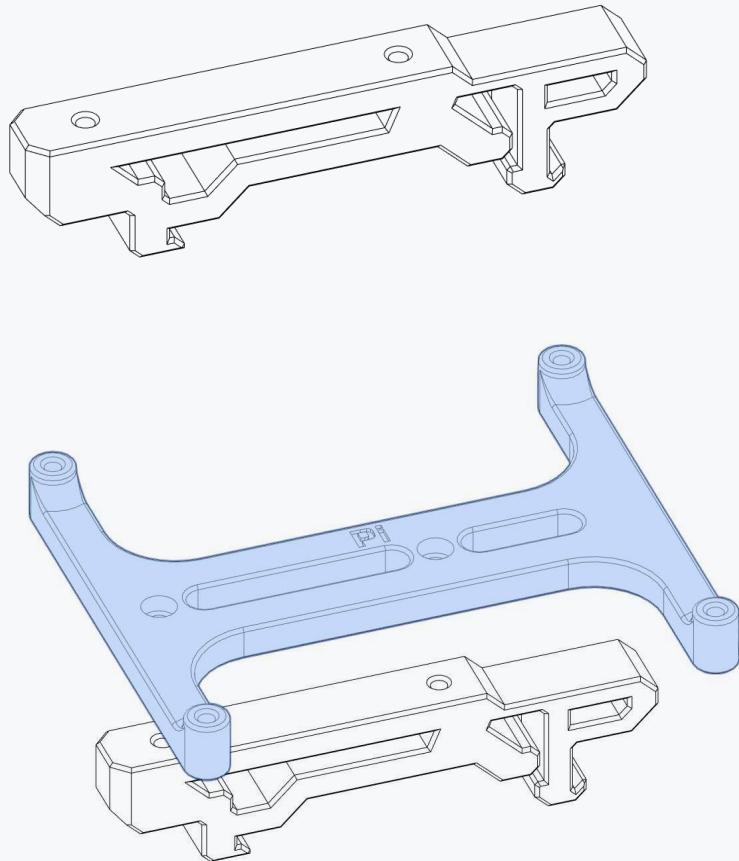
It is important to test the tap before homing!

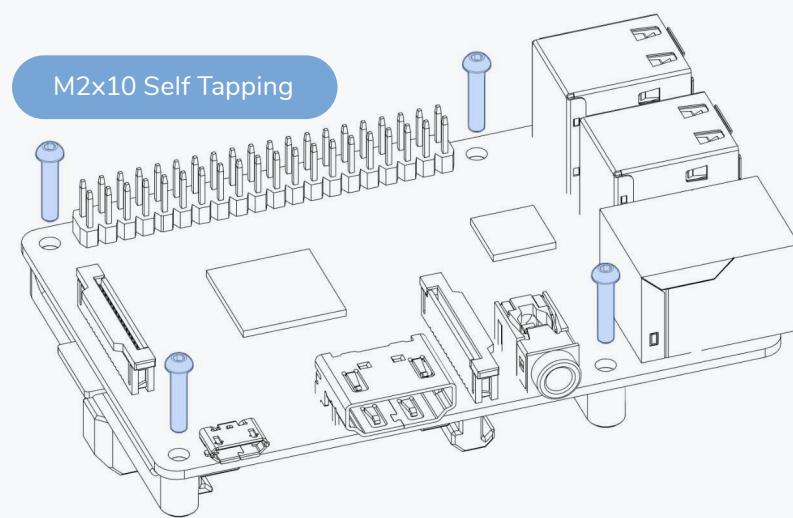
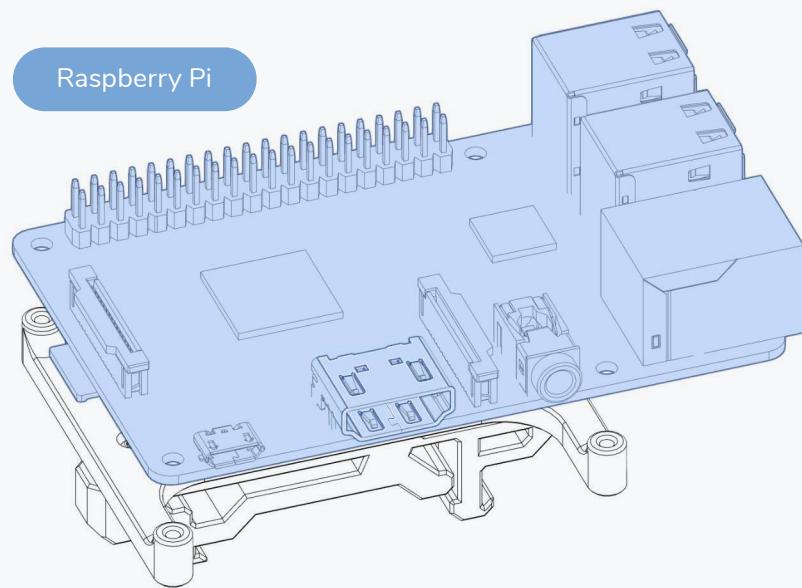


Yeah, it went about as expected.



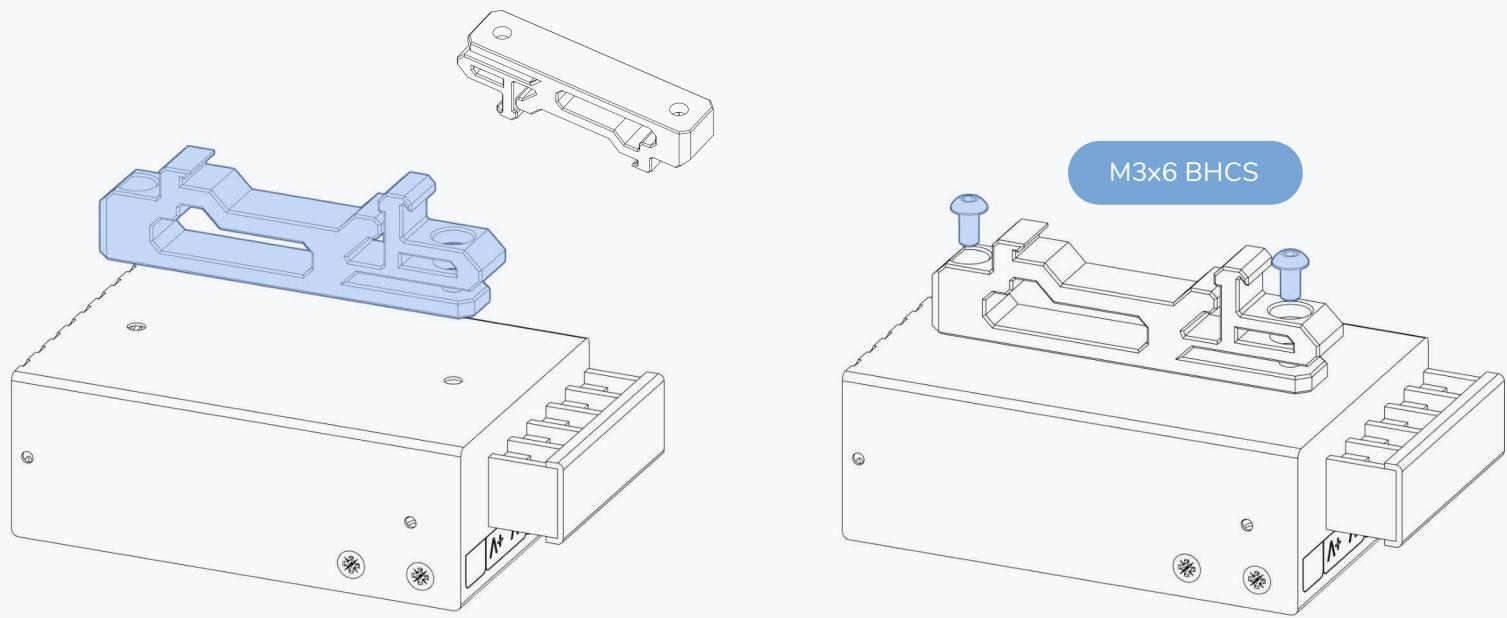


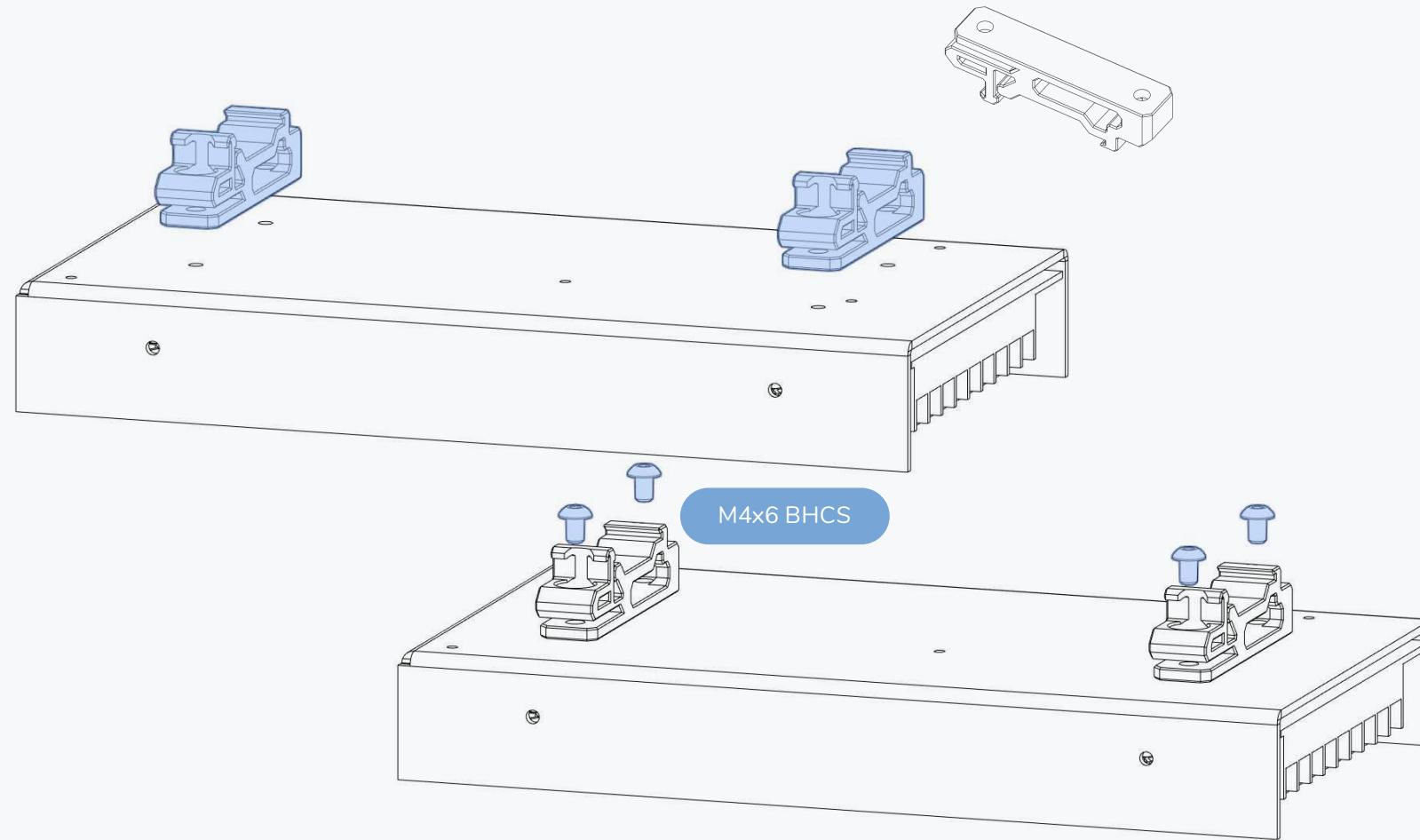


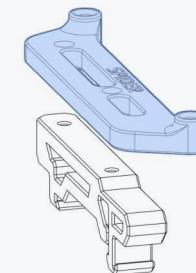
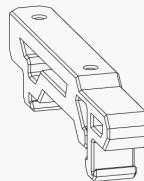
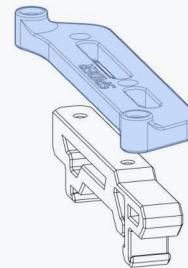
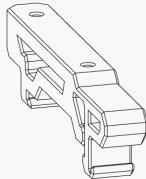


5V PSU

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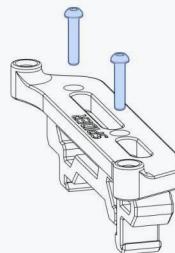




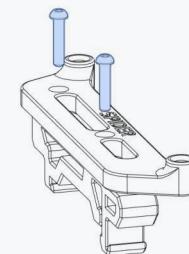
AVAILABLE MOUNTS

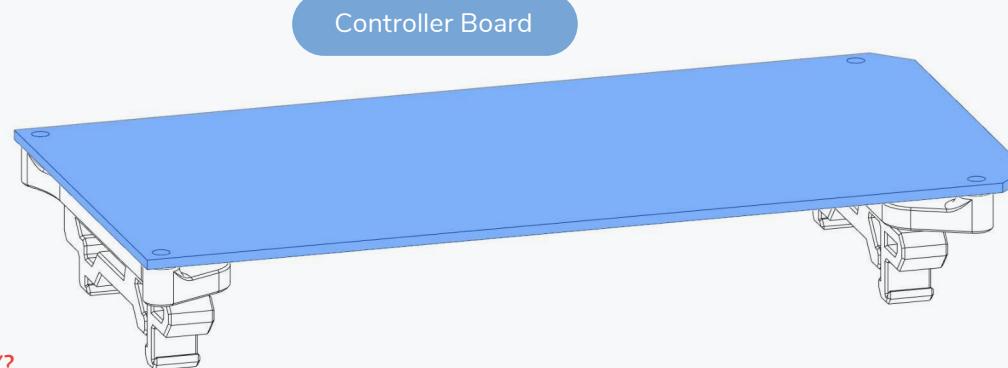
We also provide mounts for other controller boards.

They are assembled in a similar manner.

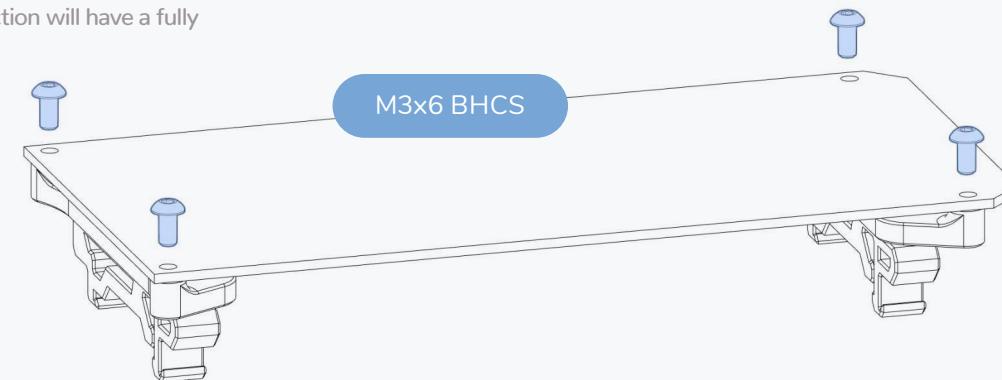


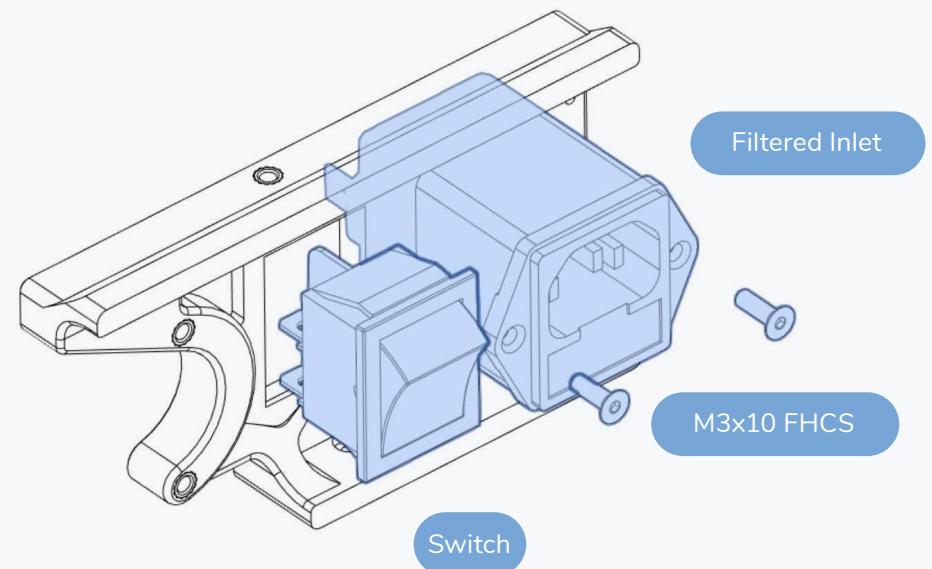
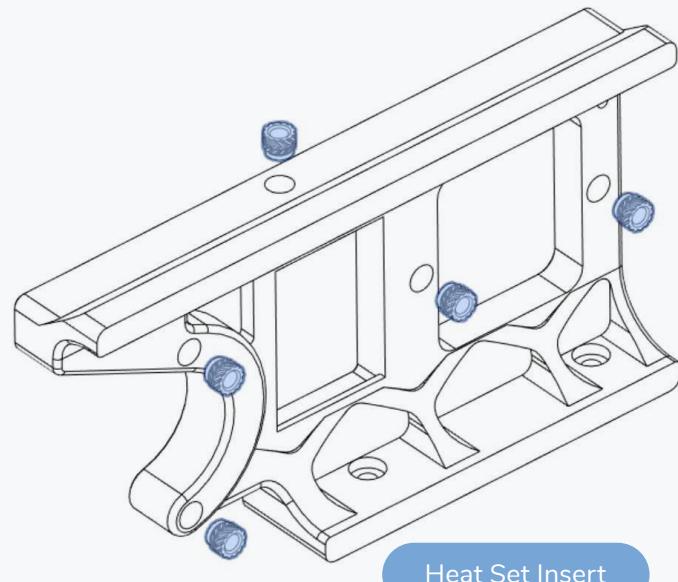
M2x10 Self Tapping

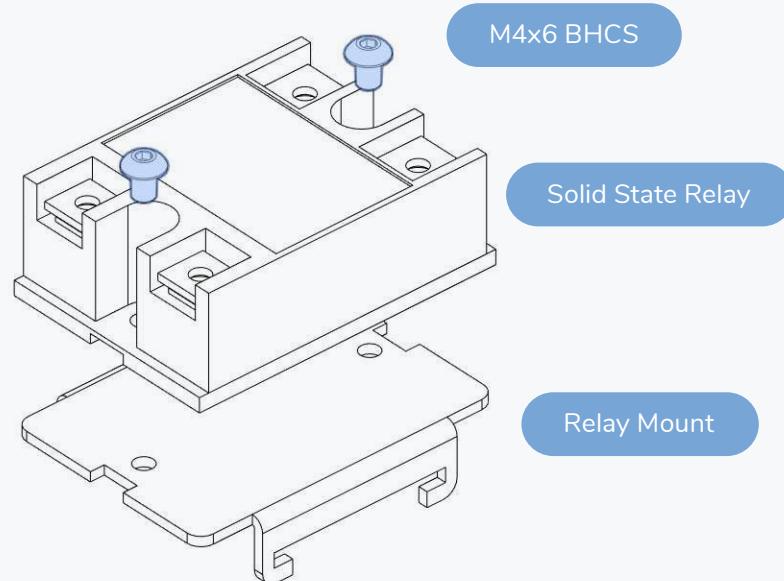


**WHY DOES IT LOOK THAT WAY?**

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

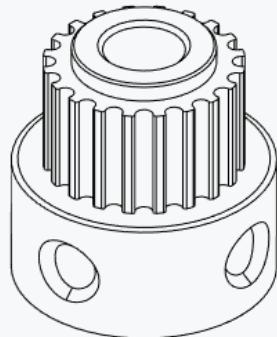




**WHERE CAN I FIND THE RELAY MOUNT?**

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**

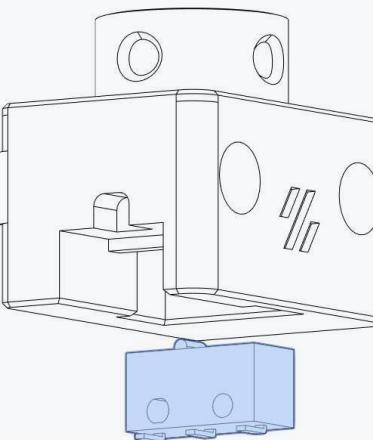
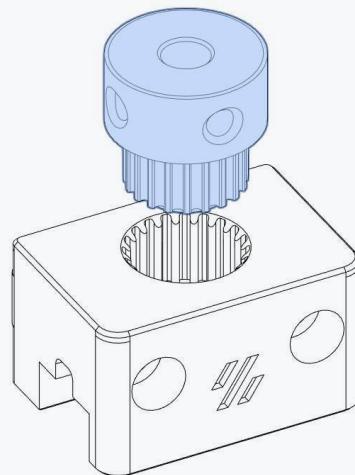
Use a bottle opener or some pliers to remove the top flange.



<https://voron.link/ict0j6x>

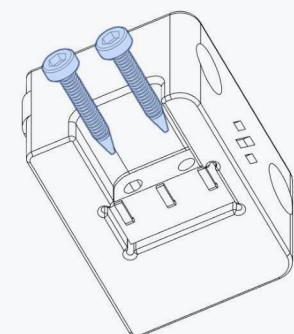
PRESS FIT

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



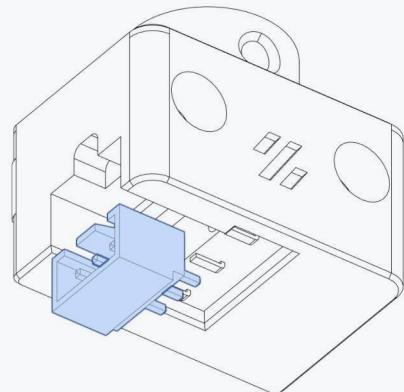
Microswitch

M2x10 Self Tapping

**SWITCH W/OUT LEVER**

This part requires a switch without lever to be installed in the shown orientation.

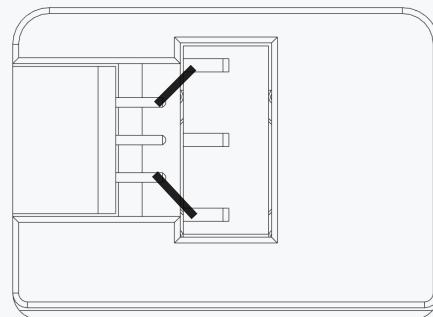
You can remove the lever from microswitches by gently pressing on the lever's hinge point.



5mm Shaft

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.

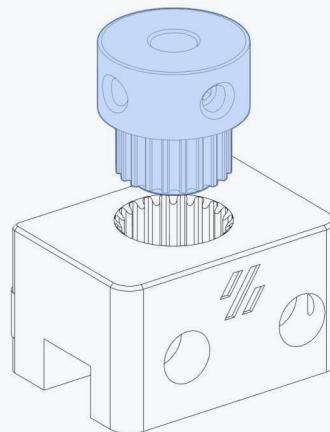


SOLDER CONNECTOR

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

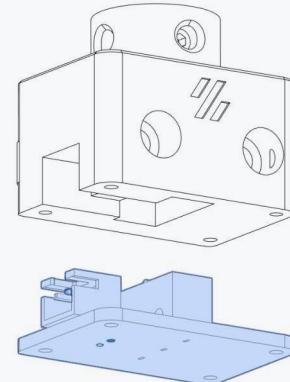
OPTION: Z ENDSTOP BOARD

GT2 20 Tooth Pulley

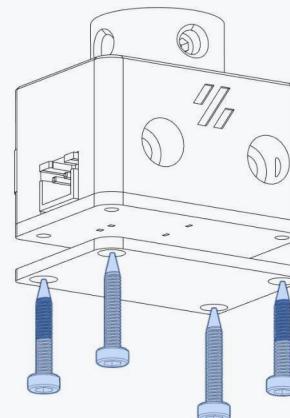


PRESS FIT

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

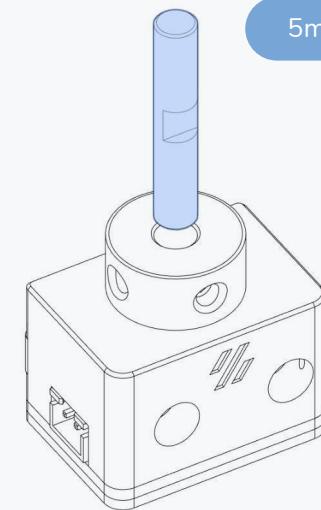


Microswitch Z Endstop Board



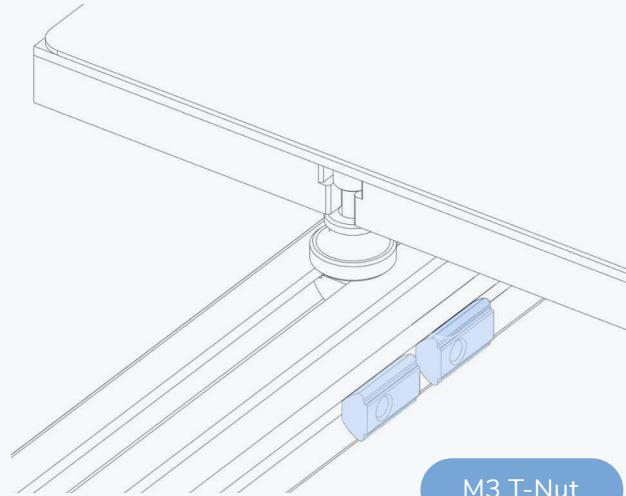
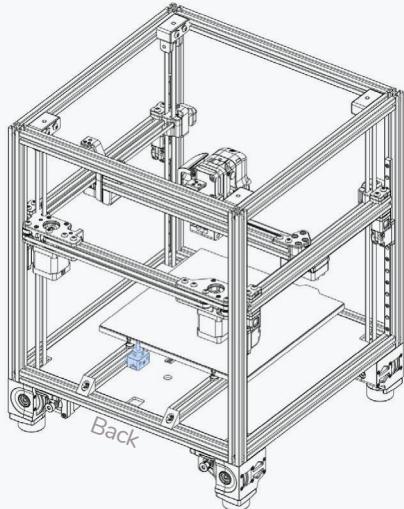
M2x10 Self Tapping

5mm Shaft

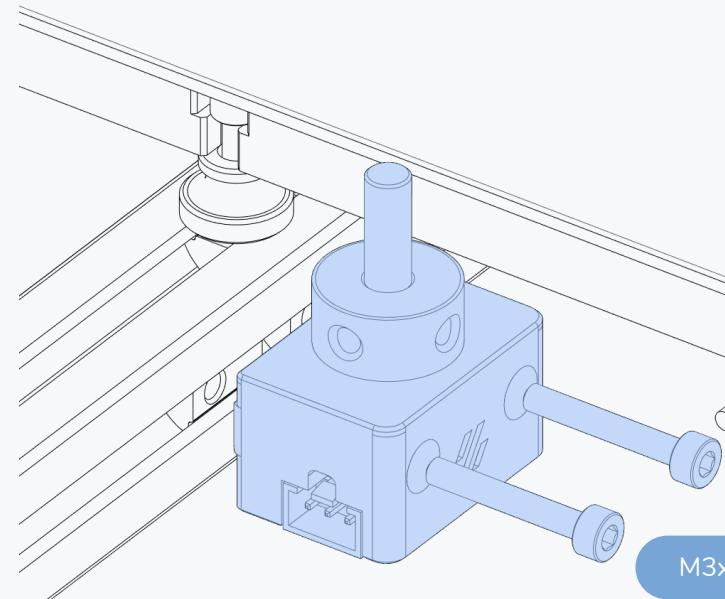


ADDITIONAL INFORMATION

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



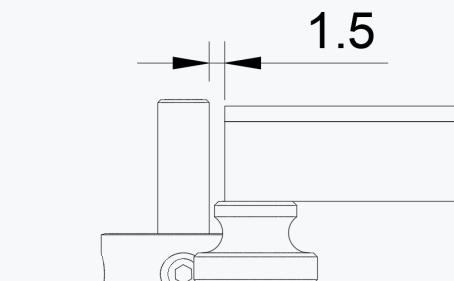
M3 T-Nut

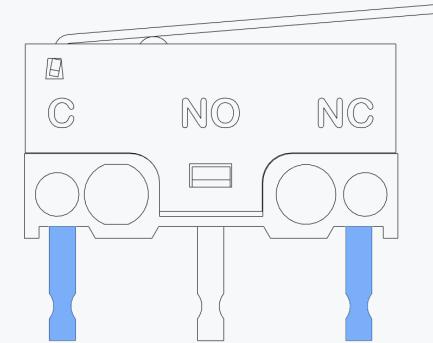
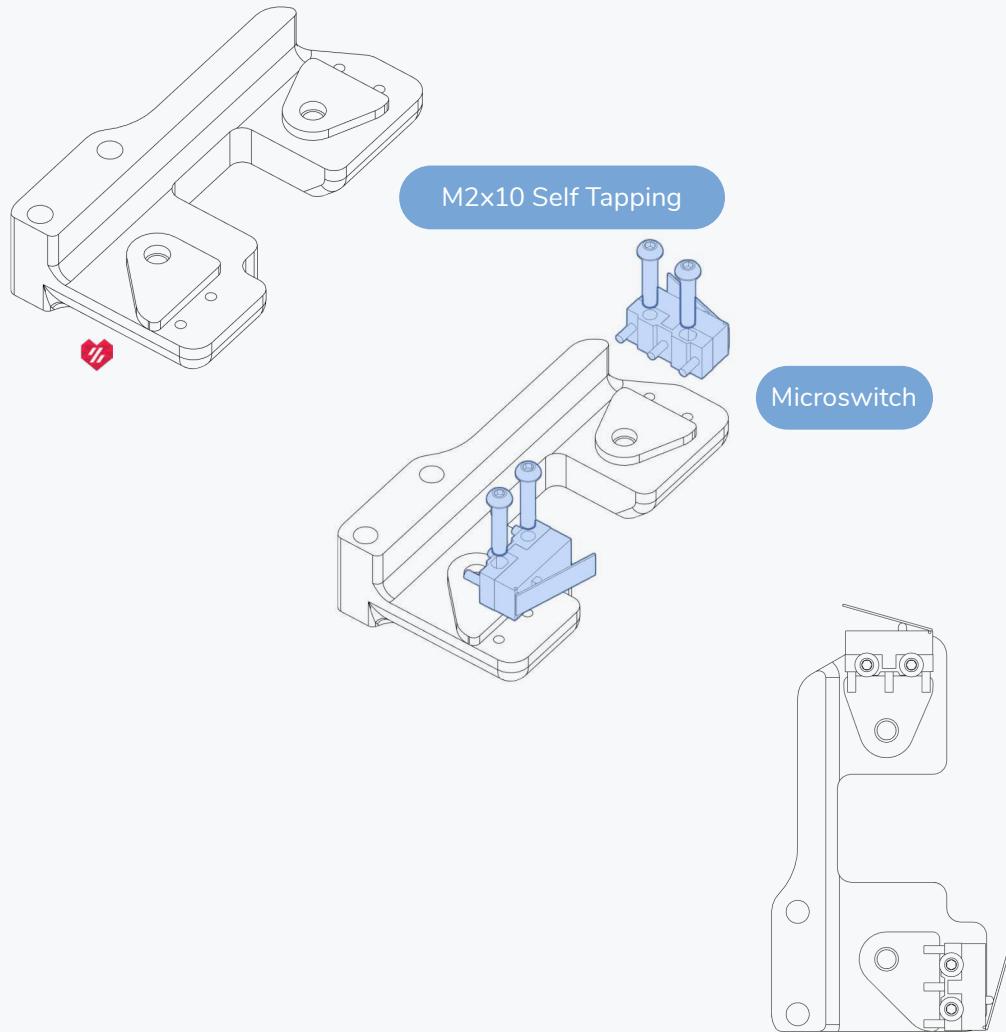


M3x20 SHCS

ADJUST Z ENDSTOP POSITION

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



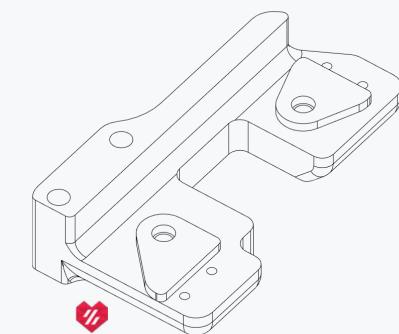


END-STOP SWITCHES FOR X AND Y

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

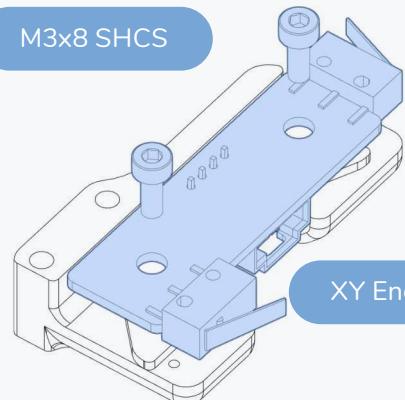
Prepare the switches for X and Y by soldering 150mm of wire to each of the outer terminals.

OPTION: XY ENDSTOP BOARD

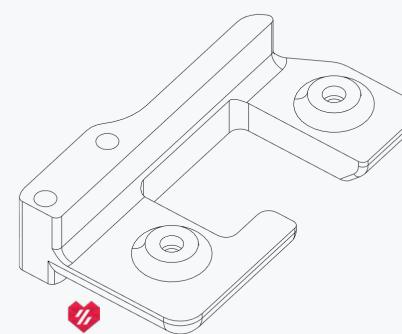


M3x8 SHCS

XY Endstop Board

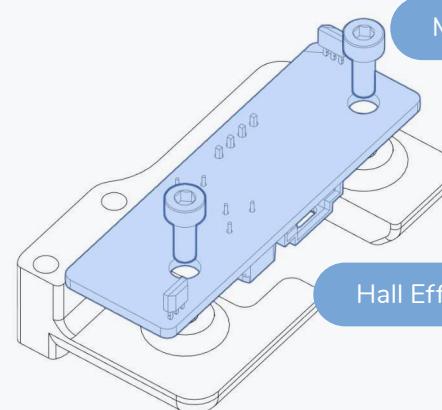


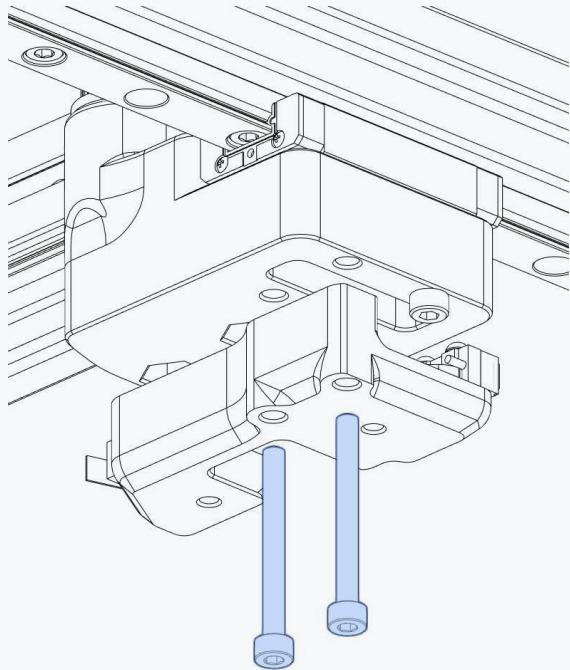
OPTION: HALL EFFECT ENDSTOP BOARD



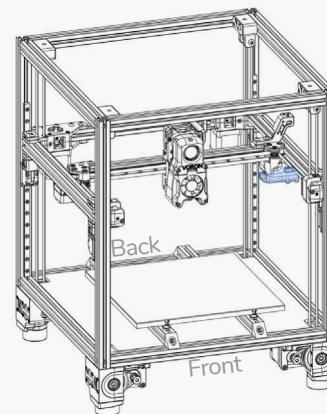
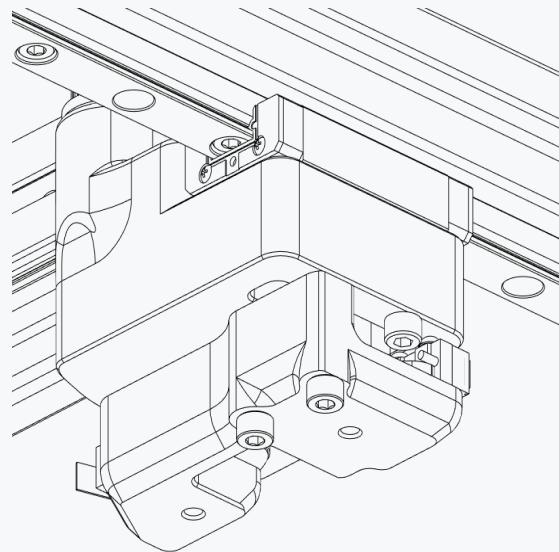
M3x8 SHCS

Hall Effect Endstop Board





M3x30 SHCS

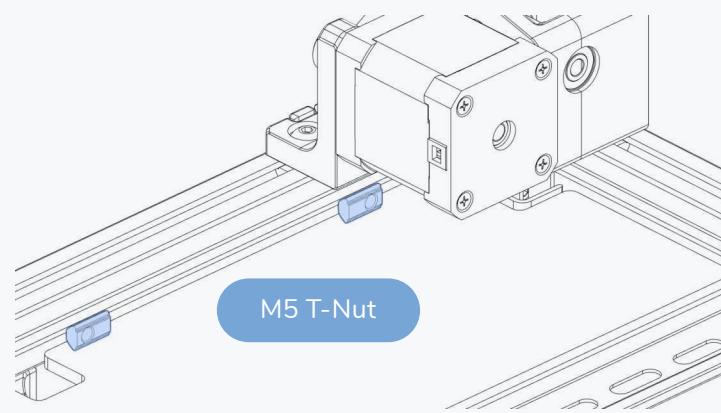


ALTERNATE MAINS DISTRIBUTION - WAGO

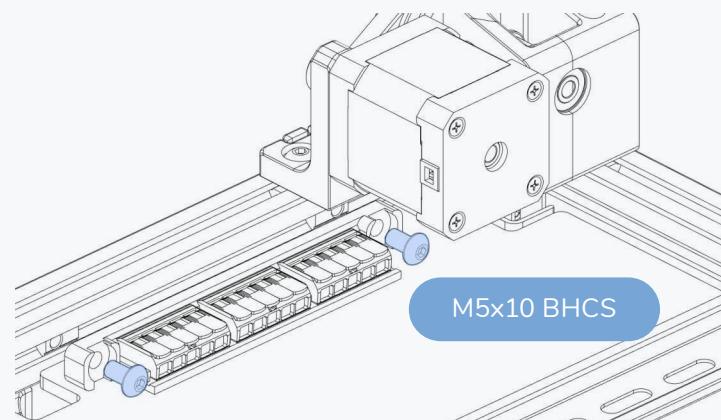
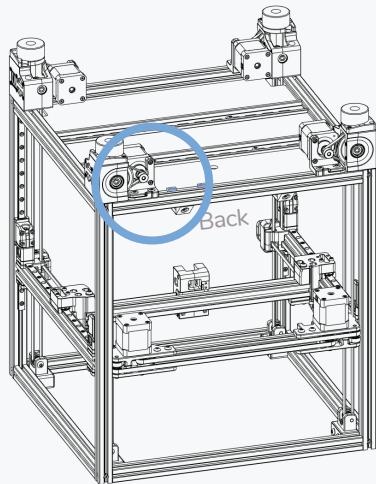
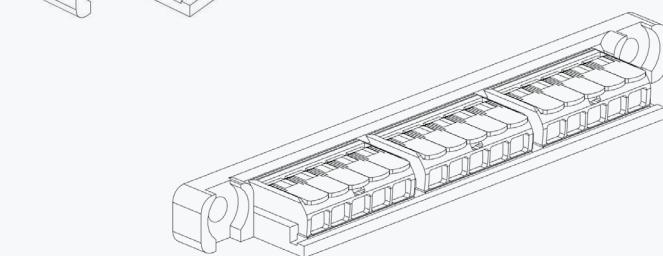
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WAGO 221 415 Clamps



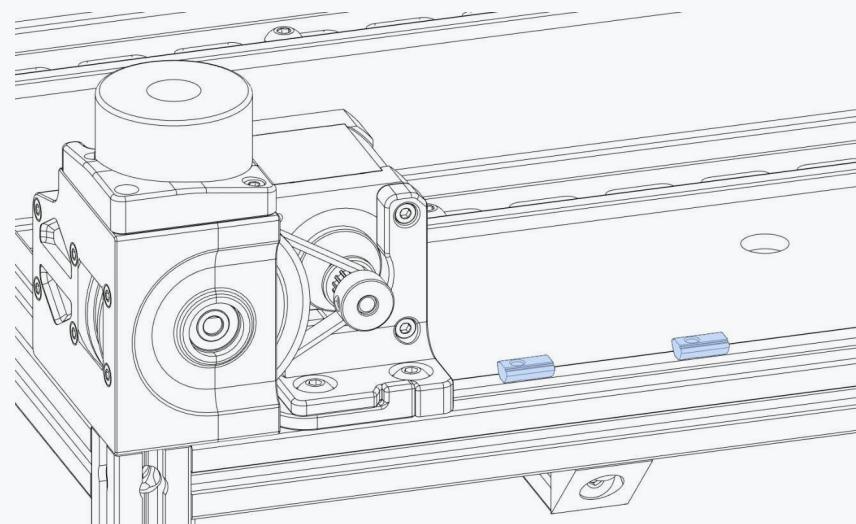
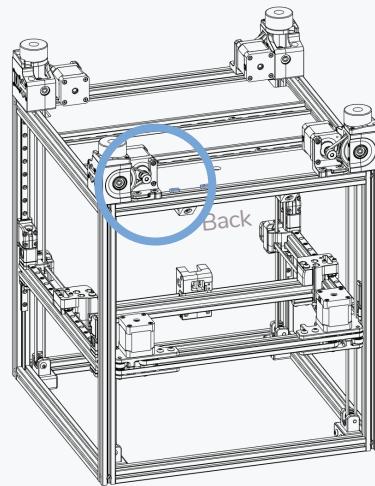
M5 T-Nut



M5x10 BHCS

UPSIDE DOWN ASSEMBLY

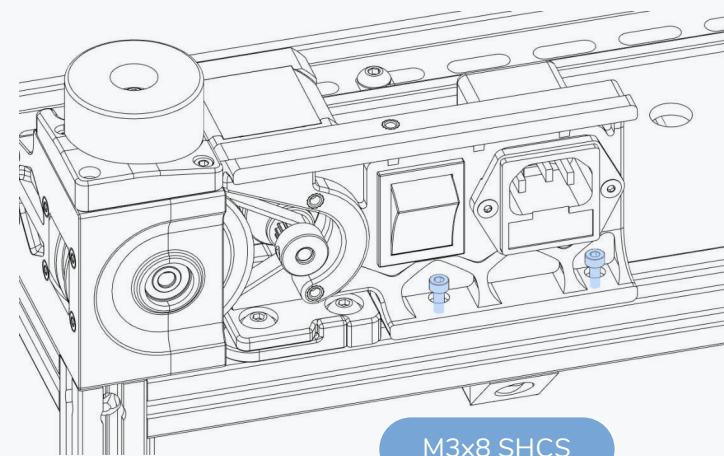
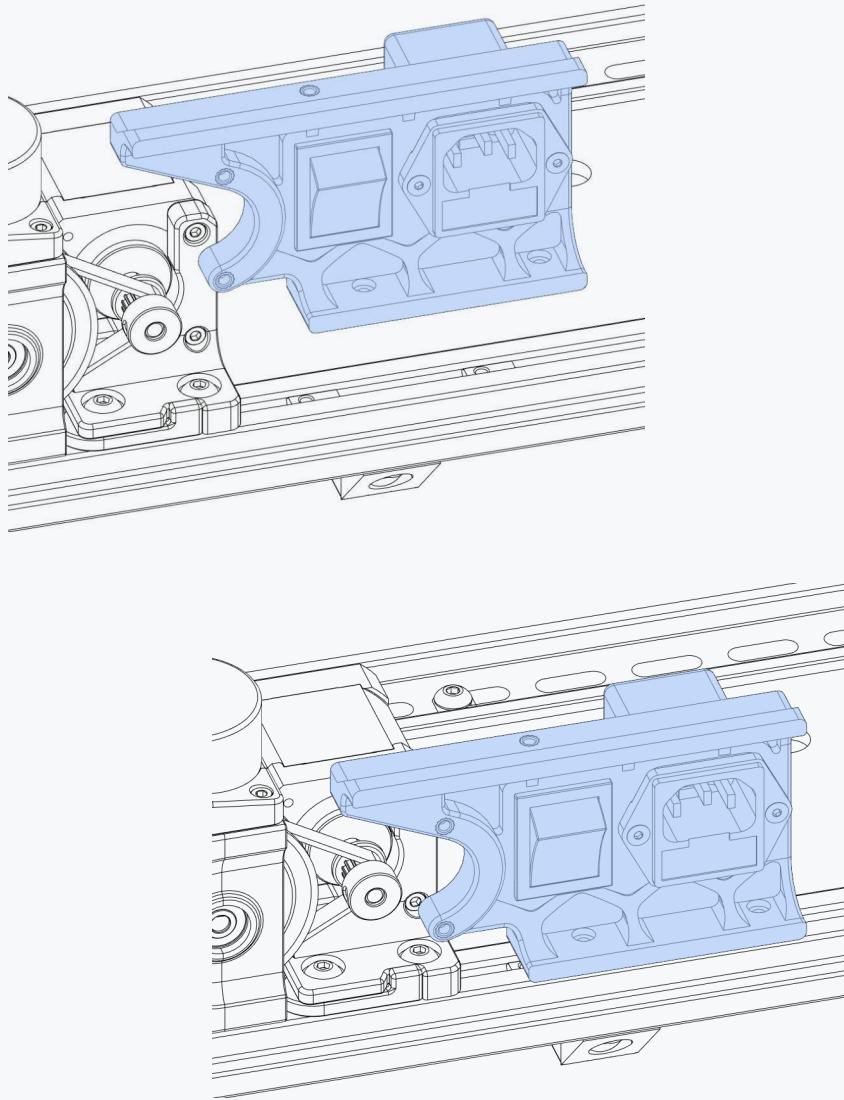
For ease of assembly we recommend to flip the printer on its head for the next steps. Hope you don't regret building a 350.



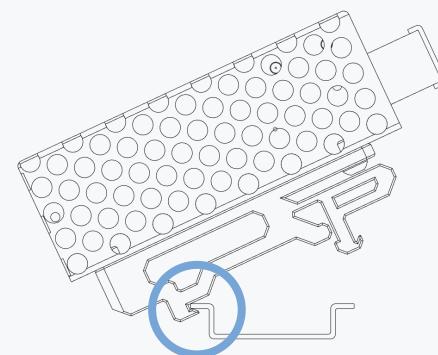
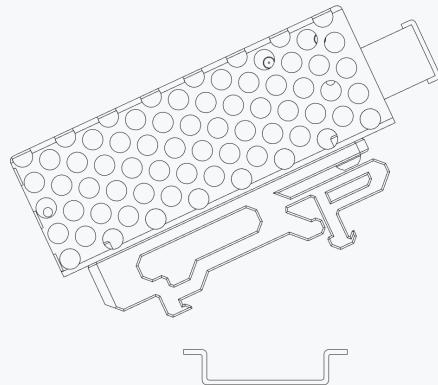
M3 T-Nut

POWER INLET

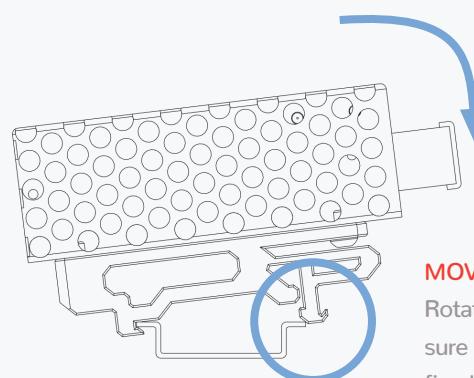
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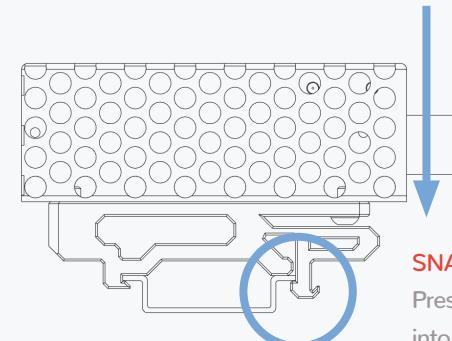
M3x8 SHCS

**HOOK FIXED SIDE**

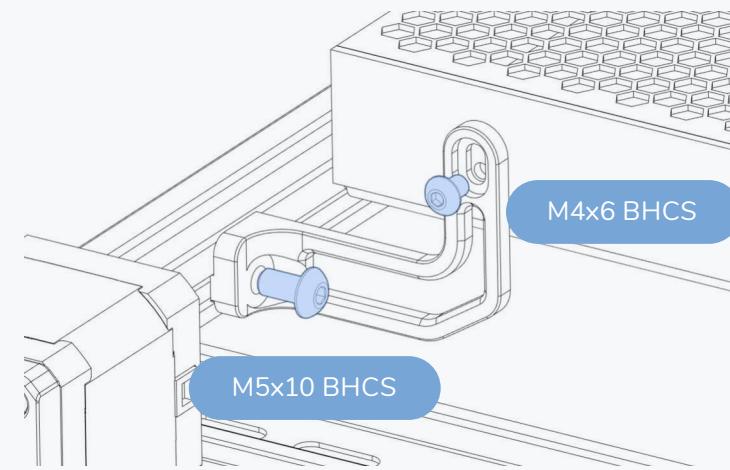
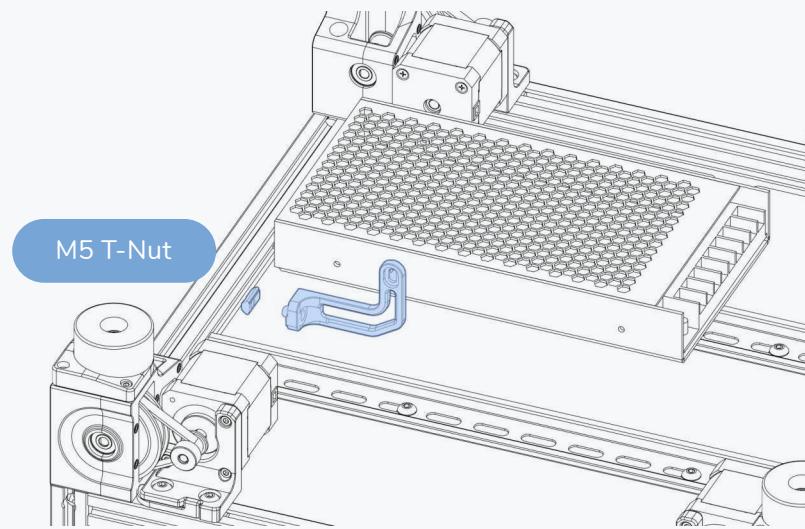
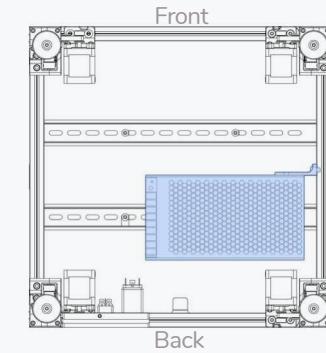
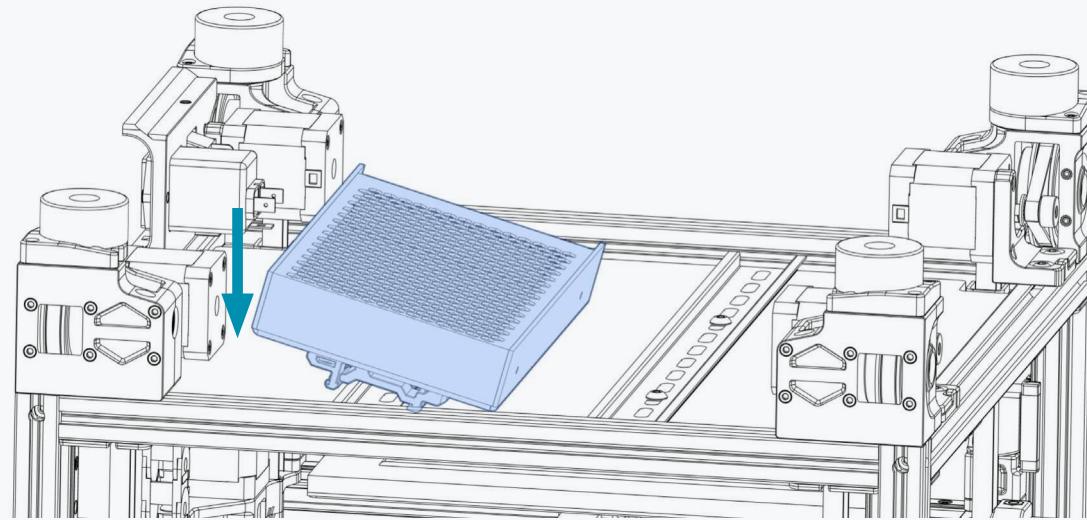
Hook the fixed side of the printed mount on side of DIN rail.

**MOVE INTO POSITION**

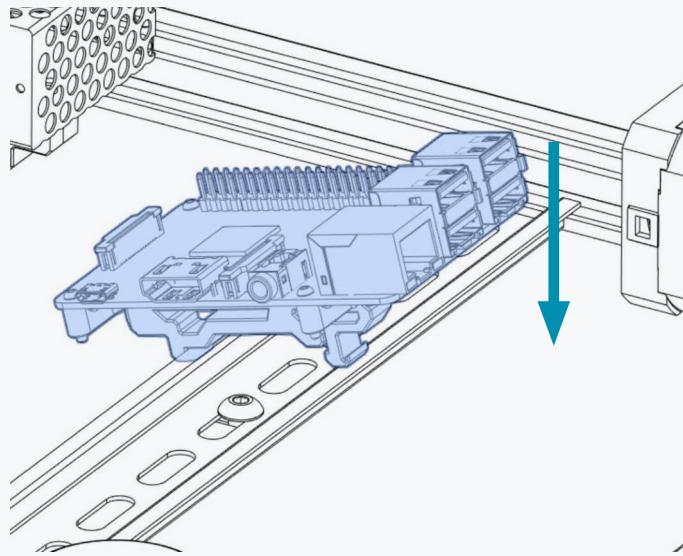
Rotate the part into place, make sure it does not unhook from the fixed side.

**SNAP INTO PLACE**

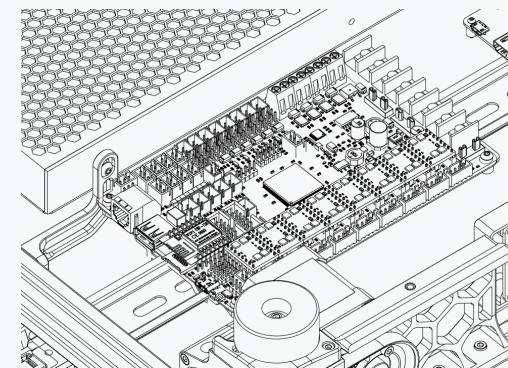
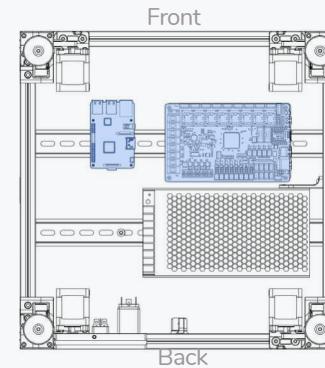
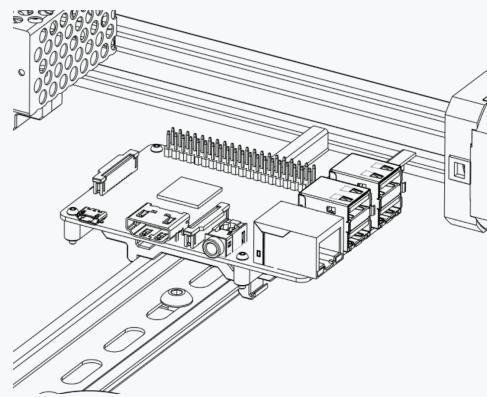
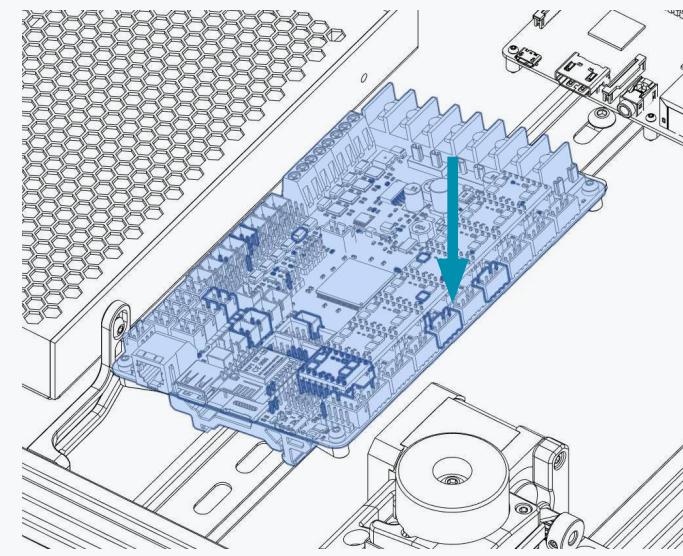
Press to snap the free side into place. The part should now sit securely on the DIN rail.



PI & CONTROLLER

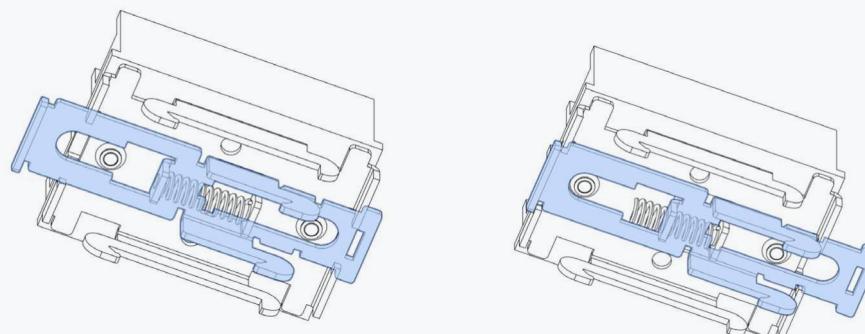
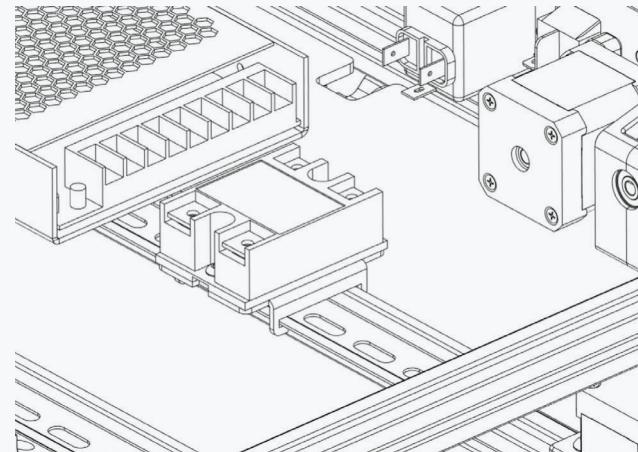
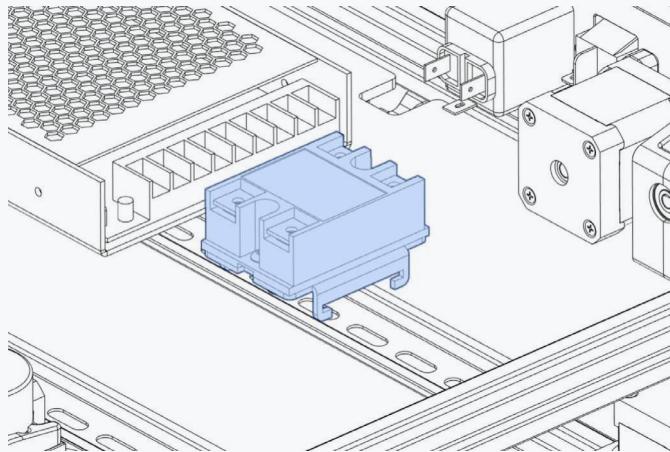


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SOLID STATE RELAY

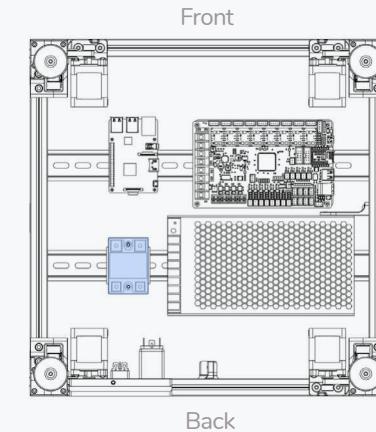
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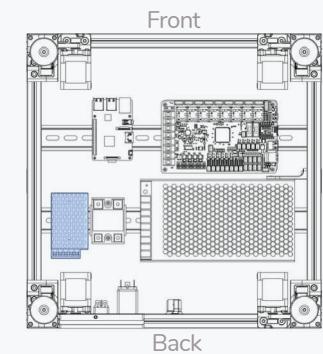
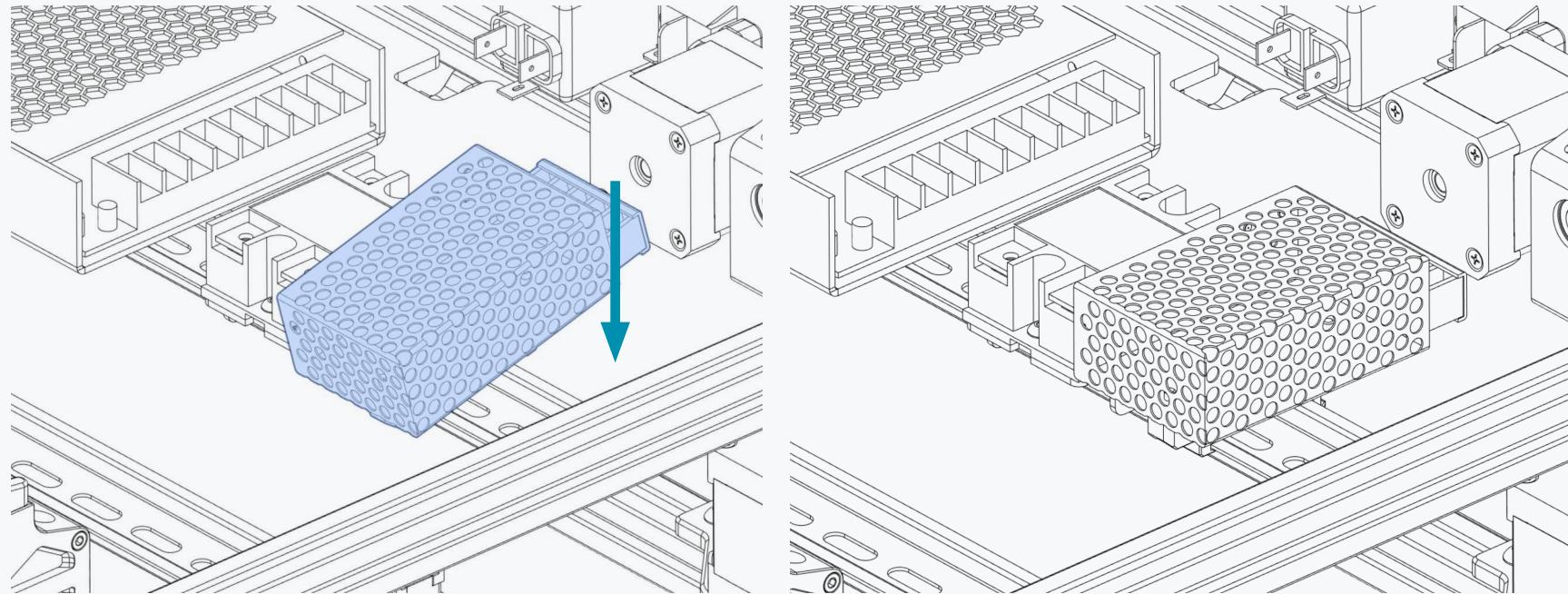


SPRING-LOADED

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.

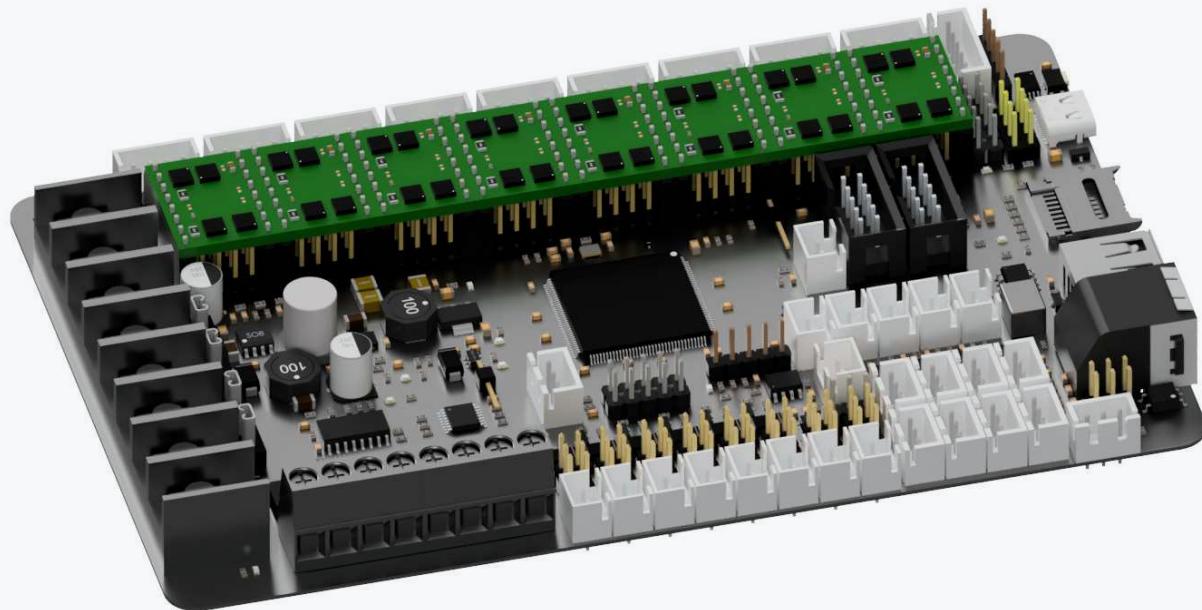




By Feburary 2019 over 100 Voron2 printers had been built and serialized.

CONTROLLER BOARD

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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

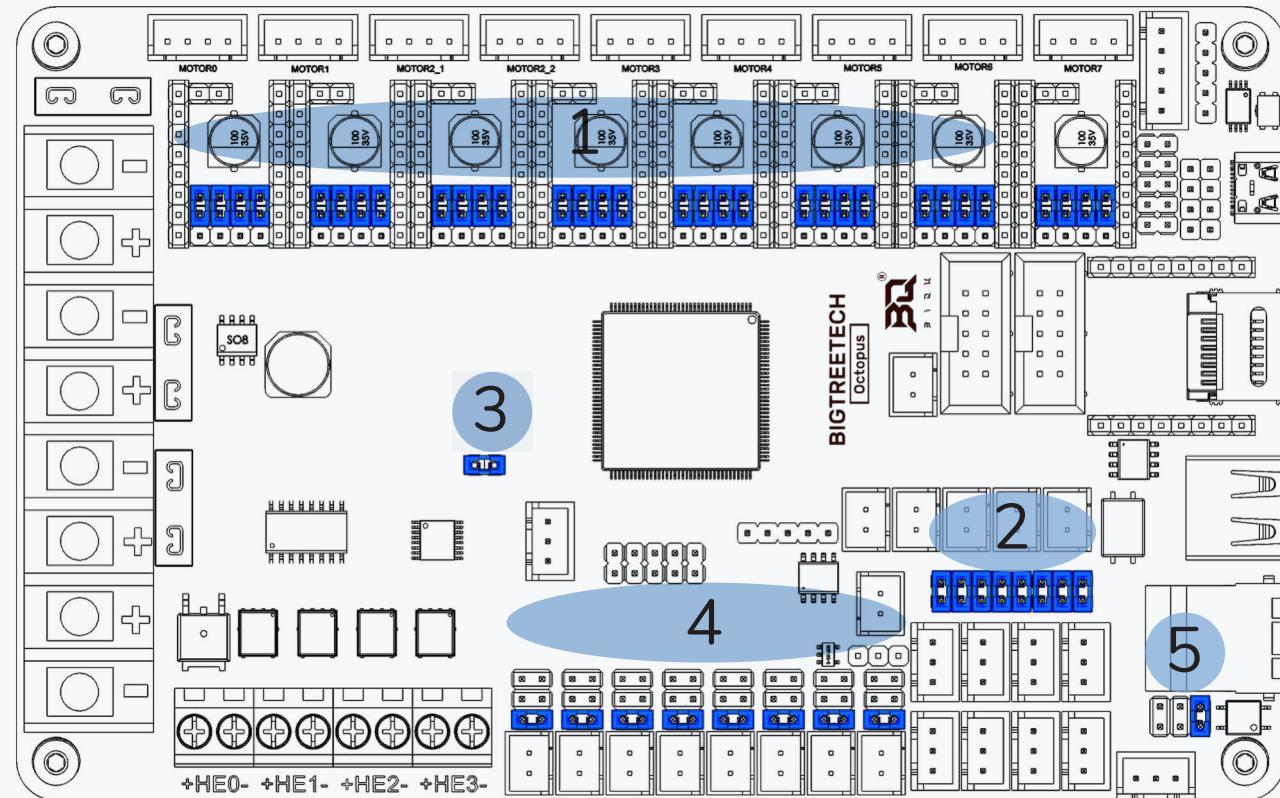
JUMPERS

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.

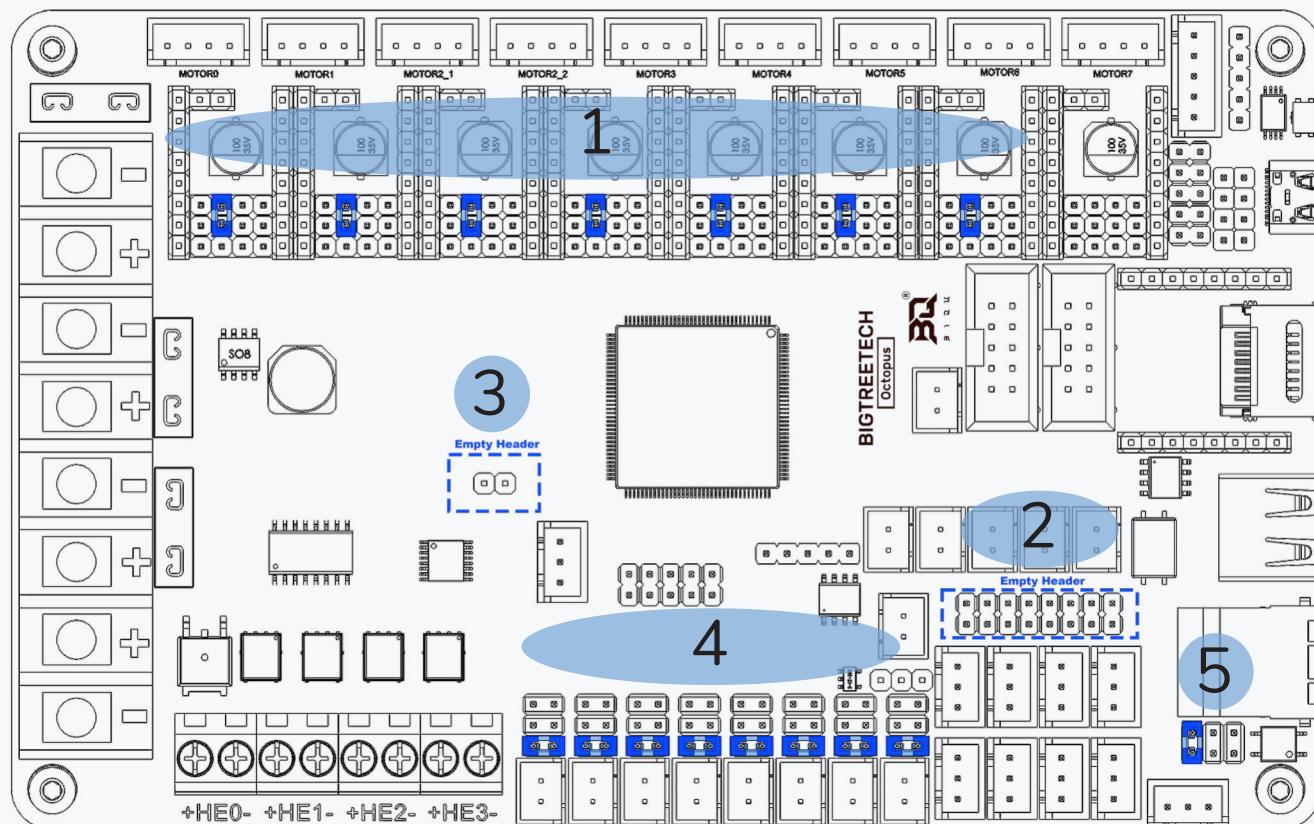


Diagram courtesy of @GadgetAngel

STEPPER DRIVERS

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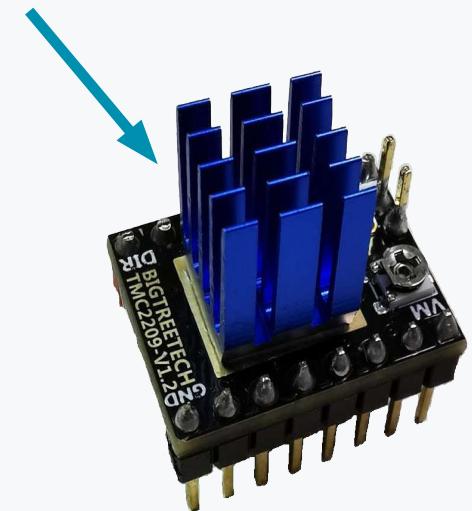
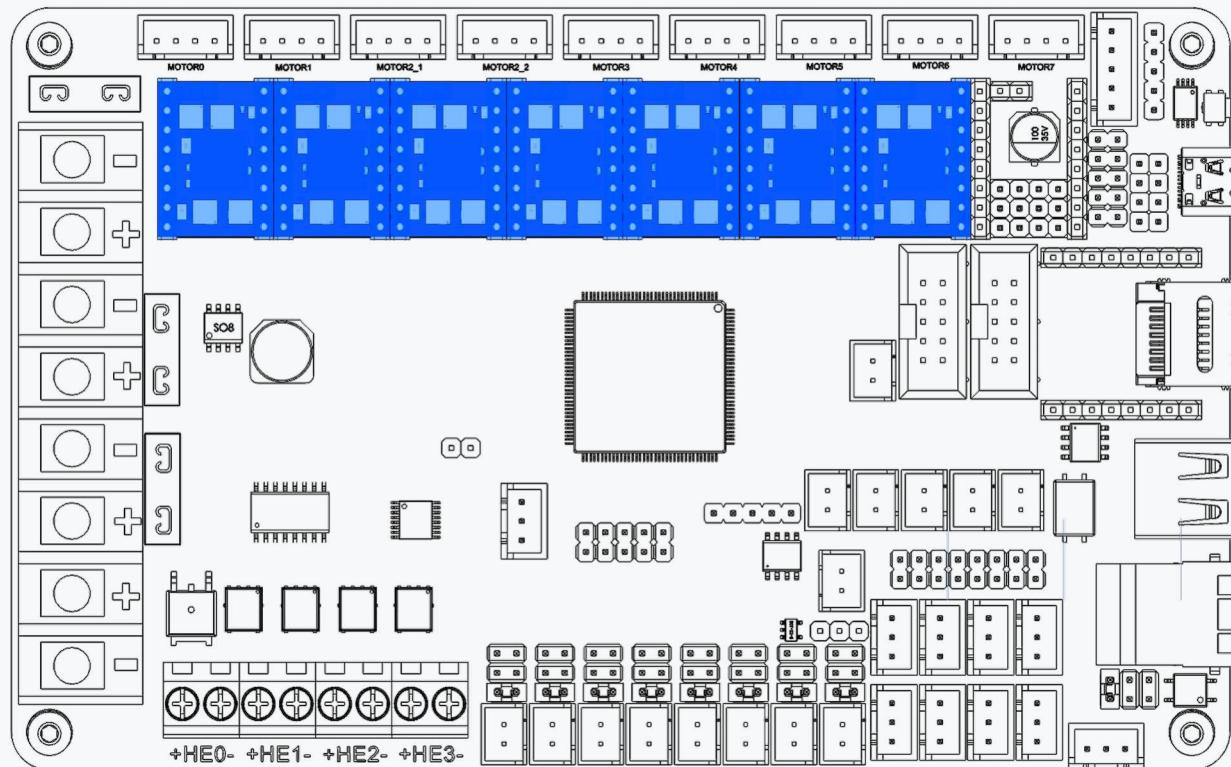
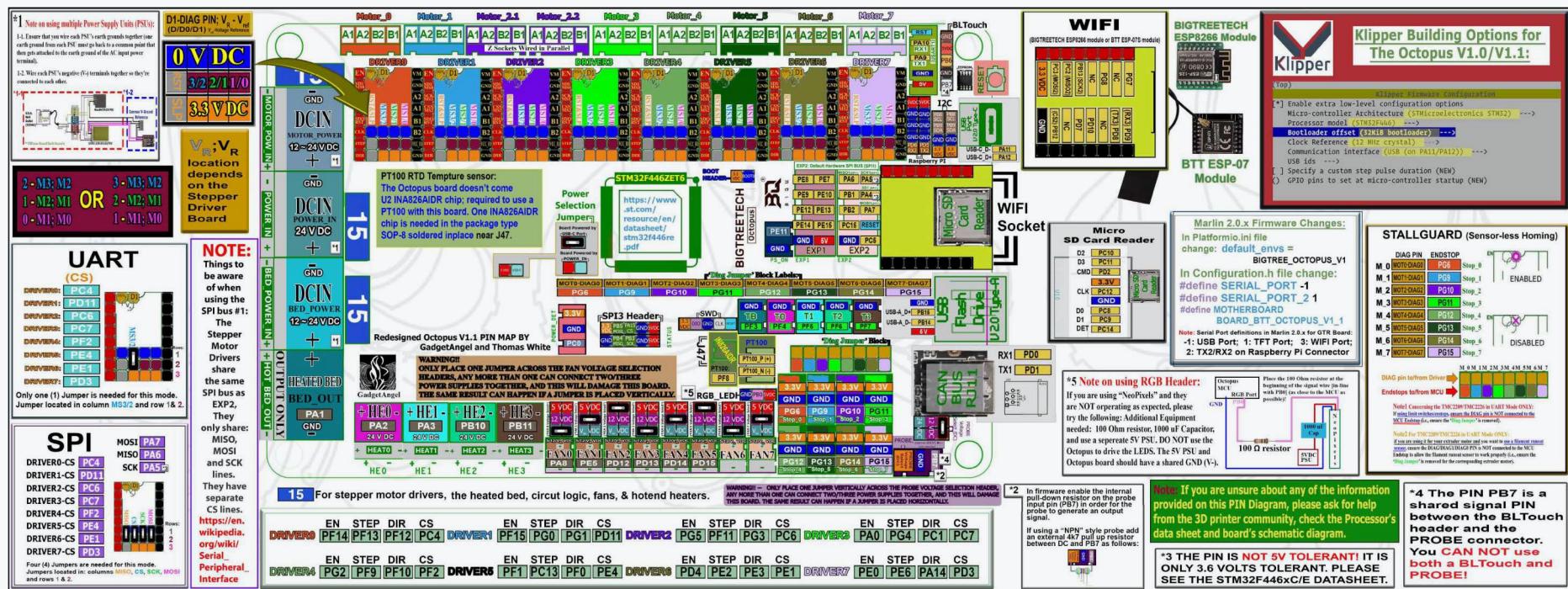


Diagram courtesy of @GadgetAngel

OCTOPUS PINOUT REFERENCE

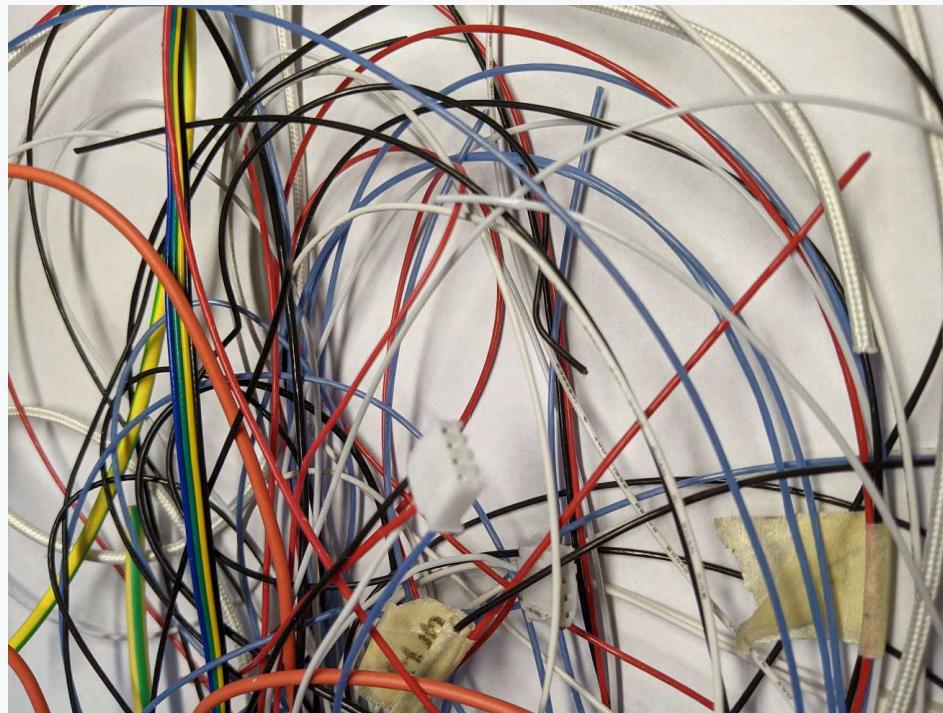
This [Coloured PIN diagram](#) can be found on GadgetAngel's GitHub repository for the Octopus V1.1.

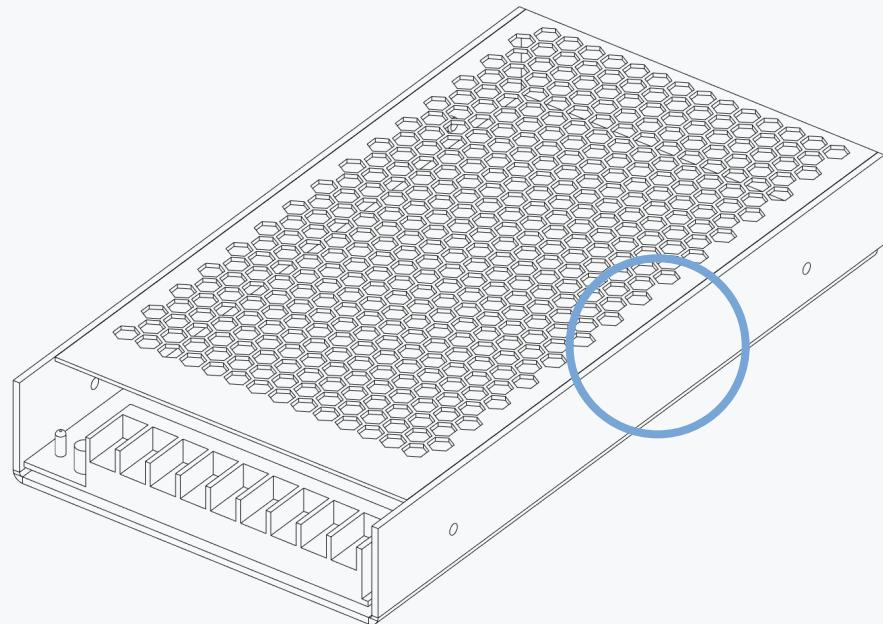


The [original PIN diagram](#) can be found on Bigtreetech's GitHub repository for Octopus V1.1 (preview friendly version)

Diagram courtesy of @GadgetAngel

A year later this figure grew to 350 Voron2 printers.

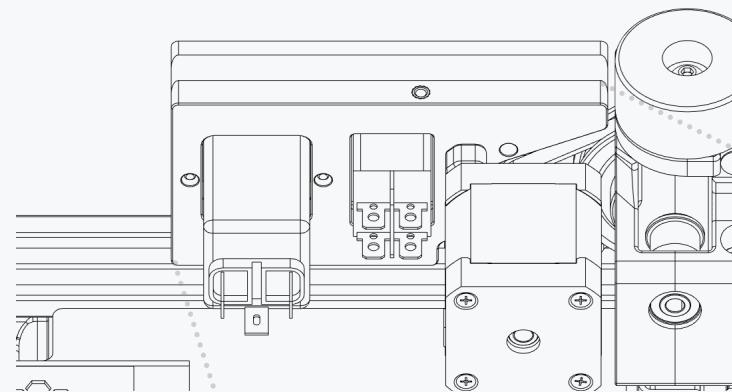


**INPUT VOLTAGE SWITCH**

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).

POWER INLET



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ATTACH 250MM OF WIRE

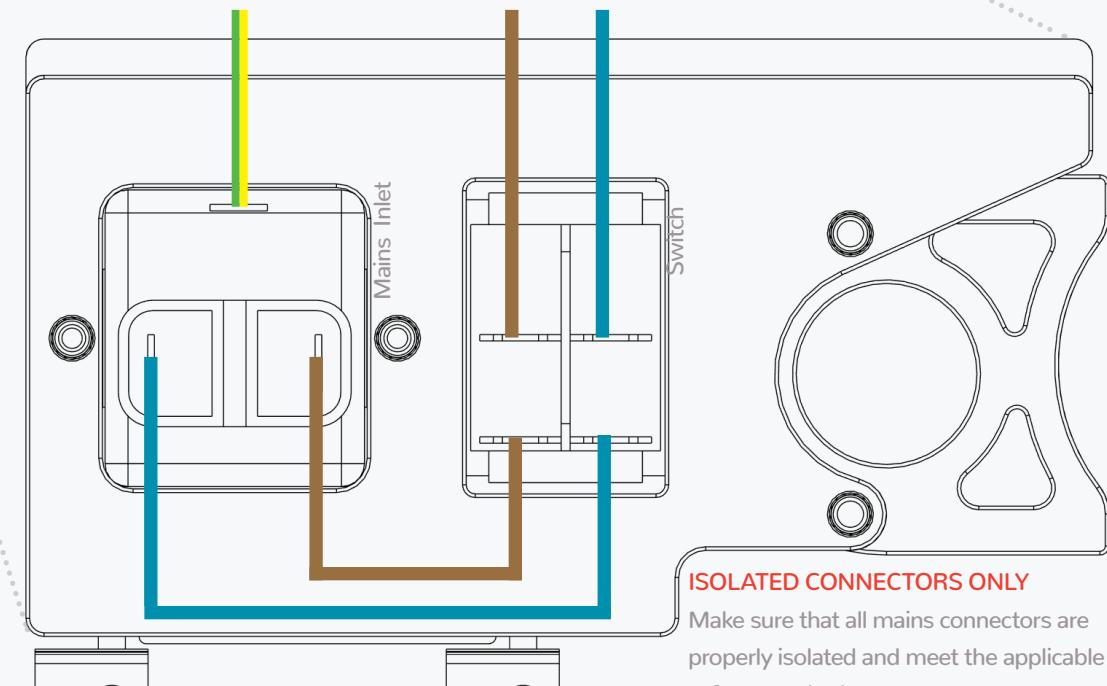
Cables should be at least 1mm² (AWG18) or thicker depending on local regulations.

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

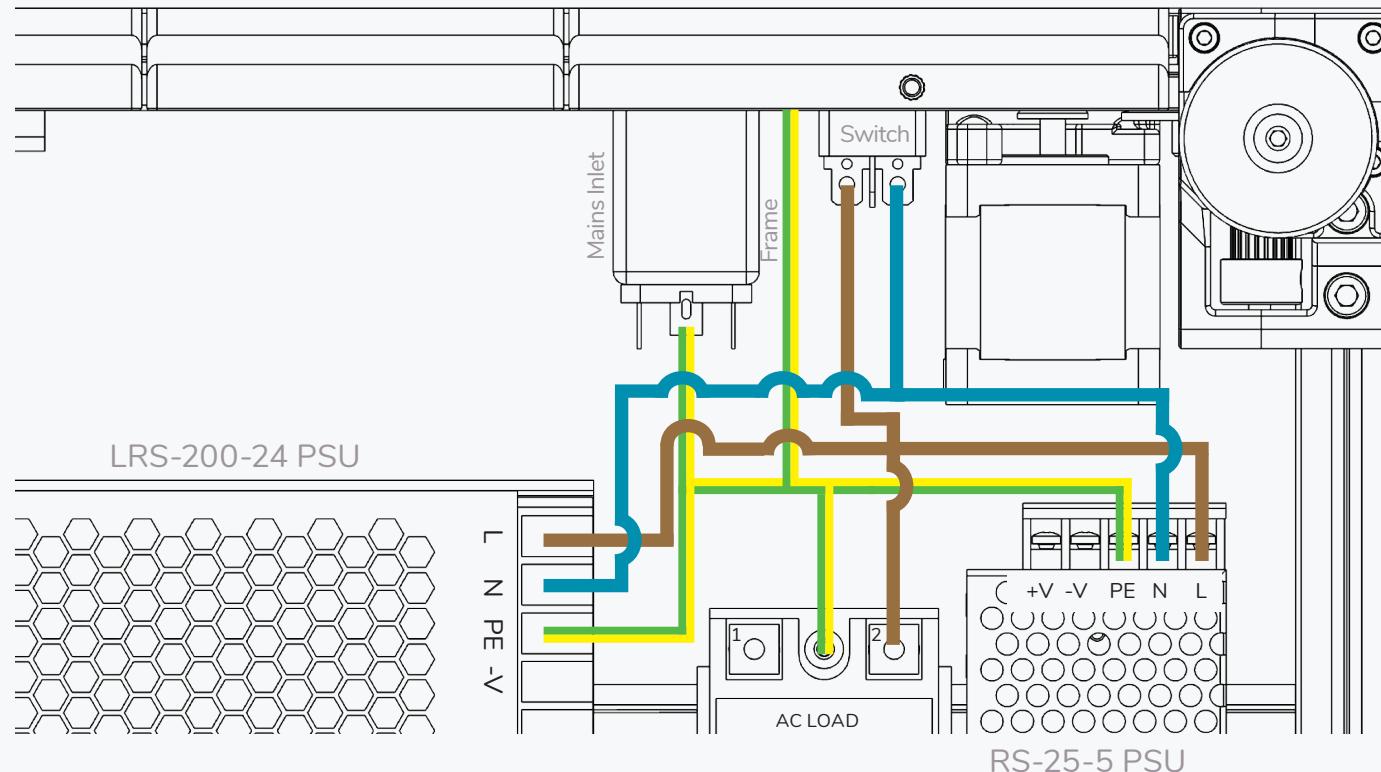
Make sure that all mains connectors are properly isolated and meet the applicable safety standards.

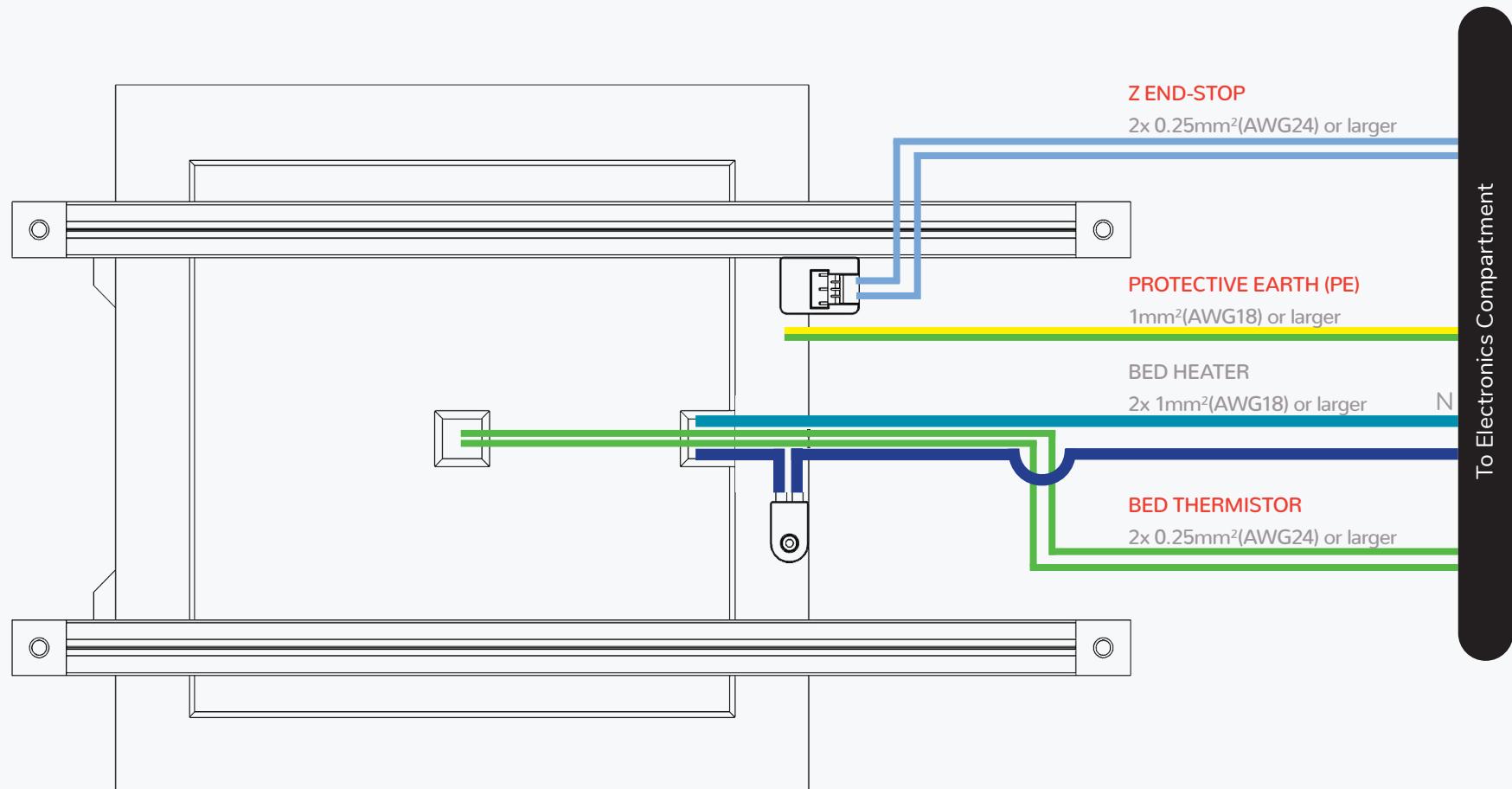
MAINS WIRING CONTINUED

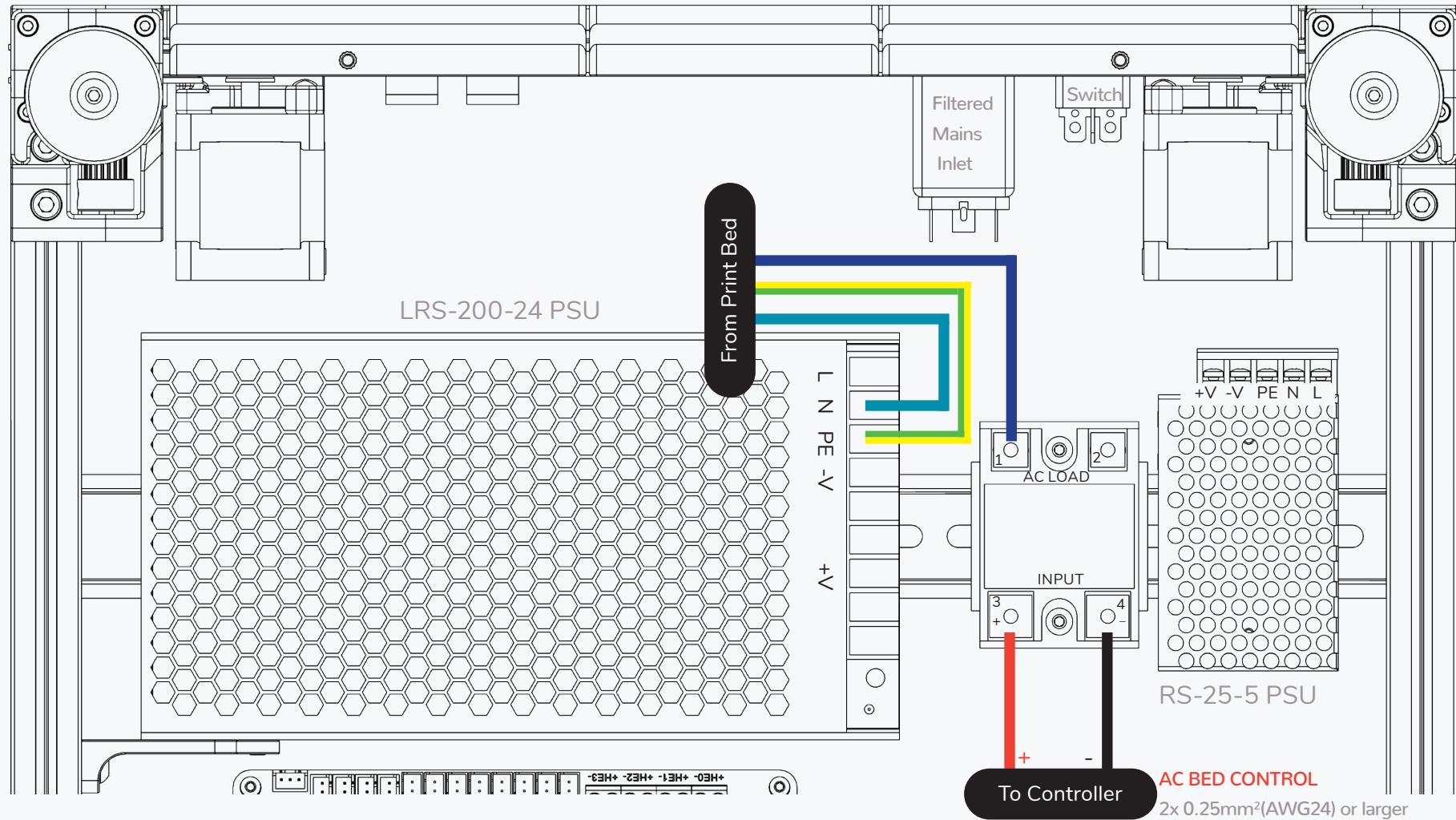
Secure the wires with cable clips / cable tie anchors.

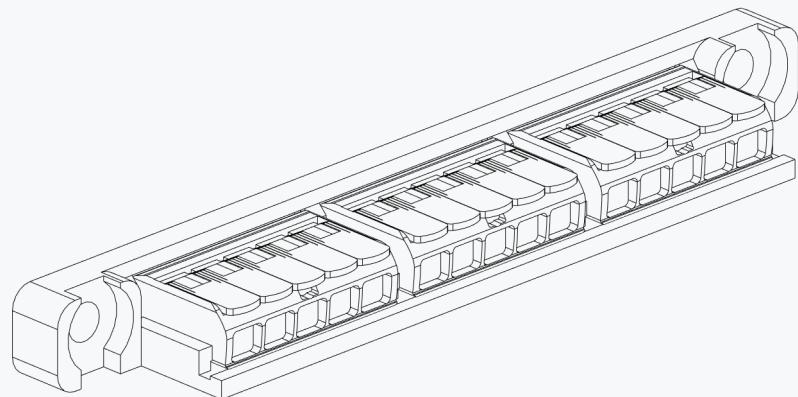
The bed heater is powered by AC voltage and receives its PE in a later step.

Observe your local regulations in regards to the Protective Earth connections for the frame/other components.





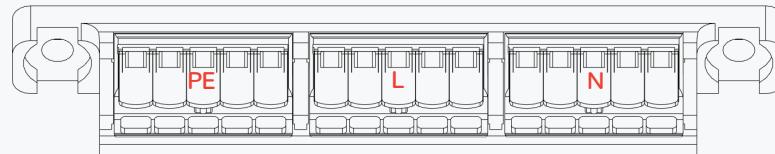


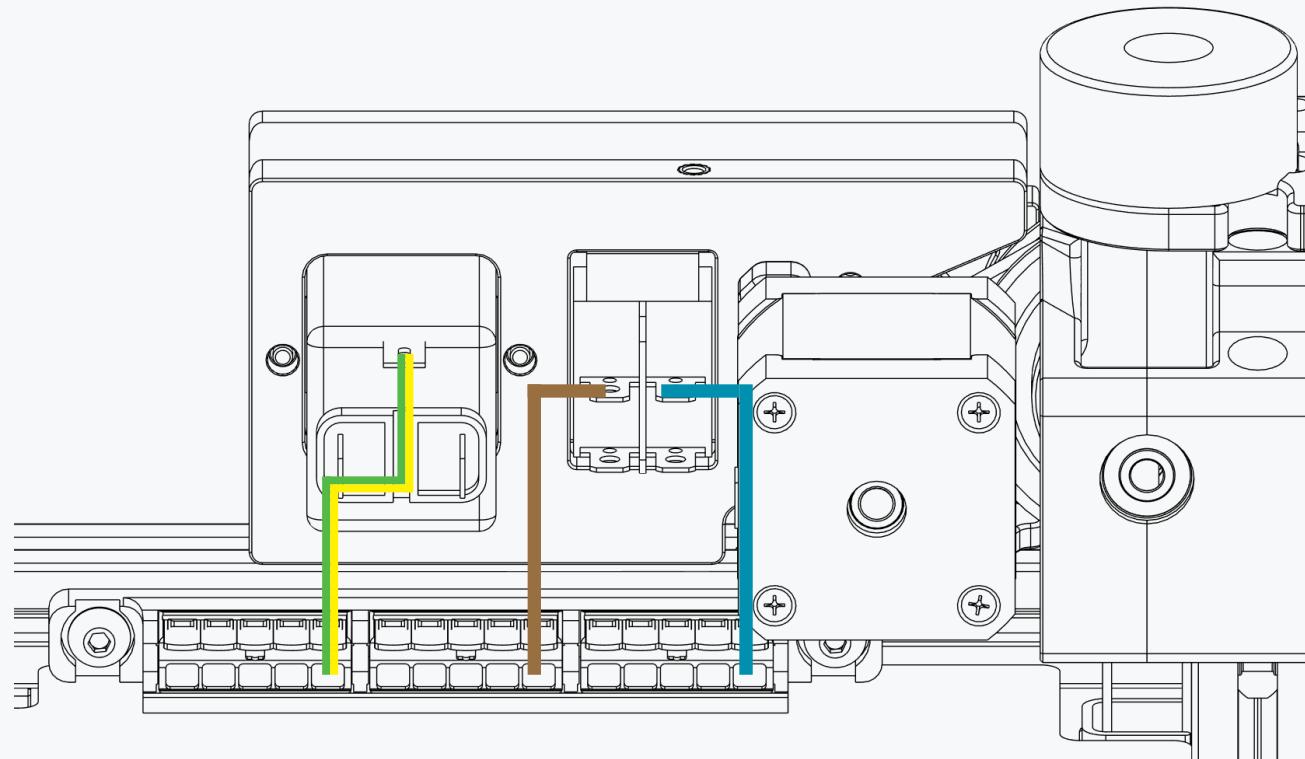


OPTION: WAGO CLAMPS FOR MAINS

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

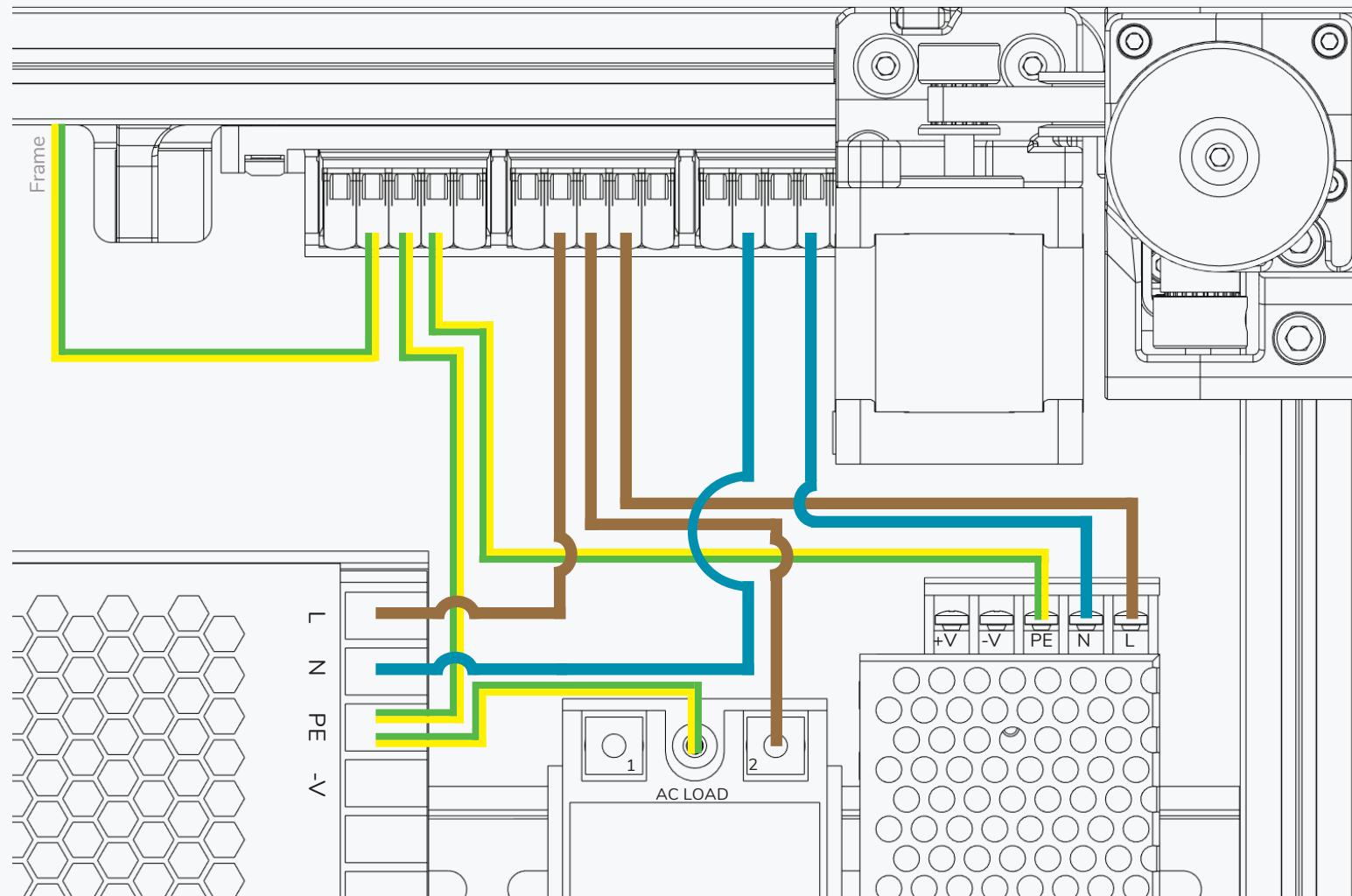
You may want to label your clamps as shown below.

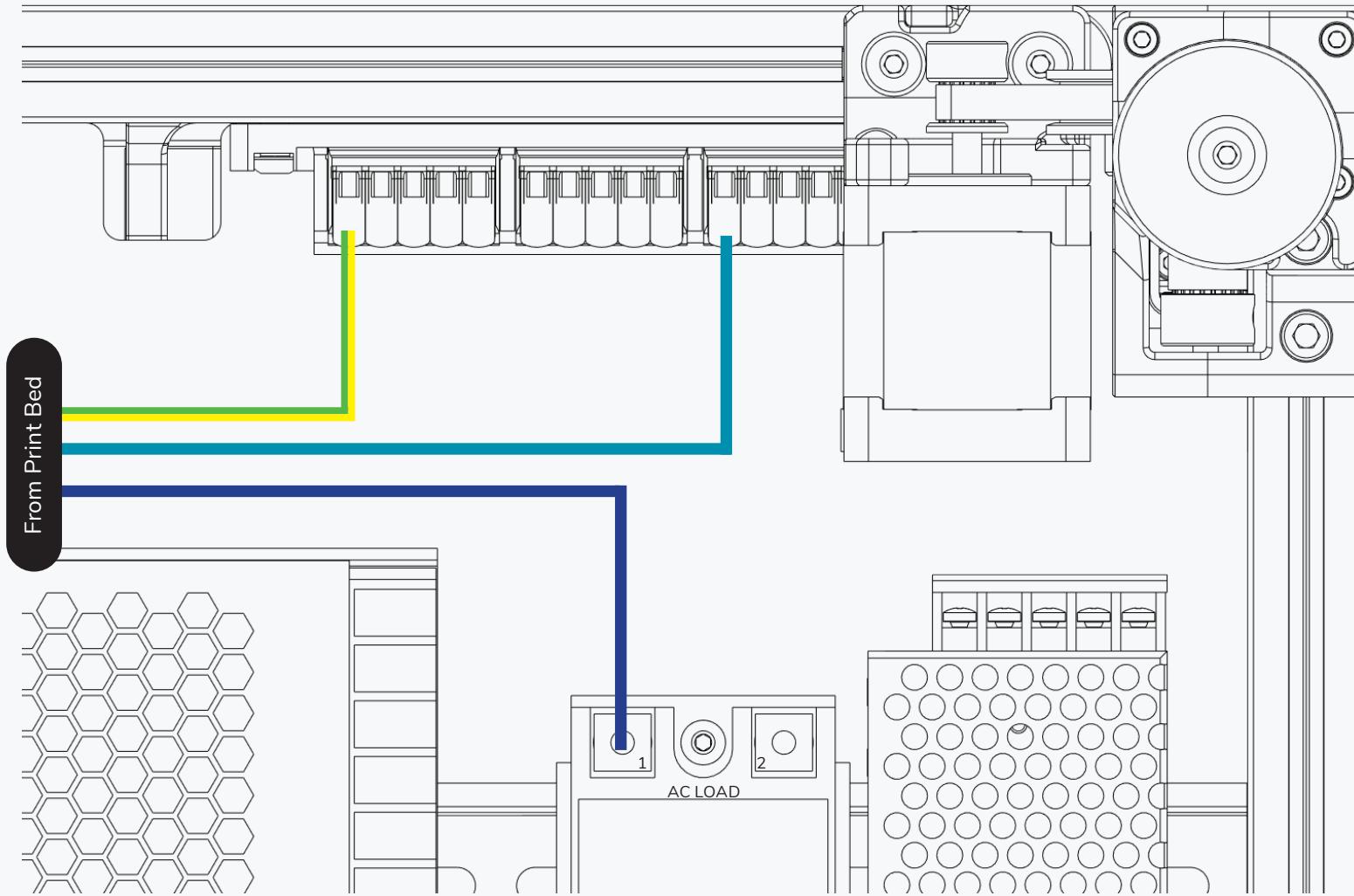


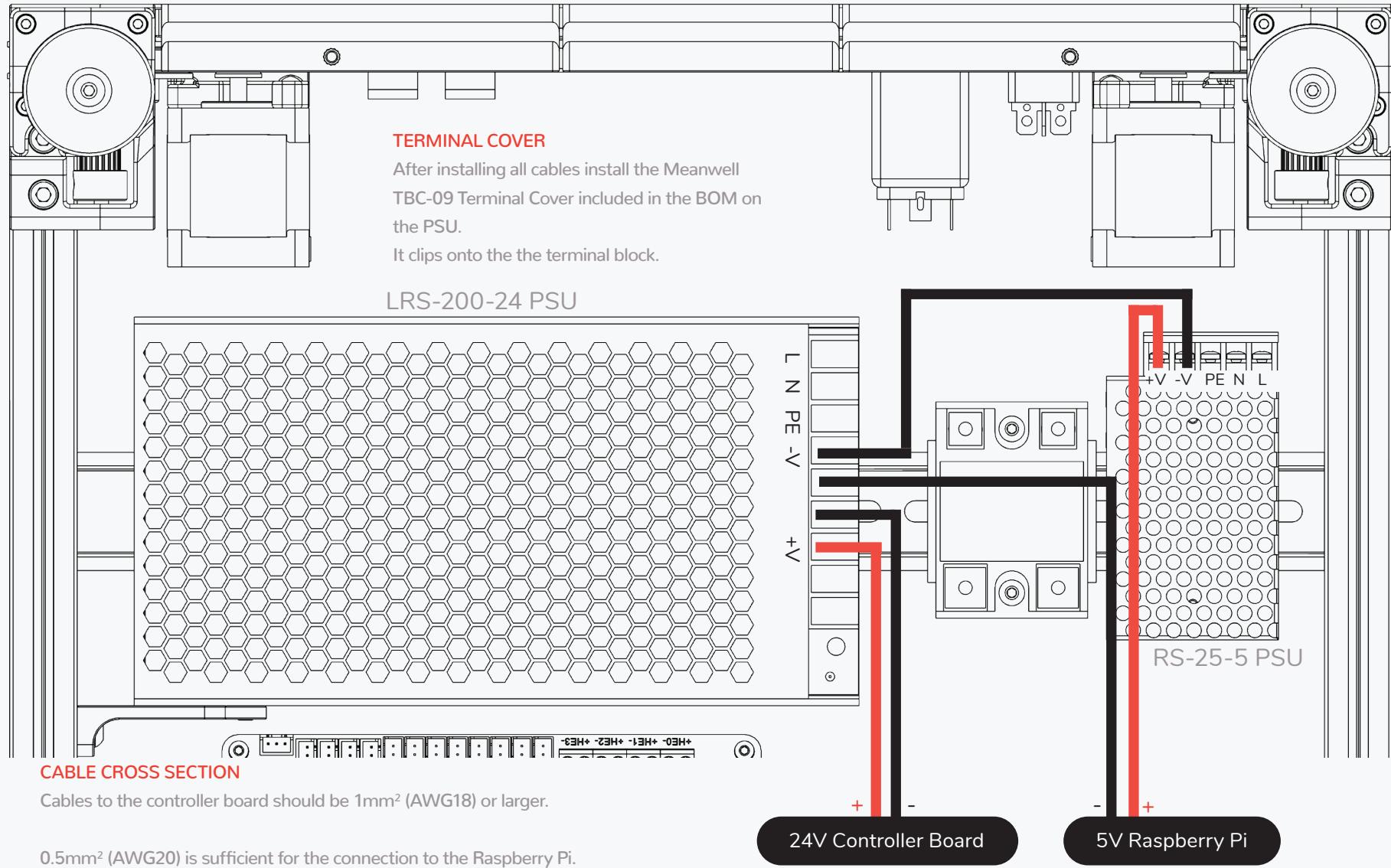


ALTERNATE MAINS WIRING - WAGO CLAMPS

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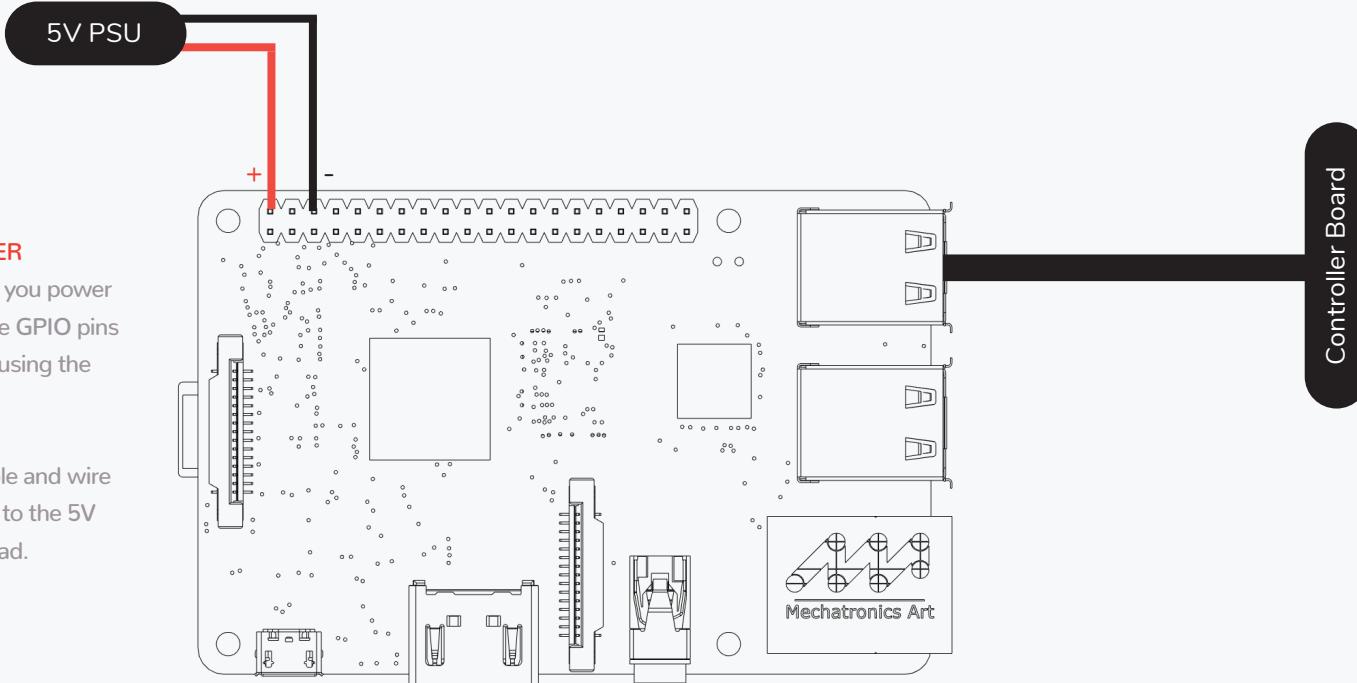




RASPBERRY PI POWER

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.



CONTROLLER BOARD

JUMPERS

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



PWR IN

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

AC BED CONTROL

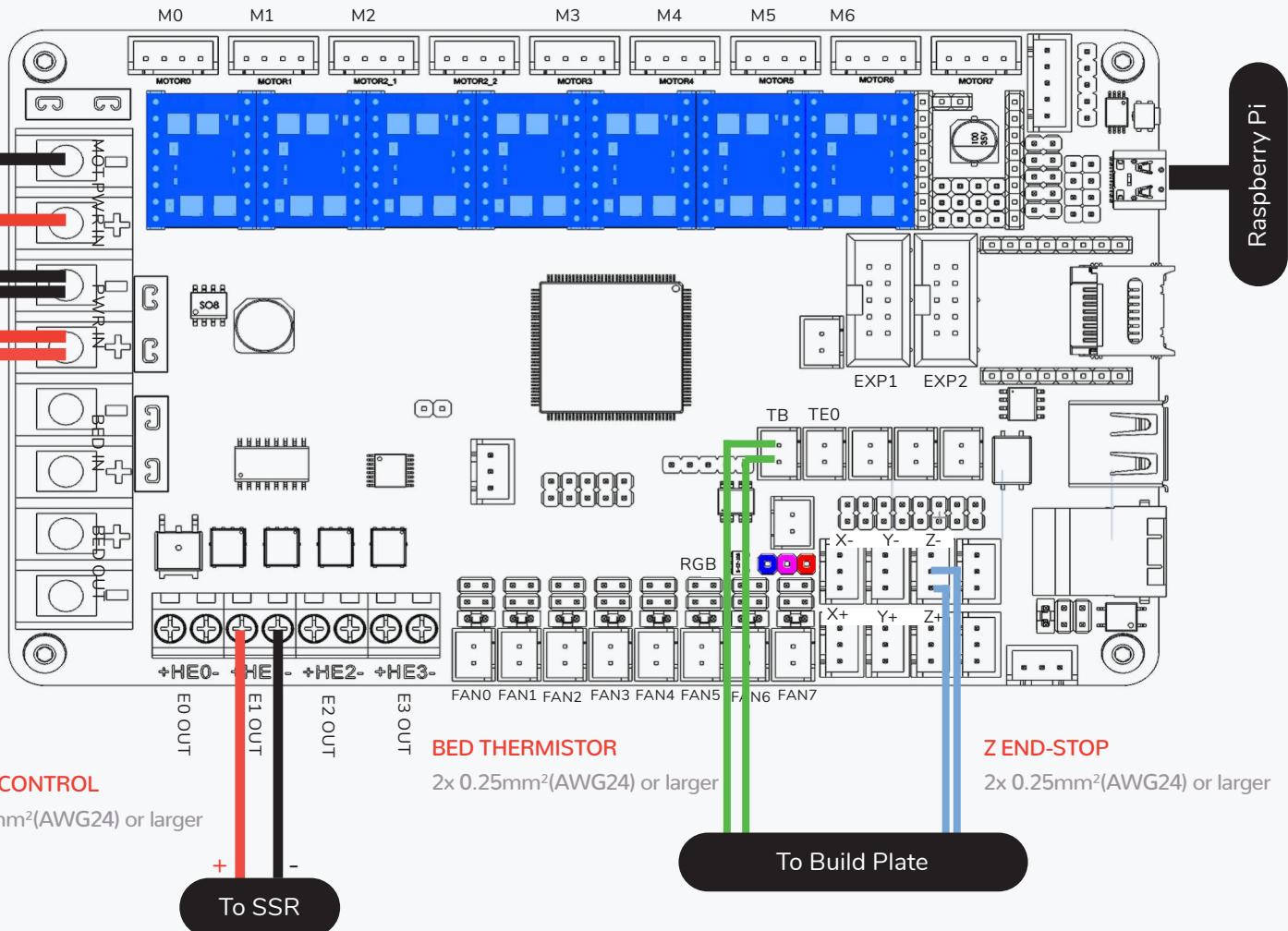
2x 0.25mm²(AWG24) or larger



To SSR

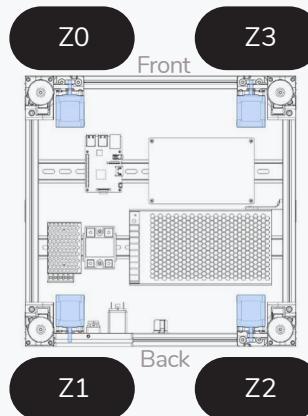
CONTROLLER BOARD

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



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CONTROLLER BOARD

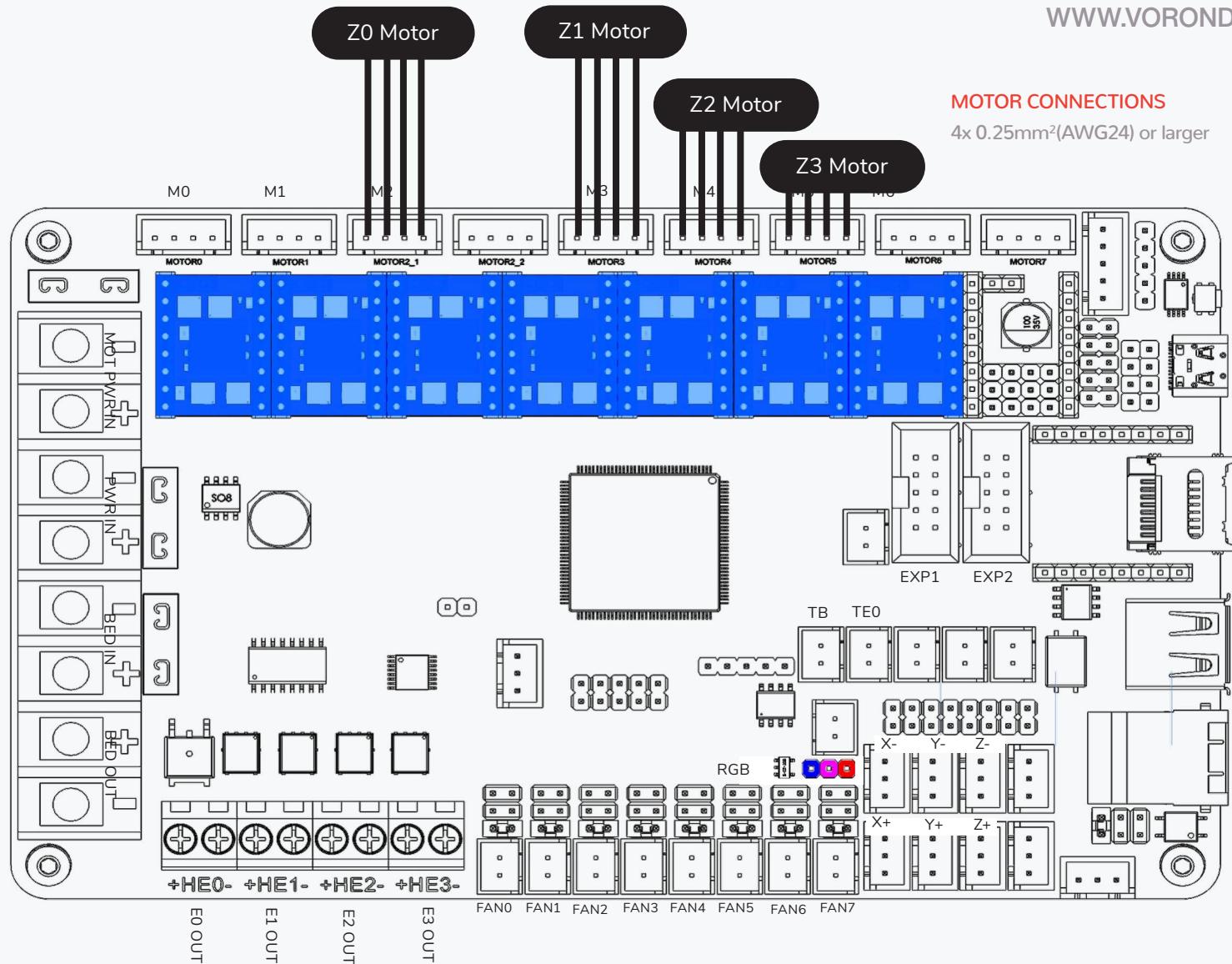


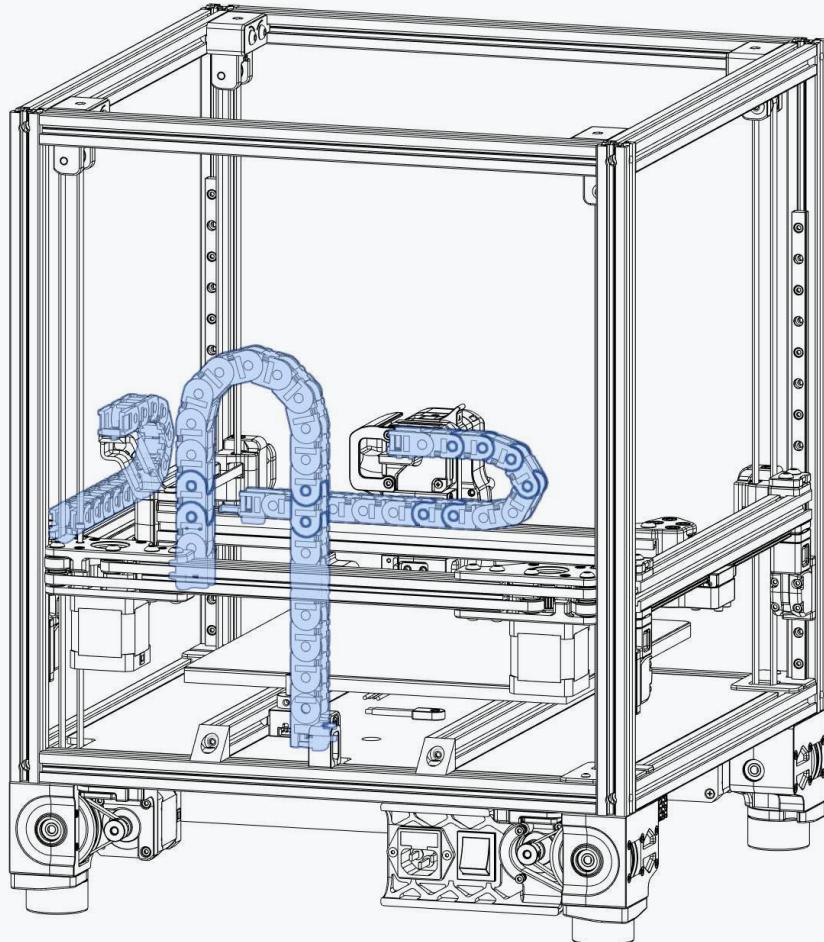
BLACK MOTOR WIRES?

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.

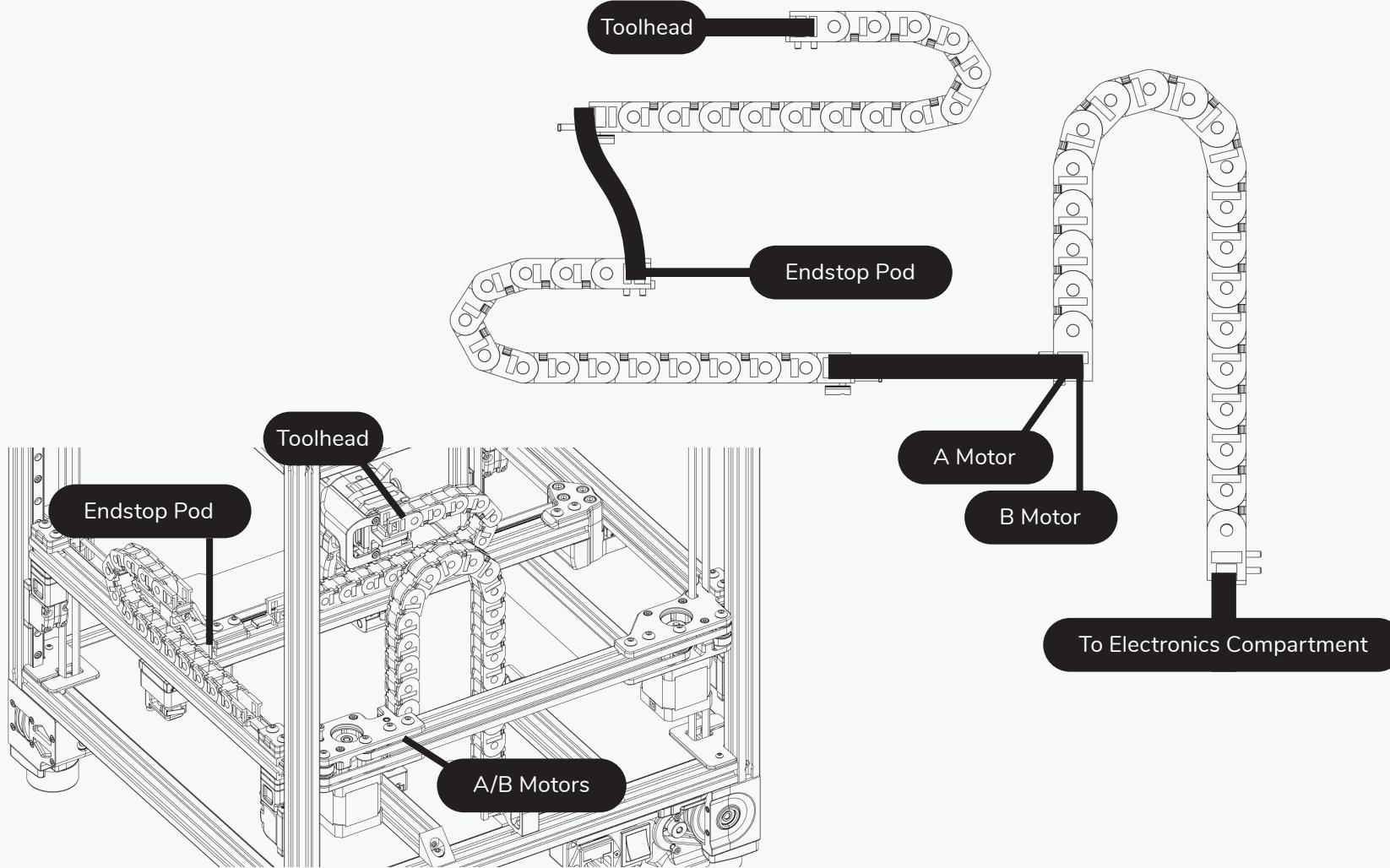


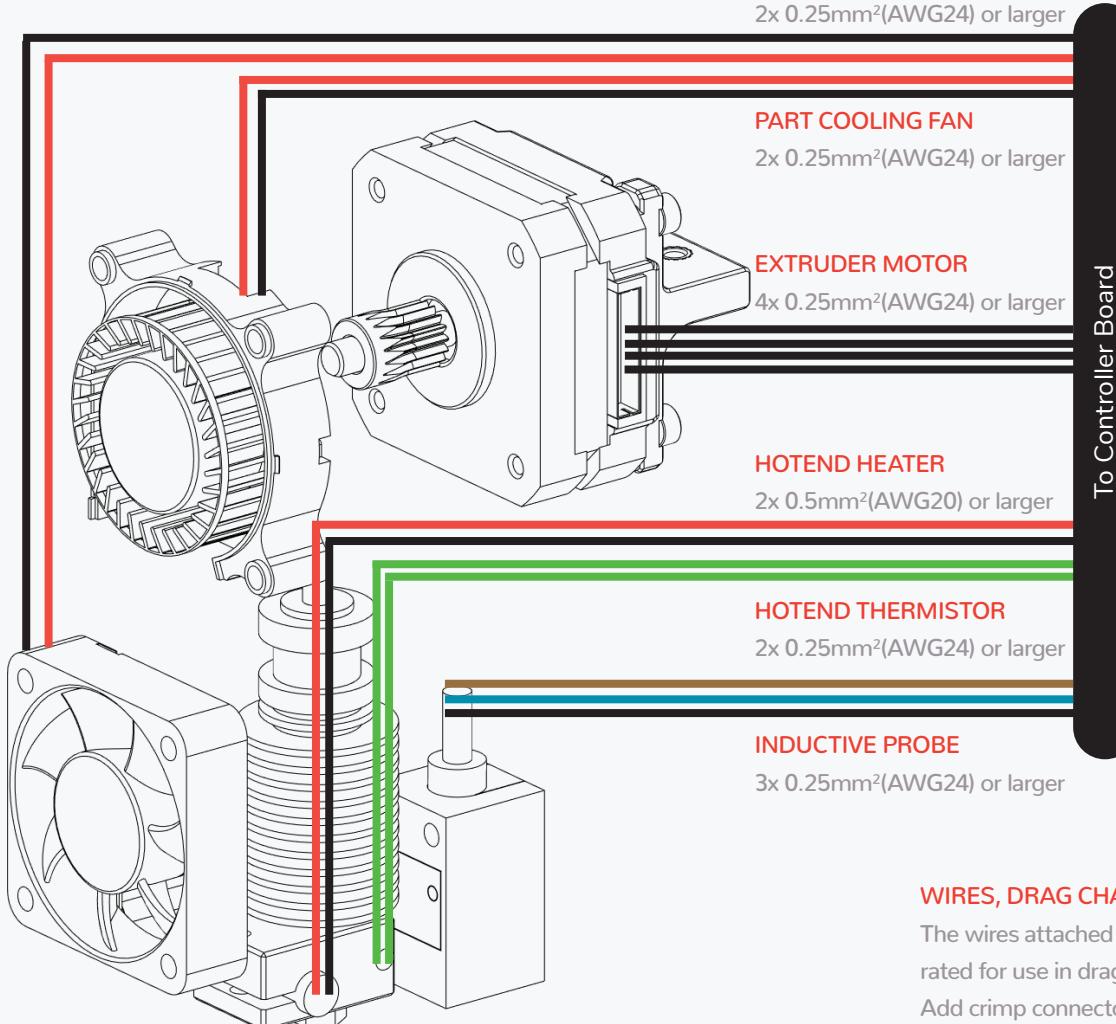


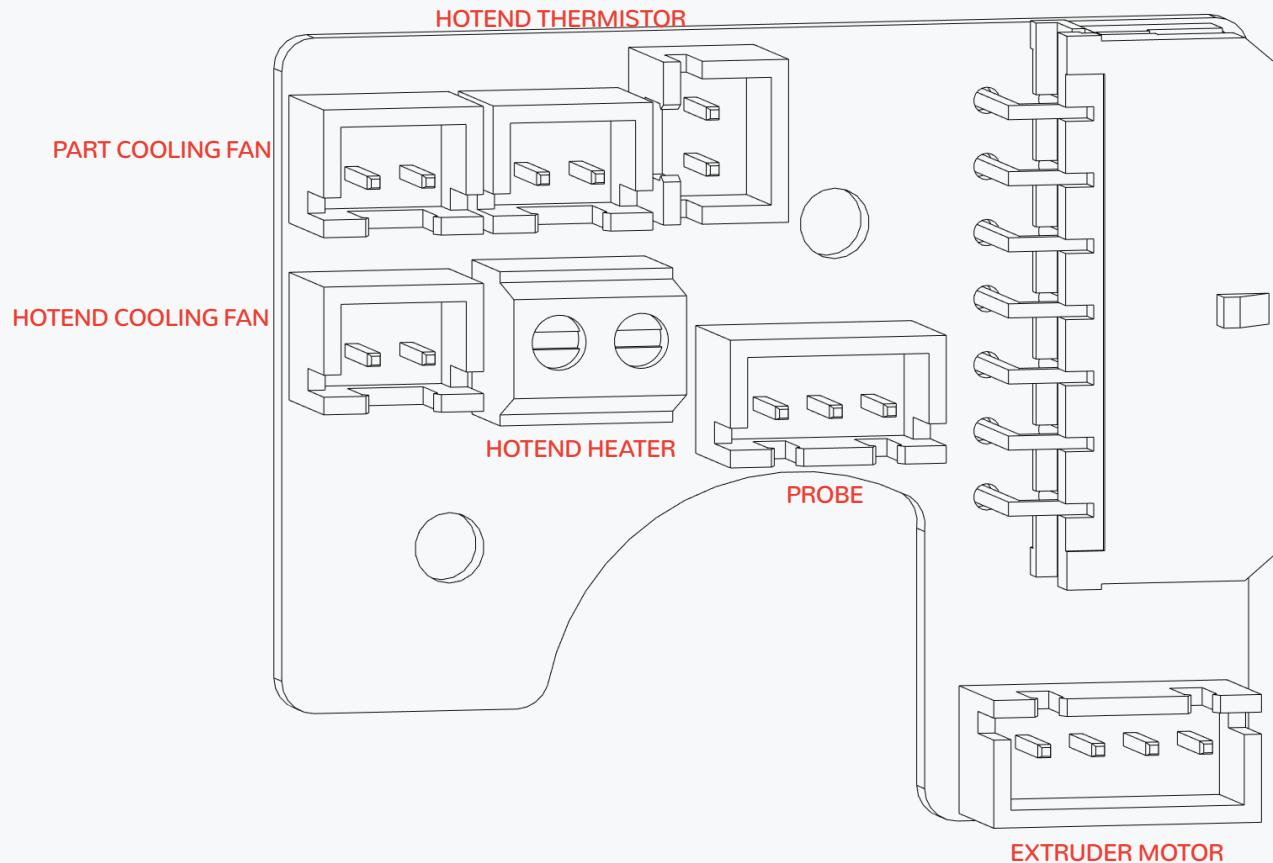
CABLE CHAINS INSTALL

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.



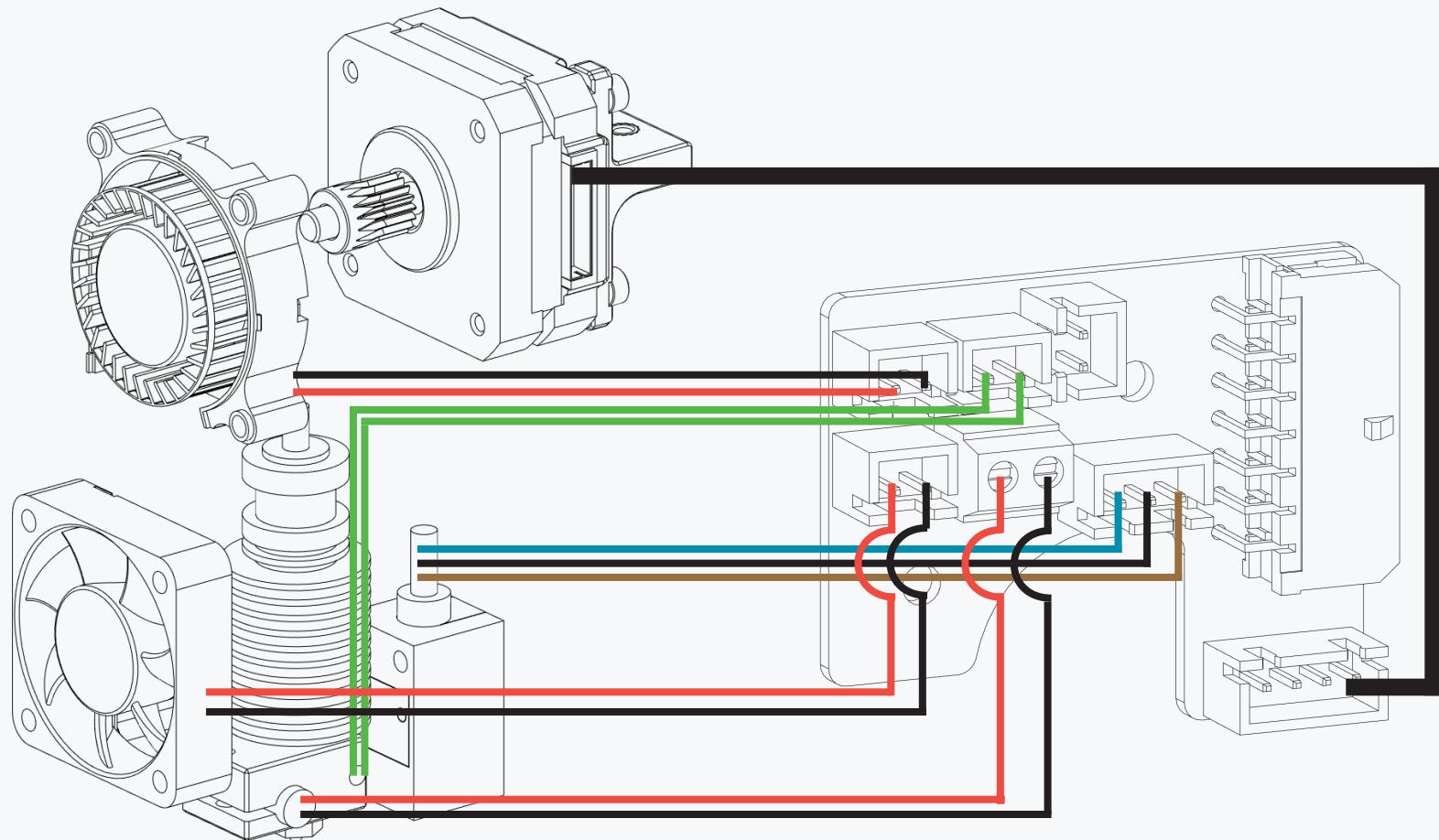


**OPTION: TOOLHEAD PCB**

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

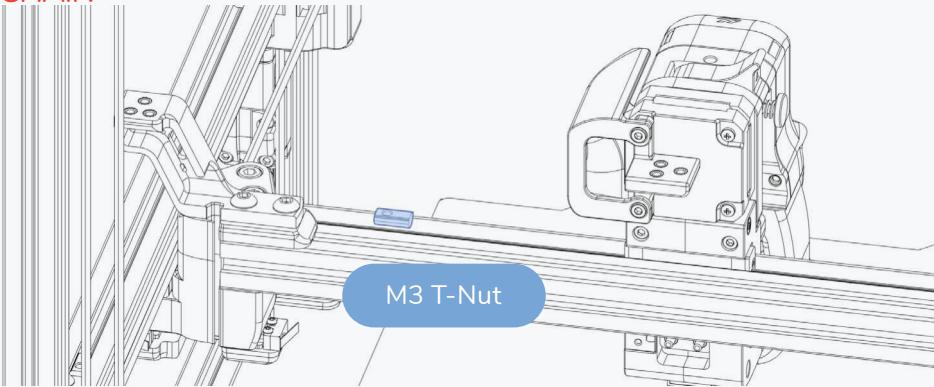


<https://voron.link/zopduze>

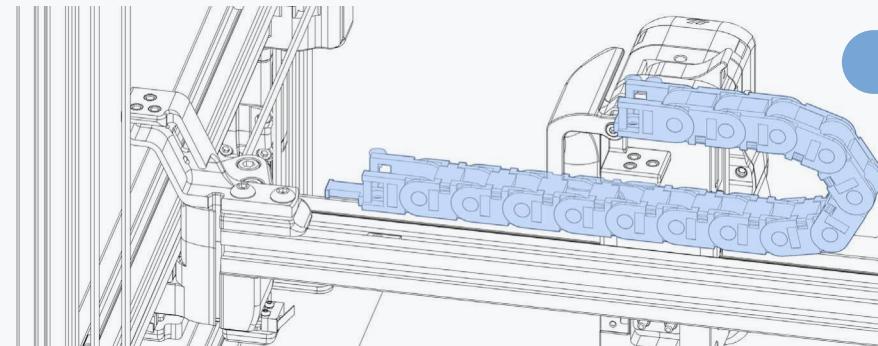


X CABLE CHAIN

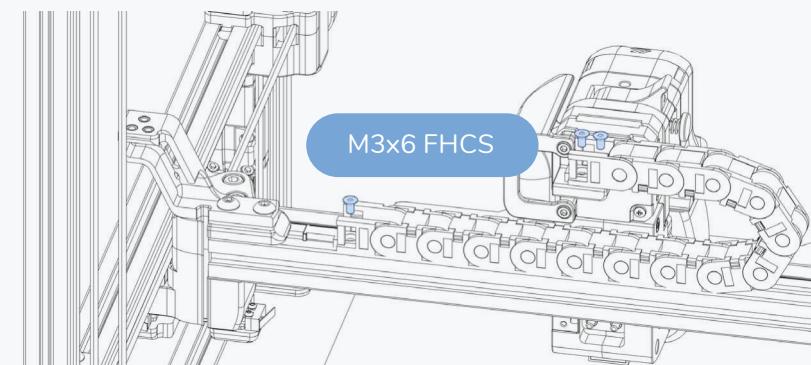
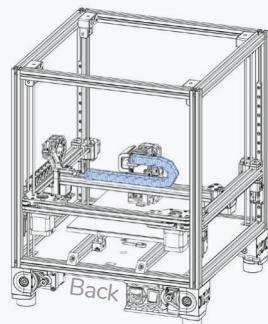
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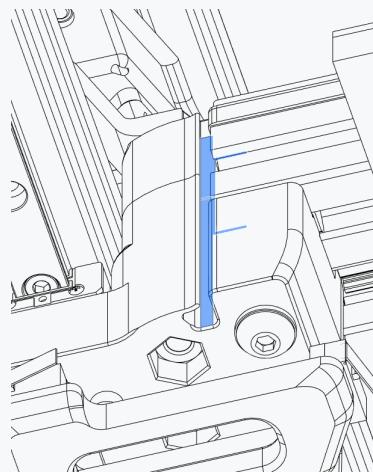
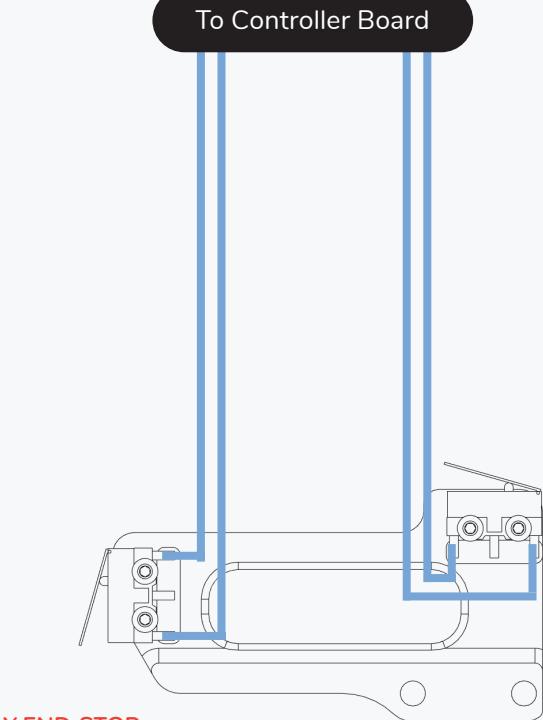
M3 T-Nut



Cable Chain



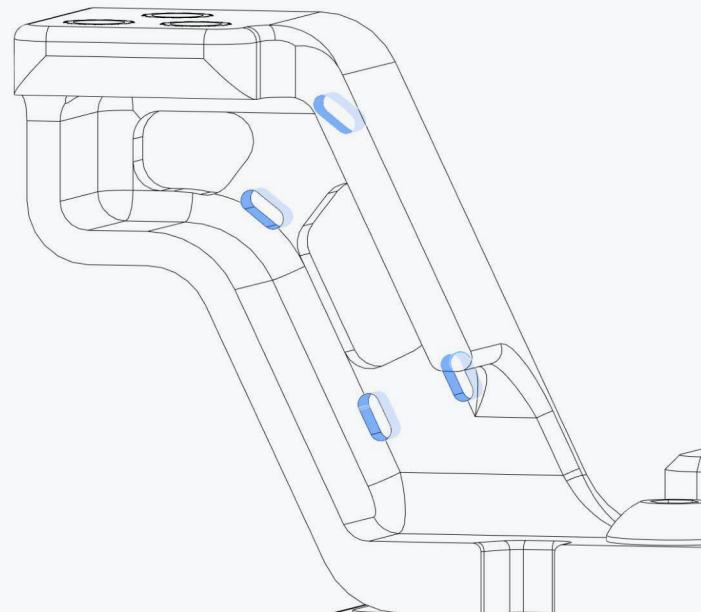
M3x6 FHCS



Y END-STOP
2x 0.25mm²(AWG24) or larger

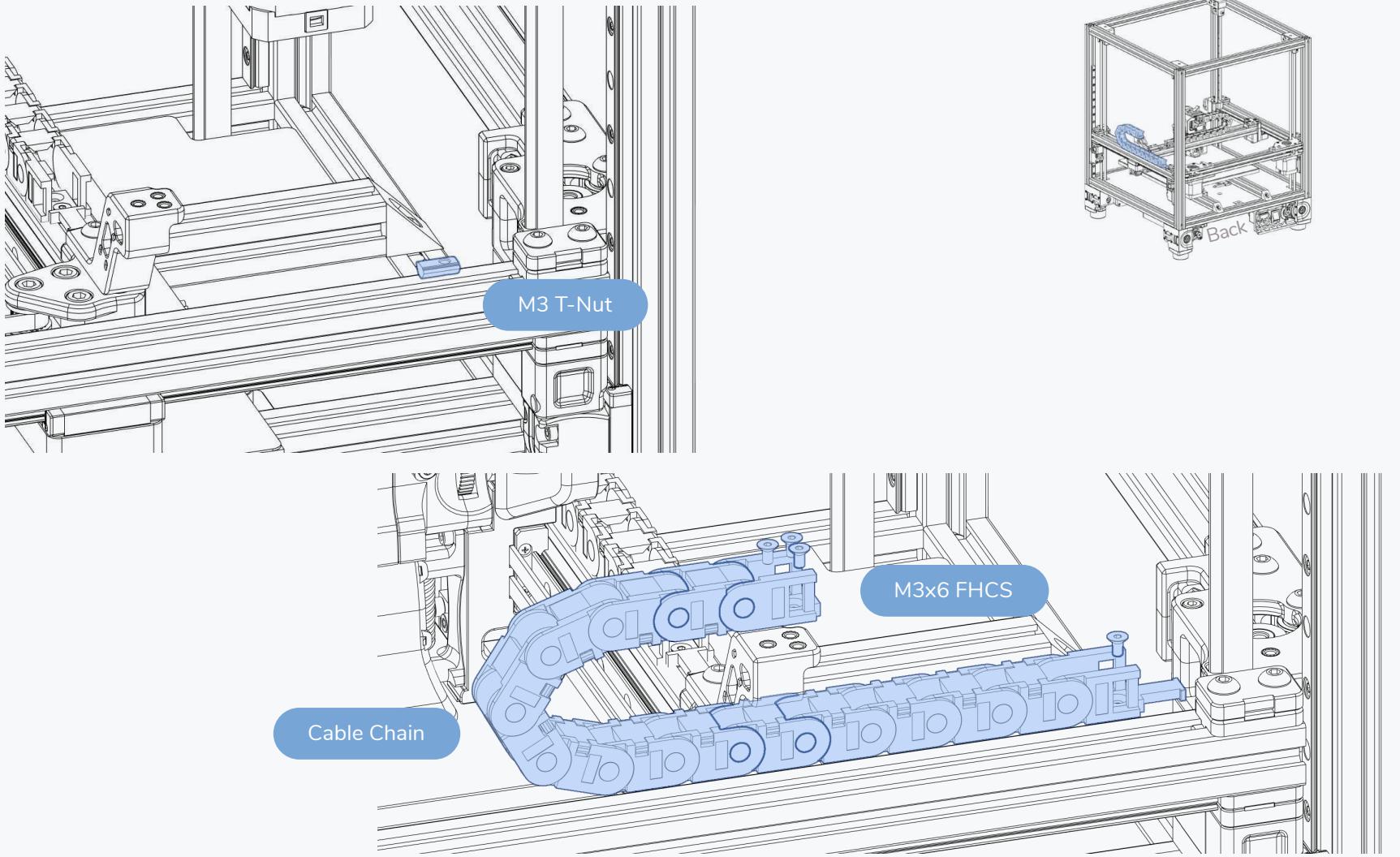
OPTION: ENDSTOP BOARD/HALL EFFECT BOARD

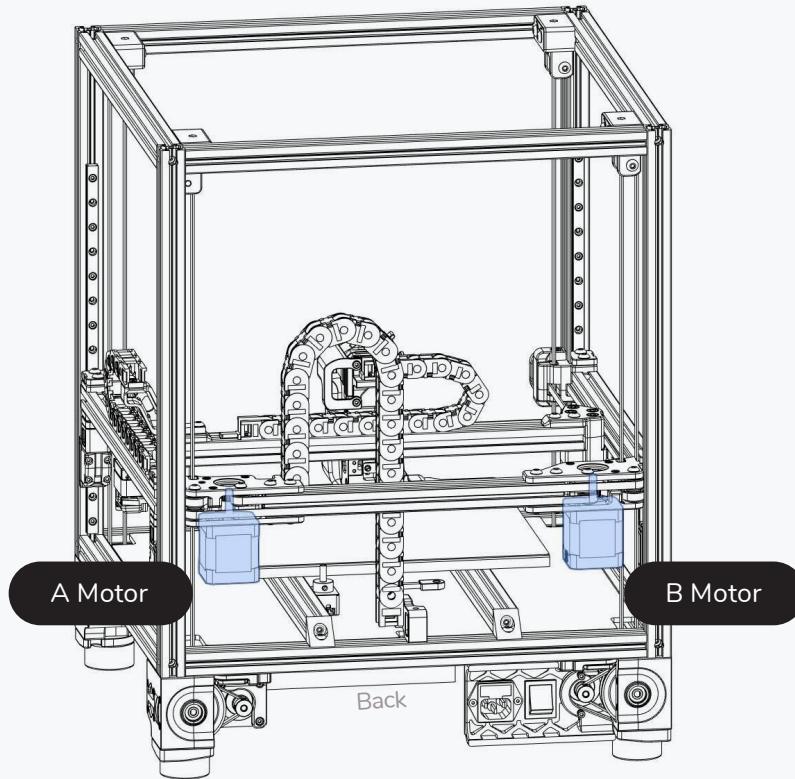
Those boards utilize a 4 pin connector instead. Please refer to <https://voron.link/djhygyu> and <https://voron.link/d6qb7o6> for details.



ZIP TIE LOOPS

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



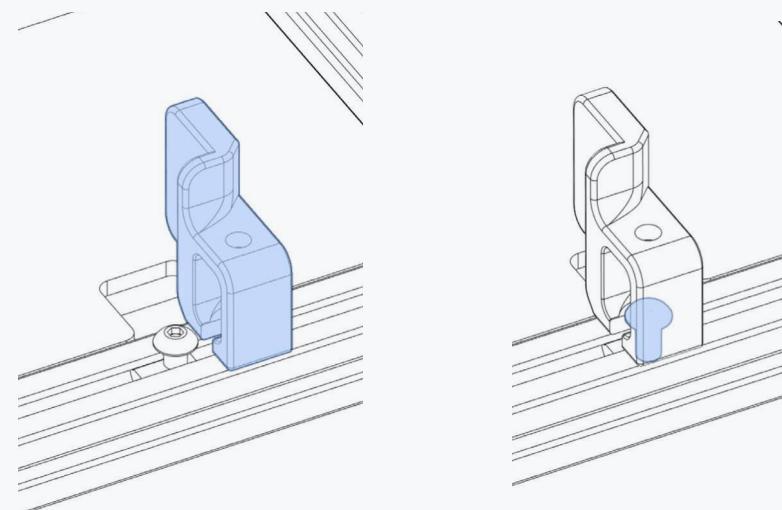
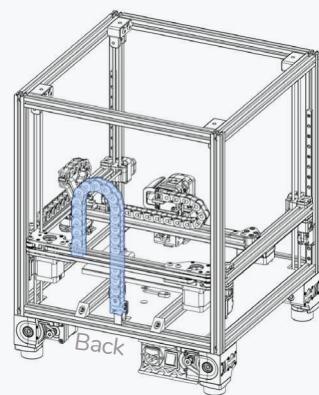
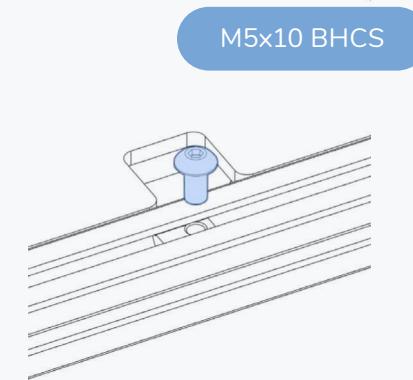
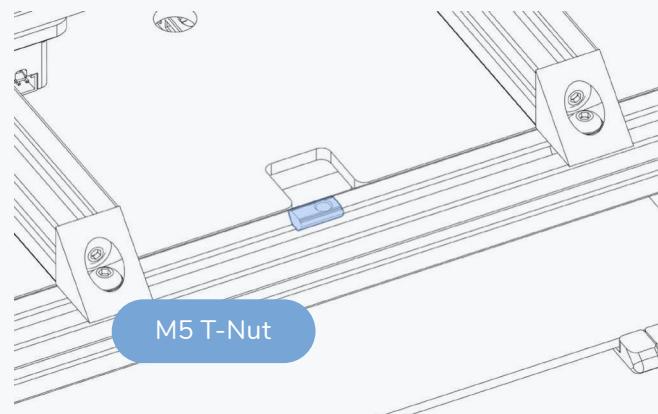
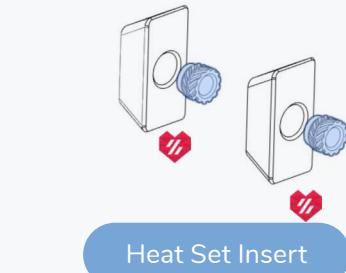


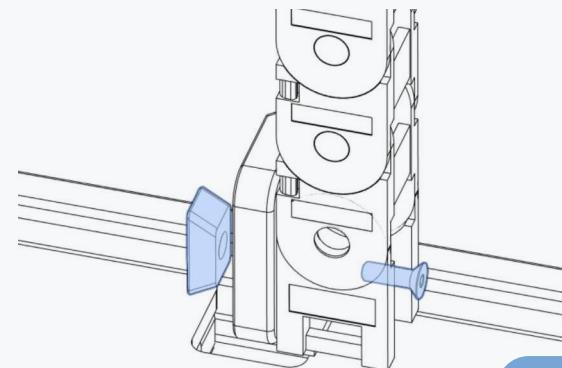
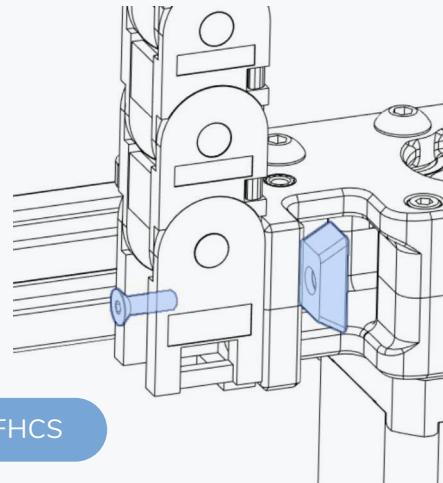
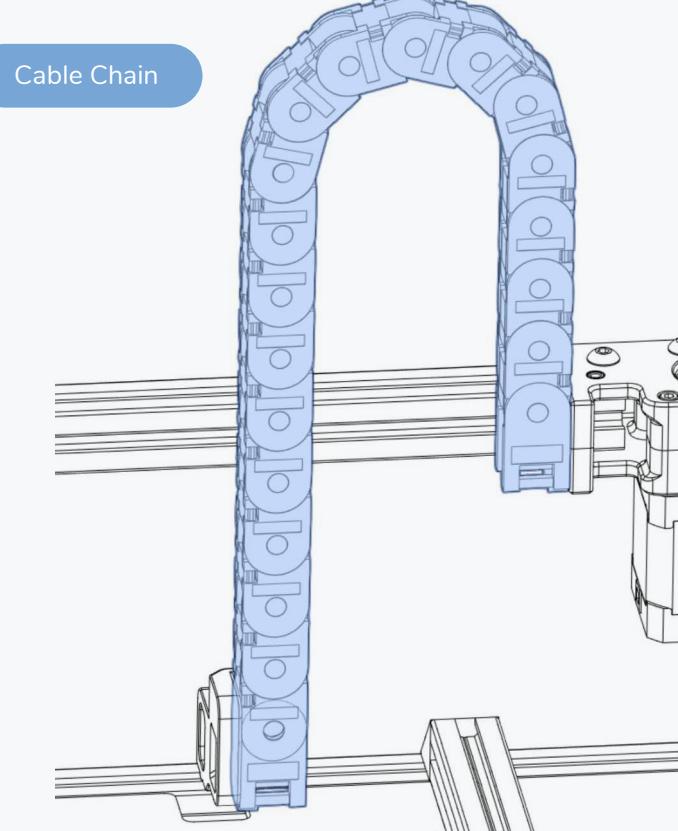
SECURING MOTOR CABLES

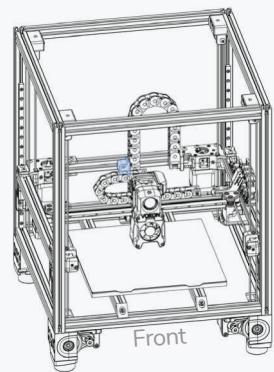
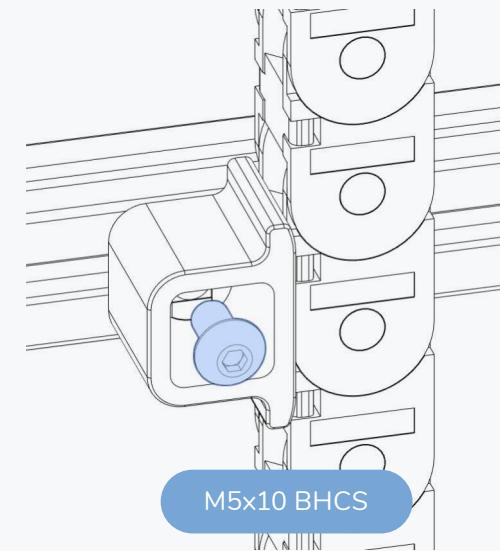
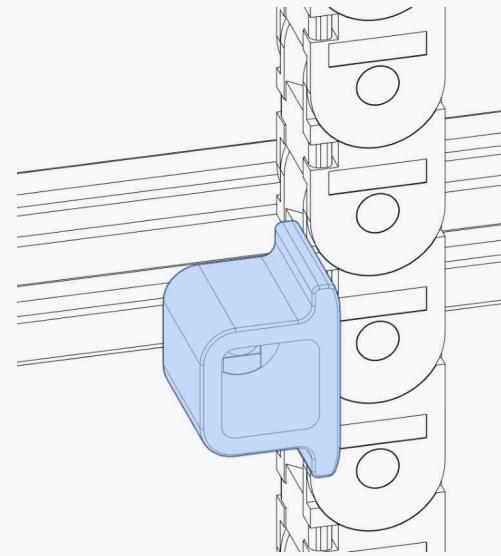
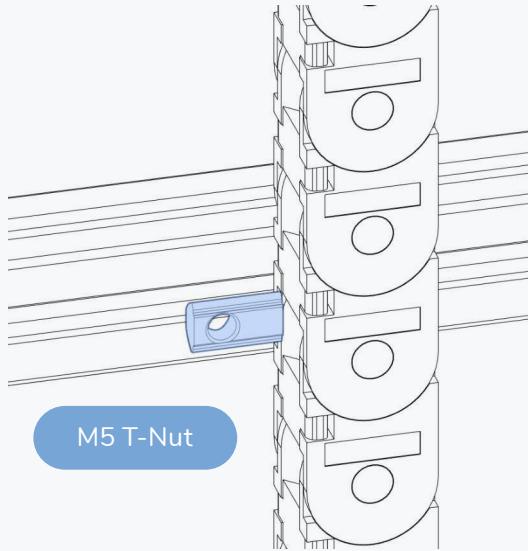
Secure the wire bundles along the small extrusion that sits between the drives with small zip ties.

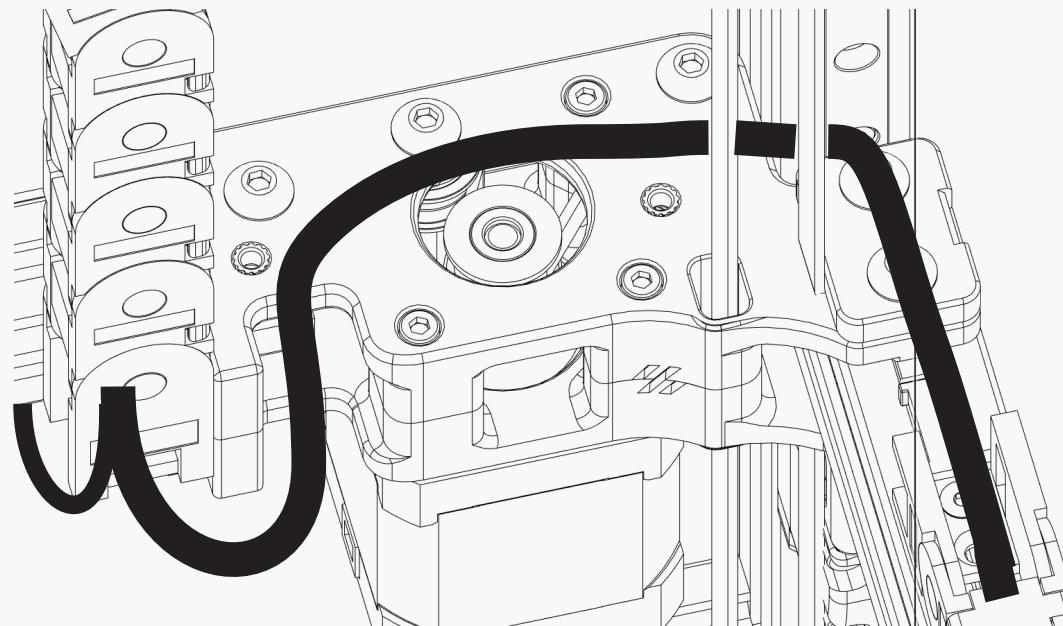
Z CABLE CHAIN

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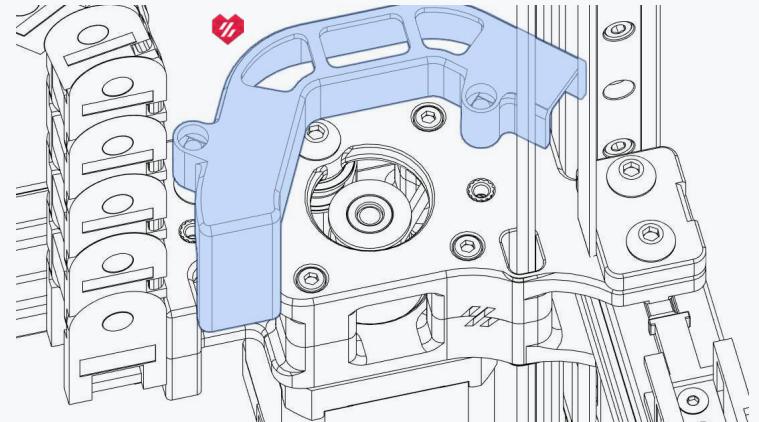




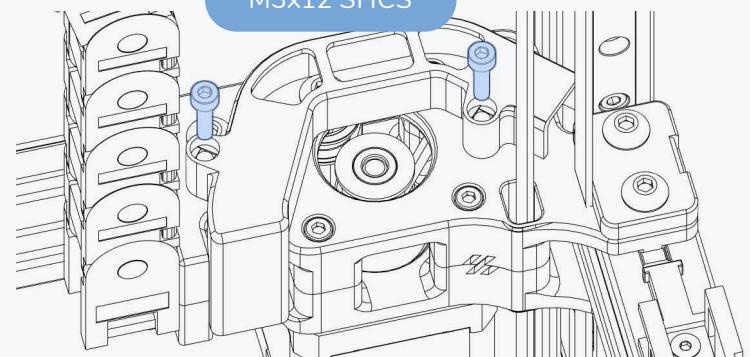


**WIRE PATH**

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.



M3x12 SHCS



CONTROLLER WIRING

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B MOTOR

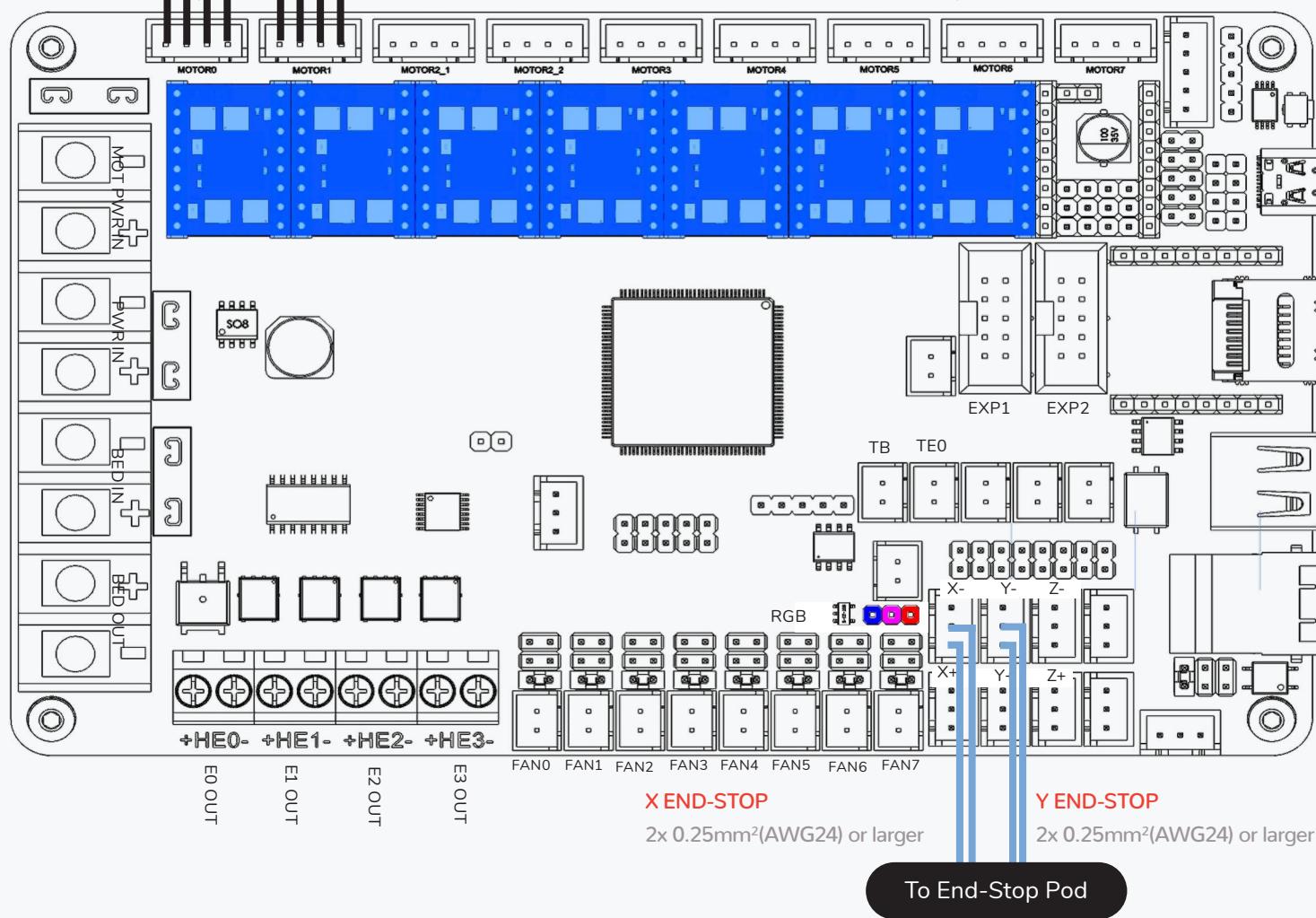
4x 0.25mm²(AWG24) or larger

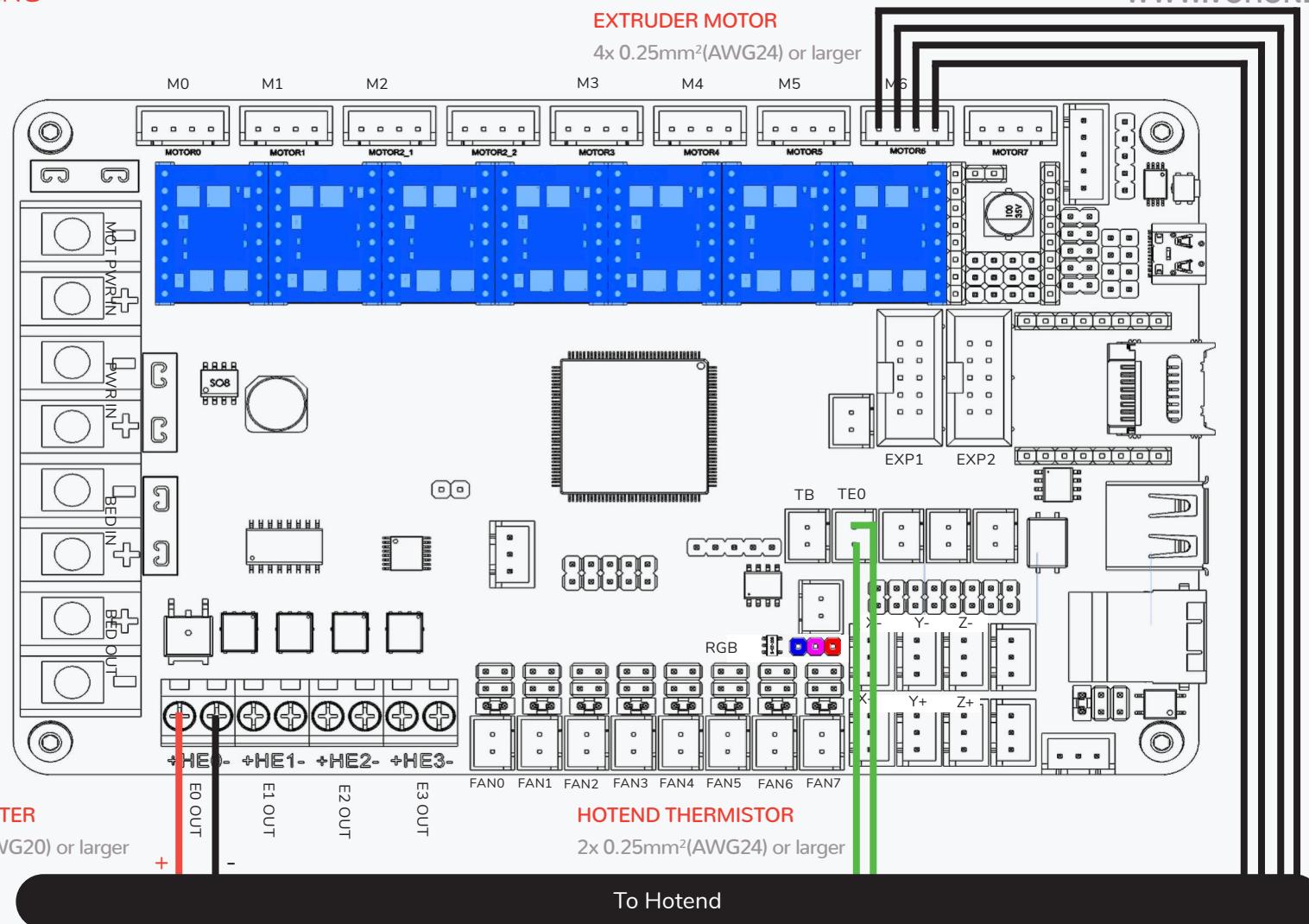
B Motor

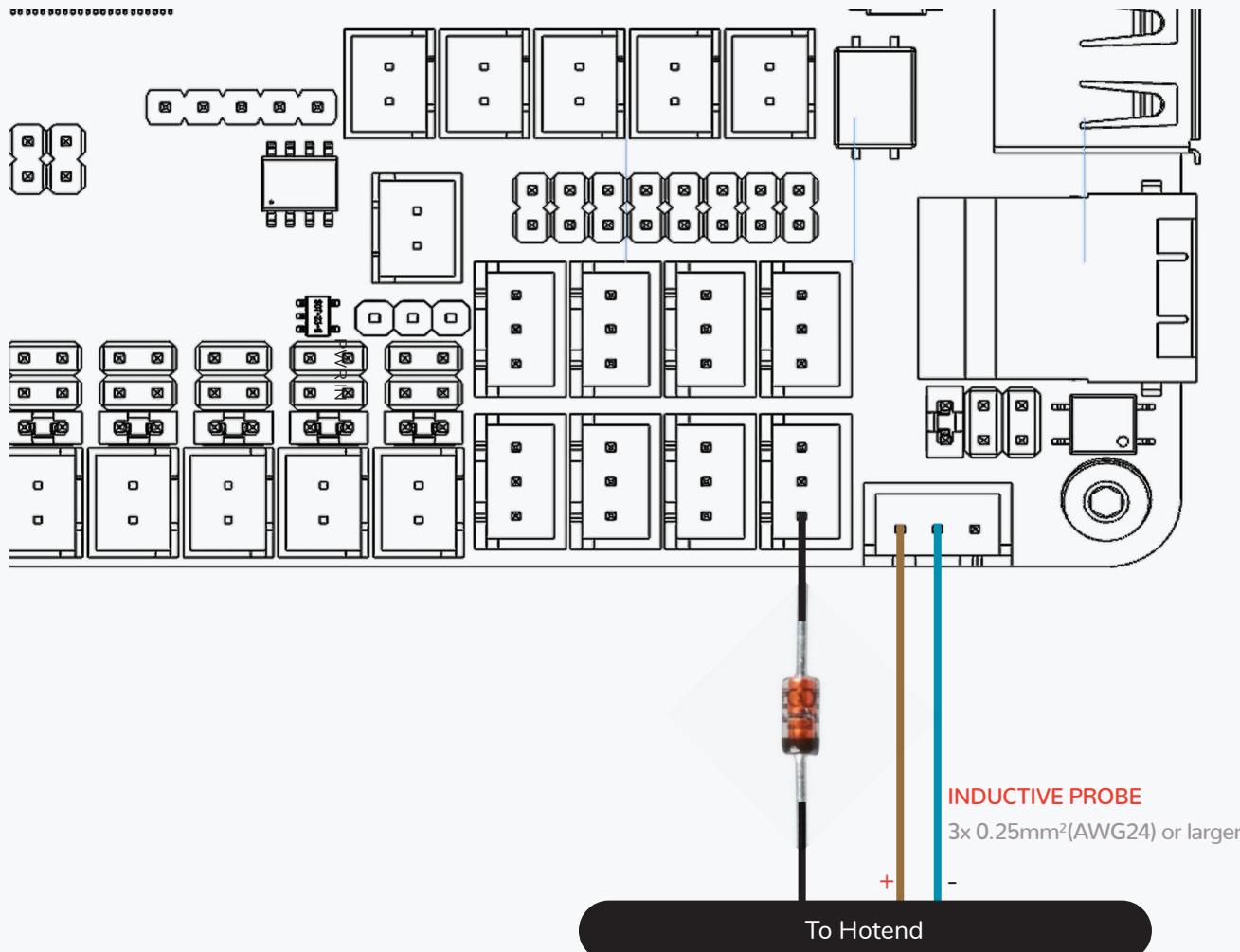
A Motor

A MOTOR

4x 0.25mm²(AWG24) or larger





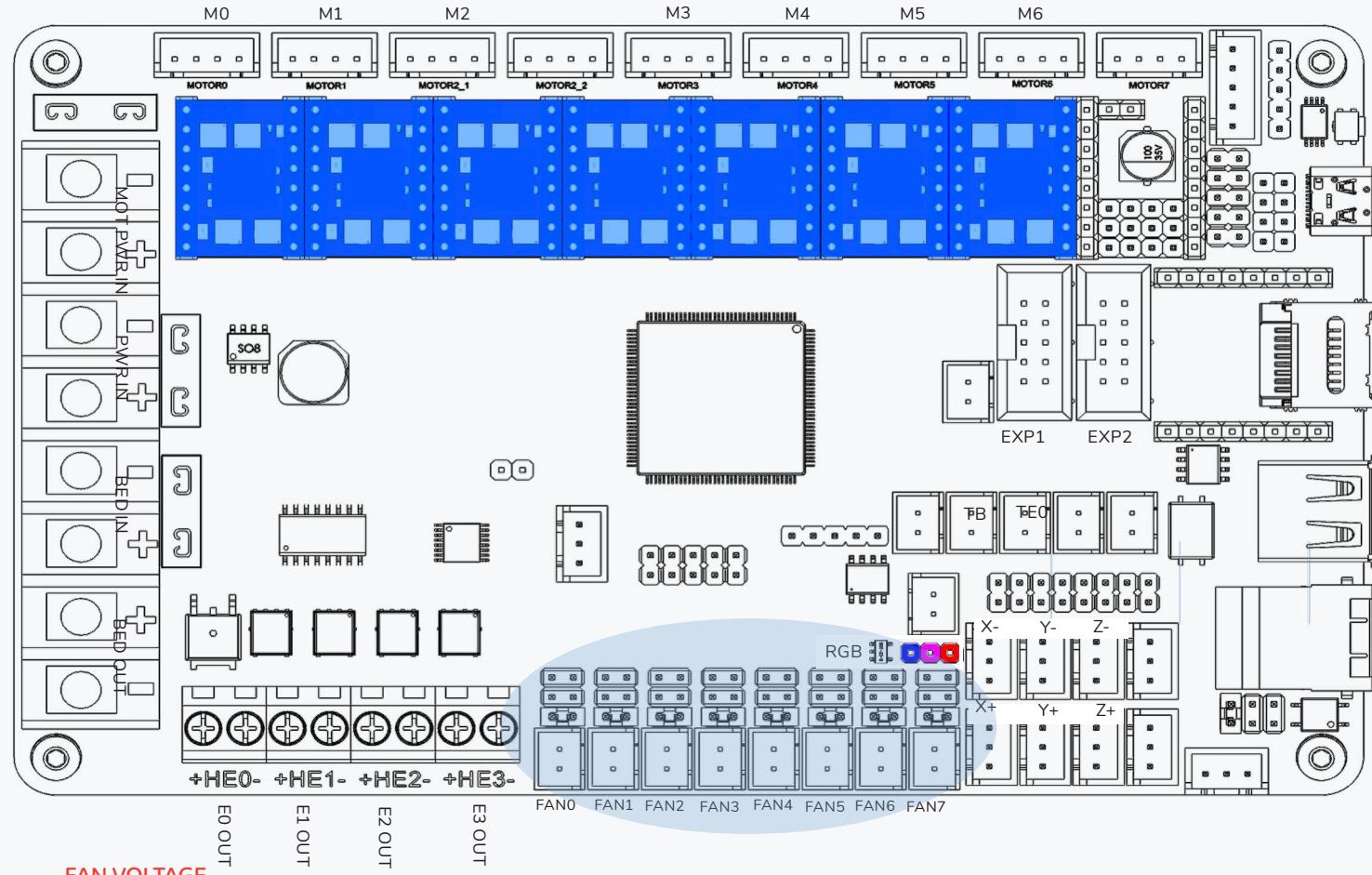


PROBE HOOKUP

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.

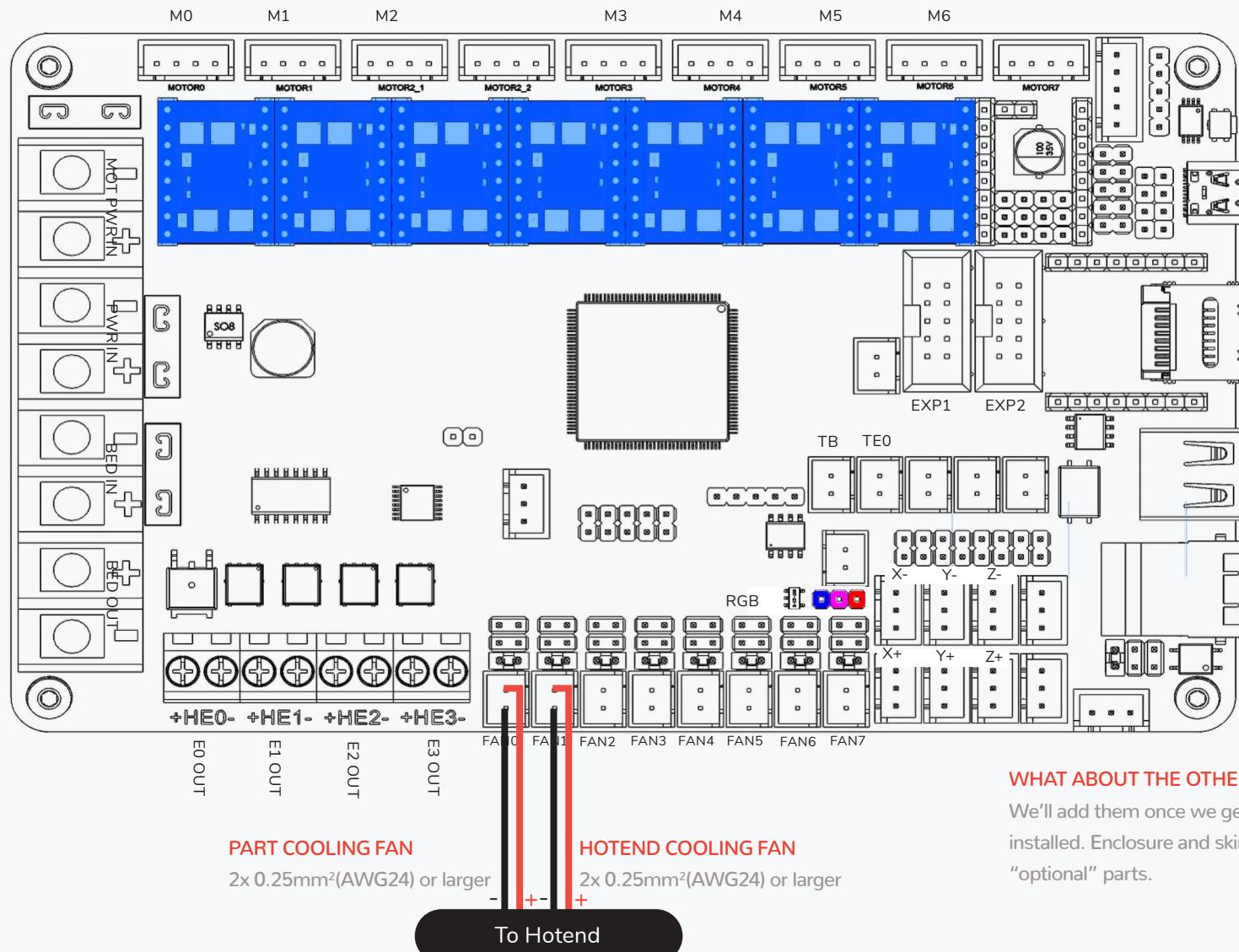
The black ring on the diode “points” toward the toolhead.

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



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.

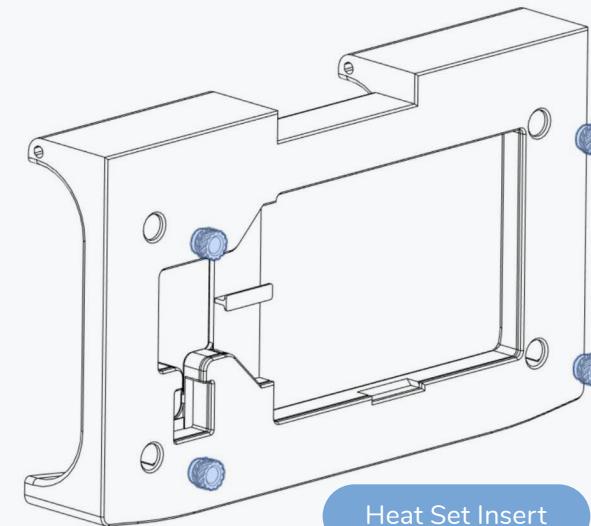
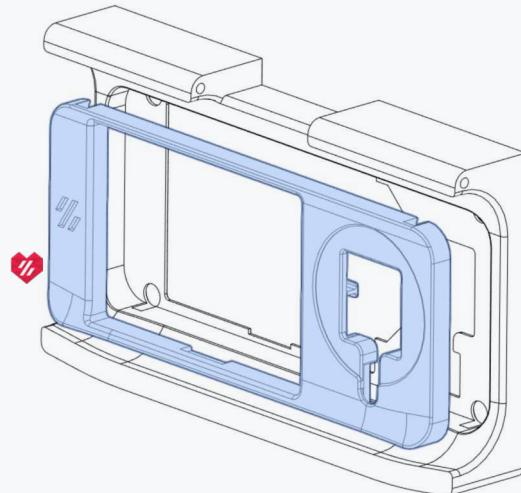
**WHAT ABOUT THE OTHER FANS?**

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

SKIRTS

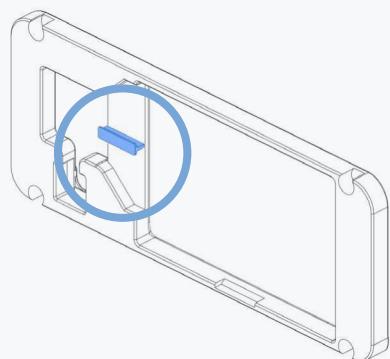
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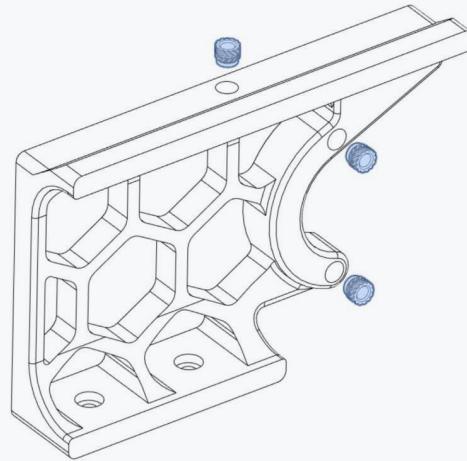
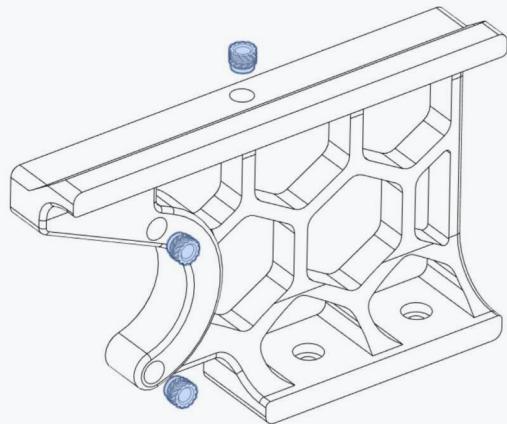
FRONT COVER

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.

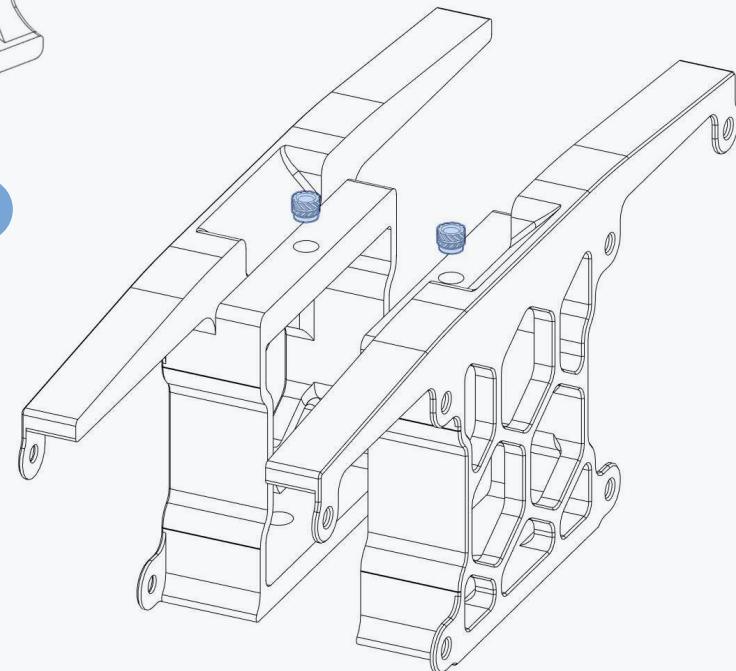
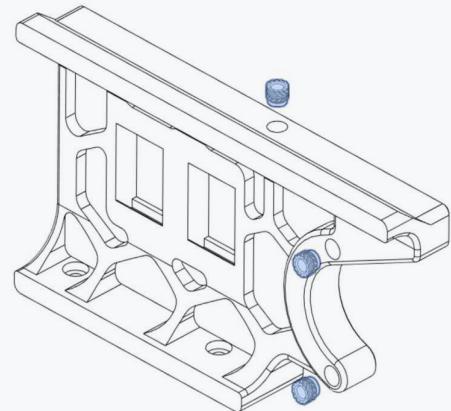


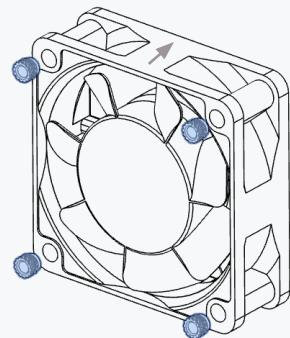
BUILT-IN SUPPORT

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

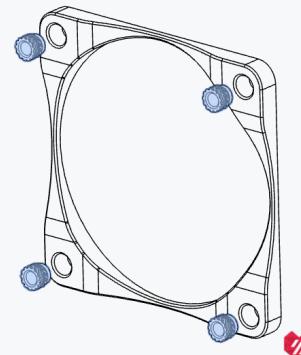


Heat Set Insert

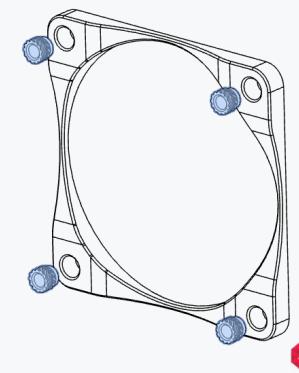
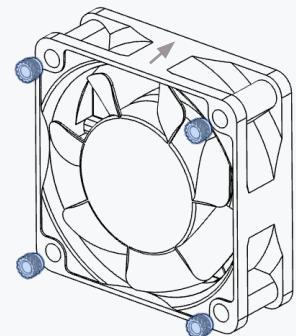


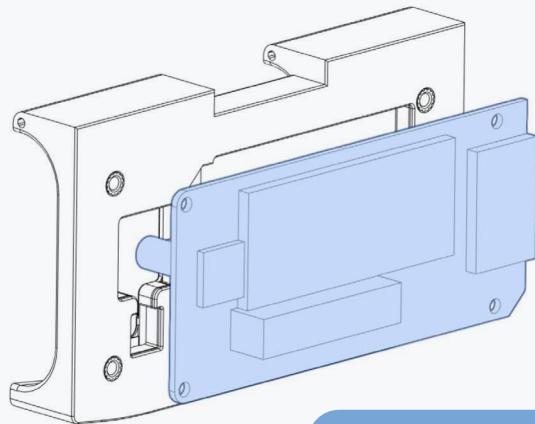


60x20 Fan

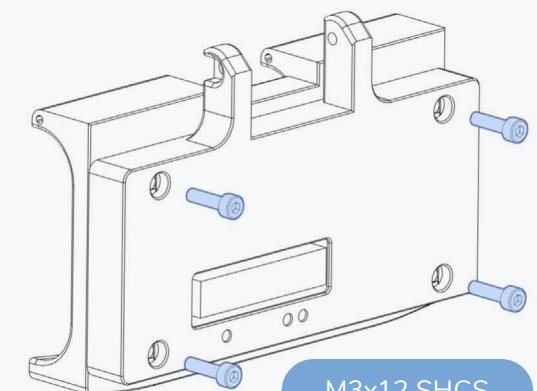
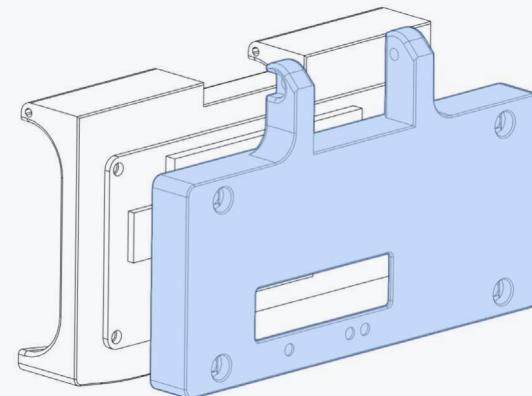


Heat Set Insert

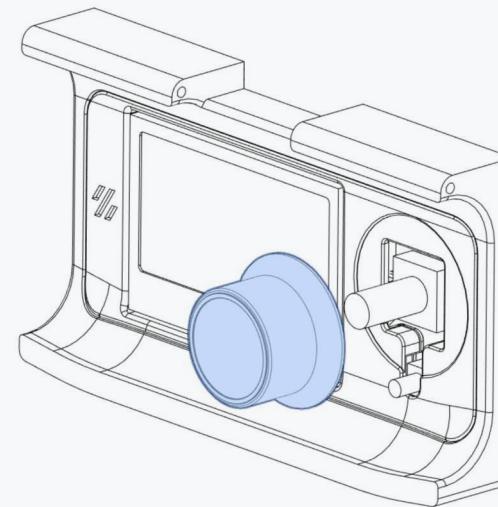
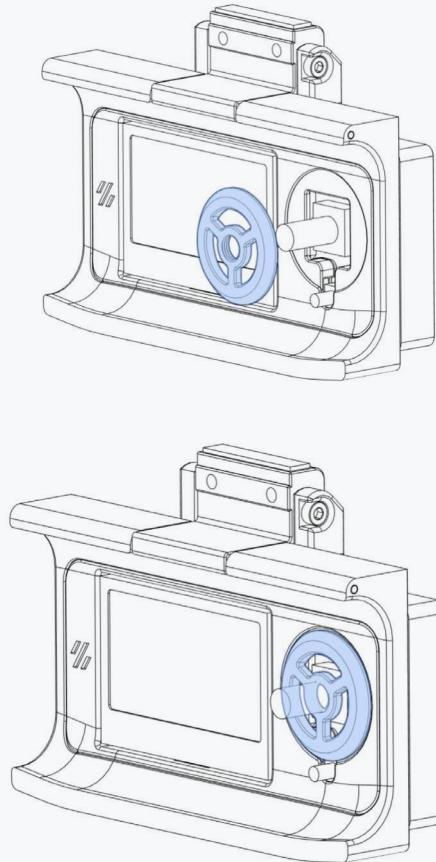




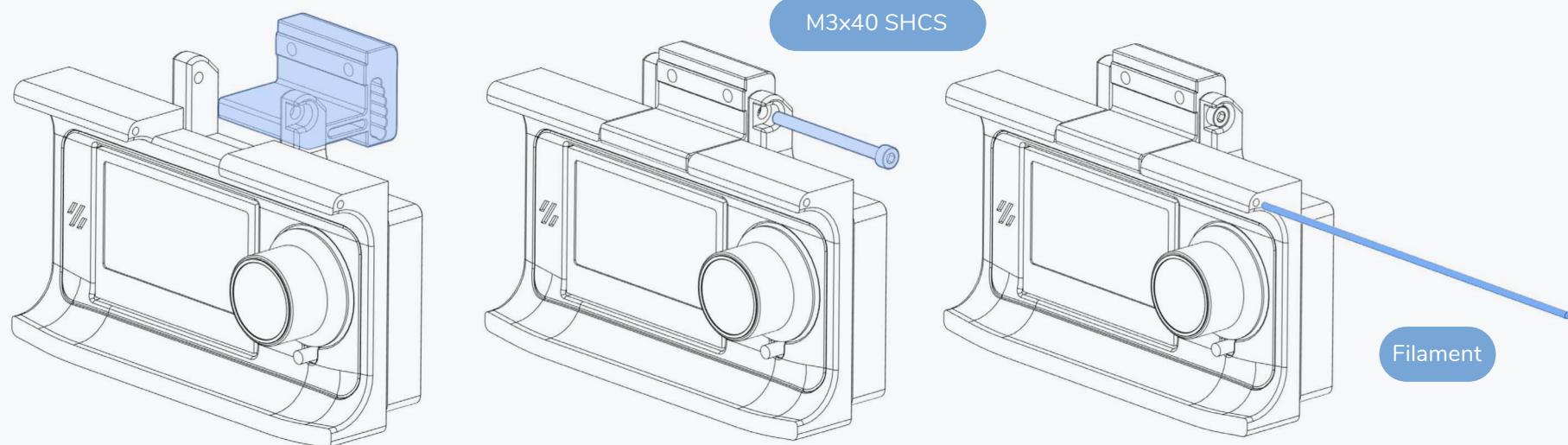
Mini 12864 Screen

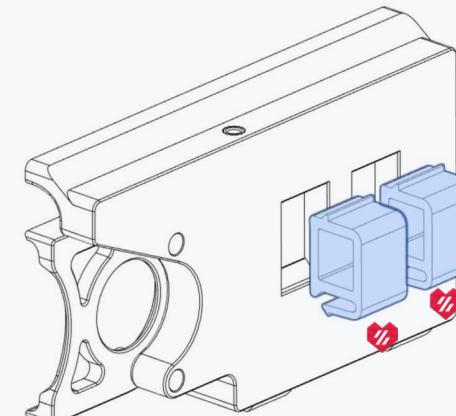
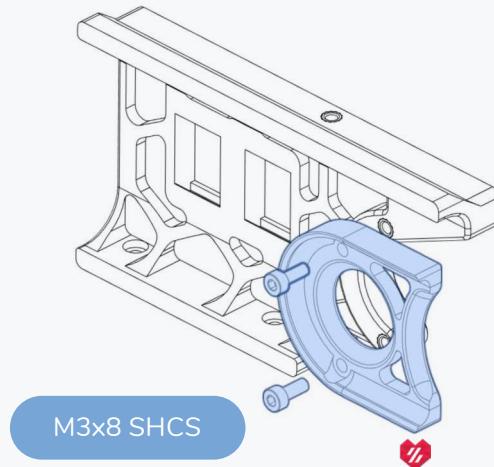
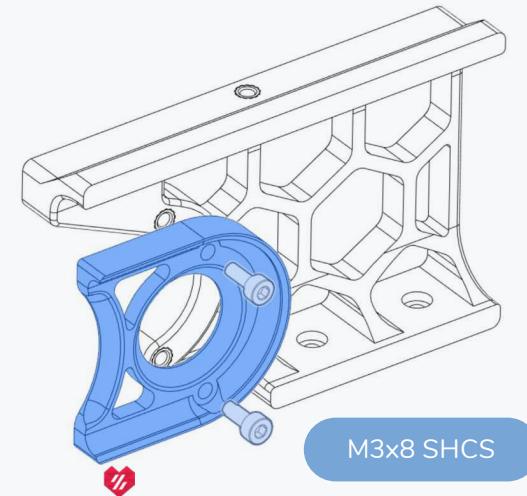
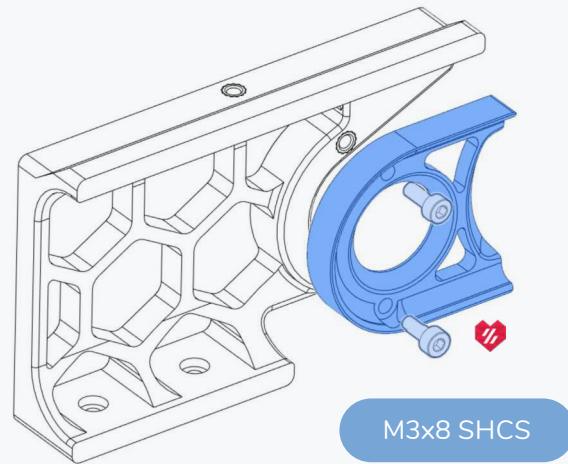


M3x12 SHCS

**OPTION: LIGHT BLOCKER**

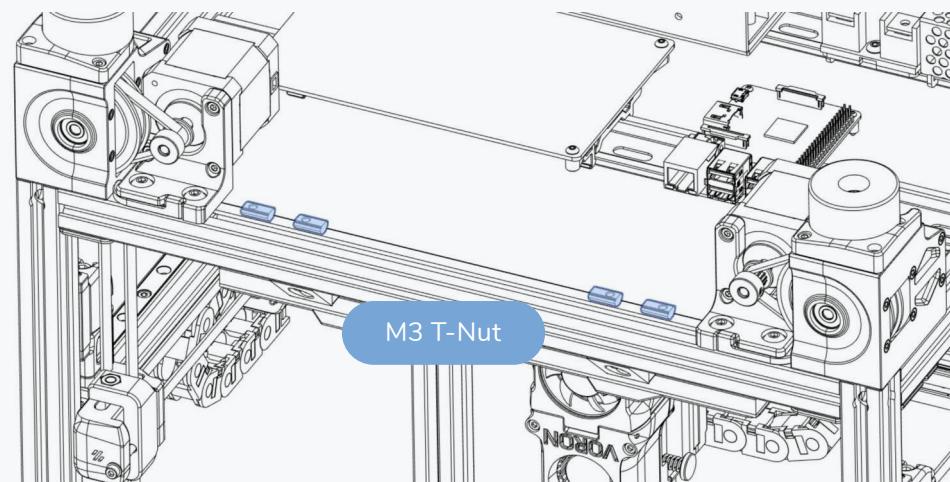
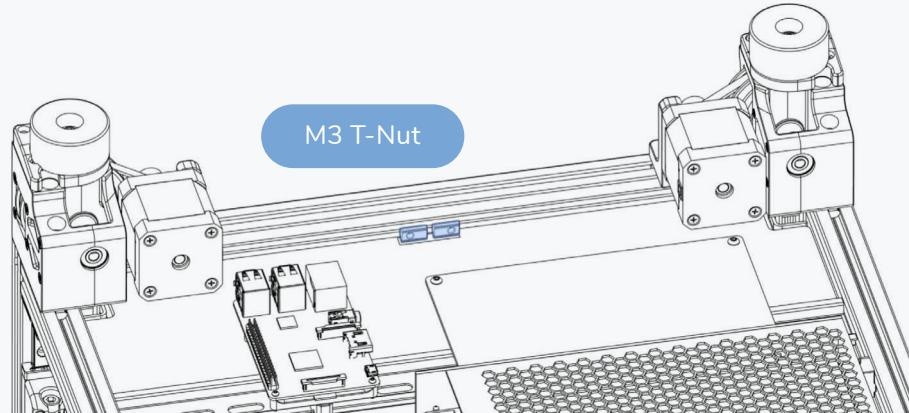
Some LCDs come with a smaller encoder knob. This extra piece prevents excess light bleed. Threads onto the encoder before the knob is pressed on.

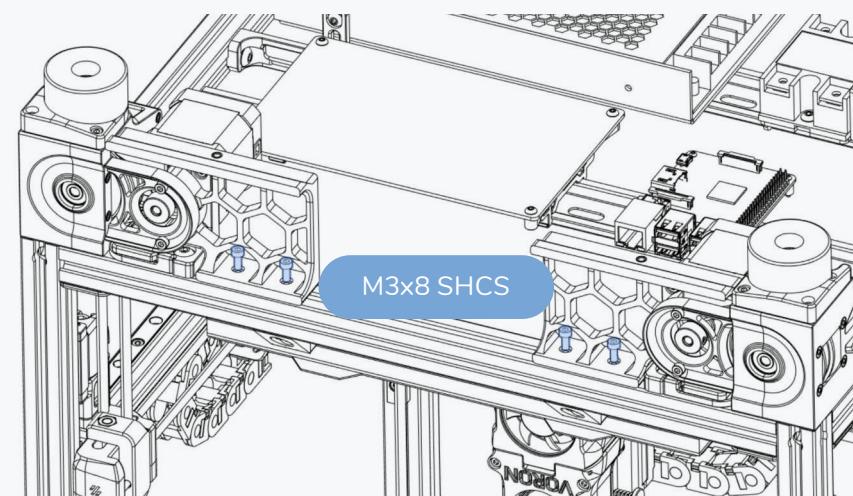
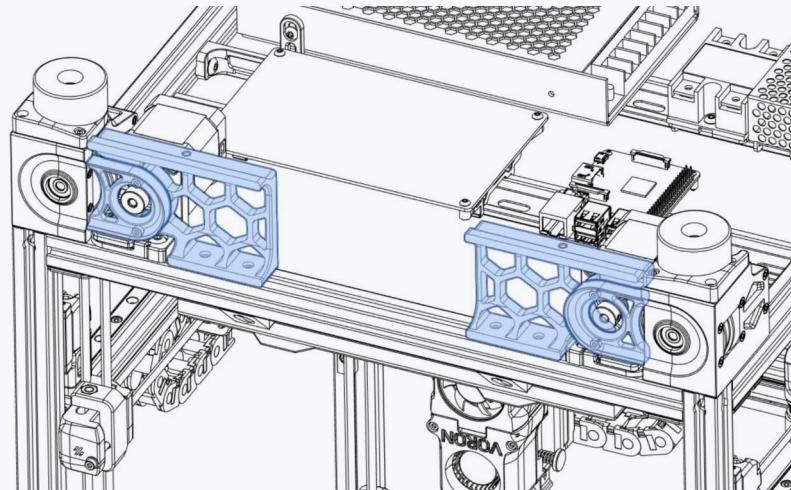


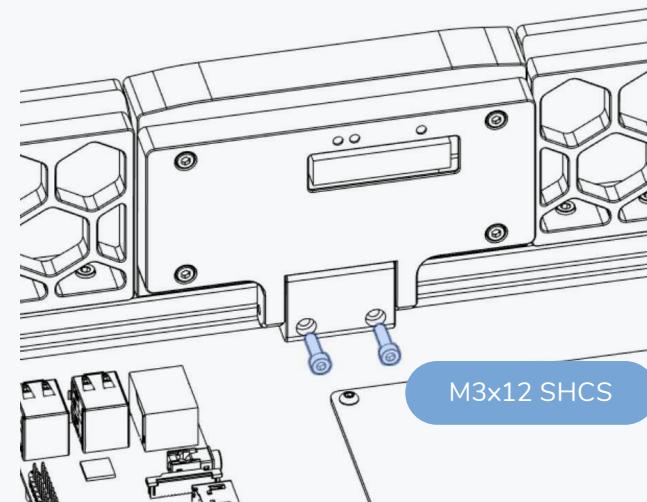
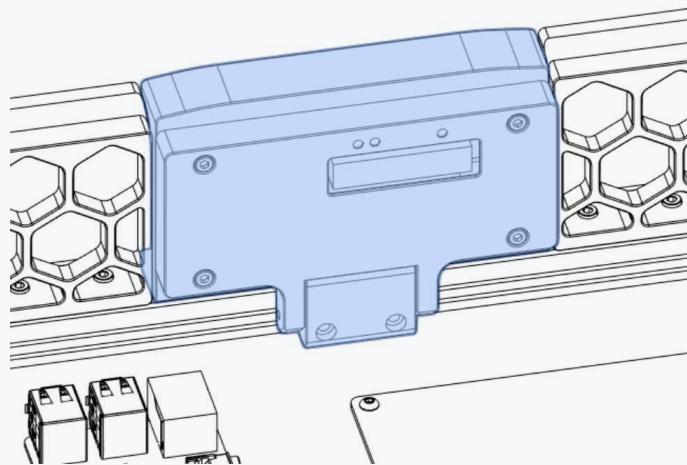


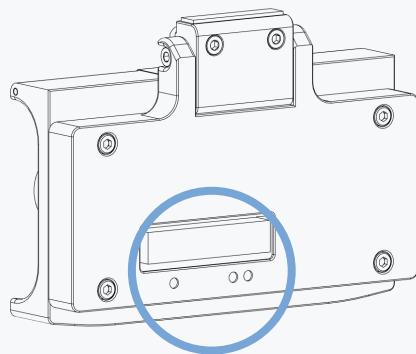
OPTION: KEYSTONE INSERTS
The picture is showing blanks
for the keystone slots.

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

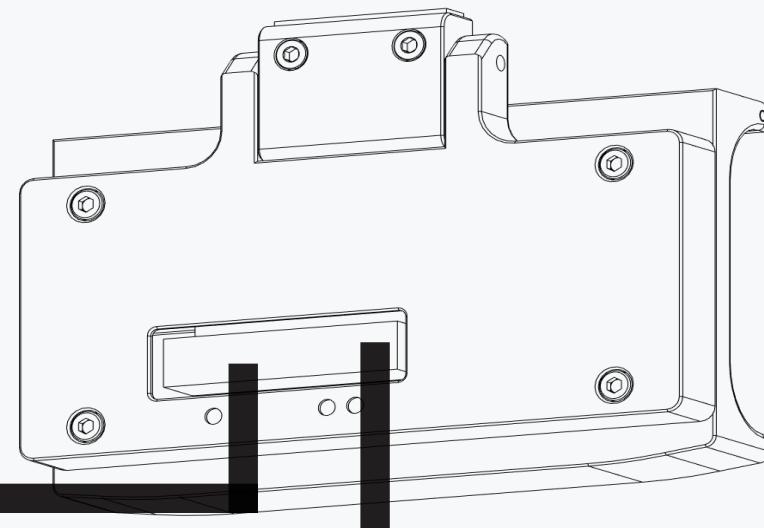






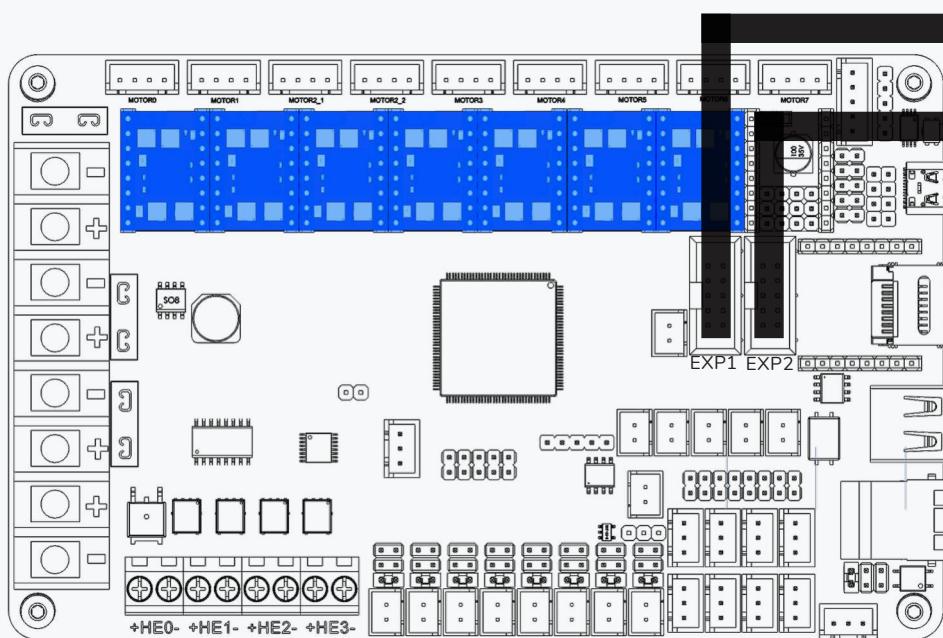
**WHICH IS WHICH?**

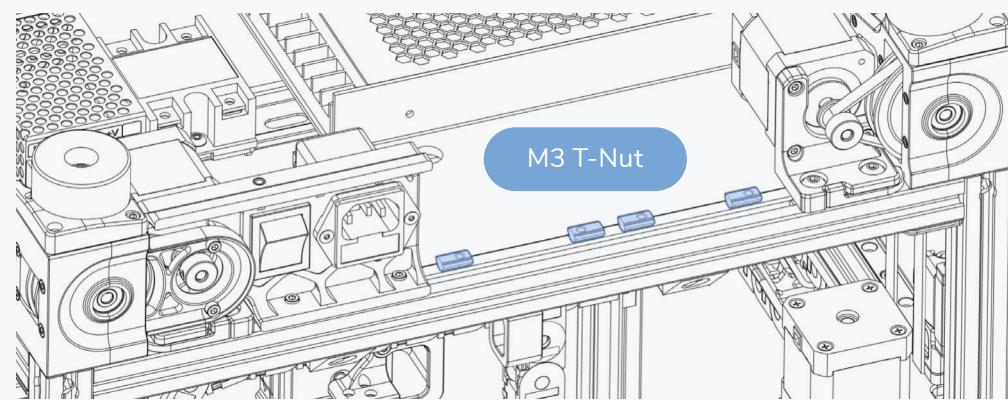
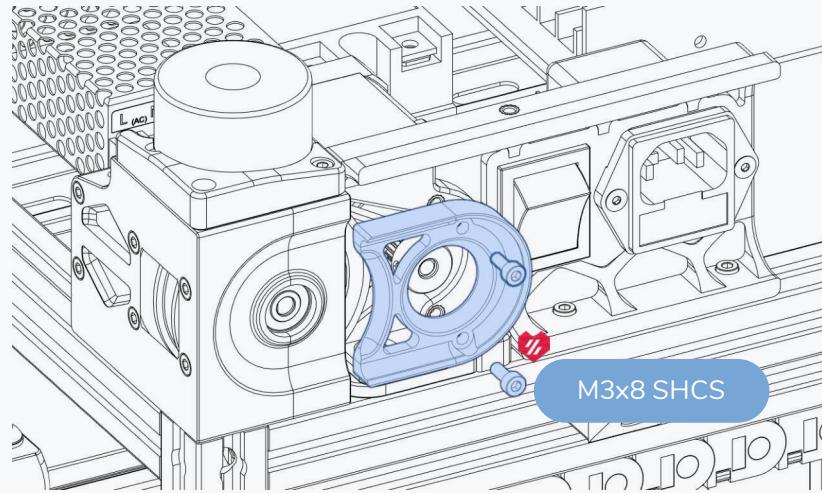
The socket with 1 dot below it is EXP1 and the socket with 2 dots below it is EXP2.



LCD

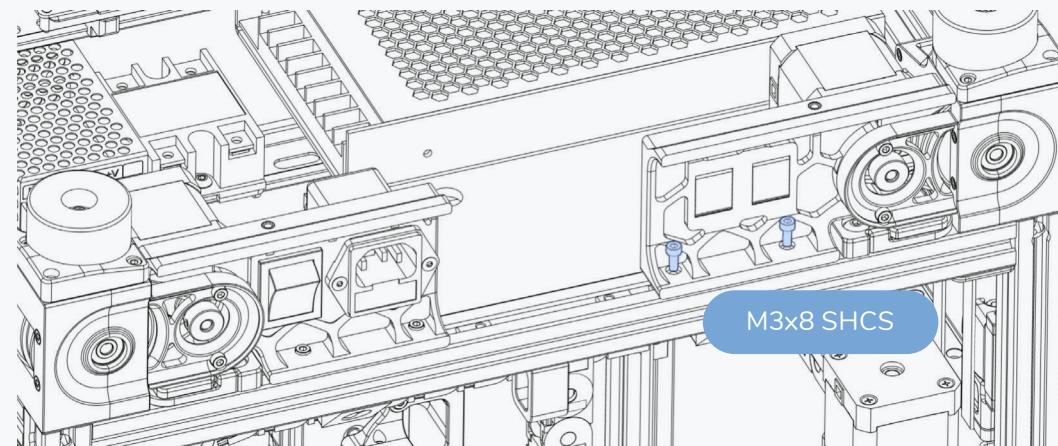
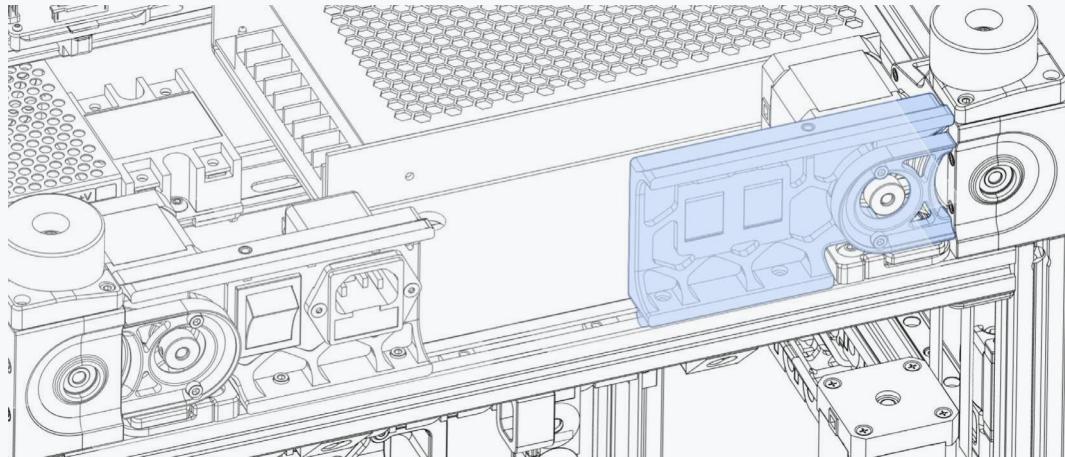
2x Flat Ribbon Cable





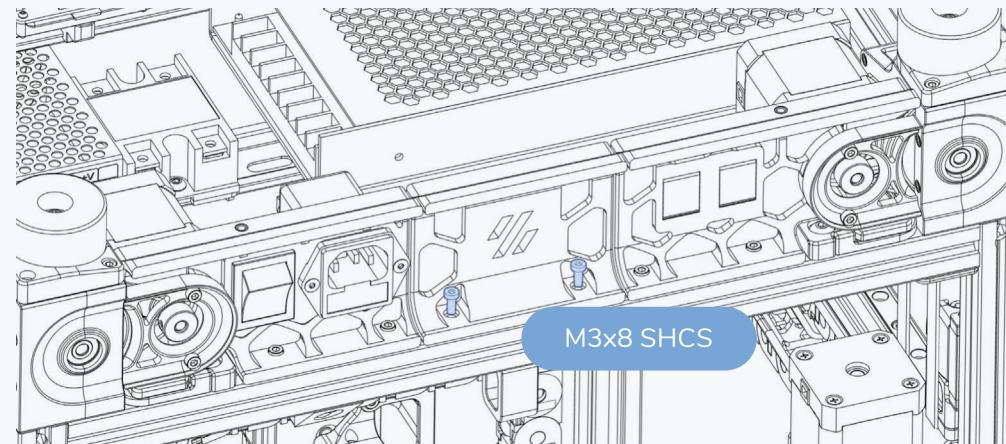
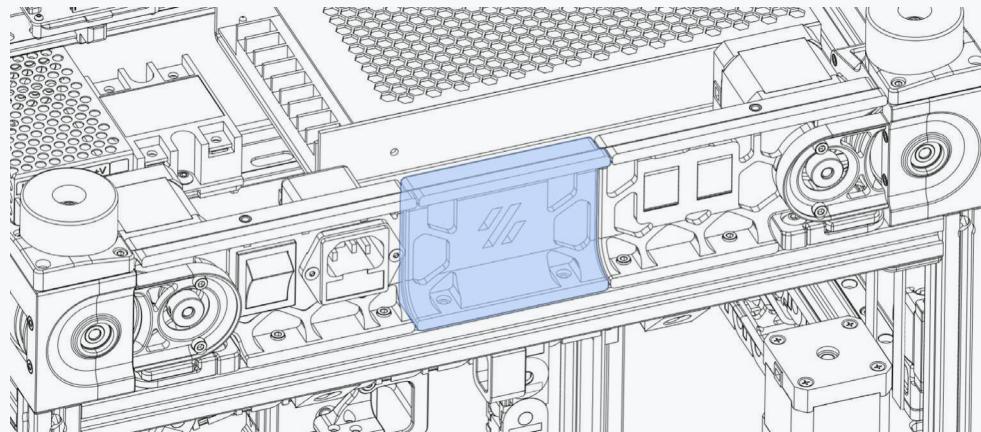
SKIRTS

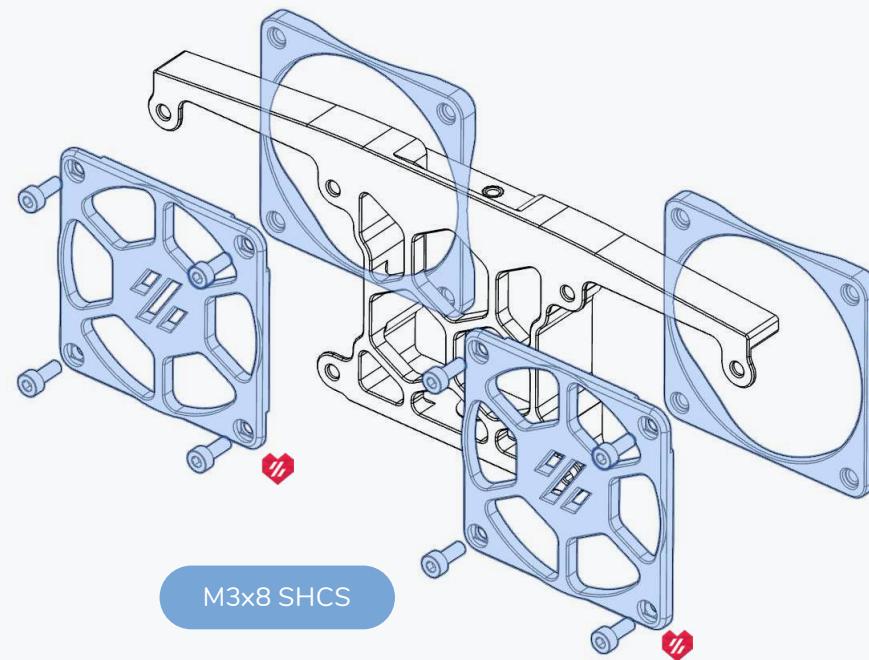
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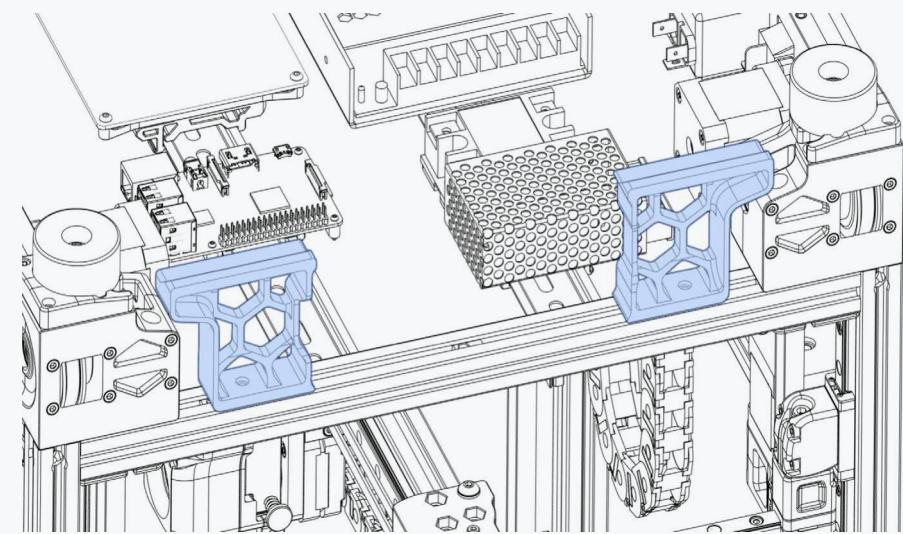
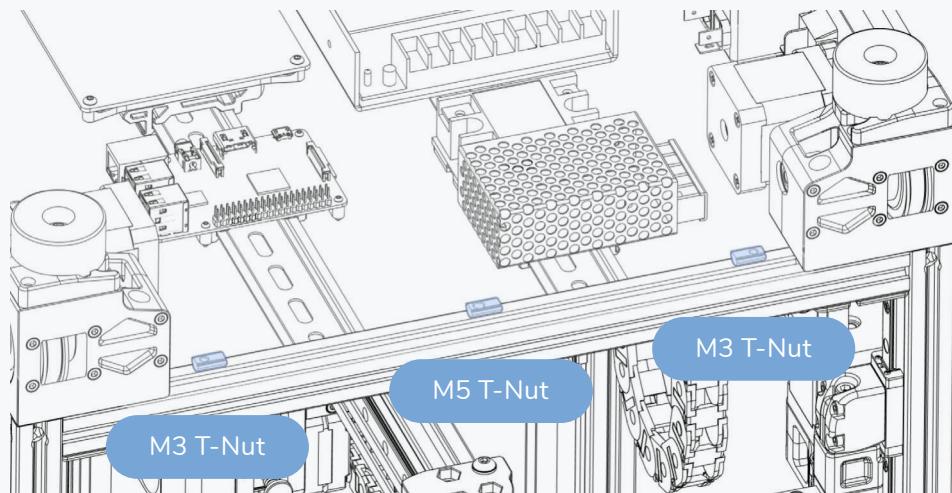


SKIRTS

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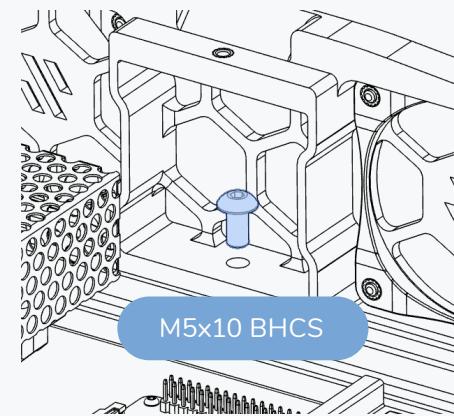
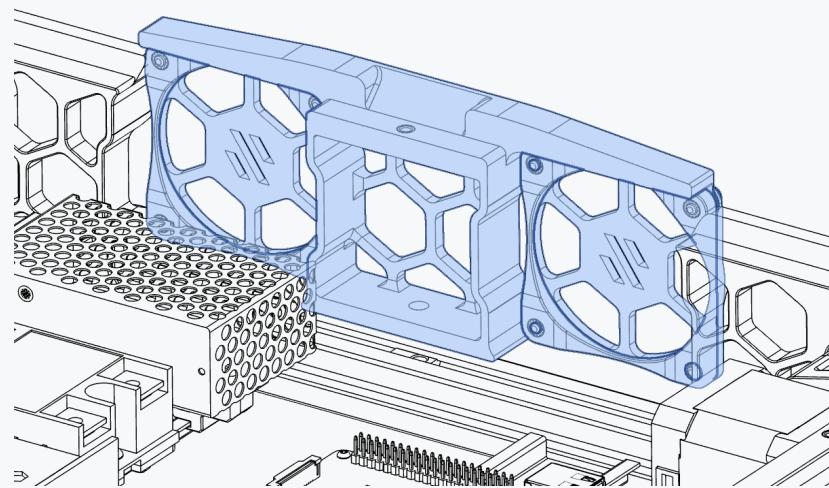
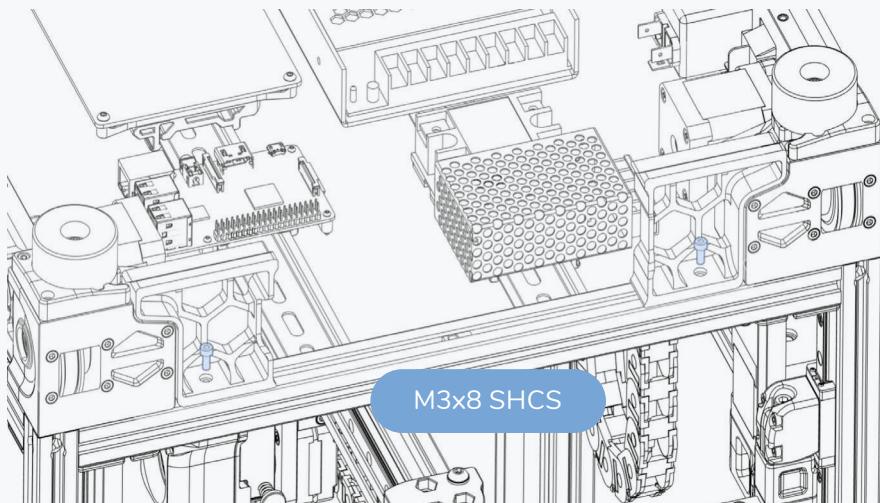


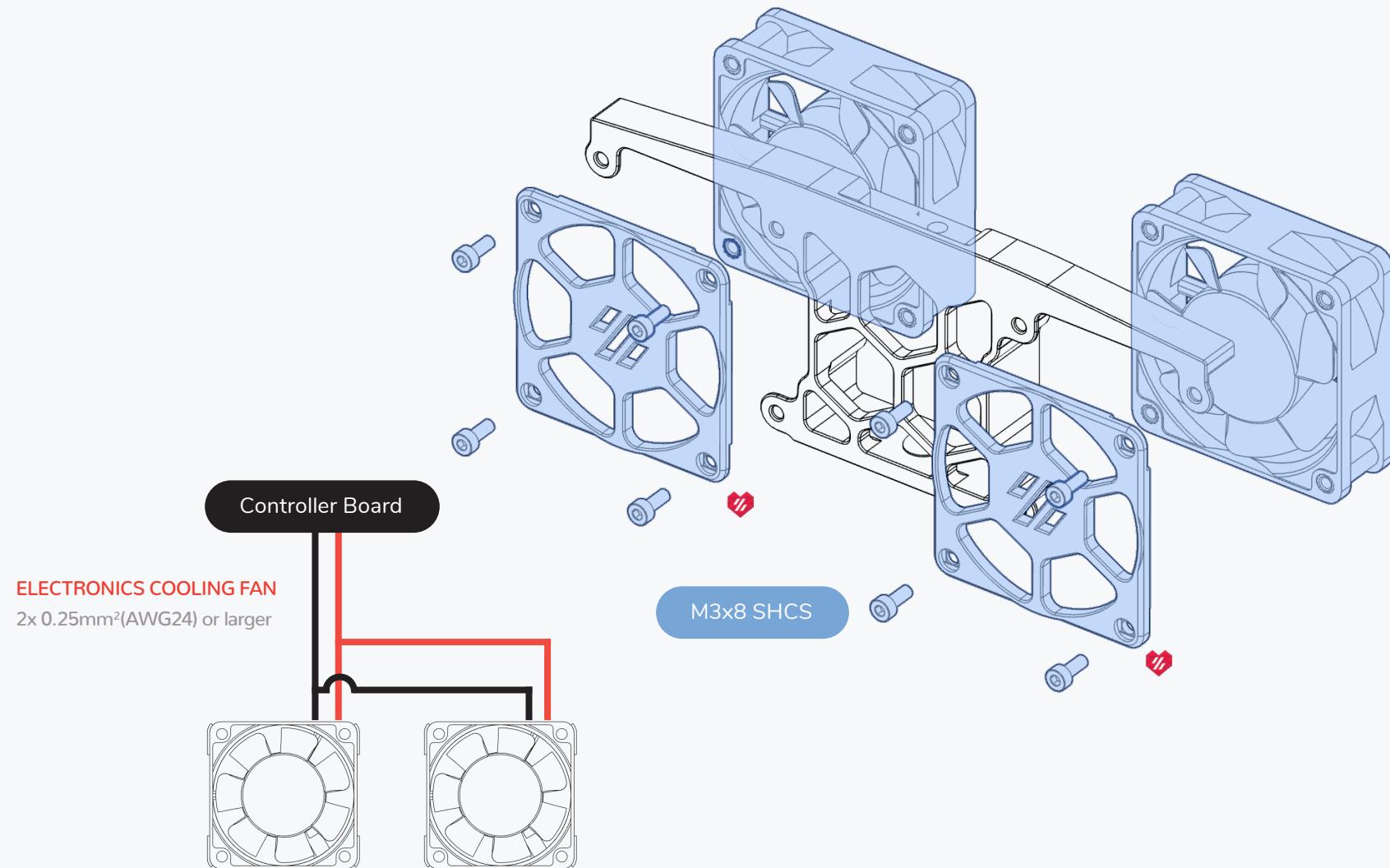




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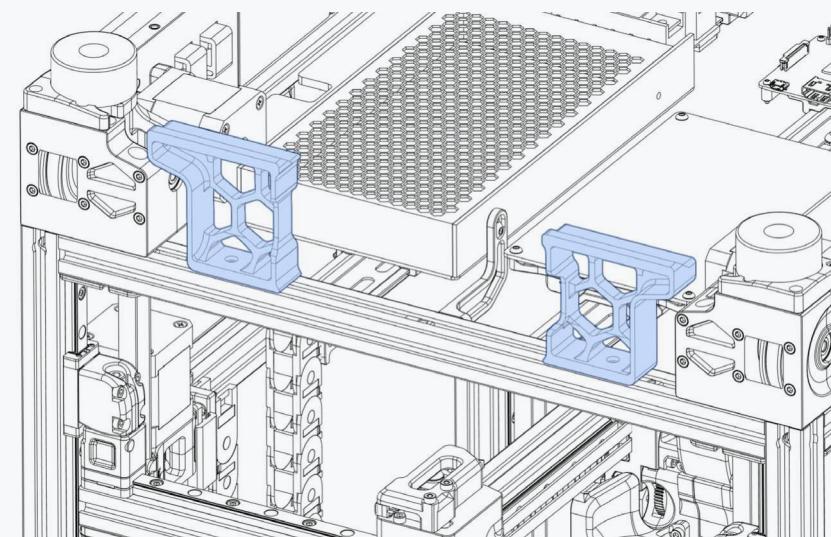
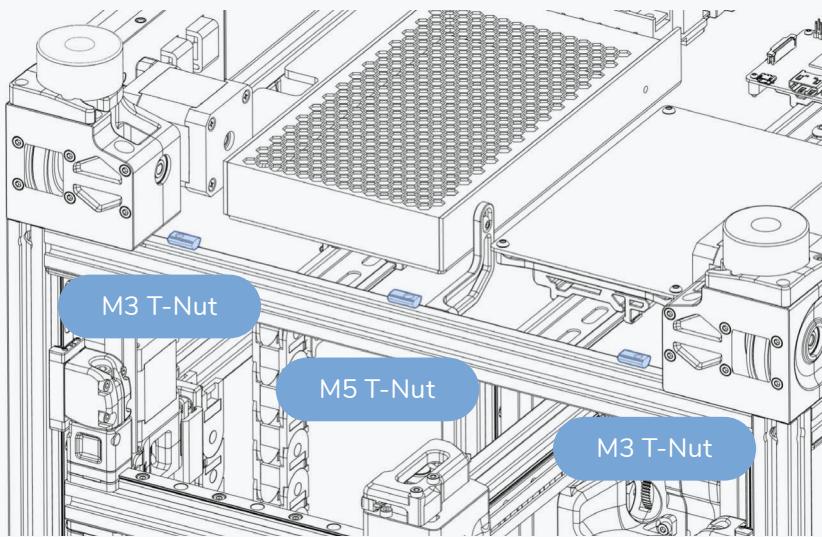
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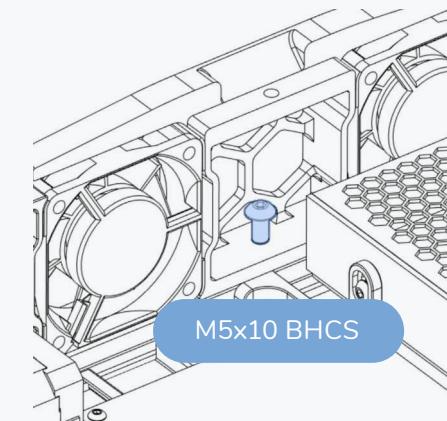
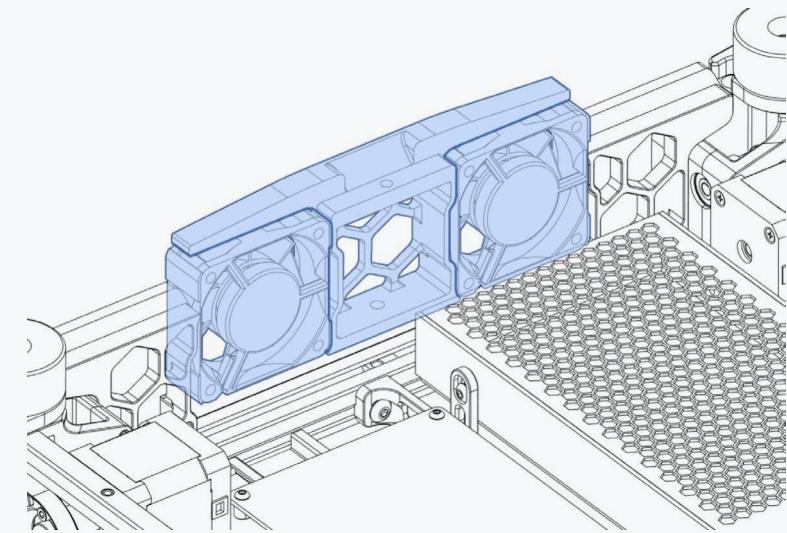
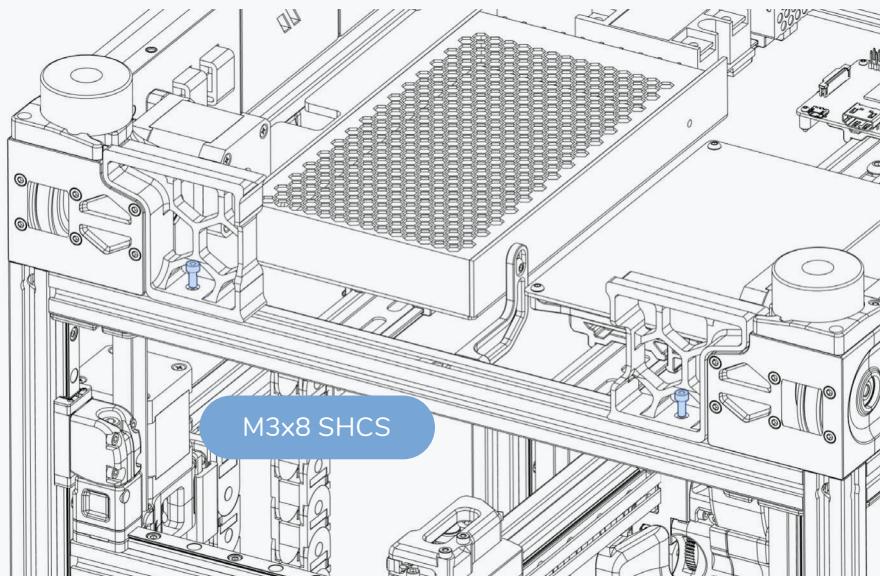
SKIRTS

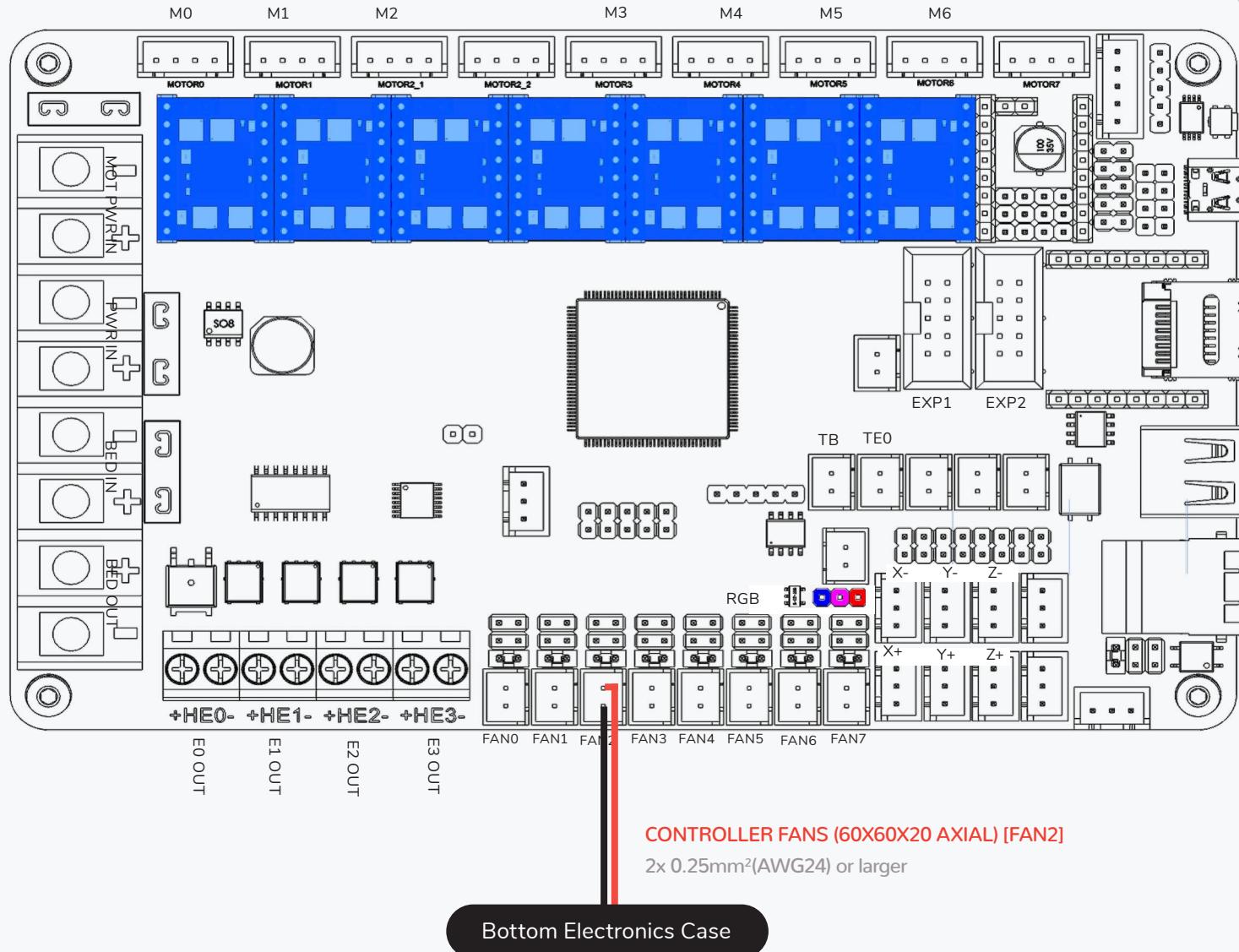
WWW.VORONDESIGN.COM

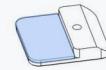
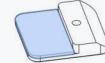


SKIRTS

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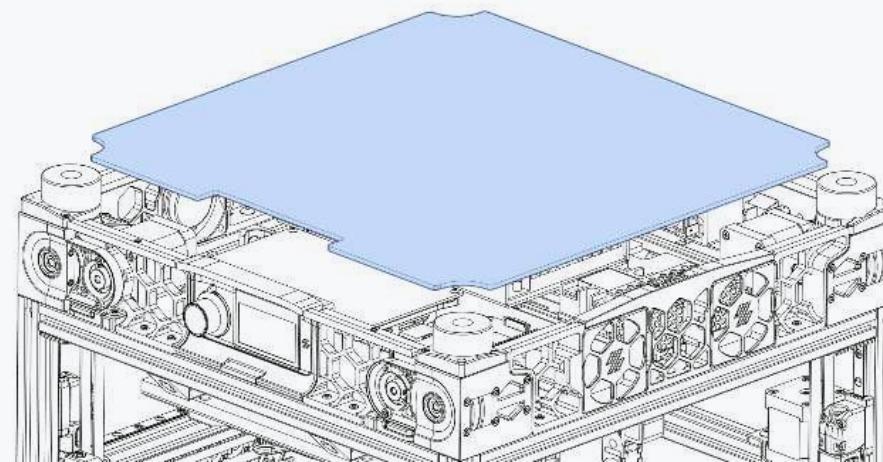
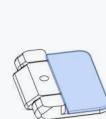


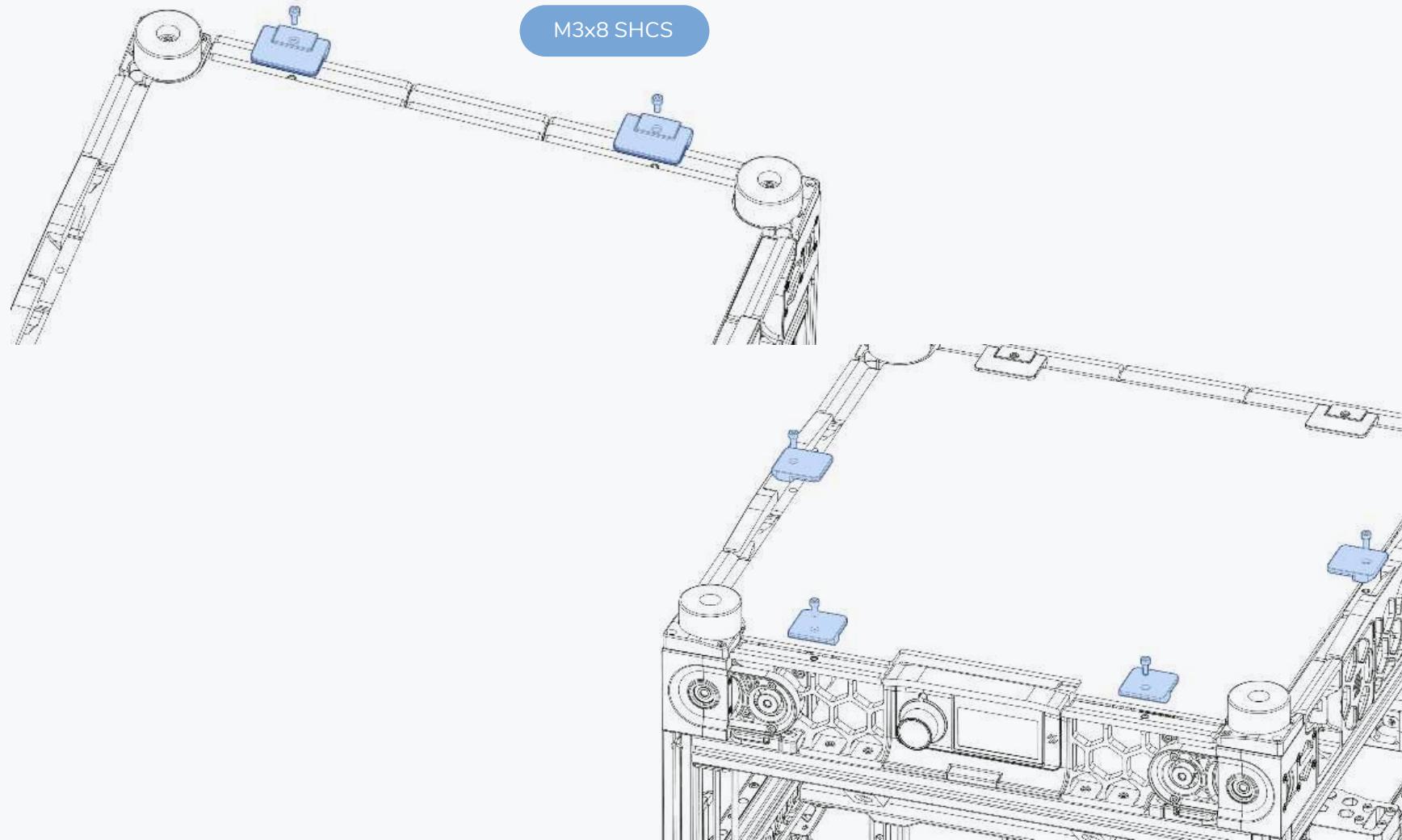


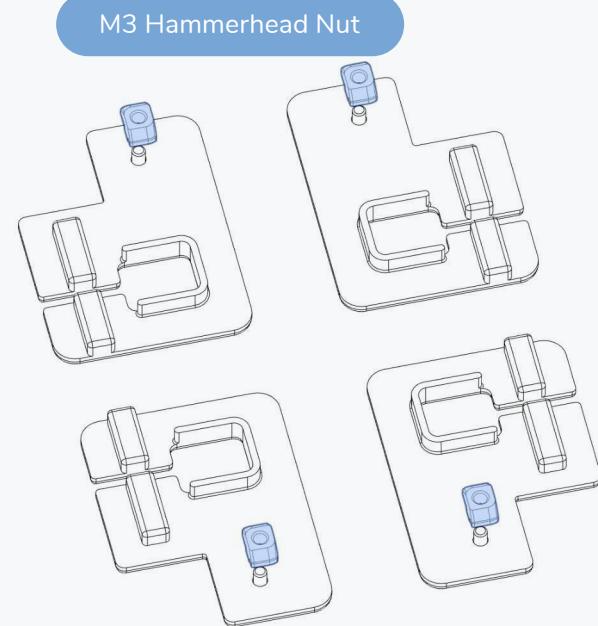
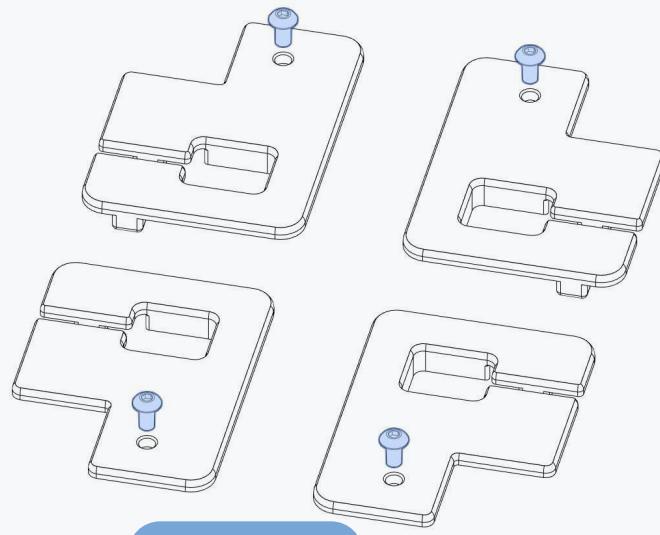


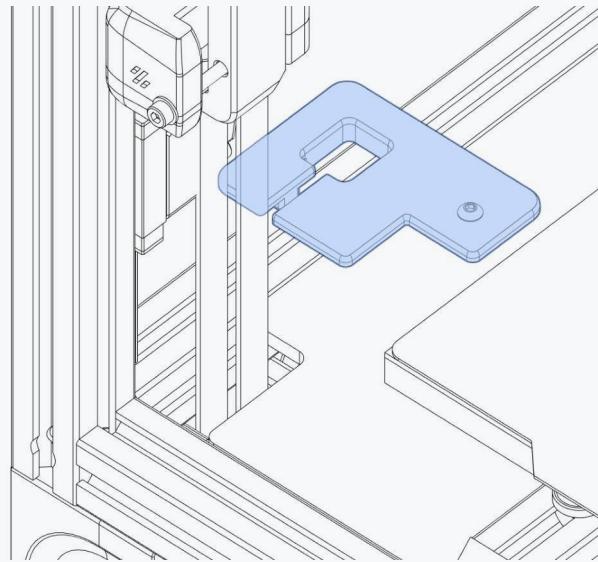
APPLY VHB TAPE

VHB Tape is a double sided adhesive tape.



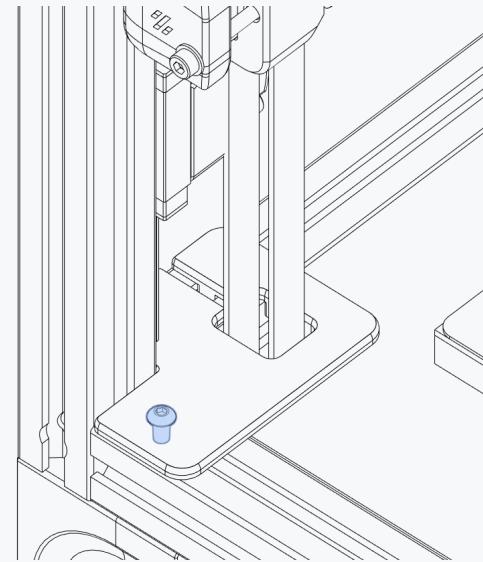
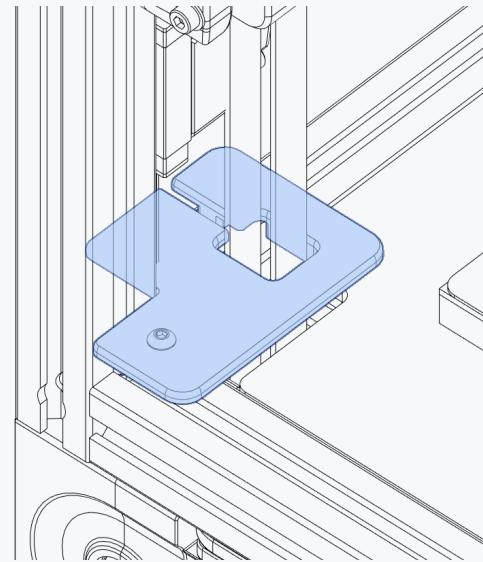






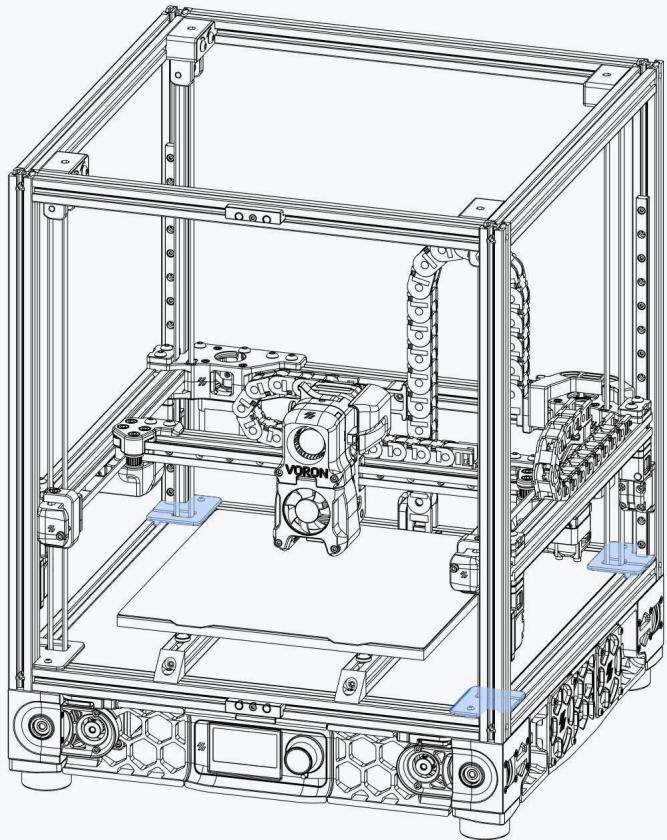
PINCH BELT

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

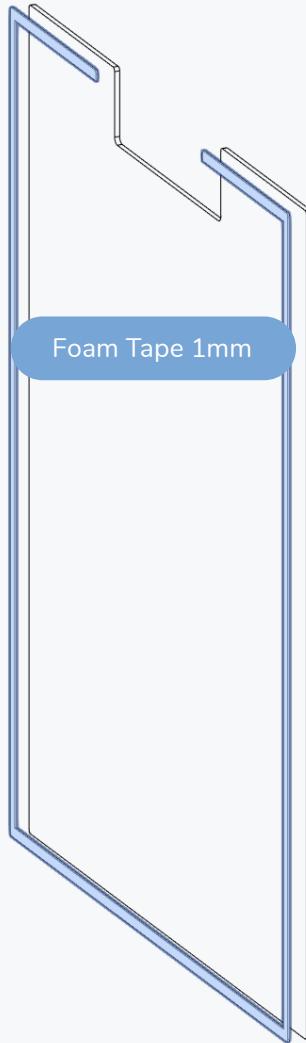
Repeat the assembly steps and install the remaining 3 covers.

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.

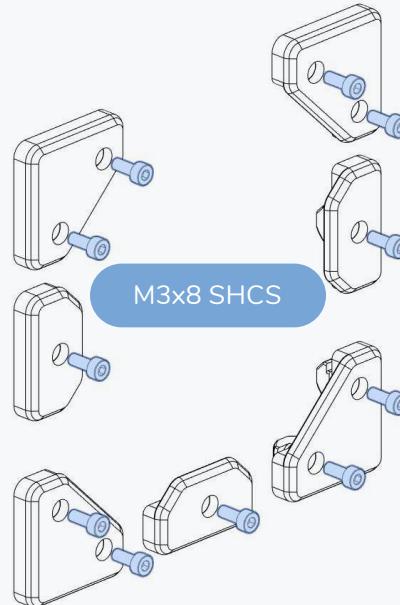
PANELS

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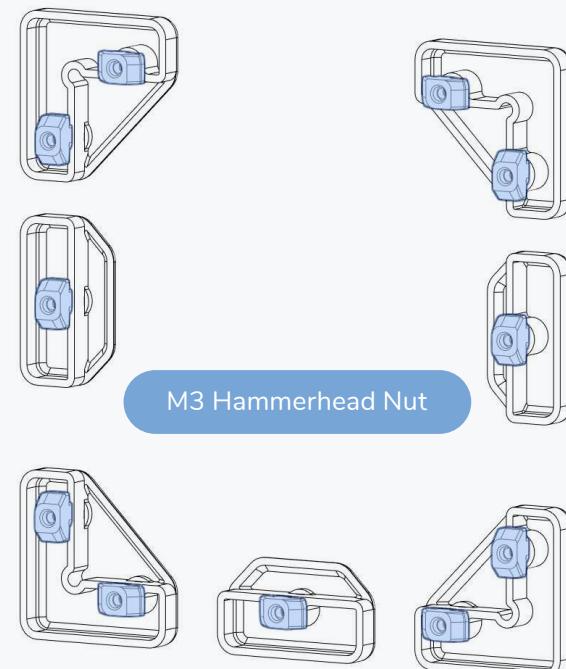


**APPLY FOAM TAPE**

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

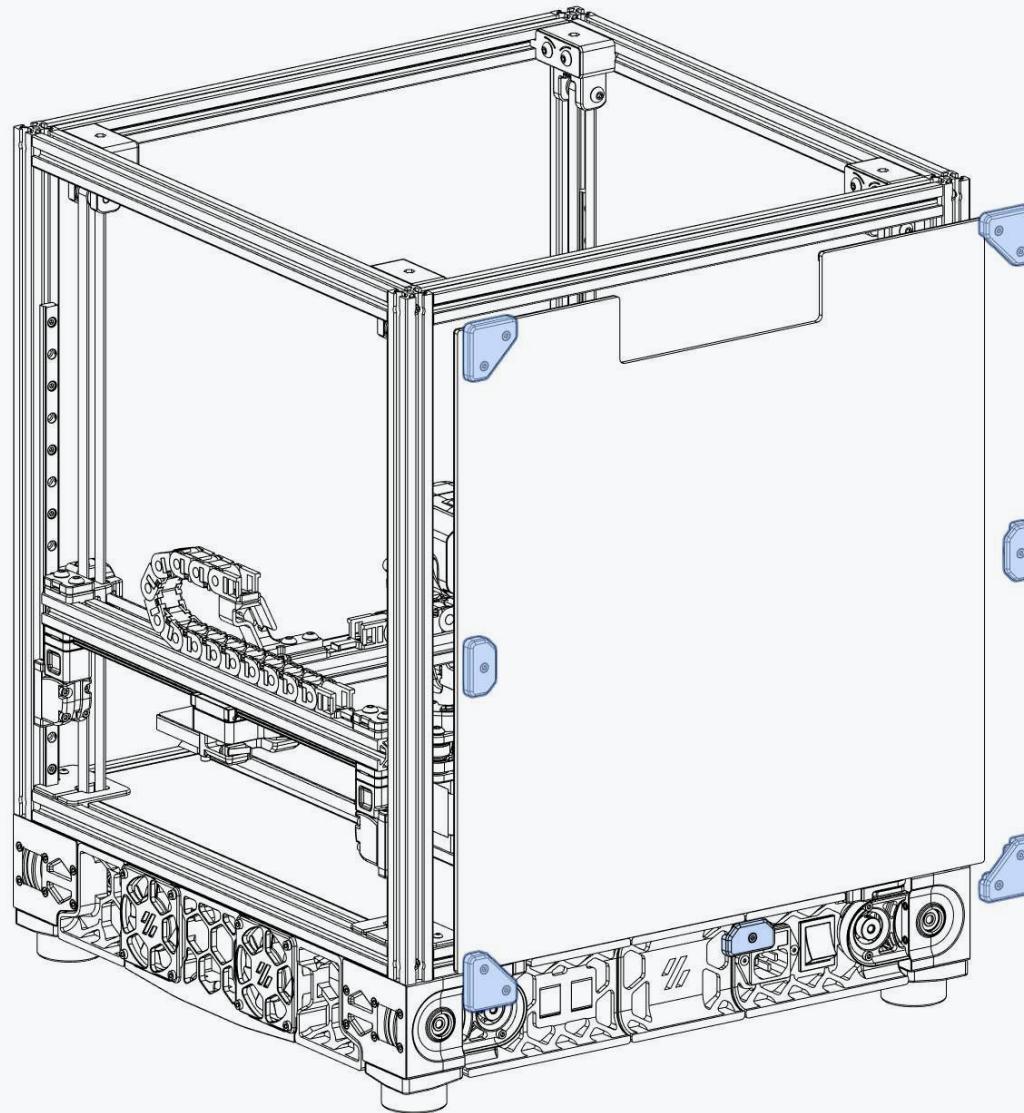
**HAMMERHEAD NUTS?**

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.



BACK PANEL

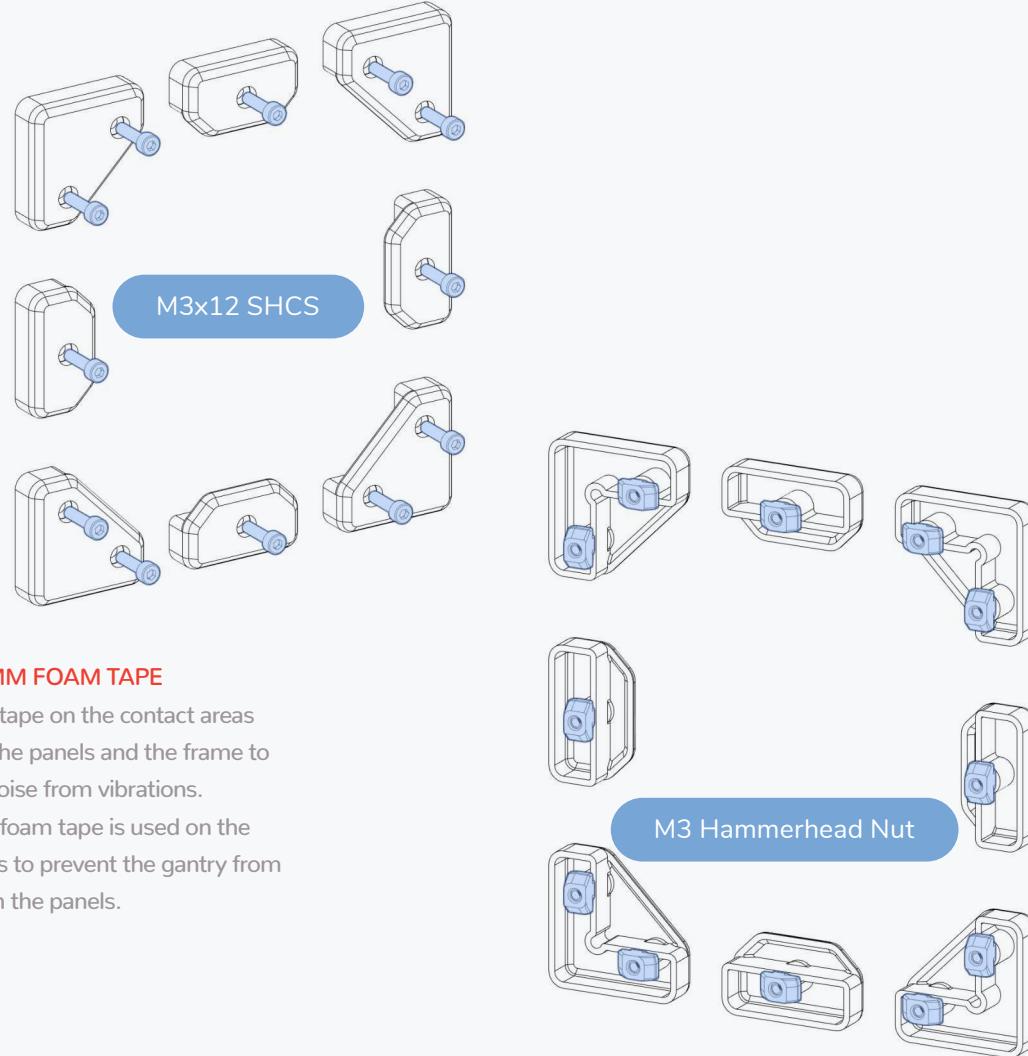
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**APPLY 3MM FOAM TAPE**

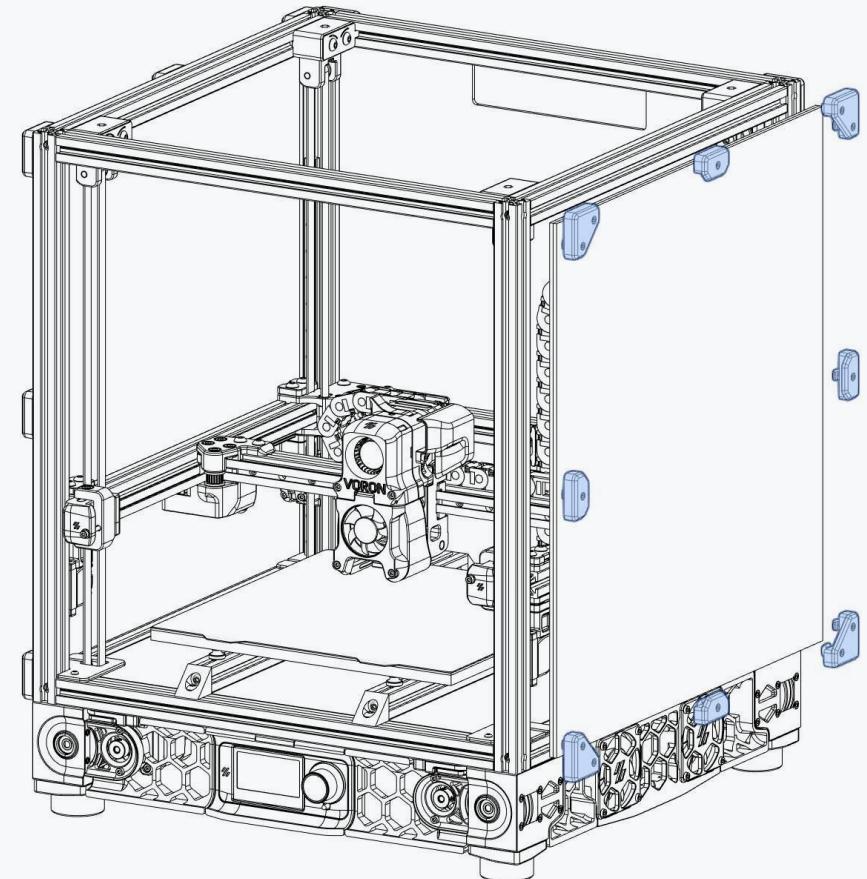
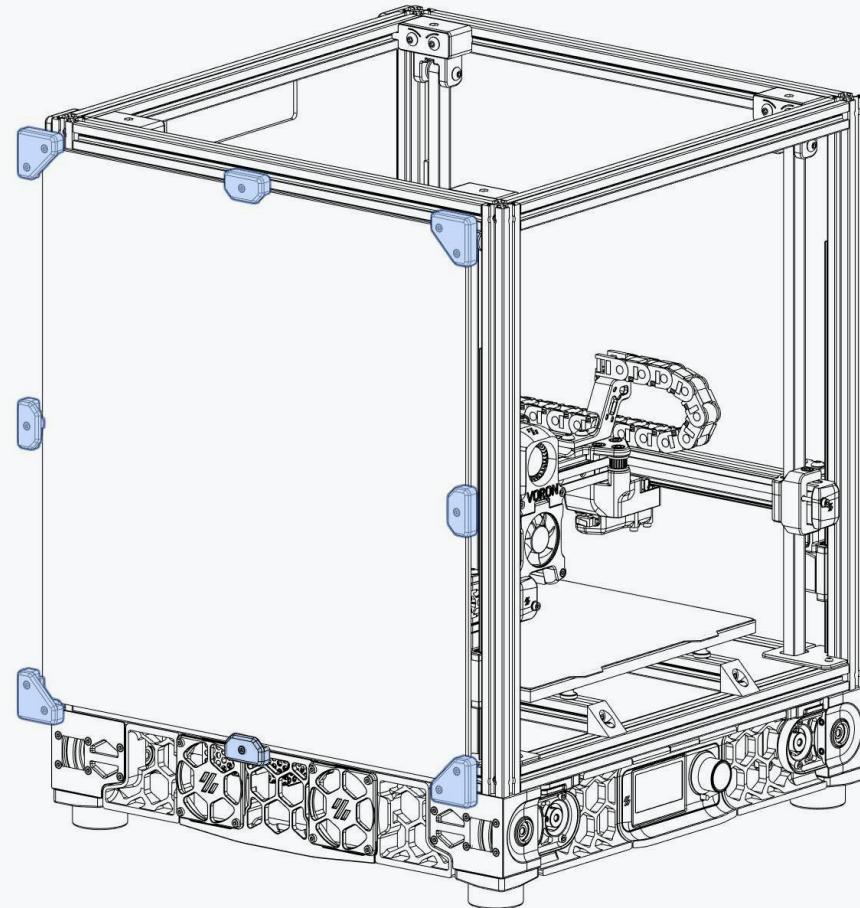
Use foam tape on the contact areas between the panels and the frame to mitigate noise from vibrations.

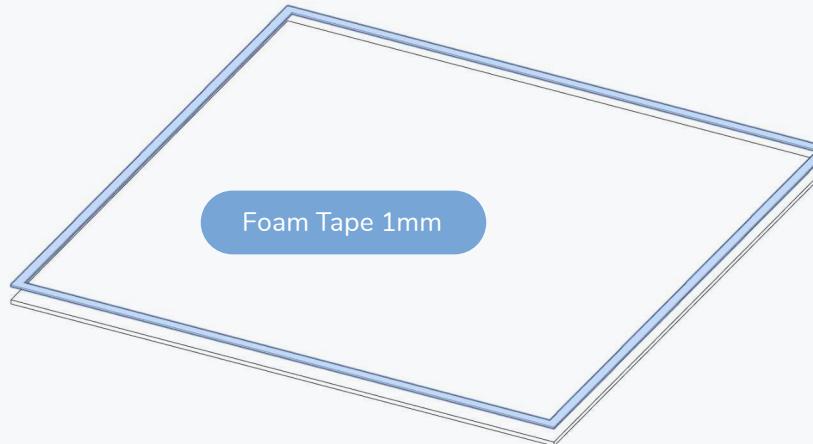
The 3mm foam tape is used on the side panels to prevent the gantry from rubbing on the panels.



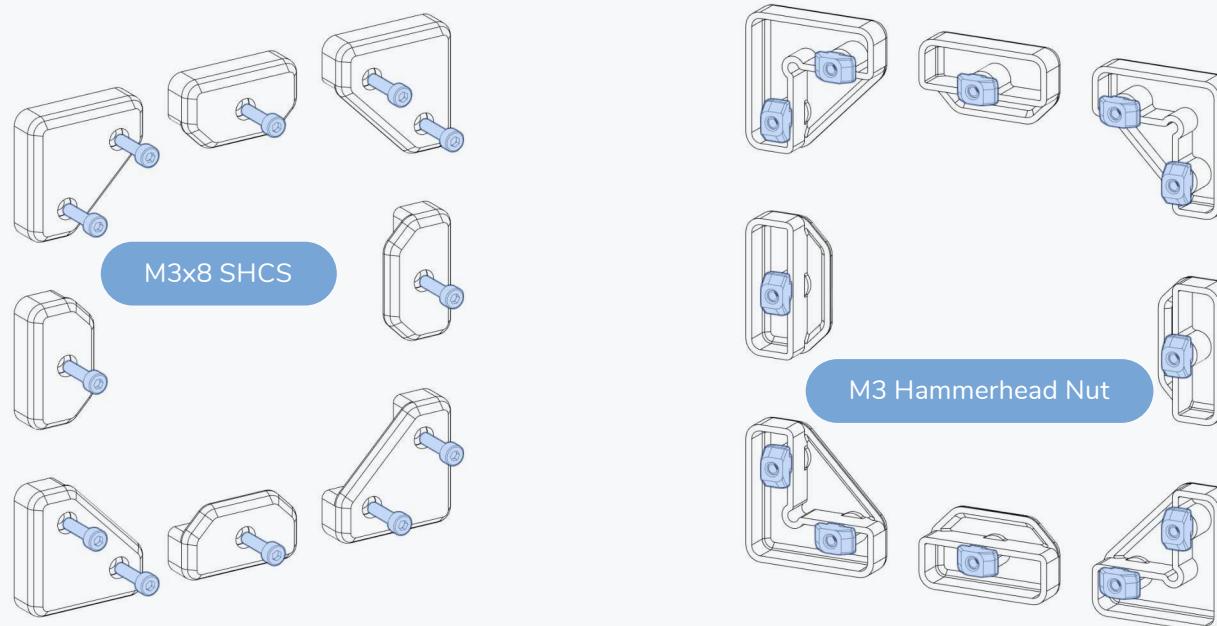
SIDE PANELS

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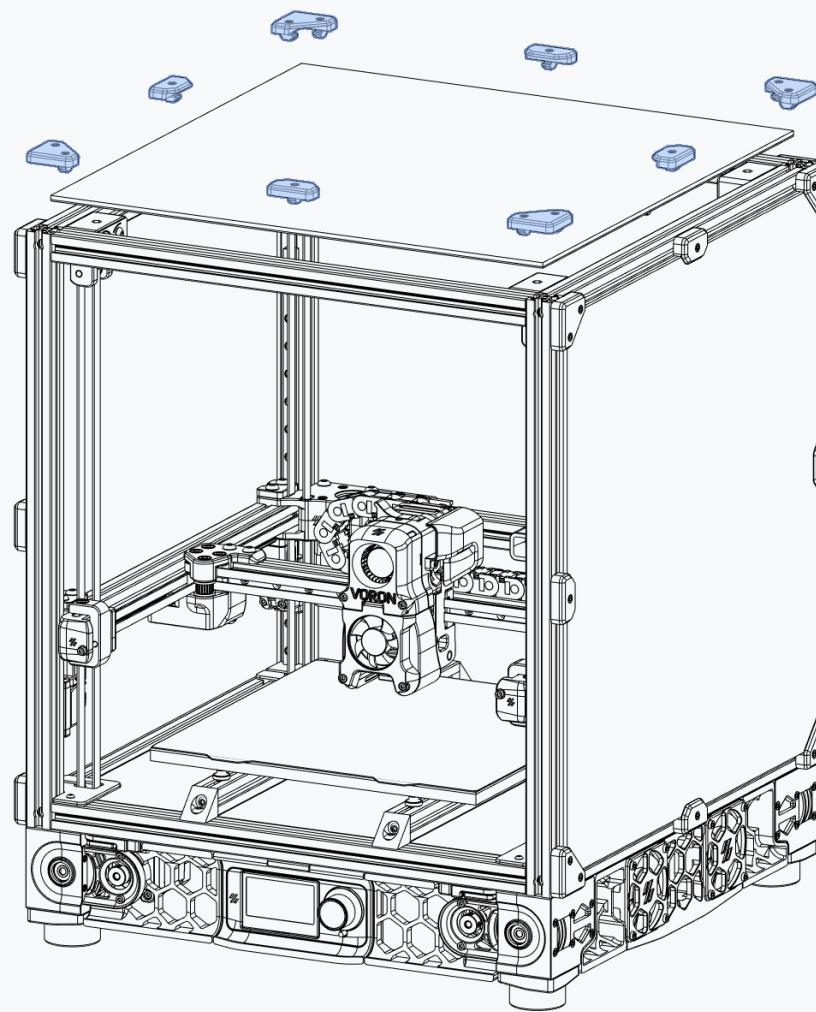
**APPLY FOAM TAPE**

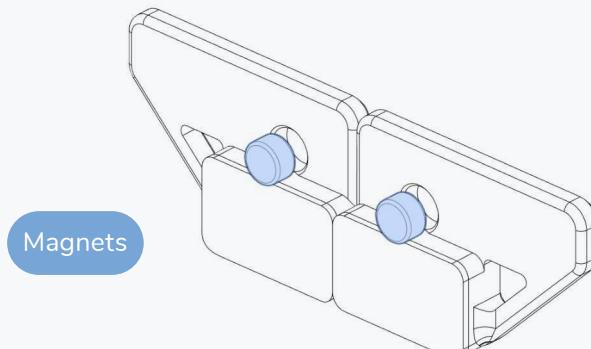
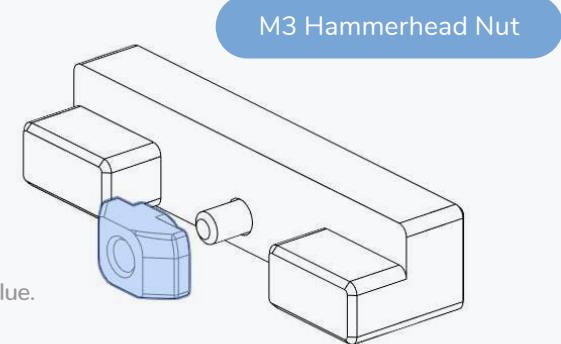
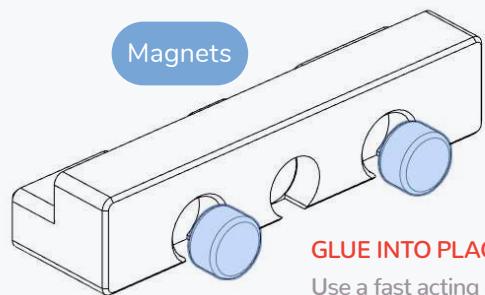
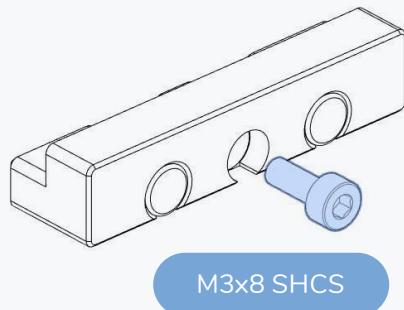
Use foam tape on the contact areas between the panels and the frame to mitigate noise from vibrations.



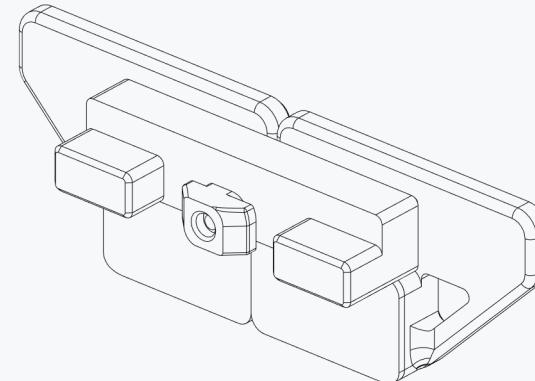
TOP PANEL

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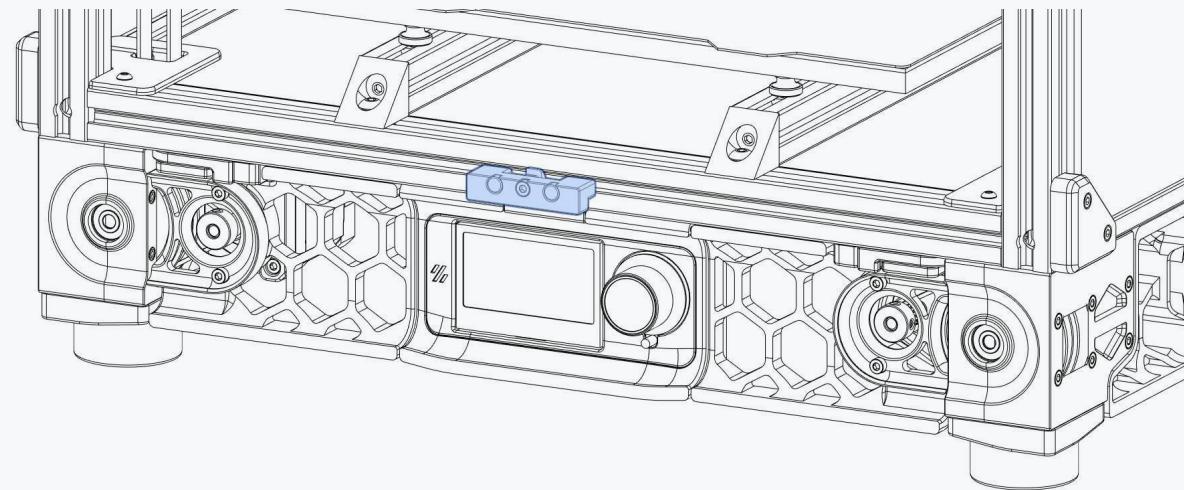
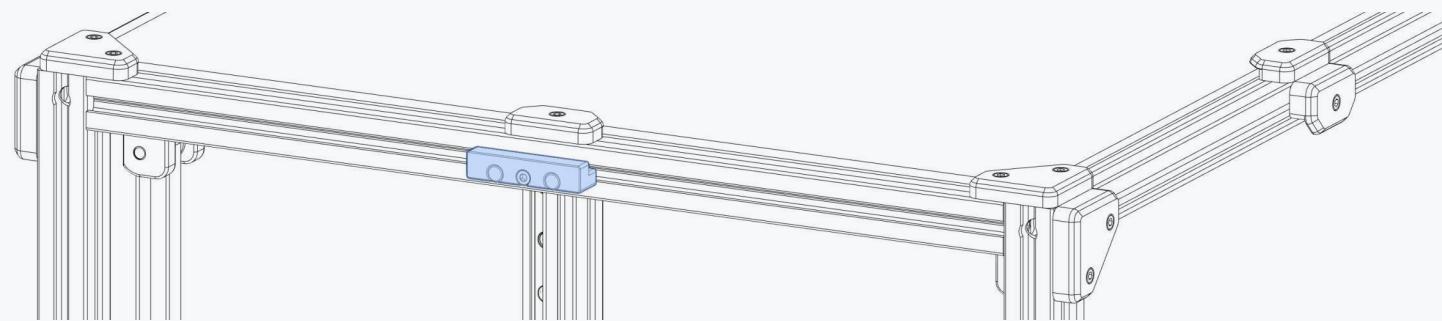
**MIND THE MAGNET POLARITY**

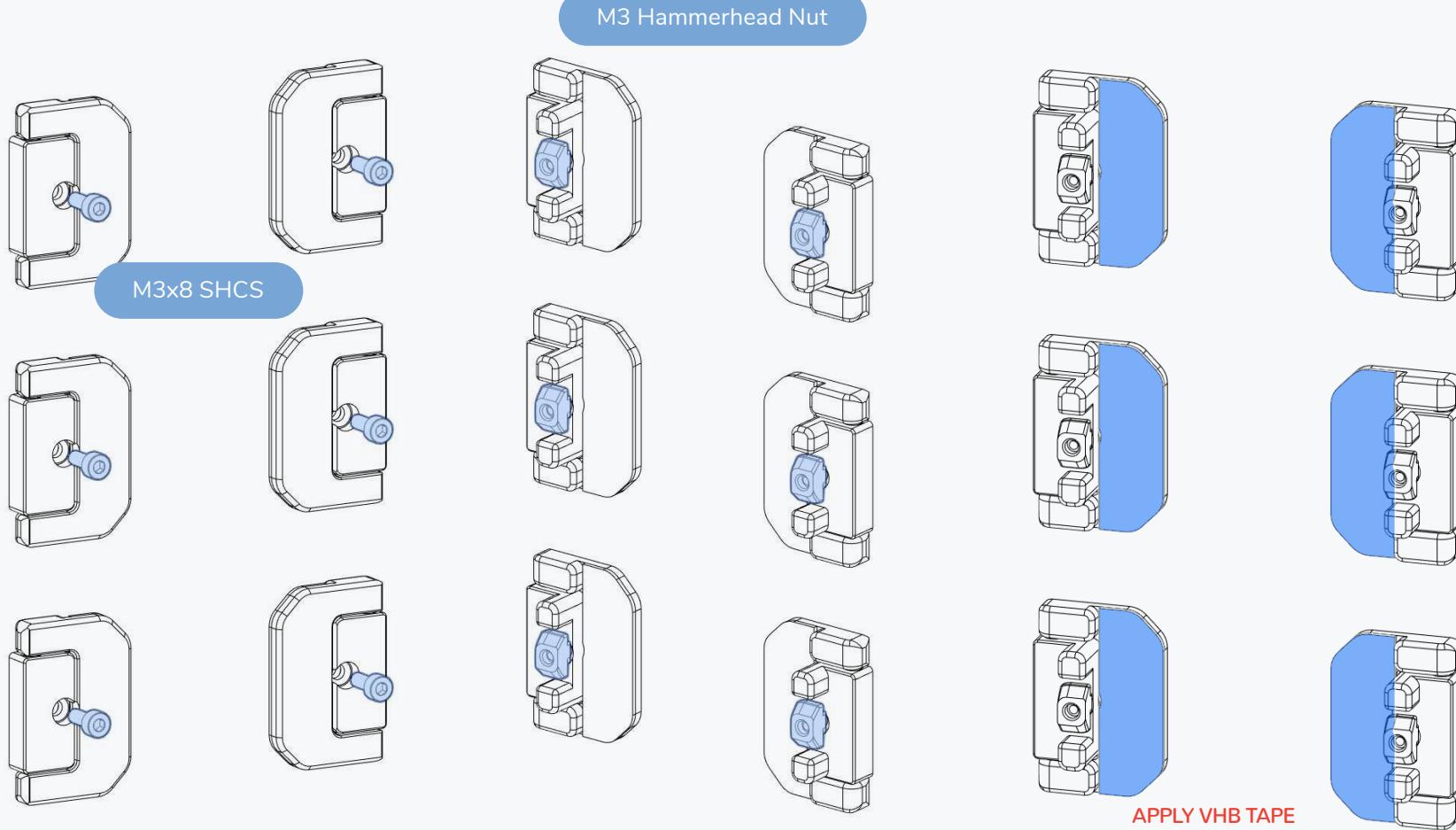
Ensure that the magnets are facing in the right direction prior to gluing them into place.



DOORS

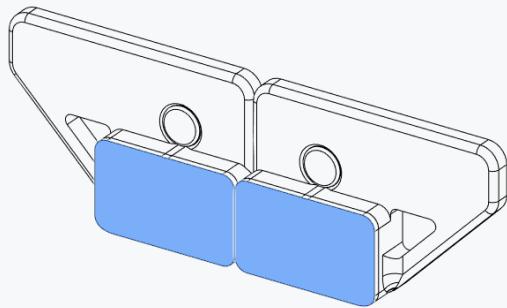
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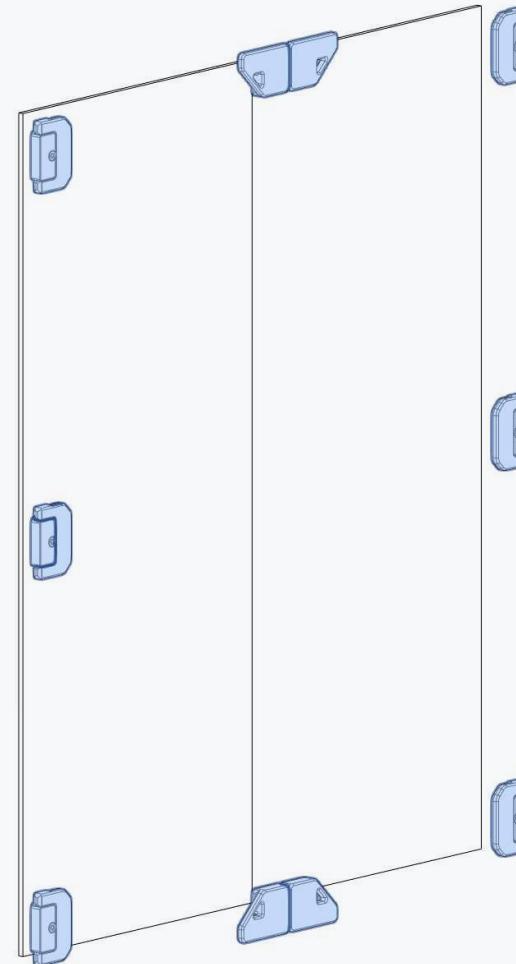
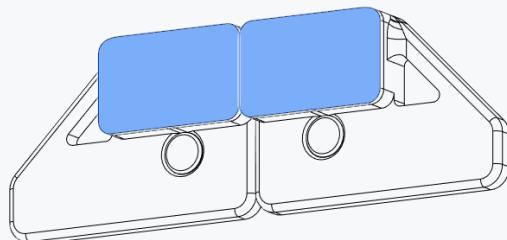


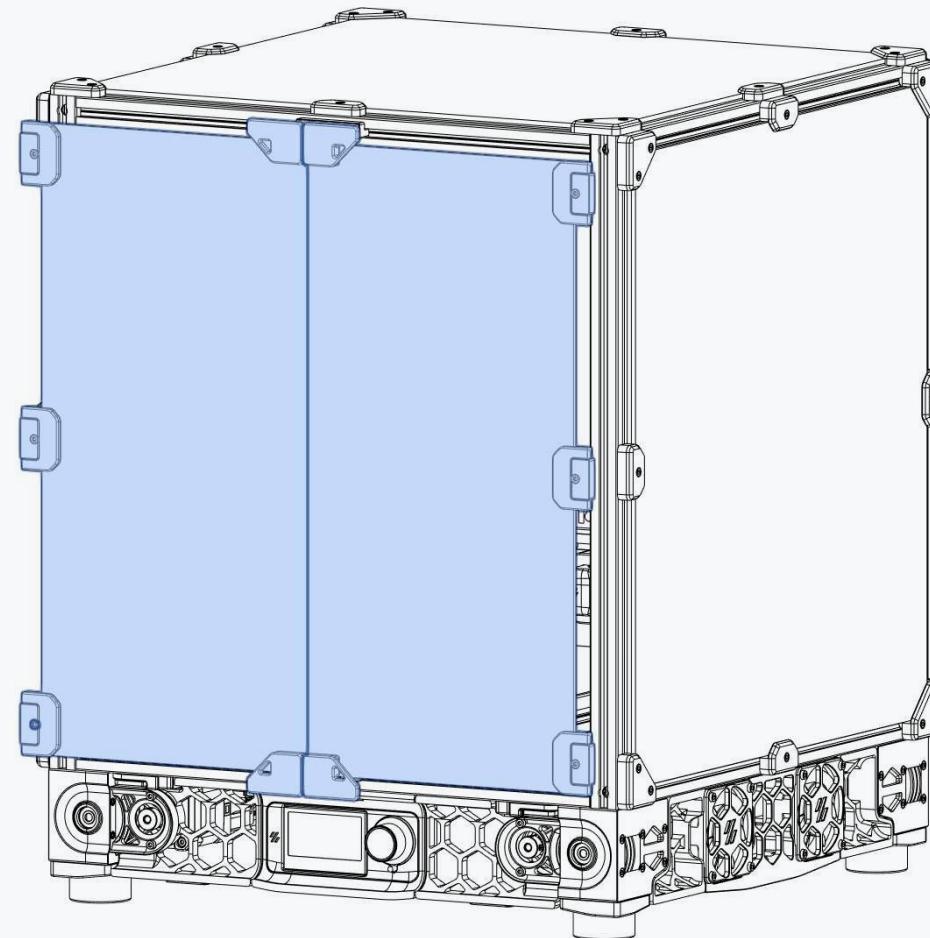
APPLY VHB TAPE

VHB Tape is a double sided
adhesive tape.

**APPLY VHB TAPE**

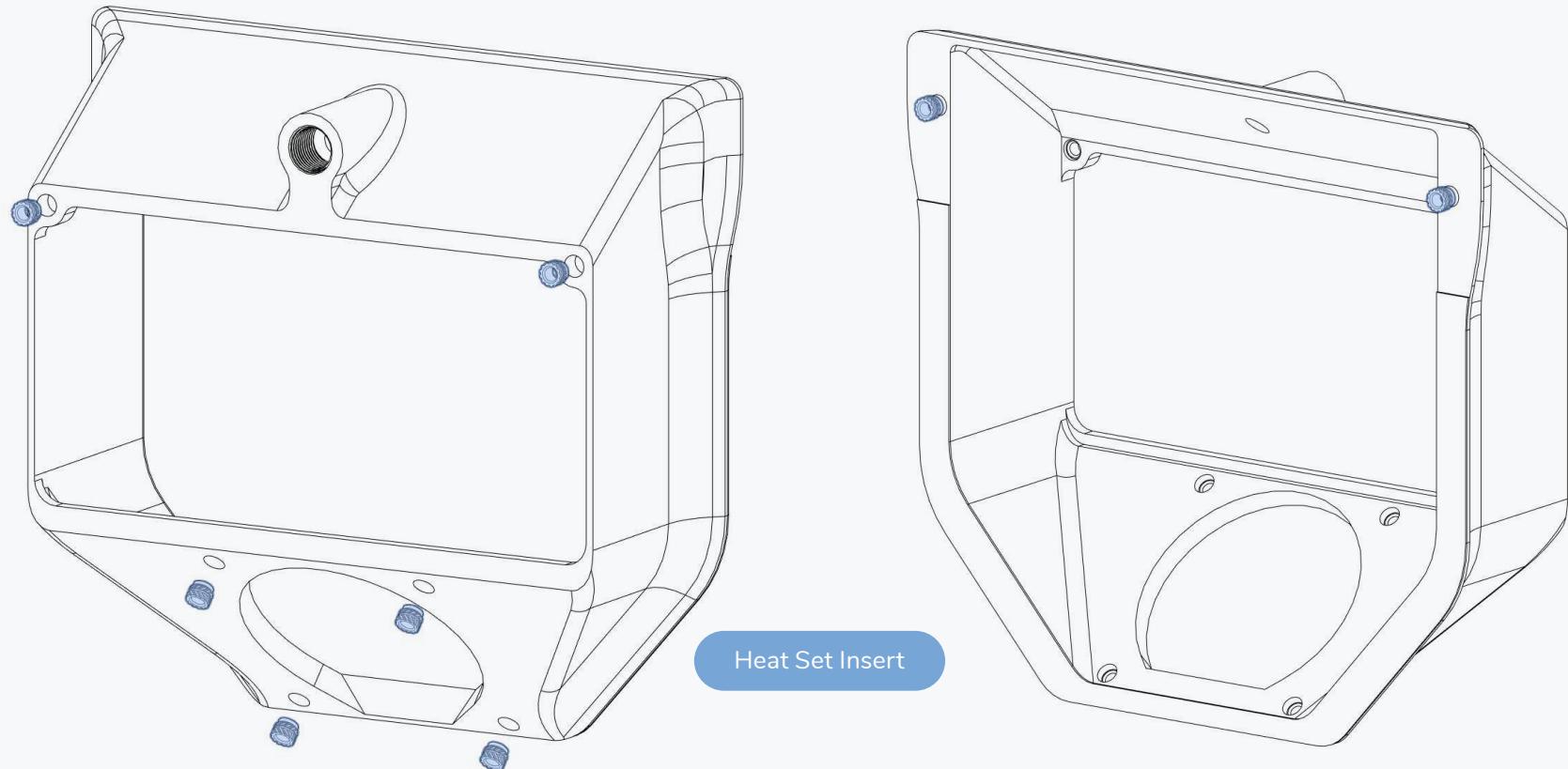
VHB Tape is a double sided adhesive tape.

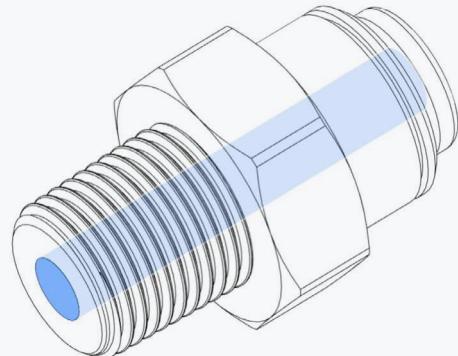




EXHAUST

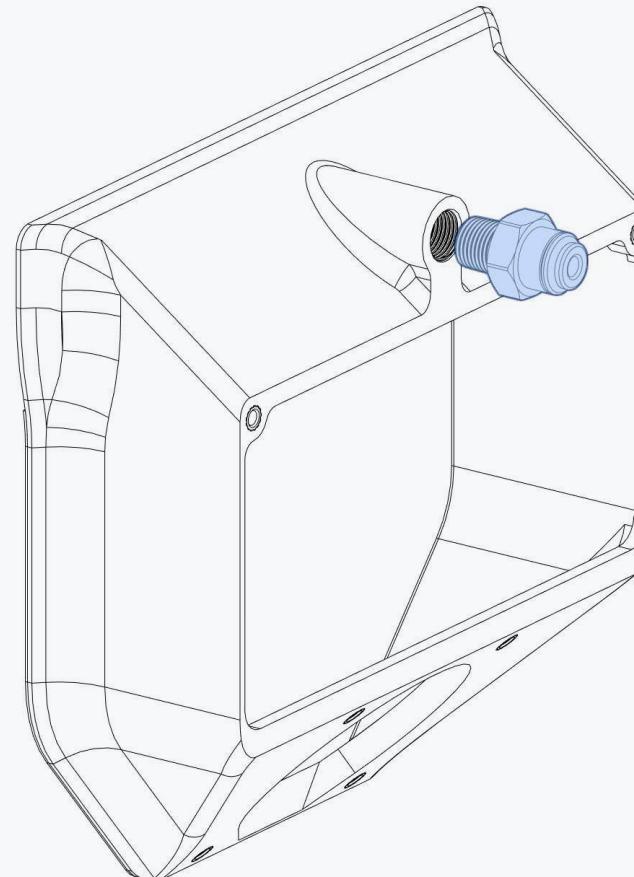
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**BSPP ADAPTER**

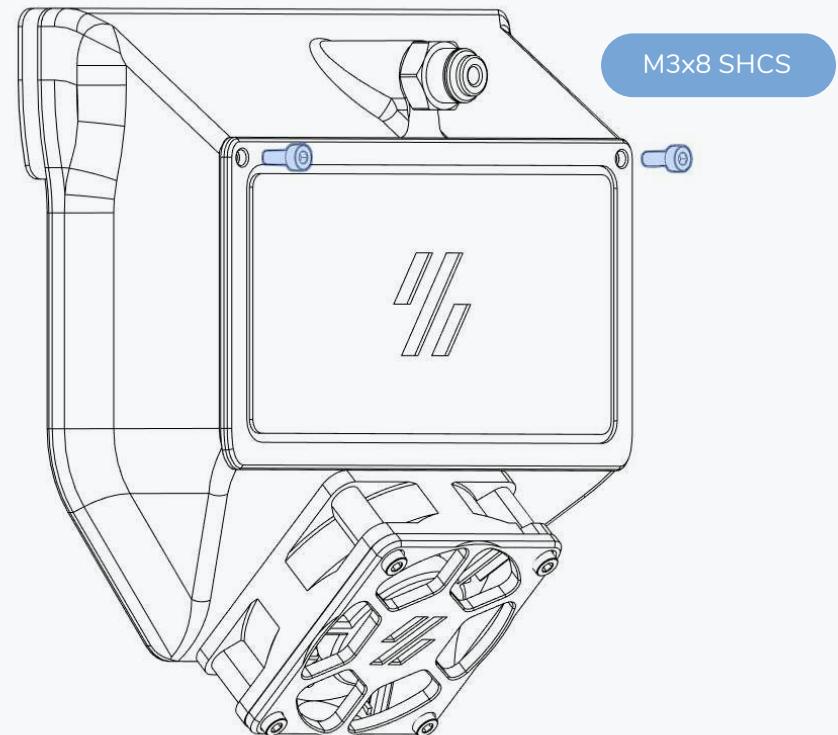
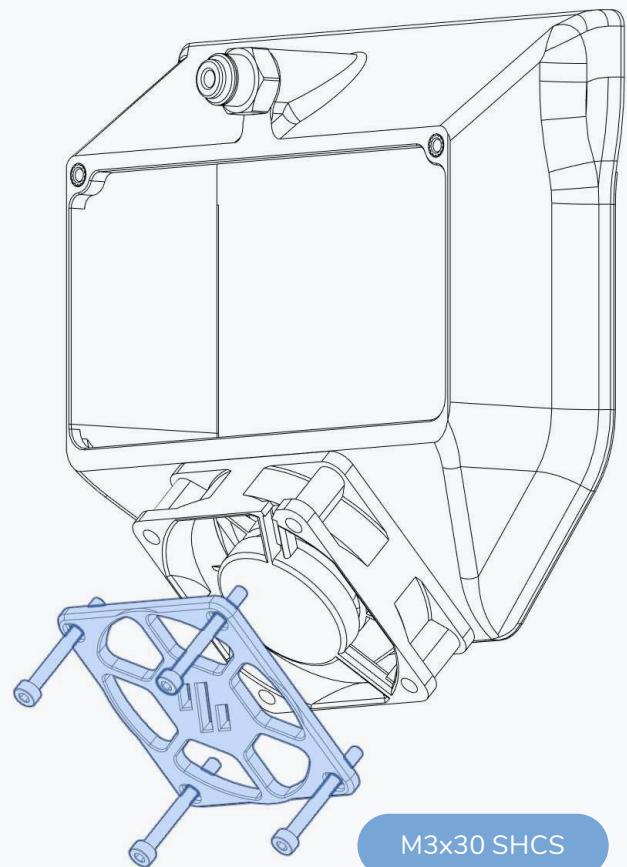
Some adapters have a small lip that prevents the PTFE tube from passing through.

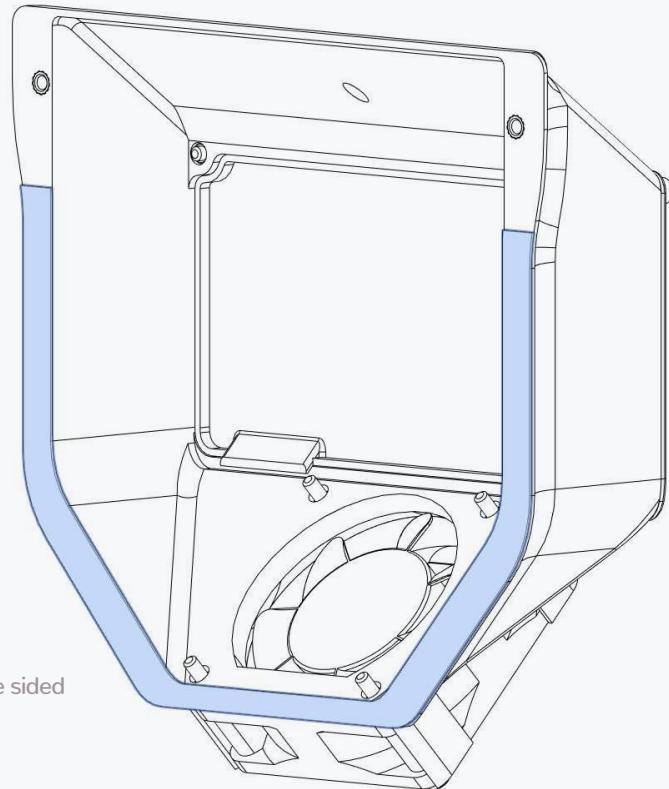
Inspect the adapter and if necessary use a drill to carefully remove the lip.



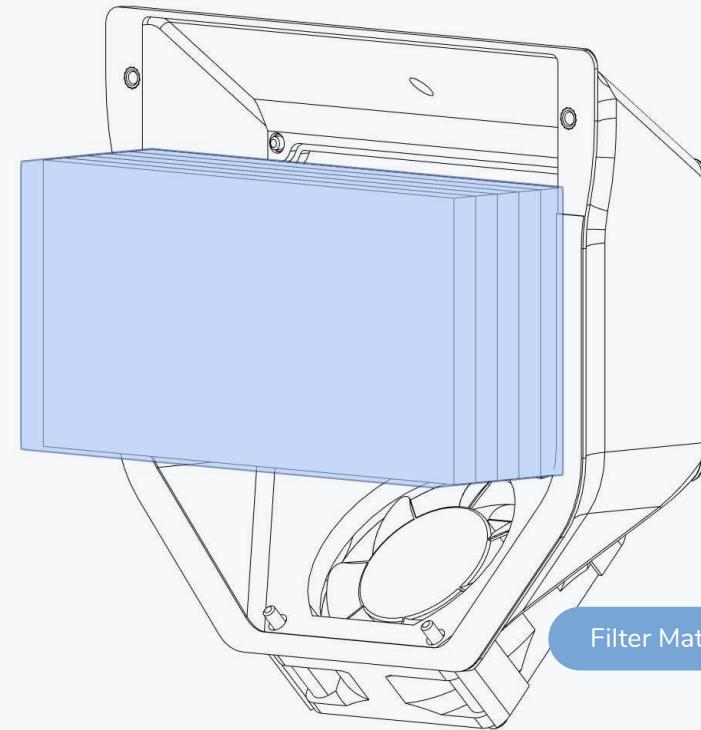
EXHAUST

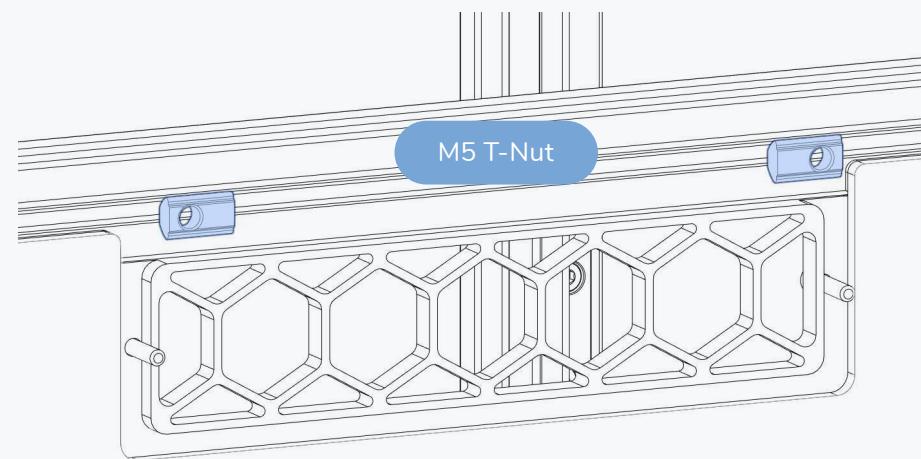
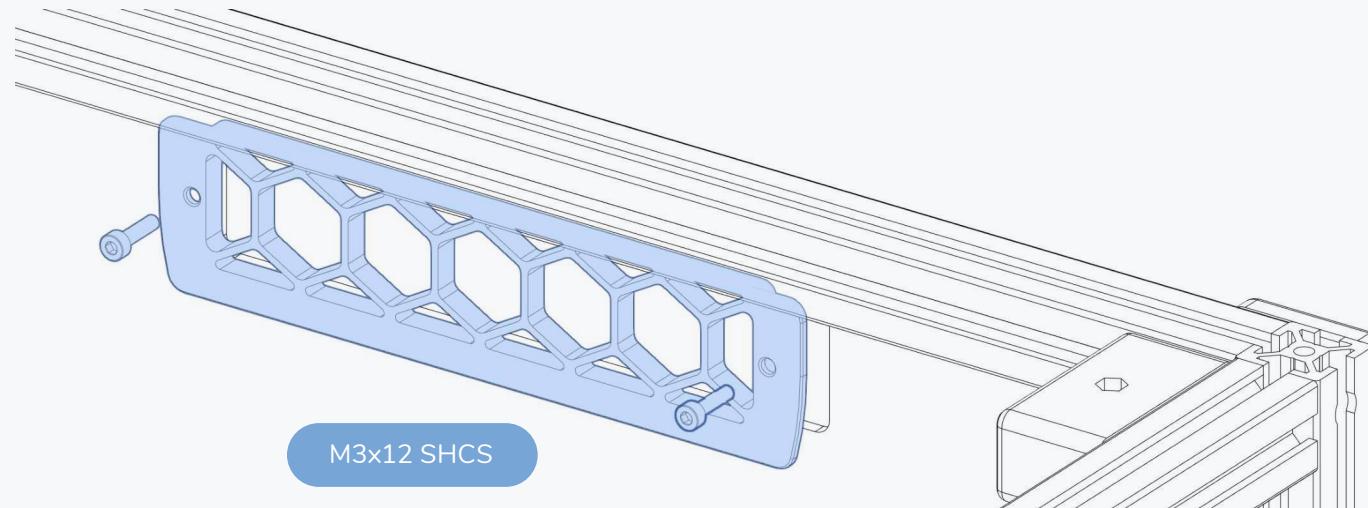
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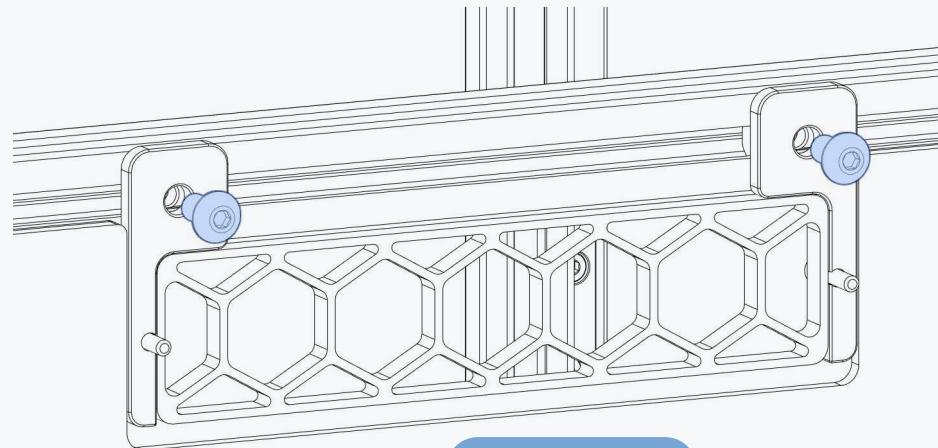
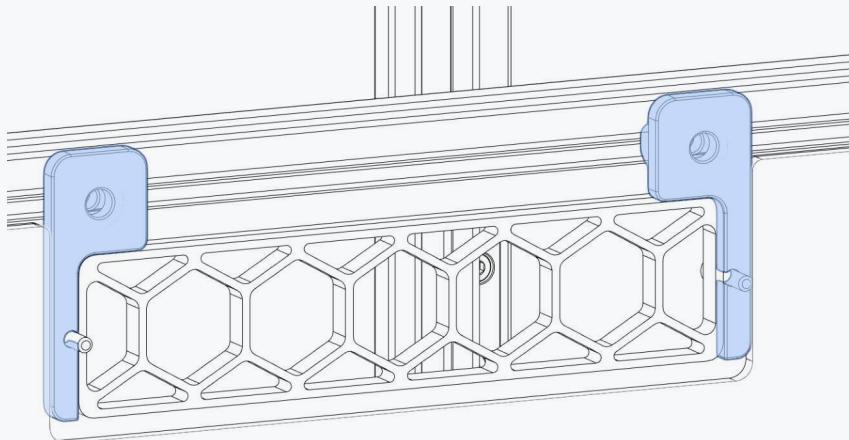


**APPLY VHB TAPE**

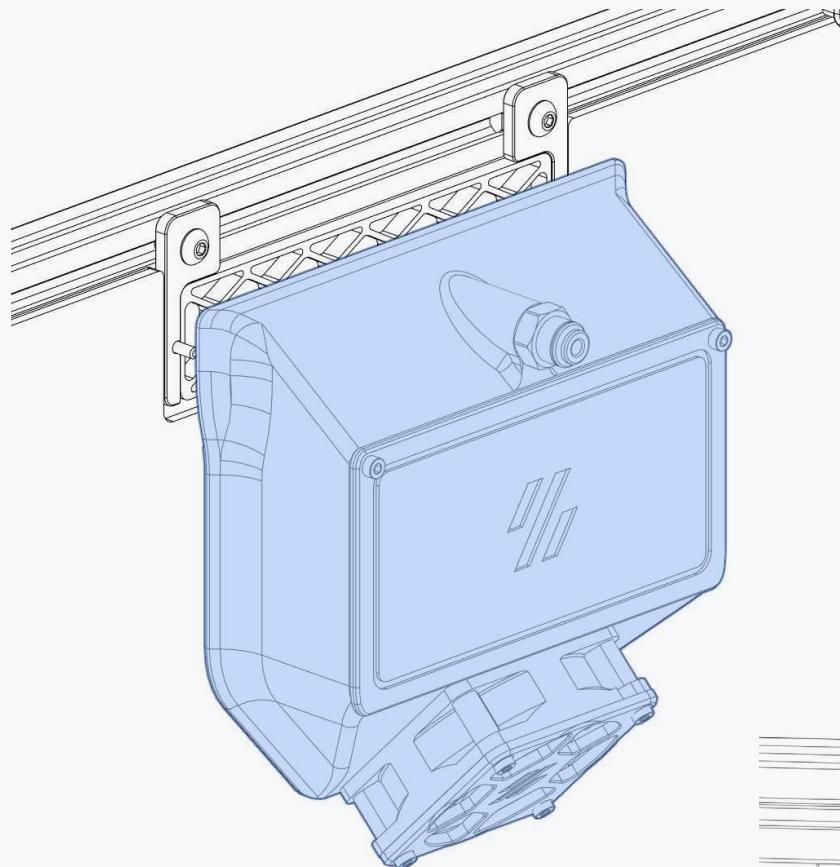
VHB Tape is a double sided adhesive tape.

**Filter Material**

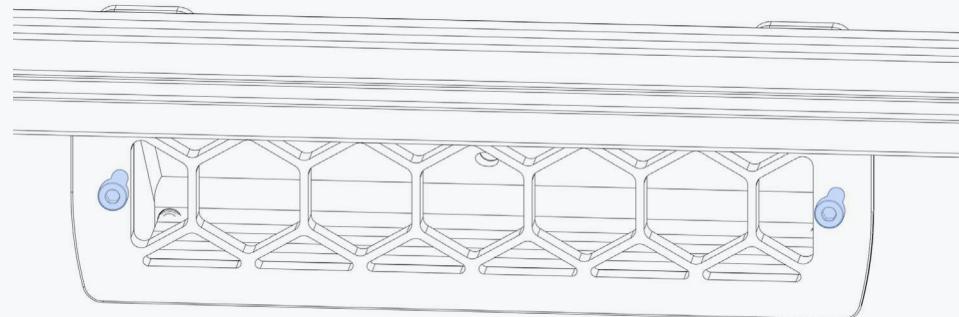




M5x10 BHCS

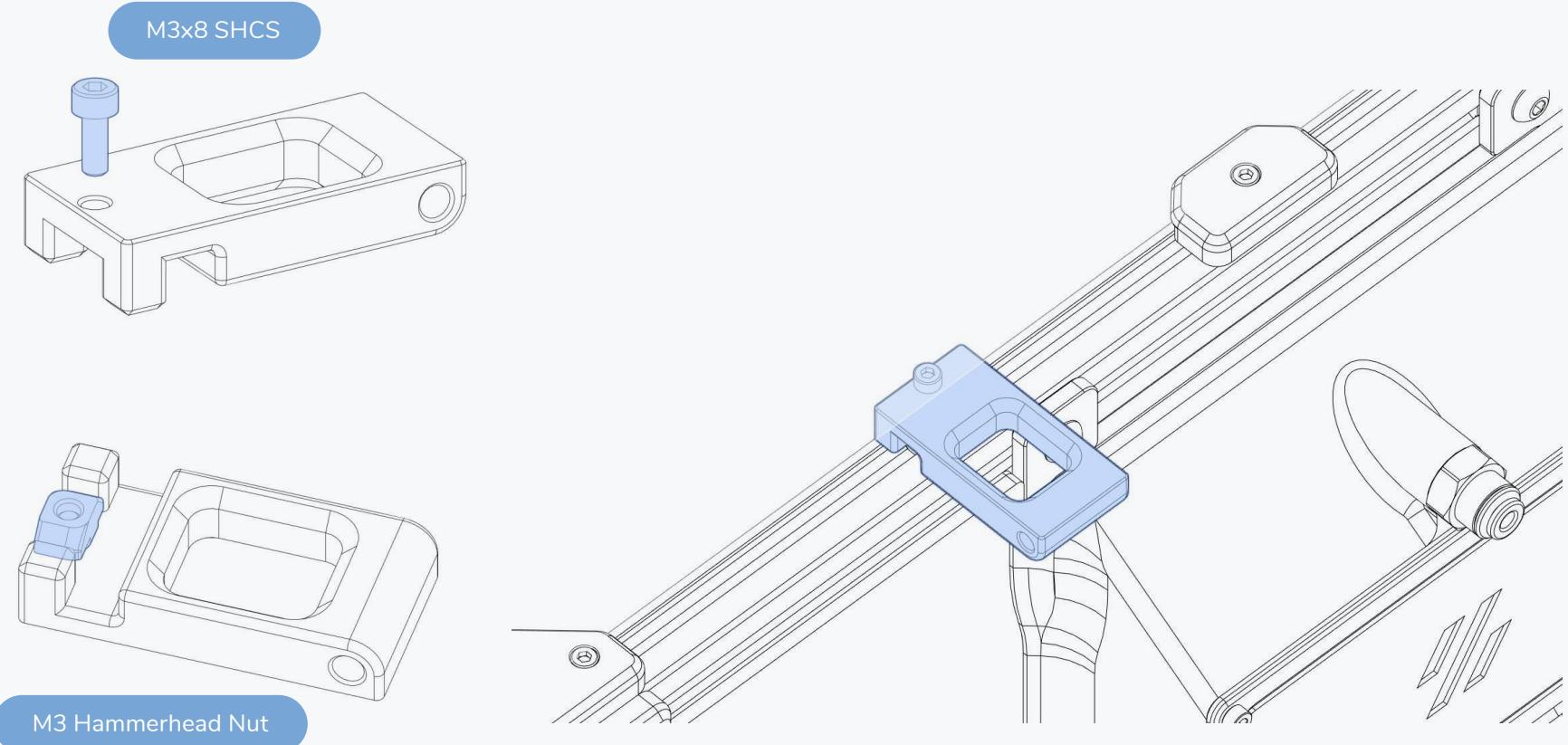
**REMOVE TAPE BACKING**

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

TIGHTEN BOLTS

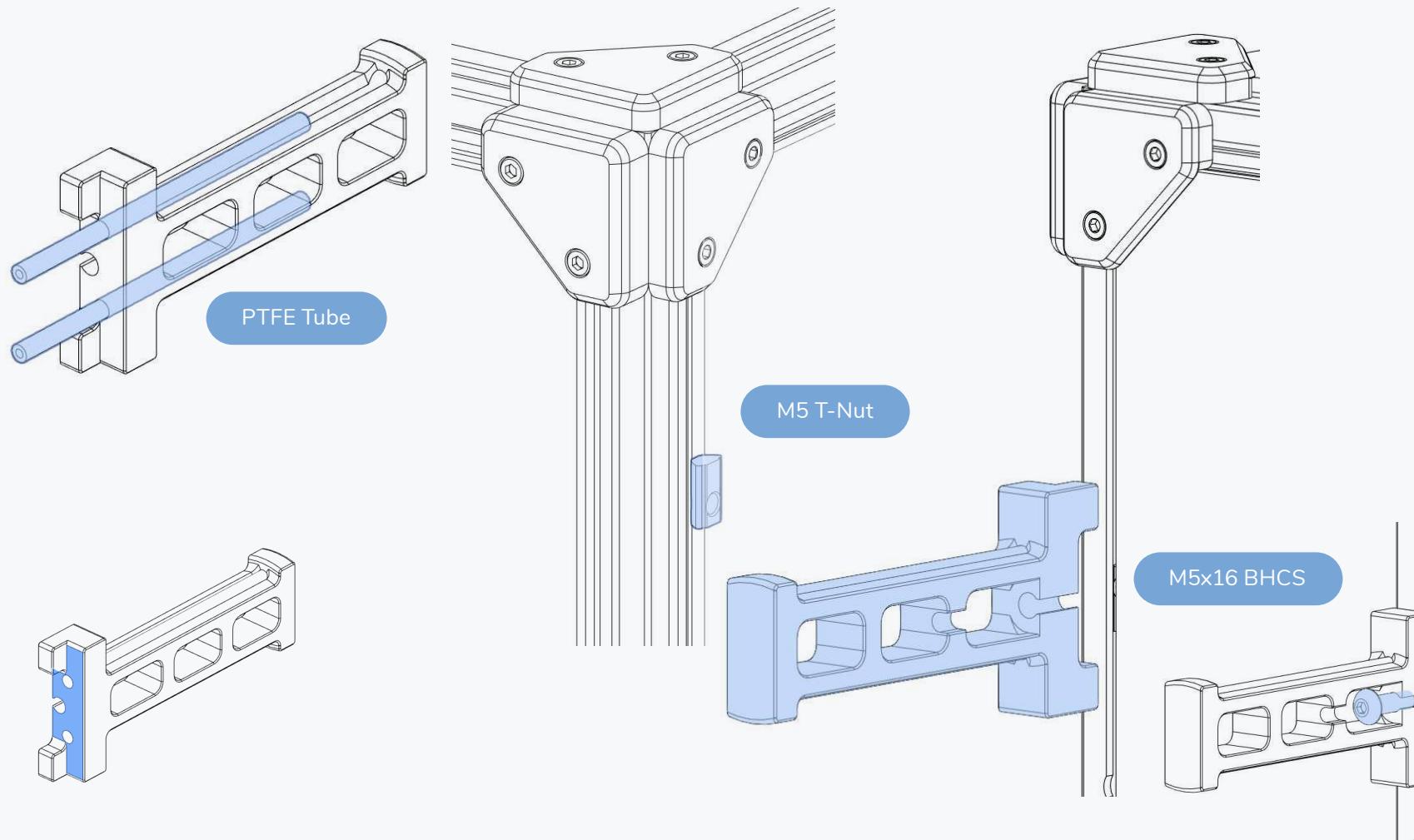
SPOOL HOLDER

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SPOOL HOLDER

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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.



DISCORD

<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
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