How to:

Belt Driven Ender 3

(and all other V-Slot i3 Printer)

Made by

KevinAkaSam

Index

First things first

Hey,

thanks for downloading my mod :)

If you have any problems with the assembly, feel free to contact me on Discord (kevinakasam#2097). Alternatively post a comment on Thingiverse, I will try to answer as soon as possible. Maybe your questions are already answered in the FAQ. If you have further suggestions or missing functions, feel free to submit a comment. All parts can be modified, but please post it as a remix ;)

Attention!! I'm not an expert and 3D printing is just my hobby. So please be careful when you build this mod and don't just go ahead. If not noted in the description on Thingiverse all parts are tested and working. Everybody bears the risks of a modification him/herself!

In this tutorial we will build the version with the V-Wheels. There is also a version for MGN-Rails. Just check the other instruction. When using the M5x8mm screws as shown in the pictures use a M5 t-nut as well. These are not shown in the pictures.

So with that mod you have to move the PSU, maybe try something like this: www.thingiverse.com/thing:3898958

Find the right STL files:

If you use a stock Ender 3, please use the 1_LeftV3.1_Bowden and 1_RightV3.1_Bowden.

If you use a DDE setup, please use 1_LeftV3.1 and 1_RightV3.1.

If you like to have a minimum height of the printer (e.g. Enclosure) then please use the rotated version. This has its own LeftTop and RightTop! In this tutorial we will build the normal version, but there are no more differences in the assembly than the printed files.

This mod uses a modified transmission from the Voron. I made a different frame to mount it on the Ender 3. The *tensionerarm* and the *tensionerring* are from the Voron guys. These aren't my work!!! The mount and the 80T gear are made by myself. You can find the link to the original files on the last page. Because the parts will be updated regularly, you can find the STLs I used on GitHub (for licensing reasons I can't upload these on Thingiverse):

www.github.com/kevinakasam/BeltDrivenEnder3/tree/main/V3/Voronparts

How to print?

All Parts can be printed without support. Keep the orientation for best results. Yes, you can use PLA but no, you shouldn't use PLA. I used PETG. Suggested print settings: 50% Infill, 5 Walls/Top-Bottom layer.

And now: Good luck and happy printing! :)

Calibrate your Printer!

Before we start with the assembly, some general info that should help (especially for the beginners). And you are most likely here because your print quality is not as good as you want. So, before we do any changes to the printer itself, let's get the settings right. If you have problems getting the tensioner block into the plate, there is most likely something wrong with your settings. So here are some basic tips:

1. **PID Autotuning:** Varying temperatures will cause the filament to extrude easier or harder - faster or slower. This makes inaccurate layers, so make sure your temperatures are constant!!!!

   www.marlinfw.org/docs/gcode/M303.html

   www.reprap.org/wiki/PID_Tuning

2. **E-steps:** After your printer is able to print filament consistently, it just needs to know how much. Calibrate your E-steps so your prints are stable and look neat!
   www.all3dp.com/2/extruder-calibration-6-easy-steps-2/

3. **Flow:** I didn't know for a long time that you can also calibrate the flow, but it has the biggest effect on print quality. Print the small test cube I uploaded on GitHub(). Print it without infill and without toplayer. 1-2 bottomlayer are enough for stability. Start with two walls. Print the small cube and measure the wall thickness(so you need a caliper for this). (It's best to use Cura(or superslicer), because there is no wall overlap sliced). With two walls the wall should be 0.8mm thick, if it is not, we have to adjust the flow(If your wallthickness is set to 0.4 !). Use the following calculation:

$$\frac{set\ wallthickness\ x\ used\ Flowrate}{measured\ wallthickness} = New\ Flowrate$$

   Round 1:
   $$\frac{0.8mm\ x\ 100\%}{0.88mm} = 90.909\%$$
   Round 2:
   $$\frac{0.8mm\ x\ 90.909\%}{0.82mm} = 88.692\%$$
   …

   Repeat this until the values are correct, this can be 10 or more rounds. If you want you can confirm your result for different wall thicknesses (3,4,... walls) too.

   If you have no caliper you can try this: www.thingiverse.com/thing:1622868

4. **Final check:** make sure your bed is always well leveled, your temperature settings match the filament and your printer is mechanically well assembled.

Thanks to Deutherius for this :)

But now let's finally solve the problem with the leadscrew!

BOM – Things you need

For links and more detailed information please check: *Bill of Materials Beltdriven Ender 3 - All Parts.pdf*

Category	Component	Quantity	Reuse from Printer?	Notes
Motion	20T 8mm Pulley	3	no	One for each side on the Rod, one for the printed 80T Gear.
	16T 5mm Pulles	1	no	Motorshaft
	Gt2 Belt	2 Meter	no	Don't buy the cheapest. You should go for one with glassfiber
	188mm Looped Belt	1	no	
	F623ZZ 3*10*4 bearing	4	no	2 Pieces for one side
	608ZZ Bearing	4	no	Do you have an old skateboard? You can steal the bearings from the wheels;)
	8mm Rod	330 mm	yes/no	Theres no link, just go to your local hardware store and take a cheap 8mm (aluminium) rod.
				Mine costs around 3€. You don't have to buy a hardened steel one. (to expensive and hard to cut)
Fasteners	M5x8mm	15	no	Any type of M5x8mm screw can be used. I really like the openbuilds one
	M5x40mm	6	yes (3 x)	Screwhead have to fit under the extrusion from the X-Axis. (Inside with the exentric nut on the plates.)
	M5x30mm	4	yes/no	Optional. for the top of the frame; the stock will work as well but only have a few millimeter to grip
	M5 T-nuts	15	no	
	M3x30mm	2	no	
	M3x25mm	2	no	
	M3x16mm	10	no	
	M3x12mm	8	no	If you have no screws, you should buy a kit. Especially for the tensioner a longer screw can be good.
	M3x10mm	2	no	
	M3x6mm	5	no	
	M3 nuts	10	no	

Electronics	Motor extension cable	1	no	The original Cable is obviously too short^^ Check if the middle cables are crossed (board to motor)!!!
Printed Parts	RightV3	1	/	Thingiverse
	LeftV3	1	/	Thingiverse
	RightTop	1	/	Thingiverse (also check @zxsix remix)
	LeftTop	1	/	Thingiverse (also check @zxsix remix)
	RightBottom	1	/	Thingiverse
	LeftBottom	1	/	Thingiverse
	Spacer	3	/	Thingiverse
	Z-Endstop	1	/	Thingiverse
	Tensioner Block	2	/	Thingiverse
	TensionerClamp	2	/	Thingiverse
	Transmission	1	/	Github
	MotorMountTensionerArm	1	/	Github
	ZDriveTensioningRing	1	/	Github
	80TRingGear	1	/	Github

FAQ

Does the X-Axis fall down when the printer is not powered on?

> No, the Axis keeps mid air as before. With the MGN Version it will be al lot easier to move the axis, but it's still not falling.

Do I have to chance the firmware?

> No, the mod is fully compatible with the stock firmware. Steps are still the same. If you want you can change the speed of the z axis now, it can move as fast as the other axis now.

Will I lose details or resolution?

> No, definitely not! You will get even better details. The belts are way more accurate than the leadscrew. You can move more precisely and for example z-hop will be awesome now.

Can I return to stock later?

> Yes sure. If you want to use the stock setup you can go back any time. All you have to do is to remove the printed parts. But why should you do that? ;)

Assembly

I. Transmission

Okay let's start with the assembly. We'll start with the Z Transmission. For this we need the original Z motor. It's the best to dismantle it now (Z-motor, leadscrew, motormount). The X axis is now no longer supported. Put something under the axis, on which you can lay it down.

Back to the transmission. Take one of the 20T pulleys. We need to remove the flange. You can either print a tool (www.youtube.com/watch?v=RKpxDKYOJYs) or just use a pair of pliers. I did it with the pliers, had no problems with that. Now take the printed pulley and put the small 20T in it. Secure the pulley with 5 M3x6mm screws.
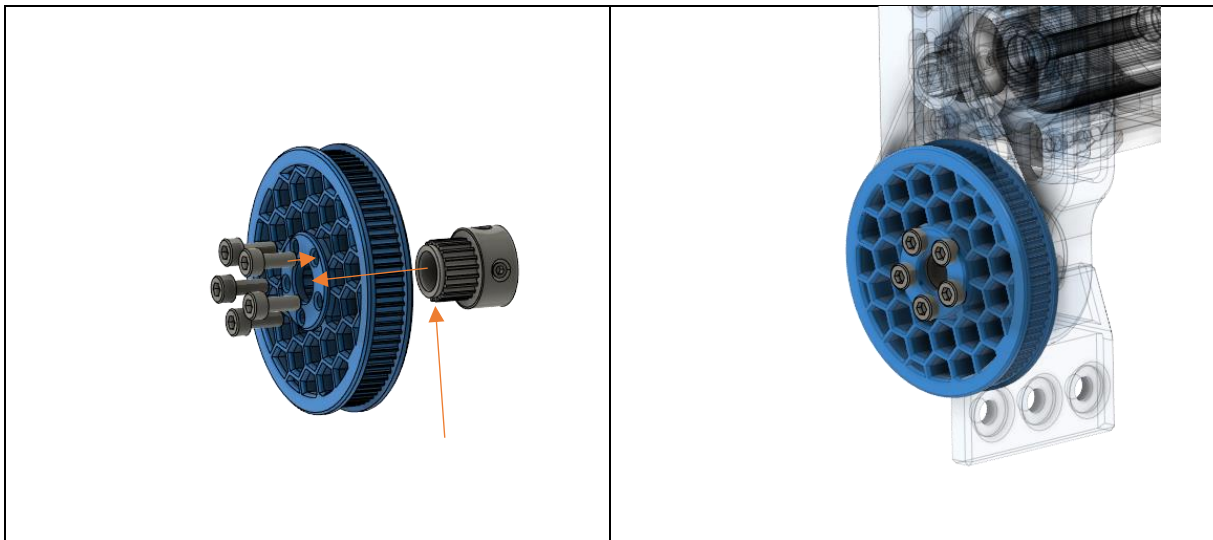
Put the part aside for now, we will need it again later. Now take the printed tensioner arm and insert the two M3 nuts as shown. Then screw the motor to the part. Also put the 16T pulley on the motor shaft.
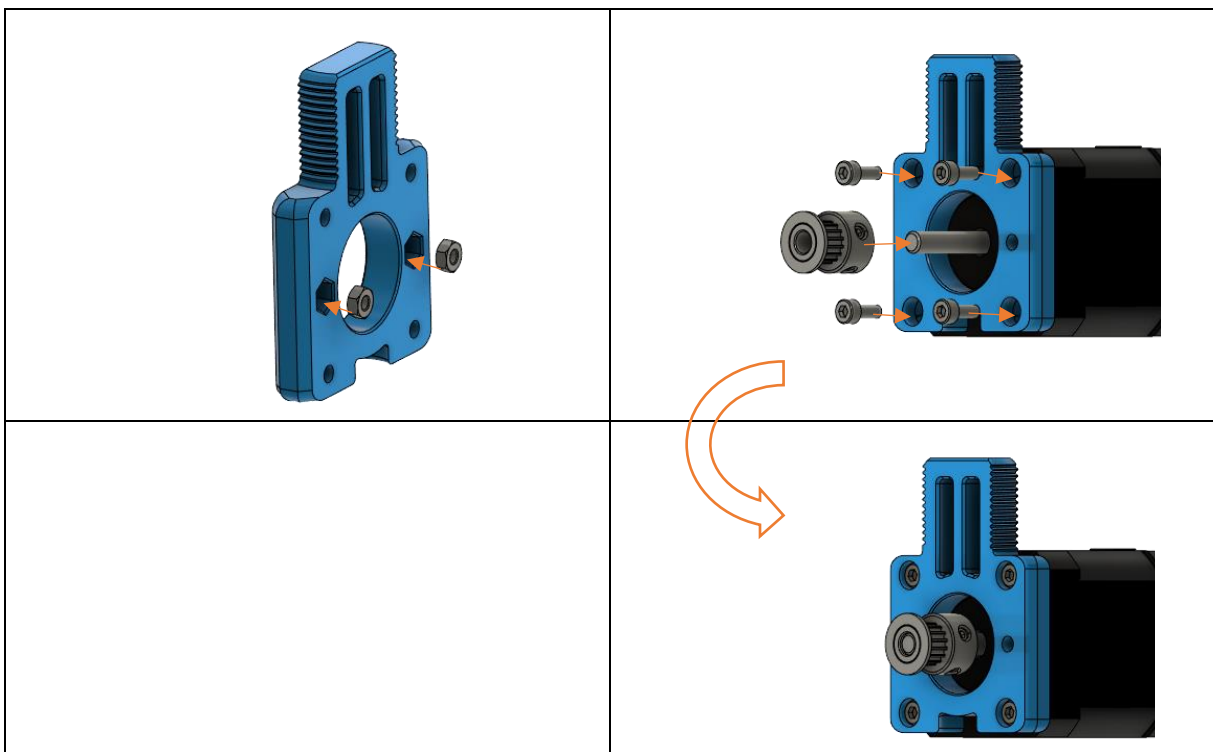
Now we just need to put everything together. Secure the motor with two M3x10mm screws on the transmission (use a washer). Do not tighten them yet! Also screw the tensioner ring onto the part with the Z motor.
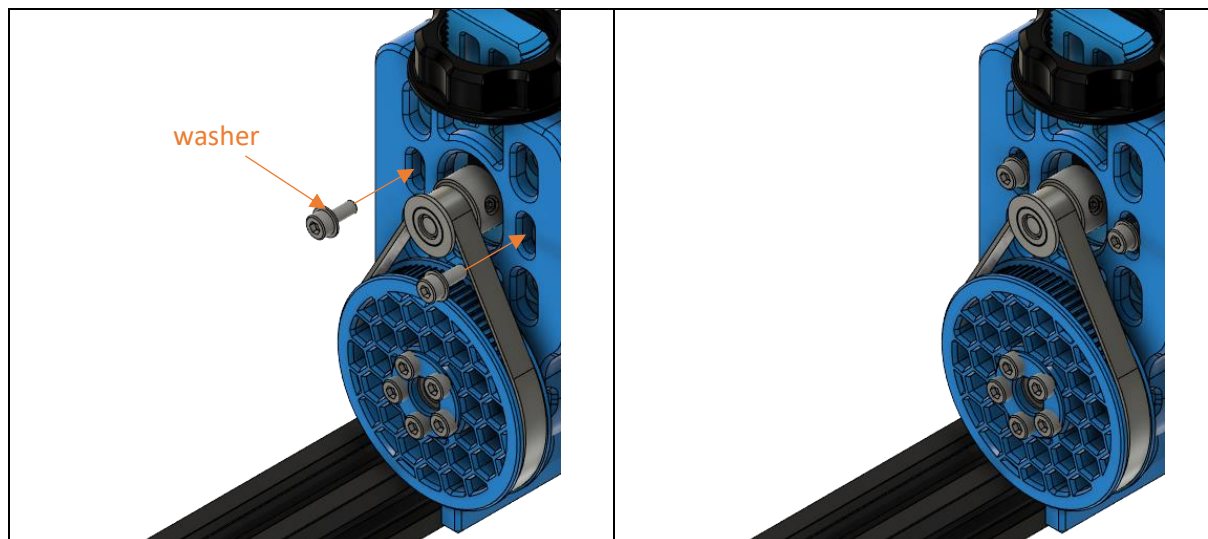
Secure the transmission with 5 M5x8mm screws on the frame and somewhere in the middle. It does not matter where the transmission is mounted.
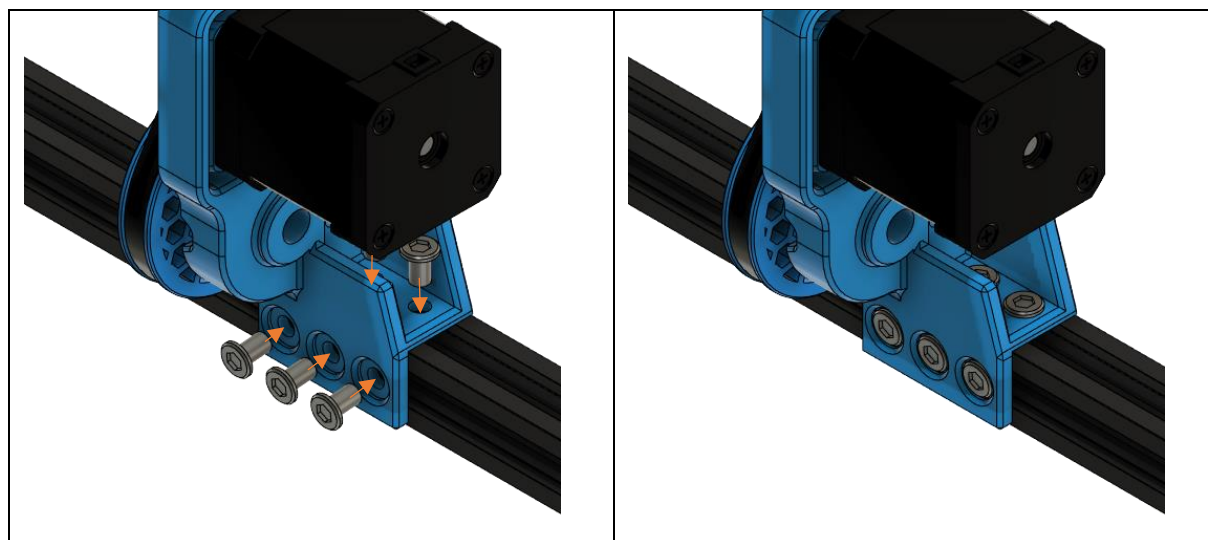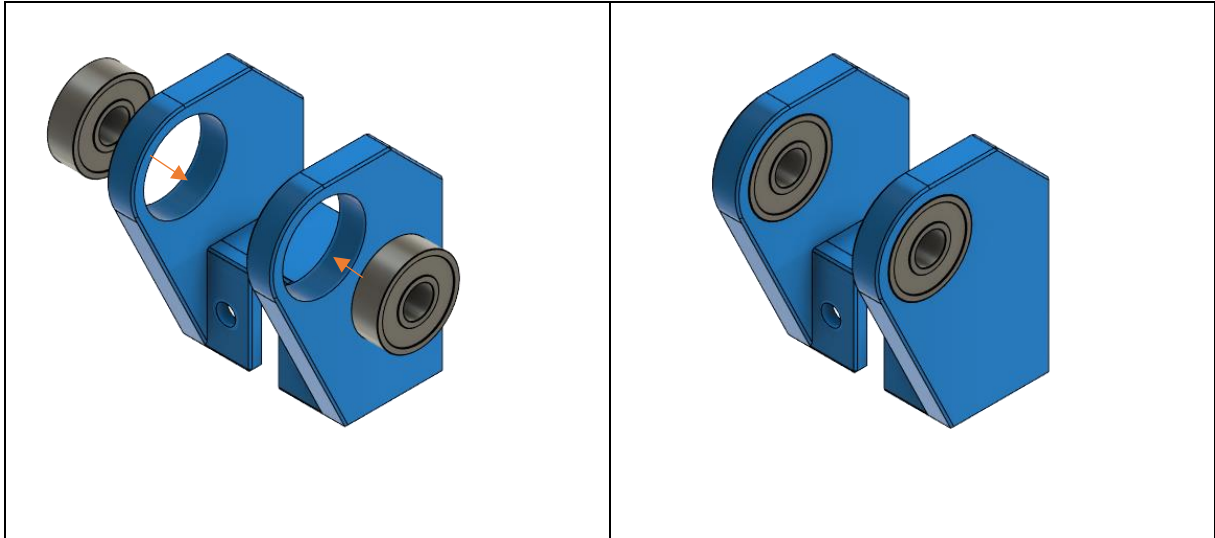

The small looped belt and the 80T gear are shown here for orientation only. We can't attach them yet, that will be done in the last step.

Your printer should look like this:
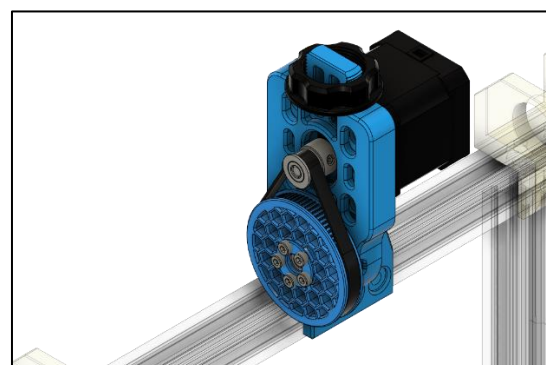
II. Top brackets

In this step we will prepare the upper part of the Z axis.

Take the "TopLeft" part for this. Insert the bearings as shown in the picture. The holes for the bearings are very tight. Be careful to not break the part when inserting the bearings! You can also use a vice to press the bearings into the part.
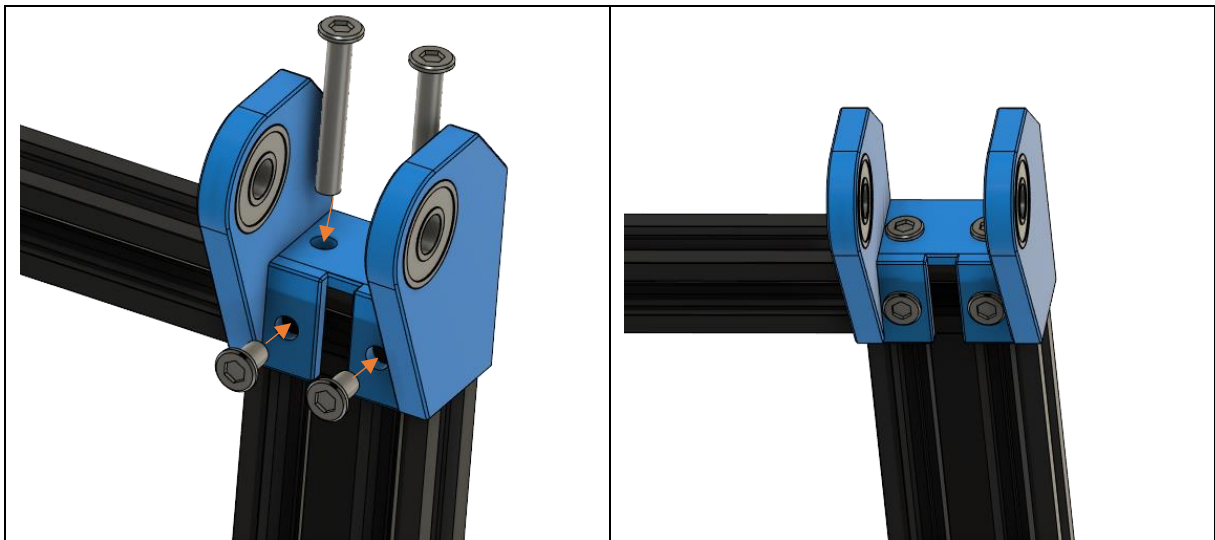
First you have to remove the upper screws in the frame. You should only do this for one side at first and later for the second. Now place the part on the frame as shown and reinsert the long M5 screws you just removed. You can also use the longer ones from the BOM if they are too short for you. Secure the part additionally with two M5x8mm screws and t-nuts.

Repeat this steps for the right side as well, your printer should look like this:
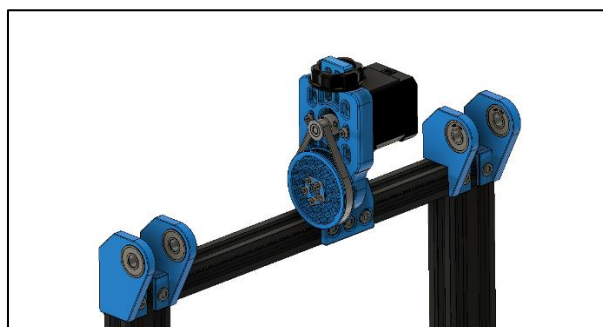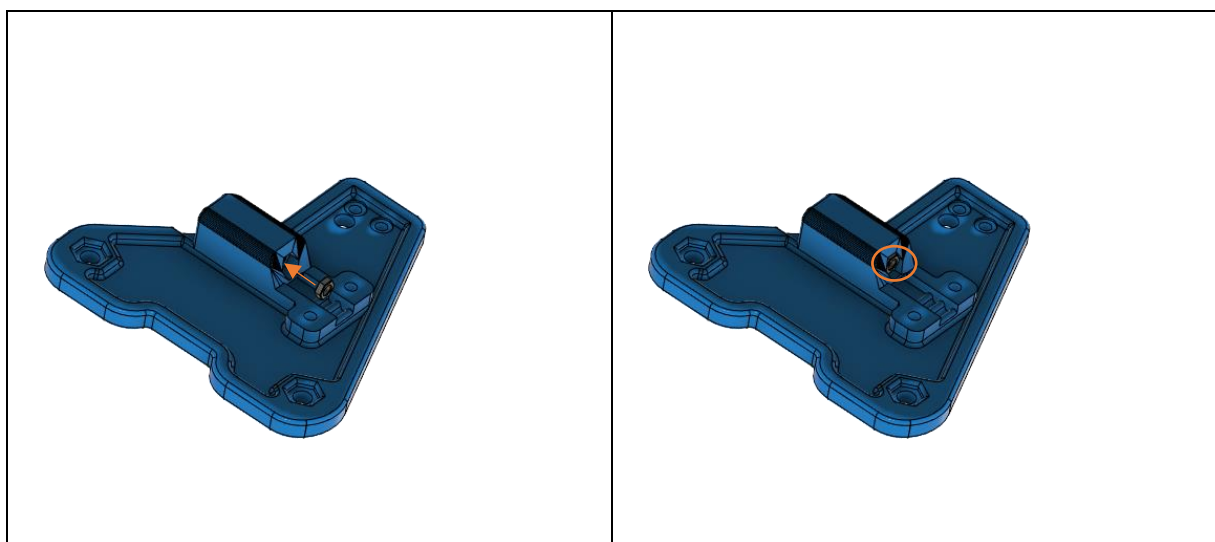
III. Z Plates

In this step we will attach the Z plates. But before that we need to make a few preparations:

Put two M3 nuts in each of the LeftV3.1 and RightV3.1 parts (or the bowden version) as shown in the picture. Don't forget this step, for both sides!!!
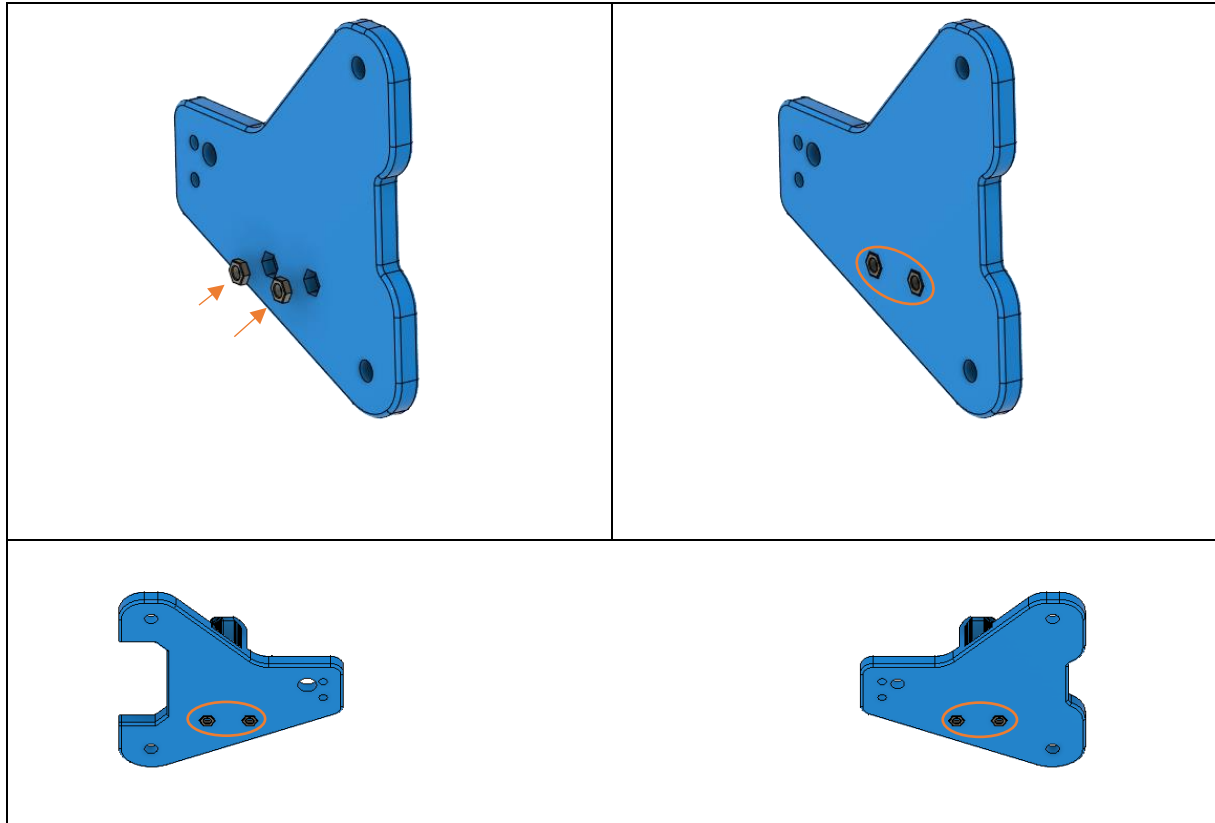
You also have to do this for the tensioner on the front as well, only one nut is needed here. Again, for **both sides!**

We'll start with the right side this time. Remove the nuts from the long M5 bolts which the wheels are sitting on. Take everything off, so that only the inner M5 screw remains: we have to change it now. To do this, loosen the two M4 screws that attach the profile to the plate. Maybe it's enough to remove one and loosen the other, so you can turn the plate and change the screw. Of course, you can also remove the plate if that's easier for you. Now replace the original M5 screw with a M5x40mm.
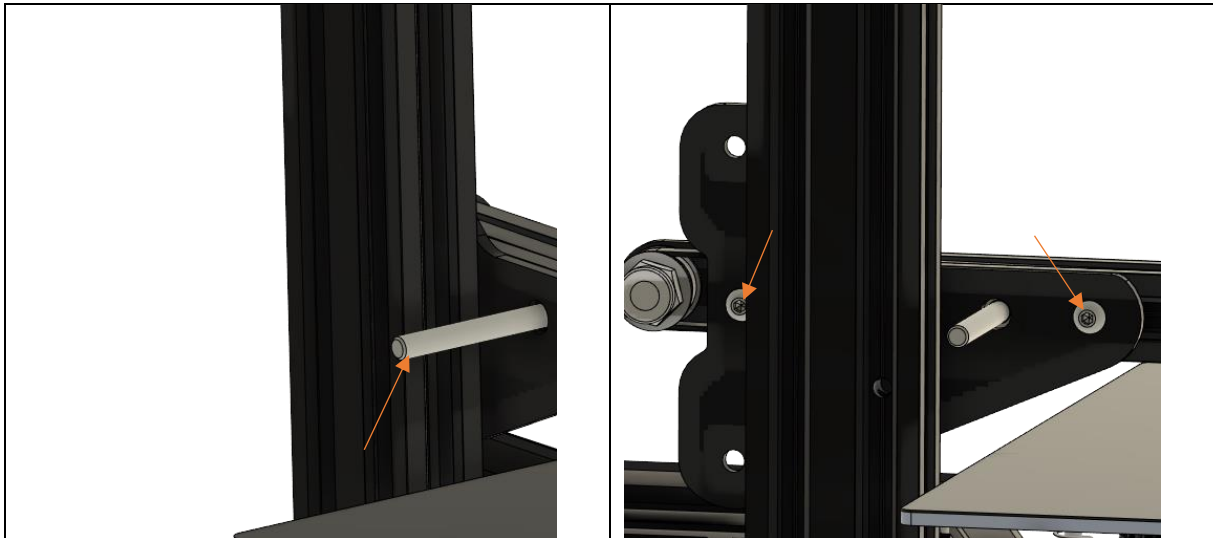

Almost done. Now mount the plate back to the profile by placing the M4 screws back in. Make sure that everything is straight and square. Now insert M5x40mm screws in the other holes as well. The order for the outer two screws is now: original spacer-wheel-printed spacer. For the inner bolt: exentric nut-wheel-printed spacer. For the eccentric nut, make sure you have the correct orientation. The thicker side must be in the original metal plate.
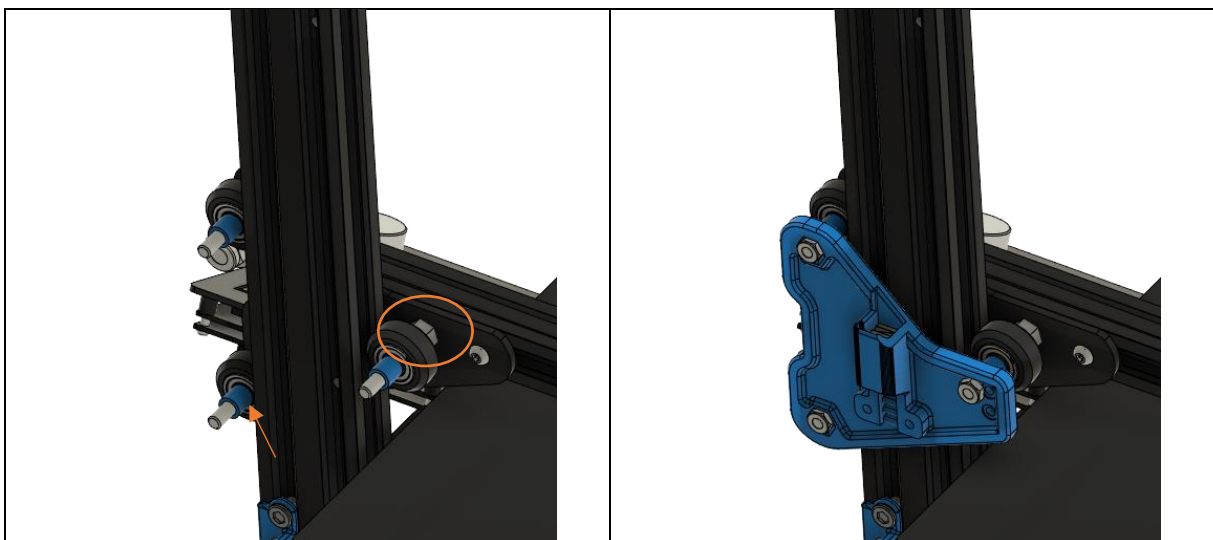

Now place RightV3.1 (or RightV3.1_bowden) on the screws. Secure the three M5 screws with the original nuts. Rotate the eccentric nut until the inner v-wheel is snug with the profile. Right side done :)

Now to the left side. Before we start disassembling the plate, loosen the 4 screws that hold the motor of the X-axis. Rotate the motor 90 degrees so that the cable connector is facing to the outside. Now tighten the motor again. This step is very important, otherwise the plate will not fit!
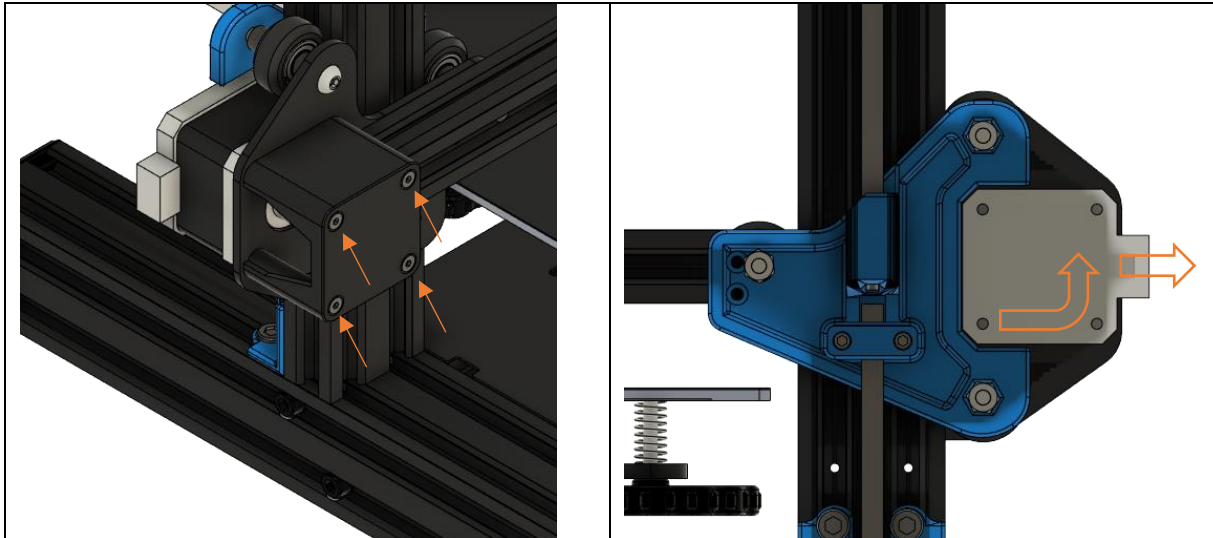

After the X-Motor is mounted, loosen the three M5 nuts. Replace the original plate with the LeftV3.1 (or LeftV3.1_bowden) and secure the screws with the original M5 nuts. Maybe you should use a washer for the inner bolt. That's it, the Z plates are mounted. We are almost there!

You're printer should look like this:
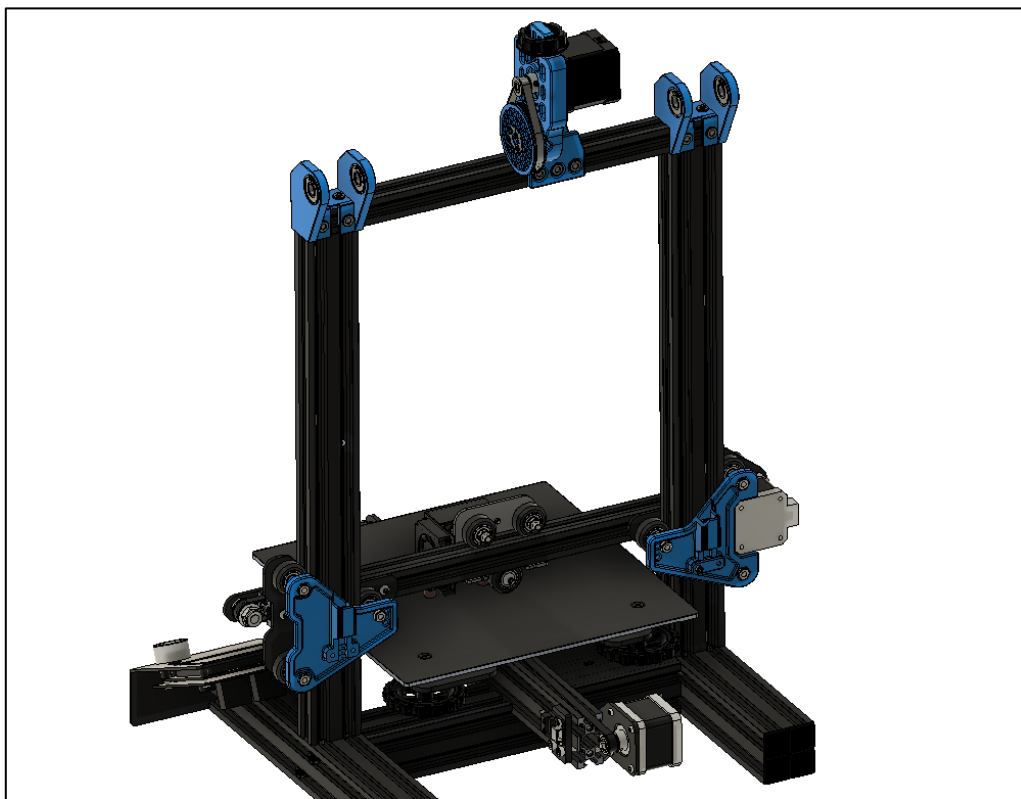
IV. Bottom brackets

Now we add the last parts to the printer. Take BottomRight for this.
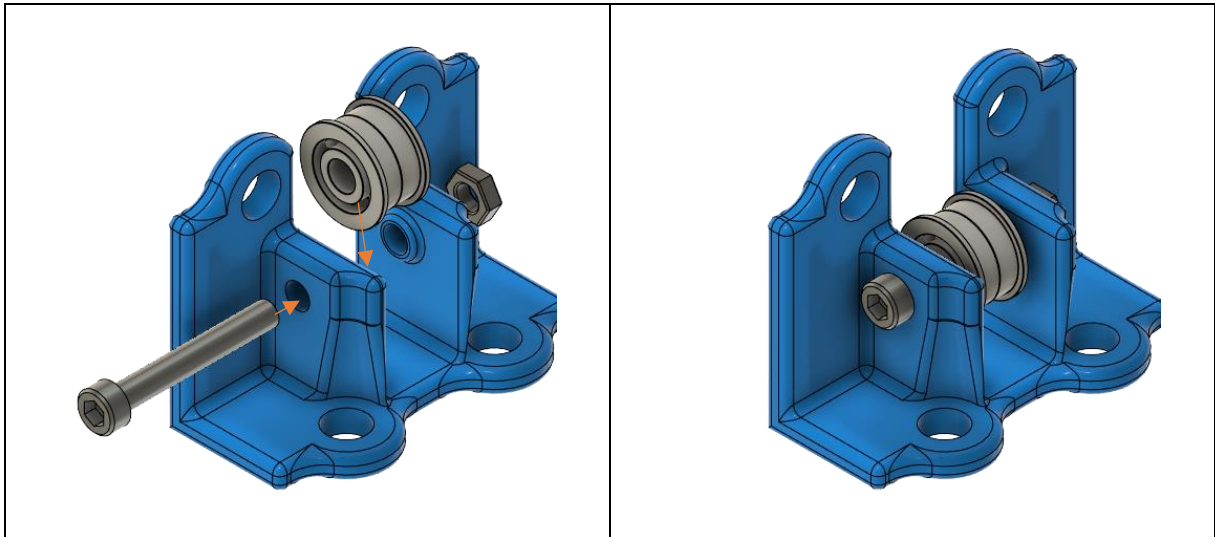
Put two of the small F623 bearings together as shown in the picture. Position the bearings in the printed part and insert a M3 screw through them. Secure it with a M3 nut. Make sure the bearing can spin freely. For mounting to the frame we need four M5 screws.
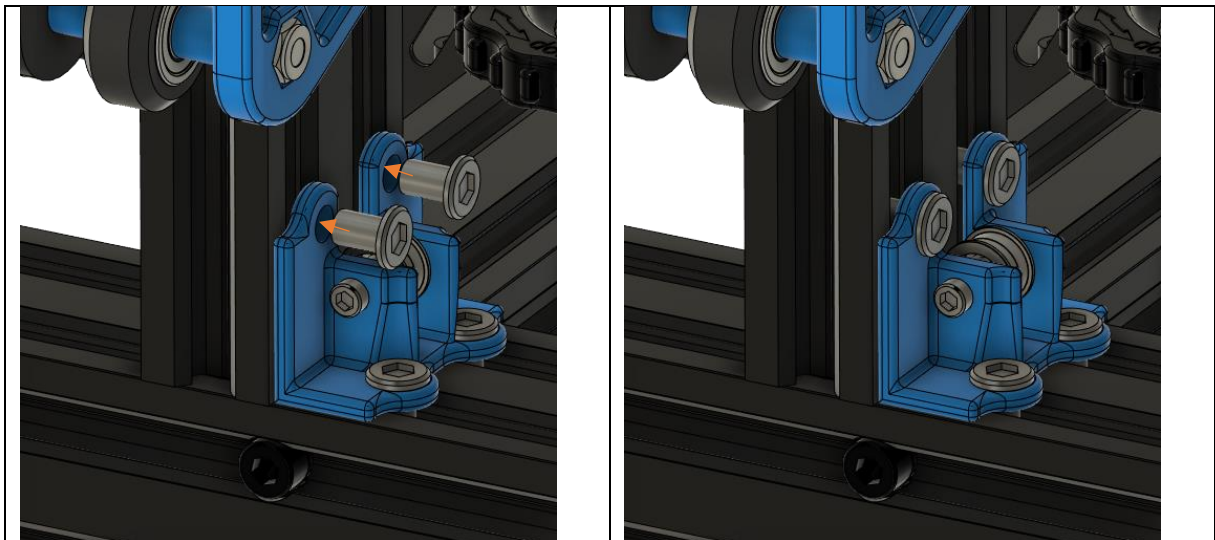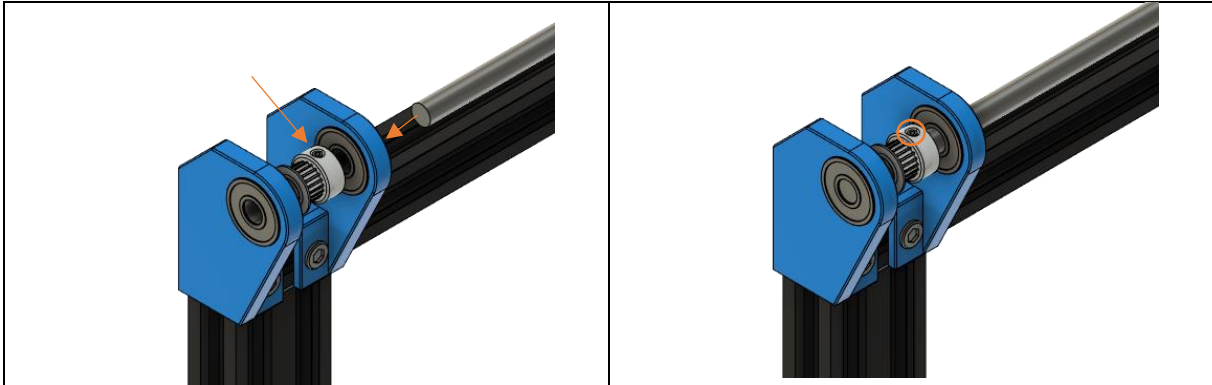
Repeat this for the other side as well:
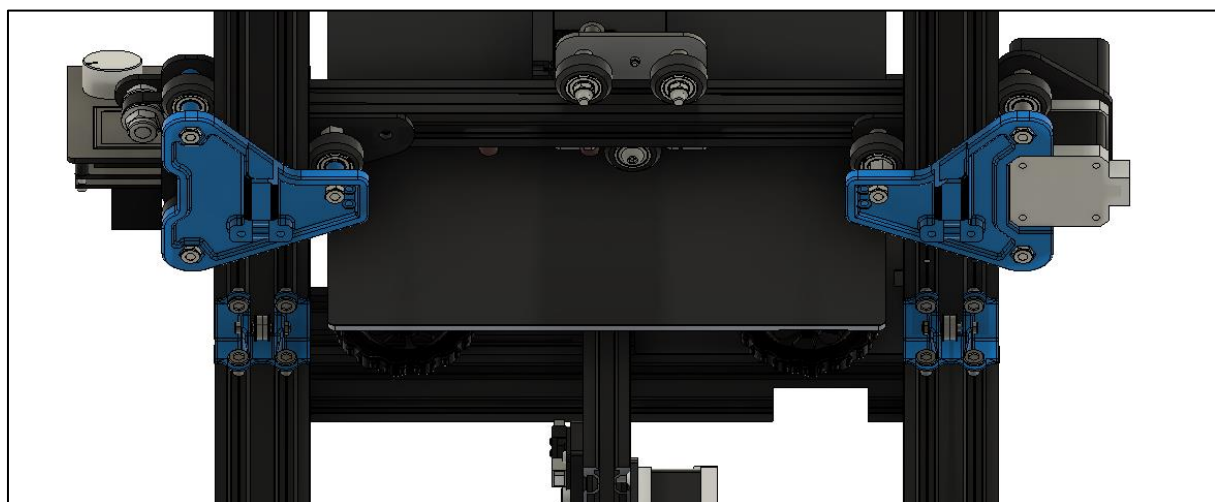
V. Belt installation

Feed the 8mm rod through one of the bearings of the first top bracket. Don't forget to put a pulley between before passing the second bearing. <u>Before you pass the rod through the opposite side, don't forget to put the 80T gear with the 188mm looped belt on the rod as well.</u>

Cut two pieces of equal length from the Gt2 Belt (about 90 cm, please measure it by yoursef). It is very very important that both belts are the same length!!! Now you have to pass the belt between the plates and the frame as shown in the picture. Fix the belt at the bottom of the plate with the clamp.
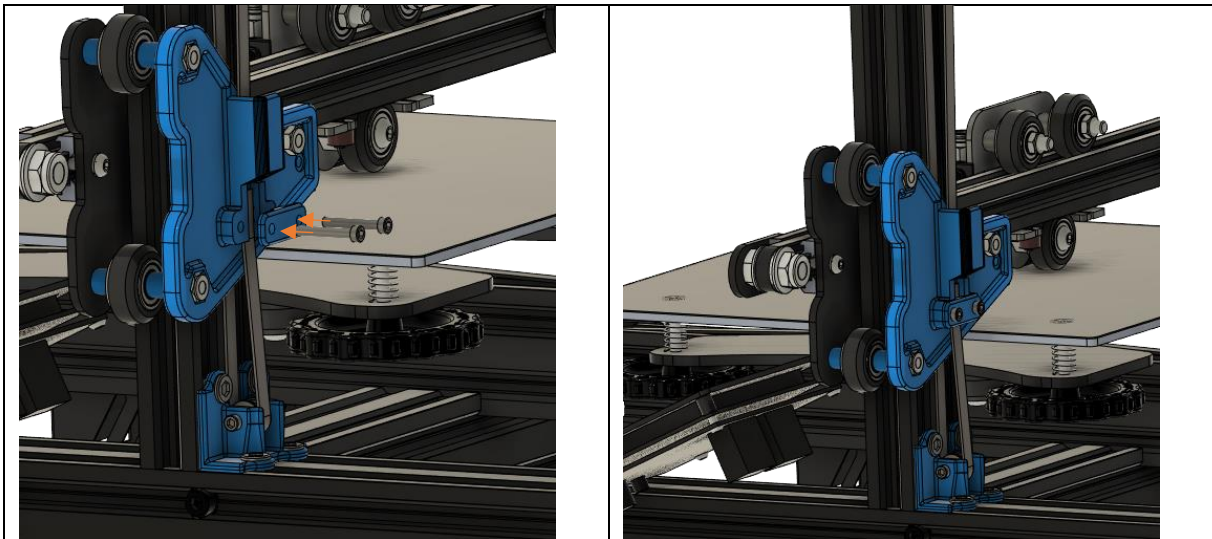
For the upper side push the tensioner block completely onto the belt, not only for a few millimetres. Now insert the block and belt into the plate and tighten the screw.
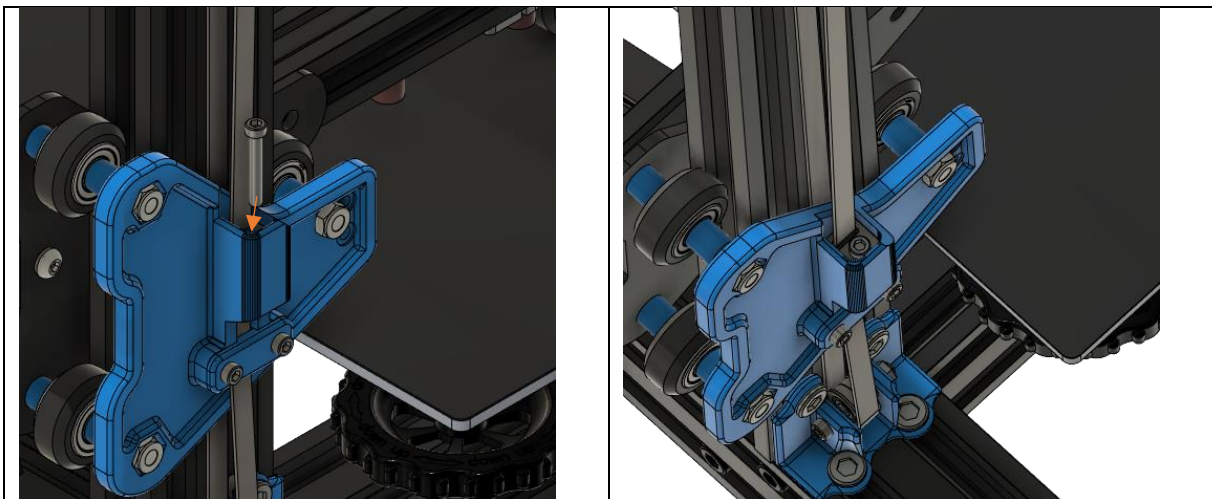
It is important to tension the belts equally on both sides! Count the turns of the screw and repeat on the opposite side. Both sides must be absolutely identical. This may sound a little tricky and difficult, but it's not that hard. Just do all steps on both sides at the same time or alternately, then nothing can go wrong ;)

Now move the X-axis all the way up so that the wheels touch the printed parts. Tighten both grub screws of the two outer 20T pulleys. This step synchronizes both sides.

And the last step: place the 80T pulley under the motor and put the 188mm belt over motor pulley as well. If the belt can run smoothly tighten the grub screws of the 80T pulley (there is a cutout in the transmission body specifically for this). Turn the tensioner ring at the top until you feel that the belt is guided well. You don't have to turn the ring too tight, it just have to prevent the 188mm belt from slipping over the teeth. Secure the motor with the two M3 screws we used at the very beginning.

Done! Your printer is now ready to go. Don't forget to check if your bed is still leveled and post a make on Thingiverse :)

And thanks for building my mod! :D

You made it this far and the mod helped you? So maybe you are interested to help a student:)

www.paypal.me/KevinOhlrich

Sources

Ender 3 CAD: https://github.com/Creality3DPrinting/Ender-3/blob/master/Ender-3%20Mechanical/STP/Ender3.STEP

Voron Parts: https://github.com/VoronDesign/Voron-2/tree/Voron2.4/STLs/VORON2.4/Z_Drive