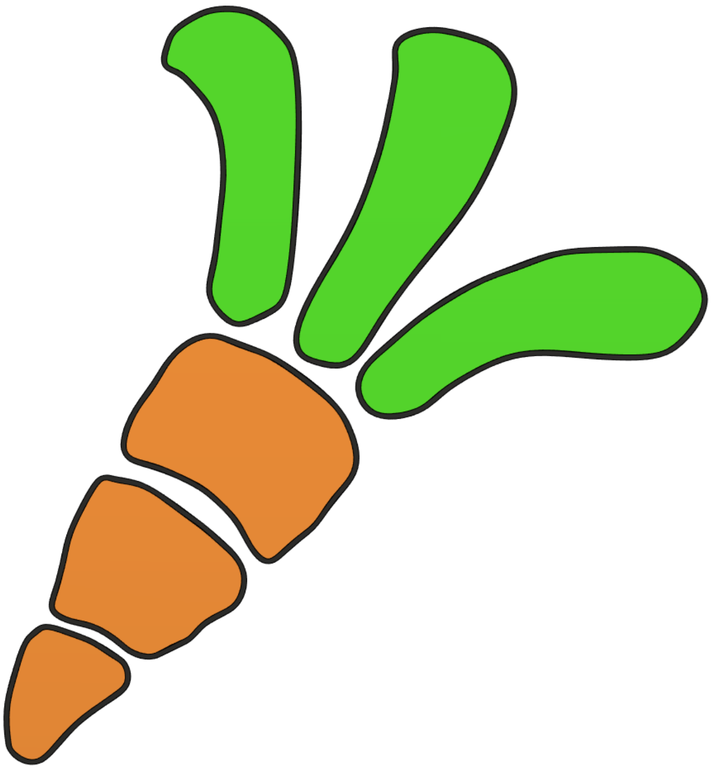


ENRAGED RABBIT : CARROT FEEDER ASSEMBLY MANUAL

VERSION 2022.02.16

TABLE OF CONTENT

ASSEMBLY

SETUP AND TUNING

INTRODUCTION

THE ENRAGED RABBIT PROJECT

This project aims to bring multimaterial capabilities to 3D printers using a single Direct Drive toolhead. While this project is mainly dedicated to be used on VORON printers, it can also be used (or adapted) on any 3D printer that runs Klipper, and potentially RRF.

Find all the project information on the Github page : https://github.com/EtteGit/EnragedRabbitProject

The project is composed of 4 different components :

- The Enraged Rabbit Carrot Feeder (ERCF). The Carrot Feeder allows to use a high number of different filaments (tested up to 9 tools so far) and feed them, one at a time, into the printer toolhead. The ERCF gear motion system (i.e. what is used to push and pull the filament) is based on the Voron Design M4 extruder.
- The Enraged Rabbit Carrot Patch (ERCP). It is a light spool-holder and buffer combo to help you deal with the filament management issue associated with multimaterial systems.
- The Enraged Rabbit King's Seat (ERKS). The King's Seat is a pellet-purge system to remove the need for a wipe-tower and make faster filament purges. This system is designed for VORON V2s only so far.
- The filament sensor : a filament sensor system located below the extruder gears to check proper loading and unloading of filament.

The ERCF was inspired by the Prusa MMU2 and the Smuff.

ACKNOWLEDGEMENTS

It is important for me to mention that while I started this project alone, many people have joined along the way and have participated (and still are) in this adventure, whether it is by providing feedback, developing a mod or simply expressing kind words. I would never been able to do all of that without this support, thanks a lot!

I would like to particularly thank Tircown (the master of sensors!), the Voron Dev team (special mention to Dunar), Benoit, Dustin Speed, Kageurufu and the HonHonHonBaguette people!

Ette // Romain

INTRODUCTION

STL FILE KEY

The STL file naming convention is the same as for VORON designs, namely :

PRIMARY COLOR

Example Filament_Block_xN.stl
These files will have nothing at the start of the filename.

ACCENT COLOR

Example [a]_Blocks_End_Feet.stl
These files will have ''[a]'' to the front to mention that they are intended to be printed with an accent color.

QUANTITY REQUIRED

Example Filament_Block_xN.stl
If a file ends with ''_x#'', that is telling you the quantity of that part required to build this system. For the ERCF, ''N'' means the number of tools.

PRINT GUIDELINES

The print guidelines are also the same as for VORON designs, namely :

FDM MATERIAL

The ERCF was tested only with ABS, so I recommend to use ABS to build the ERCF.

LAYER HEIGHT

Recommended : 0.2mm

EXTRUSION WIDTH

Recommended : Forced 0.4mm

INFILL PERCENTAGE

Recommended : 40%

INFILL TYPE

Grid, Gyroid, Honeycomb, Triangle or Cubic.

WALL COUNT

Recommended : 4

SOLID TOP/BOTTOM LAYERS

Recommended : 5

SUPPORTS REQUIRED

None at all.

Beware that this project requires a well tuned printer and slicing profile, as there are many press fits and plastic on plastic mechanisms. You should first print the ERCF_Calibration_Tool.stl, test the part, as shown in the manual, tune your printer and profile if needed, and then only print the rest of the parts.

HOW TO GET HELP

If you need assistance with your build you can head over the VORON Discord group and post your questions in the *ercf_questions* channel. It is the primary medium to help people with their ERCF build and tuning! You can also check the Github page for the latest releases.

DISCORD https://discord.gg/xgXWctB

GitHub https://github.com/EtteGit/EnragedRabbitProject

FINAL THOUGHTS

Building and using a multi-filament system can be a daunting task. Take your time! Little issues in the assembly phase tend to stack up and cause you trouble later on. If at any point you get stuck or are just not sure about something, please ask on Discord. There are no stupid questions!

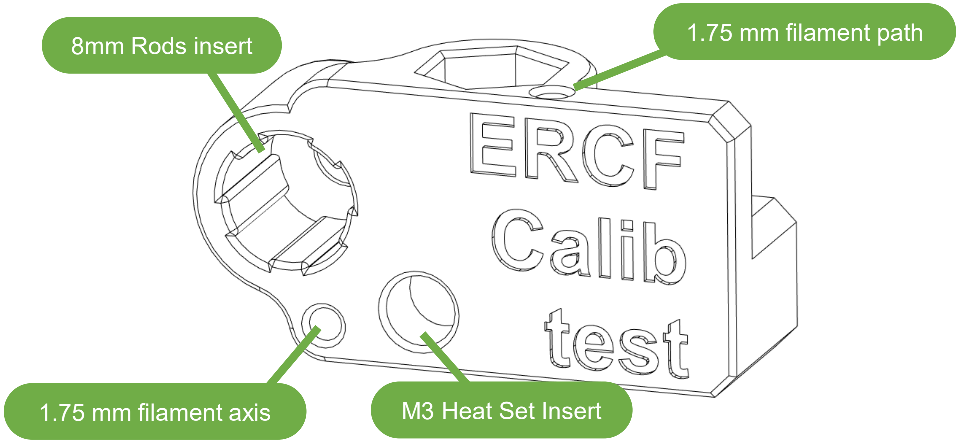
You already probably heard that multi-filament systems are quite often a pain to deal with, and that's quite true. While the goal for the Enraged Rabbit Project is to offer a cool, reliable and easy to use system, you'll probably face issues at one time or another. Check the documentation, the guides and, again, don't hesitate to come on the Discord and ask. There are plenty of possible issues, and there is a very high chance it's been seen and solved already.

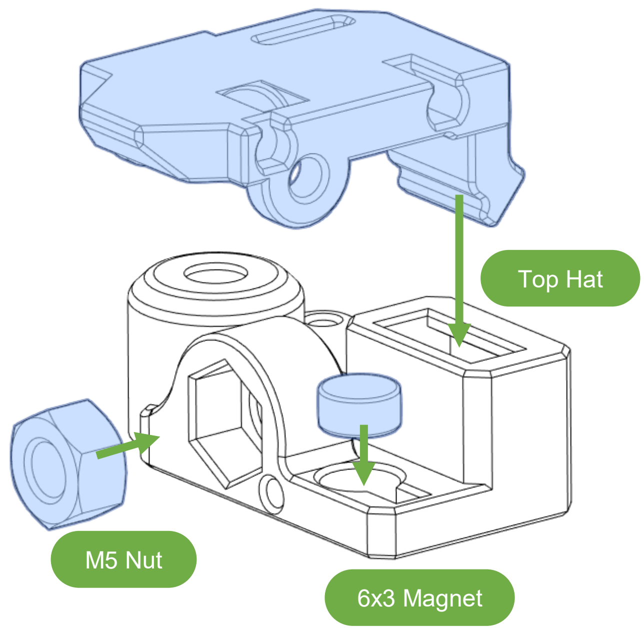
Have fun building and using the ERCF!

CALIBRATION PART

CALIBRATION TOOL

Use this print to ensure your printer and slicing profile are properly tuned to have a pleasant ERCF assembly experience.





TESTS

Make sure you can insert the different hardwares in their dedicated slots.

There is also a « Filament path » so you can check that 1.75mm filament slides through without friction. The « Filament axis » should have friction.

For the Top Hat, insert the arm of the Top Hat into the slot. You'll have to find the proper orientation to have a smooth insertion, you should not force much.

Once inserted, the Top Hat should be able to move up and down easily.

To remove the Top Hat, pull it up while rotating it.

HEAT SET INSERTS

This design relies heavily on heat set inserts. If you've never worked with heat set inserts before, watch this guide :

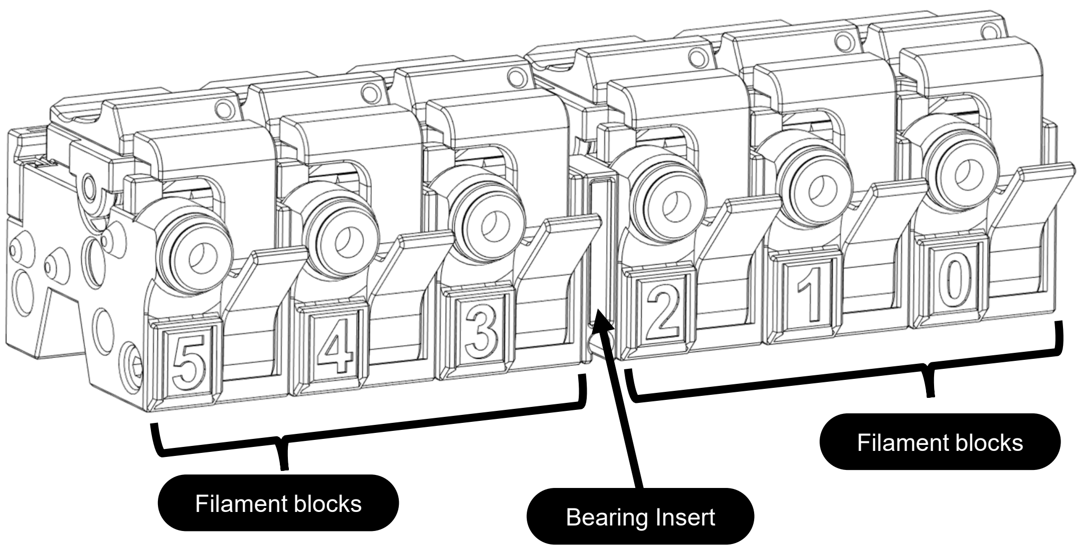
https://www.youtube.com/watch?v=cyof7fYFcuQ

Here is a list of all the pages of this manual where you need to insert those in the 3D printed parts, so you can do this step at once for the whole assembly :

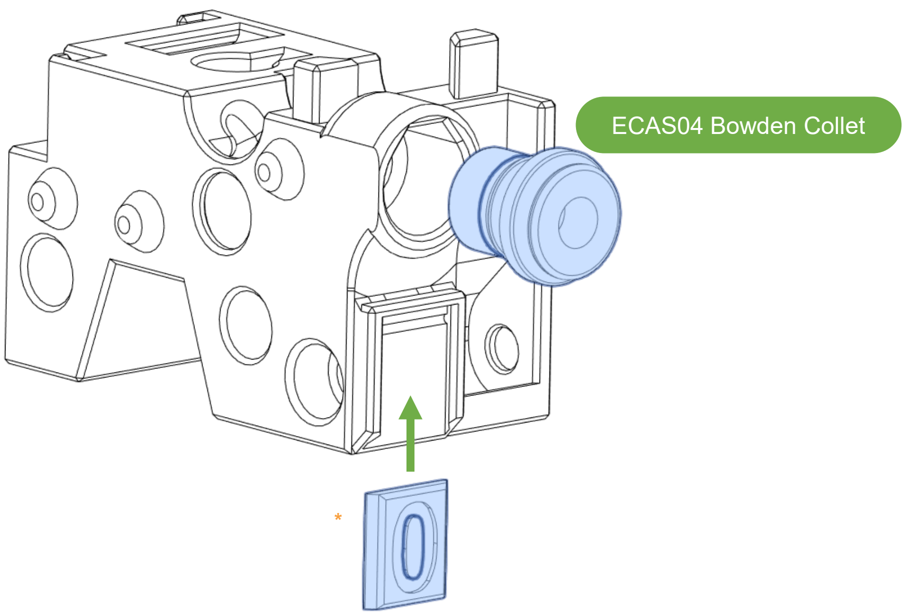
- Page 20
- Page 22
- Page 23
- Page 39
- Page 45
- Page 49
- Page 59


5
4
3
2
1
0

OVERVIEW



FILAMENT BLOCKS

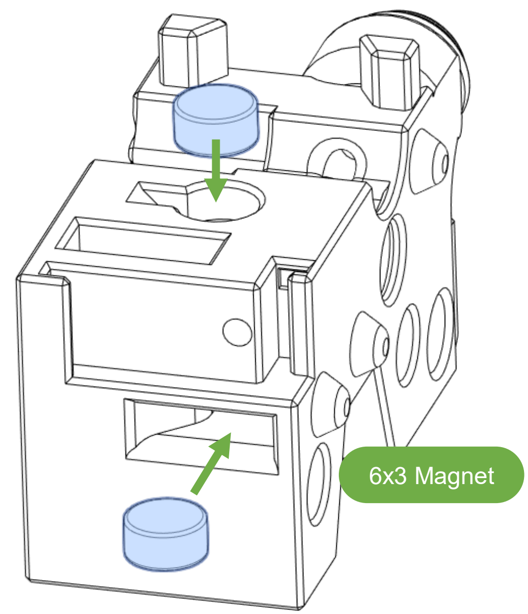


FILAMENT BLOCK NUMBERING

Use the different numbered plates to easily identify each of the ERCF tools.

MAGNET ORIENTATION

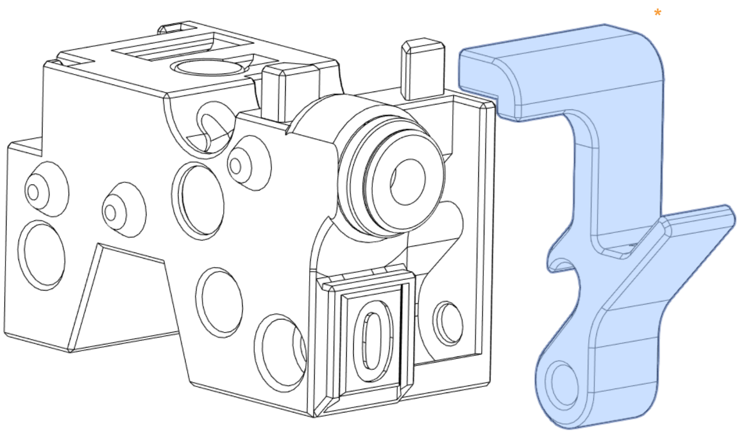
Install the top magnets with the same polarity for all filament blocks. Polarity for the front magnets does not matter.

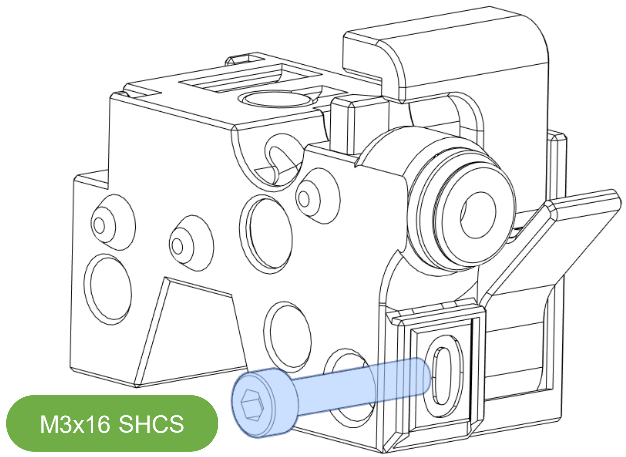


MAGNET HEIGHT

6x3 Magnets can have a very off-spec height and be much shorter than 3mm. In case you find the front magnet floating in its pocket, add a bit of CA glue to hold it in place.

FILAMENT BLOCKS

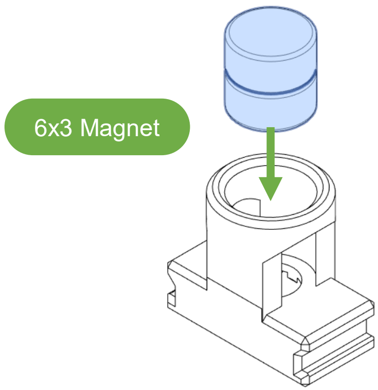




LATCH SCREW

The latch screw is screwed directly into the plastic. Don't over tighten it, it's just the latch rotation axis.

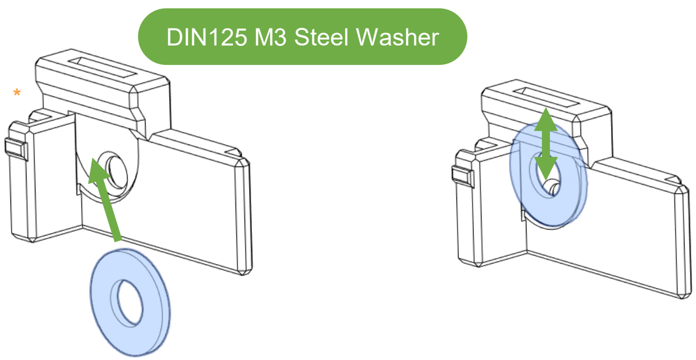
MAGNETIC GATES



GATE KEY

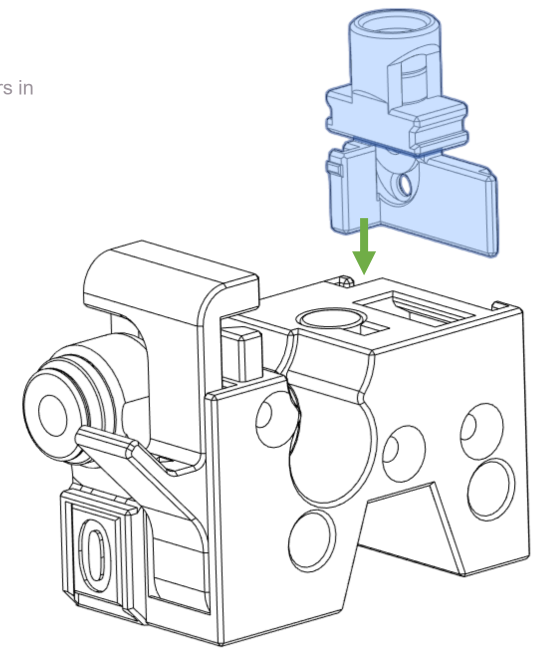
Insert the two magnets into the Gate Key.

The Gate Key allows you to open Magnetic Gates when the selector is not in front of them, and also to secure the washers in the magnetic gates when you install or remove them.



WASHER INSERTION

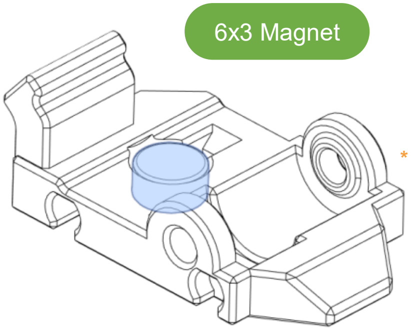
First check that each washer has a flat surface for both sides (i.e. no residues from the stamping process). If not, use a file to fix that. Insert the washer from the bottom right (using picture orientation) and push it into its slot. It should move freely up and down.

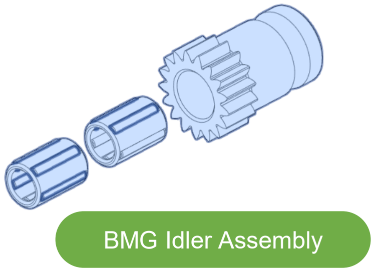


INSERTION

Use the Gate Key to keep the washer in place while you slide down the Magnetic Gate, then remove the Gate Key.

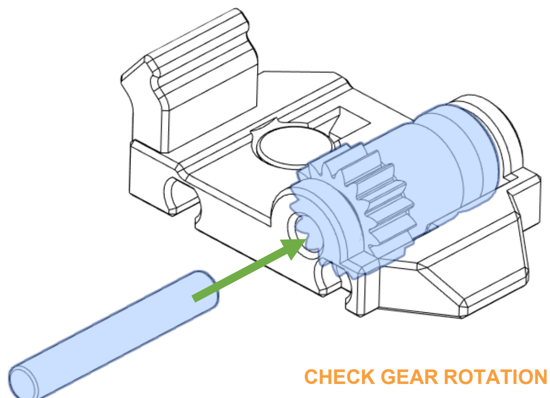
TOP HATS





MAGNET ORIENTATION

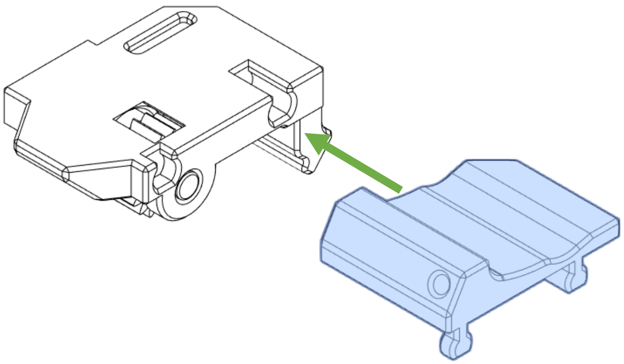
Install the magnets so they will repel from the top magnets on the Filament Blocks.



CHECK GEAR ROTATION

Make sure the BMG idler is spinning freely.

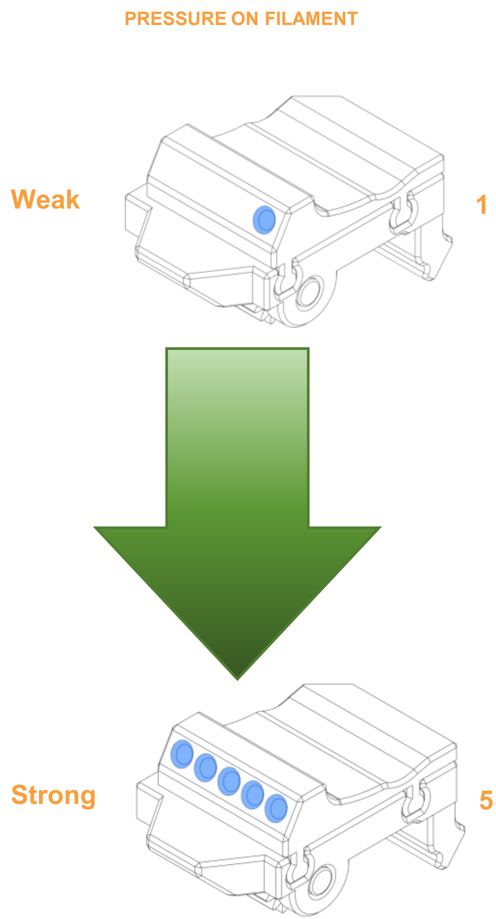
TOP HAT LOCKERS



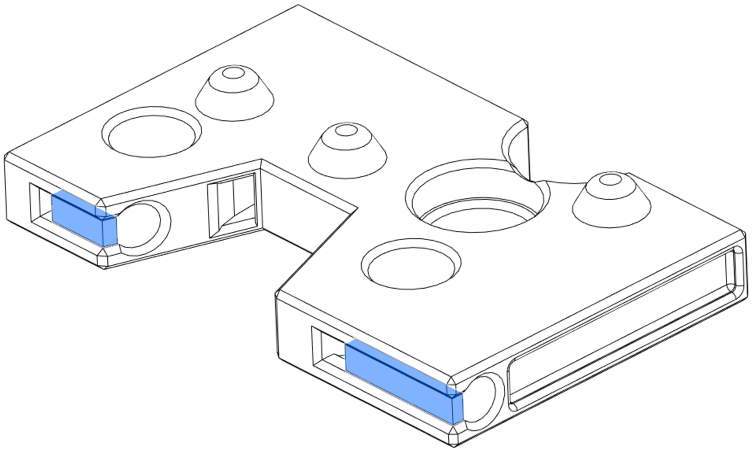
TOP HAT LOCKERS

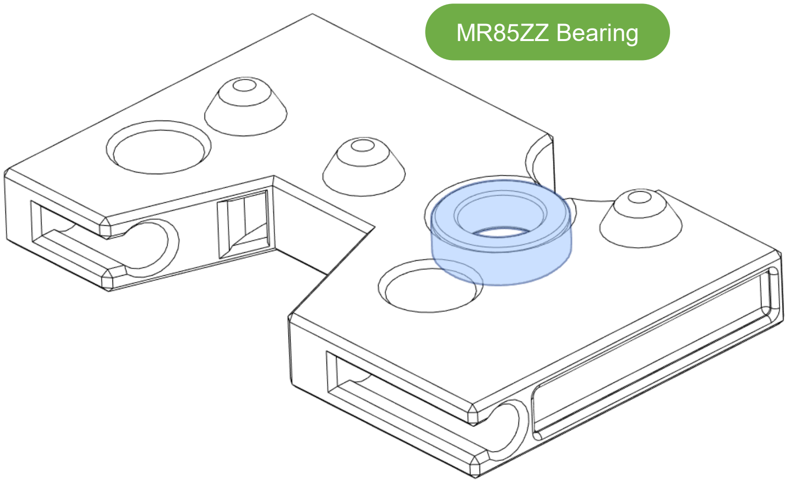
Slide-in the Top Hat Locker for each Top Hat until you hear the *click*. Top Hat Lockers values (i.e. the number of dots on the front side) are used to adjust the pressure applied on the filament for each tool. The higher the number, the stronger the pressure on the filament. Start with all tools at *1*, the values will be adjusted in the setup and tuning section of the ERCF.

Do not install the Top Hats on the Filament Blocks for now.



BEARING INSERTS

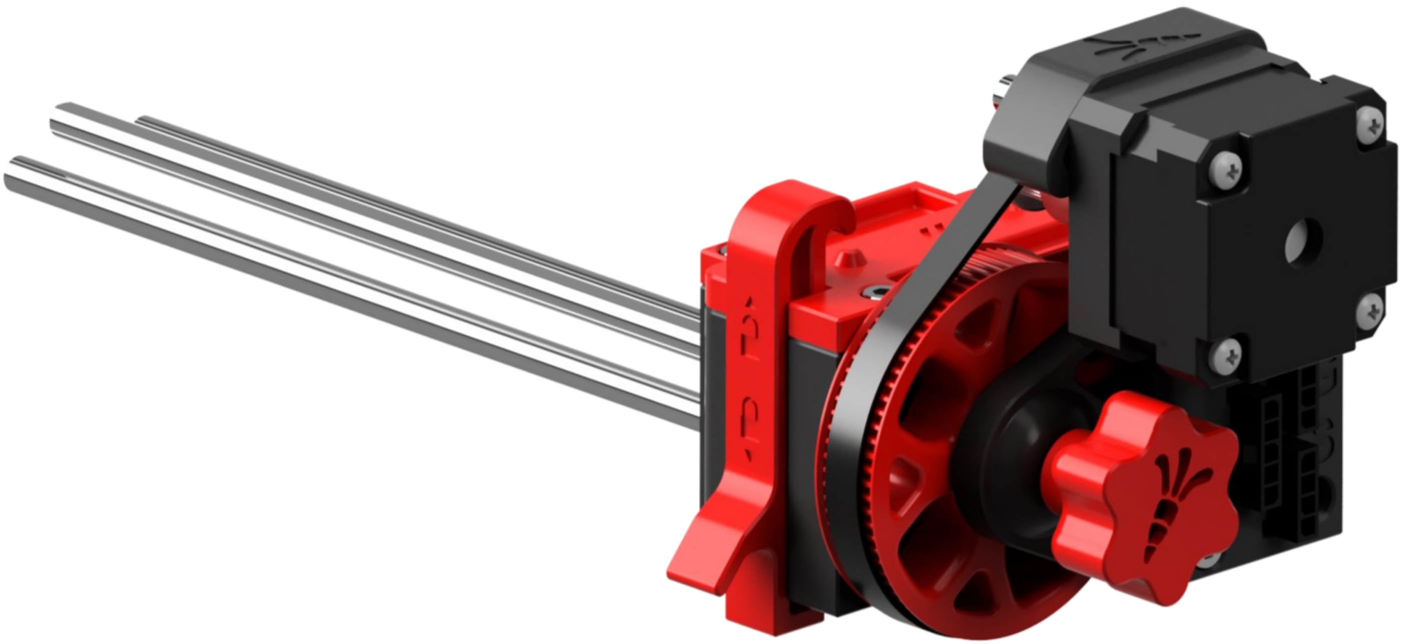




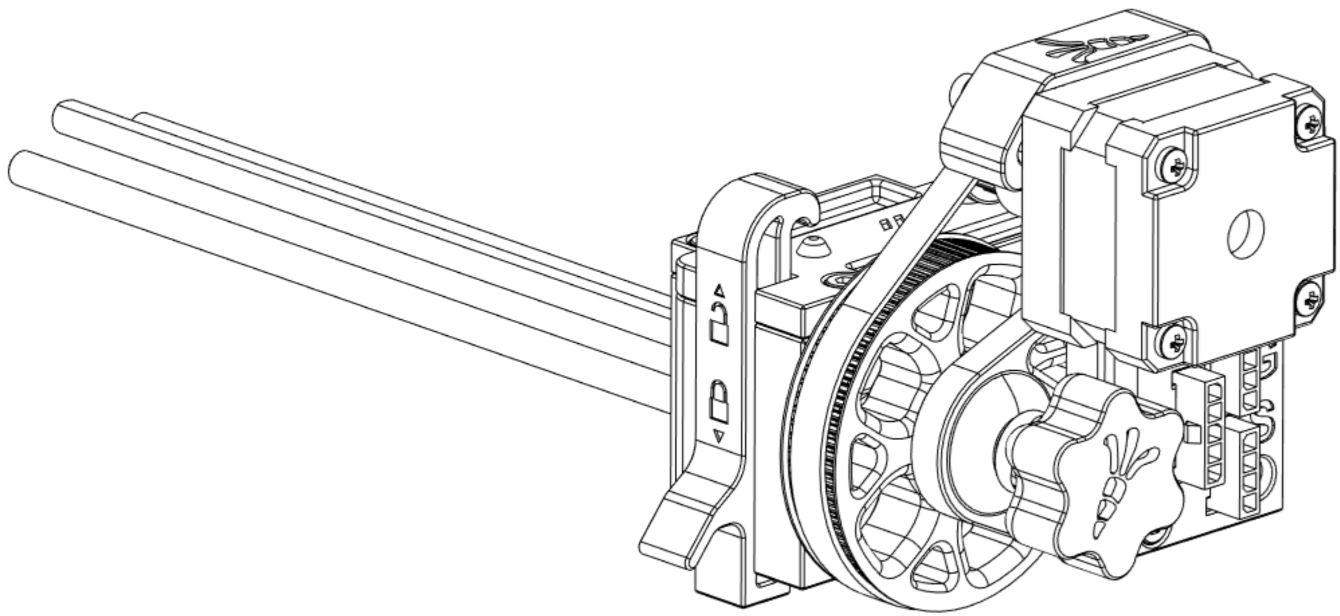
REMOVE BUILT-IN SUPPORTS

Use a small tool, like an allen key, to remove the two built-in supports.

GEAR BOX



OVERVIEW



SELECTOR MOTOR WIRE

USE OF ERCF EASY BRD

For those using the custom dedicated control board (i.e. the ERCF EASY BRD), please :

- First take a look at page 92 to get an overview of the final wiring
- Make sure that you wire the endstop, as detailed next page
- Skip the steps for the pages with the label on the right

USERS OF ERCF EASY BRD:
Skip this page – see page 92

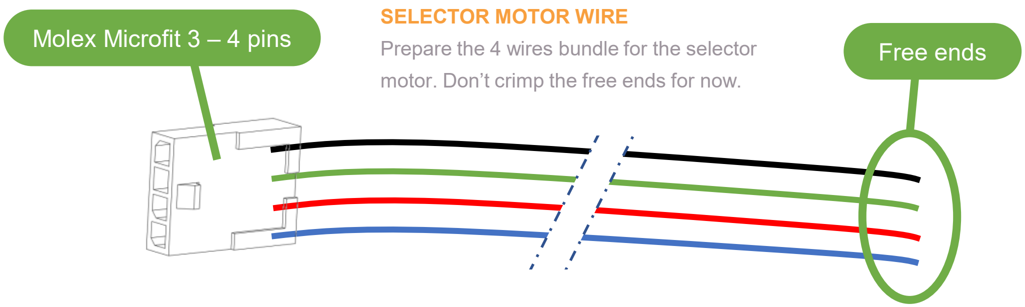
PREPARING THE WIRES

For an easier installation, it is recommended to already prepare the wires. There are two wire looms to do :

- One that goes from the connector plate to the selector motor
- One that goes from the connector plate to all the other components, namely the endstop, the servo and the encoder

SELECTOR MOTOR WIRE

Prepare the 4 wires bundle for the selector motor. Don't crimp the free ends for now.



CONNECTION ON THE SELECTOR MOTOR SIDE

It is recommended to deal with the selector motor connection later in the assembly, to ensure the crimps are done with the proper wire length.

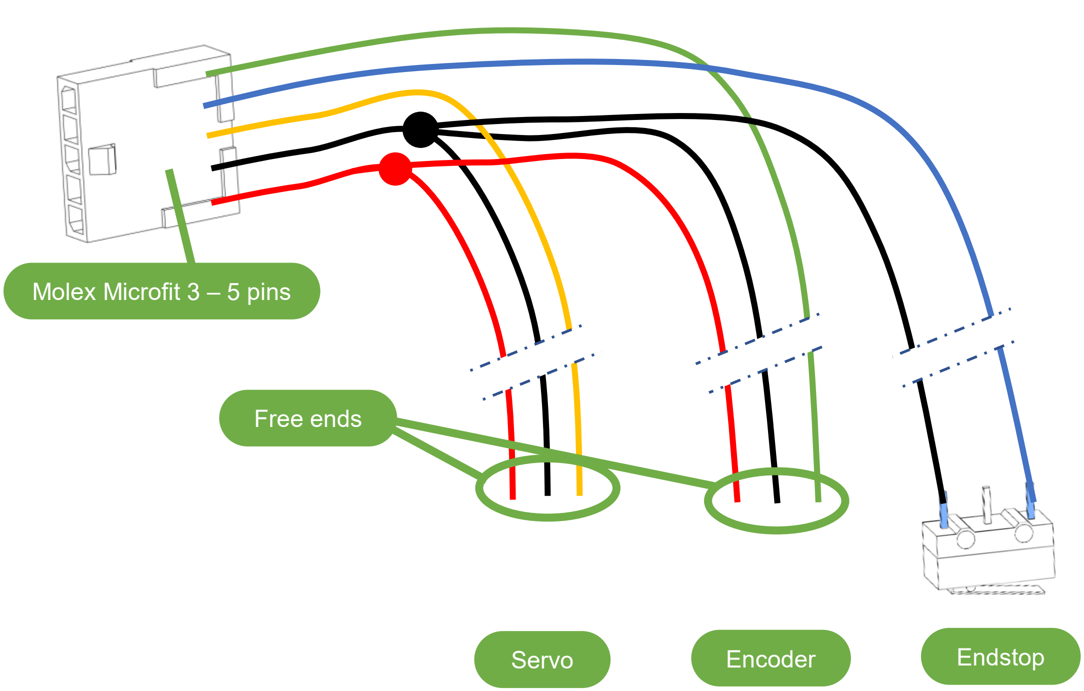
Typical wire length required for the selector motor wires

Chans.	Length (cm)
	Selector motor
3	25
6	33
9	40

VARIANT

For certain build size, the wires from the selector motor can be long enough to reach the connector plate. You can therefore crimp the Molex Microfit 3 connector directly on those if you want to.

SENSOR AND ENCODER WIRE



USERS OF ERCF EASY BRD:
Do the Endstop wiring and skip the rest of this page – see page 92

You still need to wire the endstop (free ends). Also wire lengths may be differents

Typical wire length required for each component (with some room already)

Chans.	Length (cm)		
	Endstop	Servo	Encoder
3	6	50	60
6	6	65	75
9	6	80	90

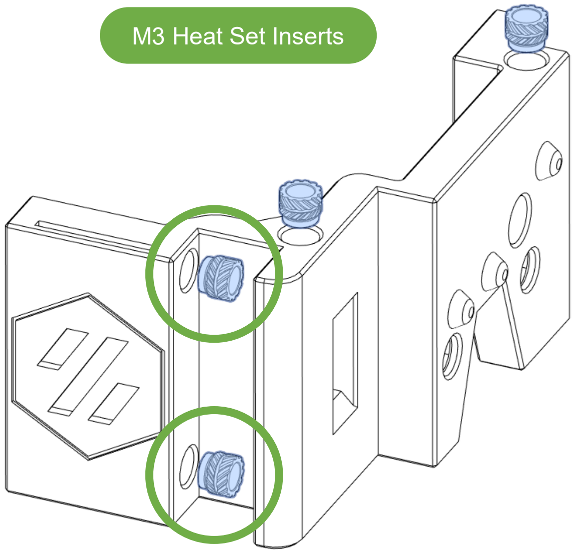
GENERAL CONNECTOR WIRE

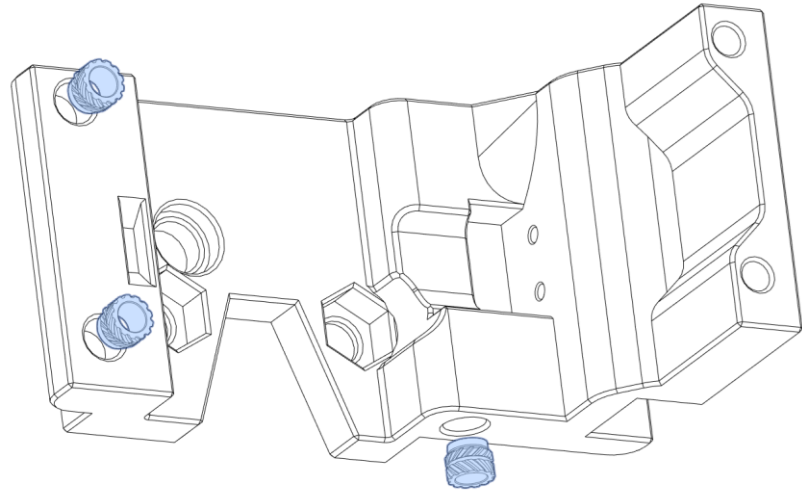
Prepare the 5 wires bundle for the ERCF. The GND is shared between the Servo, the Encoder and the Endstop. The +5V is shared between the Servo and the Encoder. **IF YOU ARE USING AN EASY BRD, DO NOT CONNECT THE SERVO AND ENCODER +5V LINE, REFER TO PAGE 92.**

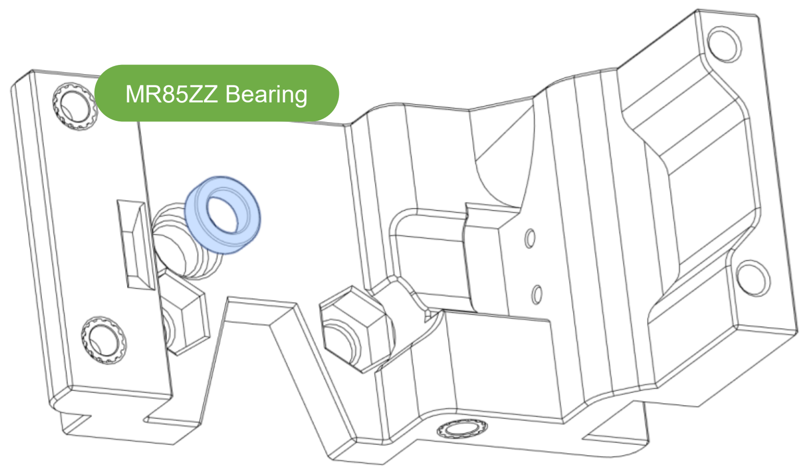
To join the multiple GND//+5V lines, either crimp them together or make a splice prior to the crimp position.

Only the Endstop is directly connected to this wire bundle, typically by soldering the wires directly on the microswitch pins.
It is recommended to do the crimps on the Servo and the Encoder sides later in the build, to ensure proper wire length.

GEAR BOX FRONT



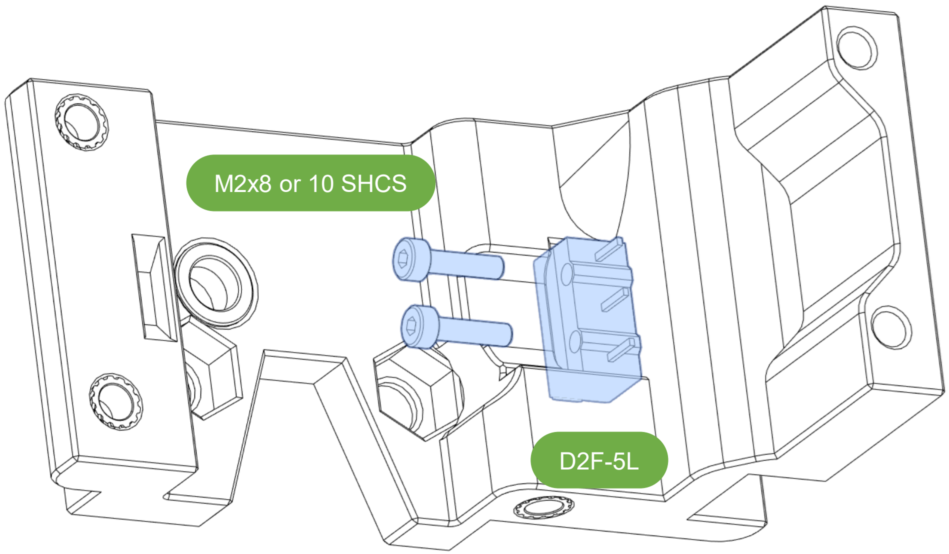


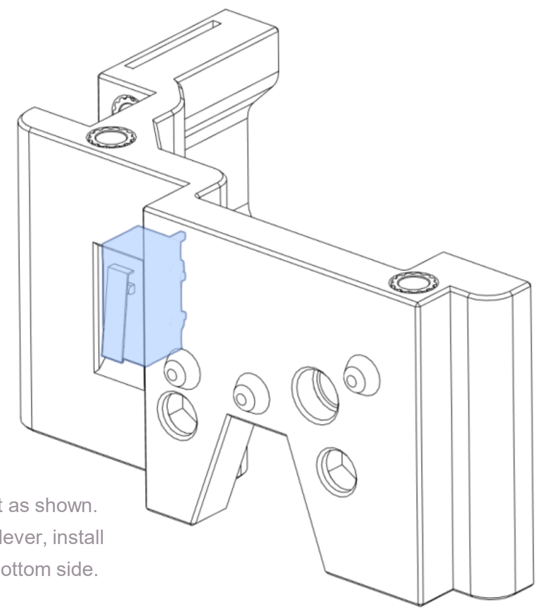


HEAT SET INSERTS TIP

Push those inserts using the soldering iron from the side and take your time to make them well flush with the surface and aligned with the screw path.

SELECTOR ENDSTOP

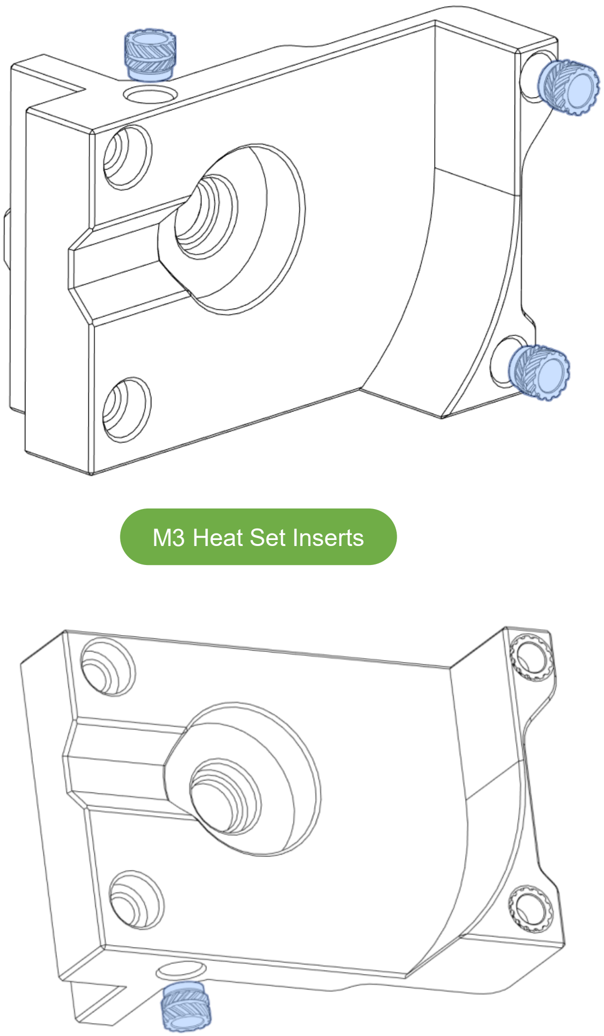


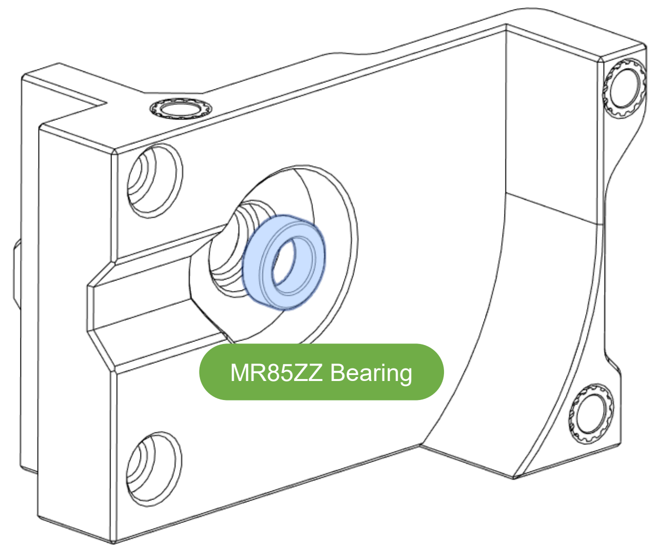


MICRO SWITCH ORIENTATION

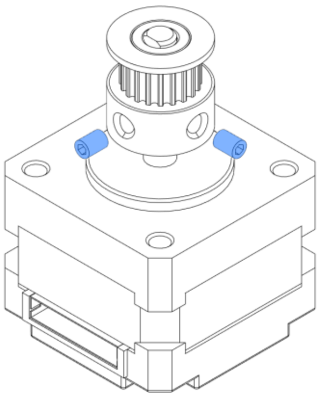
If you are using a levered micro switch, install it as shown. In case you are using a micro switch without a lever, install it in the other direction, with the button on the bottom side.

GEAR BOX BACK





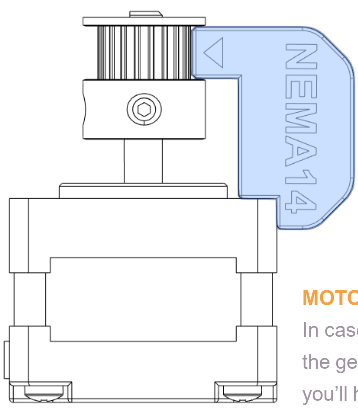
MOTOR ARM



GRUB SCREWS

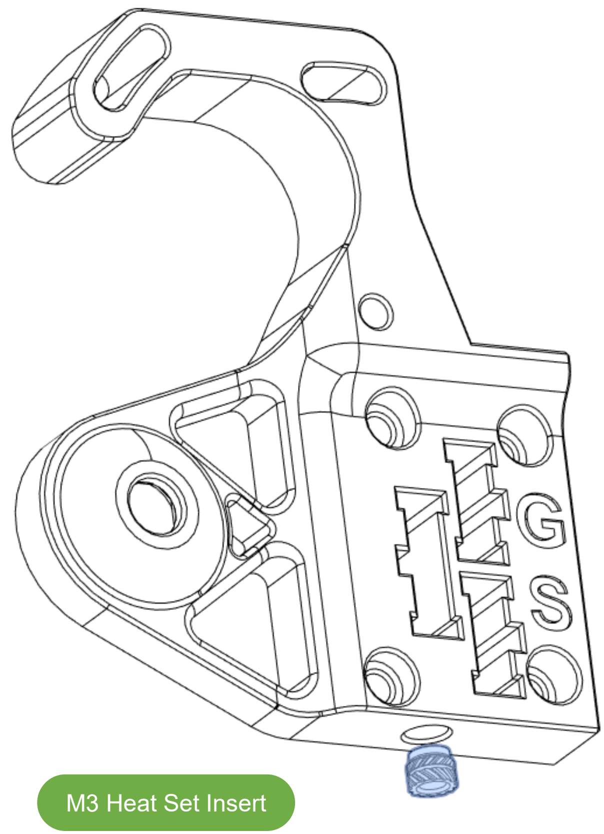
Insert both grub screws and use thread locker on them.

Use the pulley tool to install the pulley at the proper position on the motor shaft.



MOTOR SIZE

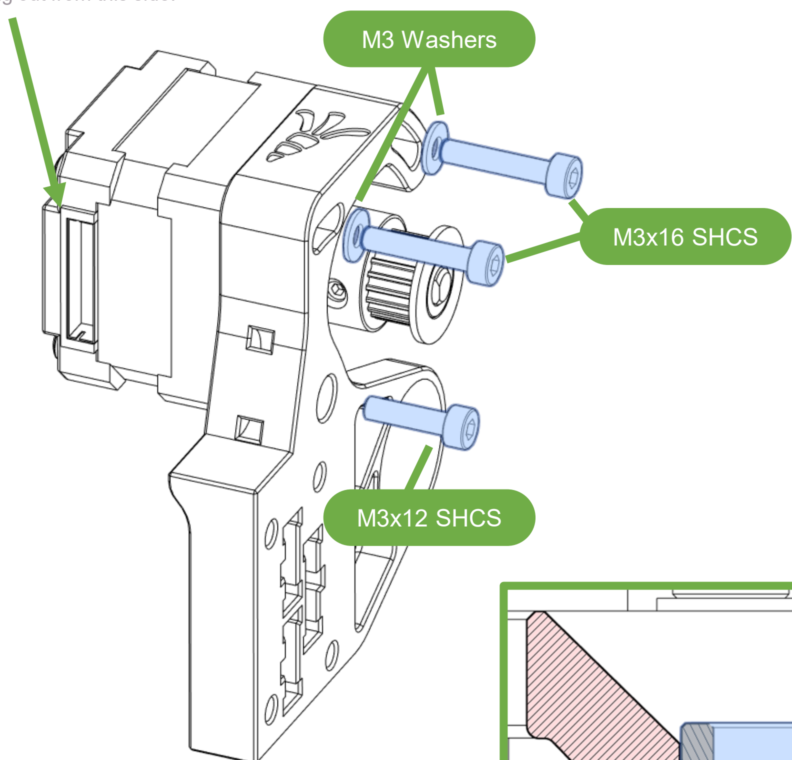
In case you are using a NEMA17 motor for the gear axis, assembly is the same, but you'll have to use the NEMA 17 pulley tool.

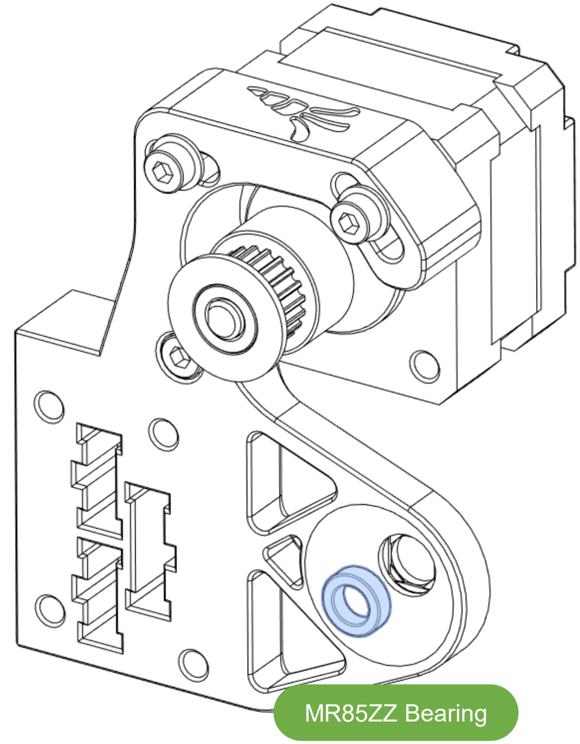


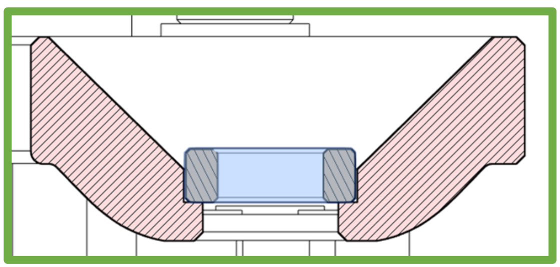
MOTOR ARM

MOTOR WIRES

Make sure the wires of the motor are coming out from this side.



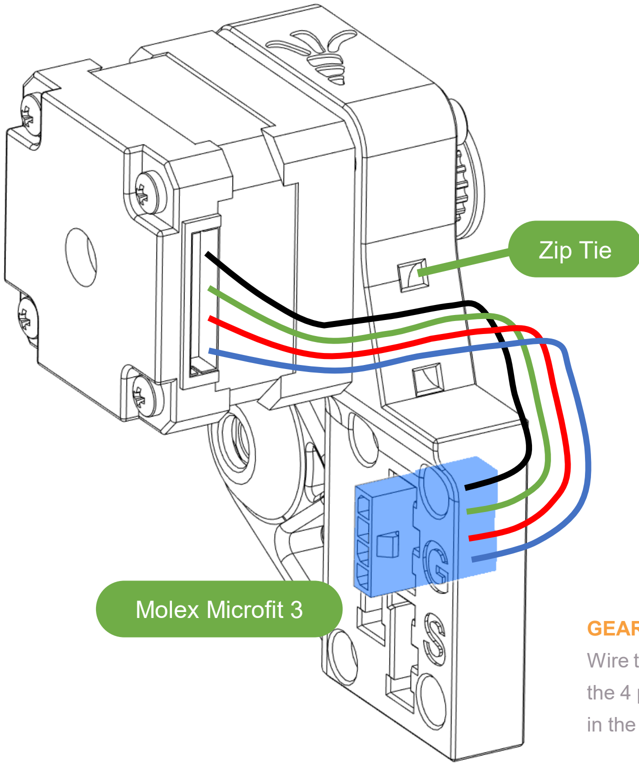




BEARING POSITION

Once installed, the bearing will not be flush and will stick out as shown.

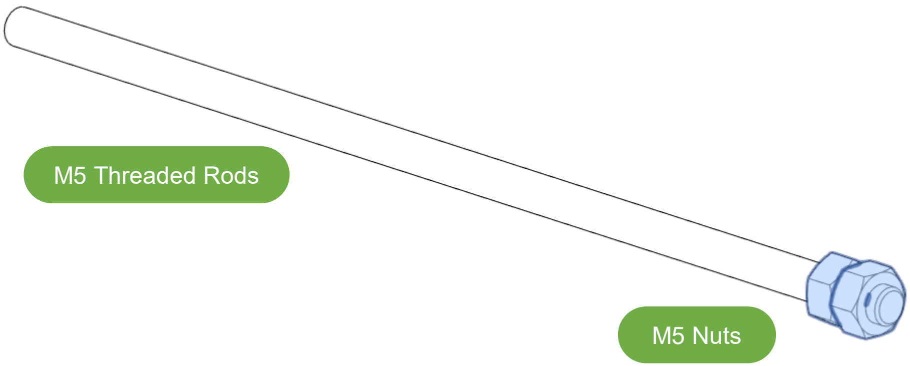
USERS OF ERCF EASY BRD:
Skip this step – see page 92



GEAR MOTOR WIRING

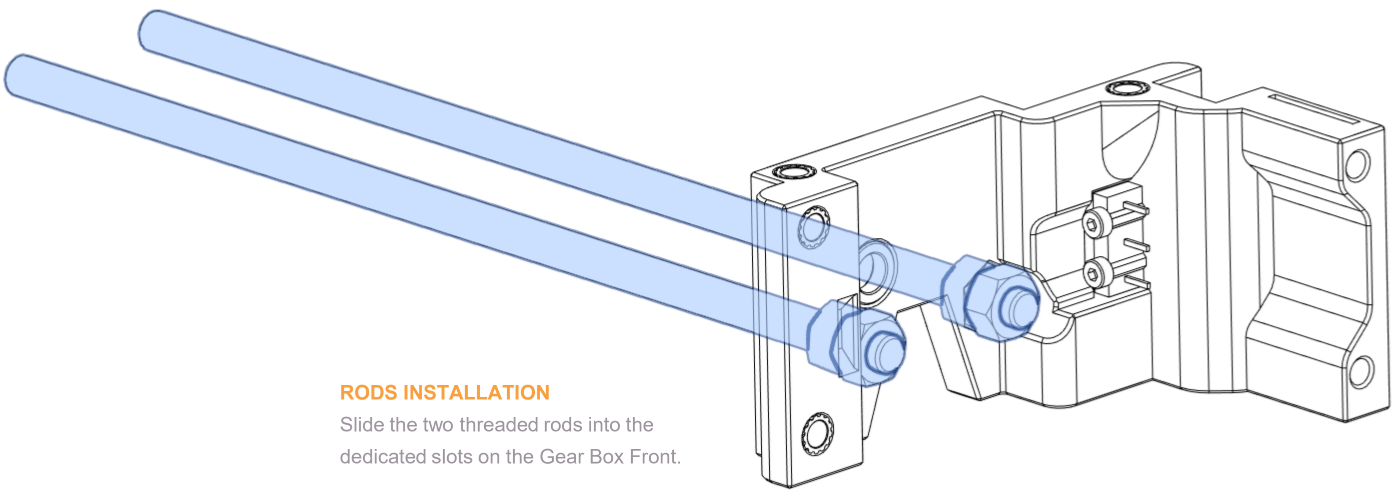
Wire the gear motor as shown. Push the 4 pins MicroFit3 female connector in the top left spot (*G*).

5MM THREADED RODS



NUTS

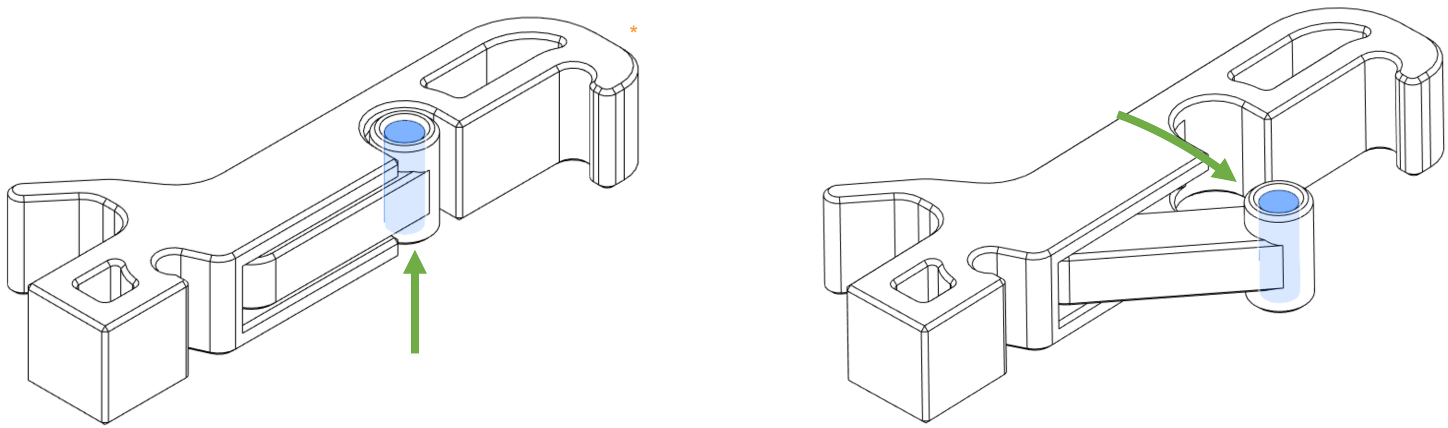
Install the two M5 nuts tightened against each other (locking mechanism) at the end of each M5 threaded rod.



RODS INSTALLATION

Slide the two threaded rods into the dedicated slots on the Gear Box Front.

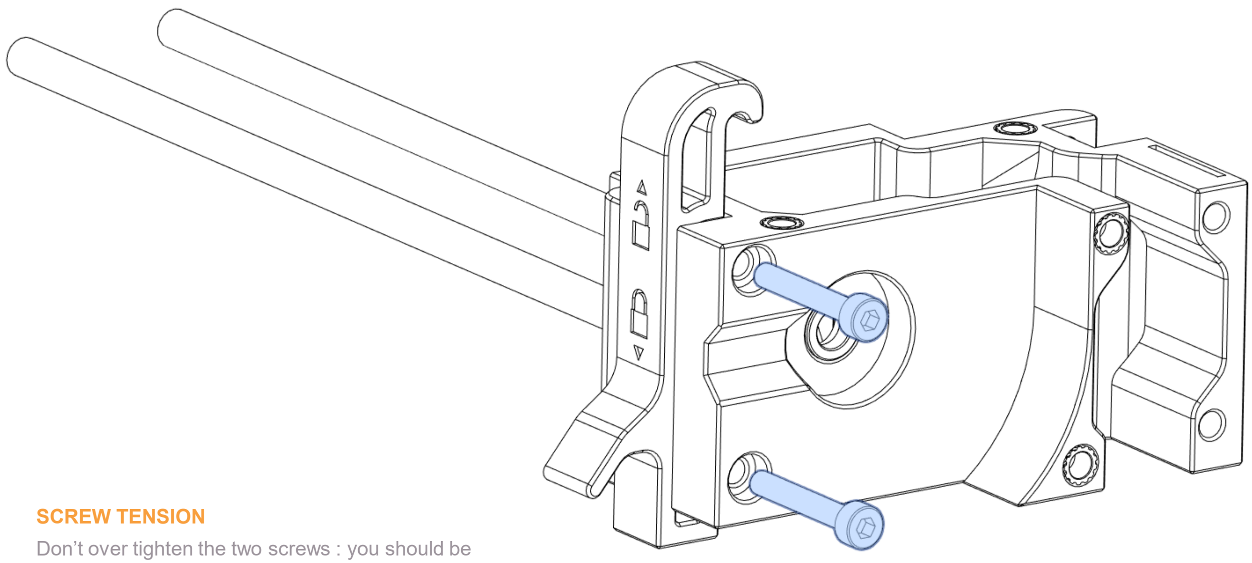
LATCHES PREPARATION



HINGE UNLOCK

Use a small tool (like an allen key) inserted into the hinge hole to free the print-in-place mechanism and ensure it rotates easily. Do that for both latches.

LEFT LATCH



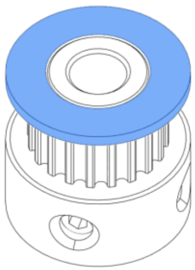
SCREW TENSION

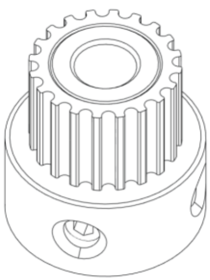
Don’t over tighten the two screws : you should be able to lock and unlock the latch without trouble.

M3x20 SHCS

M4 EXTRUDER 80T GEAR

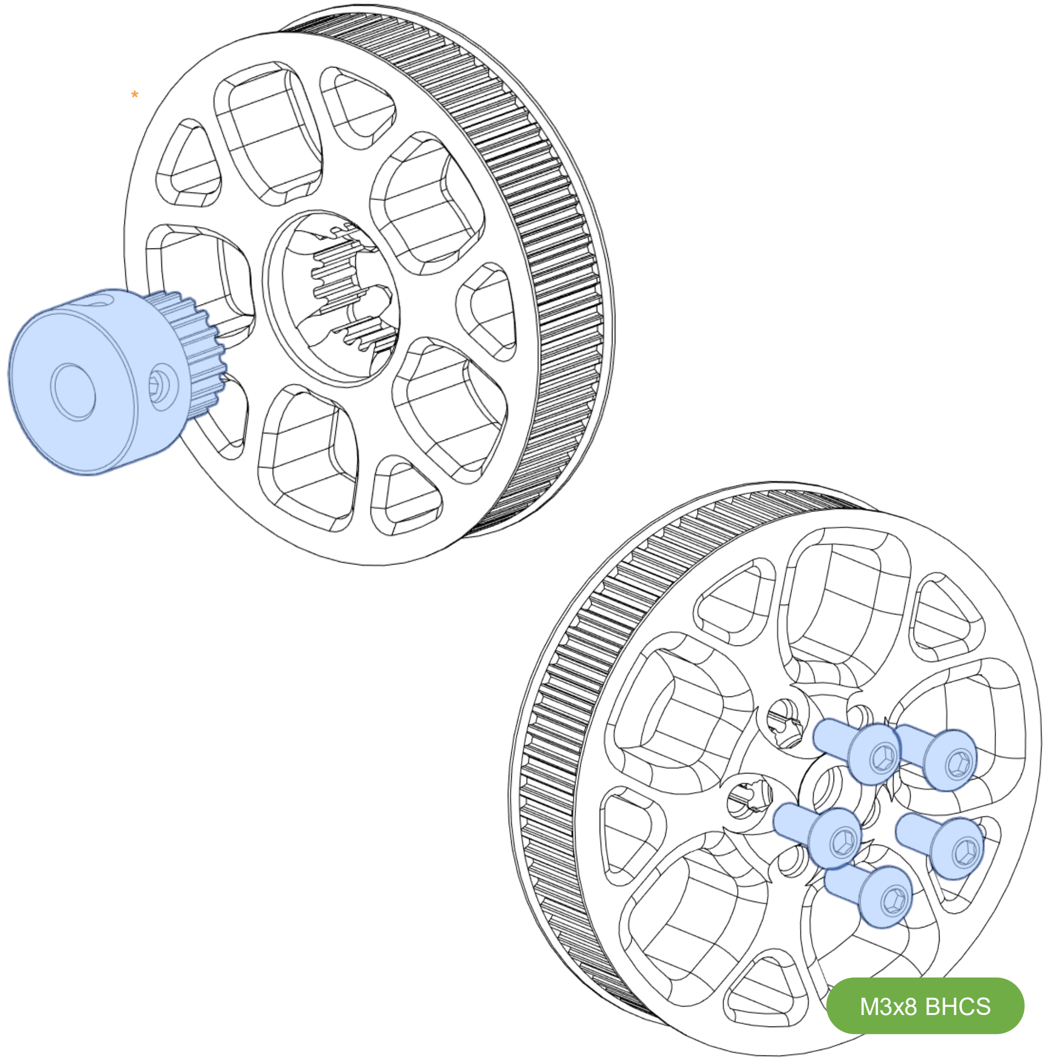
GT2 20T Pulley



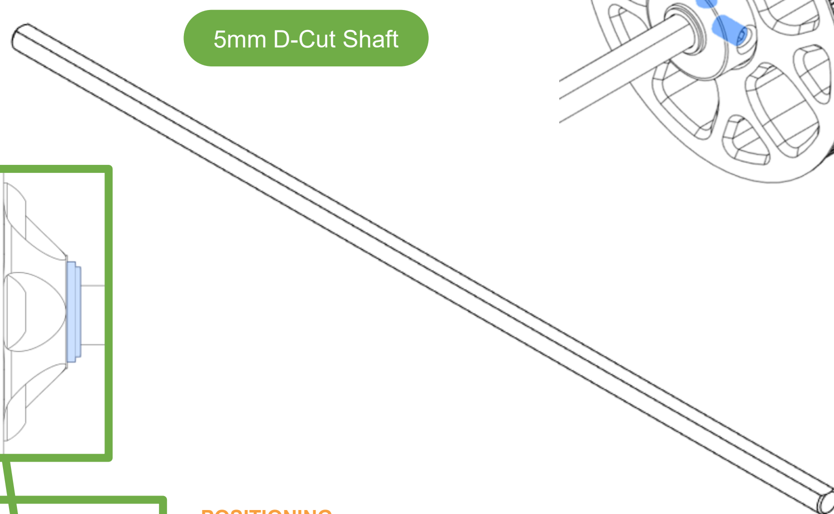


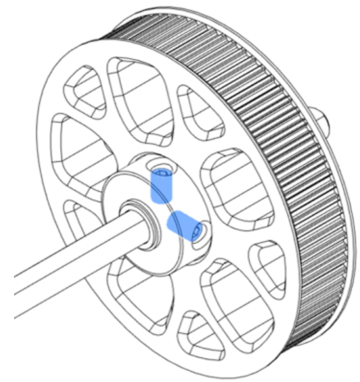
REMOVE FLANGE

Use some pliers to remove the top flange of the pulley.



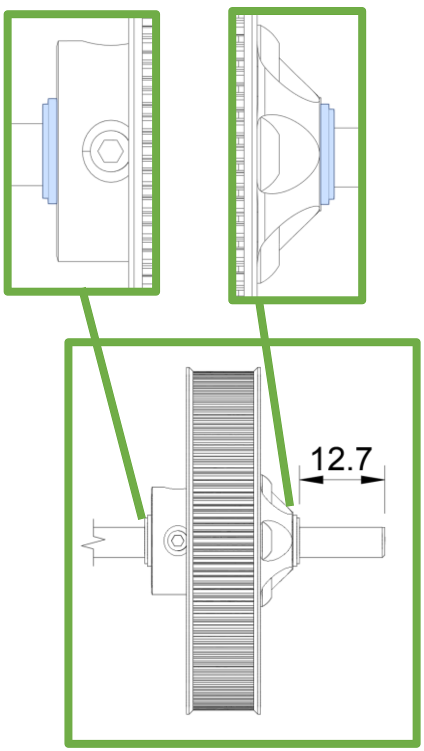
5MM D-CUT SHAFT





GRUB SCREWS

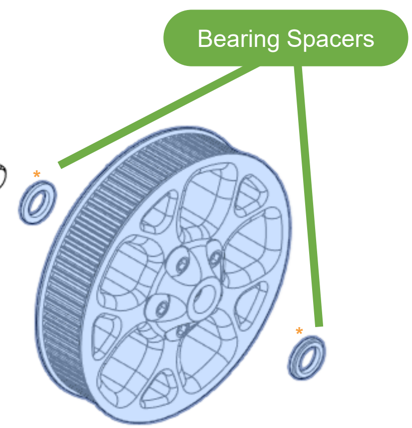
Insert both grub screws and use thread locker on them.



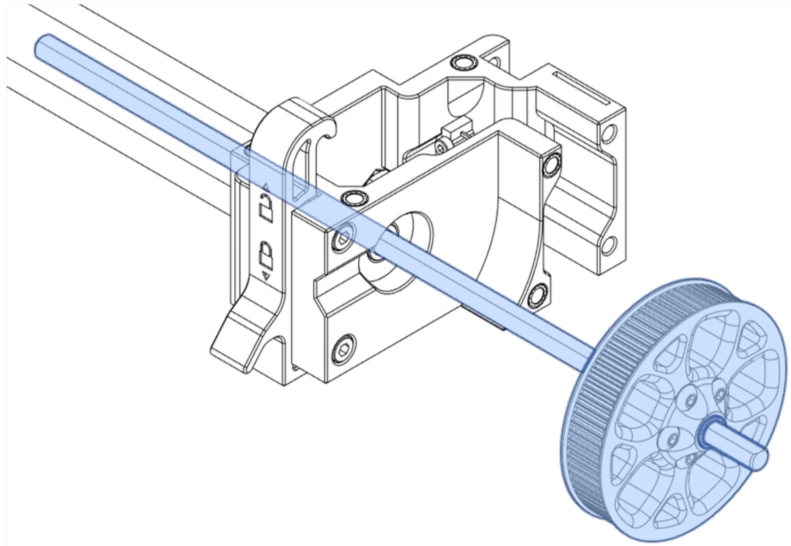
POSITIONING

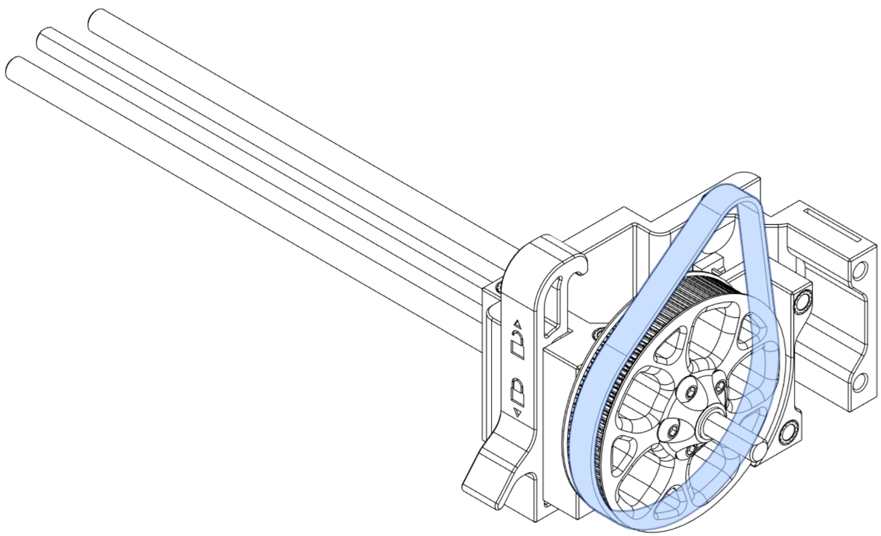
Install the Bearing spacer / M4 wheel / Bearing spacer stack at around 13mm from the D-Cut shaft end. There is no need to be very precise here.

Beware of the Bearing Spacers orientation.



GEAR BOX

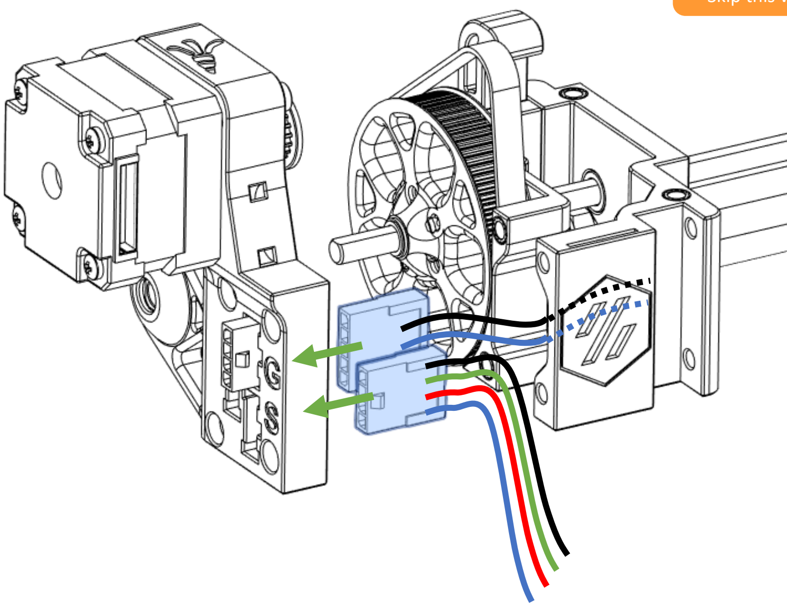




GEAR BELT

Don’t forget to install the 188mm GT2 belt around the M4 wheel after sliding the D-Cut shaft assembly into place.

USERS OF ERCF EASY BRD:
Skip this wiring step – see page 92



INSERT THE MICROFIT CONNECTORS

Insert the two microfit connectors from the wire bundles into their dedicated holes in the Motor Arm.

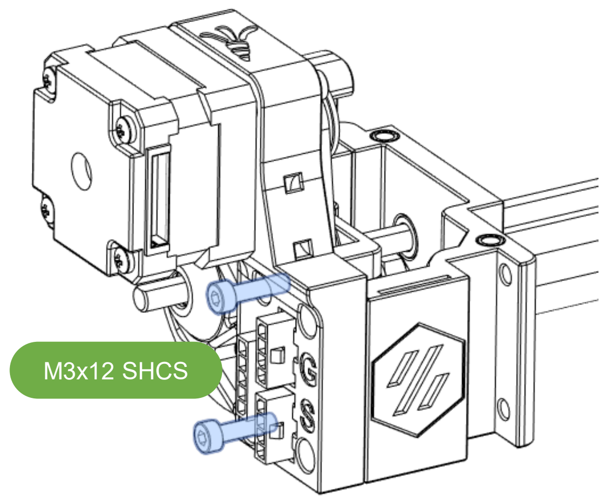
For picture clarity, only the microswitch wires are shown for the 5pins connectors (but the others are assumed present).

Let all the free wires hang to the bottom.

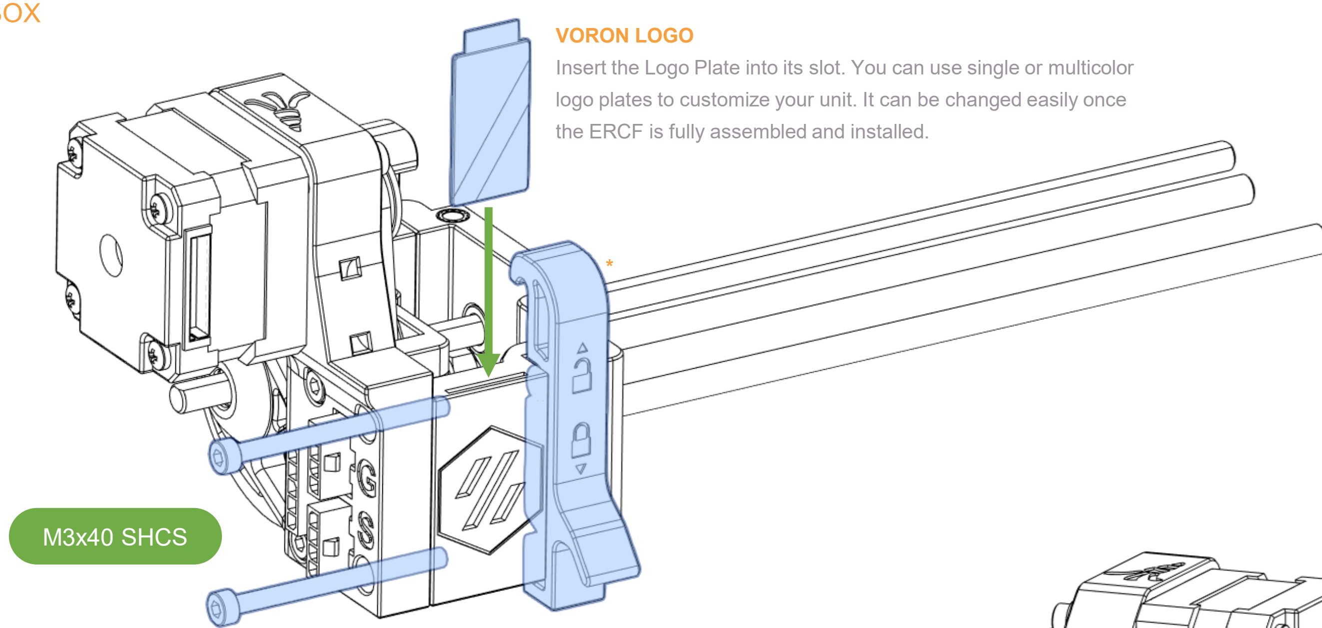
CLOSING THE GEAR BOX

Install the Motor Arm, pass the belt around the GT2 pulley of the Gear Motor, but don't tension it yet.

Make sure no wire is pinched between parts. All free wires should hang to the bottom.

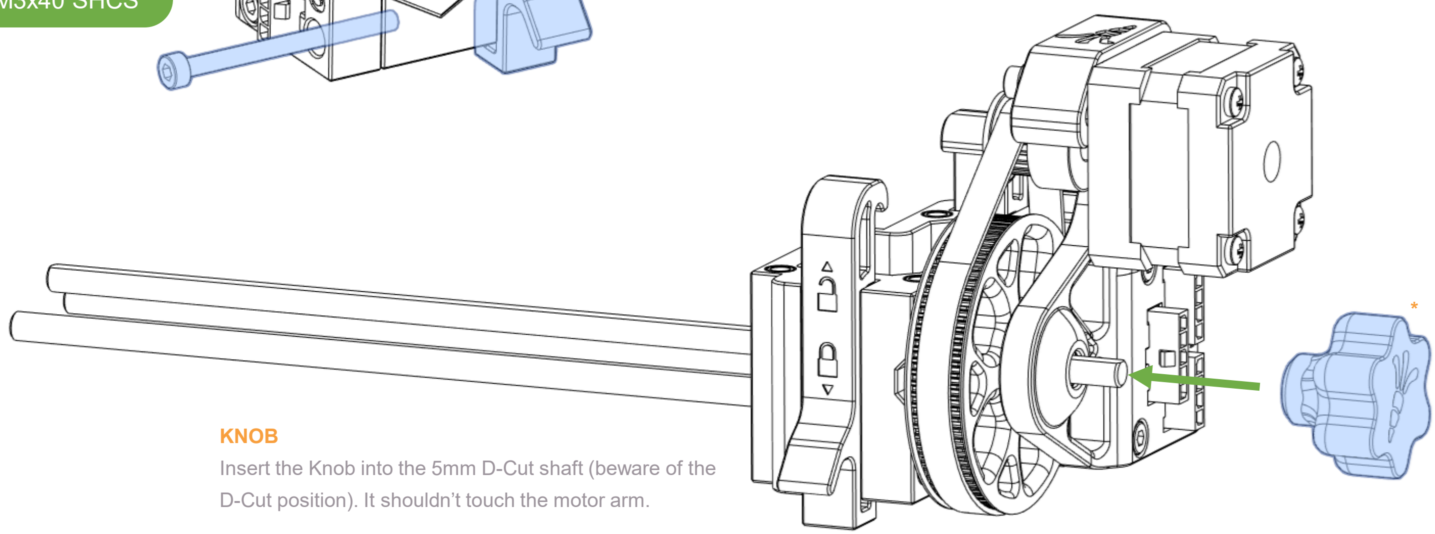


GEAR BOX



VORON LOGO

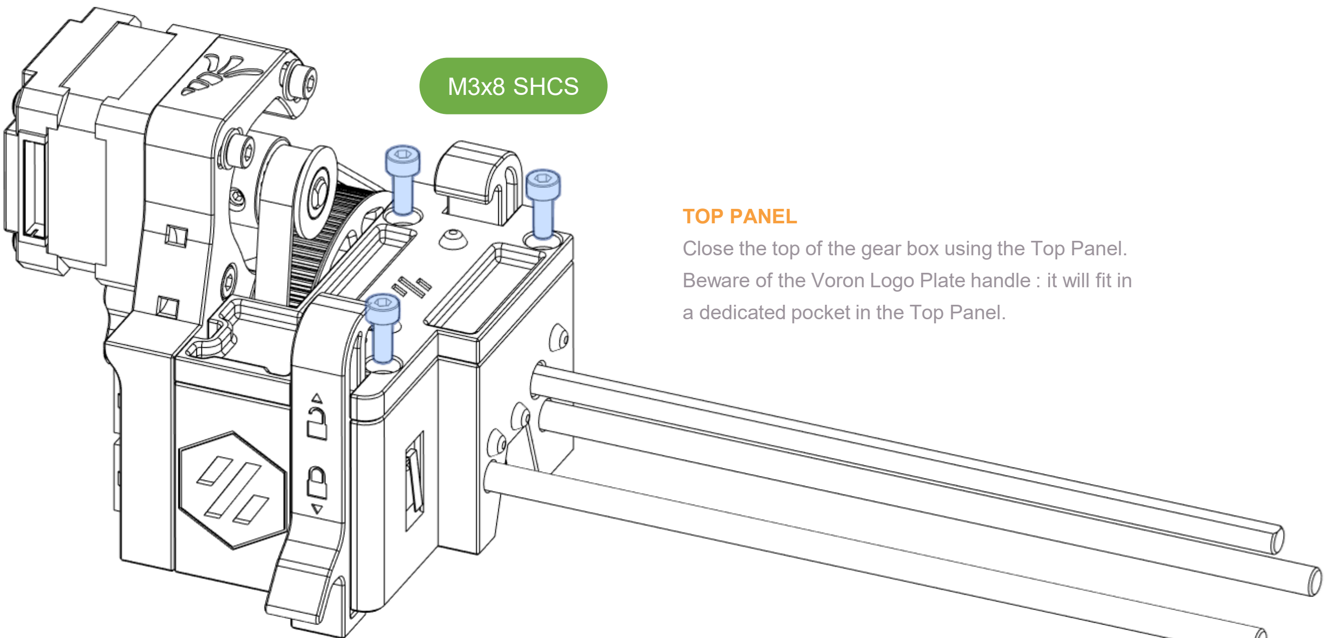
Insert the Logo Plate into its slot. You can use single or multicolor logo plates to customize your unit. It can be changed easily once the ERCF is fully assembled and installed.



KNOB

Insert the Knob into the 5mm D-Cut shaft (beware of the D-Cut position). It shouldn't touch the motor arm.

TOP PANEL



TOP PANEL

Close the top of the gear box using the Top Panel.
Beware of the Voron Logo Plate handle : it will fit in a dedicated pocket in the Top Panel.

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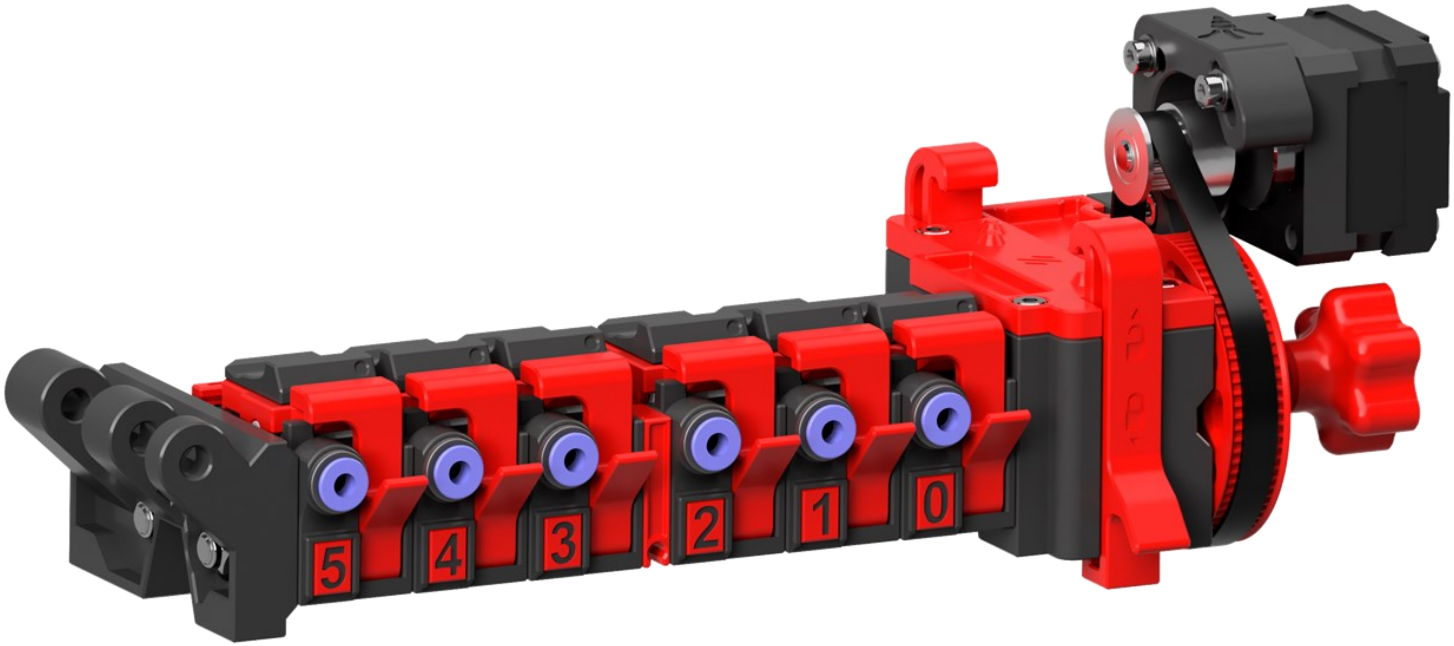
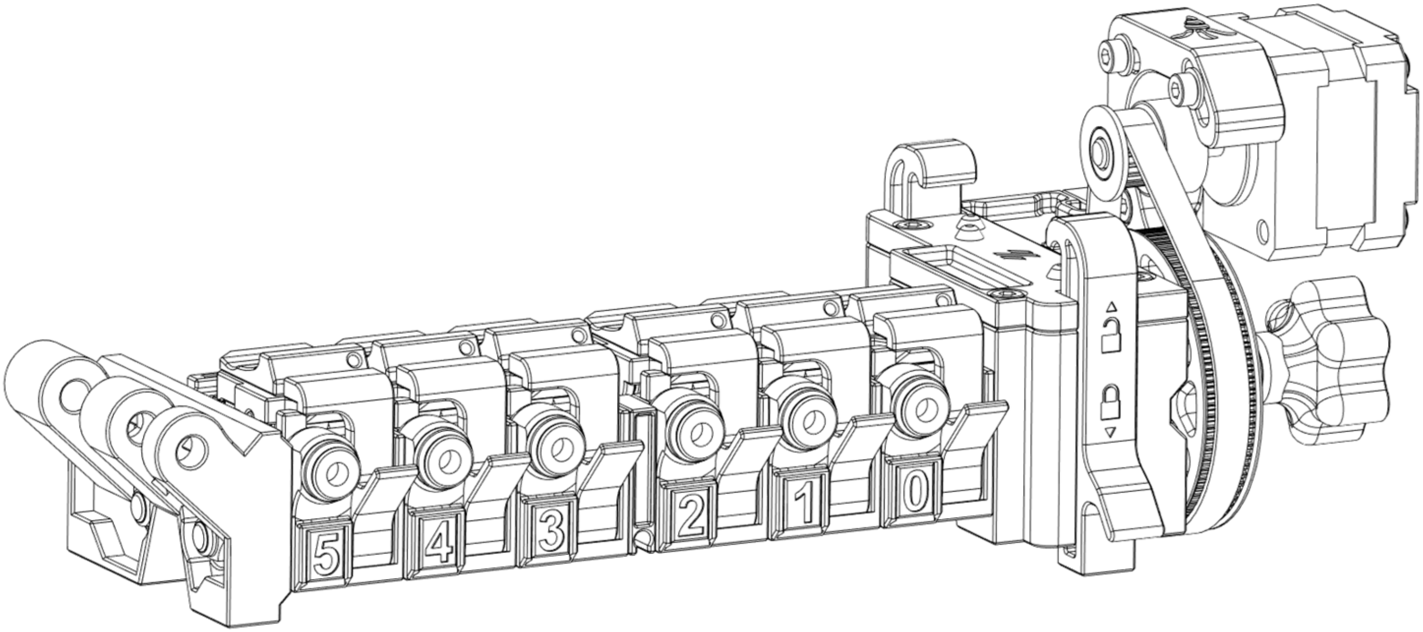
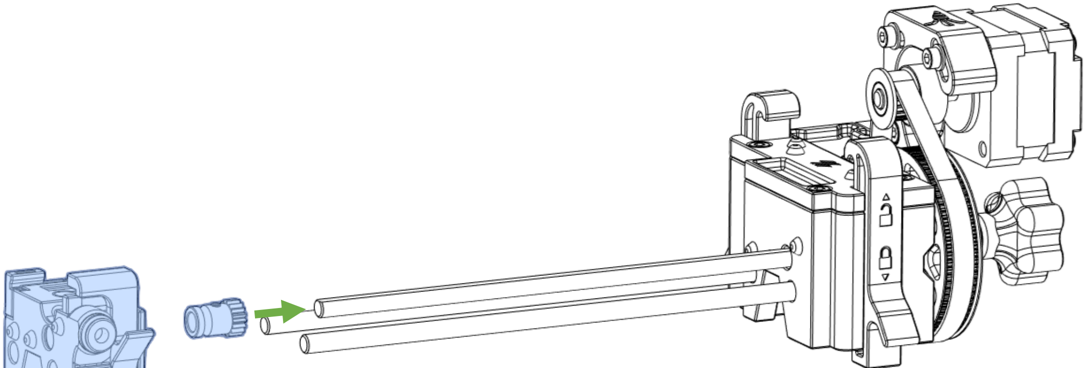
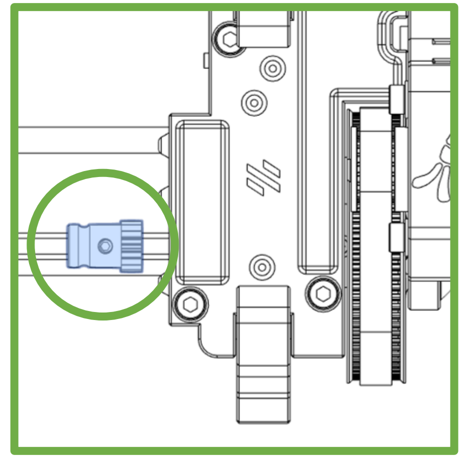
BOTTOM BLOCK




5
4
3
2
1
0

FULL BOTTOM BLOCK



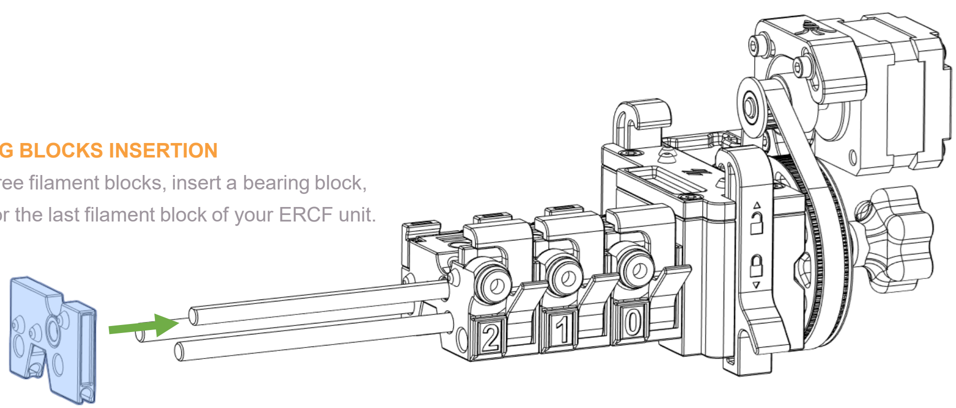


FILAMENT BLOCKS INSERTION

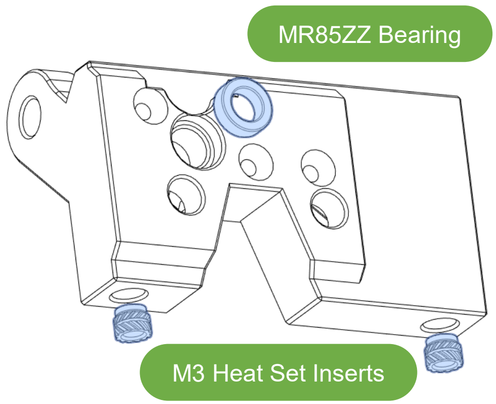
Slide a single Bondtech gear on the D-Cut shaft (beware of it's orientation!) and only then slide the first filament block. Do not tighten the grub screws yet.

BEARING BLOCKS INSERTION

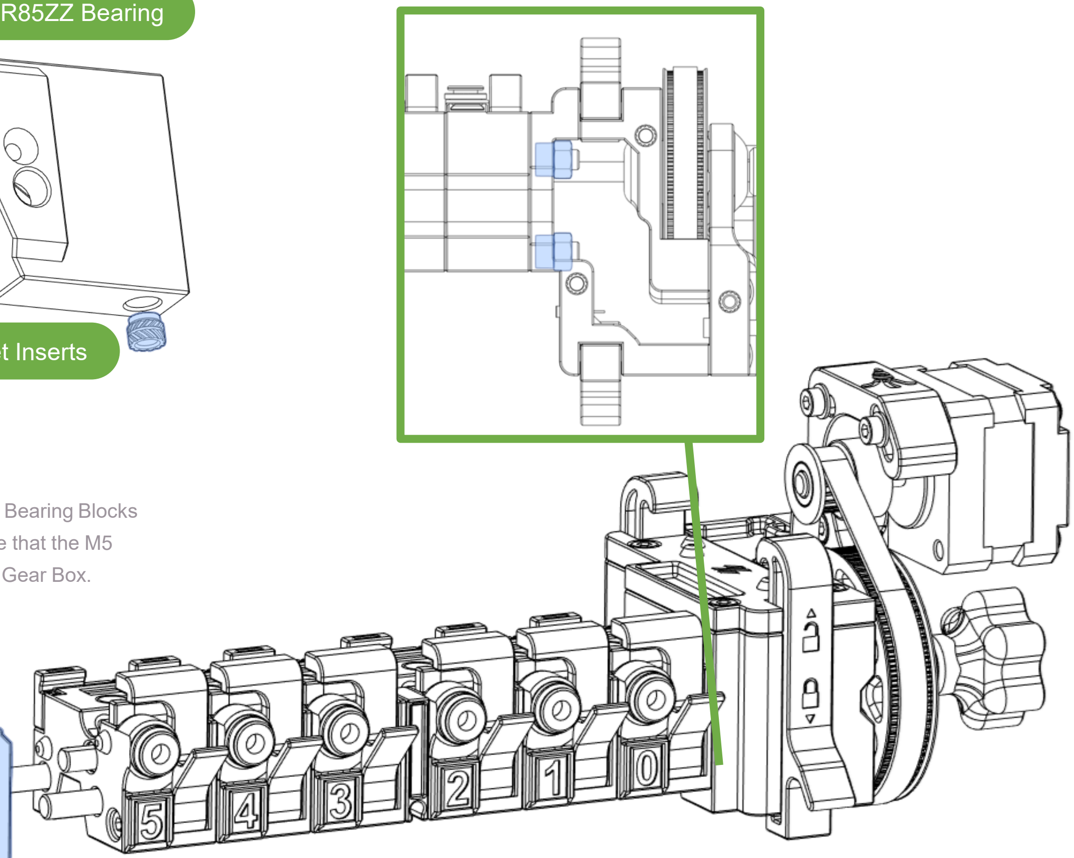
Every three filament blocks, insert a bearing block, except for the last filament block of your ERCF unit.



FILAMENT BLOCKS END

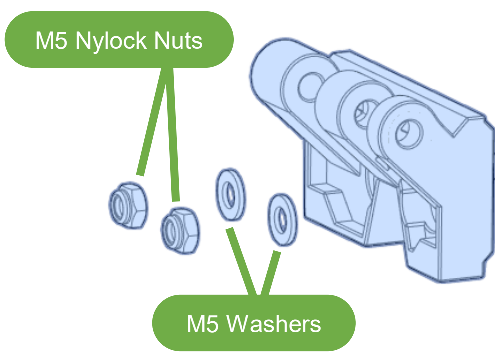


View from the bottom of the ERCF.



FILAMENT BLOCKS END

After all your Bondtechs gears, Filament Blocks and Bearing Blocks are slid n, insert the Filament Blocks End. Make sure that the M5 Threaded Rods are fully inserted in their slots in the Gear Box.

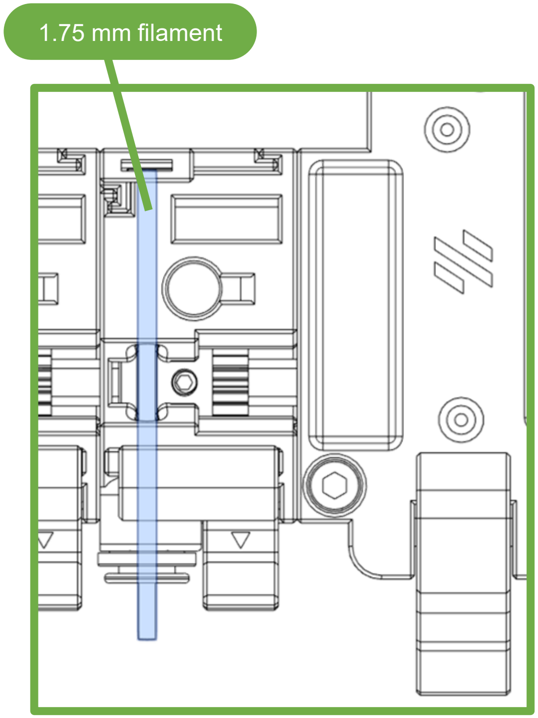


M5 NYLOCK NUTS

Do not over tighten those screws, as this will bend the unit and can cause issues later on. Whole assembly should not wobble but will still flex if you apply pressure on it, this is normal.

Do not turn the 5mm D-Cut shaft yet : no Bondtech gears grub screws are tightened at this stage.

BONDTECH GEARS ALIGNMENT



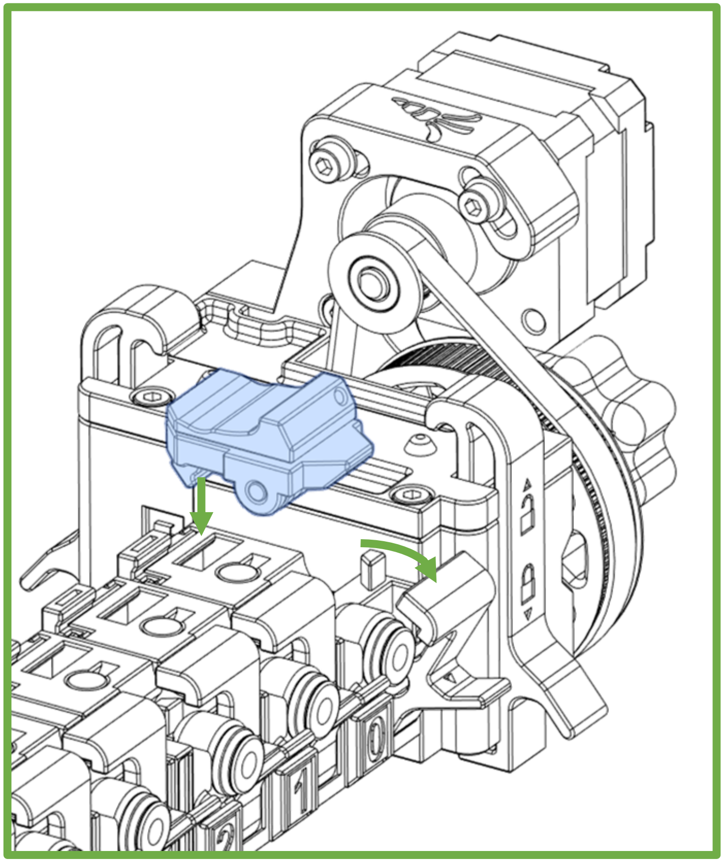
View from the top of the ERCF.

GEAR ALIGNMENT

Insert a small PTFE tube (few cms is enough) into the first tool ECAS and then insert some filament through the tool. Make sure the flat part of the D-Cut shaft is facing the Bondtech gear grub screw and use the filament to properly align the gear, then tigthen the grub screw.

Don’t forget to use thread locker on the grub screw.

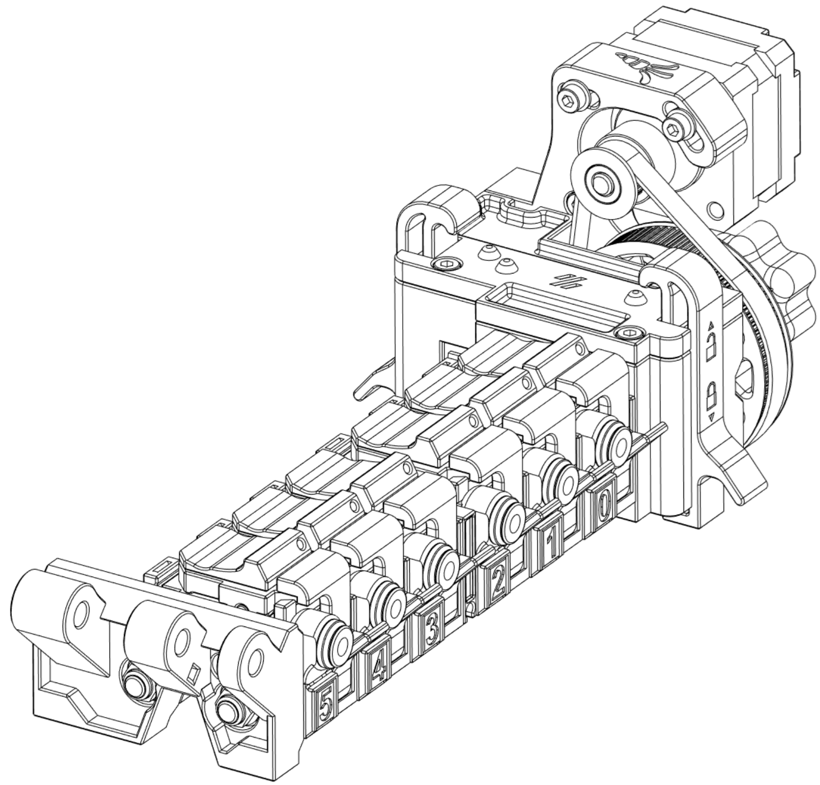
Repeat this process for all tools.



TOP HATS INSTALLATION

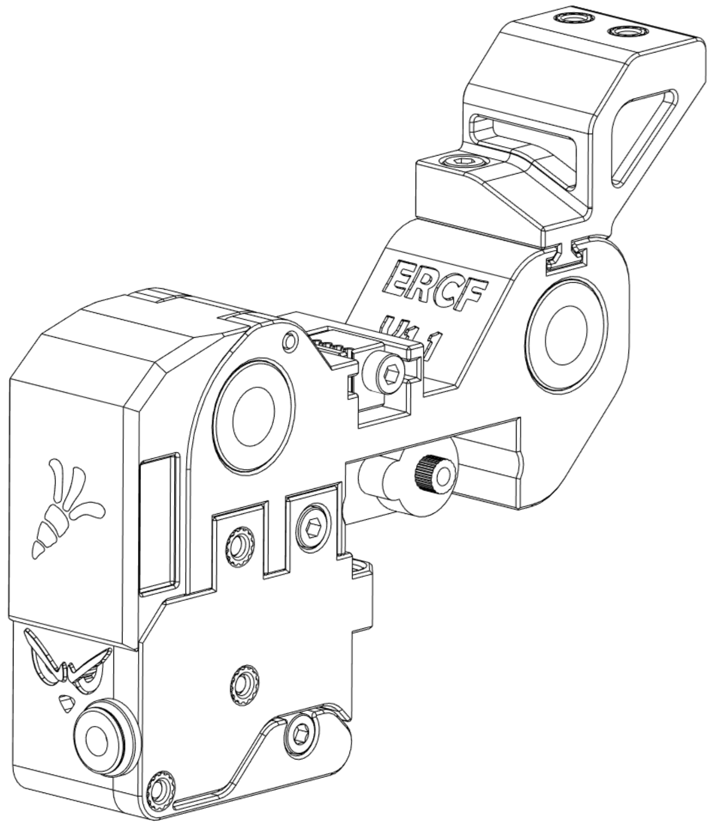
Open the latch of the first tool and slide the Top Hat arm into the Filament Block dedicated hole. You'll need to find the proper orientation to insert it, you should not force too much.

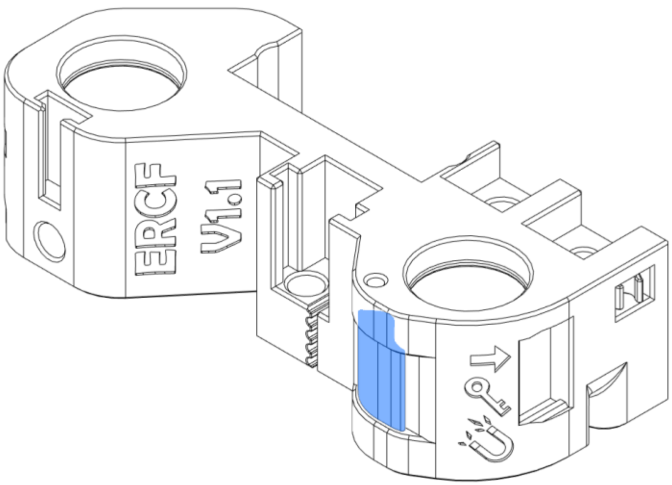
Once installed, close the latch, and repeat this process for all tools.

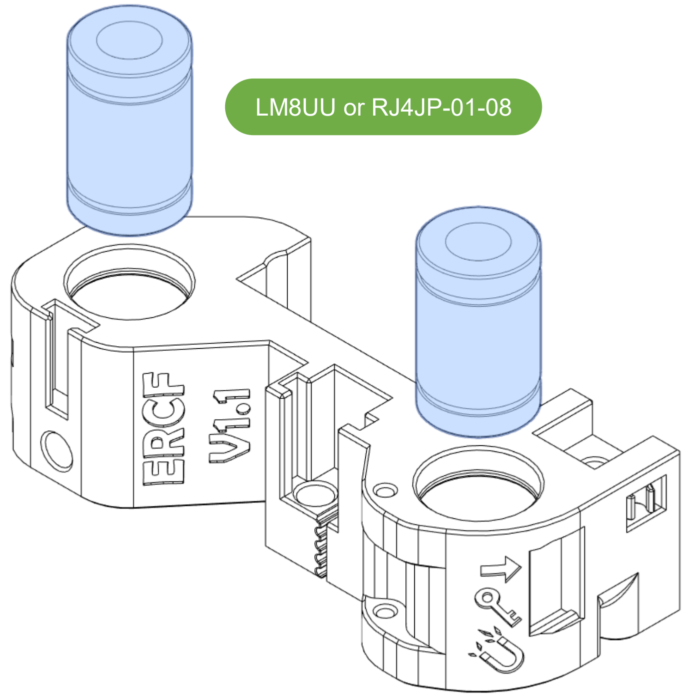


SELECTOR

OVERVIEW







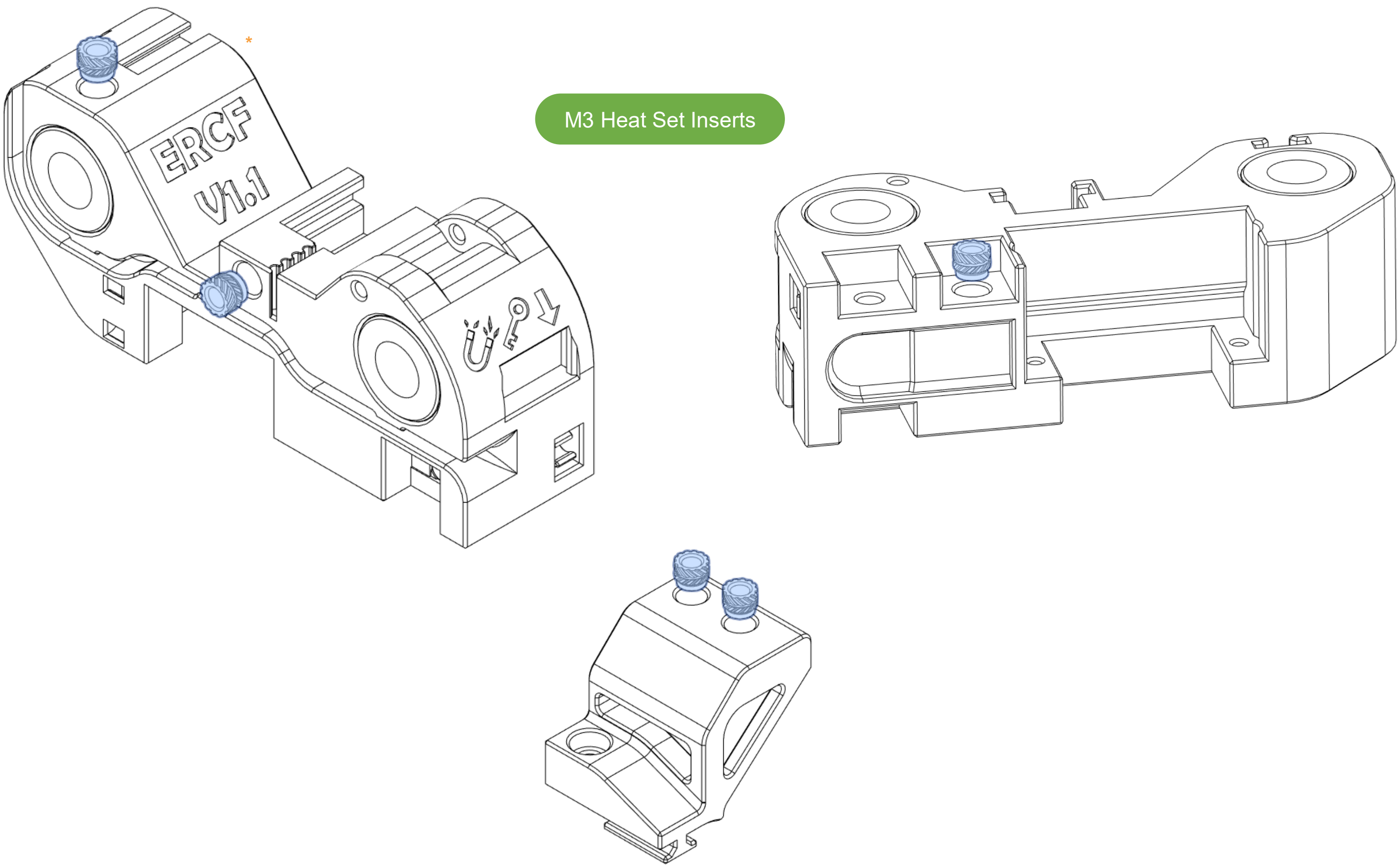
REMOVE BUILT-IN SUPPORT

Use a small tool, like a small flat screwdiver, to remove the built-in support.

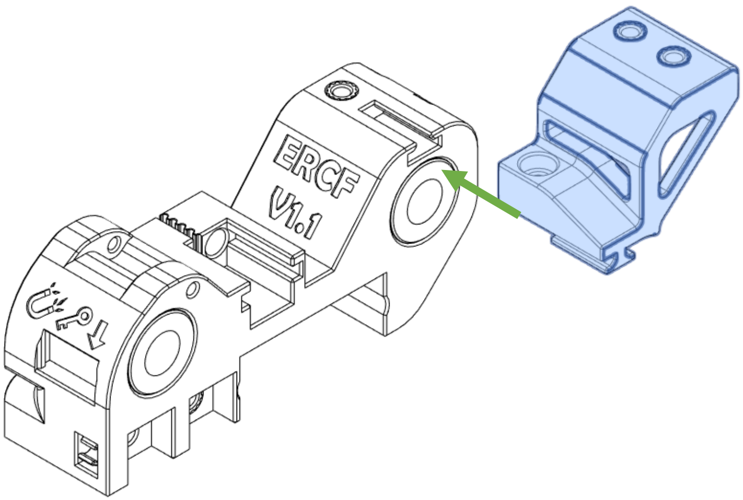
LM8UU INSERTION

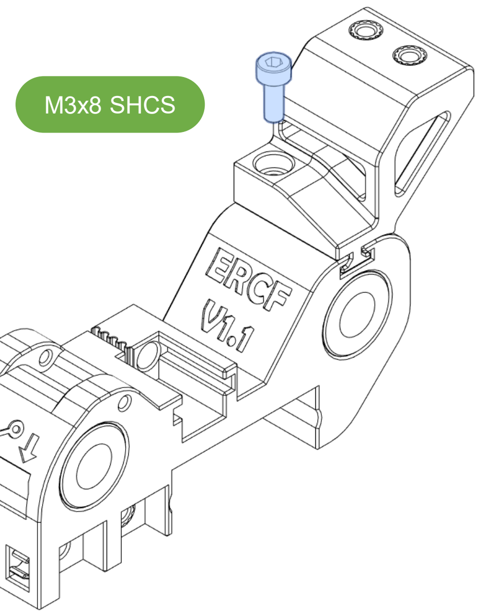
Press-fit the LM8UU in their holes.

SELECTOR CART

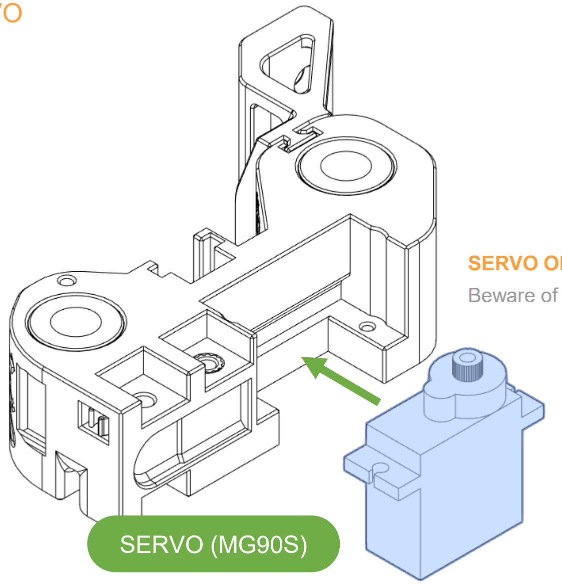


DRAG CHAIN ANCHOR



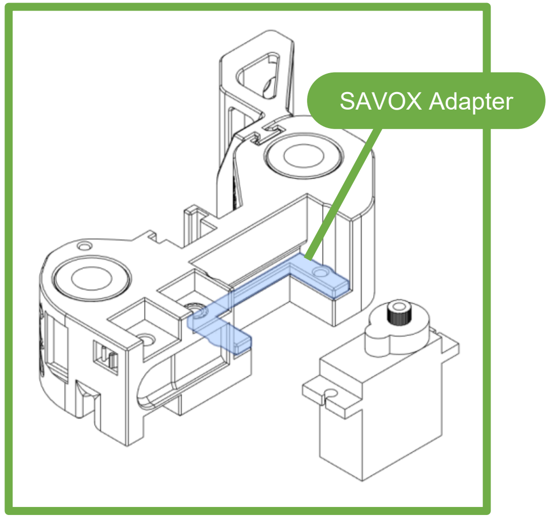


SERVO



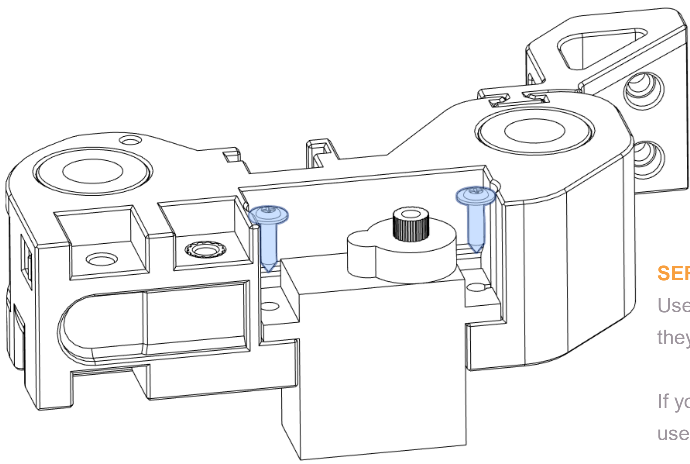
SERVO ORIENTATION

Beware of the servo orientation!



ERCF V1.0 SERVO COMPATIBILITY

In case you're using the SAVOX SH0255-MH servo, please use the Savox Adapter spacer before installing the servo.

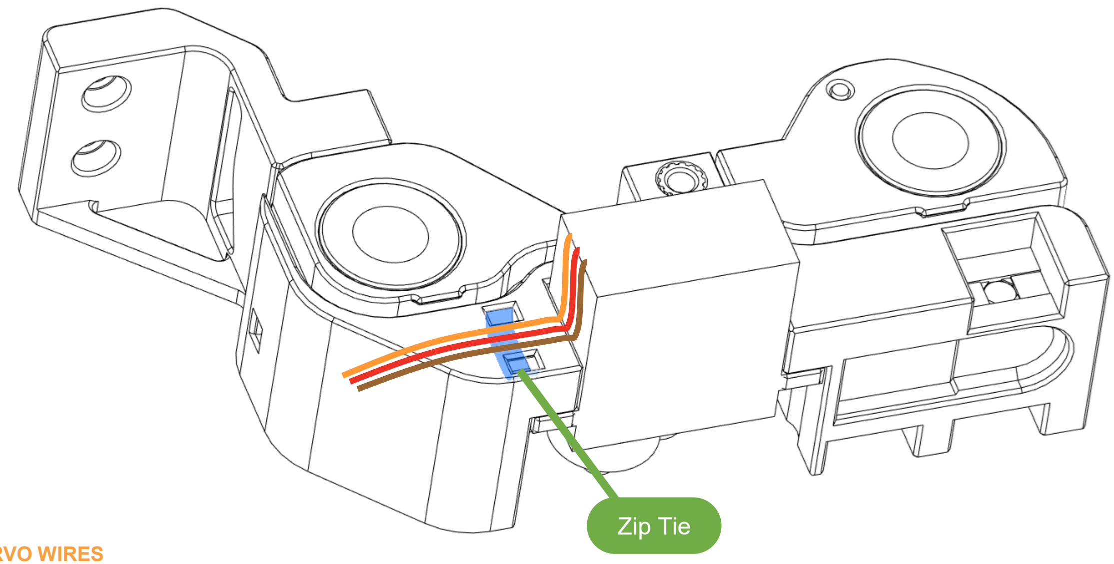


SERVO SCREWS

Use the screws from the servo kit you have, they'll tap directly into the selector cart plastic.

If you're using a SAVOX SH0255-MG servo, use two M2x10 SHCS.

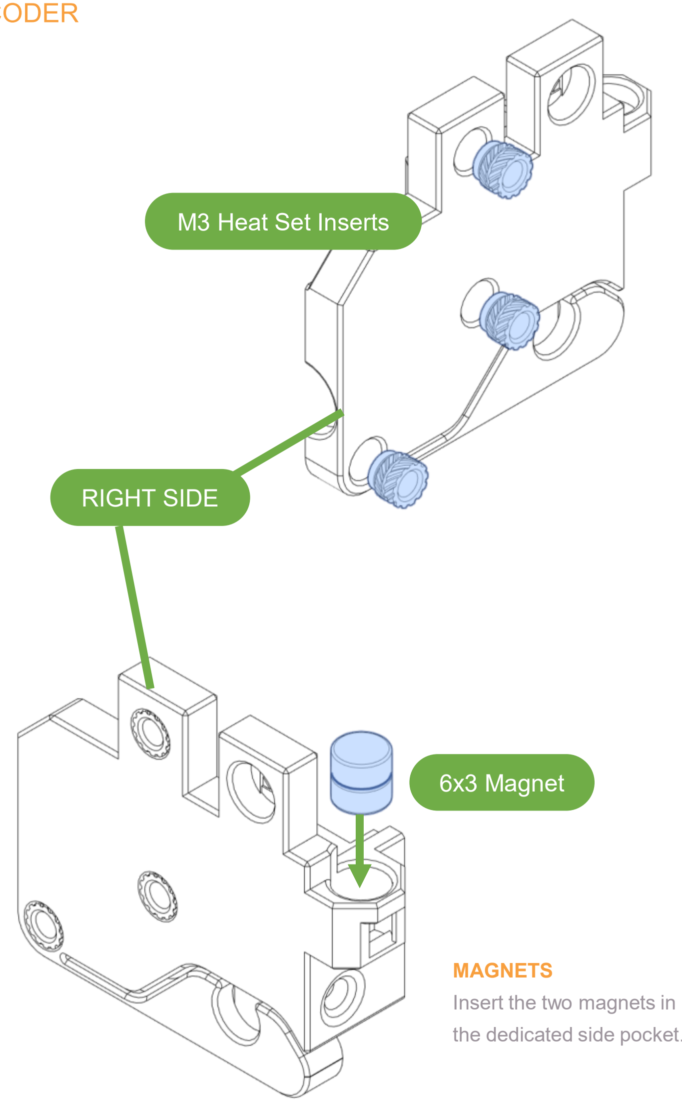
SERVO WIRES



SERVO WIRES

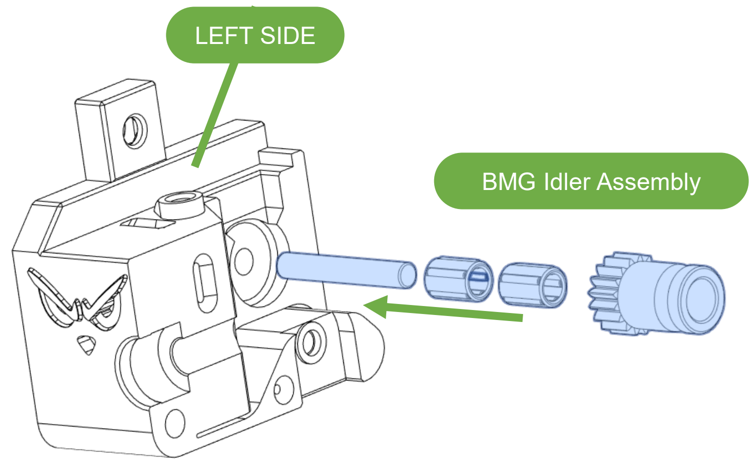
Secure the servo wires using a zip tie. Make sure the wires are flat against the side of the servo, as shown.

ENCODER

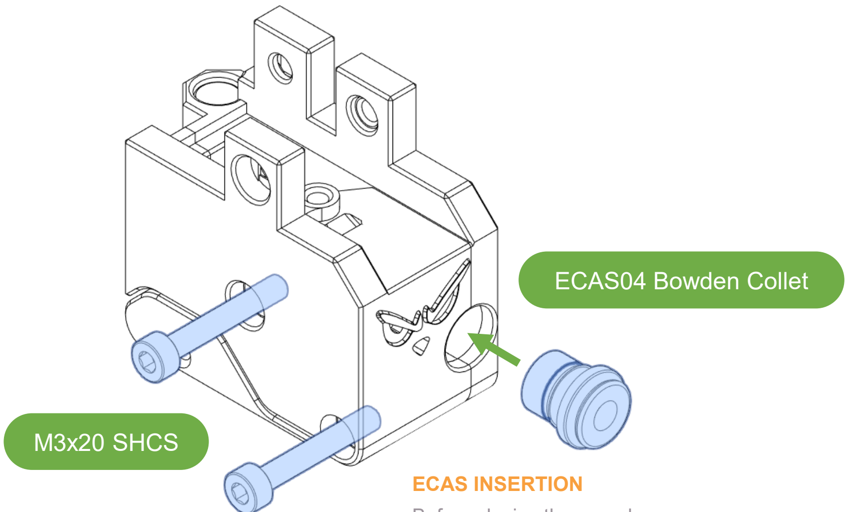


MAGNETS

Insert the two magnets in the dedicated side pocket.

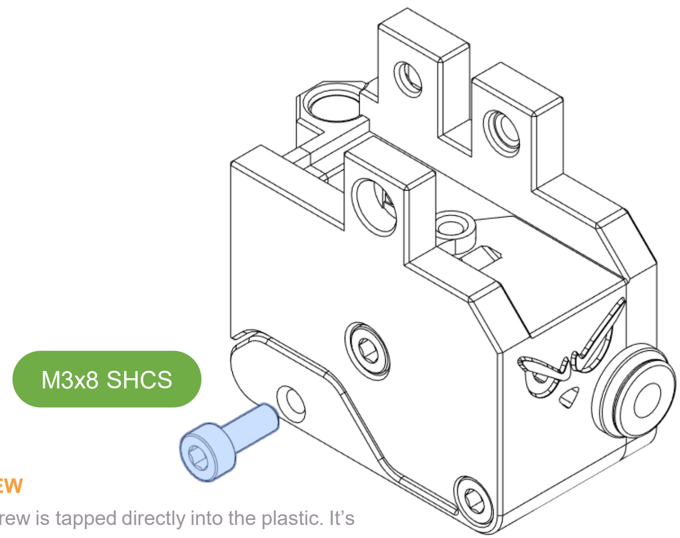


ENCODER



ECAS INSERTION

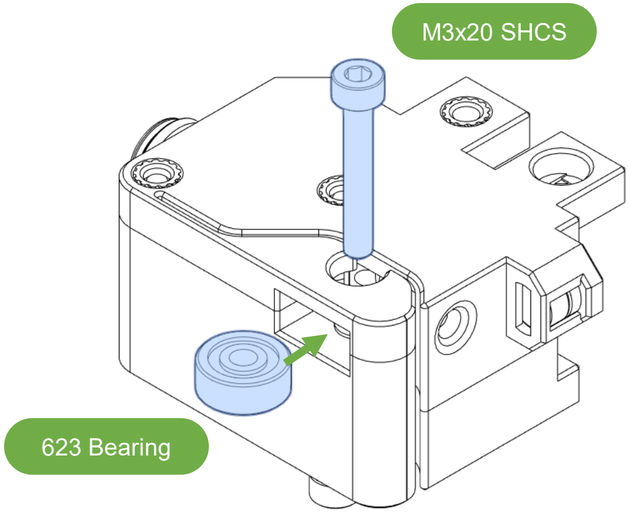
Before closing the encoder cart, insert the ECAS.



SIDE SCREW

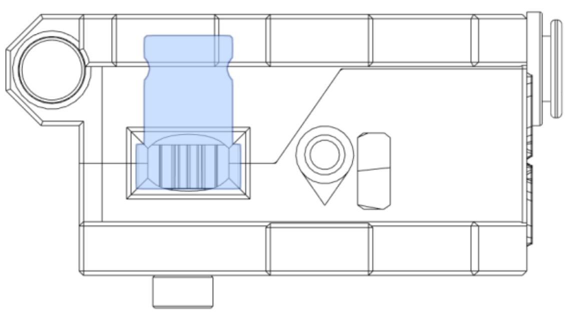
The side screw is tapped directly into the plastic. It's used to make physical contact with the selector endstop.

ENCODER

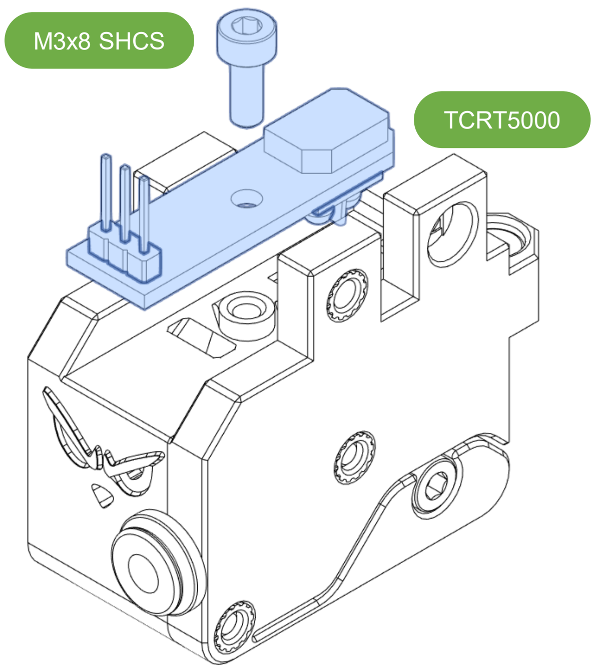


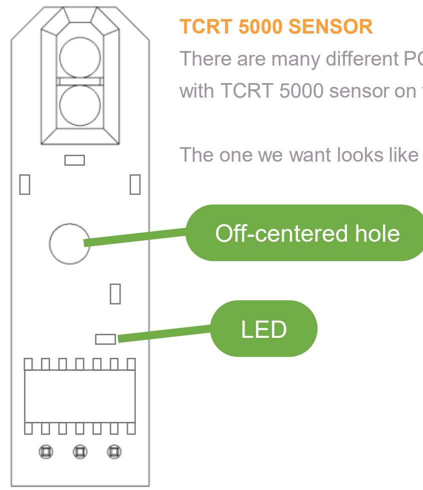
BMG GEAR ROTATION

Using some 1,75mm filament, check that the BMG gear spins well when you slide the filament in the encoder cart.



ENCODER SENSOR





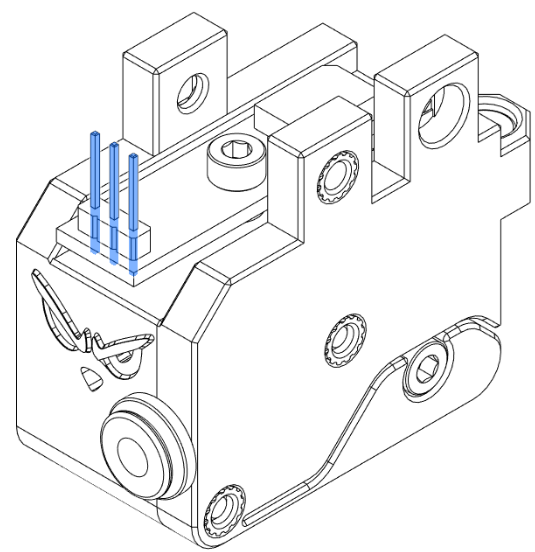
TCRT 5000 SENSOR

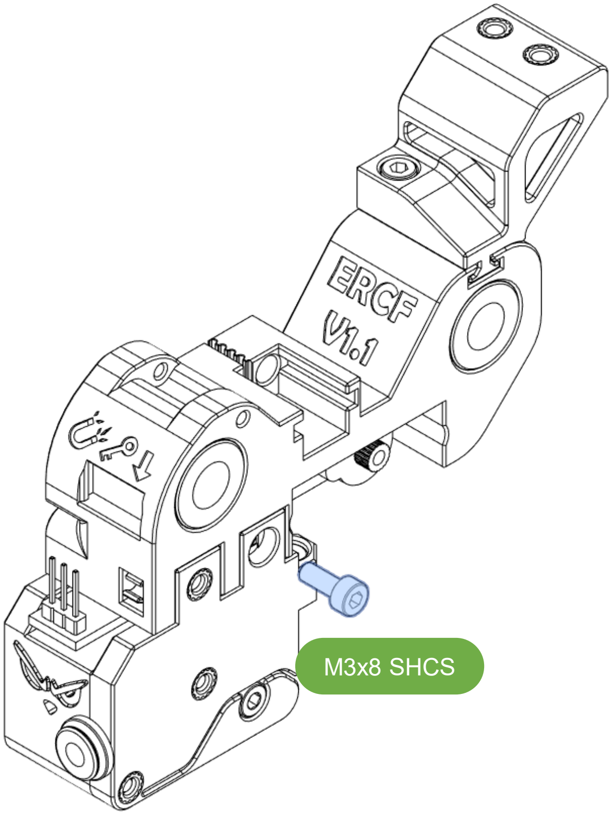
There are many different PCBs with TCRT 5000 sensor on them.

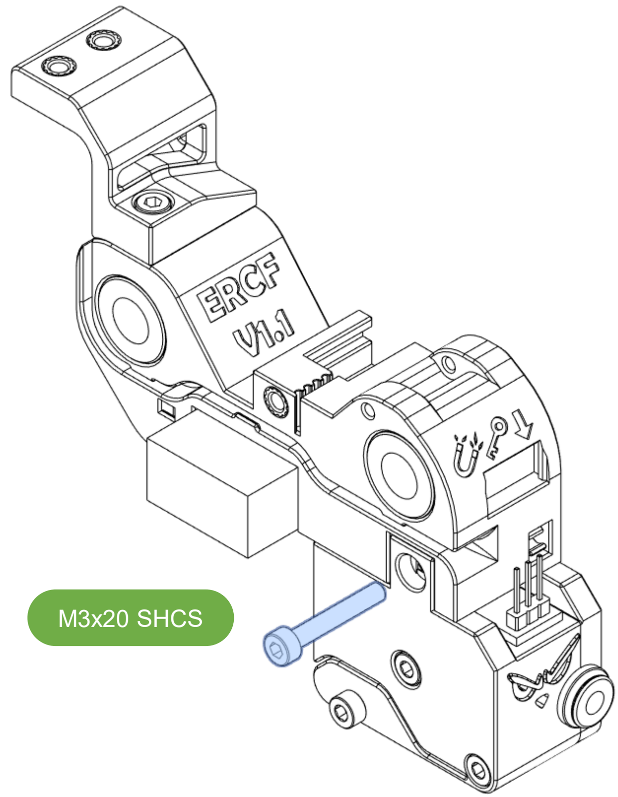
The one we want looks like this.

SENSOR PINS

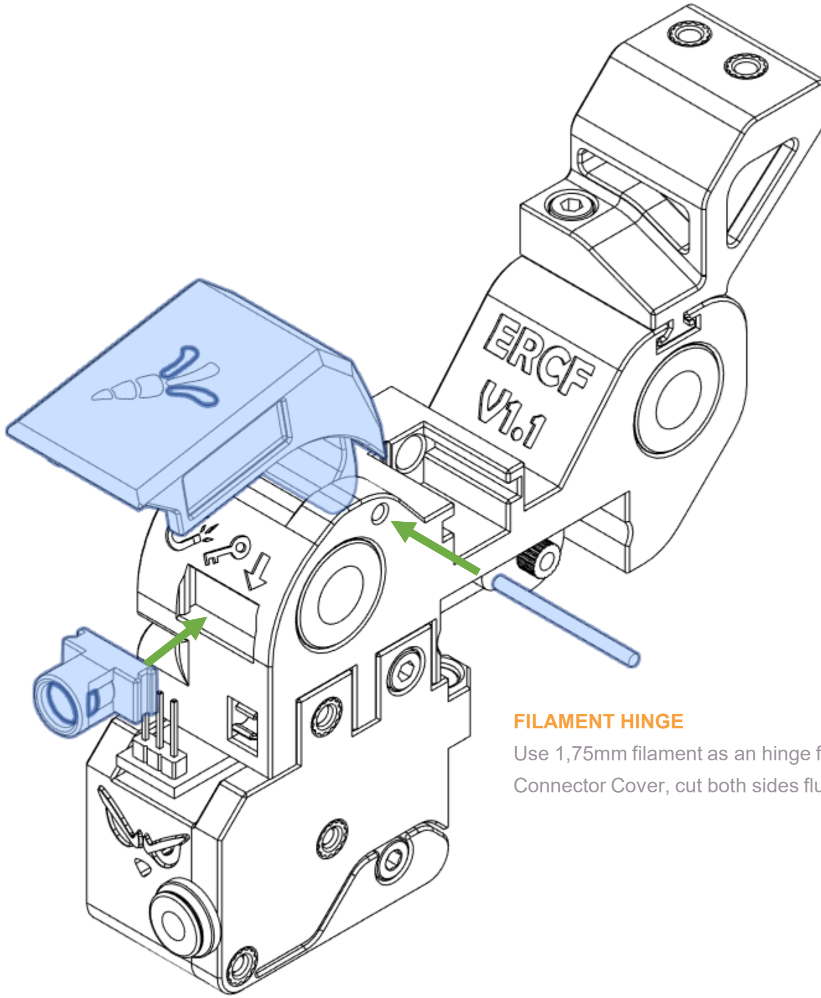
Delicately straigthen the sensor pins using pliers.




ERCF
V1.1
M3x8 SHCS


ERCF
V1.1
M3x20 SHCS

GATE KEY

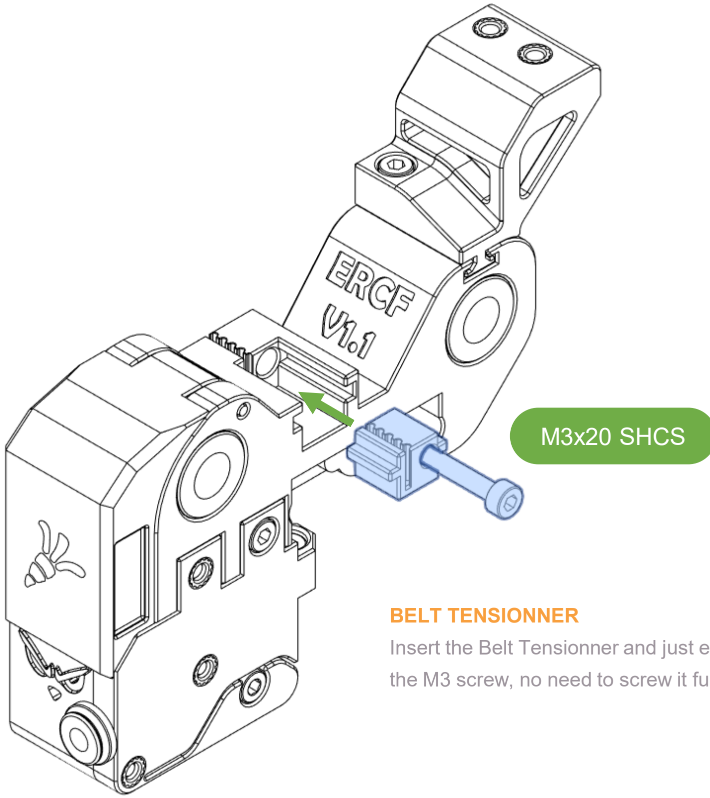


GATE KEY

Install the Gate Key we assembled in the beginning in its dock.

FILAMENT HINGE

Use 1,75mm filament as an hinge for the Connector Cover, cut both sides flush.

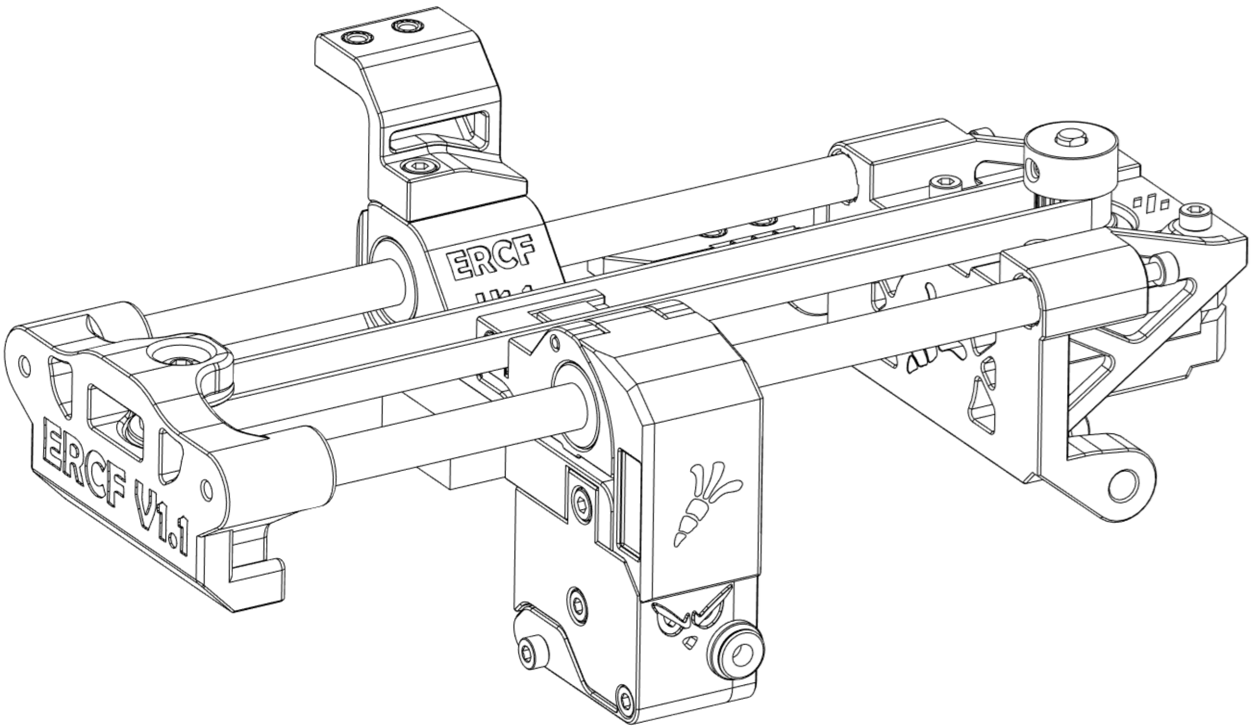


BELT TENSIONNER

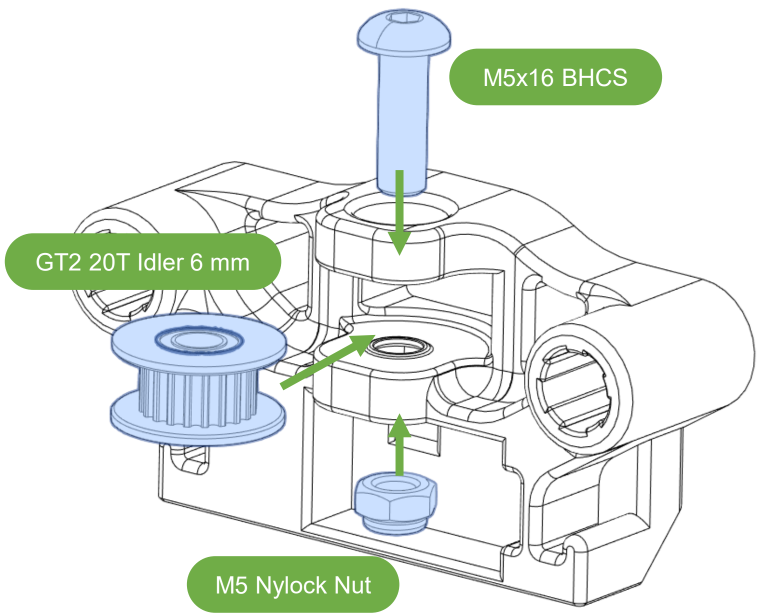
Insert the Belt Tensionner and just engage the M3 screw, no need to screw it fully.

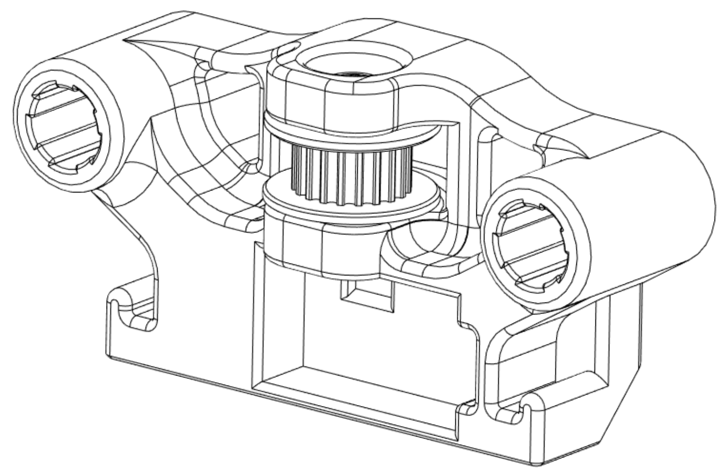

ERCF V1.1
ERCF

OVERVIEW

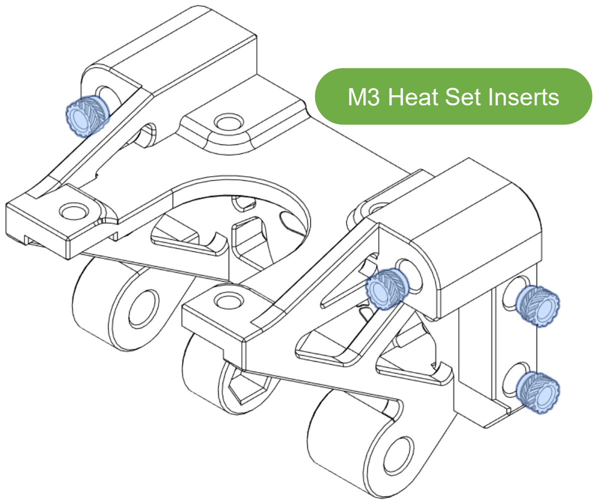


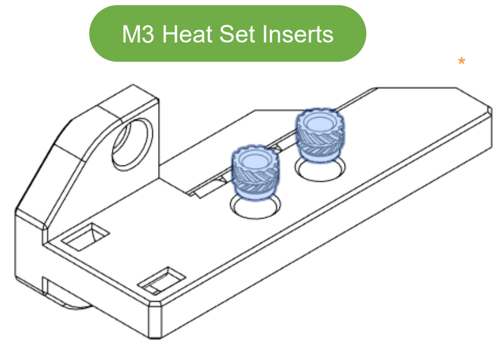
IDLER BLOCK

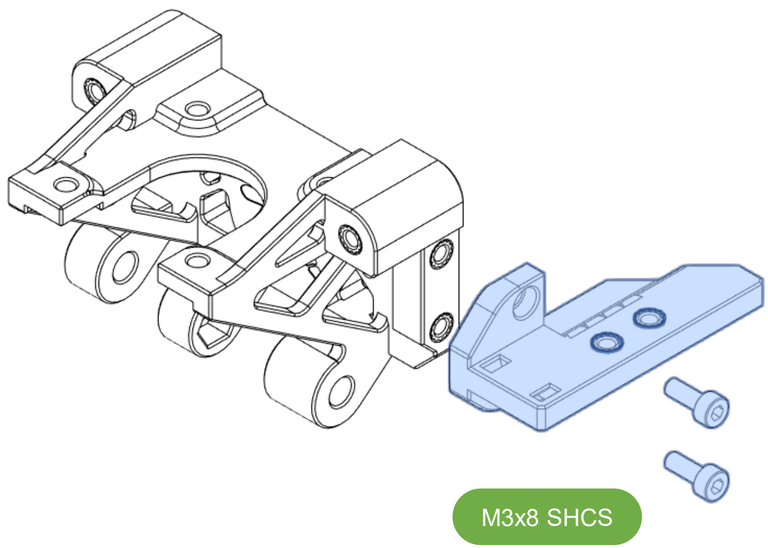




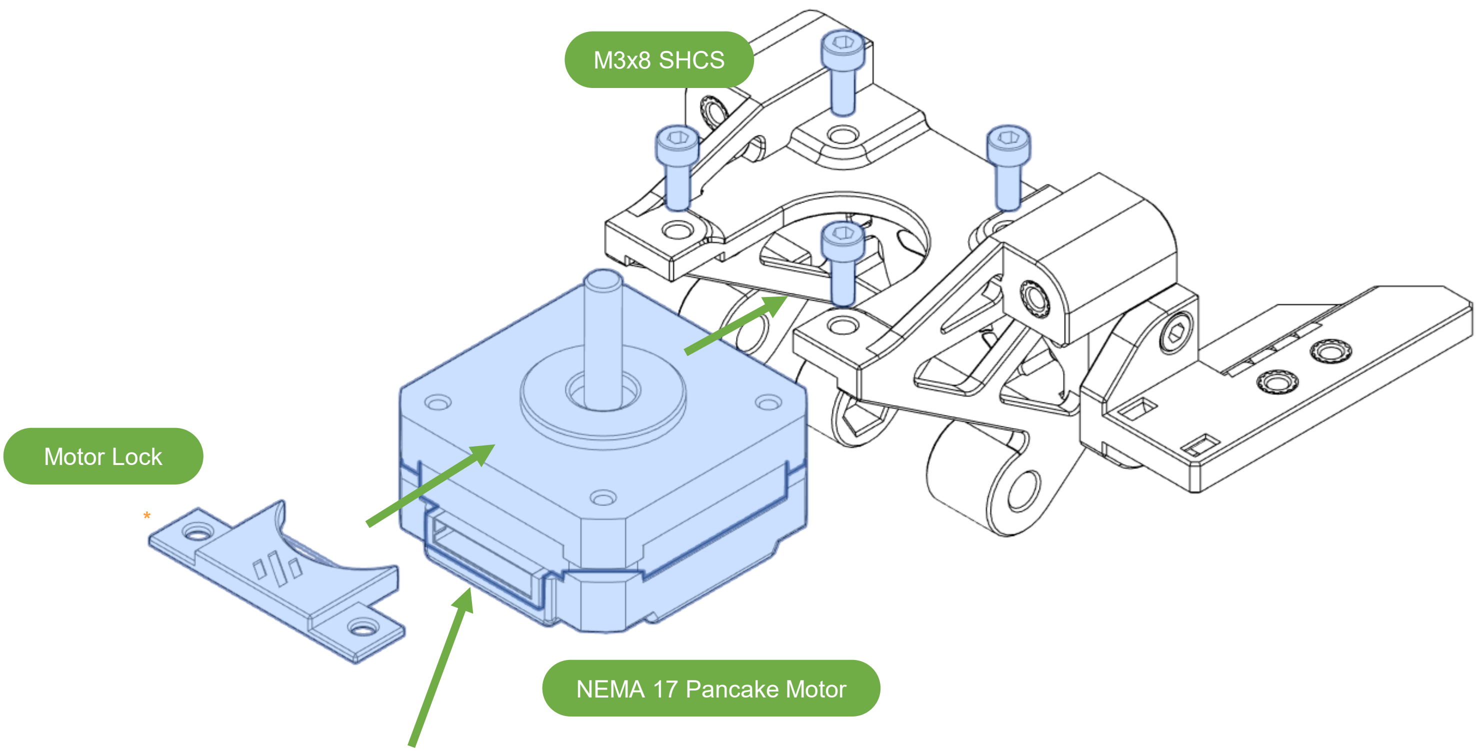
SELECTOR MOTOR SUPPORT







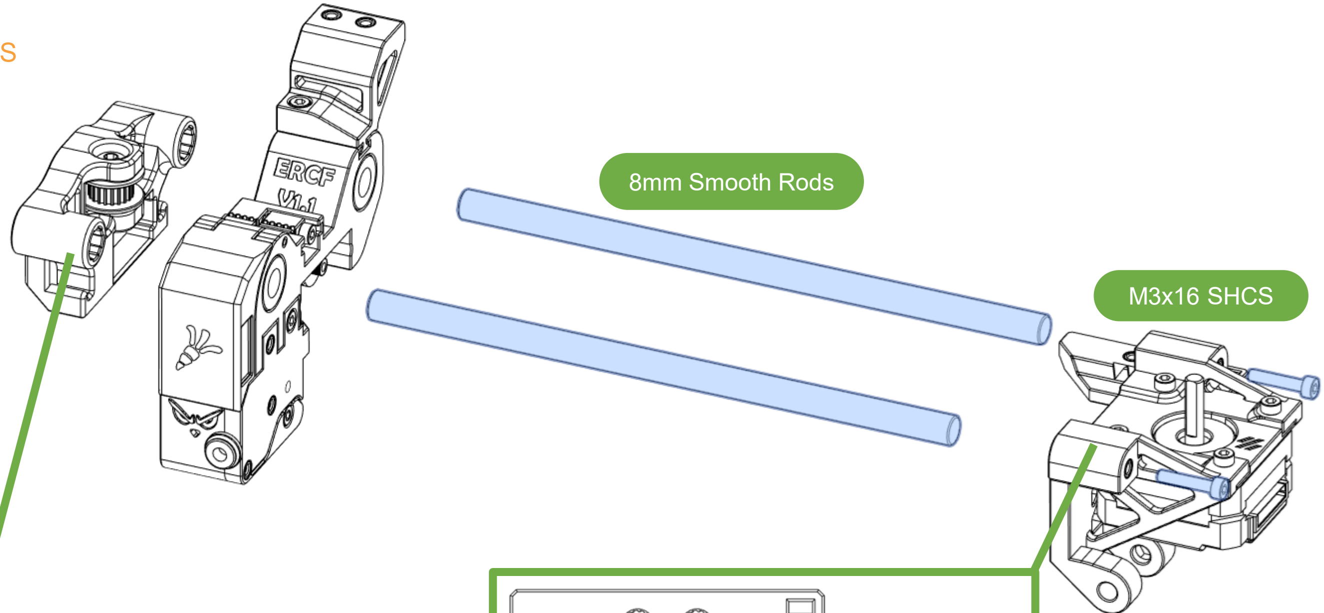
SELECTOR MOTOR SUPPORT

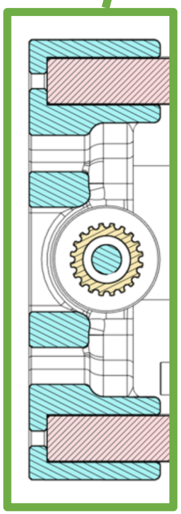


MOTOR WIRES

Make sure the wires of the motor are coming out from this side.

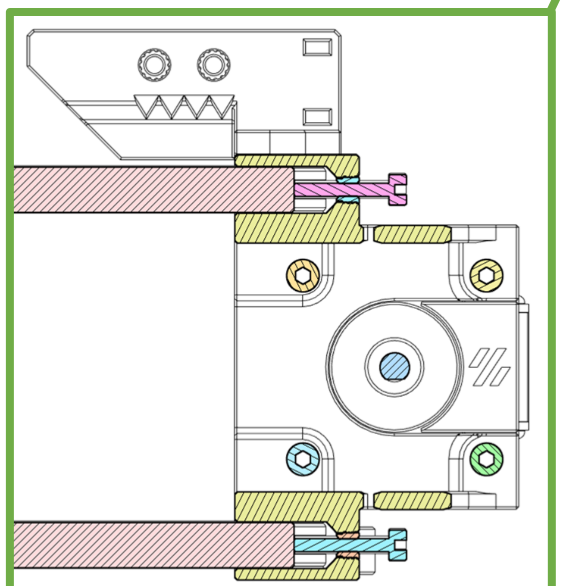
LINEAR AXIS





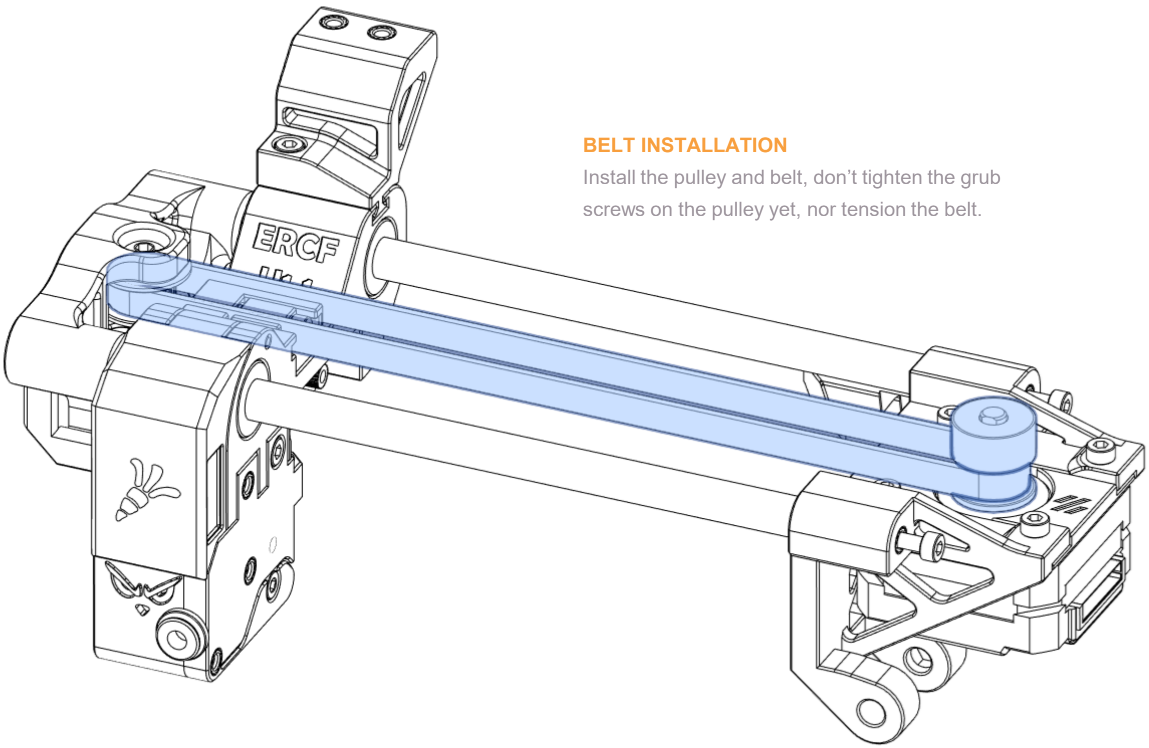
IDLER SIDE

Insert fully the 8mm Smooth Rods on the idler side. There are holes allowing you to check the rods are well in place.



MOTOR SIDE

Don't fully insert the rods on the motor side for now, let them in a central position and just get the M3x16 SHCS screws to contact.



BELT INSTALLATION

Install the pulley and belt, don’t tighten the grub screws on the pulley yet, nor tension the belt.

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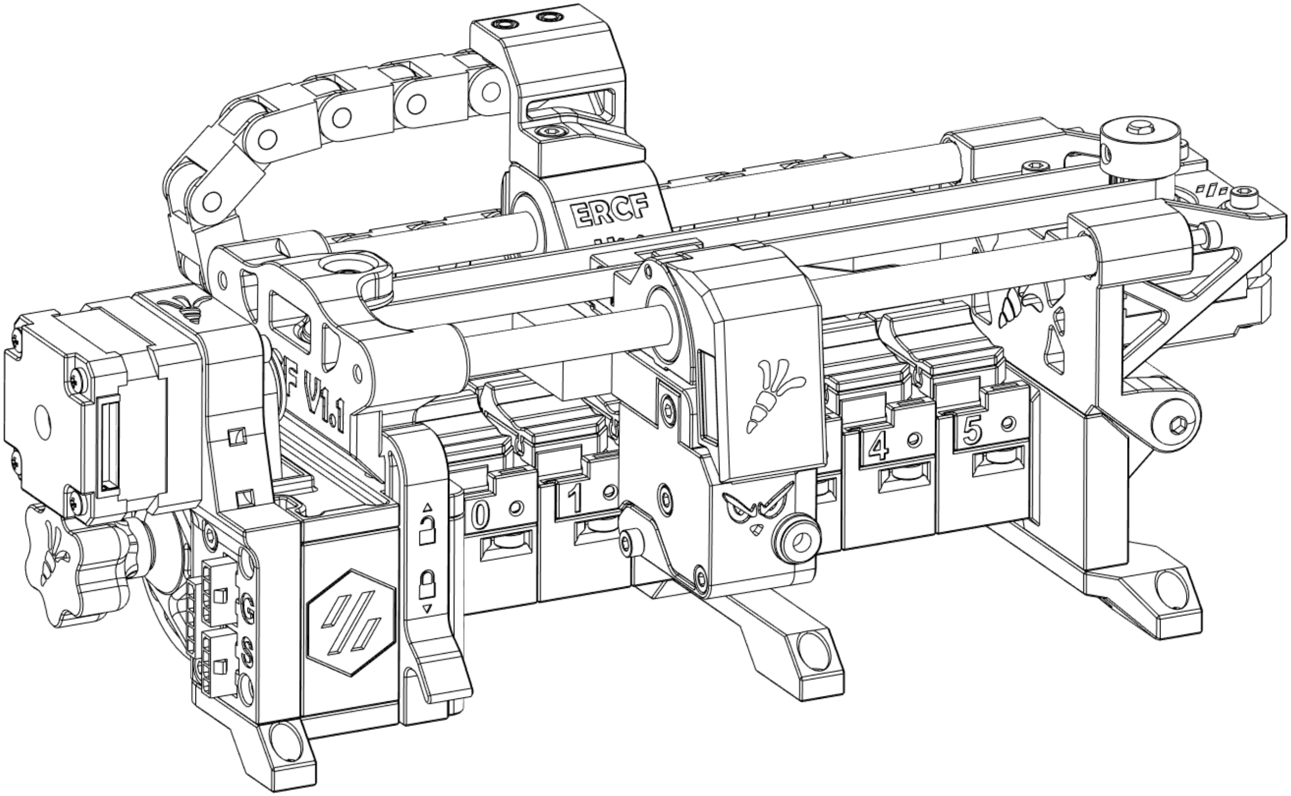
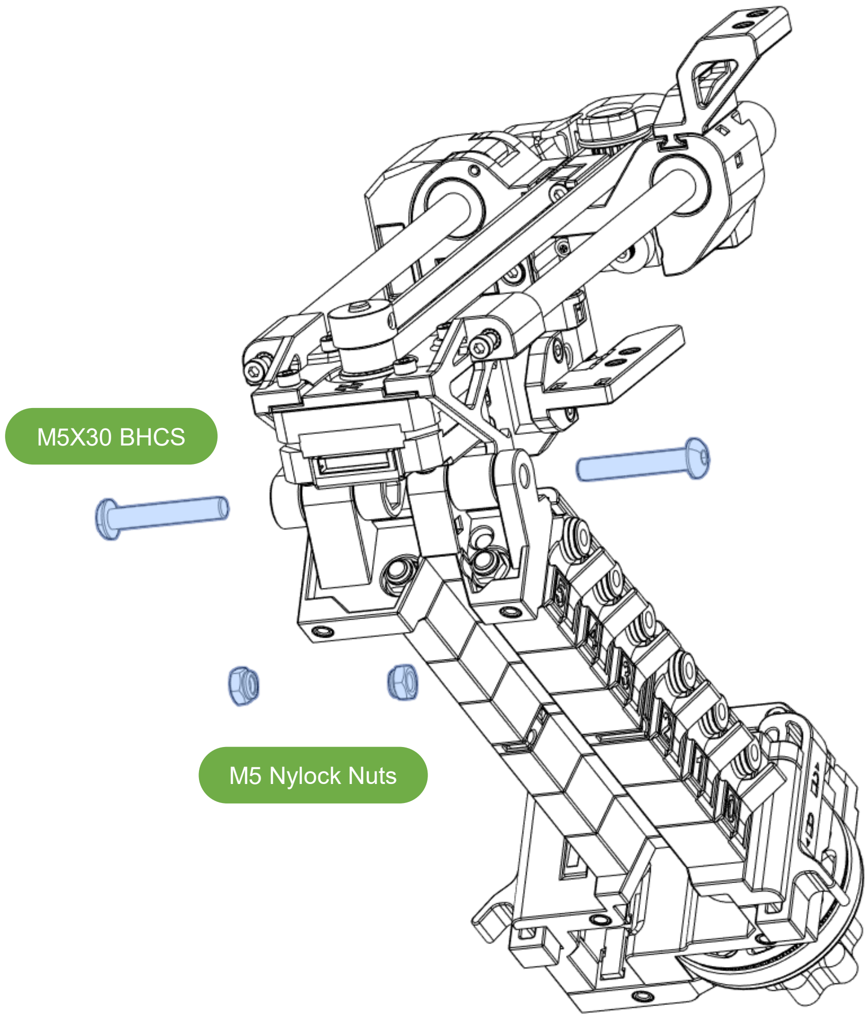
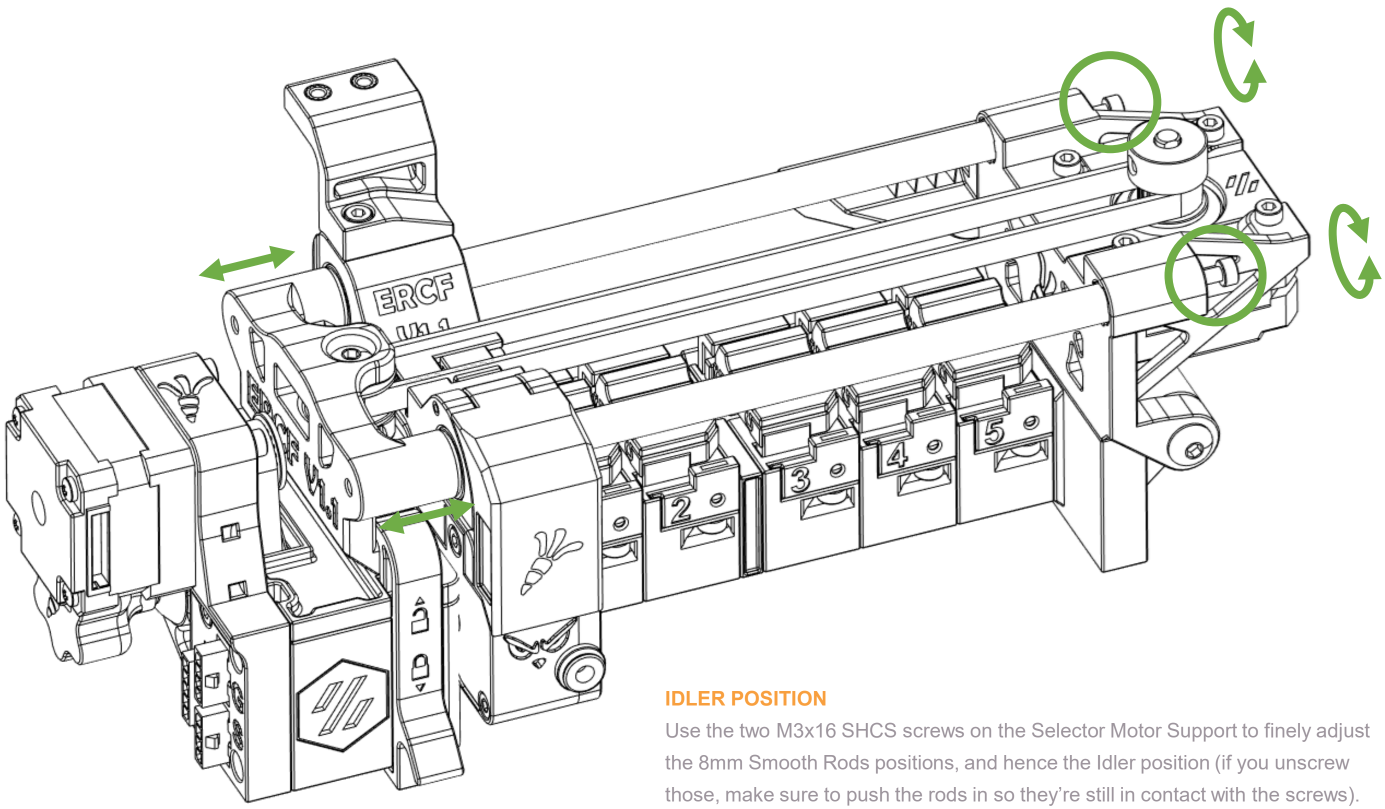
OVERVIEW



JOINING THE TWO BLOCKS



IDLER ADJUSTEMENT



IDLER POSITION

Use the two M3x16 SHCS screws on the Selector Motor Support to finely adjust the 8mm Smooth Rods positions, and hence the Idler position (if you unscrew those, make sure to push the rods in so they're still in contact with the screws).

Make sure the 3 small slots on the Idler match the Gear Box Top Panel bumps.

Once the tuning is done, lock the linear axis using the two Gear Box Side Latches.

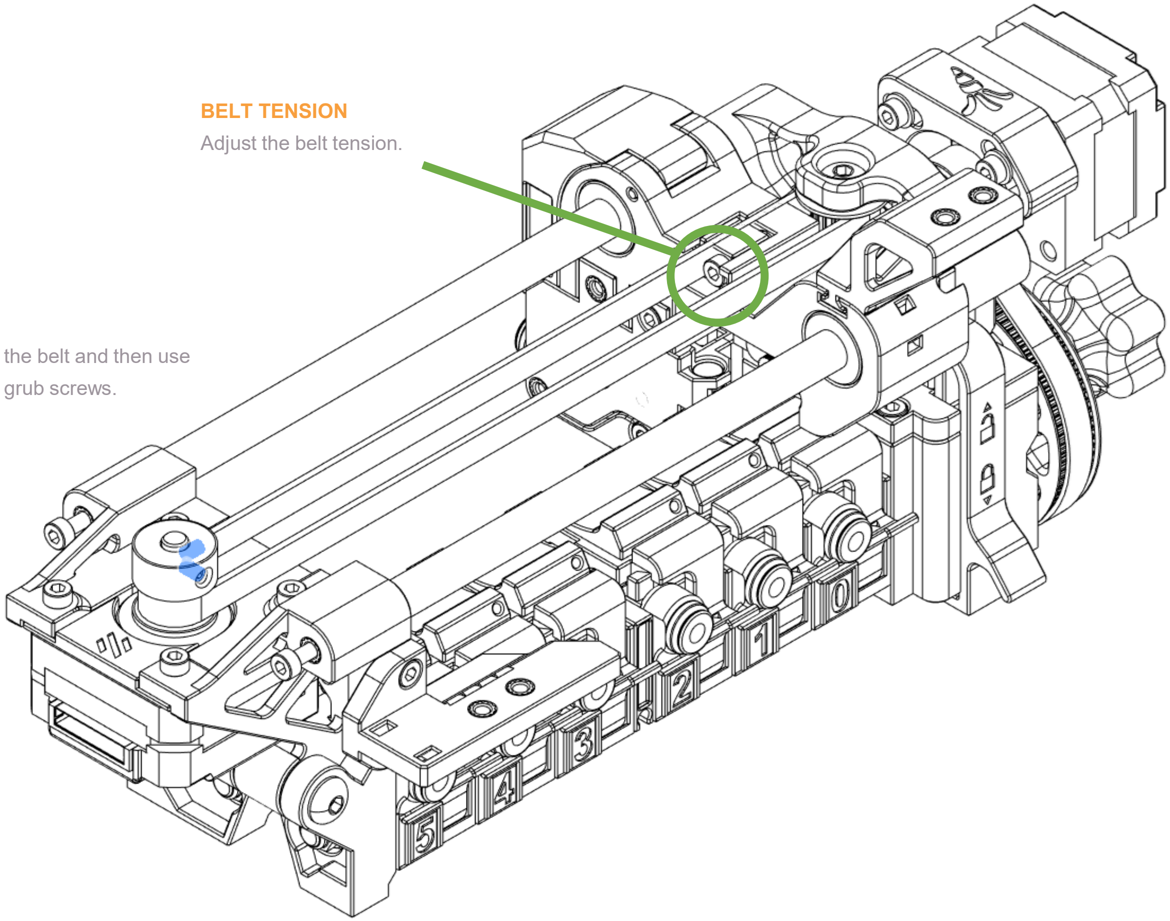
TENSIONING THE BELT

BELT TENSION

Adjust the belt tension.

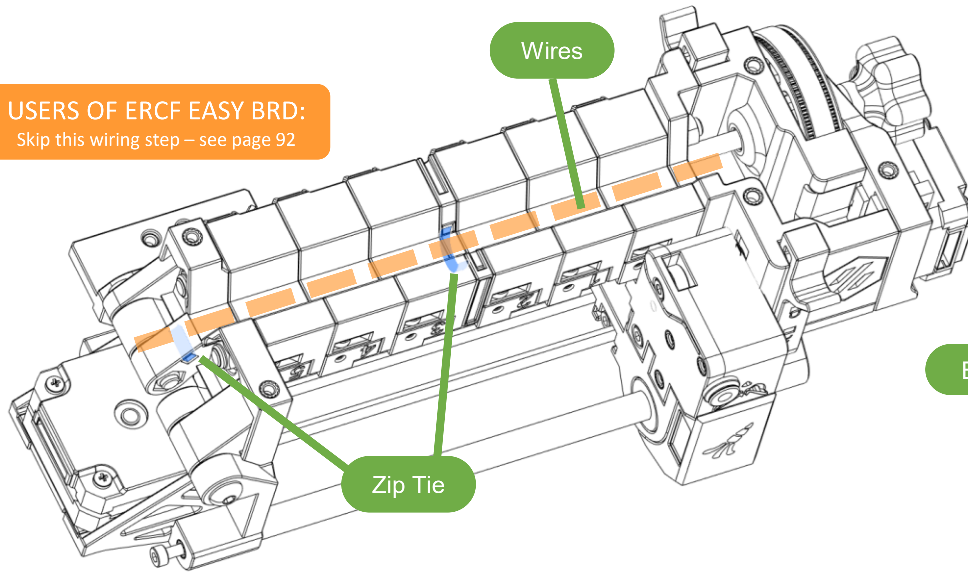
GRUB SCREWS

Align the pulley with the belt and then use thread locker on the grub screws.



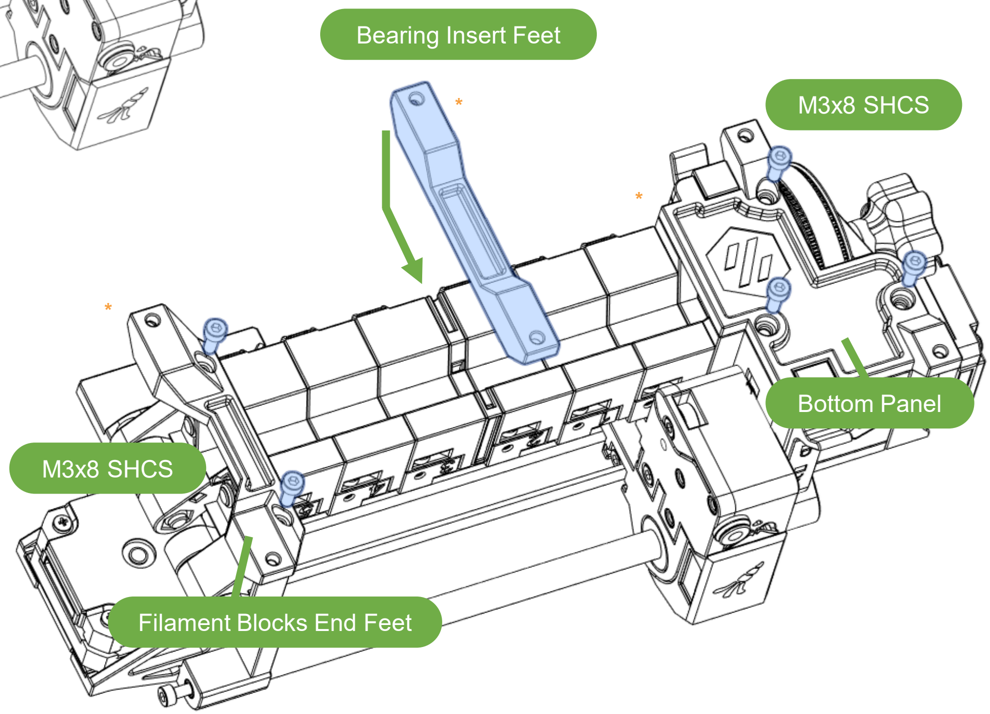
WIRE MANAGEMENT & FEET

USERS OF ERCF EASY BRD:
Skip this wiring step – see page 92



WIRING

Secure the Selector Motor, Servo and Encoder wires using zip ties. Keep a few cms of wires in the Gear Box, that will be helpful in case you have to disassemble//reassemble the ERCF.

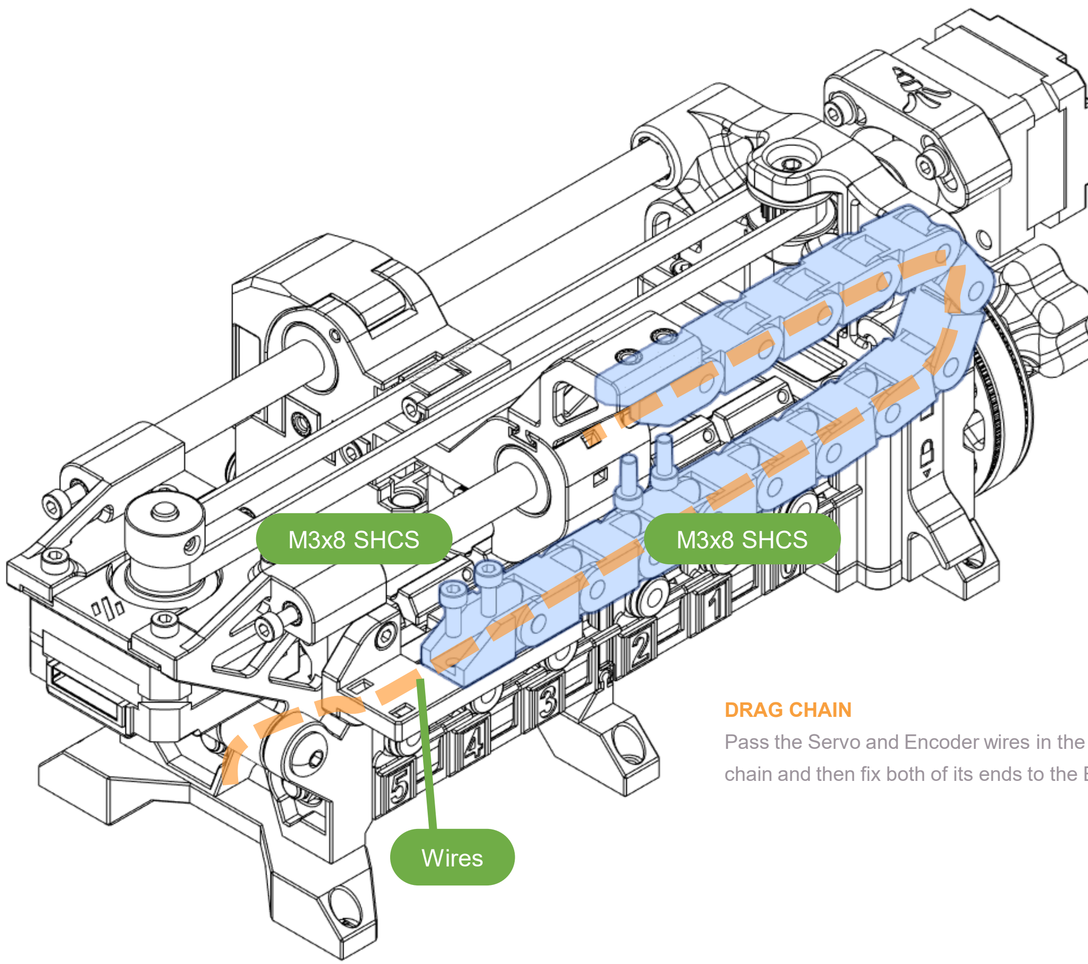


ERCF FEET

Install the Gear Box Bottom Panel and the other ERCF Feet.

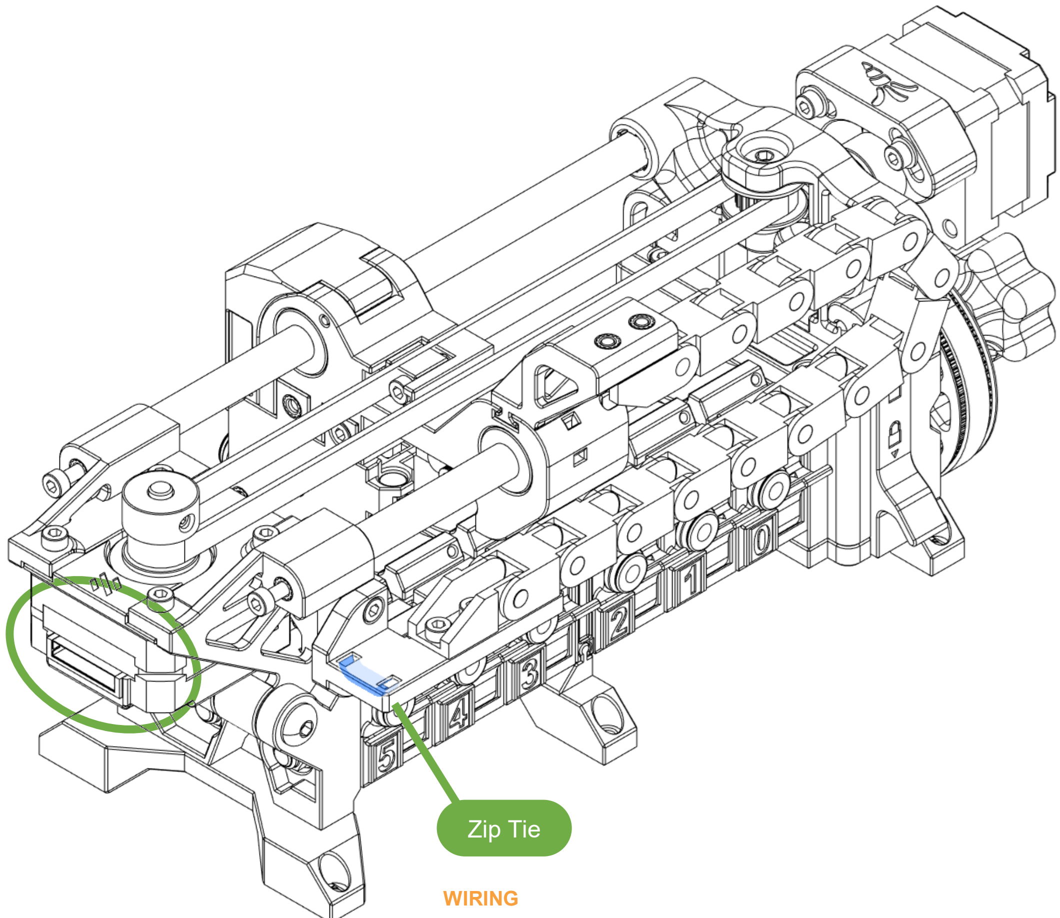
The feet for the Bearing Inserts have built-in supports. Remove them before sliding the feet in the Bearing Inserts.

DRAG CHAIN



DRAG CHAIN

Pass the Servo and Encoder wires in the drag chain and then fix both of its ends to the ERCF.



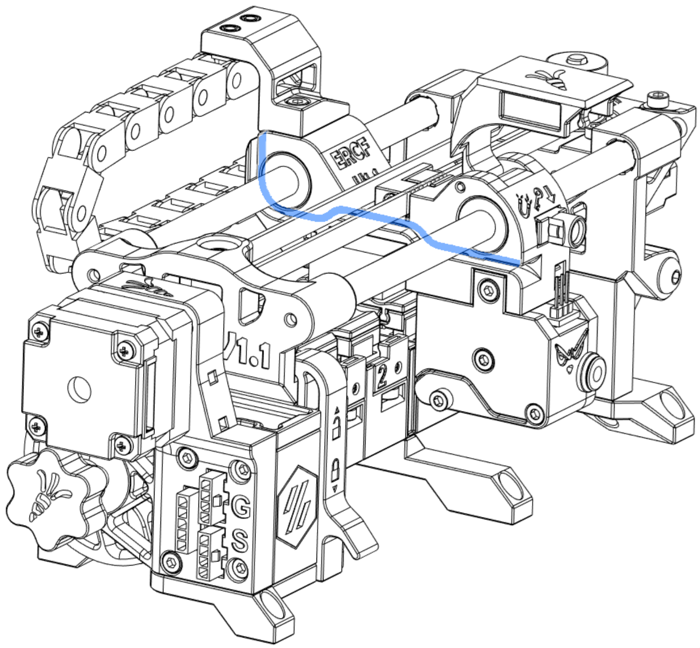
SELECTOR MOTOR

You can now do the crimps and connect the selector motor.

WIRING

Secure the drag chain wires using a zip tie.

FULL ERCF

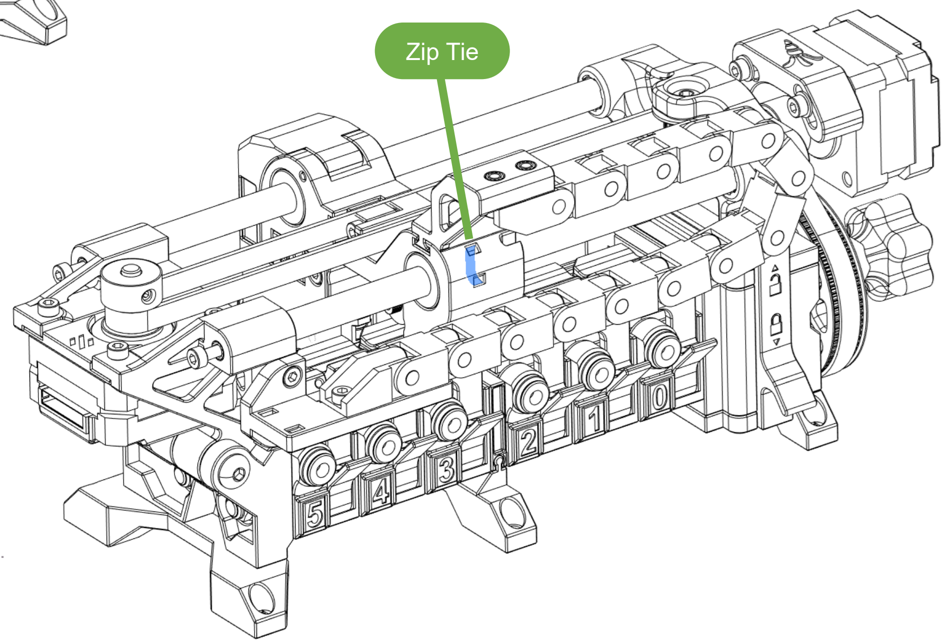


ENCODER WIRES

Pass one of the Encoder wires into the dedicated channel in the Selector Cart to define the wire length needed to plug into the Encoder.

Cut excess wire, remove the wire from the channel and do the crimps (Dupont or JST XH will work) for all wires.

Pass all the wires in the channel and then connect the Encoder and close the selector door.

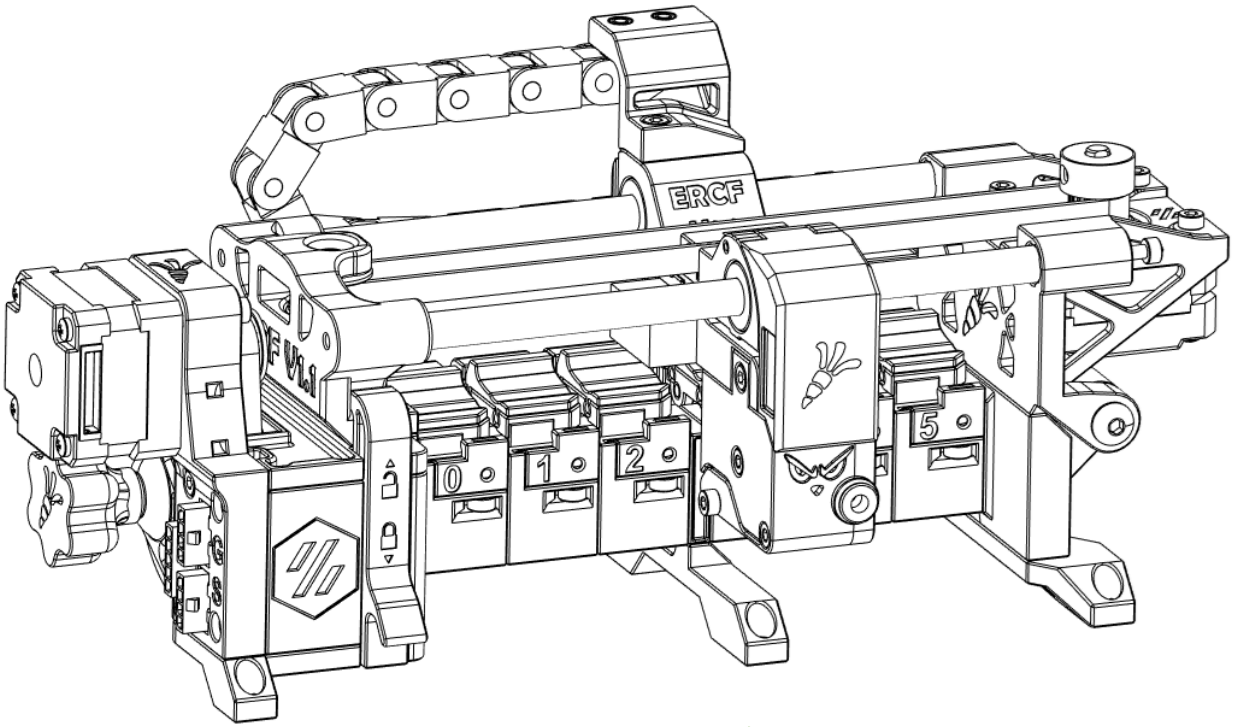


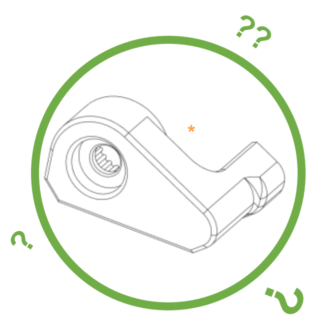
SERVO WIRES

Cut excess wires and connect the Servo (you can use a Dupont connector for example).

Secure both the Servo and Encoder wires using a zip tie.

THE END! … OR ALMOST :D





NEXT STEPS

The ERCF is now fully assembled, except, as you probably have noticed, for the Servo Arm!

Its installation on the ERCF will be done in the ERCF Setup section!

TOOLHEAD SENSOR

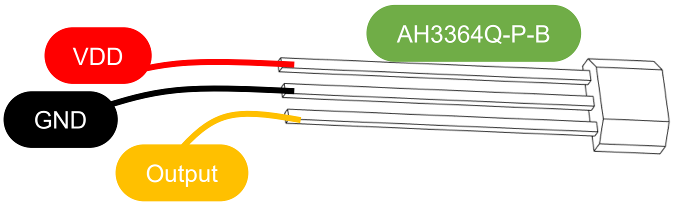
The ERCF relies on a filament sensor located below the toolhead extruder gears to maximize the load and unload sequence precision and reliability.

While any sensor (and any toolhead) can be used, this section will guide you through the assembly and installation of a filament sensor based on a design made by Tircown.

This sensor is available for the AfterBurner Clockwork, Galileo Clockwork and LGX on AfterBurner toolheads.

Only the parts that differ from the non-sensor versions of those toolheads are shown

AFTERBURNER CLOCKWORK TOOLHEAD SENSOR

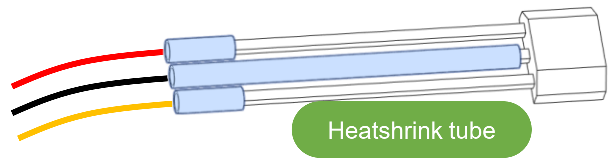


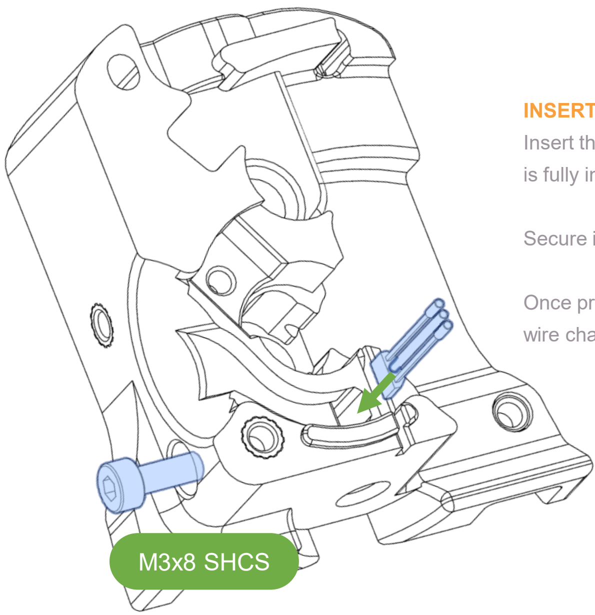
PREPARE THE HALL SENSOR

Typically, use about 15 cm of 24 AWG wire from the sensor to the connector of your choice.

Solder three wires to the sensor, at the very end of the sensor pins.

Insert a small heatshrink tube on the whole central pin and only on the solder joint for the two other pins.



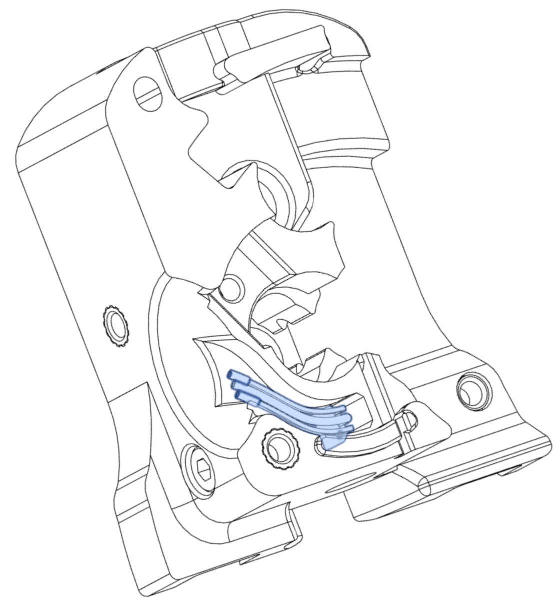


INSERT THE SENSOR

Insert the sensor in its dedicated pocket. Make sure it is fully inserted and beware of the sensor orientation.

Secure its position using a M3x8 screw.

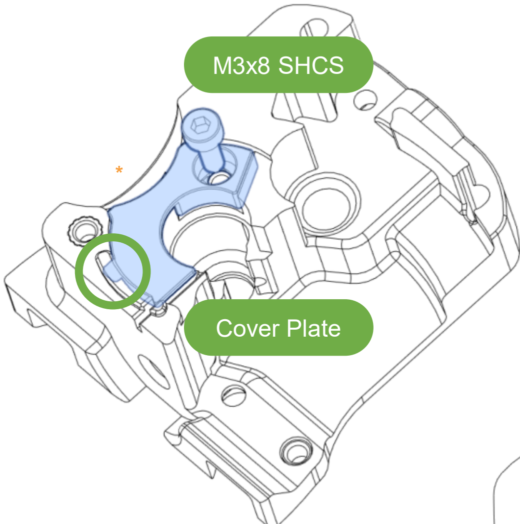
Once properly fixed, bend the pins so they fit in the wire channel of the part.



AFTERBURNER CLOCKWORK TOOLHEAD SENSOR

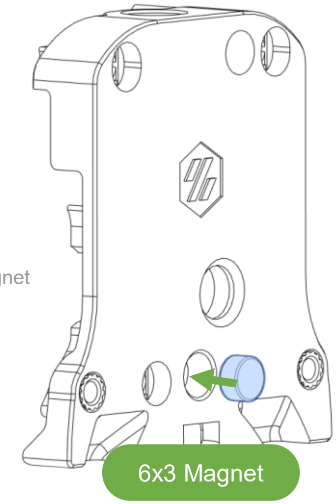
COVER PLATE

Install the cover plate on top of the wire channel. Beware of the small insert to secure the position of the cover. The M3x8 screw is tapped directly in the plastic.



MAGNET POLARITY

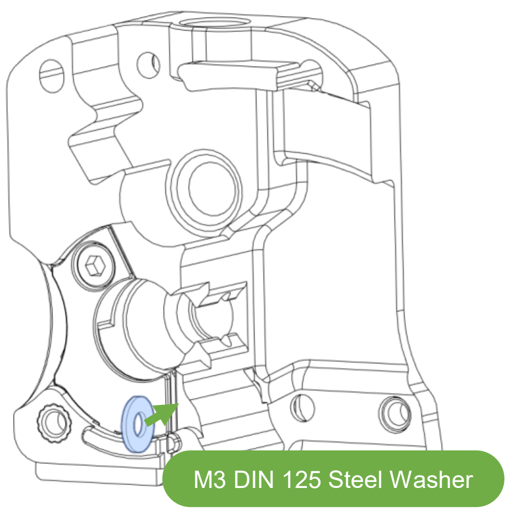
The hall sensor used is sensible to the magnet polarity, hence the magnet orientation will impact the sensor behavior, see page 82.



M3 STEEL WASHER

Make sure the washer you are using is steel (it has to be magnetic, so no plastic or stainless steel) and that its surface is smooth.

If the washer is stamped remove the burs using a file.



PTFE TO THE HOTEND

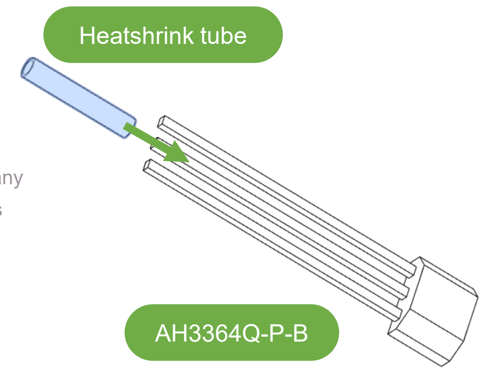
Beware that the PTFE tube that goes to the hotend is shorter than the regular AfterBurner Clockwork version.

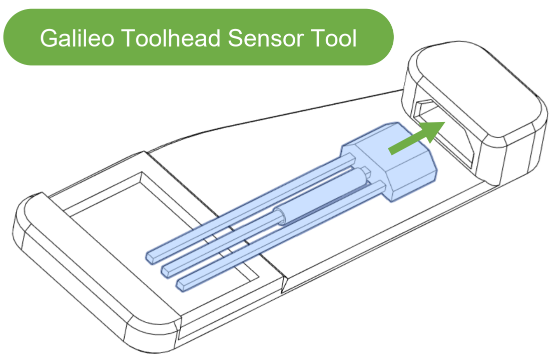
TESTING THE SENSOR

Once the M3 steel washer and the magnet are inserted, do not assemble the whole toolhead nor install it. Go to page 82 to check that the sensor is working properly first.

PREPARE THE HALL SENSOR

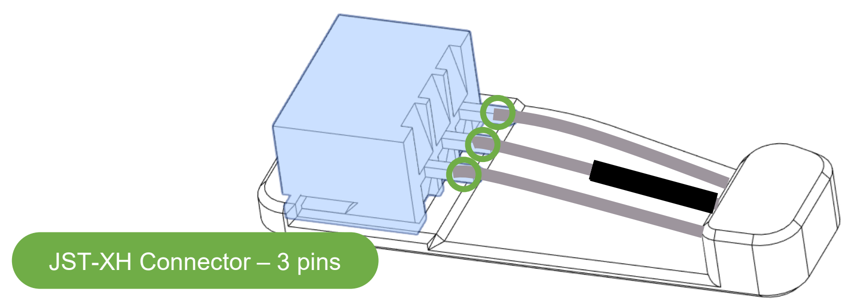
Insert a small heatshrink tube on the middle pin of the hall sensor to avoid any potential short-circuit between the pins

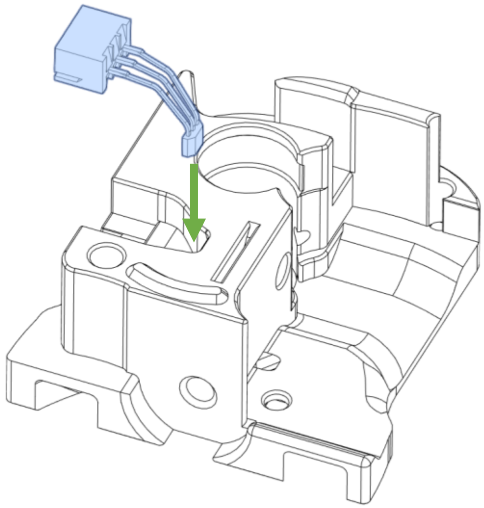




JST-XH CONNECTOR

Solder the pins of the hall effect sensor on the JST-XH connector

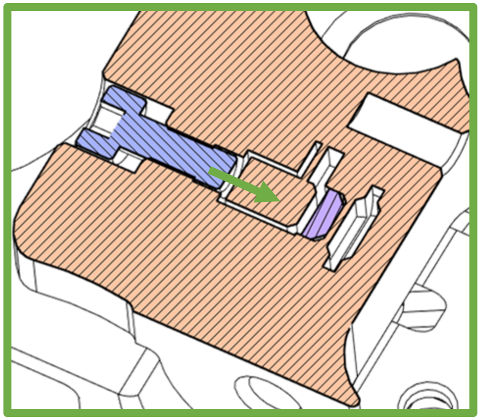


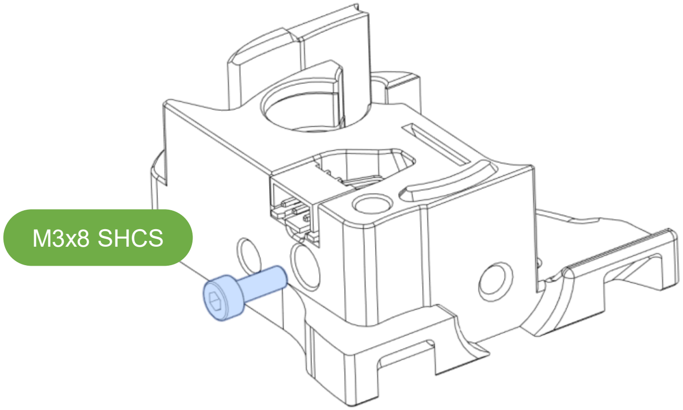


INSERT THE HALL SENSOR

Insert the sensor in its dedicated hole. Beware of its orientation and check that the sensor is fully inserted.

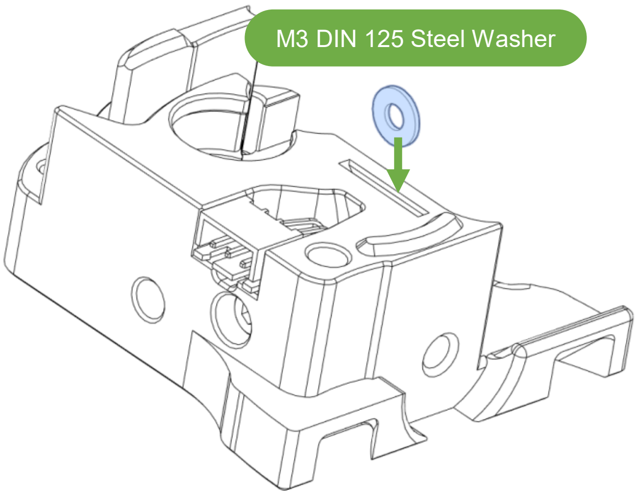
Secure the sensor position using an M3x8 screwed directly into the plastic.





PTFE TO THE HOTEND

Beware that the PTFE tube that goes to the hotend is 15 mm shorter for this version of the Galileo Clockwork (i.e. with the filament sensor) compared to the regular Galileo Clockwork.



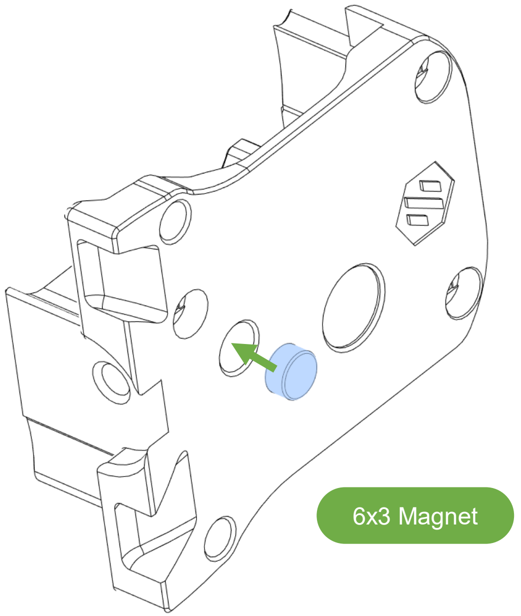
M3 STEEL WASHER

Make sure the washer you are using is steel (it has to be magnetic, so no plastic or stainless steel) and that its surface is smooth.

If the washer is stamped remove the burs using a file.

MAGNET POLARITY

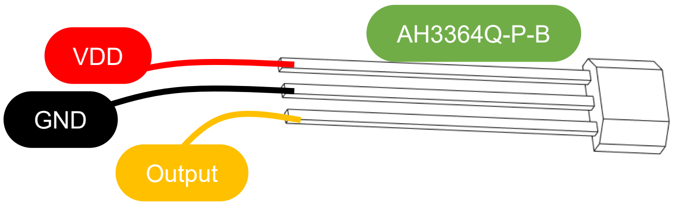
The hall sensor used is sensible to the magnet polarity, hence the magnet orientation will impact the sensor behavior, see page 82.



TESTING THE SENSOR

Once the M3 steel washer and the magnet are inserted, do not assemble the whole toolhead nor install it. Go to page 82 to check that the sensor is working properly first.

LGX ON AFTERBURNER TOOLHEAD SENSOR

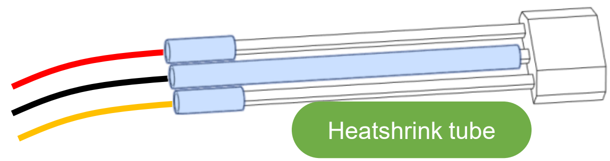


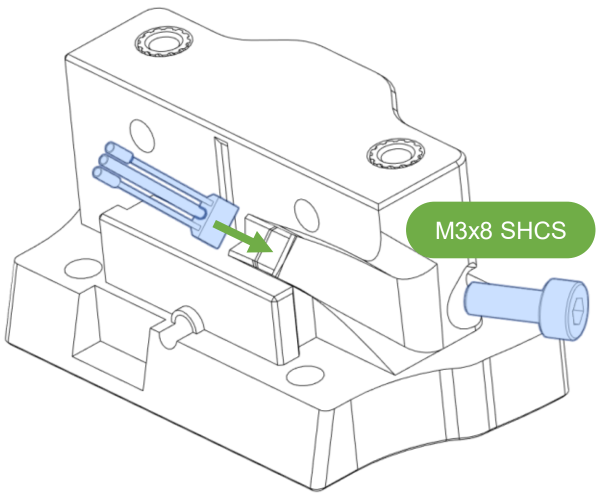
PREPARE THE HALL SENSOR

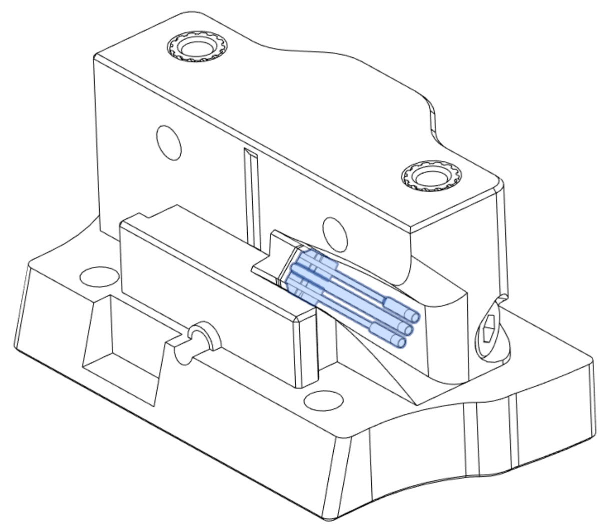
Typically, use about 15 cm of 24 AWG wire from the sensor to the connector of your choice.

Solder three wires to the sensor, at the very end of the sensor pins.

Insert a small heatshrink tube on the whole central pin and only on the solder joint for the two other pins.







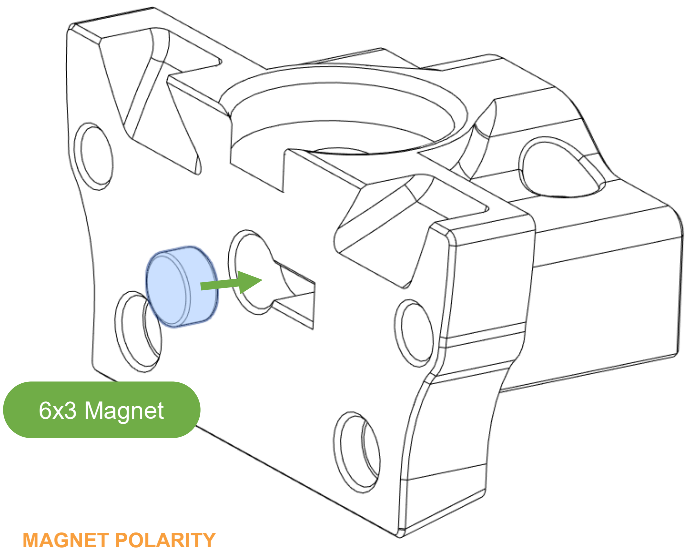
INSERT THE SENSOR

Insert the sensor in its dedicated pocket. Make sure it is fully inserted and beware of the sensor orientation.

Secure its position using a M3x8 screw.

Once properly fixed, bend the pins so they fit in the wire channel of the part.

LGX ON AFTERBURNER TOOLHEAD SENSOR



MAGNET POLARITY

The hall sensor used is sensible to the magnet polarity, hence the magnet orientation will impact the sensor behavior, see page 82.

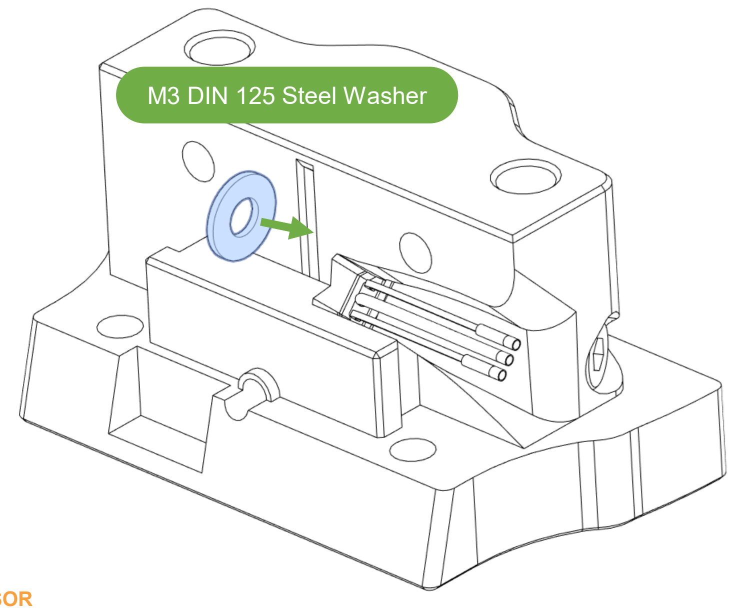
PTFE TO THE HOTEND

Beware that the PTFE tube that goes to the hotend is shorter than the regular LGX on AfterBurner version.

M3 STEEL WASHER

Make sure the washer you are using is steel (it has to be magnetic, so no plastic or stainless steel) and that its surface is smooth.

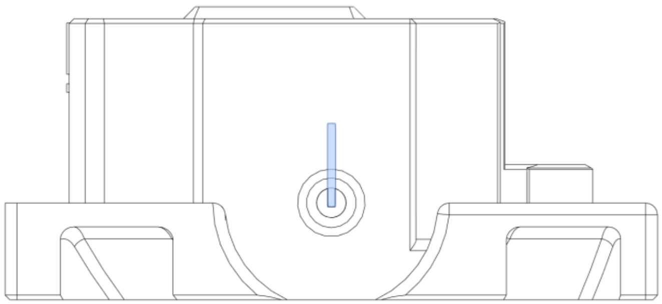
If the washer is stamped remove the burs using a file.



TESTING THE SENSOR

Once the M3 steel washer and the magnet are inserted, do not assemble the whole toolhead nor install it. Go to page 82 to check that the sensor is working properly first.

TESTING THE SENSOR



Example for the Galileo Clockwork

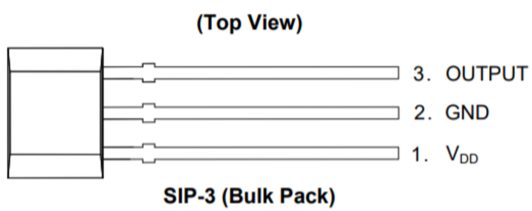
FILAMENT PATH

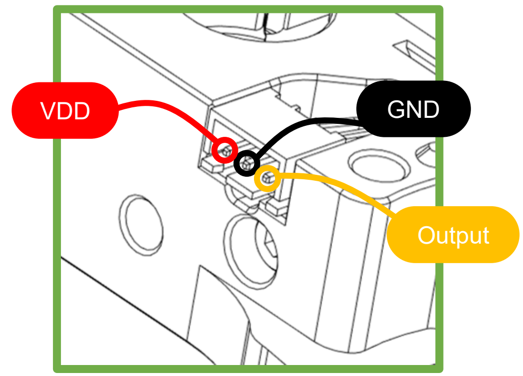
Make sure the washer is properly inserted into the filament path, as shown. Otherwise, you may have to clean the washer slot in the 3D printed part.

TESTING THE SENSOR

SENSOR CONNECTION

Ensure proper connection and plug in the sensor to your board.





Example for the Galileo Clockwork with the JST-XH connector

KLIPPER CONFIG

Make sure that the filament sensor pin on the klipper config has a pull-up (‘^’).

```
[filament_switch_sensor toolhead_sensor]
pause_on_runout: False
switch_pin: ^P1.27
```

In the ercf_hardware.cfg

TESTING THE SENSOR

SENSOR TEST

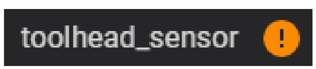
Use your default printer control frontend, like Mainsail or Fluidd, to check the sensor behavior.

Once connected and check that the sensor reports no filament when there is none in the filament path

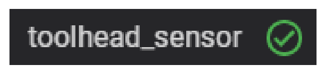
Use 1.75 mm filament and insert it in the filament path, now the sensor should trigger

In case the filament sensor is always is an triggered state, this probably means the magnet is installed with the wrong polarity. In this case, invert the magnet orientation and check again.

Once you've checked several times that the sensor triggers properly on filament insertion and removal, you can shutdown your printer and install the complete toolhead.



Example of filament sensor state with no filament inserted, on Fluidd



Example of filament sensor state with filament inserted, on Fluidd

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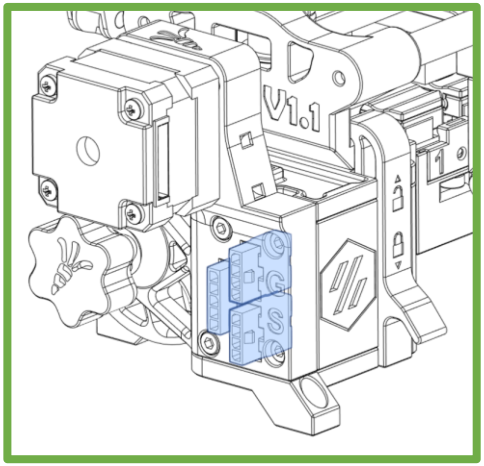
CONNECTING THE ERCF : NO CUSTOM CONTROLLER BOARD (i.e. PRINTER MAIN BOARD(S))



FIRST CONNECTION

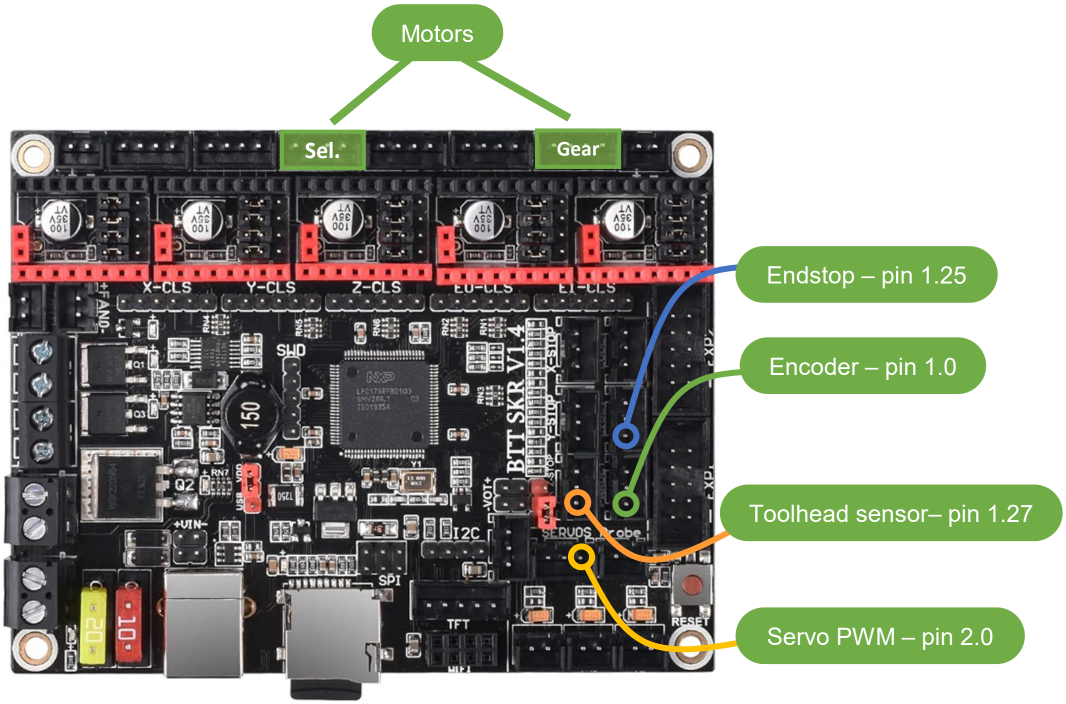
You can keep the ERCF on a table or desk for all the incoming steps, you just need to be able to connect it to your printer.

Plug in the 3 connectors to the ERCF (5 pins general connector and the two 4 pins motors connectors) and the other ends on your printer main board(s).

RECOMMENDATIONS

It is recommended to use the +5V and GND from a reliable current source, like the one in use for your Raspberry Pi.

The GND of your board, like the SKR1.4 in this example, should be connected to your 5V PSU GND.



Example for an SKR 1.4 board.

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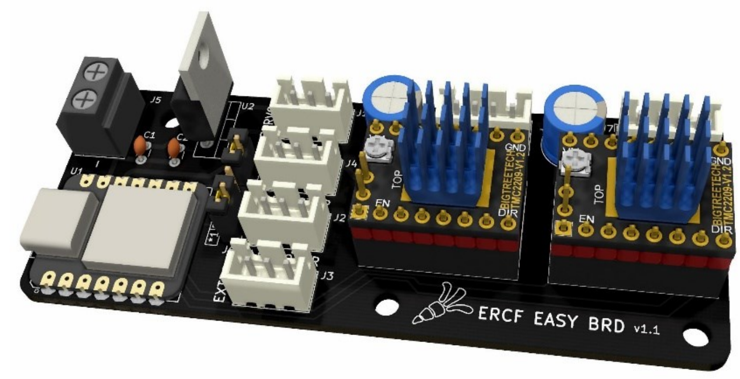
CONNECTING THE ERCF : CUSTOM CONTROLLER BOARD



ERCF EASY BRD

The ERCF EASY BRD is a dedicated controller board that contains all you need to run an ERCF unit.

The main purposes of this custom board are :
- Allowing the ERCF unit to be used on printers that run Klipper but do not have spare stepper drivers slots on the main board(s).
- Make it easier to add on an existing printer with minimal modifications in the electronic compartment, if not none at all.
- Minimize the amount of wiring between the printer and the ERCF unit.
- As easy as it gets to build for anyone with a basic soldering iron. All components are through-hole components and widely available from many sources.

The ERCF EASY BRD is intended to be placed under the ERCF unit, between the two aluminum profiles. But of course, you can place it anywhere you want.

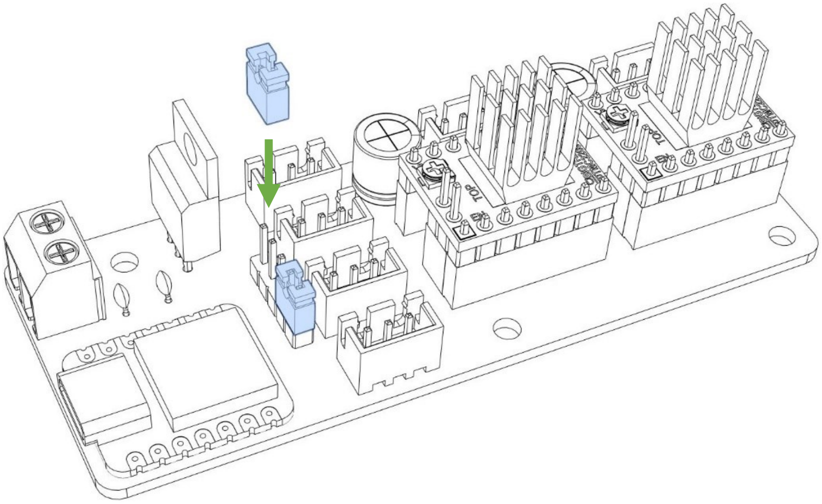
By using this custom board, you can skip all steps of the ERCF manual that relate to wiring connectors and motors.

Find all the information about the ERCF EASY BRD and related stl files on the dedicated Github page:
https://github.com/Tircown/ERCF-easy-brd

For your information, the original name of this custom board was ERCF EZ BOARD, so you can still find pictures or products sold with this name on the PCB silkscreen. The name has been changed to avoid confusion with a product line up well know in the 3D printing community, which has absolutely nothing to do with this board.

Tircown // Fabrice

ERCF EASY BRD : JUMPERS AND STEPPER DRIVERS



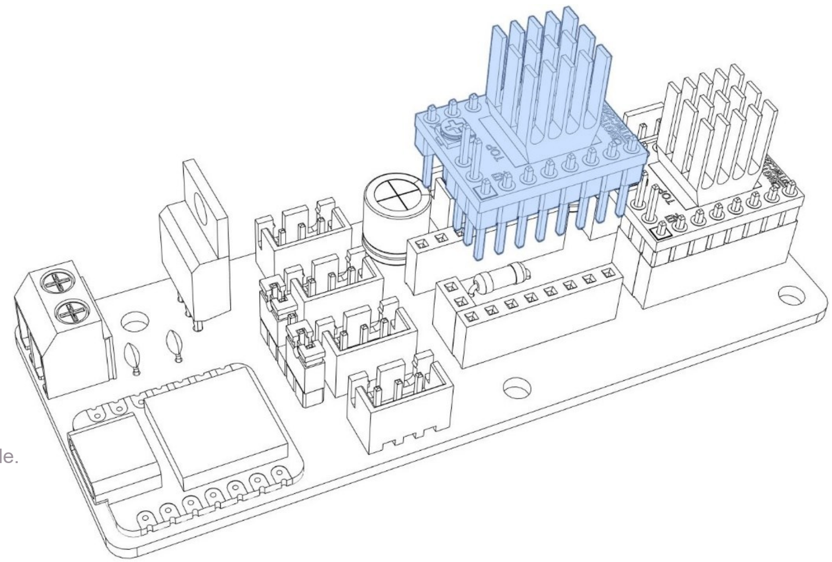
JUMPERS

The jumpers are used to allow multiple configurations. The numbering goes from left to right when the screw terminal is on top. See the silkscreeen on the PCB for more details.

[1 2] 3 [4 5] : The extra connector is wired to PA7 and the endstop to PB9. Sensorless homing is not used. This is the most common configuration.

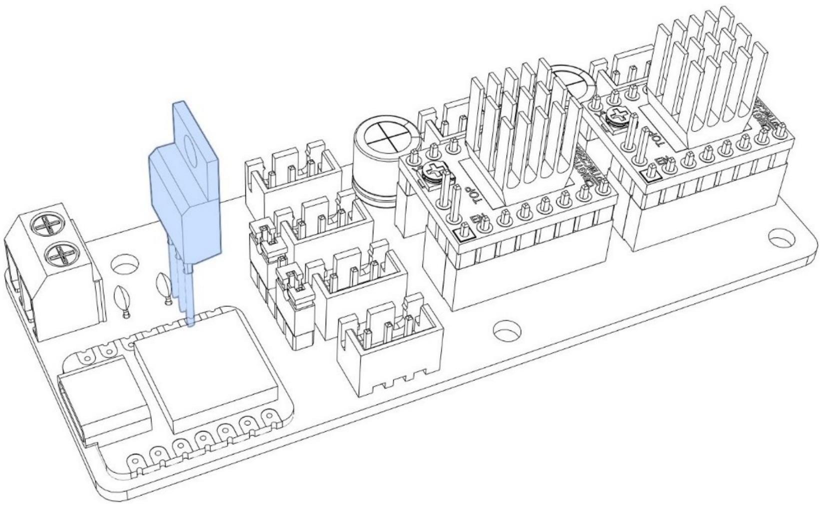
1 [2 3] [4 5] : The sensorless homing of the selector is wired to PA7 and the endstop to PB9. The extra connector is not used.

[1 2] [3 4] 5 : The extra connector is wired to PA7 and the sensorless homing of the selector motor to PB9. The endstop is not used.



STEPPER DRIVERS

Install two TMC2209 with heatsinks. Only TMC2209 are compatible.
Be careful about the orientation.

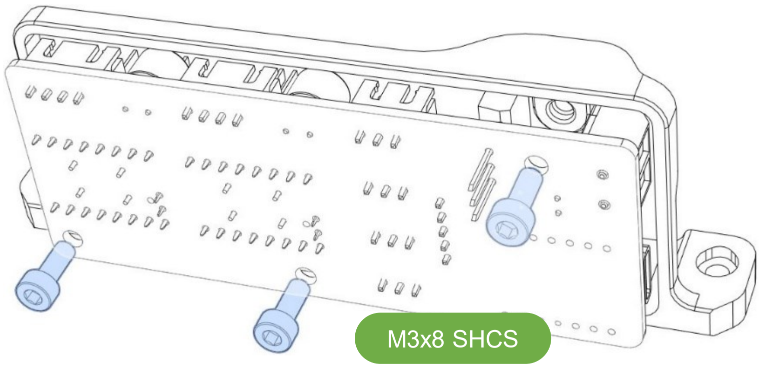


VOLTAGE REGULATOR

If you are using a 24V power supply, be sure to add a good sized heatsink. Standard TO-220 heatsinks are fine. You may need to bend or remove a fin near the jumpers and remove the middle pin.

If you are using a 12V power supply, an heatsink is mostly not required but it's a good idea to add one depending on where the board is located.

ERCF EASY BRD : BOARD INSTALLATION



MOUNT ASSEMBLY

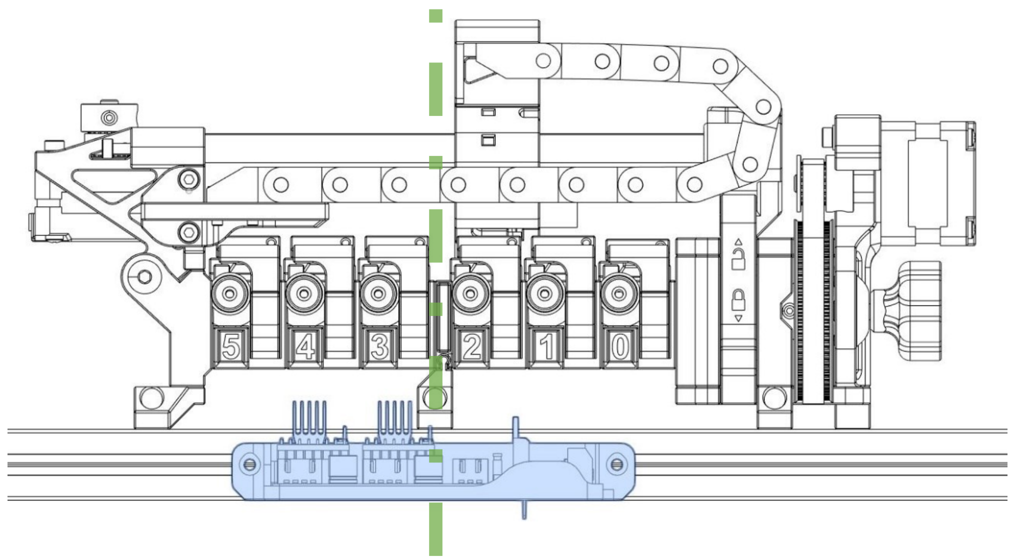
Remove the three built-in supports.

The three M3x8 screws are screwed into the plastic. Do not overtighten them otherwise the mount will bend.

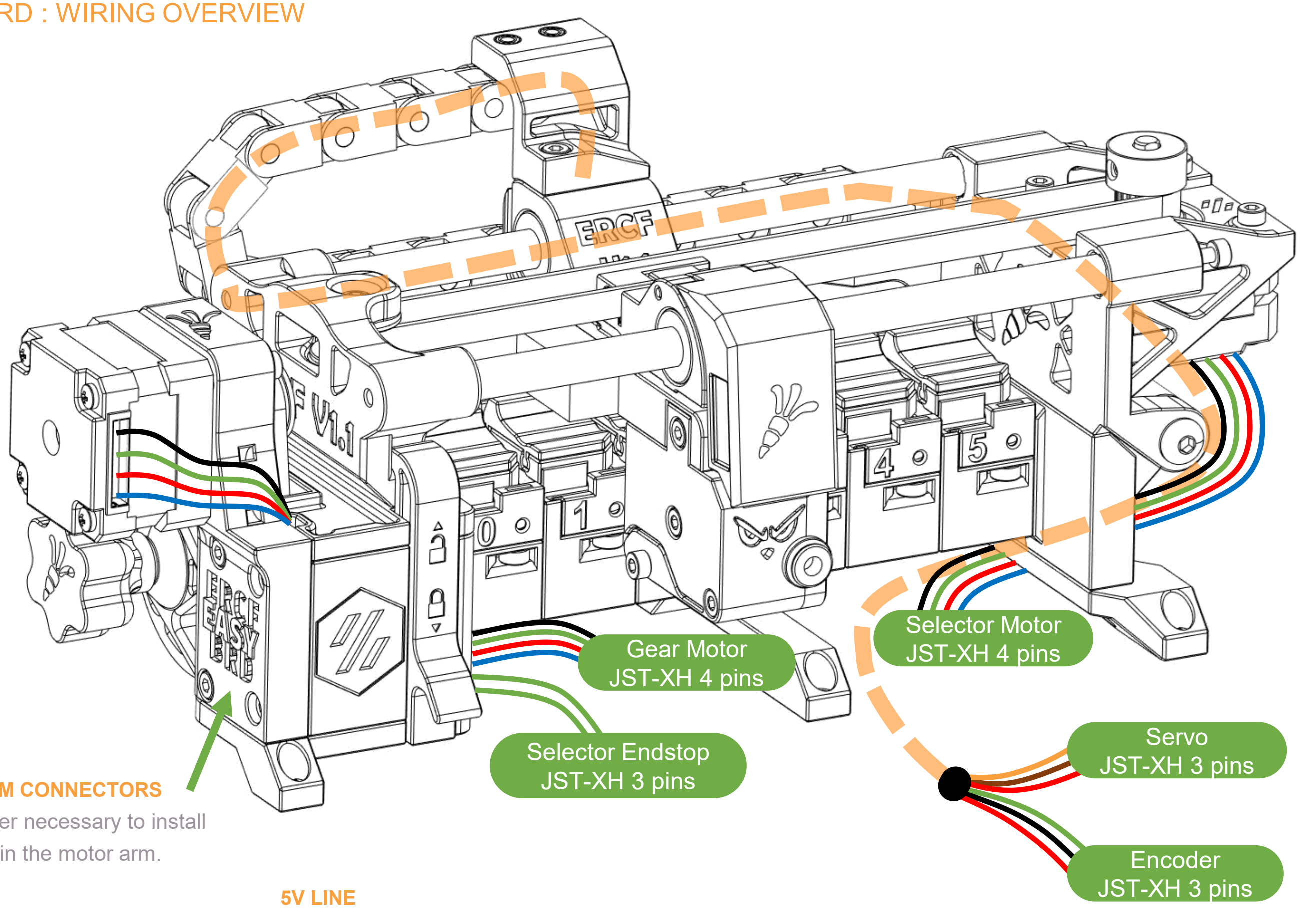
POSITIONNING

Install the mount on the side of one aluminum profile.

Take care of the position relative to the ERCF unit so the Bearing Insert Feet doesn't interfer with the wiring.



ERCF EASY BRD : WIRING OVERVIEW



MOTOR ARM CONNECTORS

It is no longer necessary to install connectors in the motor arm.

5V LINE

Do not put any sensor or input device in the servo connector that would send +5V to the microcontroller. This would destroy your board since the Seeeduino XIAO is not 5V tolerant.

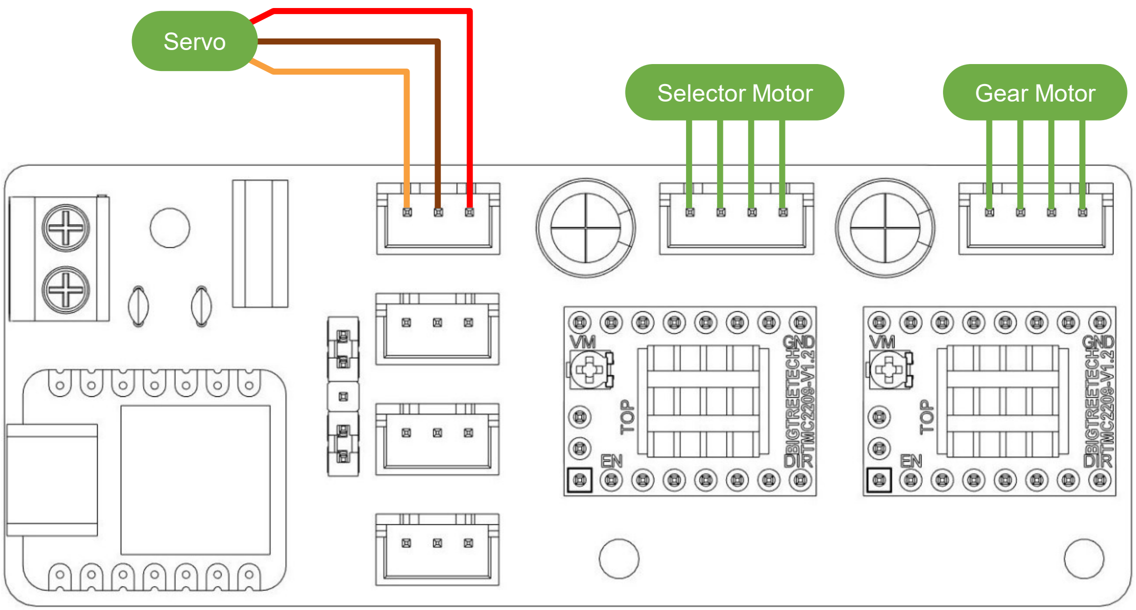
The servo connector is the only one that is powered by +5V.

Do not merge together the servo red wire and the encoder red wire!

SERVO CONNECTOR

Do not put any sensor or input device in the servo connector that would send +5V to the microcontroller. This would destroy your board since the Seeeduino XIAO is not 5V tolerant.

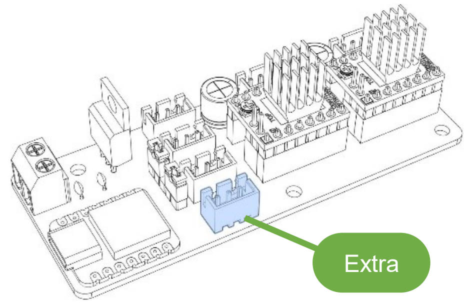
The servo connector is the only one that is powered by +5V.

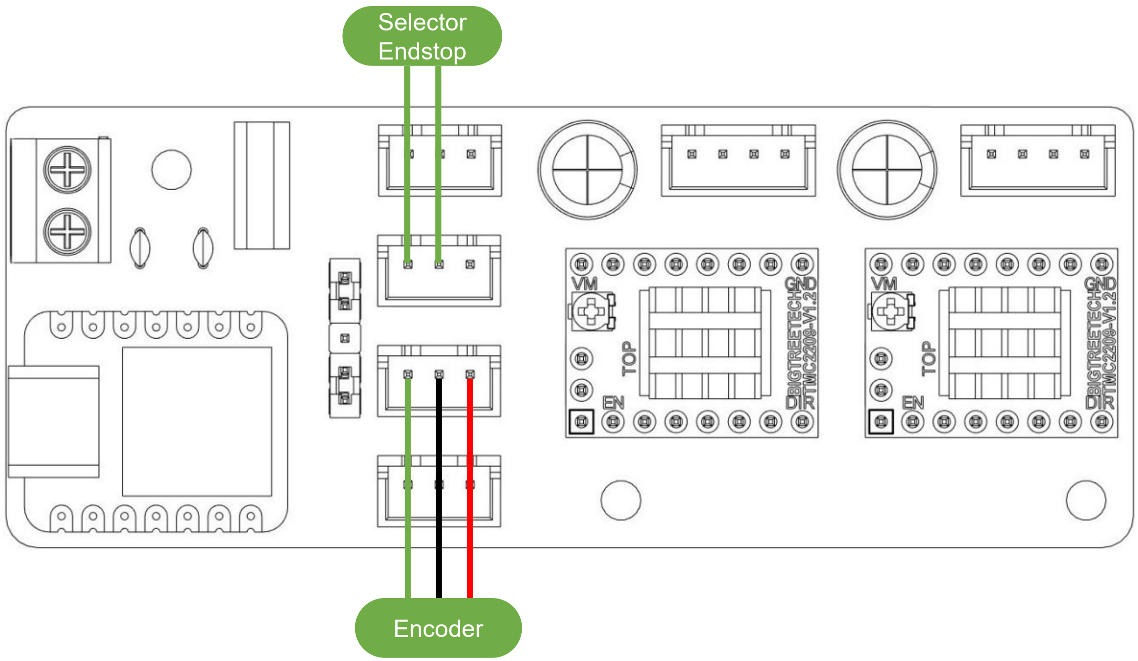


ERCF EASY BRD : SENSORS WIRING

EXTRA CONNECTOR

There is an *extra* connector available on the board. This one is not used in a classical configuration. One can use it for the toolhead sensor if the wiring seems easier.





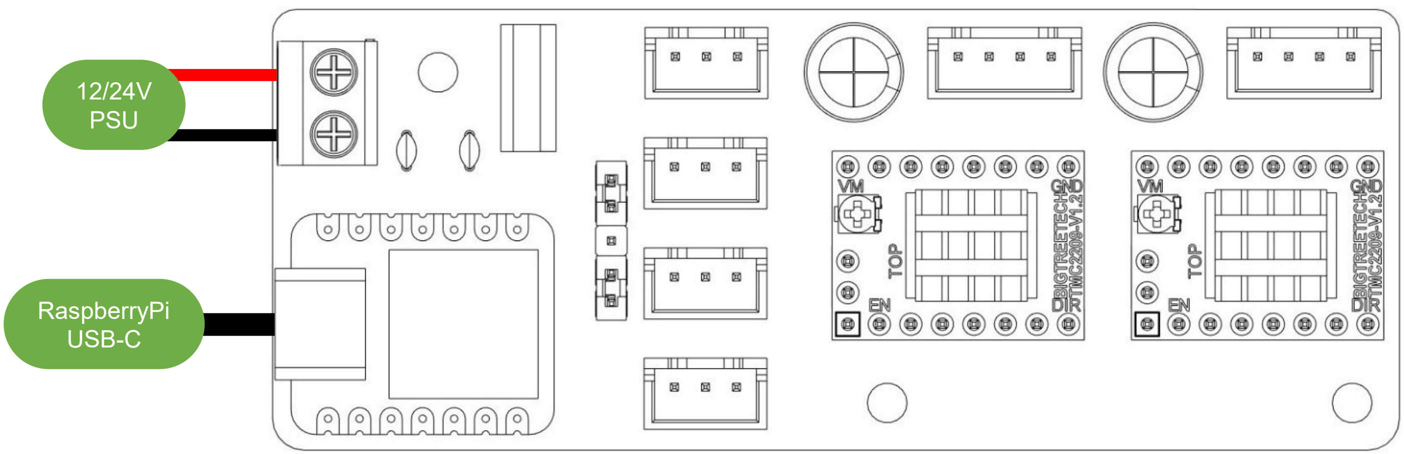
ERCF EASY BRD : GENERAL WIRING

POWER SUPPLY

The screw terminal is used to power the stepper motors and the voltage regulator which supplies 5V to the servo.
Be careful with the polarity of the wires in the screw terminal, there is no particular protection against polarity inversion.

One can use a cable with a built-in fuse to add a little protection.

The microcontroller and sensors are powered through the USB-C cable from the RaspberryPi USB port.



ERCF EASY BRD : MICROCONTROLLER

Many microcontrollers are compatible with the footprint on the PCB. Even though it was originally developed for the Seeeduino XIAO, one can use the Adafruit QT Py, the Seeeduino XIAO RP2040, the Adafruit QT Py RP2040, etc. The procedure for flashing each of them is different.

SEEEDUINO XIAO 1/2

Login to the Raspberry Pi via ssh

Run the following to install the lastest version of bossac (version ≥1.8 is required) :

```
sudo apt install libreadline-dev libwxgtk3.0-*
git clone https://github.com/shumatech/BOSSA.git
cd BOSSA
make
sudo cp bin/bossac /usr/local/bin
```

Run the following commands to prepare the firmware :

```
cd ~/klipper
make clean
make menuconfig
```

Select the options :

```
(Top)
                        Klipper Firmware Configuration
[ ] Enable extra low-level configuration options
    Micro-controller Architecture (SAMD21/SAMD51)  --->
    Processor model (SAMD21G18 (Arduino Zero))  --->
    Clock Reference (Internal clock)  --->
    Bootloader offset (8KiB bootloader (Arduino Zero))  --->
    Communication interface (USB)  --->
```

Once the configuration is selected, press q to exit, and “Yes” when asked to save the configuration.

Run the following command to build the firmware :

```
make
```

SEEEDUINO XIAO 2/2

Connect the board to the RaspberryPi if it's not already done.
Get the port of the XIAO by running the following command :

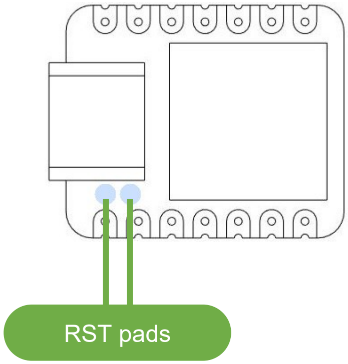
```
ls /dev/tty*
```

Prepare the following command in the terminal and replace the default /dev/ttyACM1 with the actual port :

```
sudo /usr/local/bin/bossac -i -d -p /dev/ttyACM1 -e -w -v -R --offset=0x2000 out/klipper.bin
```

Use tweezers or short lines to quickly short the RST pads twice.
The orange LED will light up and flicker. Then send in the next few seconds the prepared command.

More information on how to reset for flashing:
https://wiki.seeedstudio.com/Seeeduino-XIAO/#enter-bootloader-mode



STATUS

At this stage, it is assumed you have connected your ERCF to your printer (either using the printer main board(s) or the ERCF EASY BRD).

It is now time to configure Klipper.

In the printer.cfg

```
[pause_resume]
recover_velocity: 300.0

[include ./ercf_hardware.cfg]
[include ./ercf_software.cfg]
```

CFG & PY FILES

Add the ercf_hardware.cfg, ercf_vars.cfg and the ercf_software.cfg in your klipper configuration folder.

Add the ercf.py in the *klippy/extra* folder of your klipper installation.

Include both ercf_hardware.cfg and ercf_software.cfg files into your printer.cfg file and make sure you have a [pause_resume] section included.

EXTRUDER PARAMETERS

To allow proper operation of the ERCF, we need to increase the max_extrude_only_distance parameter of your extruder section to 200 and the max_extrude_cross_section to 50.0

In the extruder.cfg

```
[extruder]
max_extrude_only_distance: 200
max_extrude_cross_section: 50.0
```

MOTORS CONFIG

Please adapt the motor configuration in the *ercf_hardware.cfg* (current, stealthchop thresholds etc.) depending on the motors your are using

ERCF PARAMETERS

Define the *end_of_bowden_to_sensor* and the *sensor_to_nozzle* according to your extruder and toolhead//hotend. Values for typical setups are listed in comments, as shown below. You can see what those parameters represent in the scheme in page 127.

```
# ==== Toolhead specific values ====
#
# Distance between the end of the reverse bowden and the toolhead sensor. Value is toolhead specific.
# Tested values :
# Galileo Clockwork with ERCF V1.1 sensor (hall effect) : 27.0
# LGX on AfterBurner with ERCF V1.1 sensor (hall effect) : 44.0
# AfterBurner Clockwork with ERCF V1.1 sensor (hall effect) : 36.0
variable_end_of_bowden_to_sensor: 44.0
# Length from the sensor to the nozzle melt pool.
# Reduce this value if there are blobs of filament on each load, before the purge on the tower.
# Increase this value if there are big gaps on the purge tower (i.e. if it takes time for the filament to get pushed out after a swap)
# Tested values :
# Galileo Clockwork with ERCF 1.1 sensor (hall effect) & Dragon Normal Flow : 60.5
# LGX on AfterBurner with ERCF 1.1 sensor (hall effect) & Dragon Normal Flow : 55.6
# AfterBurner Clockwork with ERCF 1.1 sensor (hall effect) & Dragon Normal Flow : 54.0
variable_sensor_to_nozzle: 55.6
```

In the ercf_software.cfg

In the ercf_software.cfg

```
# Servo angle for the Up position (i.e. channel disengaged).
# Default values:
# MG90S servo : 30
# SAVOX SH0255MG : 140
variable_servo_up_angle: 30
# Servo angle for the Down position (i.e. channel engaged).
# Default values:
# MG90S servo : 140
# SAVOX SH0255MG : 30
variable_servo_down_angle: 140
```

SERVO ANGLES DEFAULT VALUES

Depending on the servo model you're using, set both the up and down angle to their corresponding default values in the ercf_software.cfg.

Precise values will be tuned later.

REVERSE BOWDEN LENGTH

You have to specifiy the length of the reverse bowden tube of your setup. This is the PTFE tube that goes from the ERCF to your printer's toolhead.

Get a rough measurement of this tube length, and substract a few cms to this value (typically 5cms). It doesn't need to be precise, it just needs to be lower than the real PTFE tube length.

```
# Base value for the loading length used by the auto-calibration macro
# Please use a value SMALLER than the real reverse bowden length (like 50mm less)
variable_min_bowden_length: 750.0
```

PIN DEFINITION

Make sure the pin defined in the 3 positions shown on the pictures below are the same exact pin (namely the pin of the encoder signal)

Do not put the ^ on the duplicate_pin_override section but use them on the other two.

```
[duplicate_pin_override]
pins: P1.0
# Put there the pin used by the encoder and the filament_motion_sensor
# It has to be the same pin for those 3

[filament_motion_sensor encoder_sensor]
switch_pin: ^P1.0
pause_on_runout: True
detection_length: 3.0
extruder: extruder
runout_gcode: ERCF_ENCODER_MOTION_ISSUE
```

In the ercf_hardware.cfg

```
[ercf]
# Encoder
encoder_pin: ^P1.0
```

In the ercf_software.cfg

MISC MACROS

You will find in the client_macros.cfg examples of CANCEL_PRINT, PAUSE and RESUME macros that are compatible with the clog detection and endless spool mode of the ERCF. Please adapt those macros to your owns, the relevant part being the lines concerning the encoder_sensor.

RELOAD

Don’t forget to reload your firmware so that all changes are accounted for.

ENDSTOP AND MOTORS

Use those GCodes to test that :

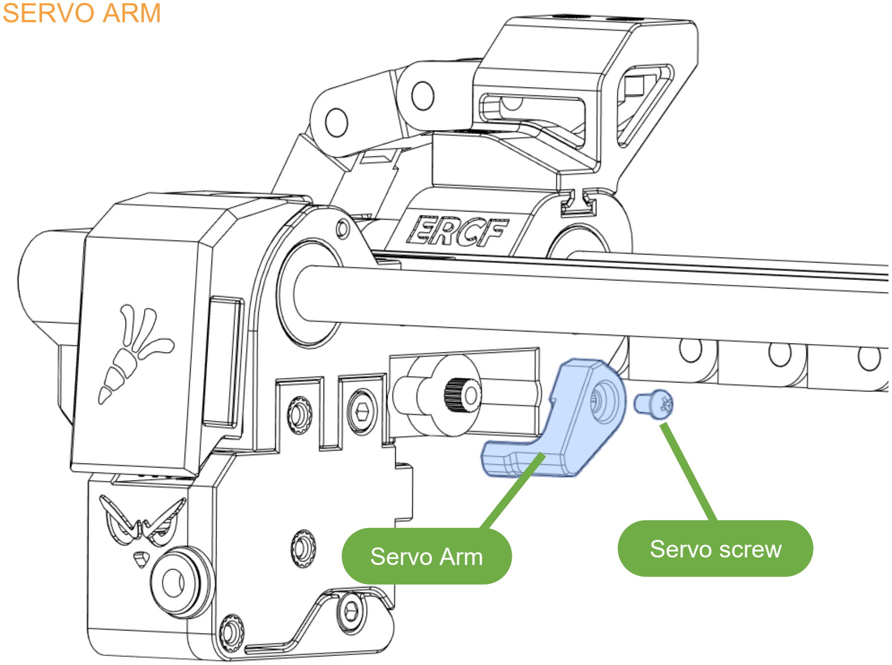
- The selector_motor endstop works as expected : TRIGGERED when you click it, open otherwise. Do not look for the gear_stepper endstop, it doesn't exist (it's a dummy pin)
- Both motors turn. Beware that those GCodes induce slow, almost silent moves

GCode : QUERY_ENDSTOPS

GCode : STEPPER_BUZZ STEPPER="manual_stepper gear_stepper"

GCode : STEPPER_BUZZ STEPPER="manual_stepper selector_stepper"

SERVO ARM

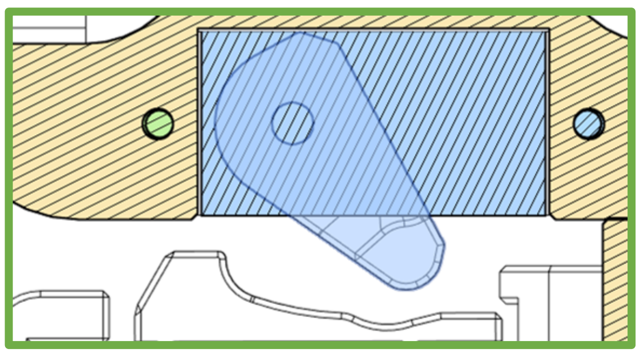


SERVO ARM

The servo only have a 180° range, hence the servo arm cannot be installed in a random position on the servo axis.

First, use **GCode : ERCF_SERVO_UP**

This will move the servo axis to the *UP* position. Now install the servo arm on the servo axis so that arm extension almost touches the bottom of the servo, as shown below.



SERVO ARM ANGLES

TUNING THE SERVO ANGLES

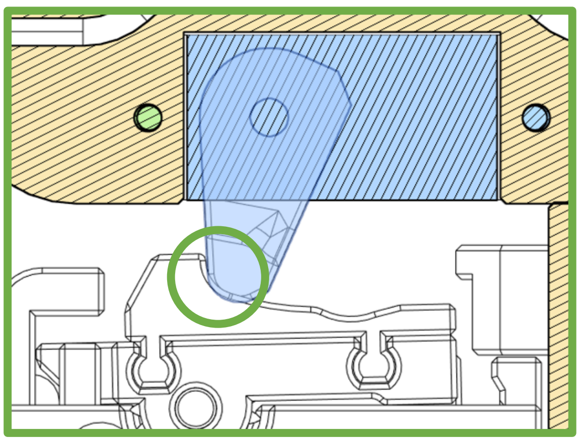
Use **GCode : ERCF_TEST_SERVO VALUE=*ANGLE***

With *ANGLE* being the angle you want to test to finely tune the up and down positions of the servo. Alternate from one position to another (Up vs Down) to always have a full swing on the movement.

To get a reliable system, ensure that:

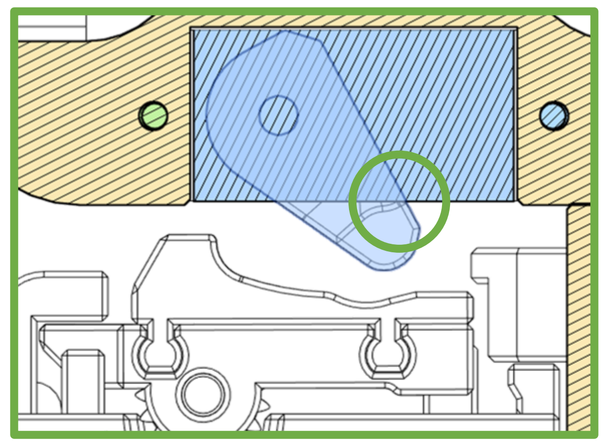
- For the up position, don't make the servo arm collide with the servo body. You want the servo arm to stop right at the servo body.
- For the down position, the servo arm needs to be in a 'vertical' position, as shown on the picture below. Start from a smaller angle and increase the test value little by little (don't forget to go back to the servo up position in between each new test). The ERCF_SERVO_DOWN command will make the gear motor buzz to ensure a proper gear meshing. If you notice the servo arm sliding back a lot (i.e. roughly more than a millimeter) after the move is done, increase the angle a little more.

Servo down position, pressing on the gears



GCode : ERCF_SERVO_DOWN

Servo up position, releasing the gears

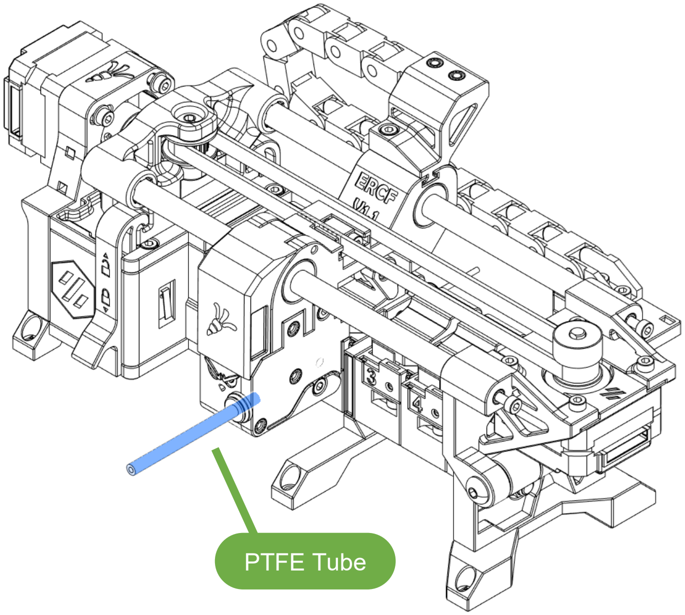


GCode : ERCF_SERVO_UP

RELOAD

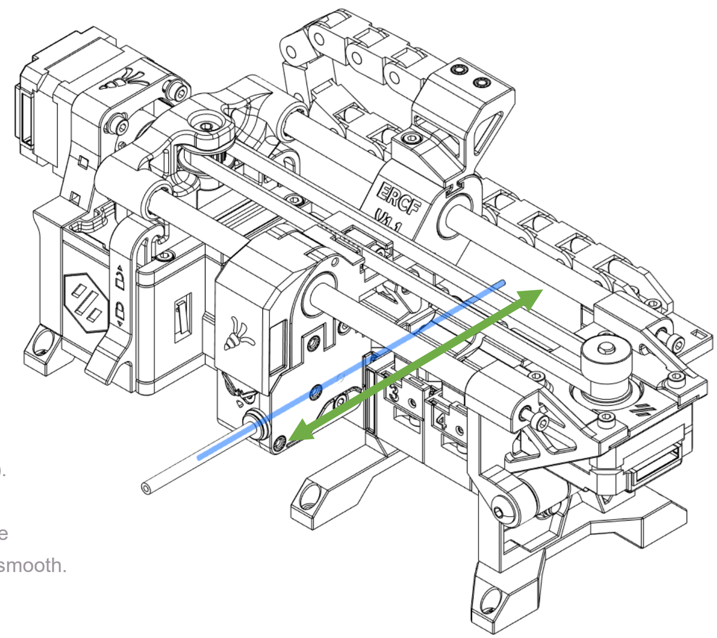
Don't forget to set the final values in the ercf_software,cfg and reload your firmware so that all changes are accounted for.

SELECTOR CALIBRATION



PTFE TUBE

Insert a small PTFE tube (like 5 cms or so) in the selector cart ECAS in order to ease filament insertion during this calibration phase.



SELECTOR POSITION

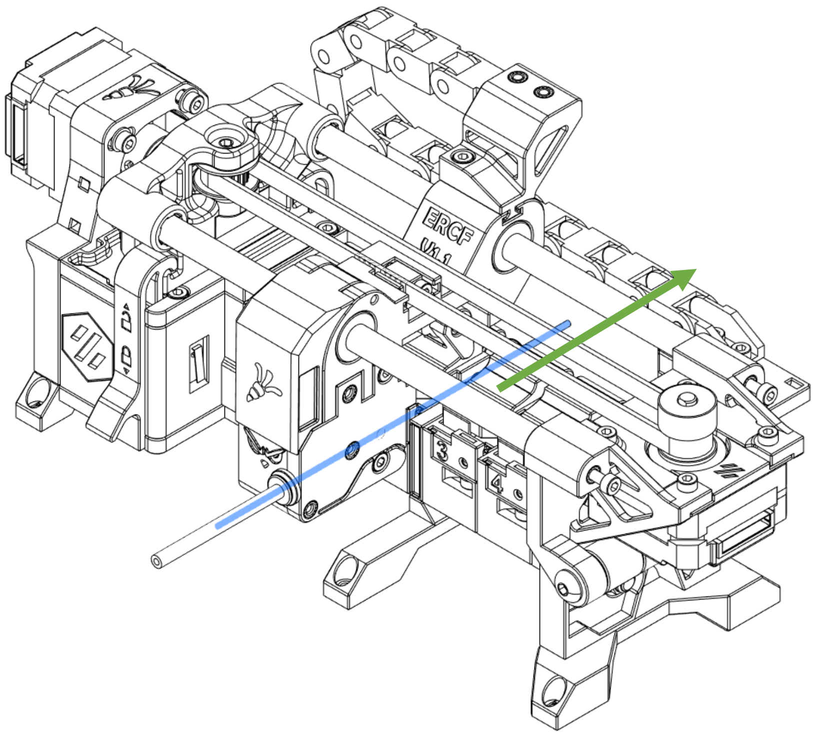
Use **GCode : ERCF_MOTORS_OFF**

Then move, by hand, the selector in front of a tool (you can start from the first tool for example).

Push and pull some 1.75mm filament in the channel and use it to finely adjust the position of the selector. Insert the filament through the Filament Block and then the Selector should be rather smooth.

See next page before doing anything else.

SELECTOR CALIBRATION



QUERY THE SELECTOR POSITION

Remove the filament from the channel.

Then use **GCode : ERCF_CALIB_SELECTOR TOOL=*N***

With *N* being the number of the tool you want to calibrate (first tool is 0).

This will make a selector homing move, and then report on the console the resulting position for the corresponding tool.
Report manually this value in the *variable_colorselector* array in the ercf_software.cfg file.

Note that the Gcode command above will automatically turn the ERCF motors OFF once it is done.

Example of the colorselector array for a 9 tools ERCF

```
# Channel position for the selector. This has to be tuned manually. Please scale this array to the number of channels you have
variable_colorselector = [2.4, 24.0, 44.8, 71.2, 92.0, 113.6, 139.2, 160.8, 181.6]
```

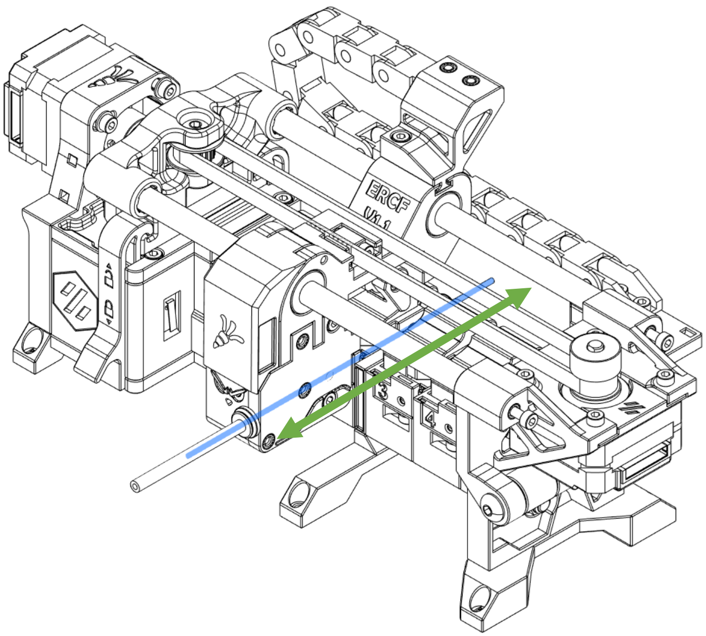
Tool 0

Tool 8

REPEAT THEN RELOAD

Repeat this whole operation for each tool of the ERCF. Don't forget to set the final values in the ercf_software,cfg and reload your firmware so that all changes are accounted for.

ENCODER TEST



ENCODER BEHAVIOR

While the selector is in front of a tool, push some 1.75mm filament through it and look at the the selector front. While you move the filament, the encoder LED should blink, making the eyes of the rabbit red.

Make sure that :

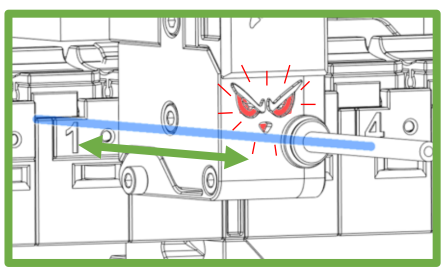
- The LED state stays the same when the filament doesn't move (either ON or OFF)
- When you move slowly the filament, the LED will turn ON and OFF, as a function of the filament position.

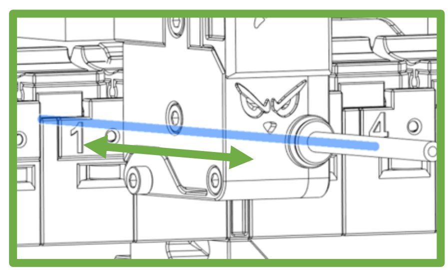
Note that moving the filament fast will just make the LED appears red (it's simply blinking really fast).

Use **GCode : ERCF_DISPLAY_ENCODER_POS**

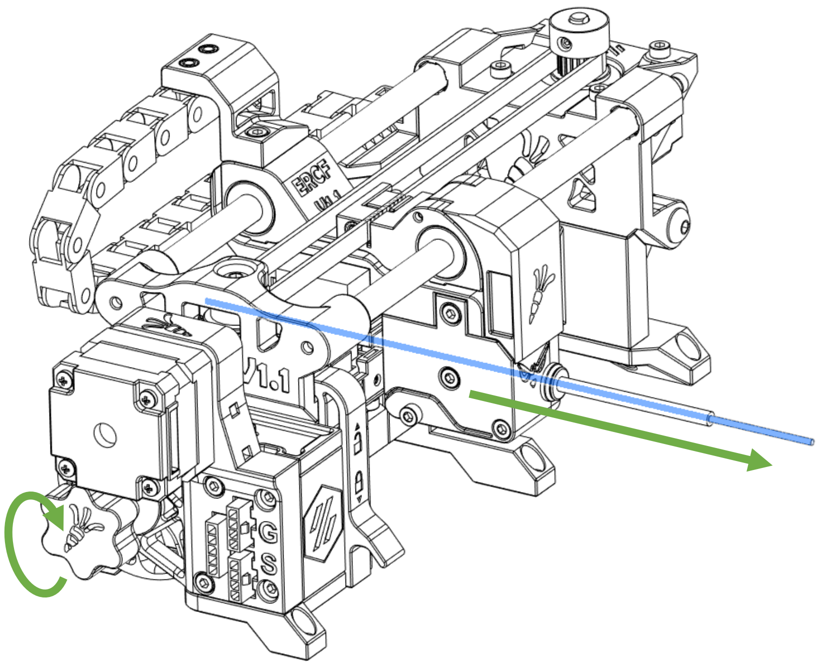
This will display the current encoder position. Make sure this value does increase when you move the filament. Note that : encoder is not yet calibrated and that the encoder cannot know the direction of the move. Hence moving the filament back and forth will keep increasing the encoder counts.

In case of issue, make sure that the BMG gear can rotate properly, and that the TCRT5000 sensor is properly connected. If you still have issues, dismount the encoder cart and check that the sensor wall, between the two LEDs, is very close to the dual gear part of the BMG idler. They shouldn't touch, but they should be very close. If need be, you can gently file down the 3D printed part where the sensor rests (i.e. the screw thread) to get the sensor closer to the BMG idler. Look into the ERCF F.A.Q. (https://github.com/EtteGit/EnragedRabbitProject/blob/main/Documentation/FAQ/FAQ_ERCF.md) for additional help if need be.





TOP HAT LOCKERS



CHECKING THE GRIP

We now have to tune the Top Hat Lockers for each tool.

Use **GCode : ERCF_MOTORS_OFF**

Put the selector in front of the first tool and push some 1.75 mm filament through it, until the filament sticks out from the PTFE tube (you should be able to grab the filament).

Use **GCode : ERCF_TEST_GRIP**

This will put the servo down (i.e. engage the gears) and turn the ERCF motors off.

Now, gently try to pull the filament. If the grip is good enough, this will make the motor gear turn, otherwise the filament will just slip on the BMG gears, indicating that the grip is not good enough.

Do not pull too fast the filament as this will send too much EMF back to the driver and potentially damage it.

Use **GCode : ERCF_SERVO_UP**

This will disengage the gear so you can remove the filament.

SWAPPING TOP HAT LOCKERS

In case the grip is not sufficient, open the ERCF and open the tool latch. Grab the Top Hat and gently pull it out from the filament block. Remove the Top Hat Locker and replace it with one of a higher value (use a *2* Top Hat Locker if you had a *1* for example).

Check that the gears for this tool are not dirty because of the filament slippage, if so clean them.

Put back the Top Hat in the Filament Block, close the block latch and then close the ERCF. Check the grip again and reapeat this process until you have a proper grip for all tools.

Not all tools will necesseraly have the same Top Hat Lockers value.

ERCF HOMING

FIRST HOME

It is now time to load all the tools with some filament (using real spools). Whatever buffer or spool rewinder solution you are using, make sure that :

- Buffers are fully loaded (in case you use buffers)
- Spools are easy to pull from (in case you are using rewinders)

Put all the filaments in the ERCF filament blocks, make sure all filament tips are in the parking position (i.e. between the gears and the magnetic gate).

Use **GCode : ERCF_HOME**

The ERCF will first engage whatever tool the selector is located at to check if the filament is already in the reverse bowden towards the toolhead (at this stage it shouldn't). Knowing the filament is not in the selector way, it will then home the selector, go to the very first tool, load it just a bit (a few centimeters after the encoder position), then unload it and disengage.

That's it, your ERCF is now homed ! Homing the ERCF allows it to now where the selector cart is. It has to be done every time the system is rebooted or if you move manually the selector.

GEAR MOTOR CALIBRATION

GEAR STEPS CALIBRATION

We now need to calibrate the gear motor steps. To do that, we'll use the tool 0 of the ERCF, this is MANDATORY.

Use **GCode : ERCF_SELECT_TOOL TOOL=0**

And then **GCode : ERCF_LOAD**

The filament in tool 0 should now be loaded by a few cms and stick out from the small PTFE tube inserted on the selector. In case it doesn't, either cut the PTFE tube a bit or use the knob to push the filament a bit. Make sure to use the ERCF_MOTORS_OFF in case you go for the knob.

Cut flush the filament at the PTFE end. This will be our reference point.

Now use **GCode : ERCF_TEST_MOVE_GEAR**

This will slowly push around 200mm of filament. Once done, measure precisely what was the real extruded length (either measure in place the filament or cut flush again at the PTFE exit and measure what you have).

Apply the following formula to get the proper step_distance for the ERCF gear motor :

New step distance = Old step distance x measurement [mm] / 200

Update the value in the ercf_hardware.cfg and reload the firmware.

You can use again **GCode : ERCF_TEST_MOVE_GEAR** directly after the reload to check that you now have precisely 200mm of filament.

ENCODER CALIBRATION

ENCODER CALIBRATION

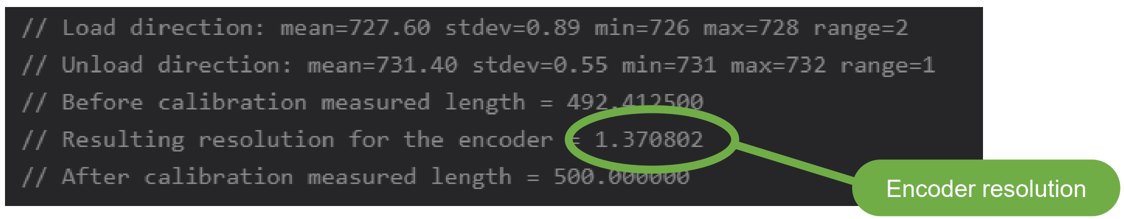
It is assumed you still have the filament of tool 0 slightly loaded (i.e. a few cms after the encoder). If not, you can use ERCF_HOME, ERCF_SELECT_TOOL TOOL=0 and ERCF_LOAD to do so.

Now use **GCode : ERCF_CALIBRATE_ENCODER**

This will push and then pull back 50 cms of filament, 5 times in a row, and measure for each move the number of increments measured by the encoder. Make sure you have those 50 cms of filament available for the ercf to push easily. In case you want to change the length of this test, use the DIST parameter.

Once done, the results will be printed on the Klipper console, as such :

Example of an encoder calibration routine



Write this new value for the encoder resolution in the ercf_software.cfg file, in the [ercf] section.

CALIBRATION RESULTS

You can have different values for the load and unload direction, up to around 5 counts. This is not an issue.

However, if you have very inconsistent results, either on the same direction (e.g. a standard deviation higher than 1.5) or between the two directions (e.g. a difference in the means higher than 7 counts), you probably have some issues with your encoder, and you should check it. It is important that the BMG gear facing the IR sensor are clean.

EJECT AND RELOAD

Use **GCode : ERCF_EJECT** and then reload your firmware so that all changes are accounted for.

PTFE TUBE RECOMMENDATIONS

The Internal Diameter (ID) of the PTFE tubes used have a drastic impact on MMU systems, and therefore for the ERCF.

It is strongly encouraged to use 2.5mm ID PTFE (or even FEP) tubing between the ERCF and the printer toolhead (i.e. the reverse bowden), as well as between the ERCF and the filament spools. It is only recommended to use 2mm ID PTFE tubing between the ERCF and the filaments spools if your ERCF is installed vertically and that you notice that the parked filaments tend to fall down by themselves out of the ERCF gears.

3mm ID tubes can also be used, but they tend to be pinched very easily.

Make sure that the PTFE lines between your spools and the ERCF and between the ERCF and the toolhead don’t have any sharp turns, as this will drastically increase the overall friction on the filament.

ERCF POSITION

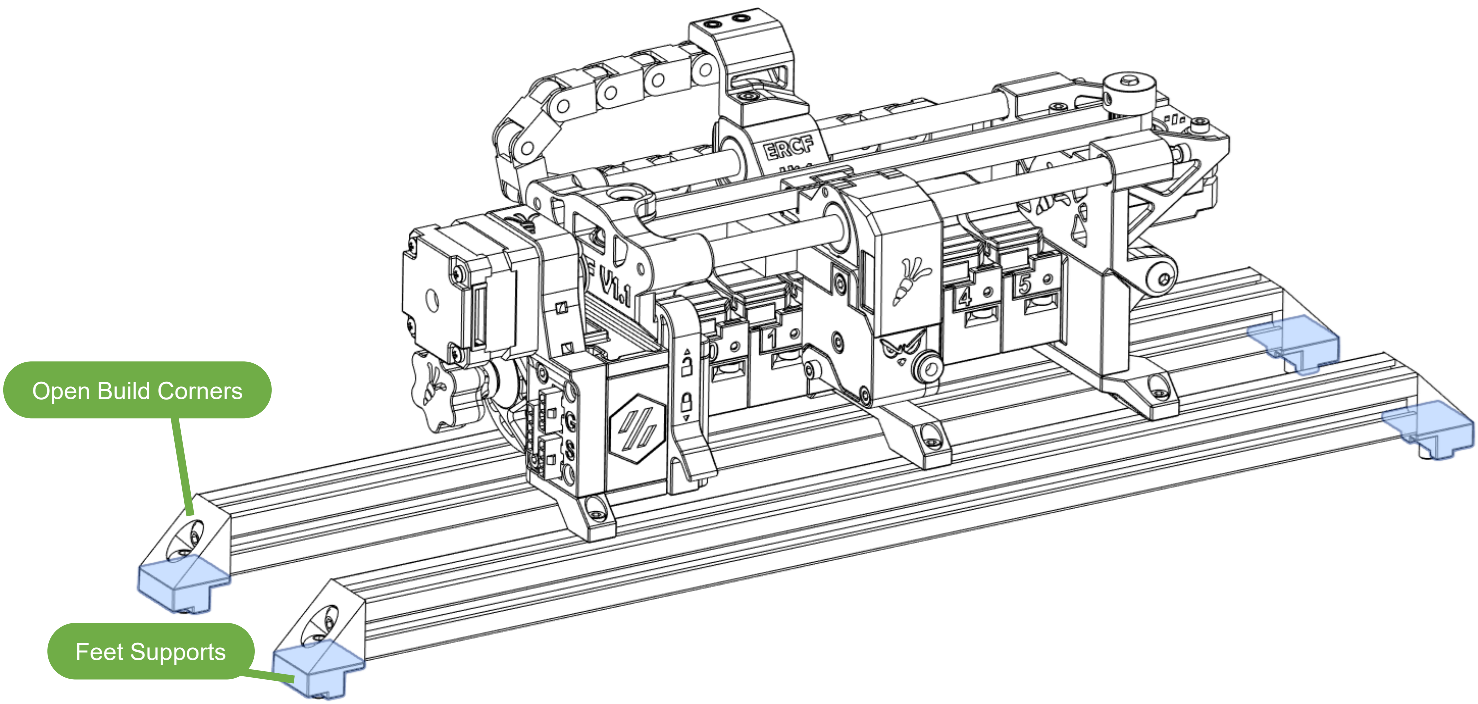
The ERCF can be installed where you want, but it is recommended to minimize the reverse bowden length to get faster swaps and limit friction along the whole filament path.

Here are some examples of where the ERCF can be mounted on different VORON printers.

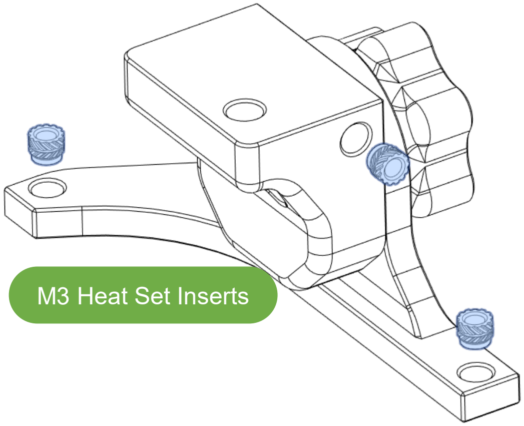
ERCF INSTALLATION ON A VORON V1 OR V2

VORON V1 OR V2

You can for instance mount the ERCF on the back or the top of the printer. A proposed solution is to use two 2020 Aluminum profiles, as shown here, and mount that on the existing V1 or V2 frame.



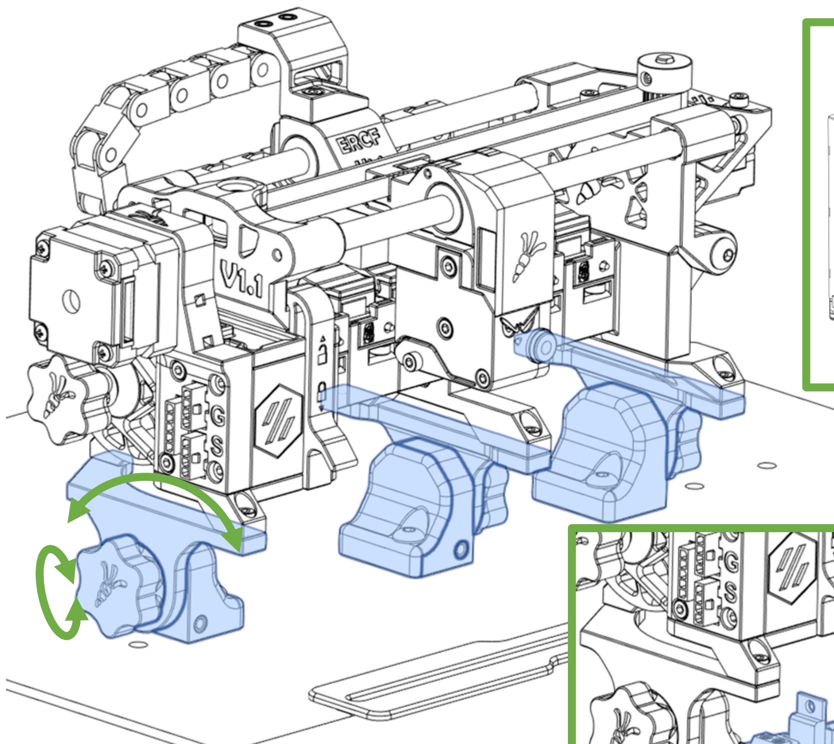
ERCF INSTALLATION ON A VORON SWITCHWIRE

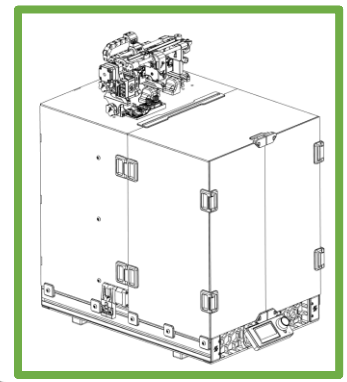


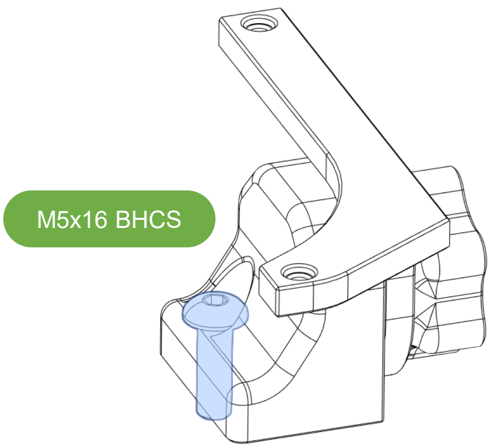
VORON SWITCHWIRE

For the VORON SwitchWire, you can install it at the top of the frame. The provided mount has an adjustable angle to match your spools positions.

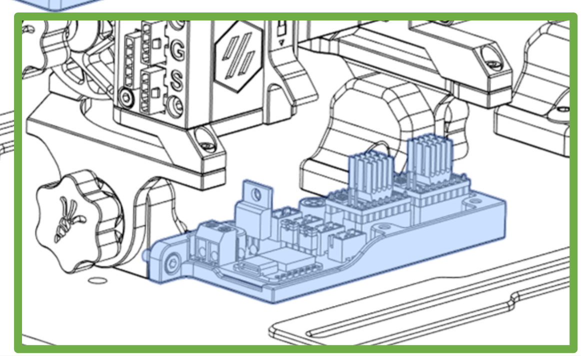
There is also a version for non-enclosed SwitchWires and an optional Ercf Easy Brd mount (board mount original mod can be found here https://github.com/Tircown/ERCF-easy-brd/tree/main/mods/Bottom%20bracket).







Optional Ercf Easy Brd mount



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ERCF FINAL CALIBRATION

ERCF CALIBRATION

Once the ERCF is properly installed and the printer toolhead sensor installed and working, we can perform the very last calibration for the ERCF.

Use **GCode : ERCF_CALIBRATE**

This will :

- Home the ERCF
- Load tool 0 to the toolhead and stop when the filament is detected by the toolhead sensor. This will be the reference loading length
- Unload the filament
- Load the next tool
- Perform a measurement with the encoder to determine the gear ratio to apply for this tool (filament will NOT go in the toolhead for this)
- Unload the filament
- Repeat the last 3 steps for all tools left

RELOAD

Don't forget to reload your firmware so that all changes are accounted for.

This is it, the ERCF is finally calibrated and ready to be used!

Please check the general guidelines and slicer settings before using the ERCF!

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TESTING FILAMENT SWAPS

Before using the ERCF on multimaterial prints, it is important to check that the complete filament swap sequence works well.
To do that, do several filament swaps, out of a print, as described below.

HOW TO SWAP FILAMENT OUT OF A PRINT

In the case you want to load a specific filament out of a print (i.e. when your printer is in idle or even during a pause),

Just use **GCode : T*N*** and replace *N* with the tool number you want to use (the first tool is number 0)

This will :

- Home the ERCF if it’s not homed already
- Unload an already loaded filament if there is any
- Load the filament in tool *N* next to the nozzle melting pool

This won’t :

- Purge the nozzle
- Do a ramming in case of unload (it will just try to get a decent filament tip without extruding anything)

The same T*N* macro will be called during an actual MM print, but with some small differences. The ERCF macros will automatically adapt in case your printer is in a print or not.

PREPARING A MULTIFILAMENT PRINT

To have successful multifilament prints, it is crucial to have properly tuned slicer profiles. A section dedicated to slicer settings can be found at page 124

WHAT TO DO IN CASE OF AN ERCF_PAUSE

During ERCF operation, the system will trigger *ERCF_PAUSE* if an issue is detected.

When this happens, the toolhead will be parked, waiting for the user to intervene. Here is what you have to do in such an event :

1. Use **GCode : ERCF_UNLOCK** to unlock ERCF operations and, if need be, heat back the hotend
2. Check what happened using the klipper console output and looking at the ERCF state
3. Load the proper filament :
   1. The filament that should be loaded is indicated in the printer status text : « Change Tool N », with N being the tool that needs to be loaded
   2. Once the ERCF is in a properly working state (i.e. all filament are parked in the filaments blocks, and the ERCF is homed),

      use **GCode : T*N***
   3. Check that the filament has been properly loaded and hit **GCode : RESUME**

ERCF MACROS OVERVIEW

This is the list of the ERCF macros that you should use. Don’t use other macros if you don’t know exactly what they will do.

GCode : ERCF_HOME	This will home the ERCF and let it in a state where no filament is in the toolhead, but the unit will be ready to load a filament from a T*N* GCode
GCode : T*N*	Load the *N* tool of the ERCF
GCode : ERCF_EJECT	Eject currently loaded filament
GCode : ERCF_UNLOCK	Unlock ERCF operations during a manual intervention

CLOG DETECTION MODE

The clog detection and endless spool modes are in Beta for now, use at your own risks (you may run into issues with the PAUSE States)
Also note that there might be issues using clog detection mode in multifilament prints, because of the gcode generated by the slicer.

CLOG DETECTION

The default configuration has the clog detection turned OFF. This feature relies on the filament_motion_sensor feature of Klipper (see https://github.com/Klipper3d/klipper/blob/master/docs/Config_Reference.md#filament_motion_sensor) and will allow to pause a on-going print in case the encoder measurement doesn't match the extruder (e.g. a clog).

To use this feature, un-comment this line and set the *pause_on_runout* to *True* :

```
[filament_motion_sensor encoder_sensor]
switch_pin: ^P1.0
pause_on_runout: False
detection_length: 3.0
extruder: extruder
# runout_gcode: ERCF_ENCODER_MOTION_ISSUE
```

In the ercf_hardware.cfg

Clog detection OFF

```
[filament_motion_sensor encoder_sensor]
switch_pin: ^P1.0
pause_on_runout: True
detection_length: 3.0
extruder: extruder
runout_gcode: ERCF_ENCODER_MOTION_ISSUE
```

In the ercf_hardware.cfg

Clog detection ON

And set the *clog_detection* option value to *1*:

```
# Options to use or not
# Beware that the clog detection and endless spool mode are in BETA mode for now
# Use at your own risk (beware of the involved macros and the pause(s) and resume ones)
# Put 0 to disable, 1 to enable
variable_clog_detection: 1
```

In the ercf_software.cfg

Note that you should adapt your Print_Start macro to ensure that :

- The filament sensor is turn OFF at the very begining of your print start (i.e. *SET_FILAMENT_SENSOR SENSOR=encoder_sensor ENABLE=0*)
- The filament sensor is turn ON just before the real print starts (i.e. *SET_FILAMENT_SENSOR SENSOR=encoder_sensor ENABLE=1*)

You will have to make sure the sensor is properly turned ON or OFF at the proper moments by yourself

ENDLESS SPOOL MODE

The clog detection and endless spool modes are in Beta for now, use at your own risks (you may run into issues with the PAUSE States)

ENDLESS SPOOL MODE

The endless spool mode is an extension of the clog detection. In case a filament run-out is sensed and if the Endless Spool mode is ON, the ERCF will load the next tool (i.e. N+1) and resume the print all by itself. The endless spool mode will not work if the clog detection is not activated.

To activate the endless spool mode, set this parameter to *1*:

```
# Options to use or not
# Beware that the clog detection and endless spool mode are in BETA mode for now
# Use at your own risk (beware of the involved macros and the pause(s) and resume ones)
# Put 0 to disable, 1 to enable
variable_clog_detection: 1
variable_endless_spool_mode: 1
```

In the ercf_software.cfg

It is highly recommended to check the *ERCF_CLOG_OR_RUNOUT* and *ERCF_CHECK_IF_RESUME* macros in the ercf_software.cfg and to adapt it to your own setup, notably for the nozzle cleaning and possible purge part.

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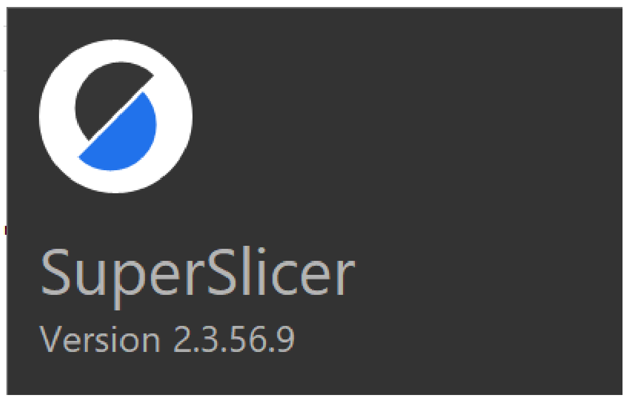
SLICER SETTINGS

This part of the manual will guide you through setting up your slicer to work with the ERCF. This guide assumes you are using SuperSlicer v2.3.56.9 (https://github.com/supermerill/SuperSlicer/releases/tag/2.3.56.9), but it will most likely work the same with othert SuperSlicer version and PrusaSlicer. Only the changes from a default (i.e. single extruder and single tool) profile will be discussed.

Cura and other slicers will not be covered.



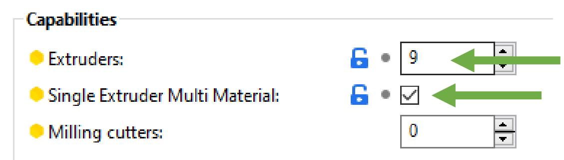
PRINTER SETTINGS TAB

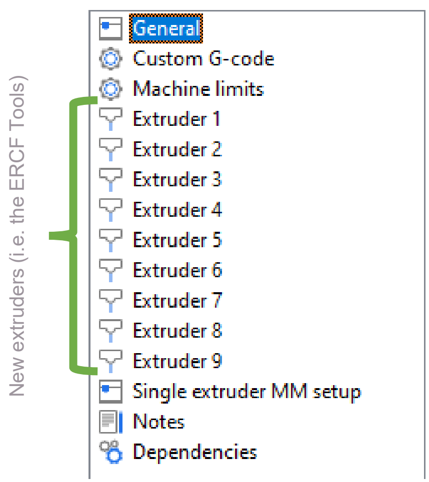
Make sure you have access to all fields

GENERAL

In the general section of the Printer Settings Tab, activate the ‘Single Extruder Multi Material’ option and set the proper number number of ‘Extruders’ (i.e. the number of channels on your ERCF)

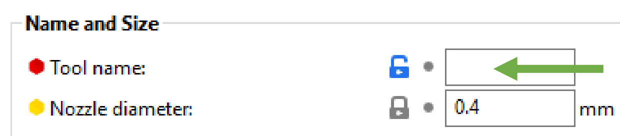
The different extruders will then appears in the menu list





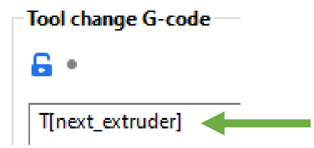
EXTRUDER N

For each of the Extruder in your list, make sure that the ‘Tool name’ is left blank



CUSTOM G-CODE : TOOL CHANGE

Set the ‘Tool change G-code’ to ‘T[next_extruder]’, this will make the Gcode generate ‘T0’ Gcode to request a Tool Change for Tool 0 for example (‘T1’ for Tool 1 etc.)

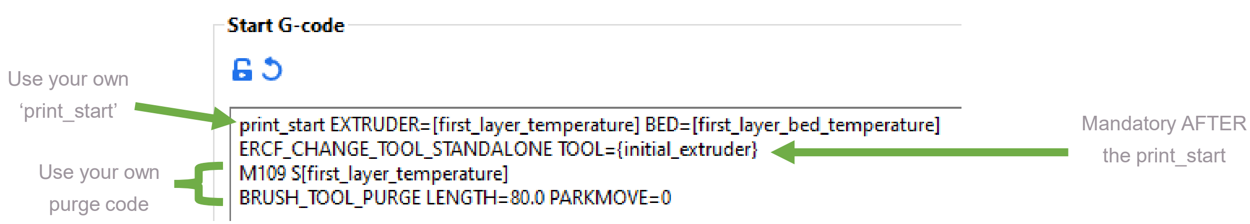


GLOBAL BEHAVIOR

The Start and End gcode showed below are designed for using the ERCF as the filament management solution, even for single color prints. This means that the proper filament will be loaded at the beginning of the print (right after the print_start macro has finished) and the filament will be unloaded at the end of the print. So, when your printer is not printing, no filament will be in the toolhead and the whole print_start gcode will be executed without any filament loaded, so adapt it accordingly (e.g. if you have any purge sequence in it, that will be useless)

CUSTOM G-CODE : PRINT START

For the ‘Start G-code’, insert ‘ERCF_CHANGE_TOOL_STANDALONE TOOL={initial_extruder}’ after your regular PRINT_START macro (it should all be in a single line). This will load the first filament used for the print (whether it is a single or multi filament print). Don’t forget to call some sort of purge after that (purge line or purge in a bucket, depending on your setup)



CUSTOM G-CODE : PRINT END

I suggest to use a dedicated parameter to choose the option to unload at the end of a print or not. The print_end macro I'm using is shown below as an example.

Note that if you don't unload at the end of your print and start a new print with the incorrect filament inserted, the ERCF will eject it automatically and load the proper filament anyway. It is just simpler and cleaner to unload the filament anyway at the end of a print.

End G-code

```
print_end UNLOAD_AT_END=1    ;end script from macro
```

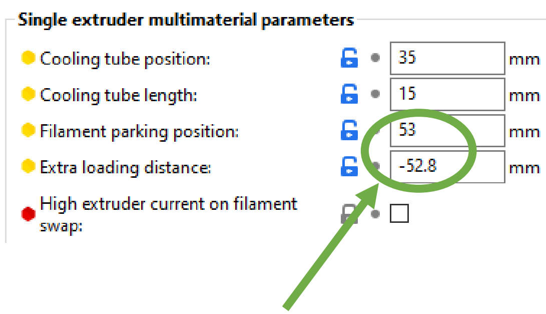
```
[gcode_macro PRINT_END]
#   Use PRINT_END for the slicer ending script - please customise for your slicer of choice
gcode:
    {% set unload = params.UNLOAD_AT_END|default(0)|int %}
    SET_FILAMENT_SENSOR SENSOR=encoder_sensor ENABLE=0
    M400                           ; wait for buffer to clear
    G92 E0                         ; zero the extruder
    G1 E-10.0 F3600                ; retract filament
    G91                            ; relative positioning
    G0 Z1.00 X20.0 Y20.0 F20000    ; move nozzle to remove stringing
    SET_FAN_SPEED FAN=nevermore_fan SPEED=1.0
    UPDATE_DELAYED_GCODE ID=nevermore_stop_delayed DURATION=900
    TURN_OFF_HEATERS
    G1 Z2 F3000                    ; move nozzle up 2mm
    G90                            ; absolute positioning
    G0  X250 Y300 F3600            ; park nozzle at rear
    {% if unload|int == 1%}
      ERCF_EJECT
    {% endif %}
    M107                           ; turn off fan
    BED_MESH_CLEAR
```

ERCF Eject condition

Example of a print_end macro with the ERCF Eject as an option

SINGLE EXTRUDER MM SETUP

In the ‘Single Extruder MM Setup’ section, the ‘Single Extruder Multimaterial Parameters’ have to be defined. They will change based on the hotend you are using. The example below is for a **Dragon Normal Flow**:



It is important that the ‘Filament Parking Position’ is a few mm smaller than the ‘sensor_to_nozzle’ variable in the ercf_software.cfg

Also make sure that the ‘Extra Loading Distance’ is the negative value of the ‘Filament Parking Position’ + 0.2 mm

Values in this screenshot are just exemples, please adapth them to your setup

Hotend	Parameter	
	Cooling tube position	Cooling tube length
Dragon ST	35	15
Dragon HF	30	10
Mosquito	38	20

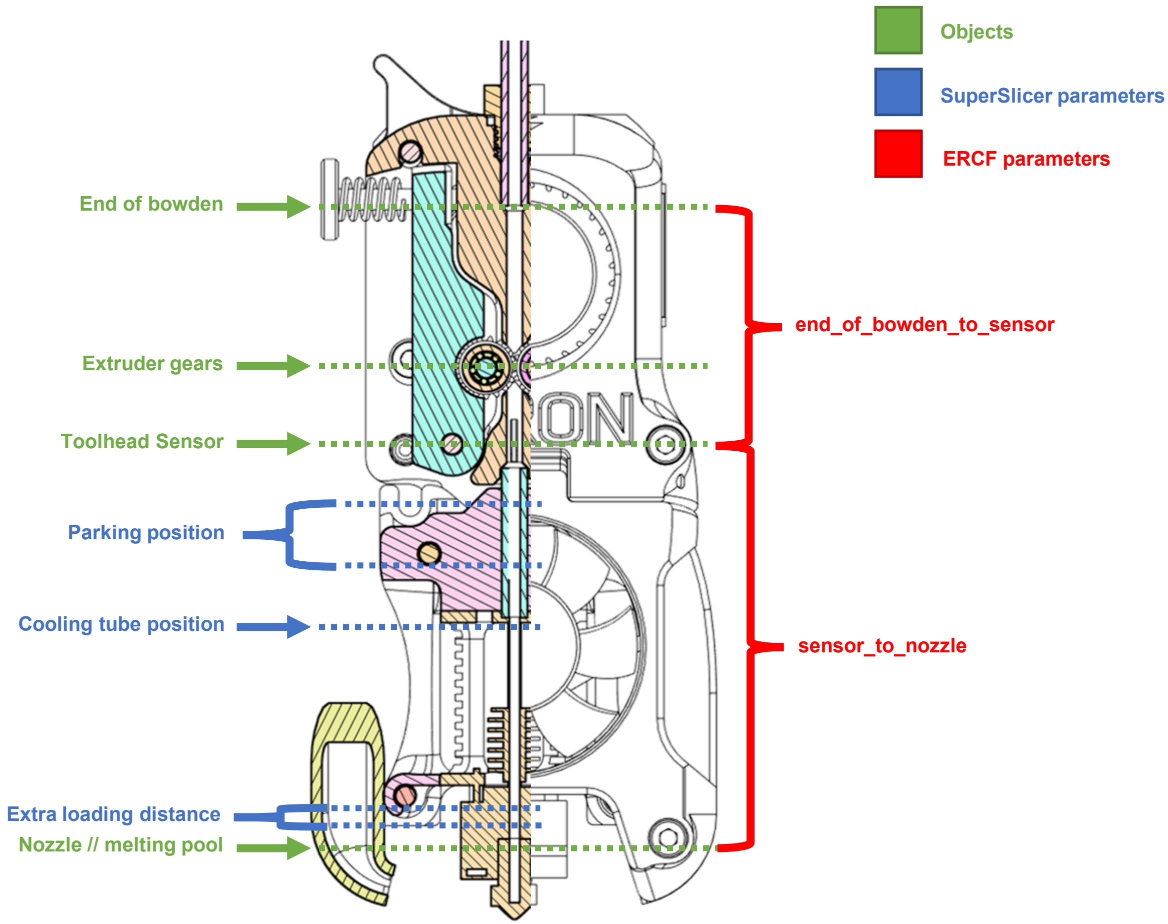
Typical values for toolheads

ADVANCED WIPE TOWER PURGE VOLUME

This part of the setup will be discussed further in the guide, when discussing about the different purging options.

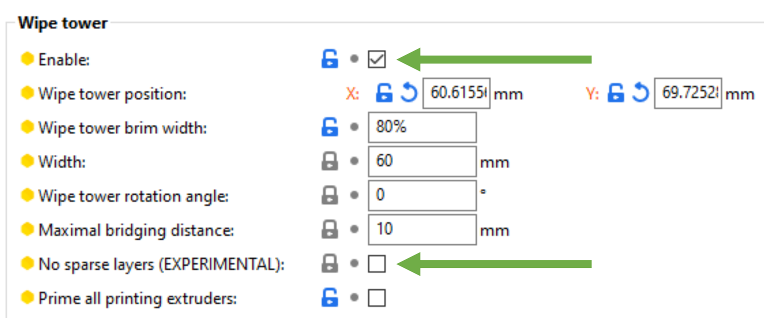
TOOLHEAD SCHEMATICS

Position of the different elements and parameters on an AfterBurner Toolhead



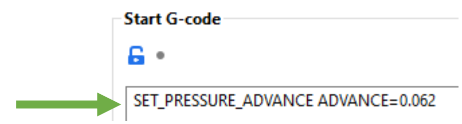
MULTIPLE EXTRUDERS

In the ‘Multiple extruders’ section, enable the Wipe Tower if you want to purge into it. You can also try the ‘No sparse layers (EXPERIMENTAL)’ option to avoid filing the Wipe Tower in case of no swap during a layer. Beware though that the toolhead will move up and down to reach the actual Wipe Tower height, so ensure the Wipe Tower is far enough from the print itself.



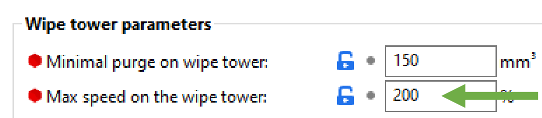
CUSTOM G-CODE

Remeber to set your filament specific pressure advance value in the filament custom G-Code Start G-code

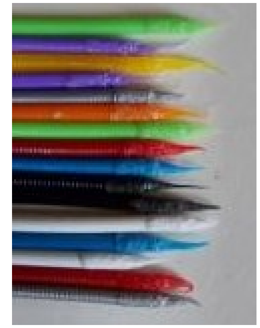


WIPE TOWER PARAMETERS

To speed up the purging process, increase the ‘Max speed on the wipe tower’ parameter to its maximum value (i.e. 200%)



FILAMENT TIP TUNING



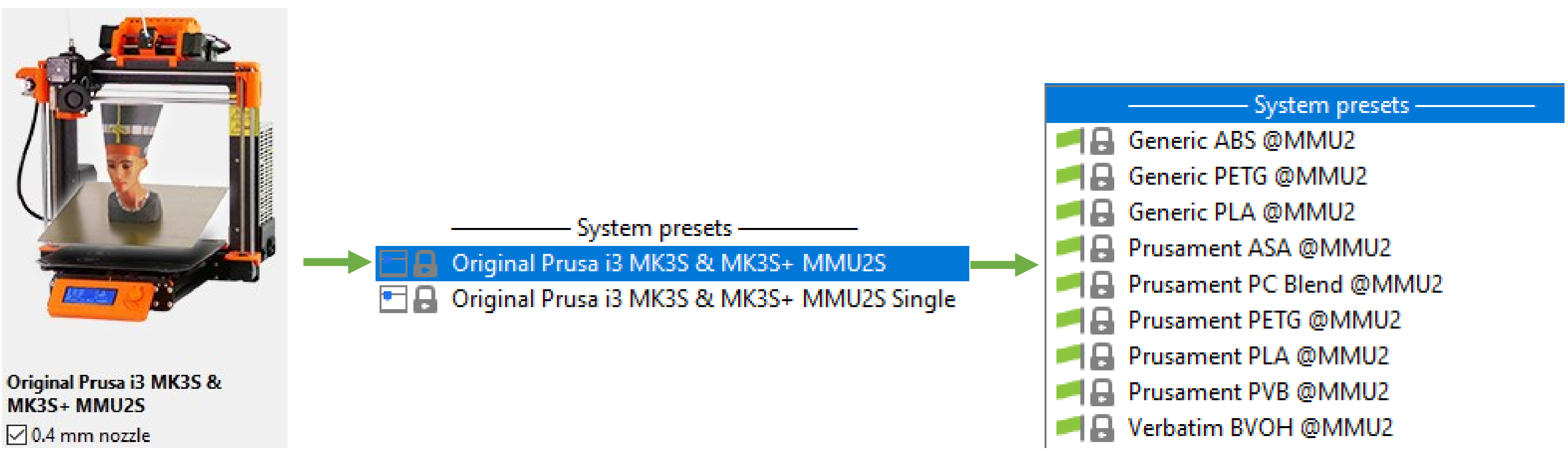
TUNING FILAMENT TIPS

The shape of filament tips is of crucial importance for a reliable system. The filament tips need to look like tiny spears, free of any blobs or long hairs. Here are some proper tips that won't cause any issue :

Do not attempt a large multi filament print if your filament tips are not well tuned.

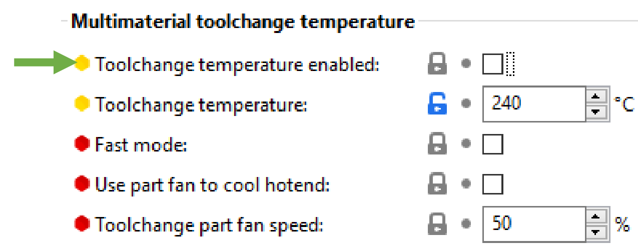
A very solid base for filament profile *multimaterial* section is to use the default filament Prusa MMU2S profiles.
To do that, add an MK3S+ MMU2S printer from the system presets printers, and then select the MMU2S printer (NOT the *Single* one)

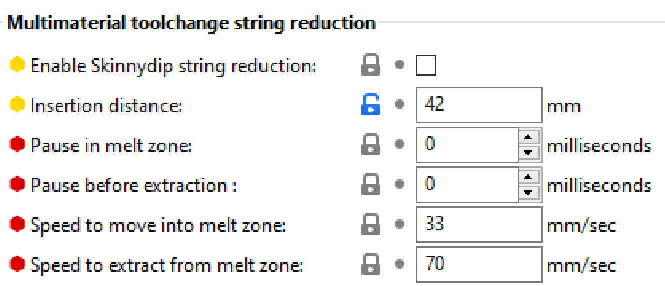
From there, you'll be able to access the list of filament system presets built for MultiMaterial (they have the *@MMU2* tag in their name, only use those).
Use the filament type of your choice (ABS, PETG, PLA etc.) and use their *Multimaterial* section settings for your own filaments profiles.



MULTIMATERIAL TOOLCHANGE TEMPERATURE

This section allows you to change the temperature of the hotend during the unload of this filament. While usually not needed, I can be useful to use this option in case of very stringy filament, putting a toolchange temperature lower than the filament printing temperature.





MULTIMATERIAL TOOLCHANGE STRING REDUCTION

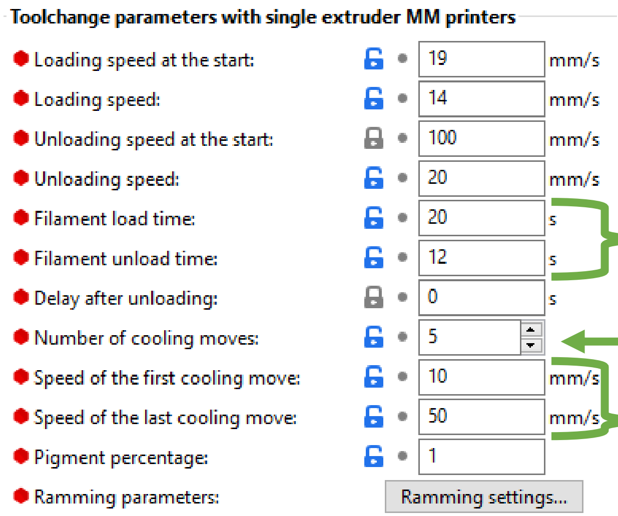
Also known as SkinnyDip, this option enables a final dip of the filament tip in the nozzle melting pool, to remove possible hairs at the end of the filament tip.
It's advised to not use this option first and to only try it after everything else is tuned.

The only important parameter of SkinnyDip is the *Insertion distance*, make sure this value is smaller than your *Cooling tube position*, otherwise it will extrude plastic through the nozzle.

To tune the SkinnyDip insertion length value, start with a small value (like 6mm smaller than your *Cooling tube position*), and then increase it slightly, step by step,

A too high value will create major issues such as double tips (i.e. blobs at the end of an hairy tip) and will most likely hinder the ERCF reliability, so be sure of your settings if you plan to use it.

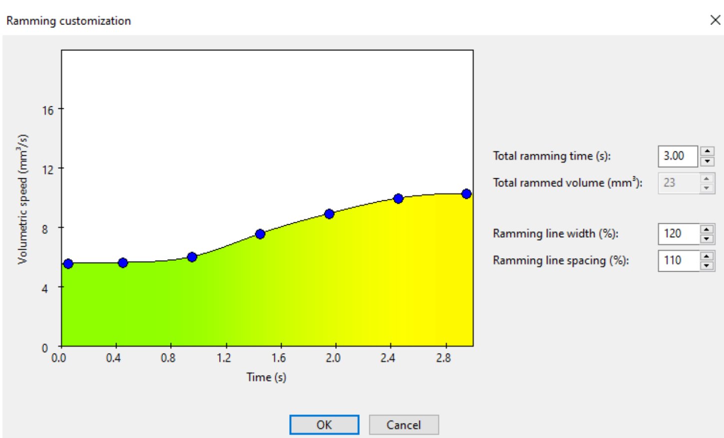
FILAMENT TIP TUNING



Time estimations for the slicer, no impact on the filament tips

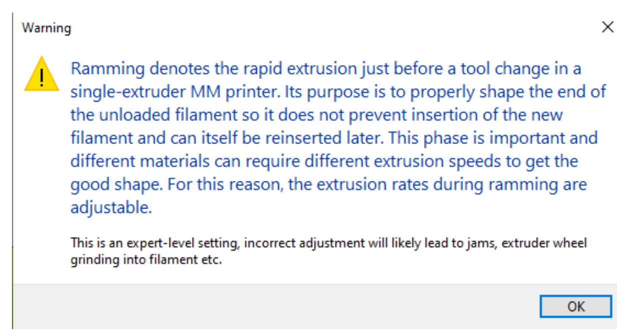
The more cooling moves, the thinner the tip

The cooling moves speed will increase from the first to the last speed.
This will impact the overall duration of the cooling process.



RAMMING VOLUME

You can adjust the total ramming time and/or ramming volume to finely tune the filament tip shape. Results and values will vary for different filaments.



FILAMENT TIP TUNING

TESTING THE PARAMETERS

To easily and quickly test those parameters, you can use : **GCode : ERCF_FORM_TIP_STANDALONE**

All the possible parameters (and their default values) are shown below. To use this macro to tune the filament tips :

1. Open your printer
2. Remove the reverse bowden from the toolhead and insert just a small PTFE tube
3. Heat the hotend to the filament printing temperature you want to tune
4. Insert the filament you want to tune in the toolhead down to the nozzle, make sure some plastic is getting out
5. Use the **ERCF_FORM_TIP_STANDALONE** macro with the **FINAL_EJECT=1** parameter and whatever other(s) parameter(s) you want to test. Remember to set all the parameters to the proper values (e.g., ramming volume, cooling moves etc.) to have the same sequence as you would do during a real print.
6. Once the sequence is done, remove the filament, check the tip
7. Repeat steps from 4 to 6 until you are happy with the parameters
8. Don't forget to report the new parameters in your filament profile

```
{% set COOLING_TUBE_LENGTH = params.COOLING_TUBE_LENGTH|default(15) %} # Dragon ST: 15, Dragon HF: 10, Mosquito: 20
{% set COOLING_TUBE_RETRACTION = params.COOLING_TUBE_RETRACTION|default(35) %} # Dragon ST: 35, Dragon HF: 30, Mosquito: 38
{% set INITIAL_COOLING_SPEED = params.INITIAL_COOLING_SPEED|default(10) %}
{% set FINAL_COOLING_SPEED = params.FINAL_COOLING_SPEED|default(50) %}
{% set COOLING_MOVES = params.COOLING_MOVES|default(5) %}
{% set TOOLCHANGE_TEMP = params.TOOLCHANGE_TEMP|default(0) %}
{% set USE_SKINNYDIP = params.USE_SKINNYDIP|default(1) %}
{% set USE_FAST_SKINNYDIP = params.USE_FAST_SKINNYDIP|default(1) %}
{% set SKINNYDIP_DISTANCE = params.SKINNYDIP_DISTANCE|default(26) %}
{% set DIP_INSERTION_SPEED = params.DIP_INSERTION_SPEED|default(33) %}
{% set DIP_EXTRACTION_SPEED = params.DIP_EXTRACTION_SPEED|default(70) %}
{% set MELT_ZONE_PAUSE = params.MELT_ZONE_PAUSE|default(0) %}
{% set COOLING_ZONE_PAUSE = params.COOLING_ZONE_PAUSE|default(0) %}
{% set UNLOADING_SPEED_START = params.UNLOADING_SPEED_START|default(199) %}
{% set UNLOADING_SPEED = params.UNLOADING_SPEED|default(20) %}
{% set RAMMING_VOLUME = params.RAMMING_VOLUME|default(0) %} # in mm3
{% set INITIAL_RETRACT = params.INITIAL_RETRACT|default(0) %} # Use an initial retract or not. Don't use it if you want to ram the filament
{% set FINAL_EJECT = params.FINAL_EJECT|default(0) %} # Fully eject the filament afterwards, default is no
```

ERCF_FORM_TIP_STANDALONE parameters

PURGE VOLUME

OVERVIEW

There are 3 different options when it comes to defining the purging volumes for multi-filament prints :

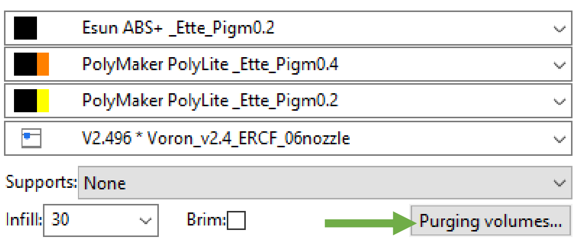
- Manual definition
- Manual matrix volume
- Advanced purging volume using filament pigmentation

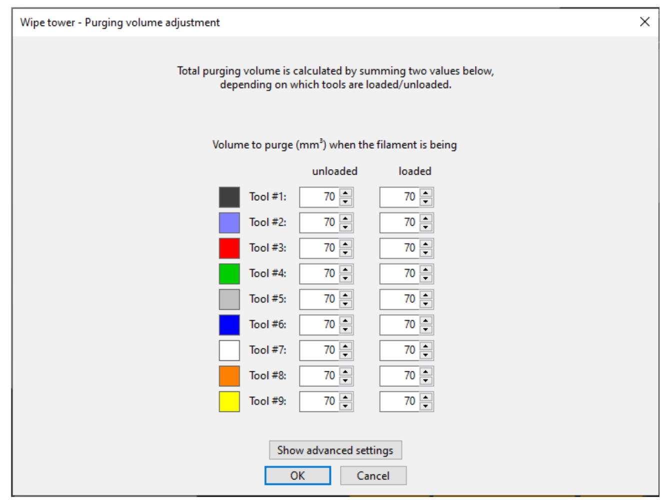
Right now, no method is perfect. The manual volume definition is simple to setup but lacks depth, the matrix one becomes way too complicated if you have a high number of tools and finally the advanced purging volume algorithm requires a filament profile for each different pigmentation value.

Still, I personnaly recommend using the advanced purging volume calculations.

MANUAL PURGING VOLUME DEFINITION

This option allows you to define the total purge volume for each tool by defining the *unloaded* and *loaded* values. For instance, swapping from Tool 0 to Tool 1, the purge volume used will be the sum of the Tool 0 *unloaded* and the Tool 1 *loaded*.

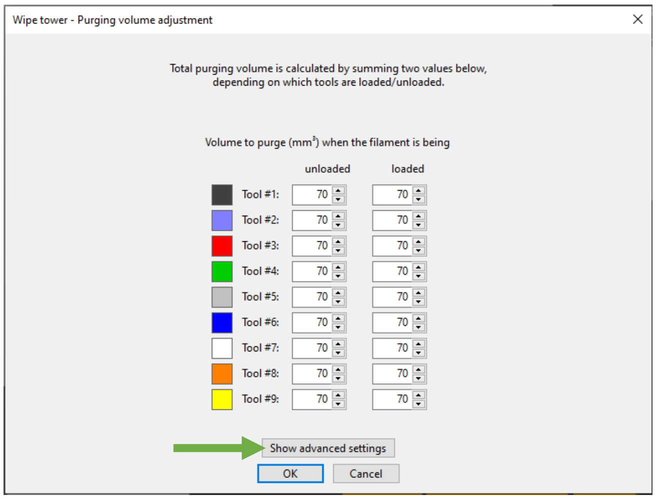


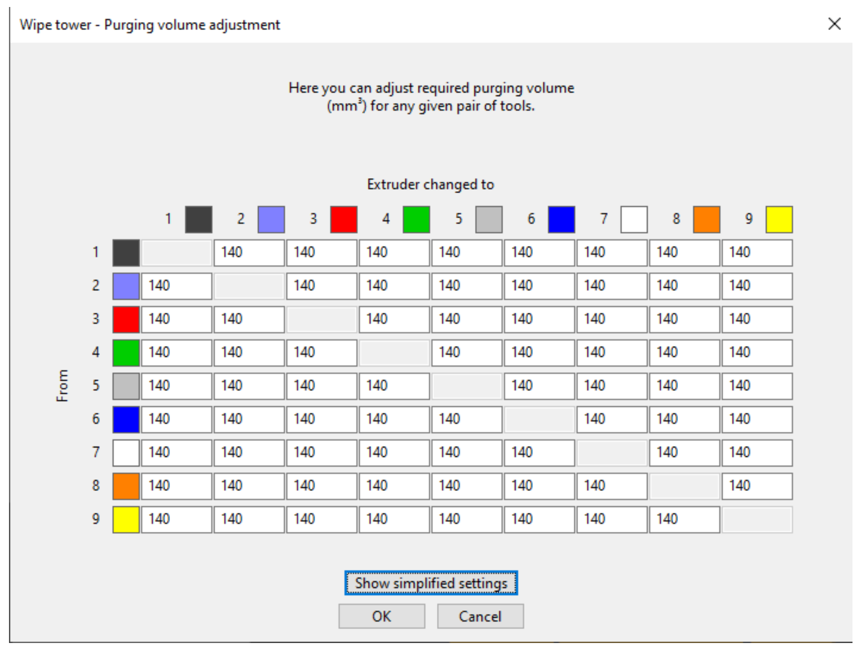


PURGE VOLUME

MATRIX PURGING VOLUME DEFINITION

Clicking on the *Show advanced* settings in the manual purging volume panel will pop the purging matrix. With this, you can define every single transition precisely, from whatever tool to whatever tool you have. As you can see, when you have a lot of tools you'll have to track a lot of transitions, which can be painful.





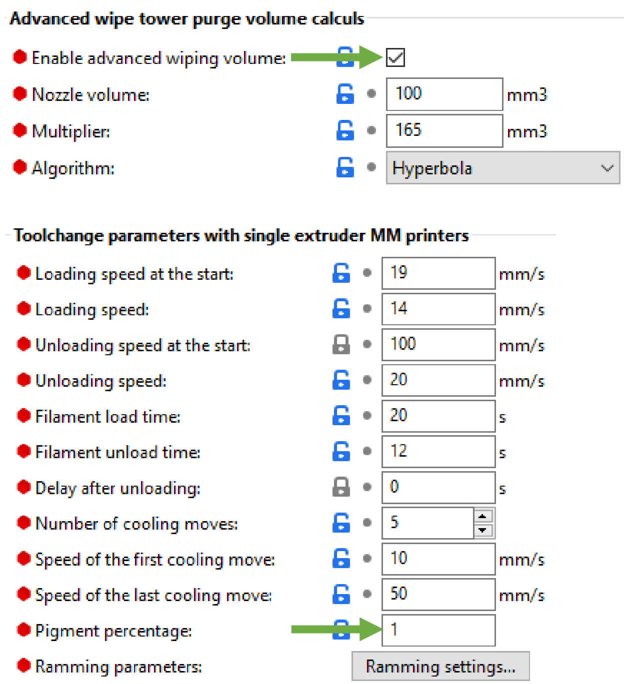
PURGE VOLUME

ADVANCED PURGE VOLUME ALGORITHM

If you enable the *Advanced wiping volume* option in the *Printer settings*, *Single Extruder MM setup* section, the slicer will use the *Pigment percentage*, ranging from 0 to 1, to define the purge volume for each swap.

You can adjust the different values of this option to finely tune the final purging volume.

Note that if you have the same profile for filaments of different colors, you'll need to duplicate those filament profiles and adjust, for each, the pigment percentage value. Don't forget to select the proper filament profile for each tool.



Calculator exemple

Nozzle volume	200
Multiplier	100

Linear

From \ To	0	0,2	0,4	0,6	0,8	1
0	200	180	160	140	120	100
0,2	220	200	180	160	140	120
0,4	240	220	200	180	160	140
0,6	260	240	220	200	180	160
0,8	280	260	240	220	200	180
1	300	280	260	240	220	200

Quadratic

From \ To	0	0,2	0,4	0,6	0,8	1
0	200	179	154	118	69	0
0,2	221	200	179	154	118	69
0,4	246	221	200	179	154	118
0,6	282	246	221	200	179	154
0,8	331	282	246	221	200	179
1	400	331	282	246	221	200

Hyperbolic

From \ To	0	0,2	0,4	0,6	0,8	1
0	300	271	256	245	238	233
0,2	340	300	278	264	254	247
0,4	380	329	300	282	269	260
0,6	420	357	322	300	285	273
0,8	460	386	344	318	300	287
1	500	414	367	336	315	300

CALCULATOR

You can find on the ERCF github repository a spreadsheet file that includes the calculations used to define those purging volume, allowing you to finely tune the values that suits you best.

SENSOR TO NOZZLE TUNING

TUNING THE SENSOR_TO_NOZZLE

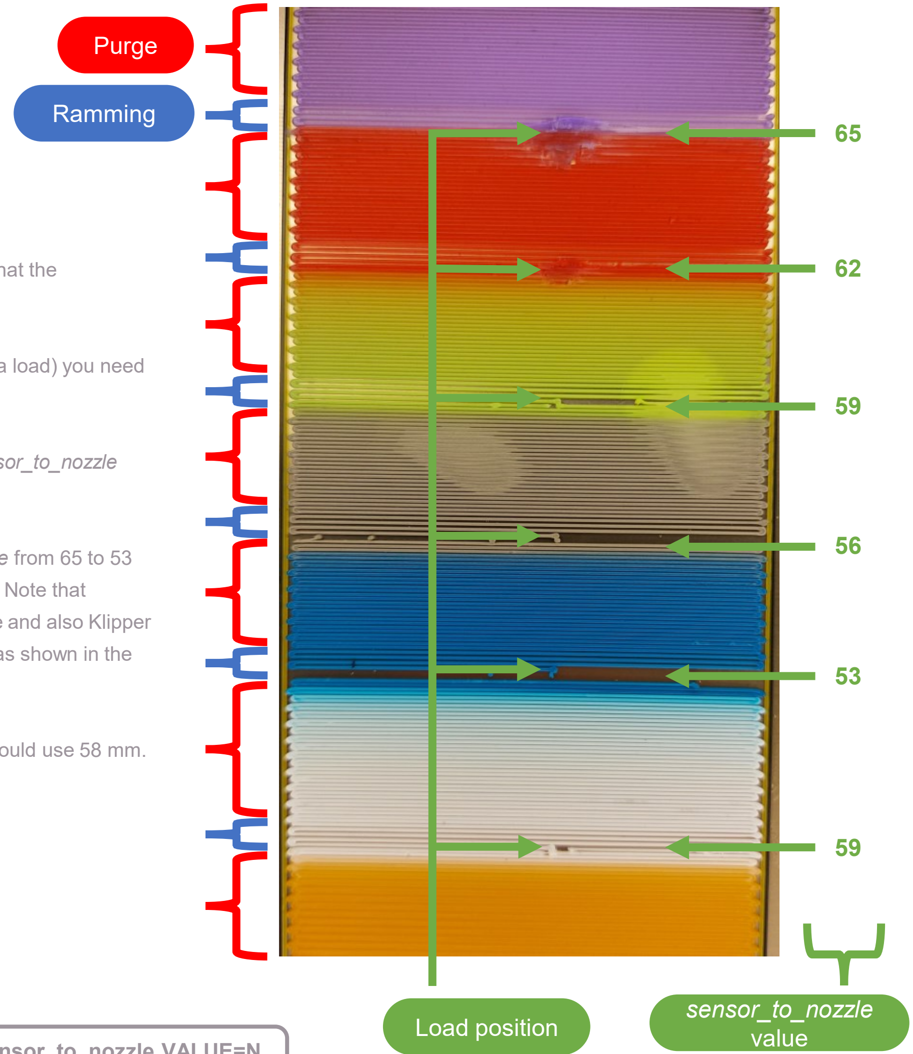
Once you are printing your first multi filament print, check the purge tower to verify that the *sensor_to_nozzle* value is well tuned.

If you notice over extrusion during loads (i.e., plastic blobs on the purge tower after a load) you need to reduce the *sensor_to_nozzle* value.

If you notice big gaps on the purge tower after a load, you need to increase the *sensor_to_nozzle* value.

You can see an exemple of a purge tower here, with values for the *sensor_to_nozzle* from 65 to 53 mm in my own setup. In this exemple, the proper value seems to be around 59 mm. Note that because there is some uncertainty in this process (because of the filament tip shape and also Klipper command buffer), there will be some differences even when the value is the same, as shown in the green to grey and white to orange transitions in this exemple.

As a result, use a slightly lower value than what this test shows. In this exemple, I would use 58 mm.



You can test different *sensor_to_nozzle* values during a print using :

GCode : SET_GCODE_VARIABLE MACRO=ERCF_VAR VARIABLE=sensor_to_nozzle VALUE=N

Replace *N* with the value you want to use. Beware that once you've found the proper value for your system, you'll need to update the *sensor_to_nozzle* value in the ercf_software.cfg, otherwise the change won't be taken into account after a reload of your firmware.

Front page : Manual version
Table of content pagination
EASY BRD WIRING PAGE Here here here here here here here