

## ENRAGED RABBIT : CARROT FEEDER ASSEMBLY MANUAL

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VERSION 2021.09.25

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## INTRODUCTION

### THE ENRAGED RABBIT PROJECT

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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

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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

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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

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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.

## INTRODUCTION

### HOW TO GET HELP

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If you need assistance with your build you can head over the VORON Discord group and post your questions (typically in the « voronuser\_mods » 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.



<https://discord.gg/xgXWctB>



<https://github.com/EtteGit/EnragedRabbitProject>

### FINAL THOUGHTS

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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!

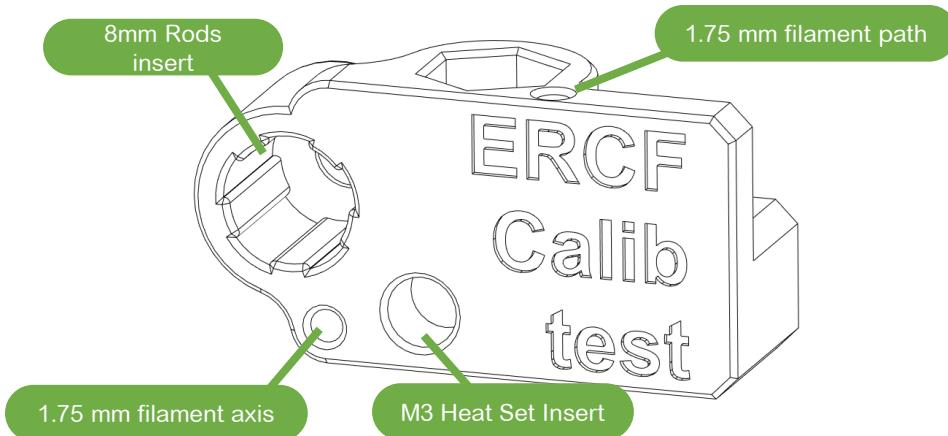
You already probably heard that multi-filament systems are quite often a pain to deal with, and that's quite true. While the goal for the Enraged Rabbit Project is to offer a cool, reliable and easy to use system, you'll probably face issues at one time or another. Check the documentation, the guides 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.



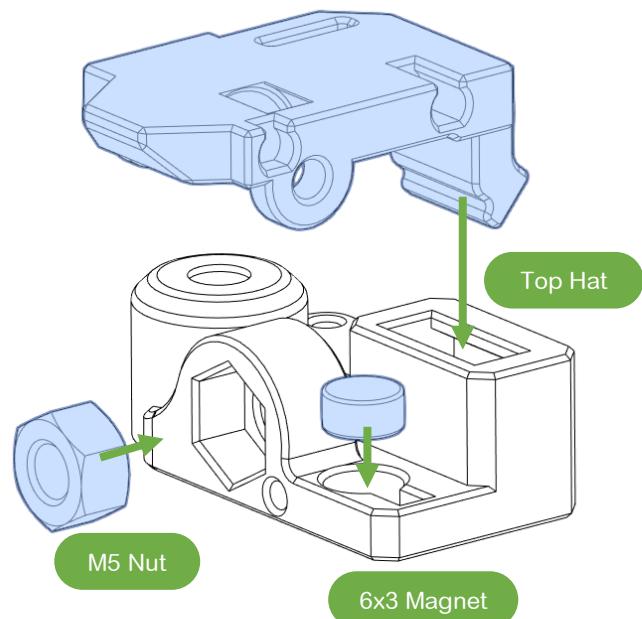
#### TESTS

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.

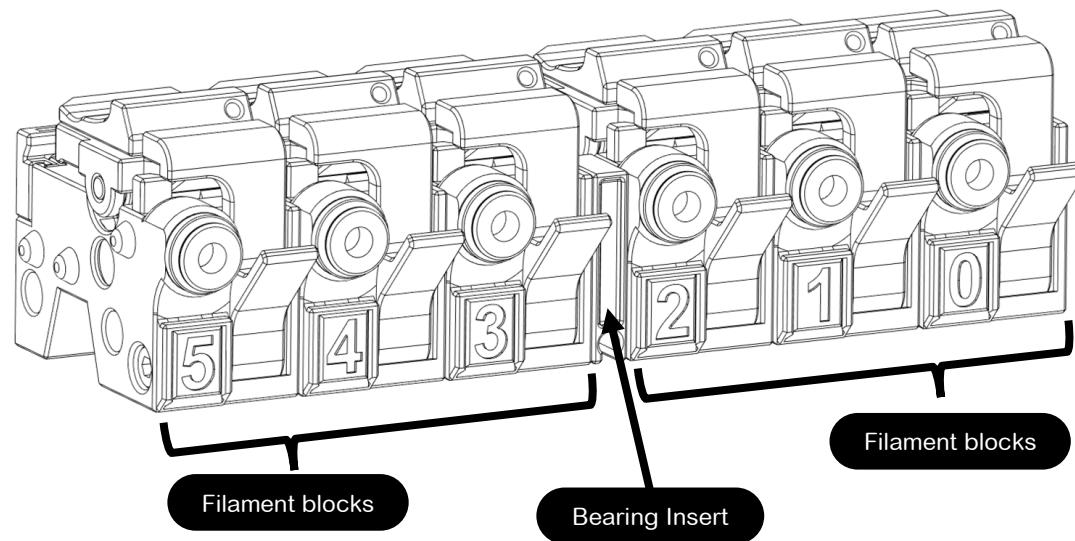


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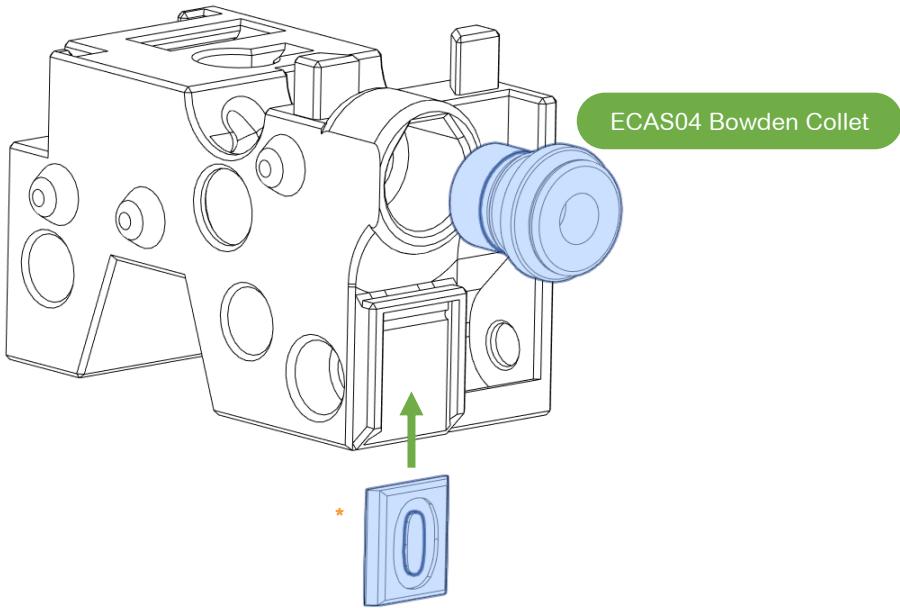
## FILAMENT BLOCKS



## OVERVIEW



## FILAMENT BLOCKS

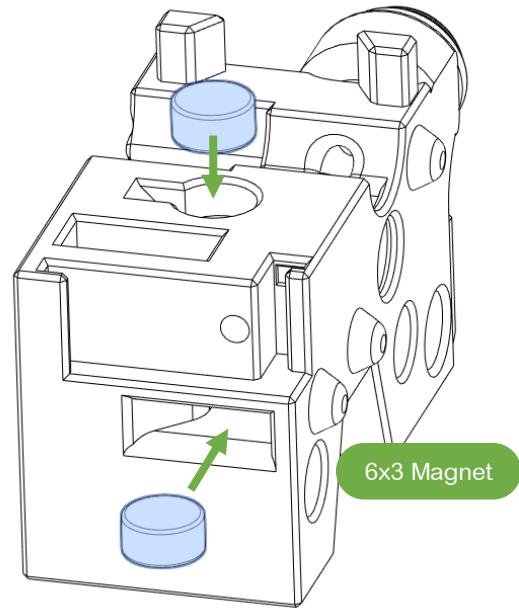


### FILAMENT BLOCK NUMBERING

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

## MAGNET ORIENTATION

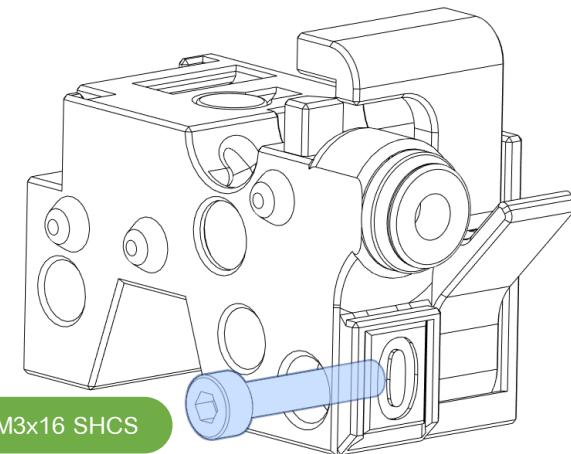
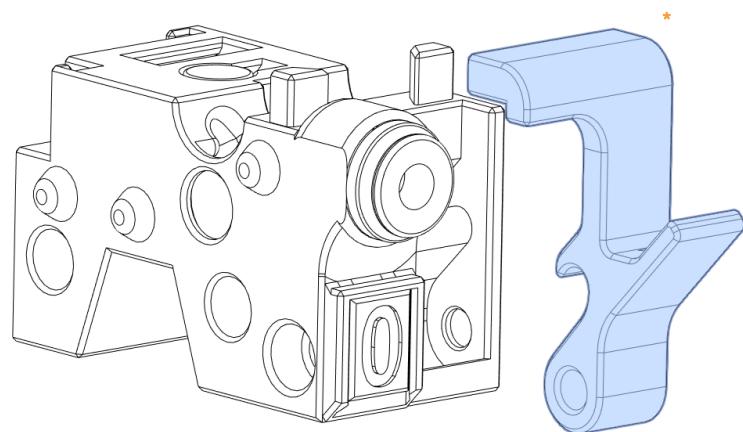
Install the top magnets with the same polarity for all filament blocks. Polarity for the front magnets does not matter.



### 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.

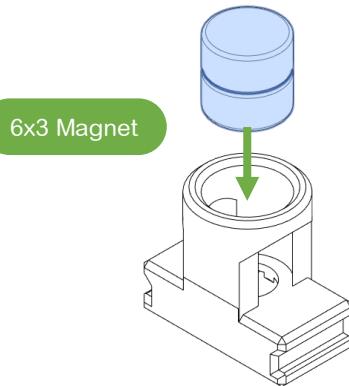
## FILAMENT BLOCKS



### LATCH SCREW

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

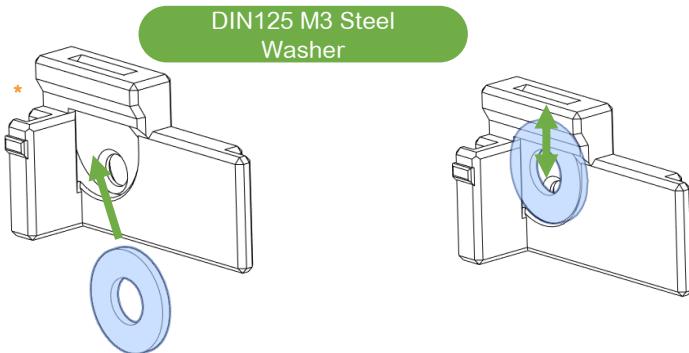
## MAGNETIC GATES



### GATE KEY

Insert the two magnets into the Gate Key.

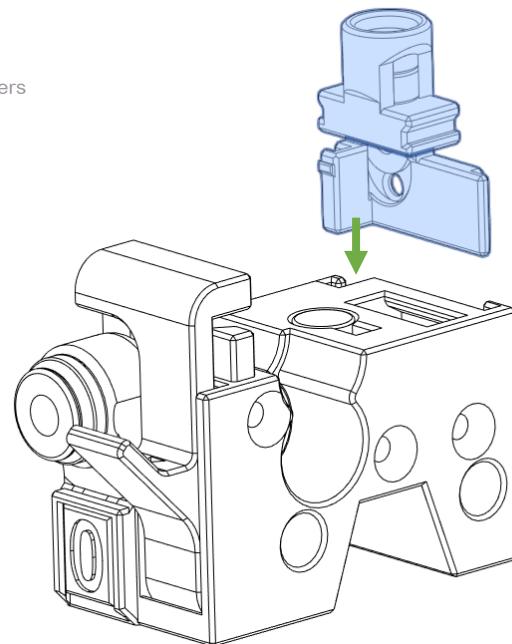
The Gate Key allows you to open Magnetic Gates when the selector is not in front of them, and also to secure the washers in the magnetic gates when you install or remove them.



### 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.

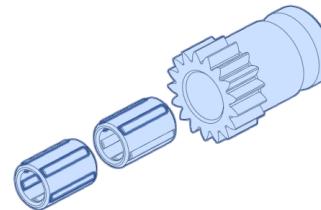
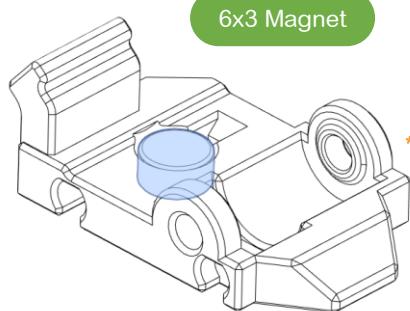
Insert the washer from the bottom right (using picture orientation) and push it into its slot. It should move freely up and down.



### INSERTION

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

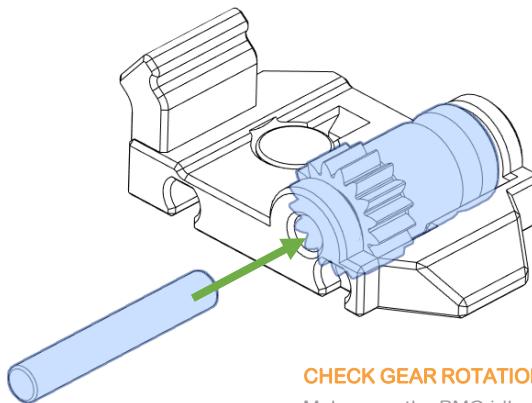
## TOP HATS



BMG Idler Assembly

### MAGNET ORIENTATION

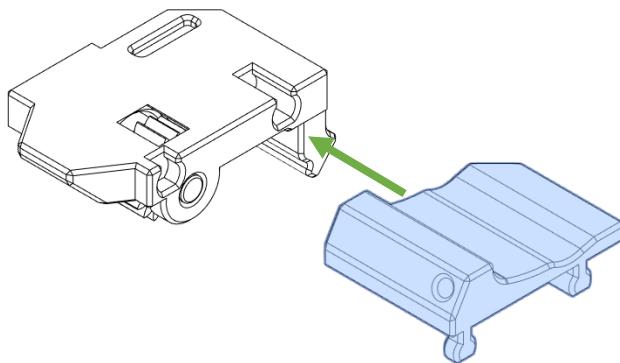
Install the magnets so they will repel from the top magnets on the Filament Blocks.



### CHECK GEAR ROTATION

Make sure the BMG idler is spinning freely.

## TOP HAT LOCKERS

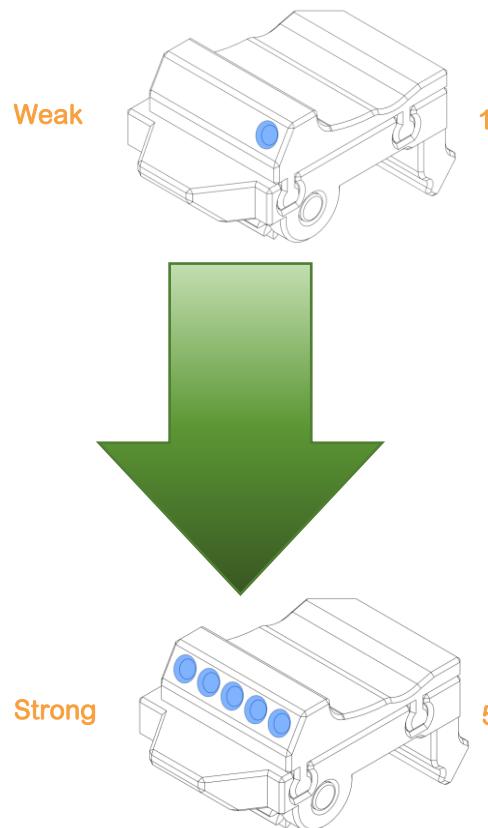


### TOP HAT LOCKERS

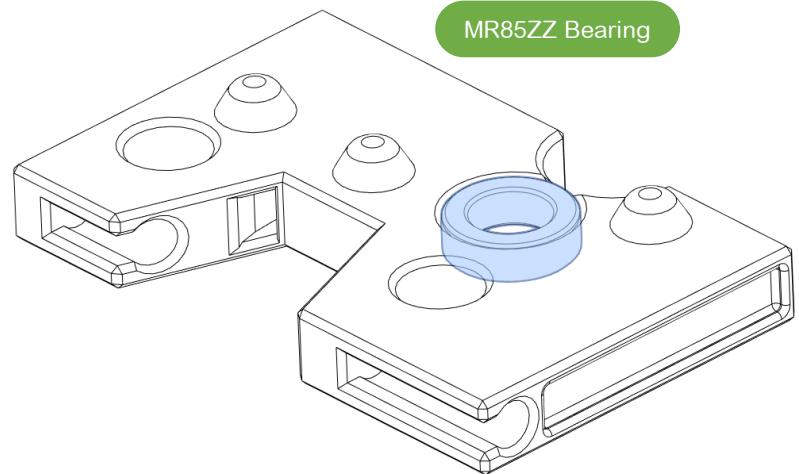
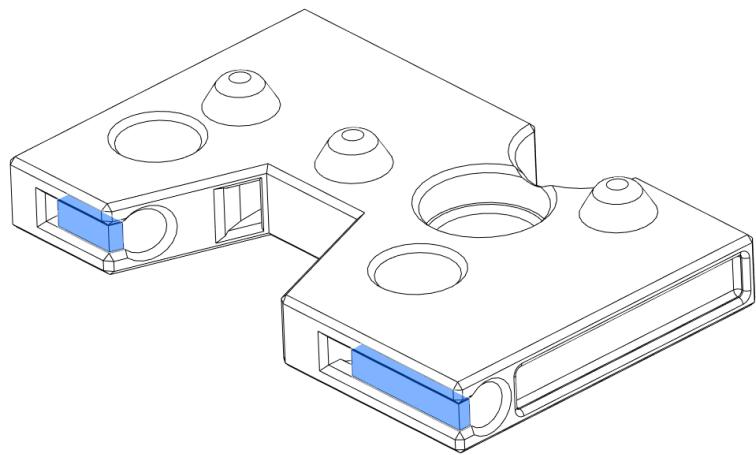
Slide-in the Top Hat Locker for each Top Hat until you hear the « click ». Top Hat Lockers values (i.e. the number of dots on the front side) are used to adjust the pressure applied on the filament for each tool. The higher the number, the stronger the pressure on the filament. Start with all tools at « 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.

### PRESSURE ON FILAMENT



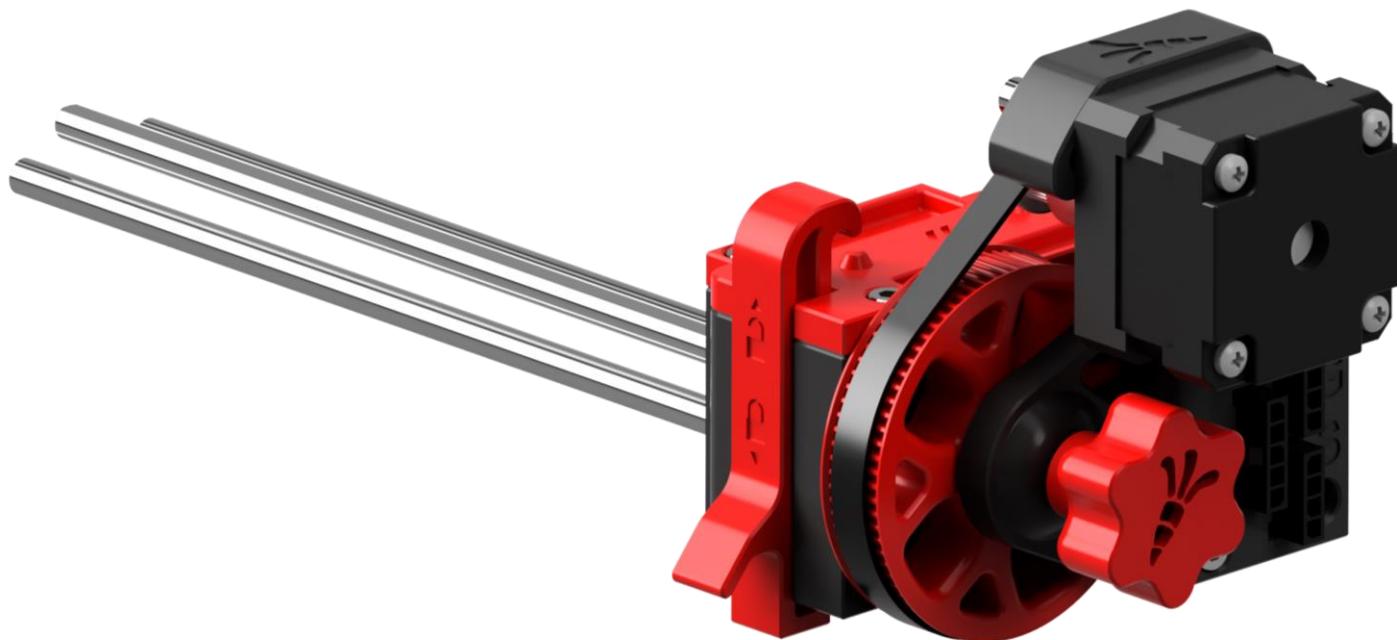
## BEARING INSERTS



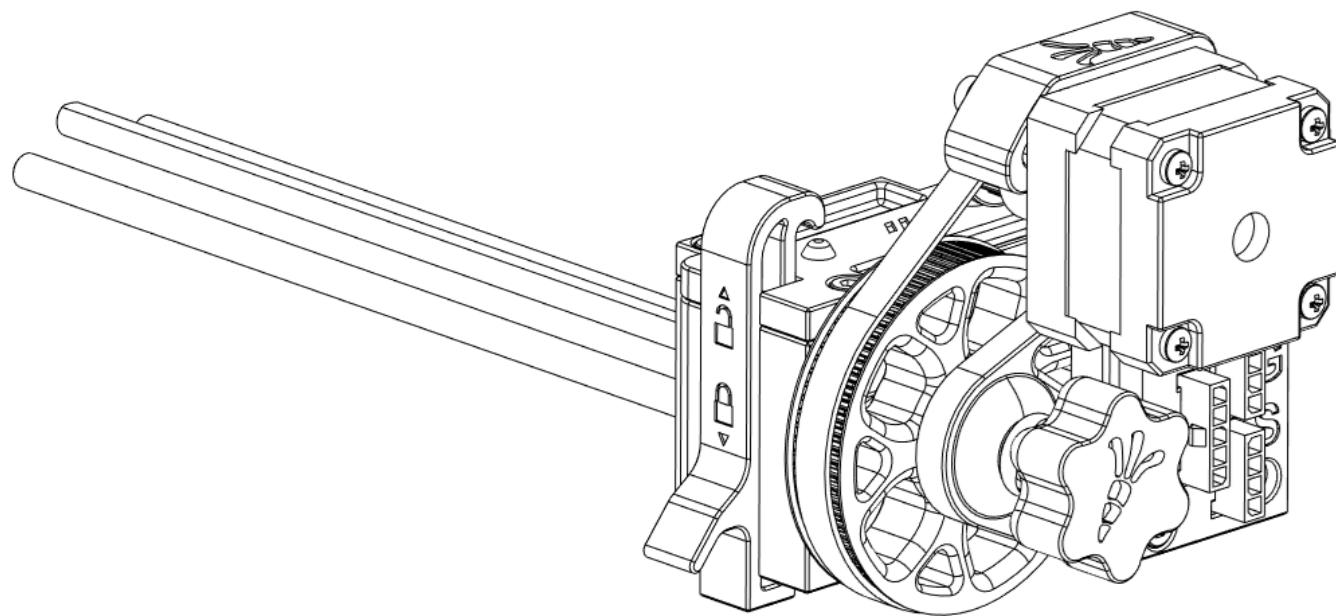
## REMOVE BUILT-IN SUPPORTS

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 XXX to get an overview of the final wiring
- Skip the steps for the pages with the label on the right

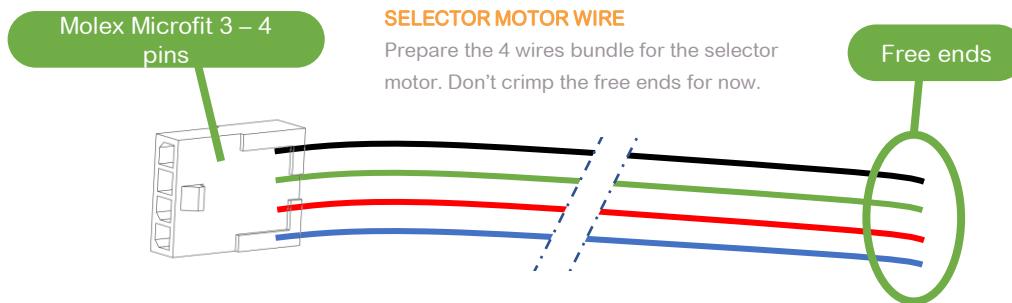
### USERS OF ERCF EASY BRD:

Skip this step – see page 80

### 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.

Free ends

### 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.

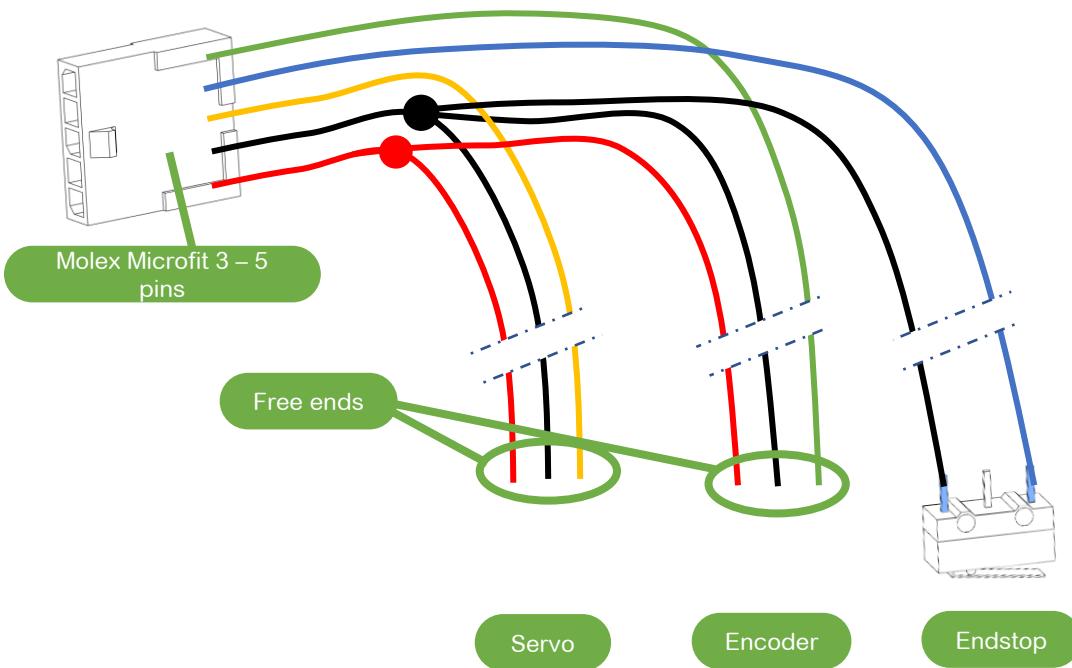
Typical wire length required for the selector motor wires

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:

Skip this step – see page 80

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

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

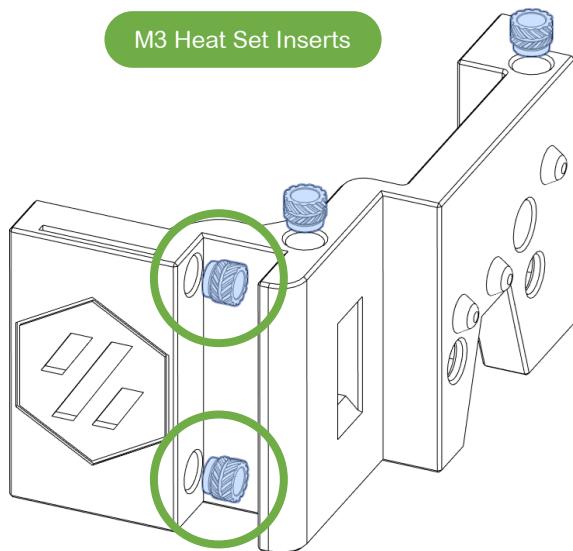
## GENERAL CONNECTOR WIRE

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 80.**

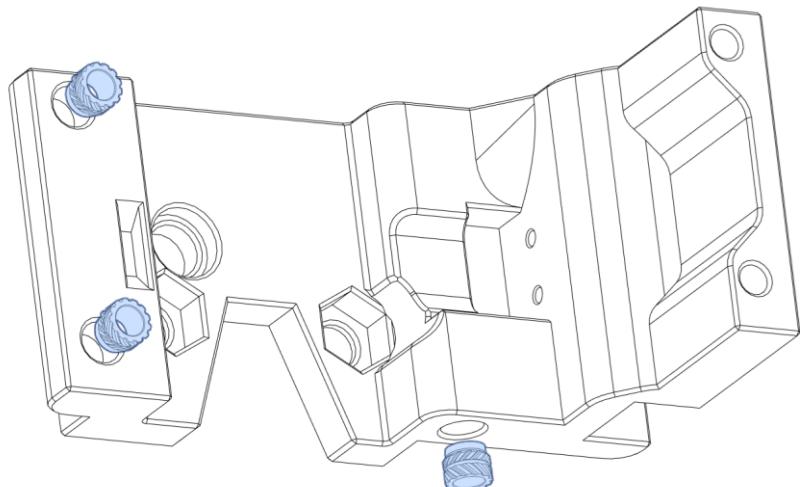
To join the multiple GND//+5V lines, either crimp them together or make a splice prior to the crimp position.

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

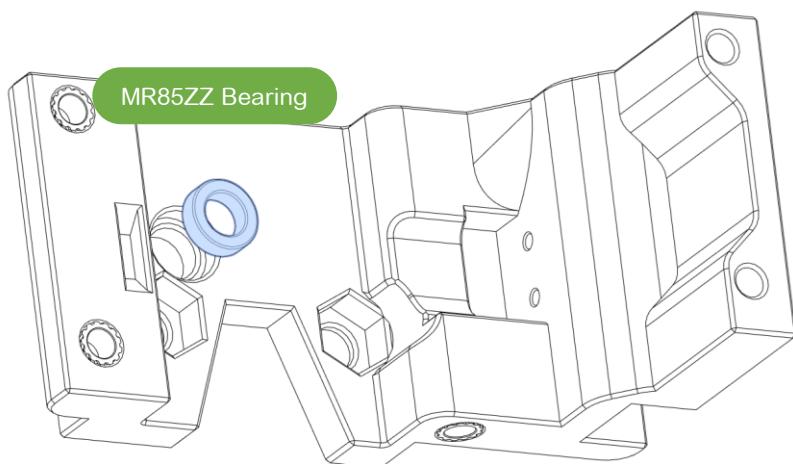


M3 Heat Set Inserts



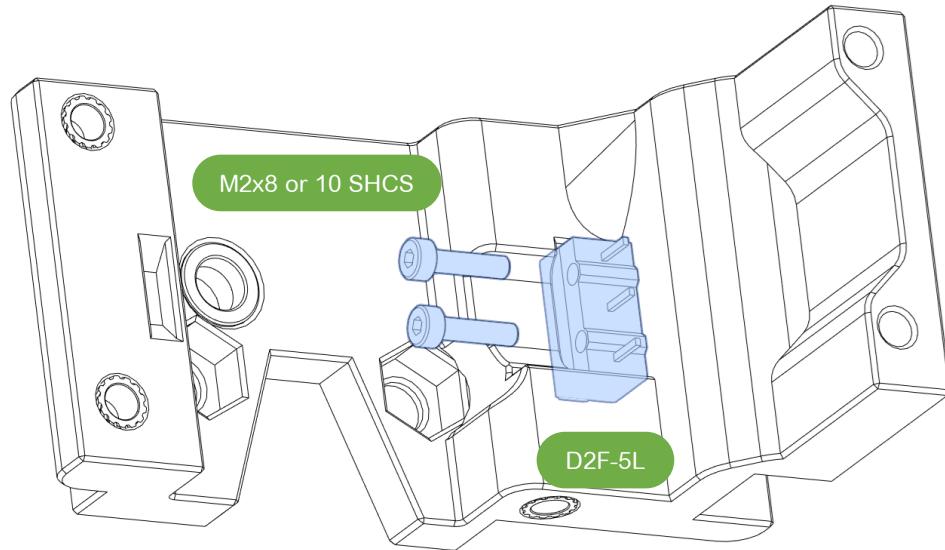
### HEAT SET INSERTS TIP

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.



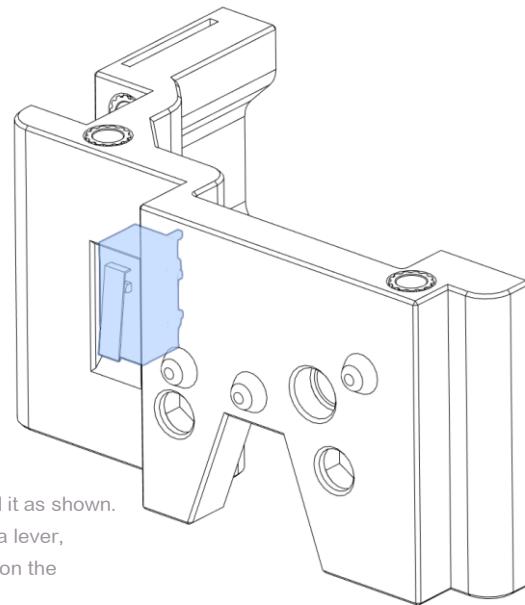
MR85ZZ Bearing

## SELECTOR ENDSTOP

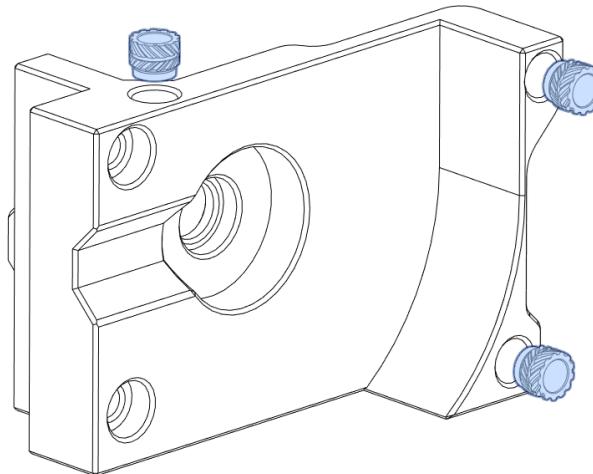


### MICRO SWITCH ORIENTATION

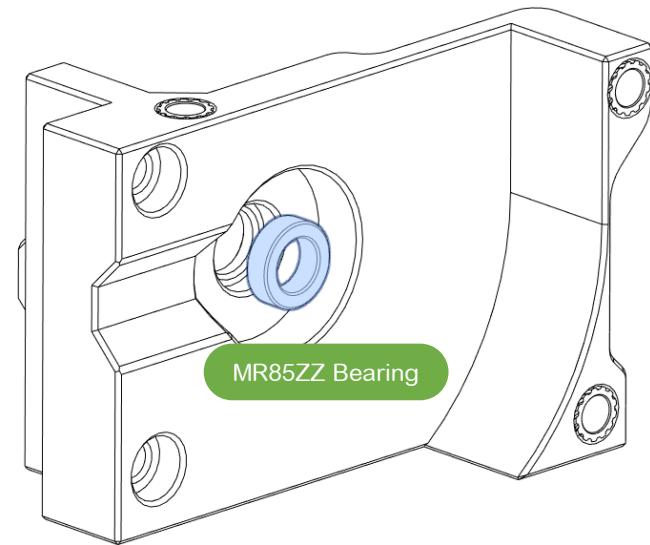
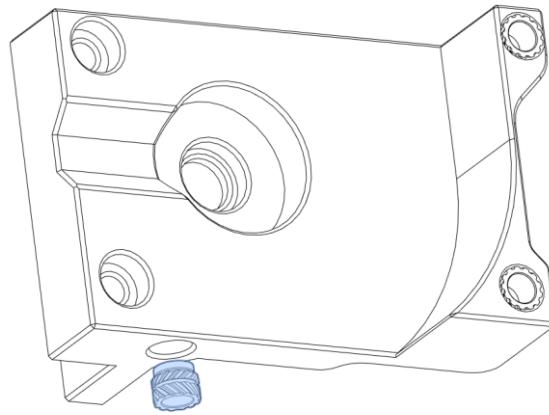
If you are using a levered micro switch, install it as shown. In case you are using a micro switch without a lever, install it in the other direction, with the button on the bottom side.



## GEAR BOX BACK

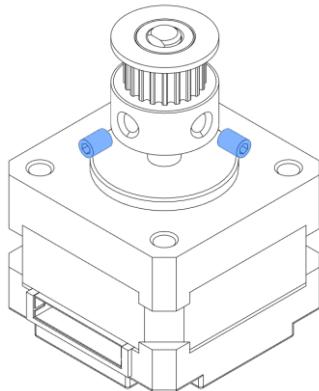


M3 Heat Set Inserts



MR85ZZ Bearing

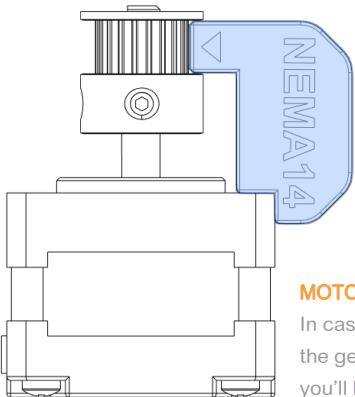
## MOTOR ARM



### GRUB SCREWS

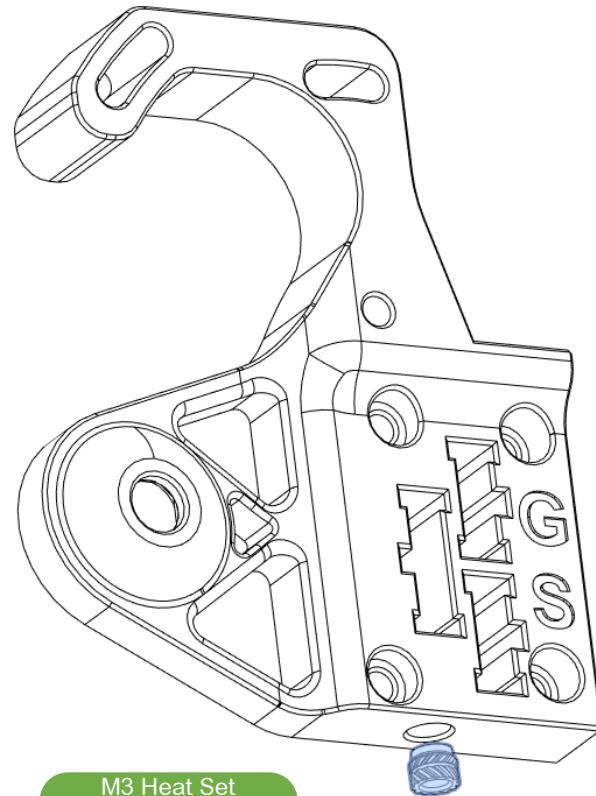
Insert both grub screws and use thread locker on them.

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



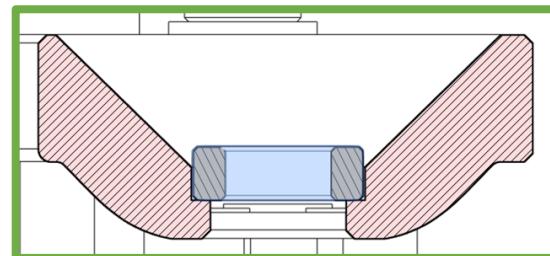
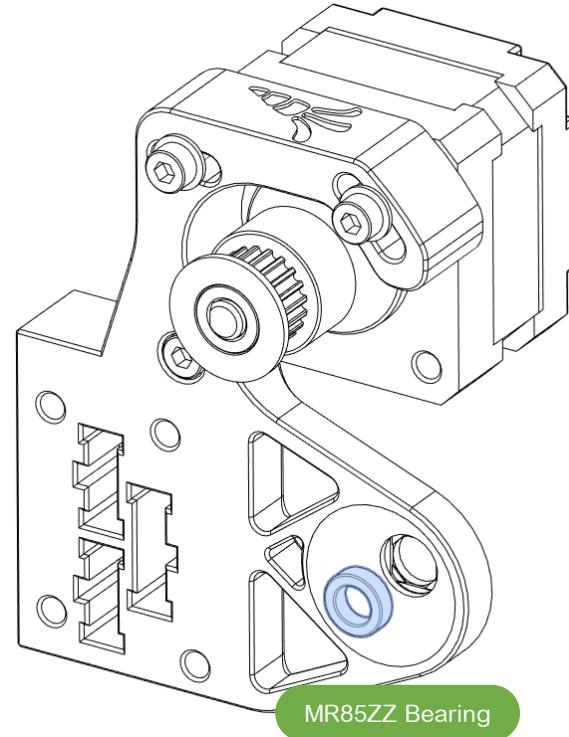
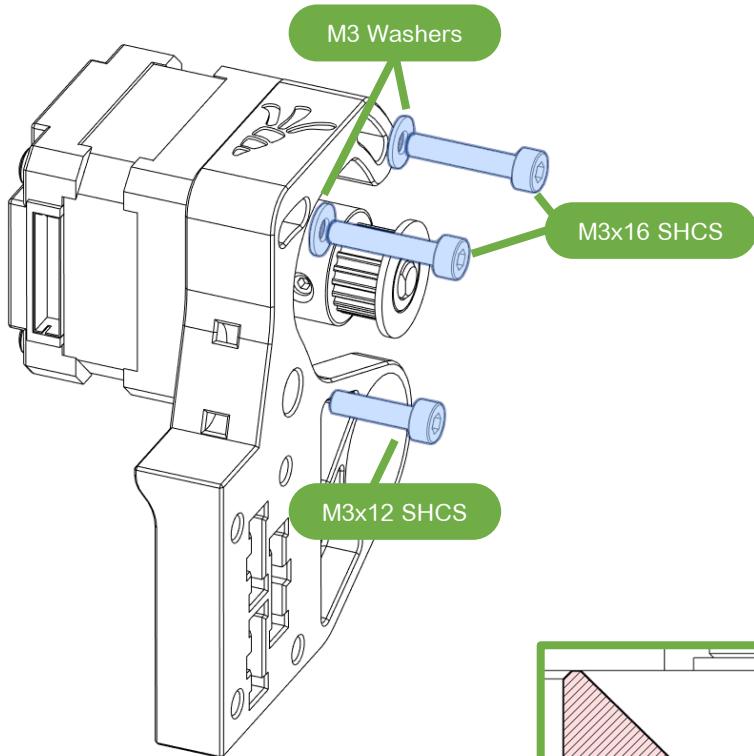
### MOTOR SIZE

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.



M3 Heat Set  
Insert

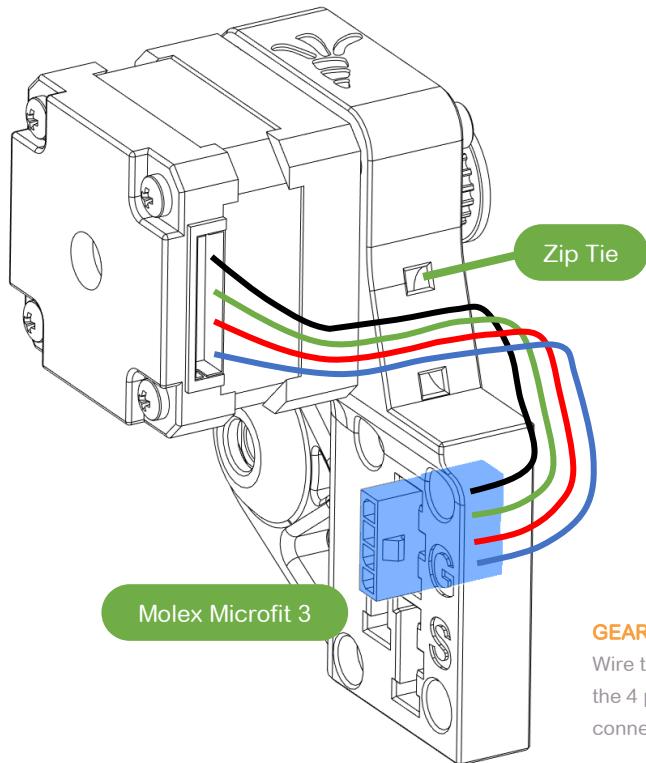
## MOTOR ARM



### BEARING POSITION

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

## MOTOR WIRING

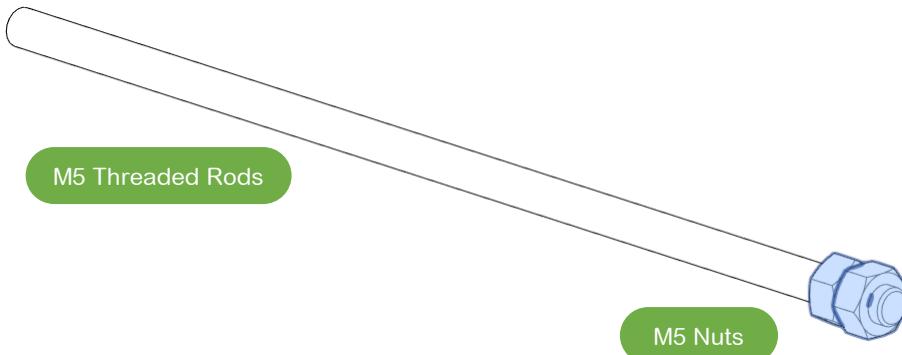


USERS OF ERCF EASY BRD:  
Skip this step – see page 80

### GEAR MOTOR WIRING

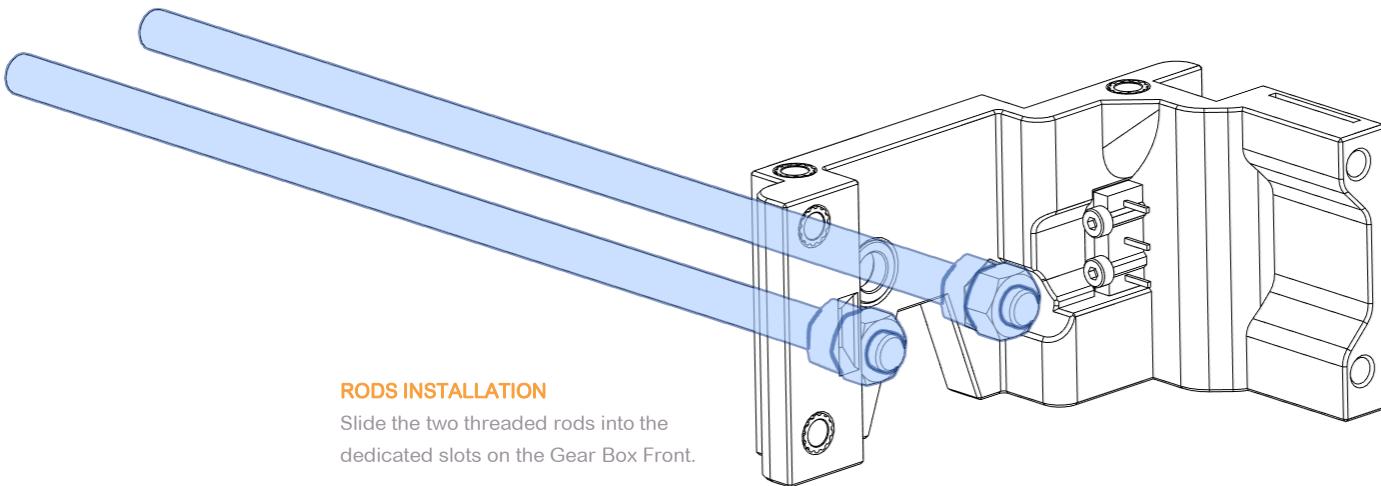
Wire the gear motor as shown. Push the 4 pins MicroFit3 female connector in the top left spot (« G »).

## 5MM THREADED RODS



### NUTS

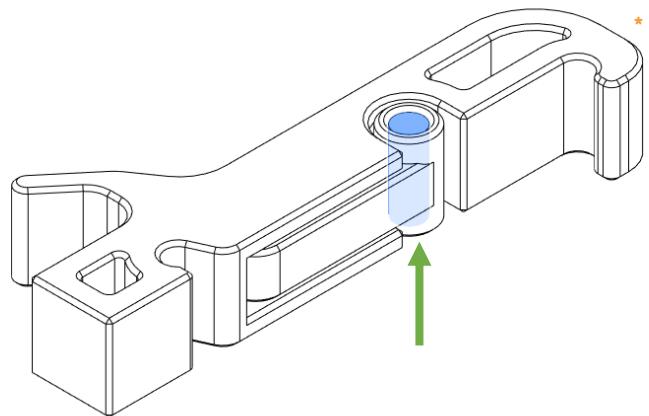
Install the two M5 nuts tightened against each other (locking mechanism) at the end of each M5 threaded rod.



### RODS INSTALLATION

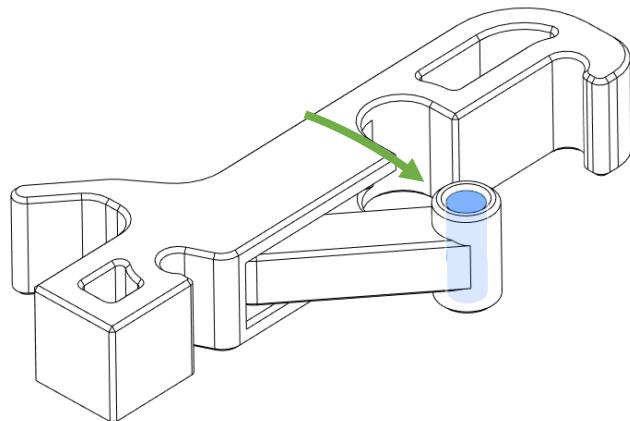
Slide the two threaded rods into the dedicated slots on the Gear Box Front.

## LATCHES PREPARATION

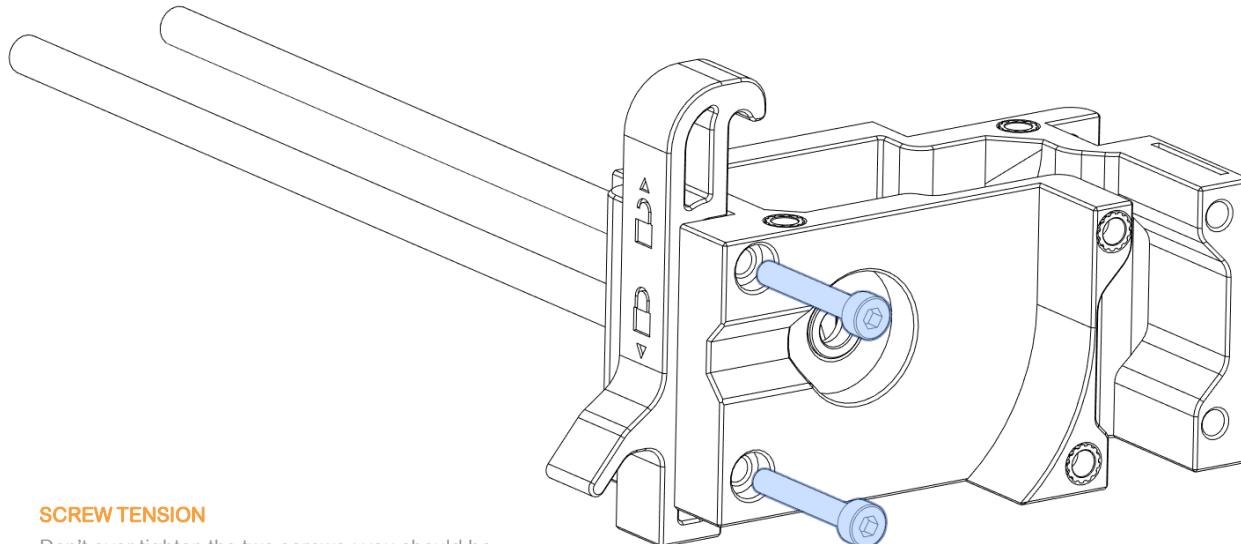


### HINGE UNLOCK

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



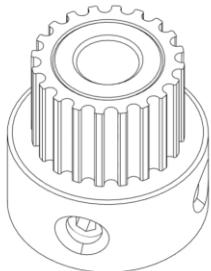
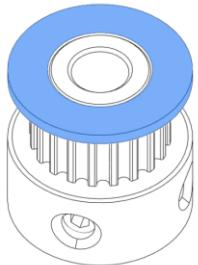
### SCREW TENSION

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

M3x20 SHCS

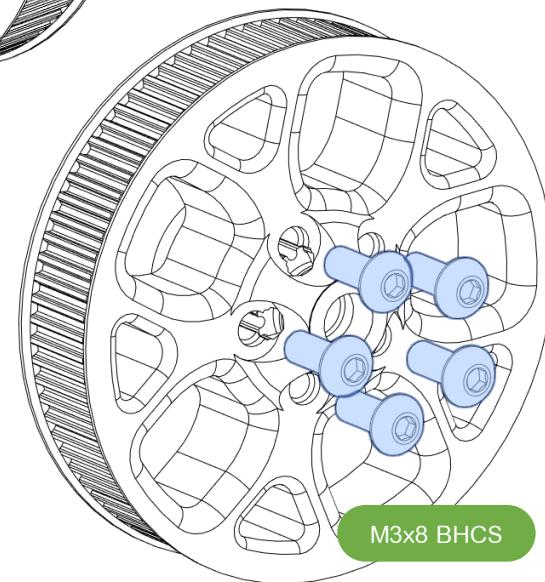
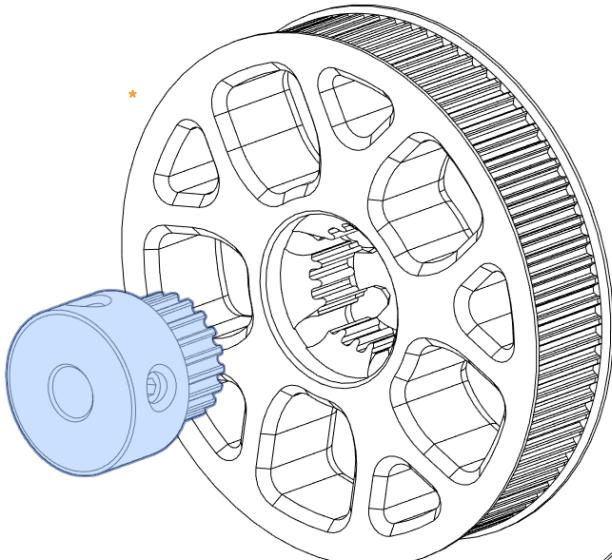
## M4 EXTRUDER 80T GEAR

GT2 20T Pulley



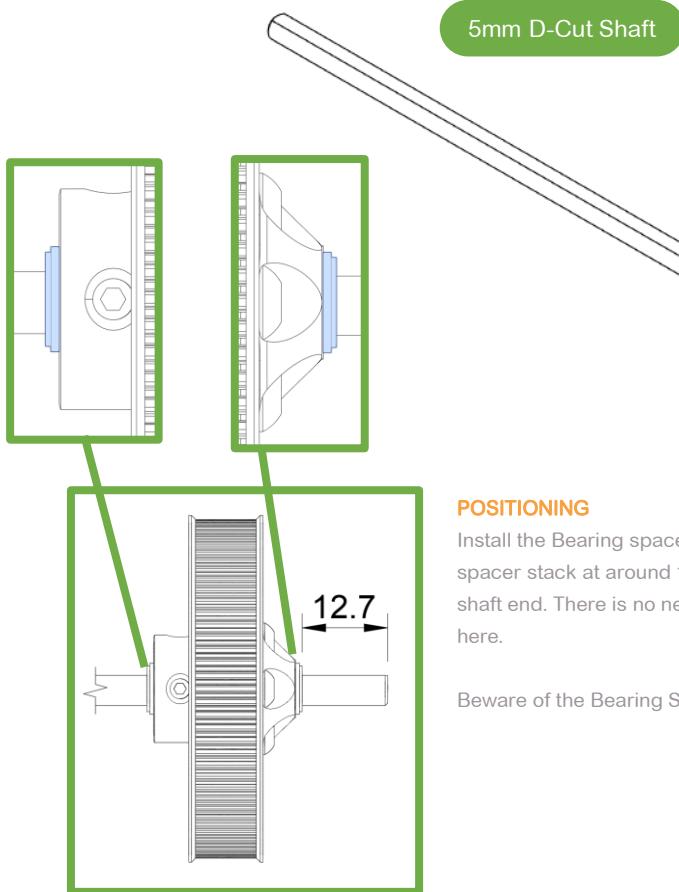
### REMOVE FLANGE

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



M3x8 BHCS

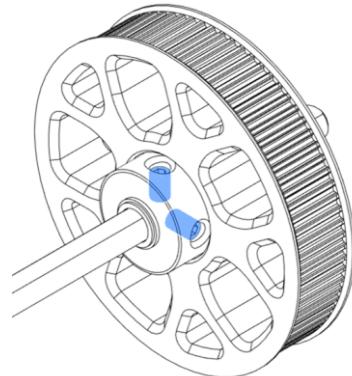
## 5MM D-CUT SHAFT



### POSITIONING

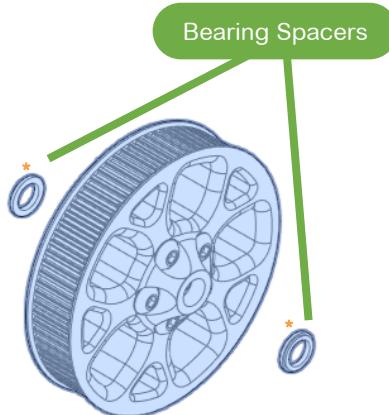
Install the Bearing spacer / M4 wheel / Bearing spacer stack at around 13mm from the D-Cut shaft end. There is no need to be very precise here.

Beware of the Bearing Spacers orientation.

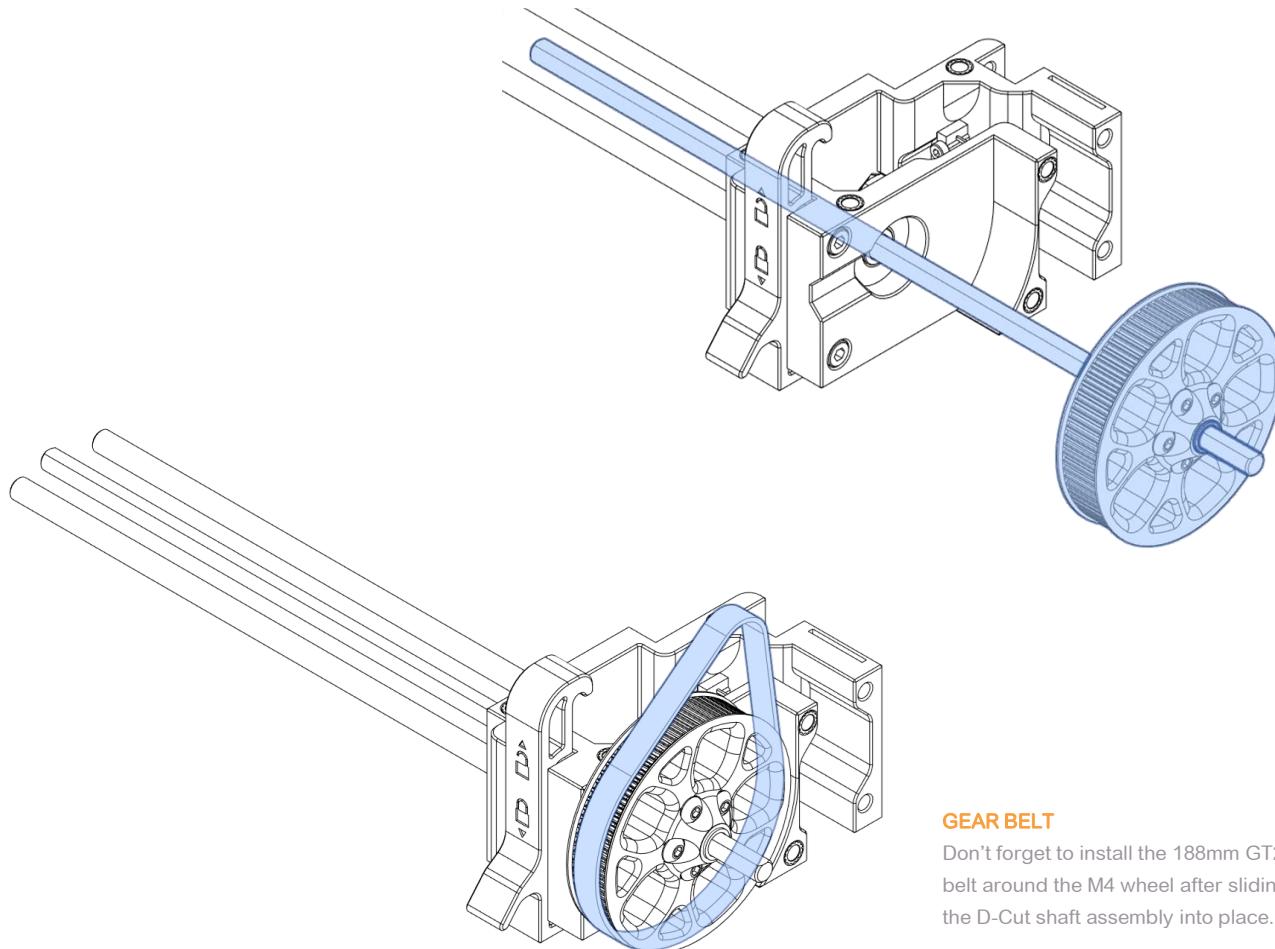


### GRUB SCREWS

Insert both grub screws and use thread locker on them.



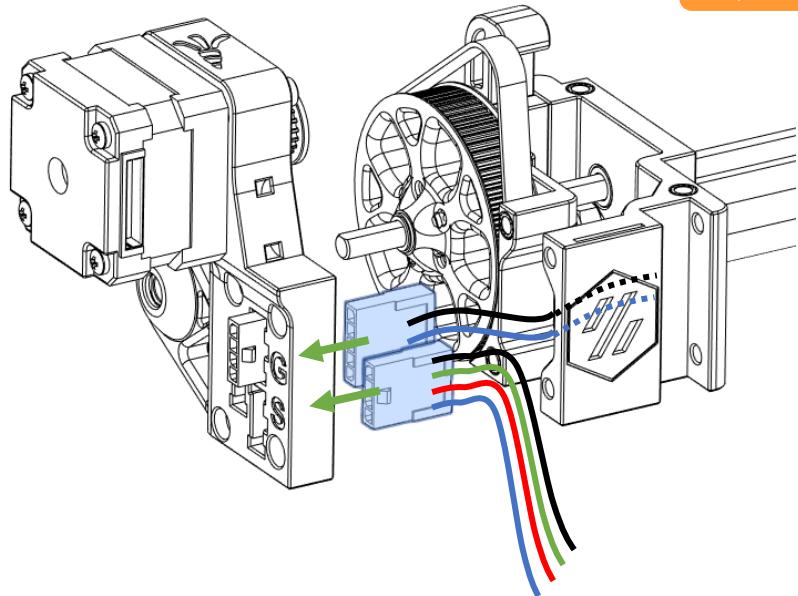
## GEAR BOX



### GEAR BELT

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

## GEAR BOX



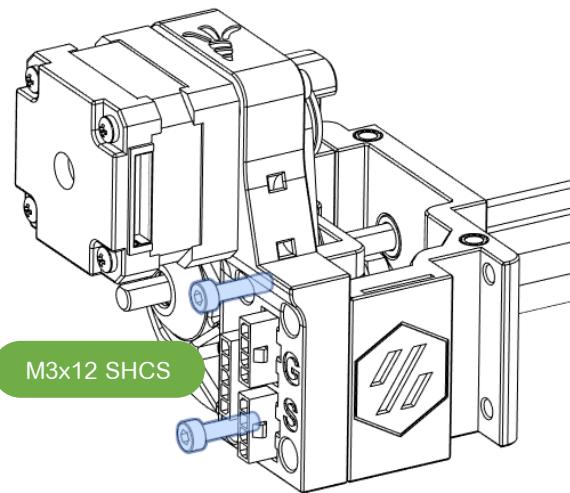
USERS OF ERCF EASY BRD:  
Skip this wiring step – see page 80

### 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.

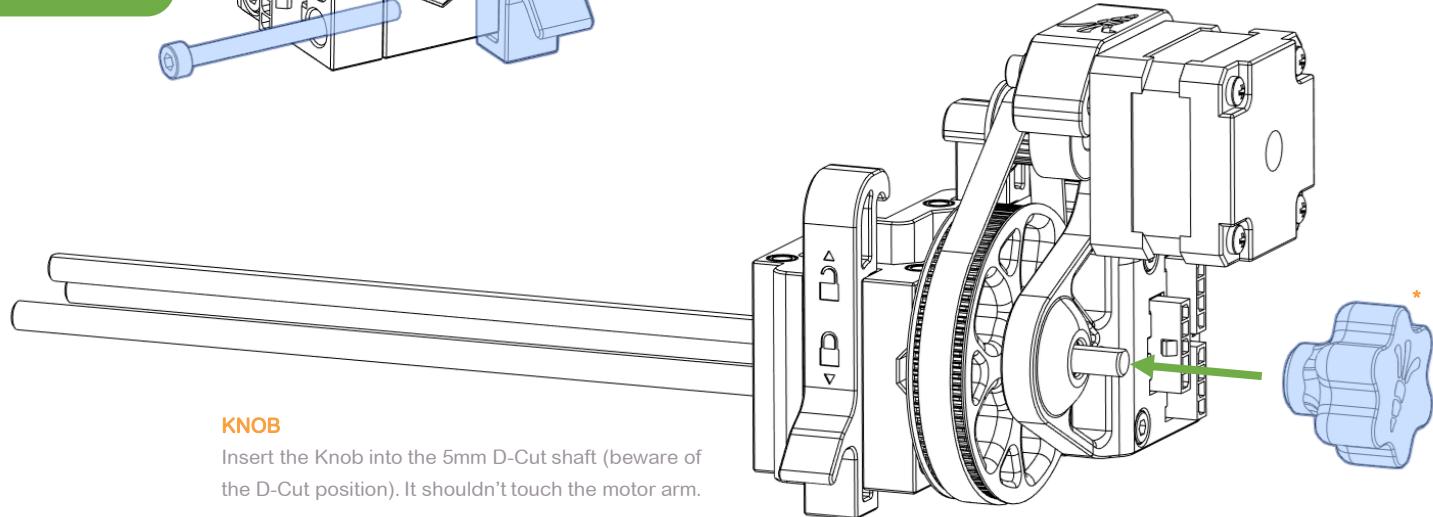
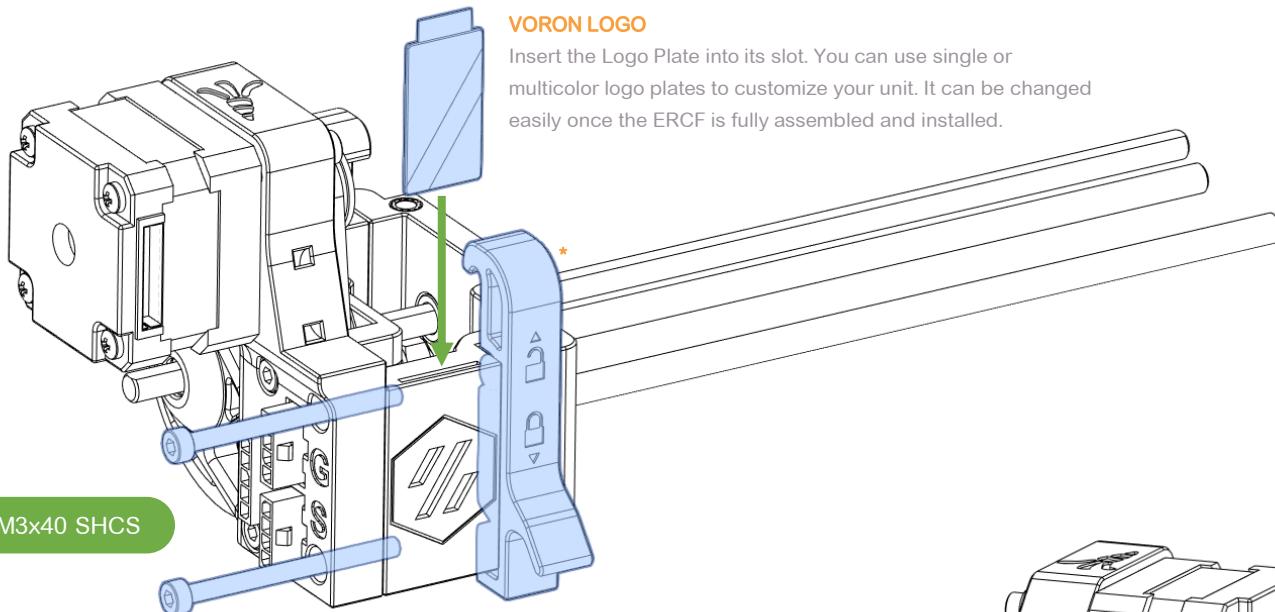


### CLOSING THE GEAR BOX

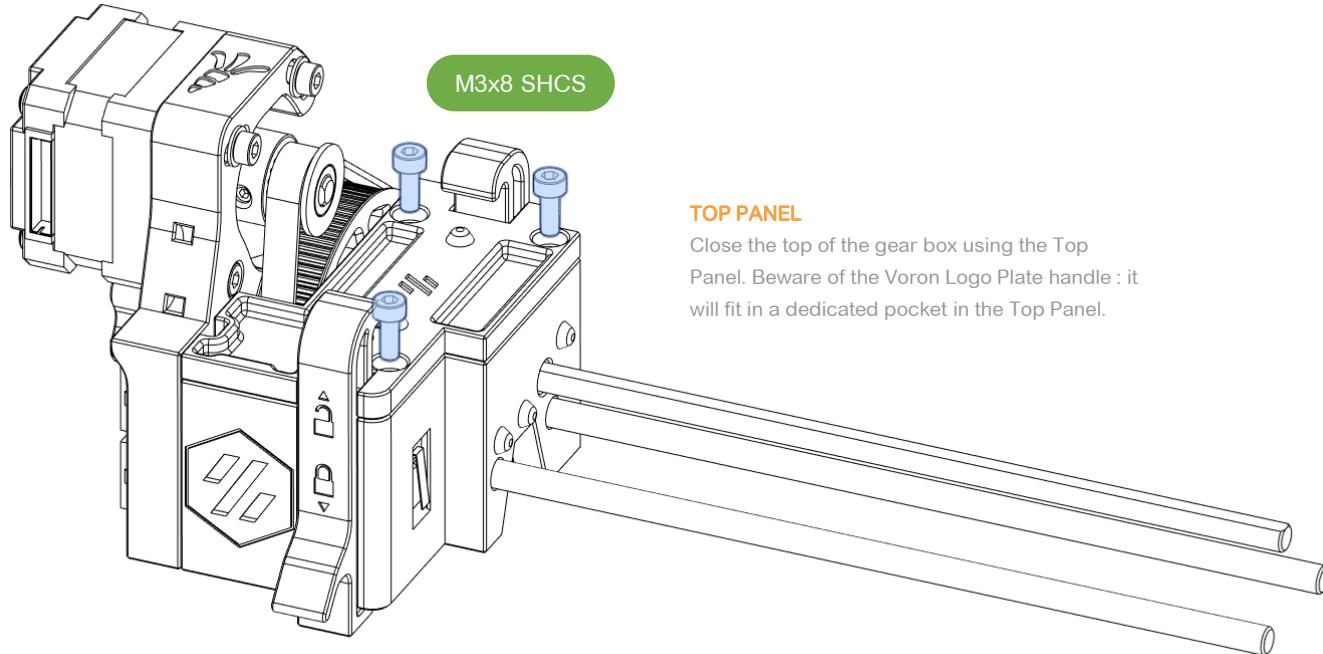
Install the Motor Arm, pass the belt around the GT2 pulley of the Gear Motor, but don't tension it yet.

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

## GEAR BOX



## TOP PANEL

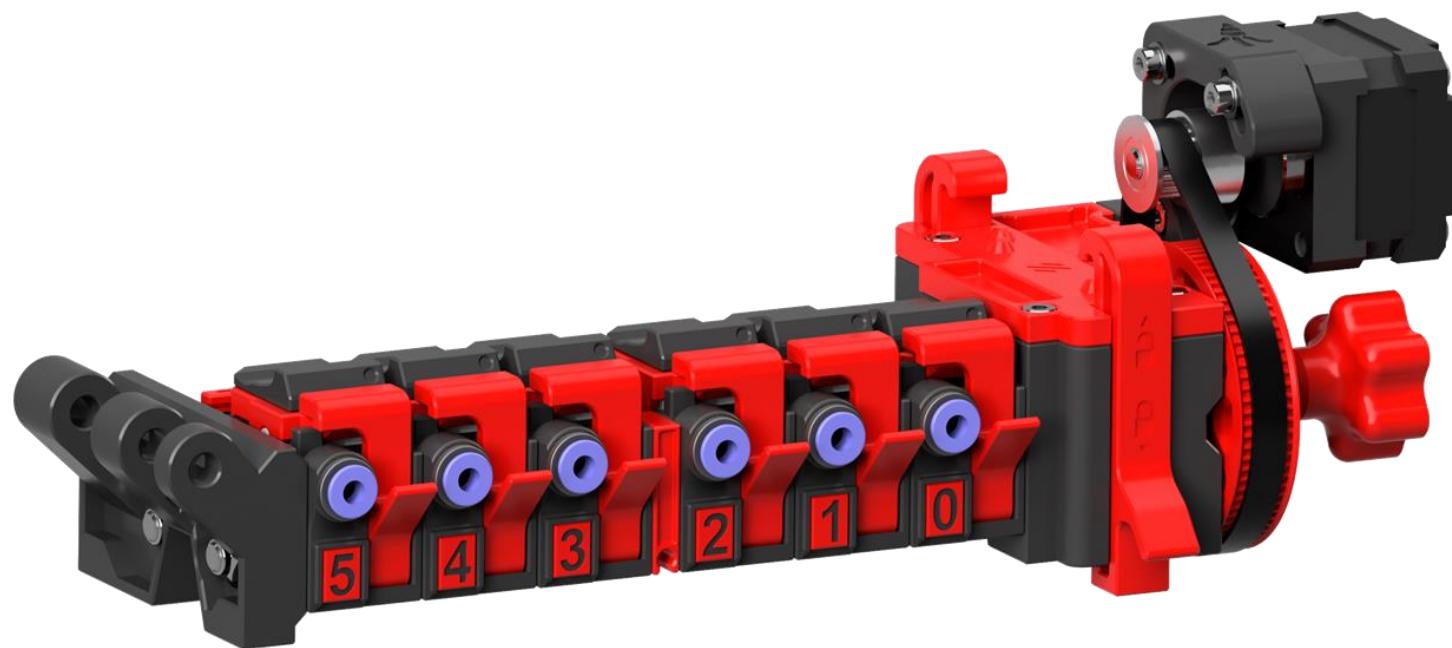


### TOP PANEL

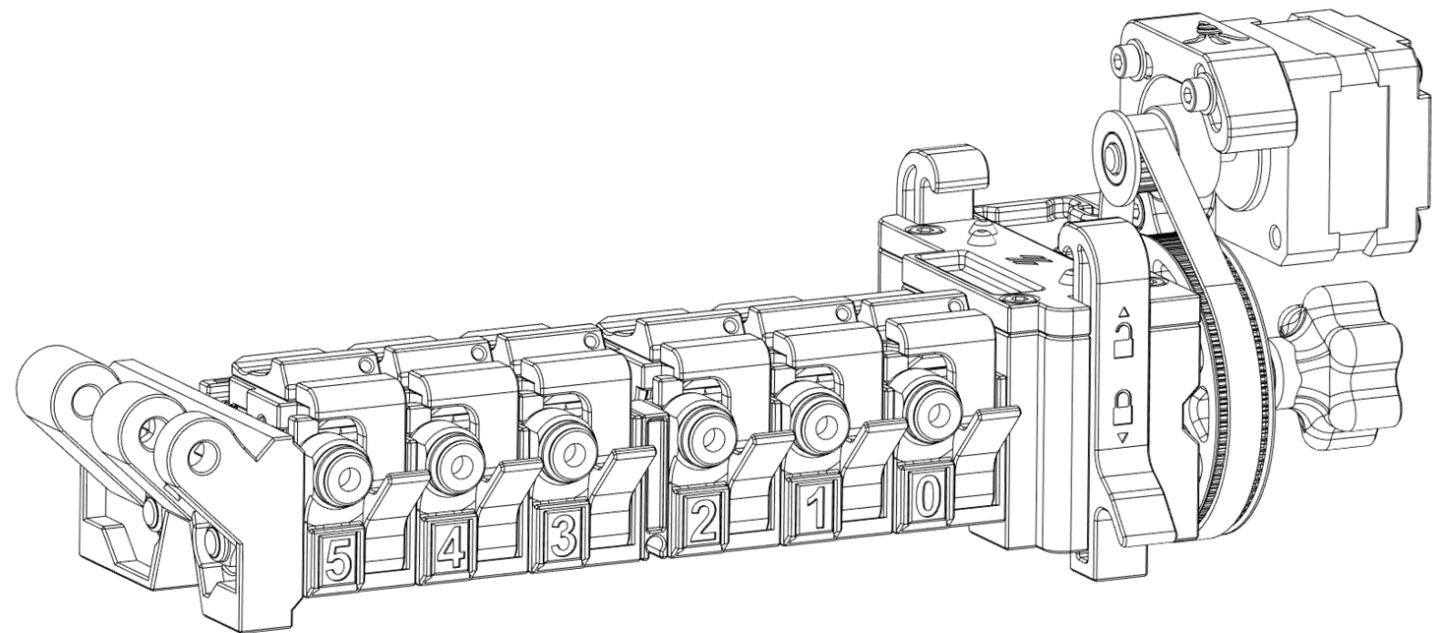
Close the top of the gear box using the Top Panel. Beware of the Voron Logo Plate handle : it will fit in a dedicated pocket in the Top Panel.

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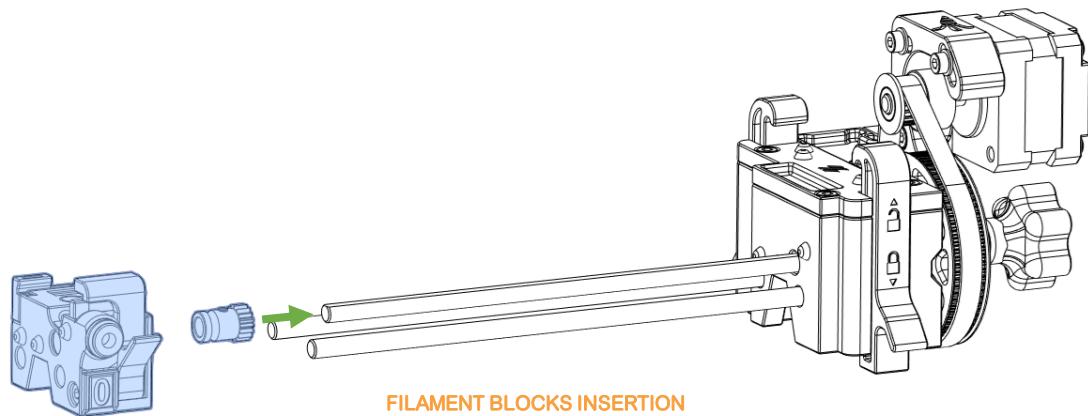
BOTTOM BLOCK



## OVERVIEW



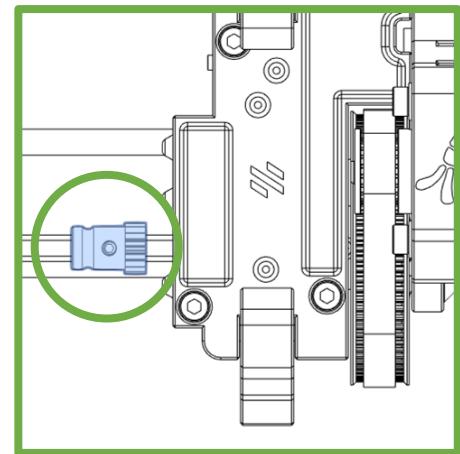
## FULL BOTTOM BLOCK



### FILAMENT BLOCKS INSERTION

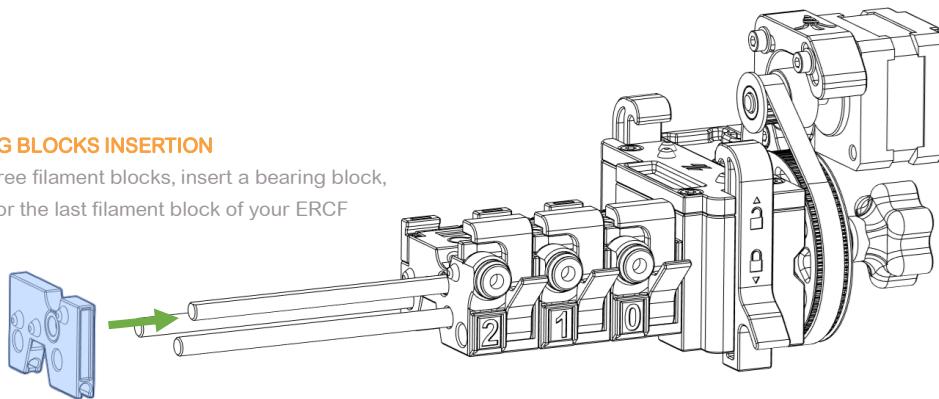
Slide a single Bondtech gear on the D-Cut shaft (beware of its orientation!) and only then slide the first filament block.

Do not tighten the grub screws yet.

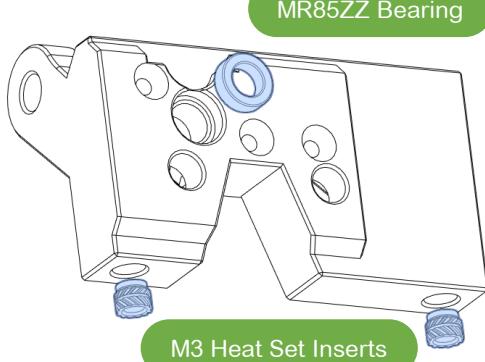


### BEARING BLOCKS INSERTION

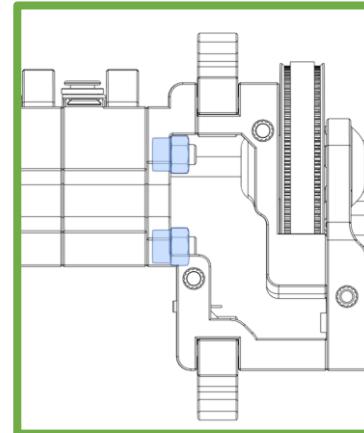
Every three filament blocks, insert a bearing block, except for the last filament block of your ERCF unit.



## FILAMENT BLOCKS END

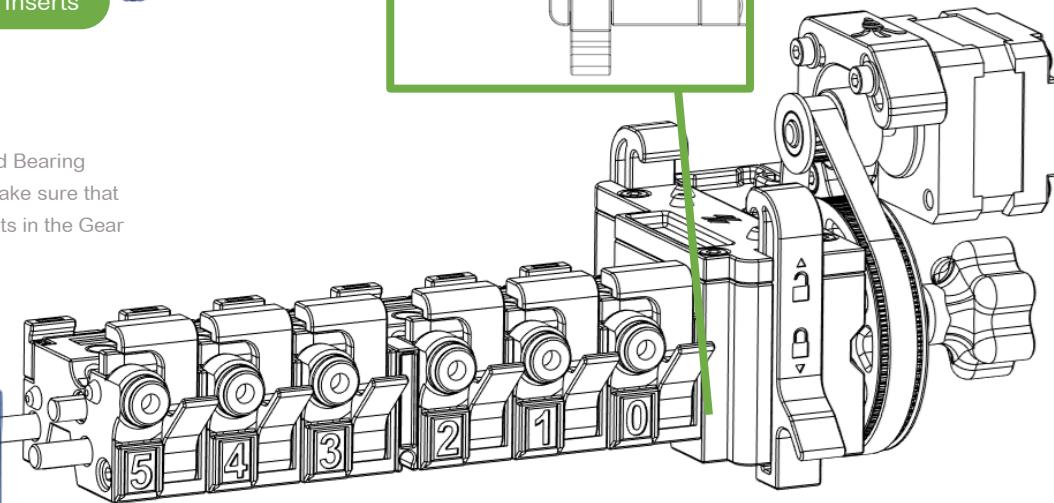
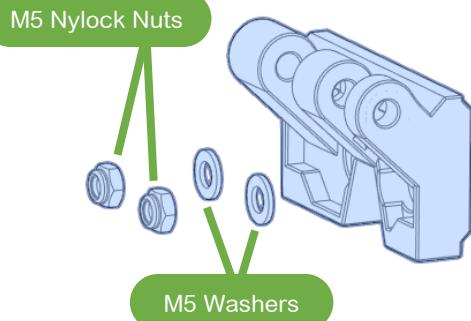


View from the bottom of the ERCF.



## FILAMENT BLOCKS END

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

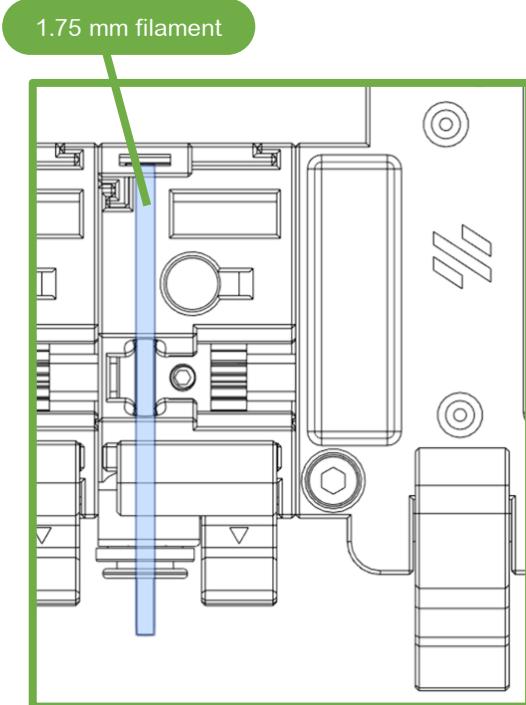


### M5 NYLOCK NUTS

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



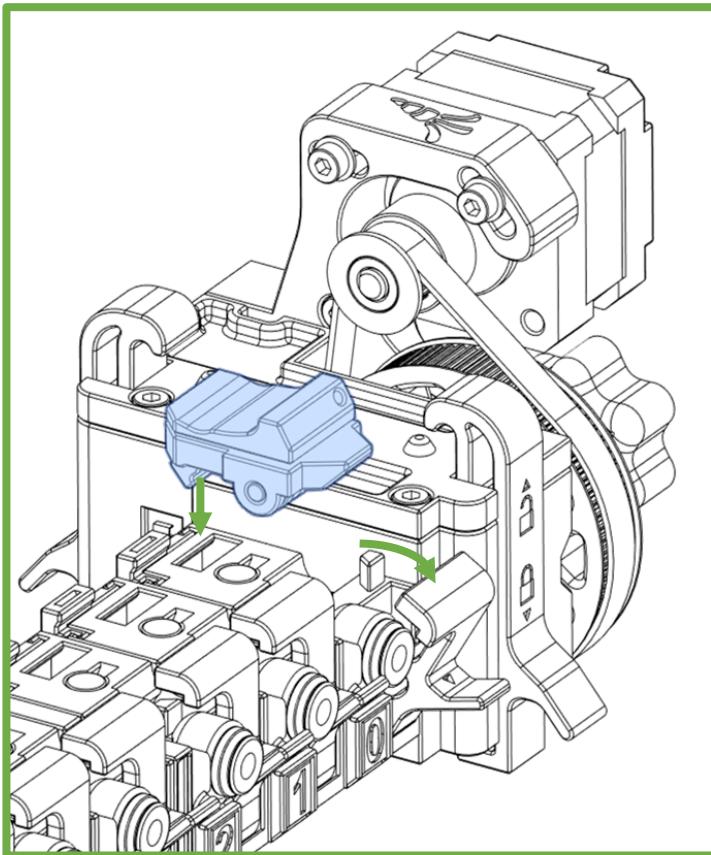
### GEAR ALIGNMENT

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 tighten the grub screw.

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

Repeat this process for all tools.

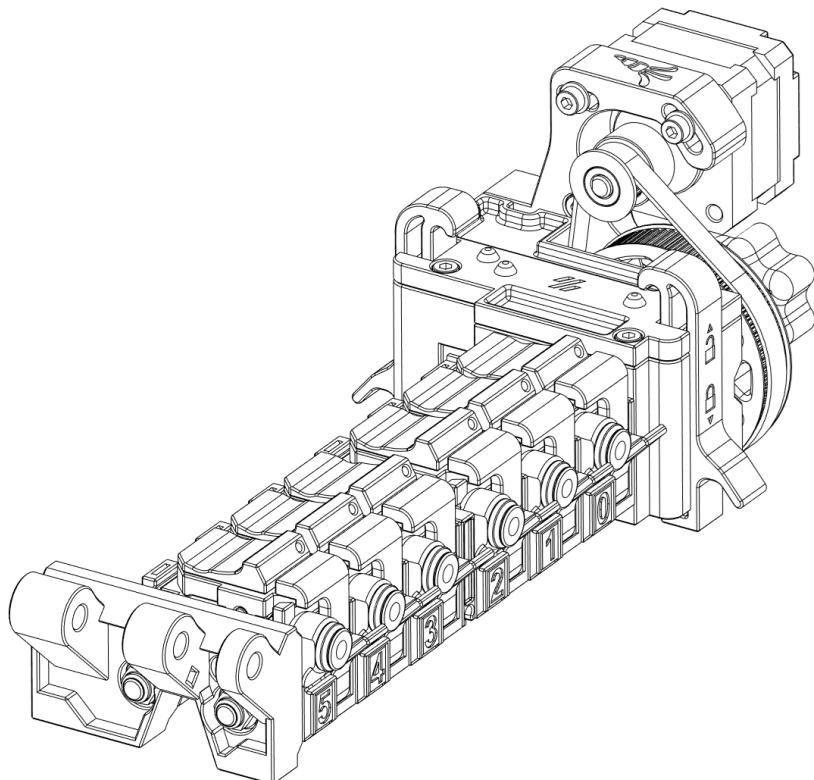
## TOP HATS



### 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.

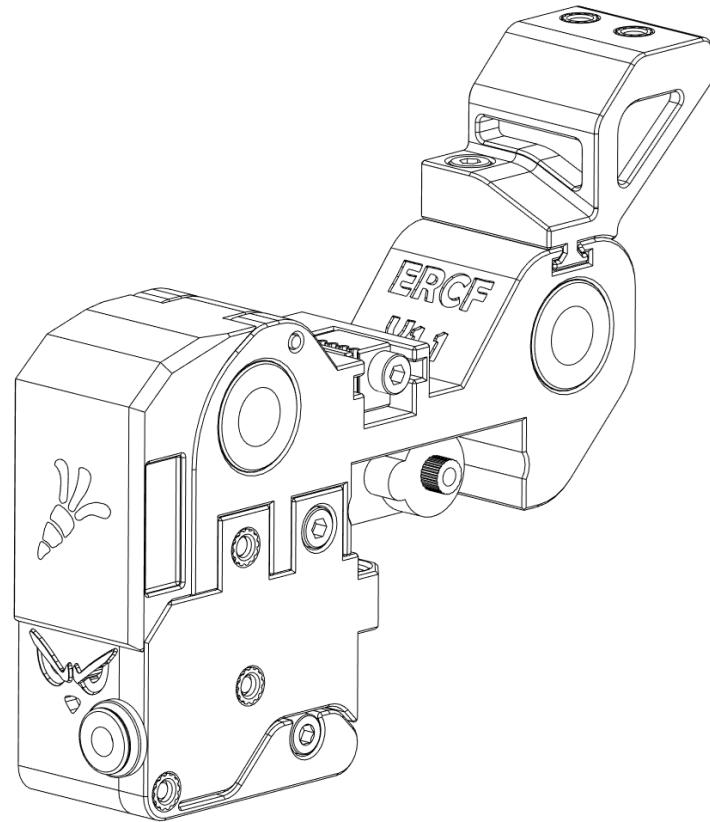
Once installed, close the latch, and repeat this process for all tools.



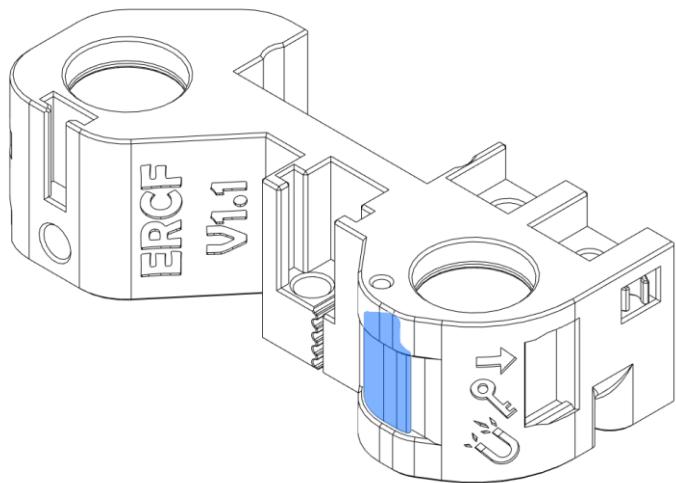
## SELECTOR



## OVERVIEW

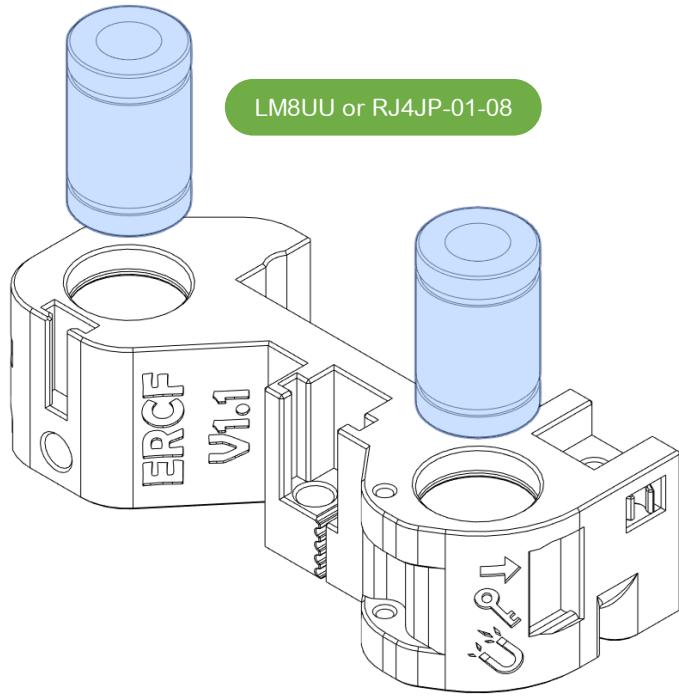


## SELECTOR CART



### REMOVE BUILT-IN SUPPORT

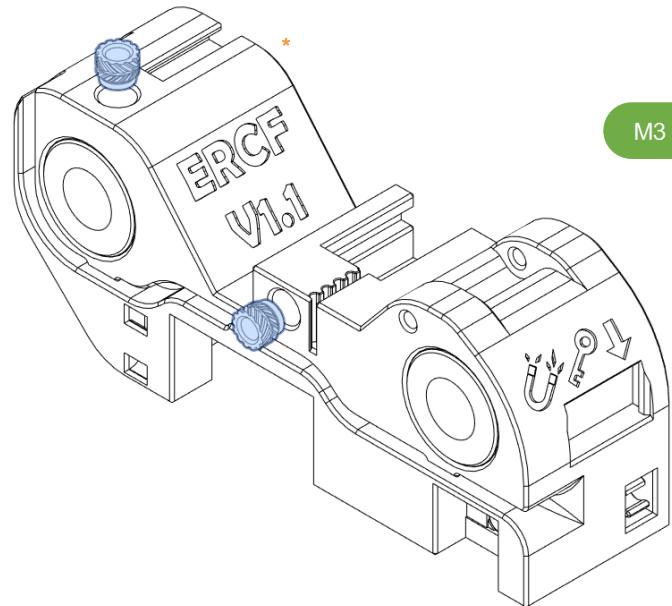
Use a small tool, like a small flat screwdriver, to remove the built-in support.



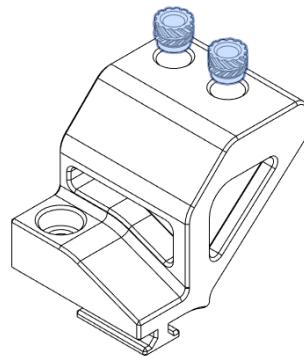
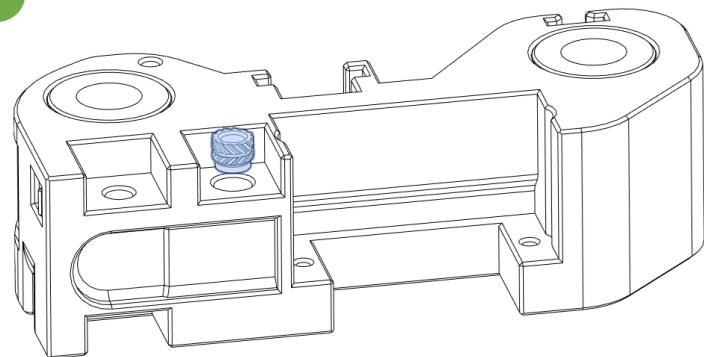
### LM8UU INSERTION

Press-fit the LM8UU in their holes.

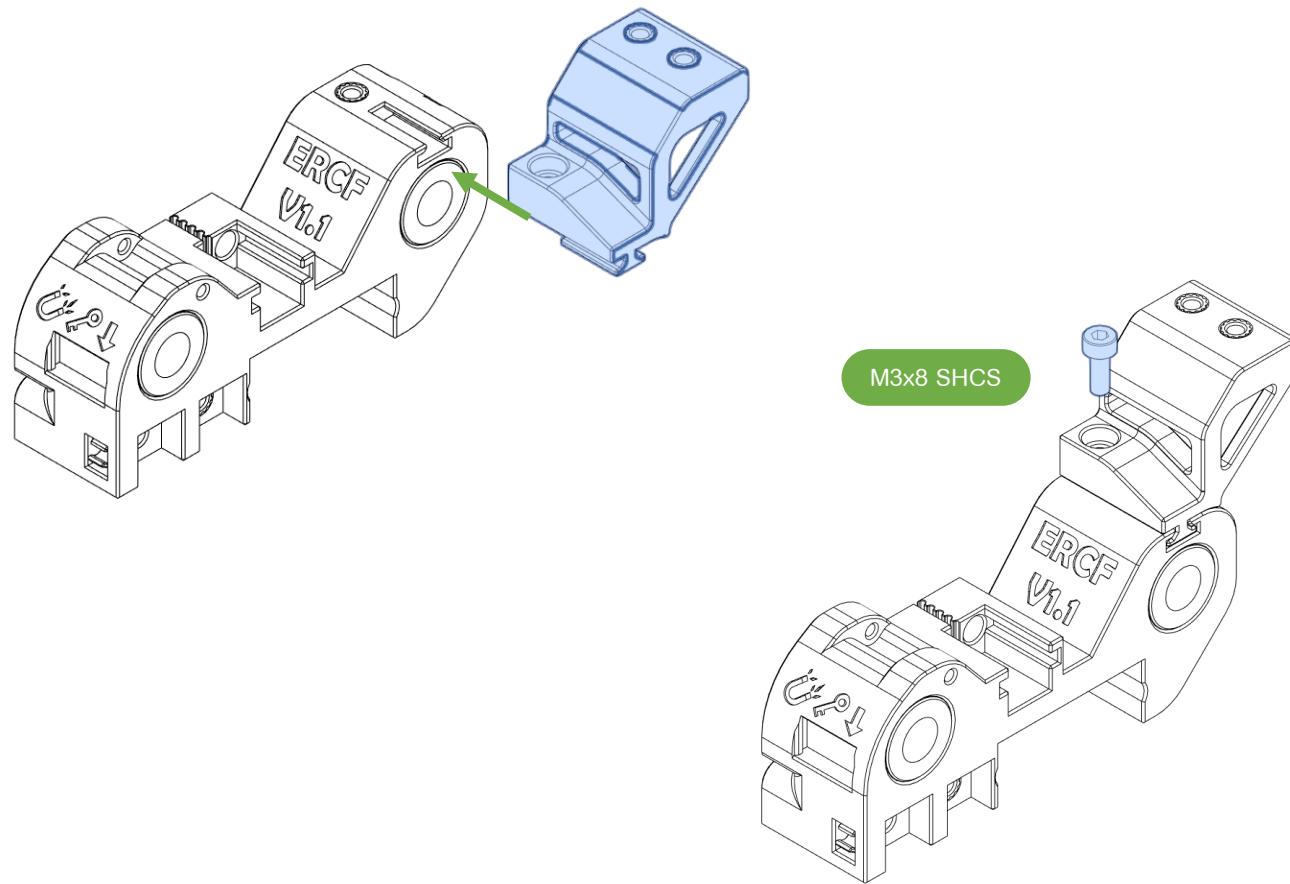
## SELECTOR CART



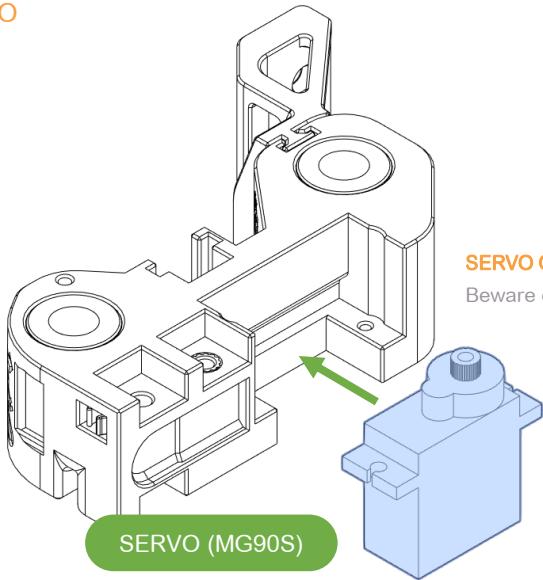
M3 Heat Set Inserts



## DRAG CHAIN ANCHOR

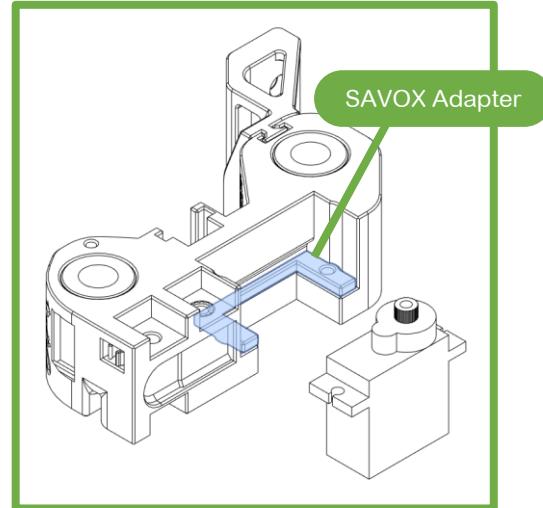


## SERVO



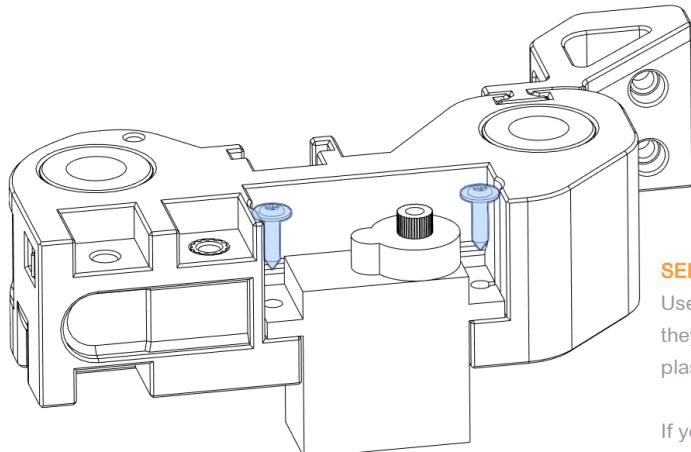
### SERVO ORIENTATION

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.

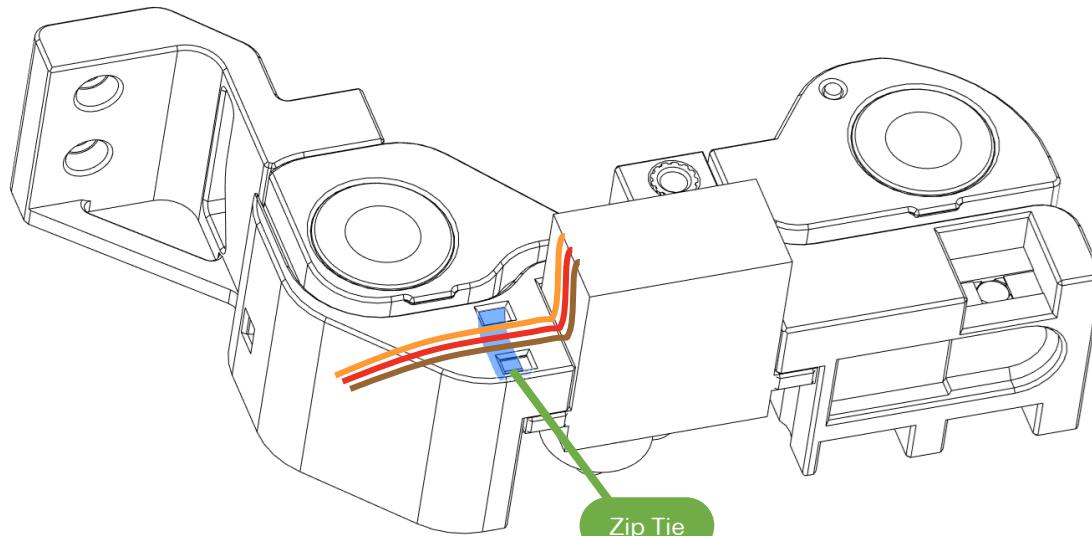


### SERVO SCREWS

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-MH servo, use two M2x10 SHCS.

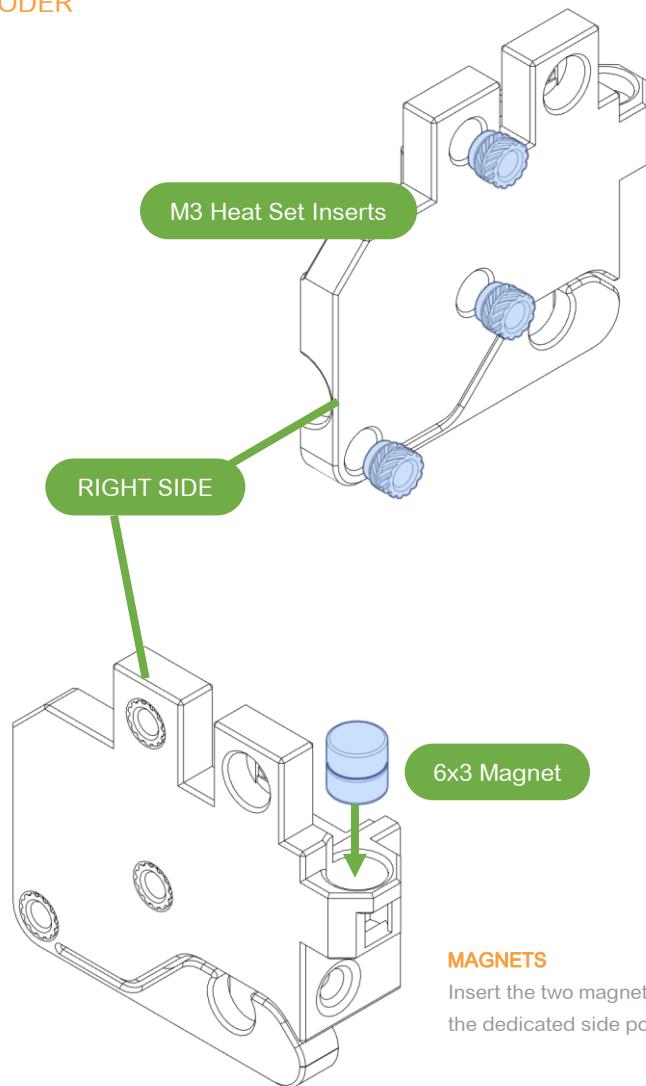
## SERVO WIRES



### SERVO WIRES

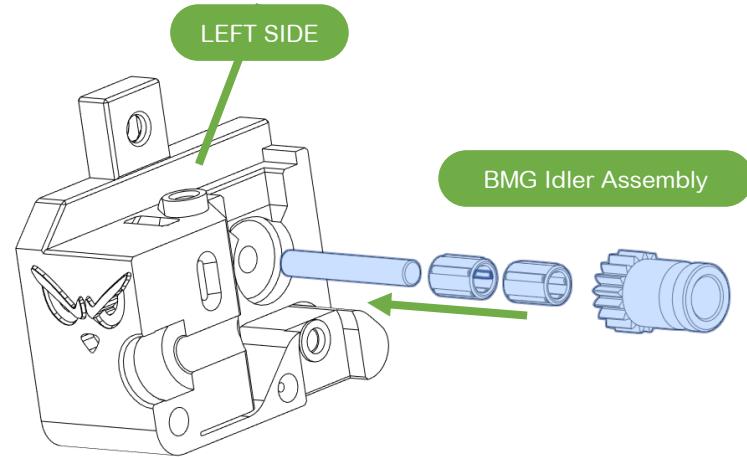
Secure the servo wires using a zip tie. Make sure the wires are flat against the side of the servo, as shown.

## ENCODER

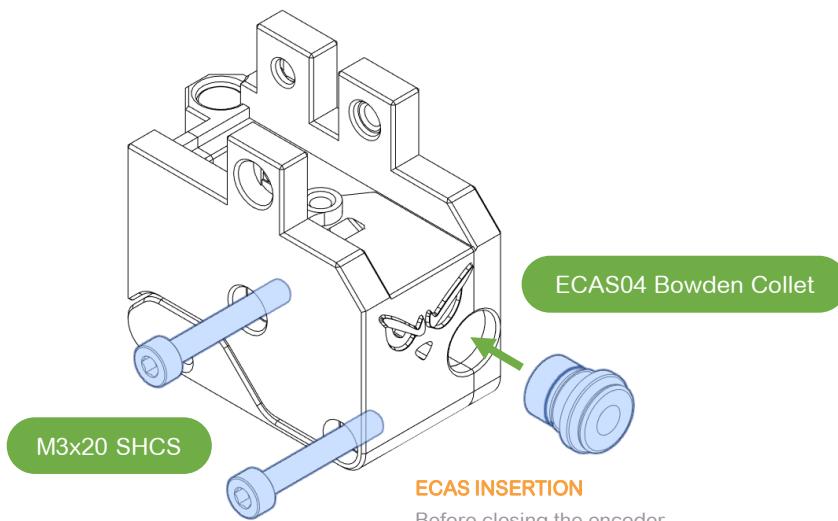


## MAGNETS

Insert the two magnets in the dedicated side pocket.

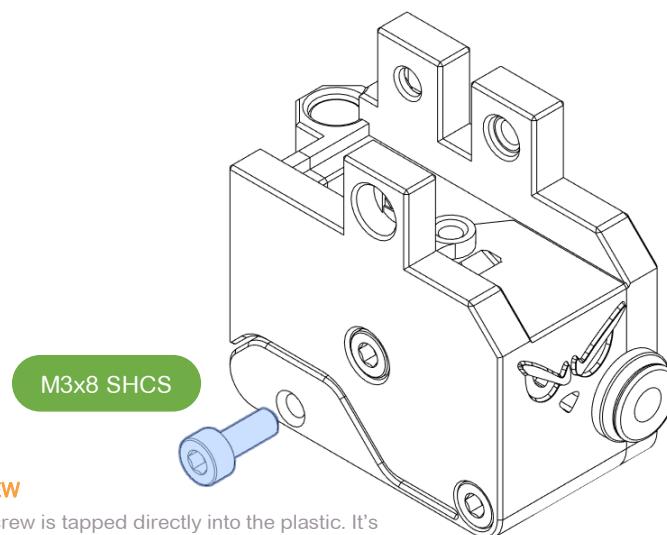


## ENCODER



### ECAS INSERTION

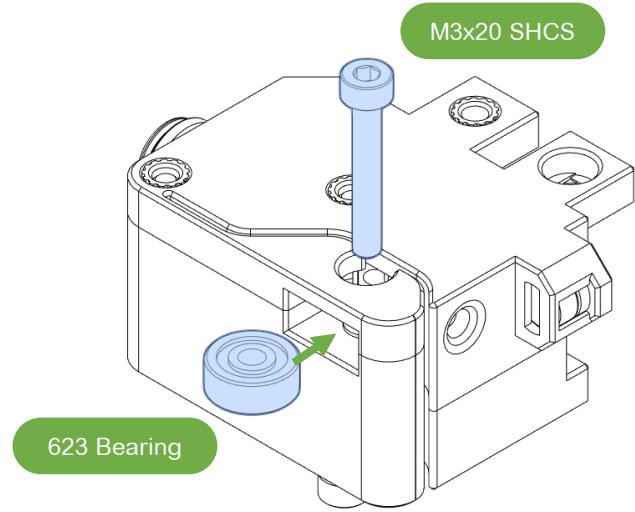
Before closing the encoder cart, insert the ECAS.



### SIDE SCREW

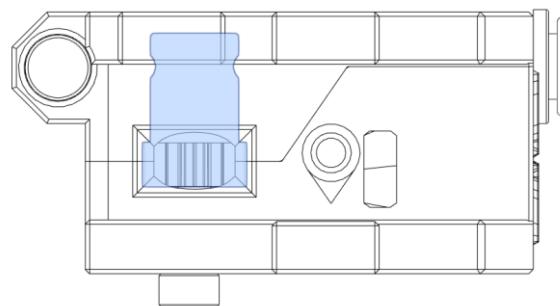
The side screw is tapped directly into the plastic. It's used to make physical contact with the selector endstop.

## ENCODER

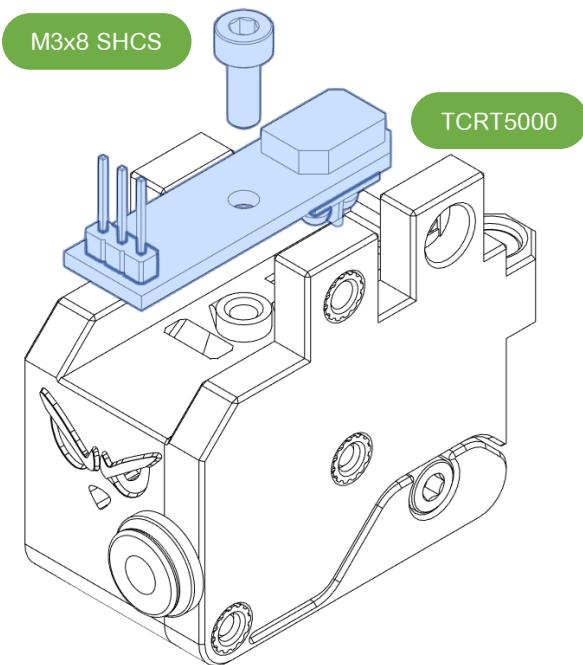


### BMG GEAR ROTATION

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



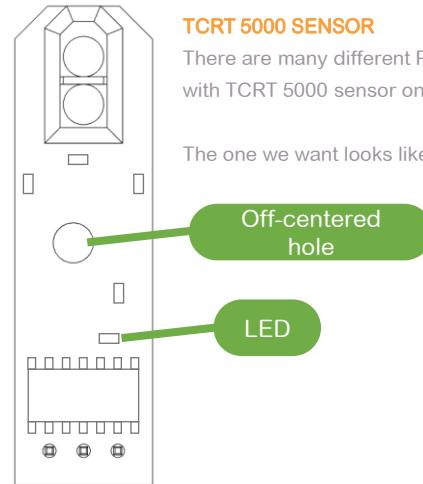
## ENCODER SENSOR



## TCRT 5000 SENSOR

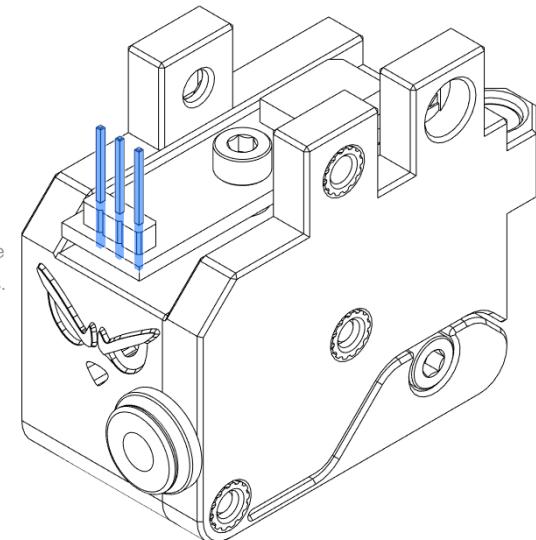
There are many different PCBs with TCRT 5000 sensor on them.

The one we want looks like this.

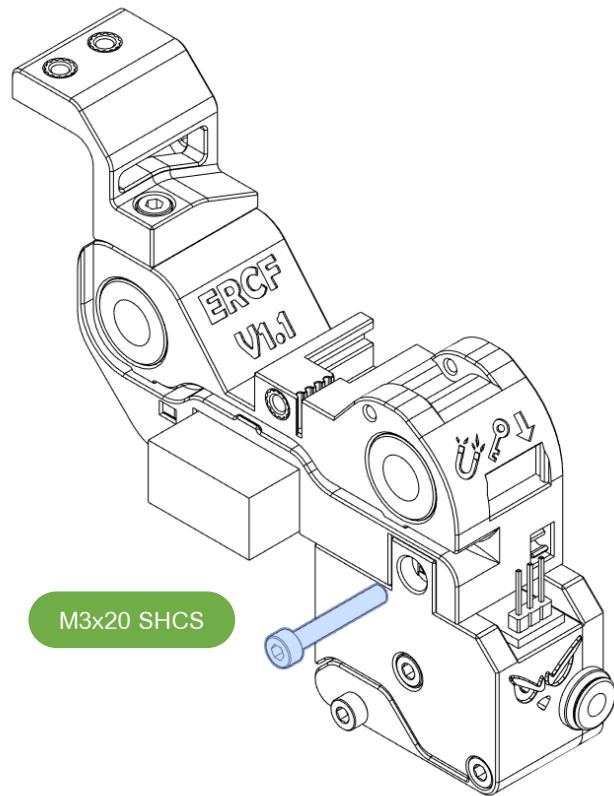
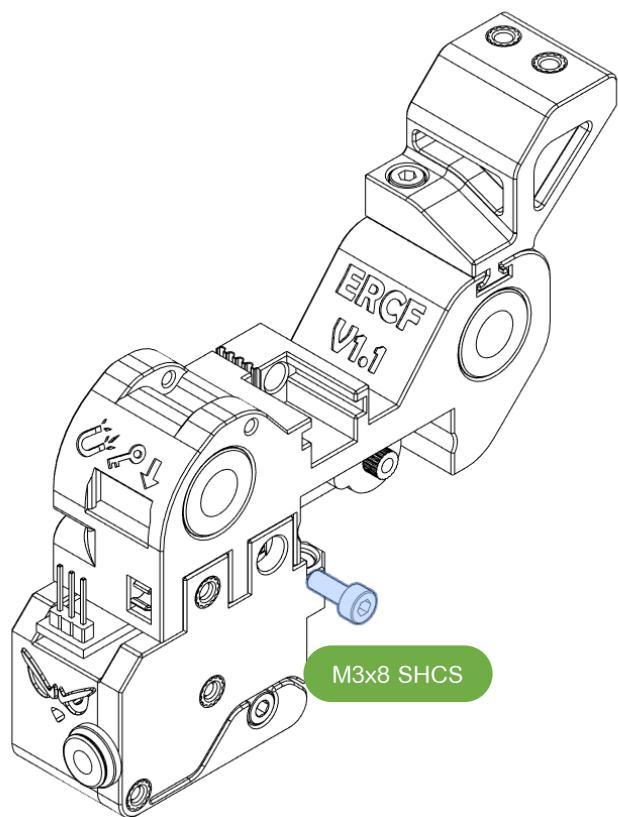


## SENSOR PINS

Delicately straighten the sensor pins using pliers.



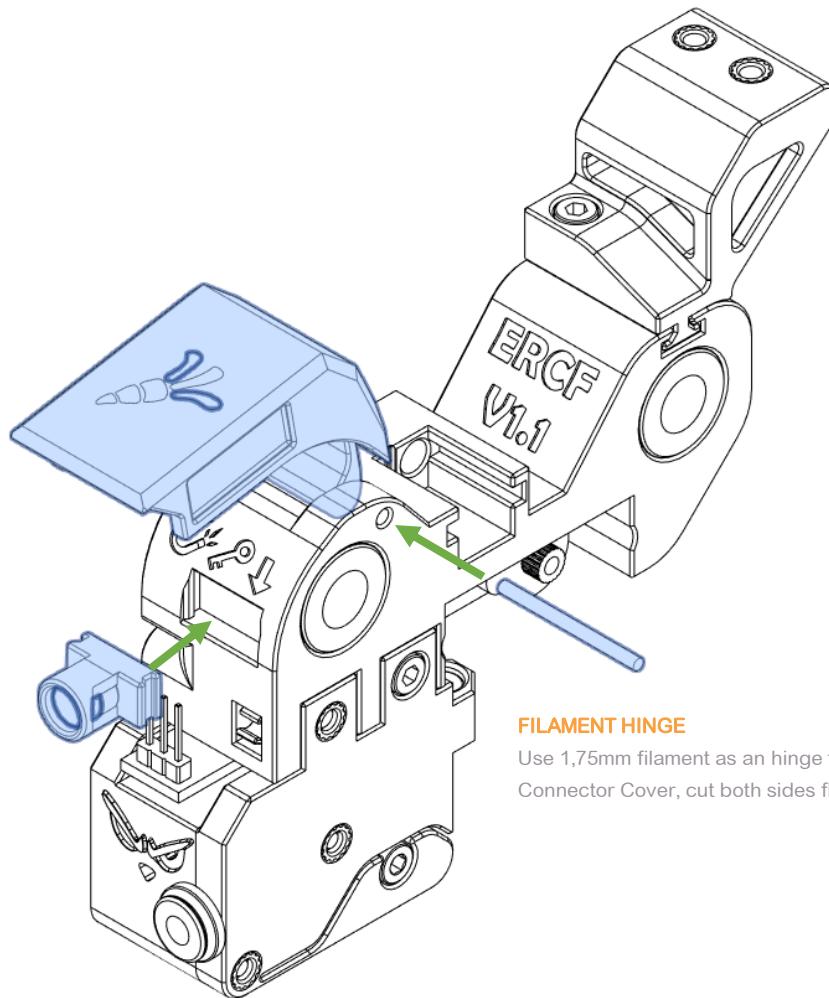
## SELECTOR CART



## GATE KEY

### GATE KEY

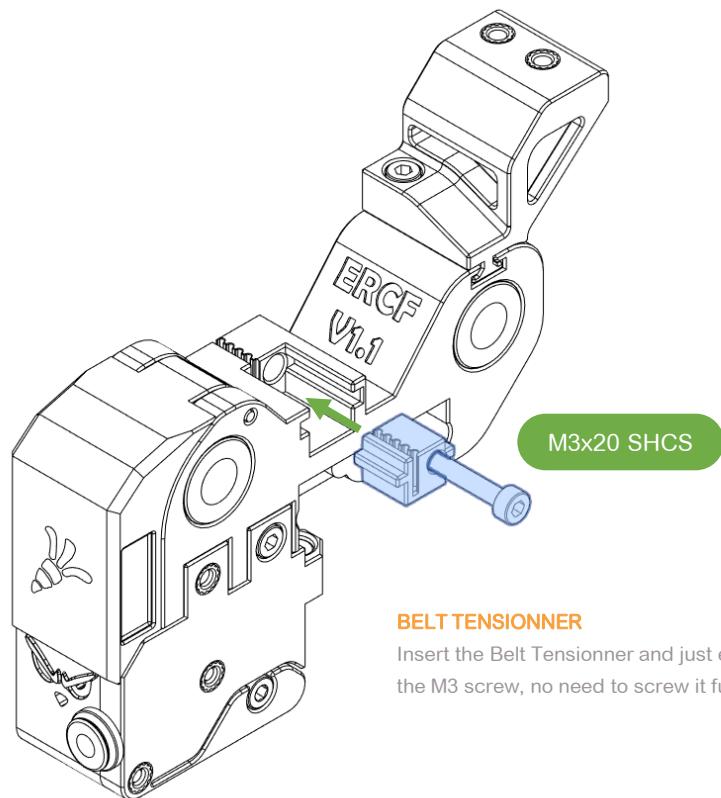
Install the Gate Key we assembled in the beginning in its dock.



### FILAMENT HINGE

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

## BELT TENSIONNER



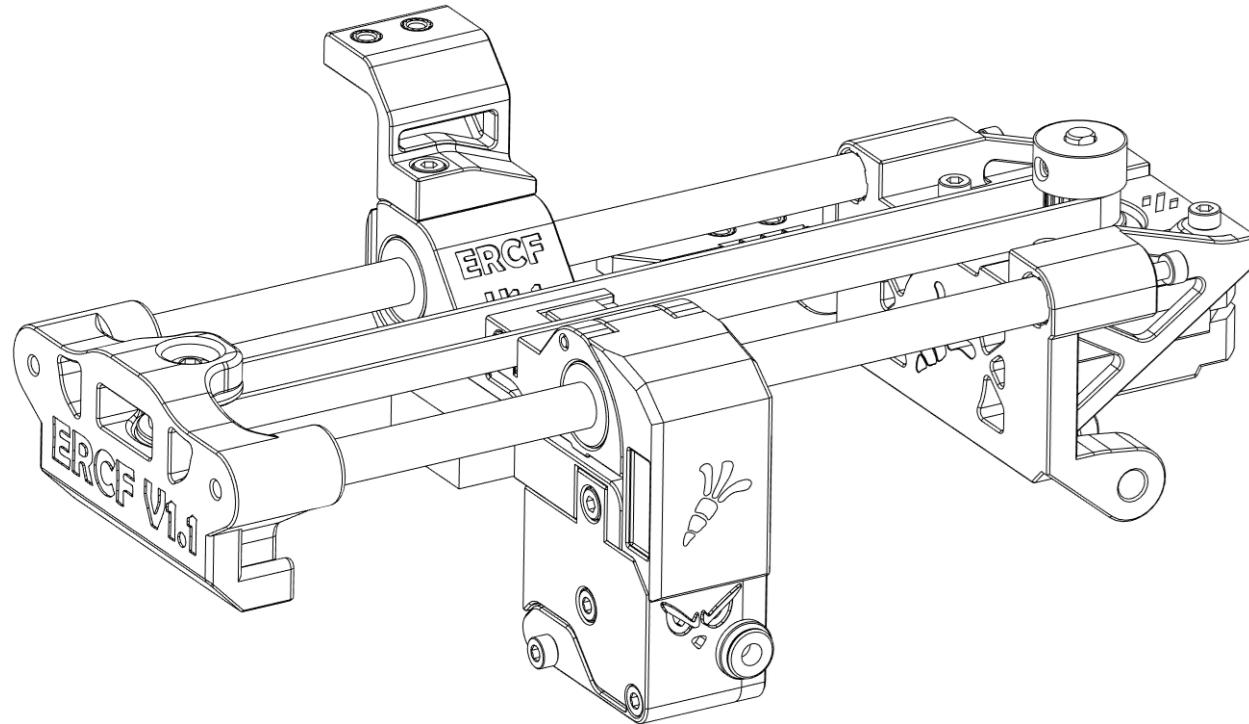
### BELT TENSIONNER

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

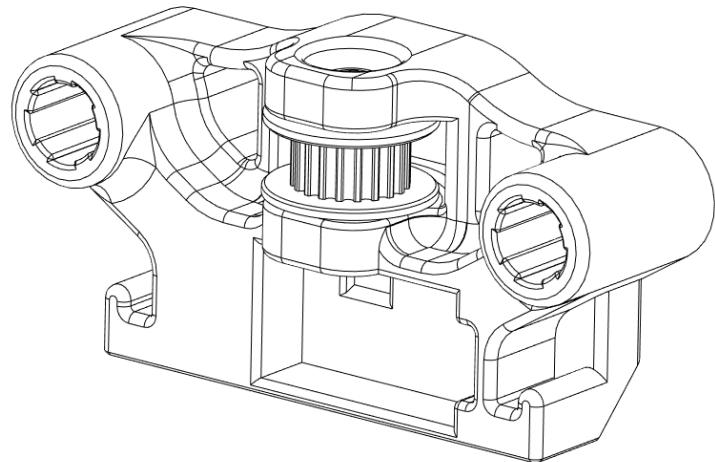
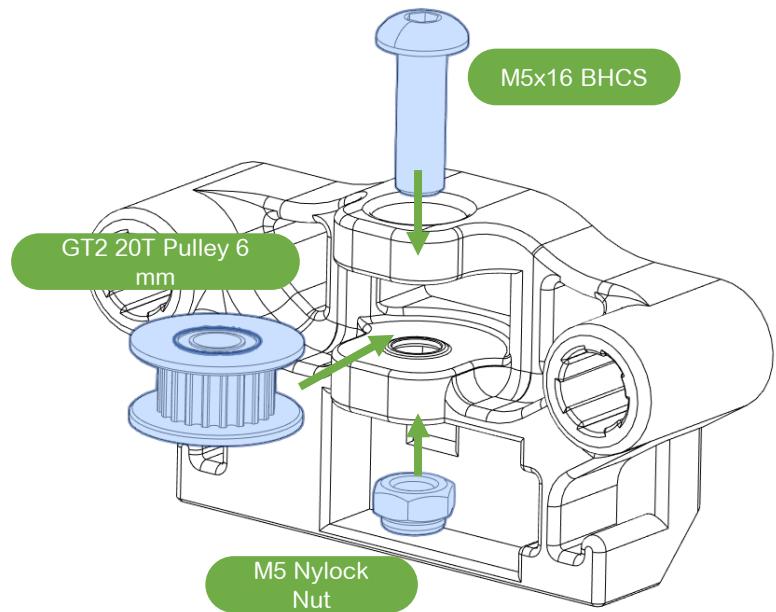
## LINEAR AXIS



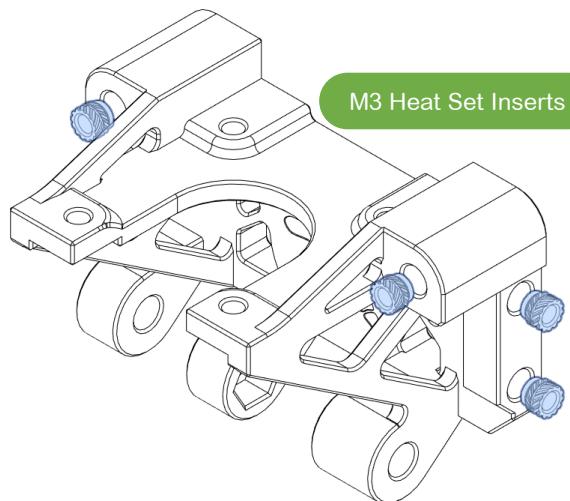
## OVERVIEW



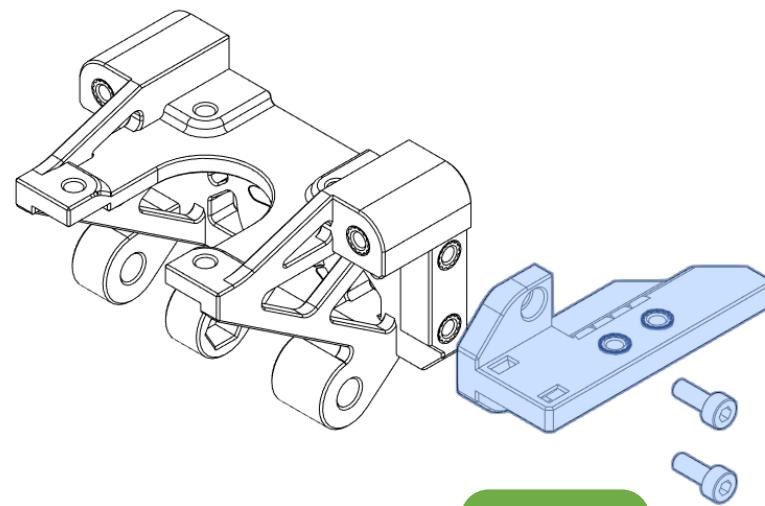
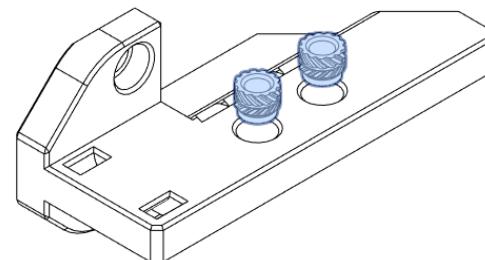
## IDLER BLOCK



## SELECTOR MOTOR SUPPORT

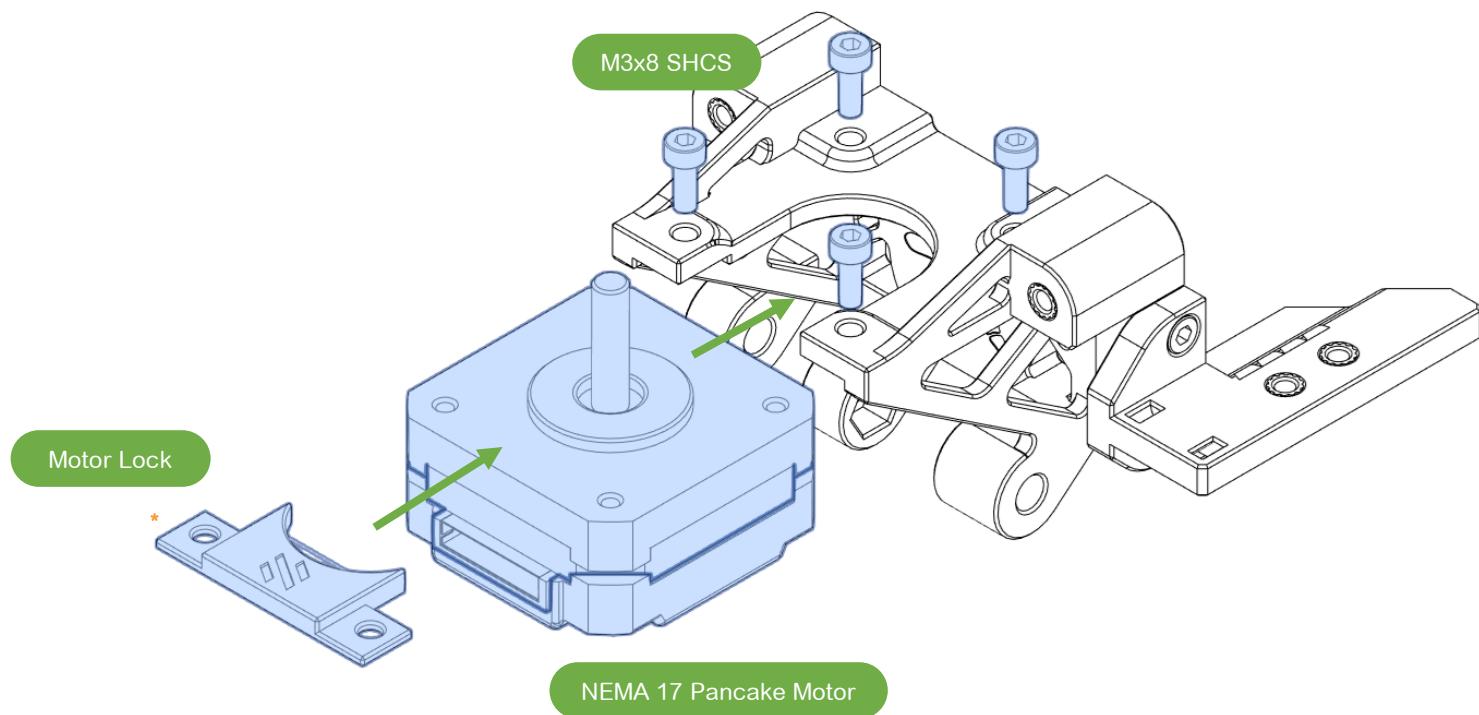


M3 Heat Set Inserts

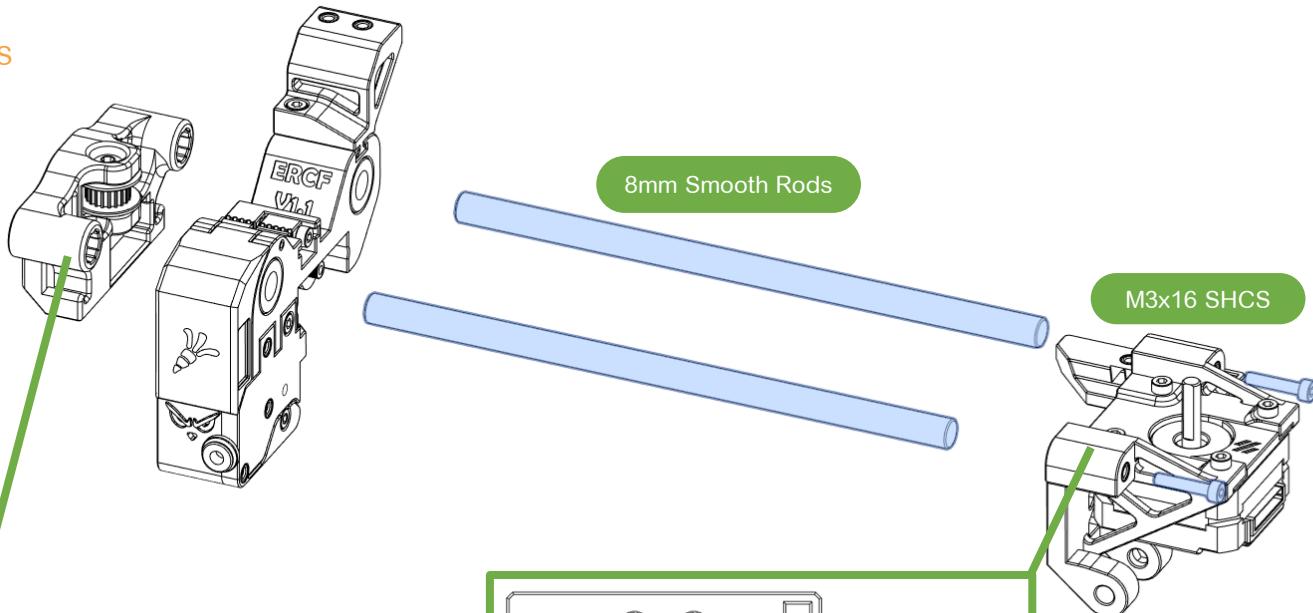


M3x8 SHCS

## SELECTOR MOTOR SUPPORT

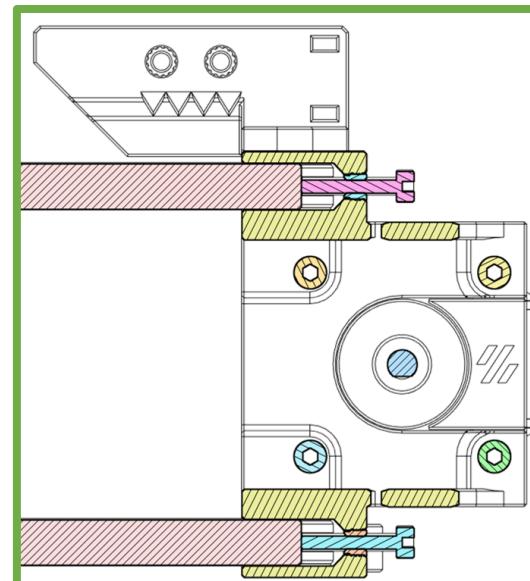
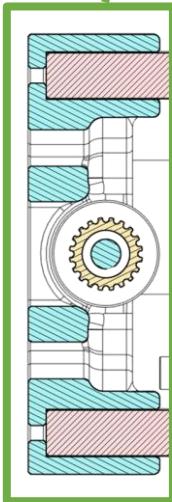


## LINEAR AXIS



### IDLER SIDE

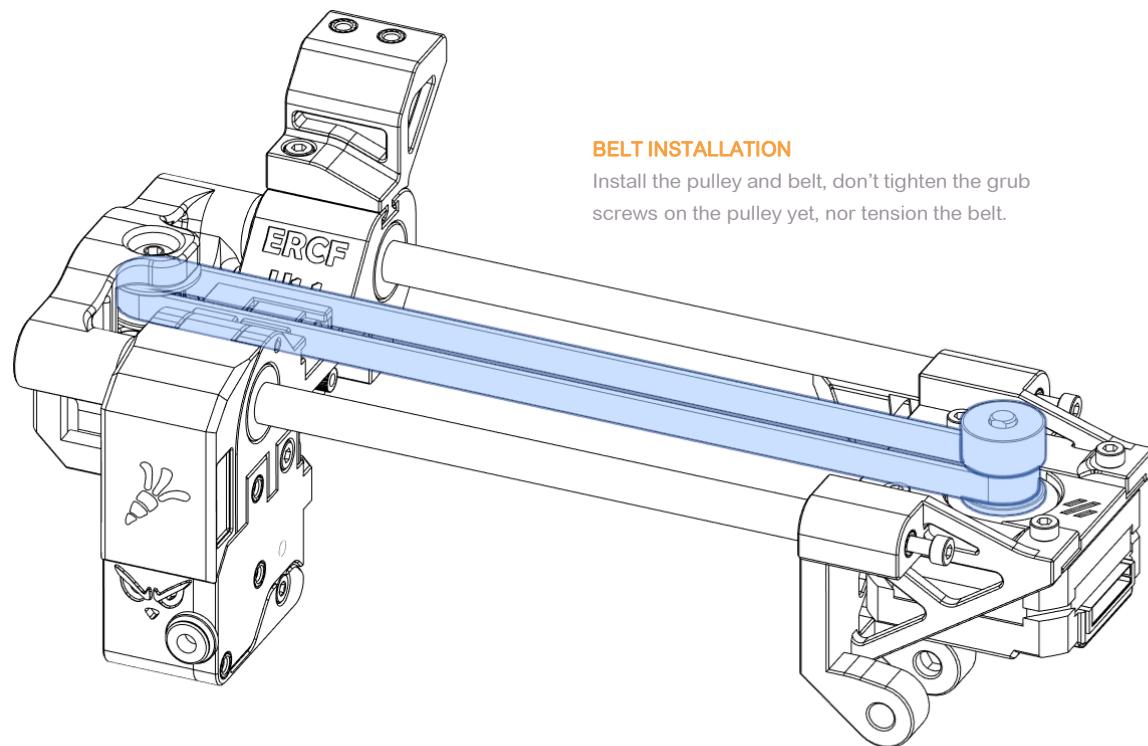
Insert fully the 8mm Smooth Rods on the idler side. There are holes allowing you to check the rods are well in place.



### 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



### BELT INSTALLATION

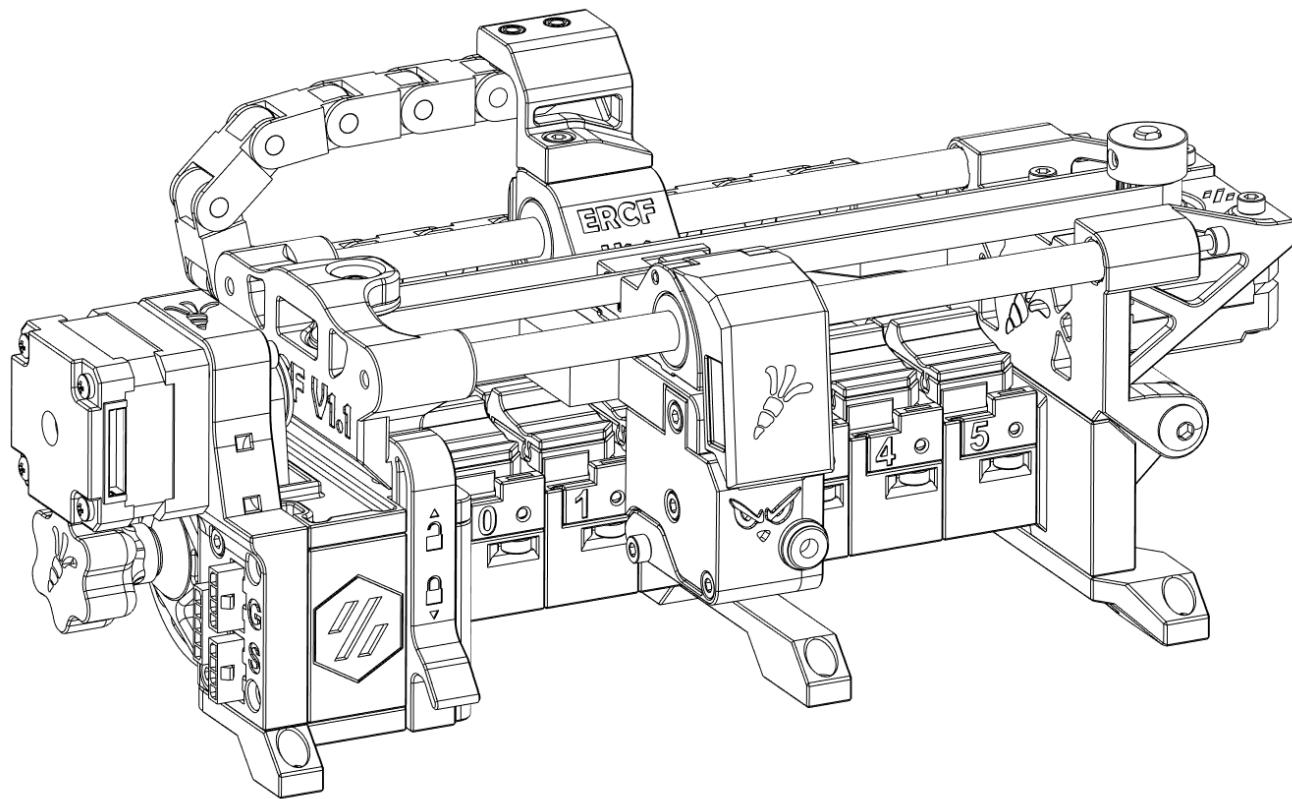
Install the pulley and belt, don't tighten the grub screws on the pulley yet, nor tension the belt.

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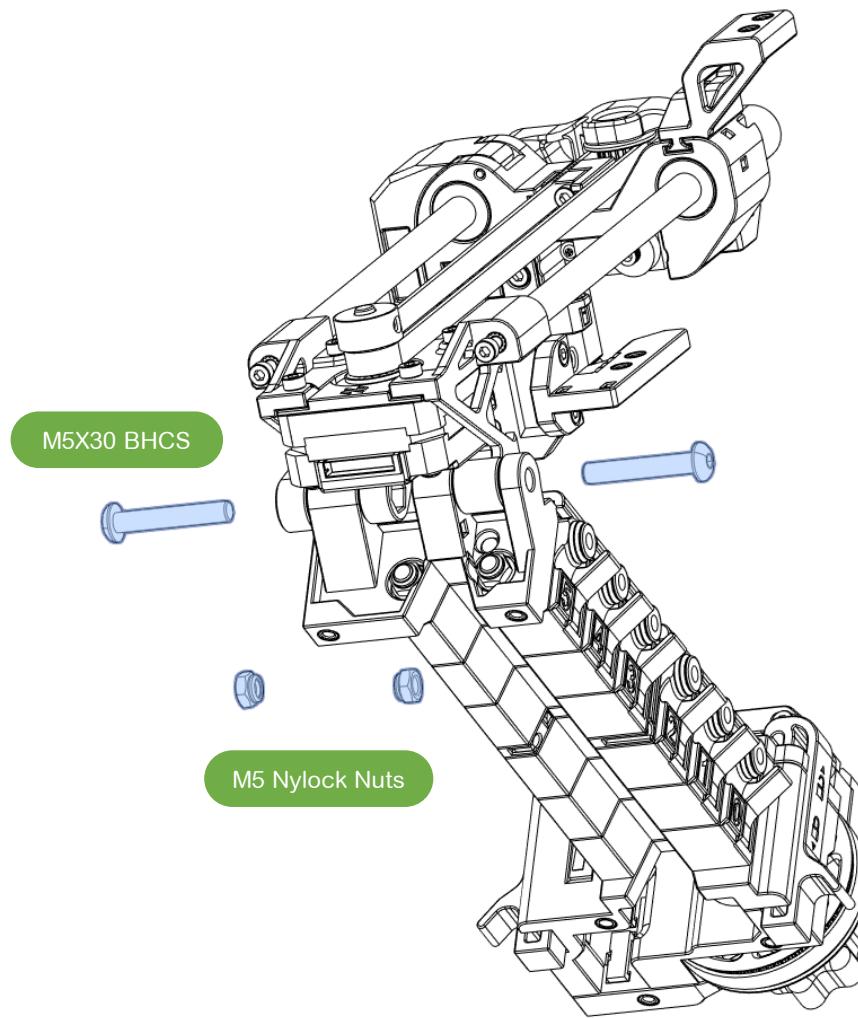
## FINAL ASSEMBLY



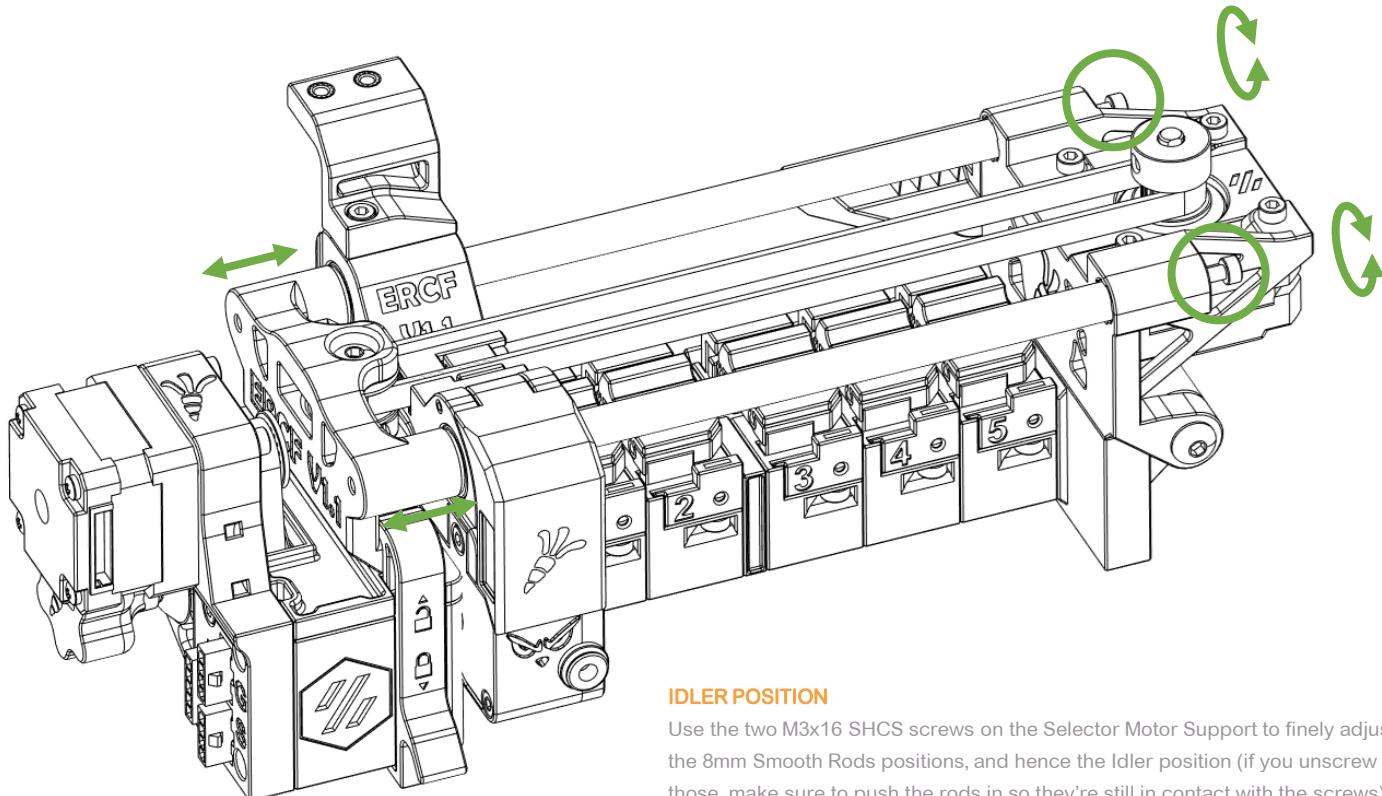
## OVERVIEW



## 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).

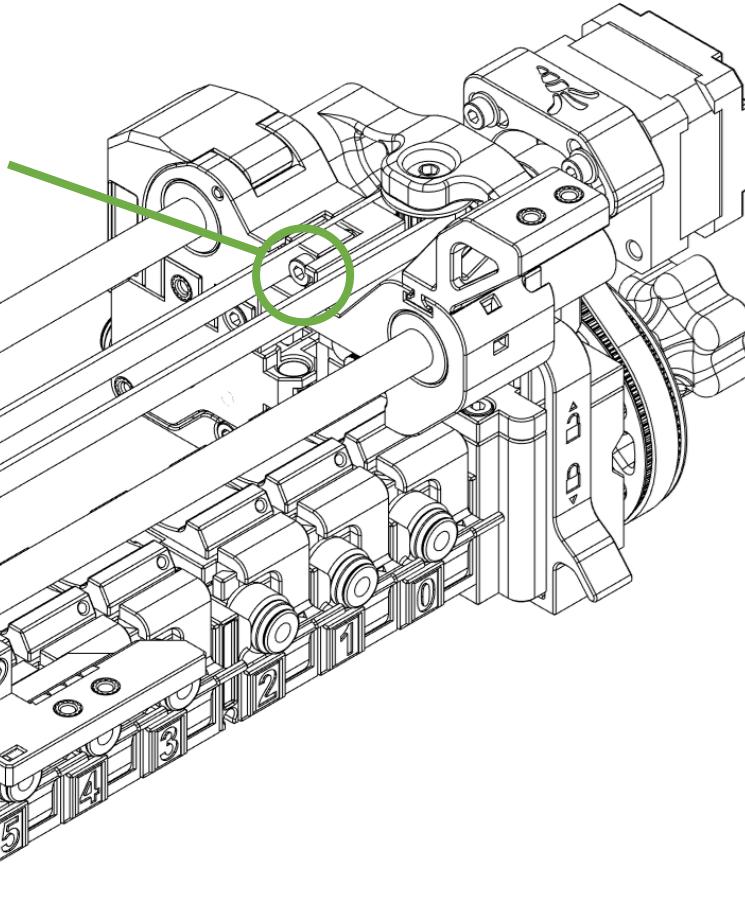
Make sure the 3 small slots on the Idler match the Gear Box Top Panel bumps.

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.



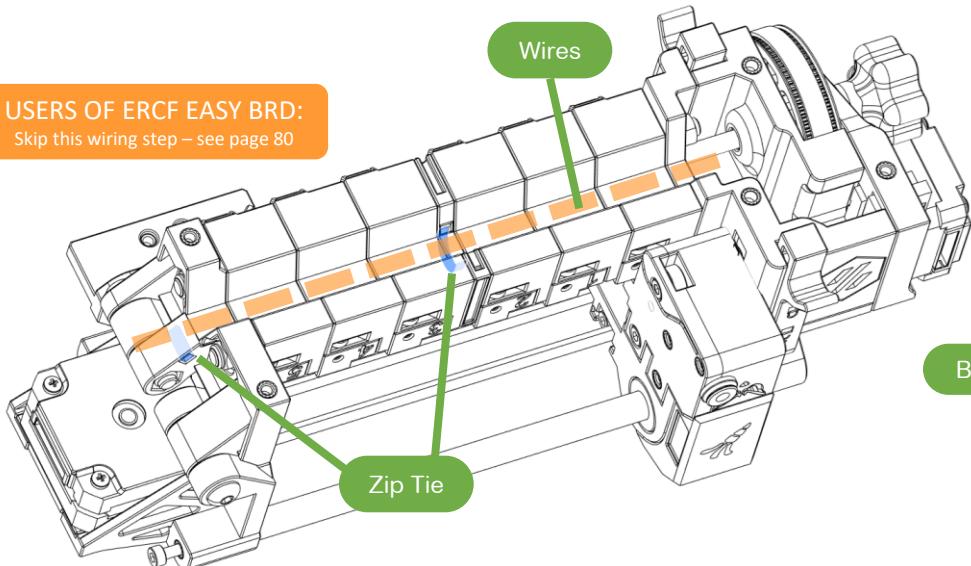
### GRUB SCREWS

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

## WIRE MANAGEMENT & FEET

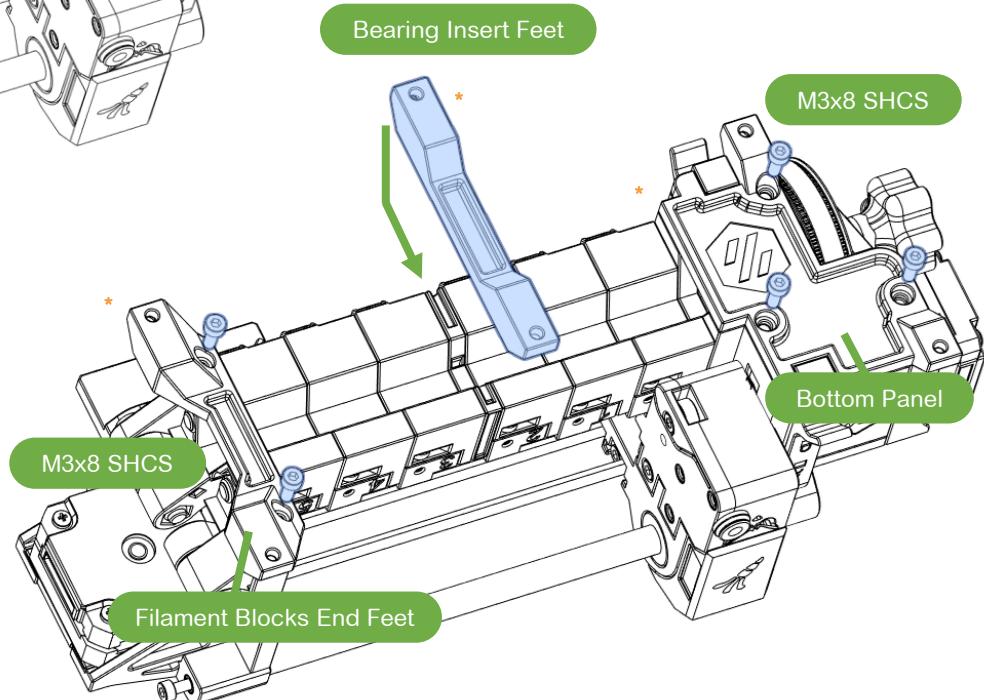
### USERS OF ERCF EASY BRD:

Skip this wiring step – see page 80



### 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.



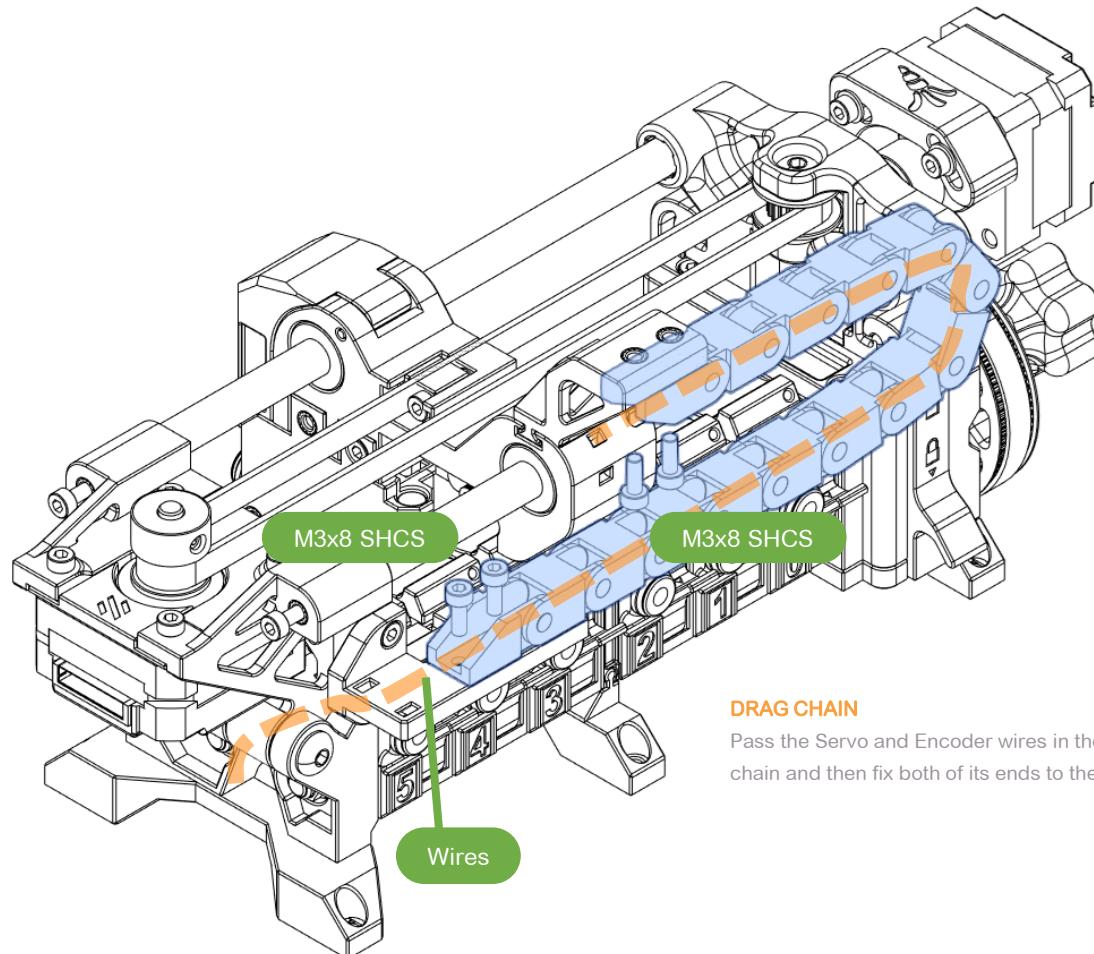
### ERCF FEET

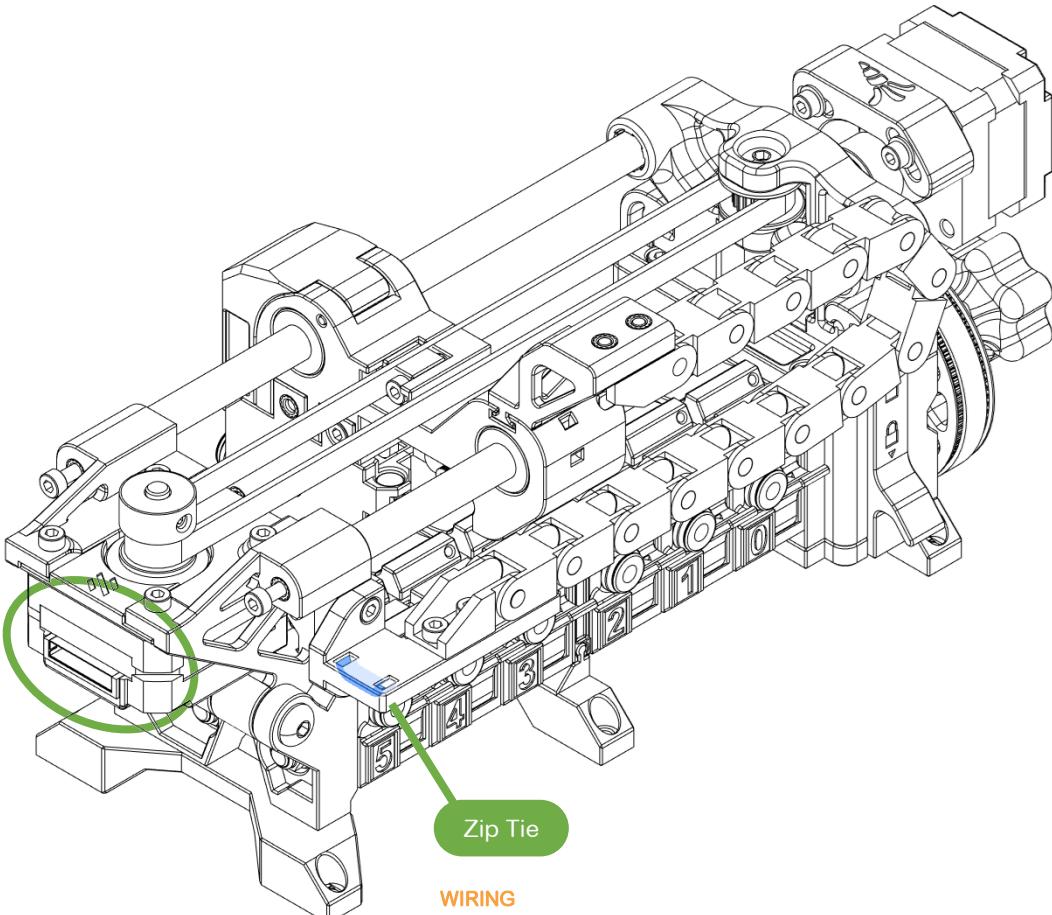
Install the Gear Box Bottom Panel and the other ERCF Feet.

The feet for the Bearing Inserts have built-in supports.

Remove them before sliding the feet in the Bearing Inserts.

## DRAG CHAIN



**SELECTOR MOTOR**

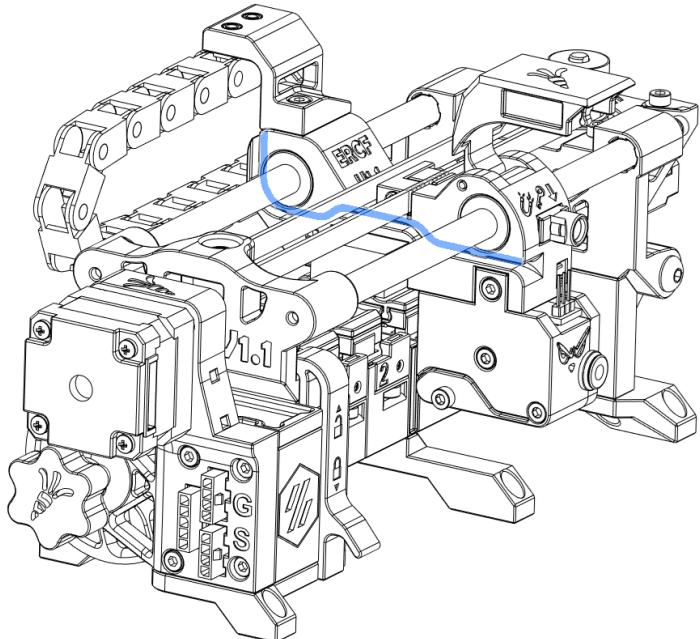
You can now do the crimps and connect the selector motor.

Zip Tie

**WIRING**

Secure the drag chain wires using a zip tie.

## FULL ERCF

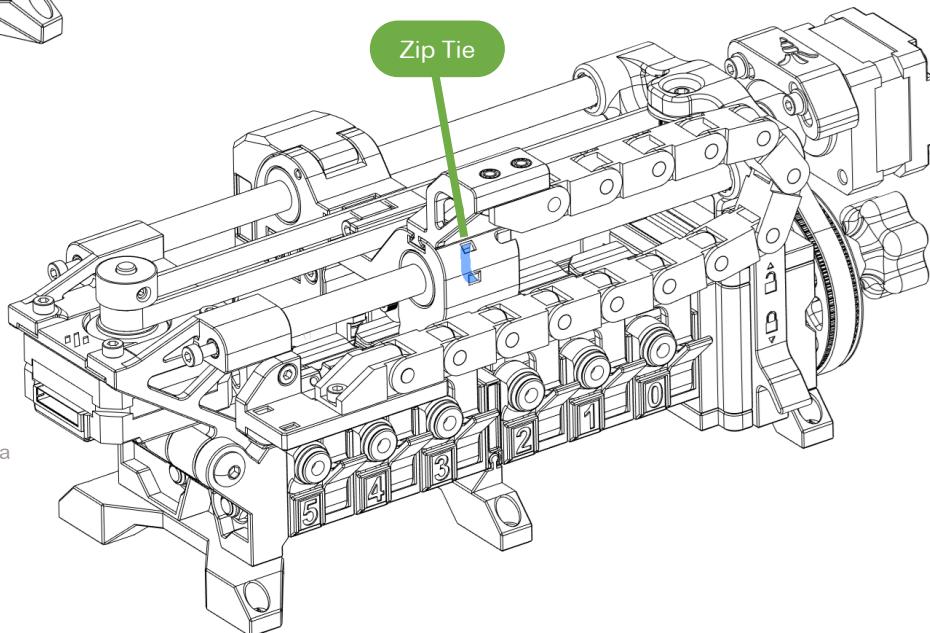


### ENCODER WIRES

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.

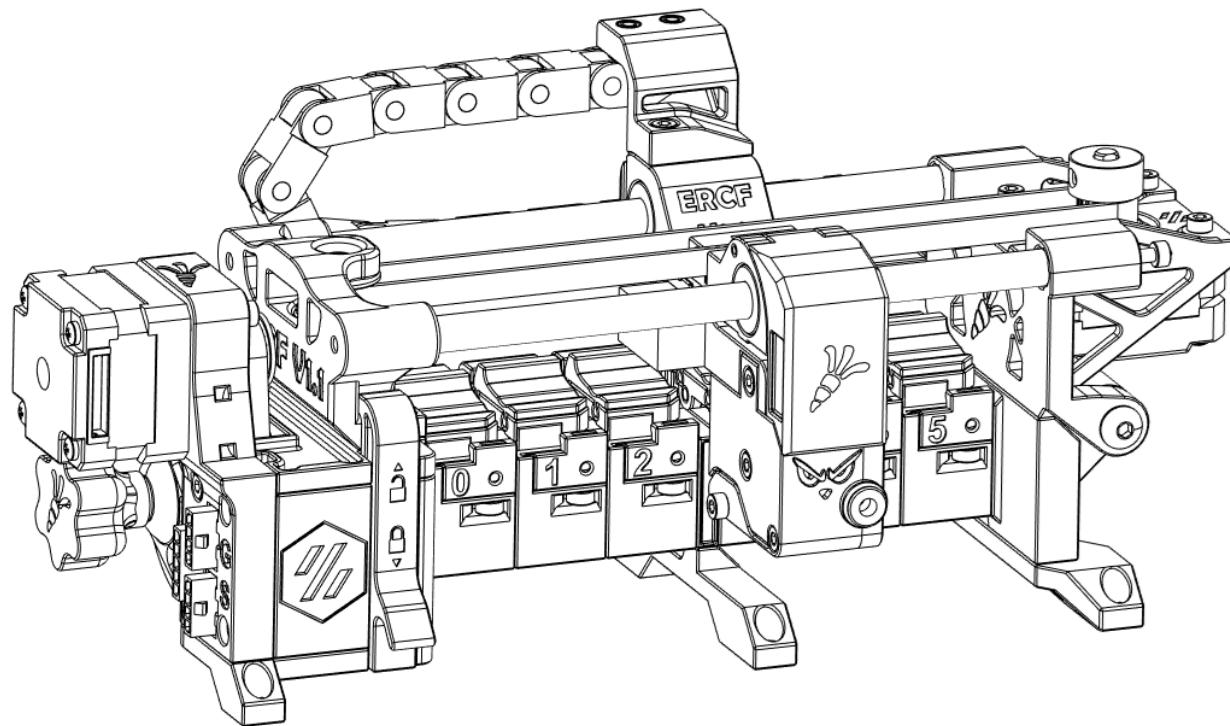


### SERVO WIRES

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

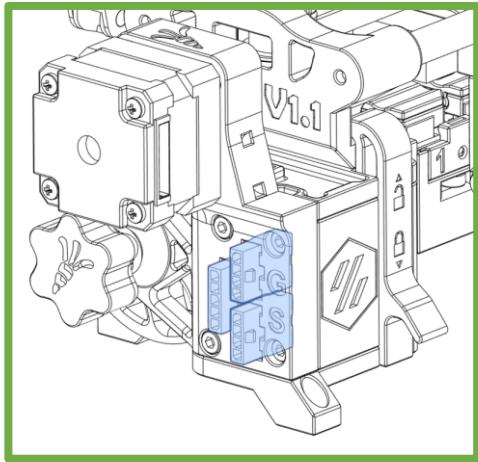


#### NEXT STEPS

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!

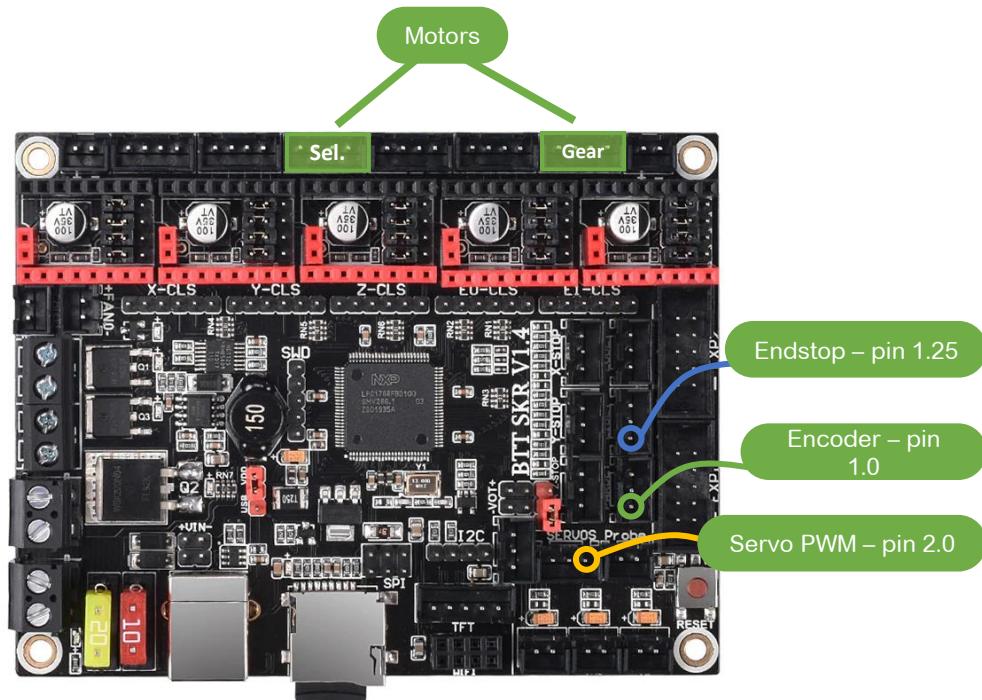
## CONNECTING THE ERCF : NO CUSTOM CONTROLLER BOARD (i.e. PRINTER MAIN BOARD(S))



### 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).



Example for an SKR 1.4 board.

### 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.

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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.

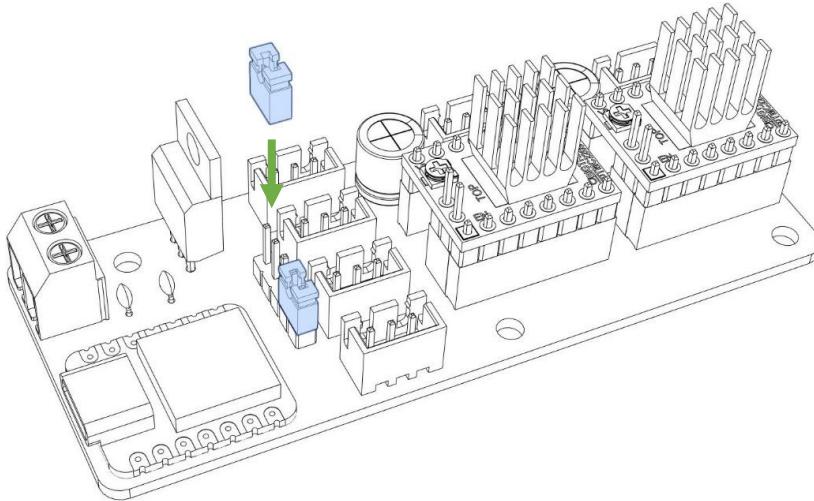
By using this custom board, you can skip all steps of the ERCF manual that relate to wiring connectors and motors.

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 known in the 3D printing community, which has absolutely nothing to do with this board.*

## ERCF EASY BRD : JUMPERS AND STEPPER DRIVERS



### STEPPER DRIVERS

Install two TMC2209 with heatsinks. Only TMC2209 are compatible.

Be careful about the orientation.

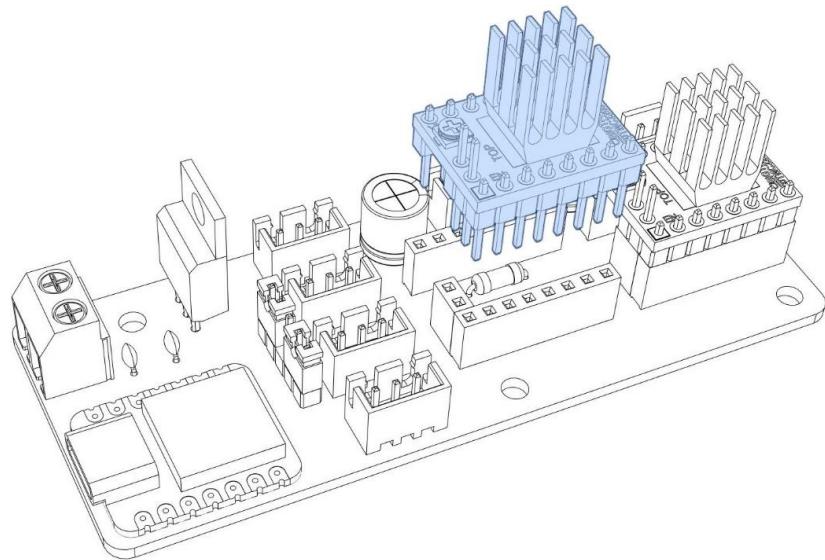
### JUMPERS

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

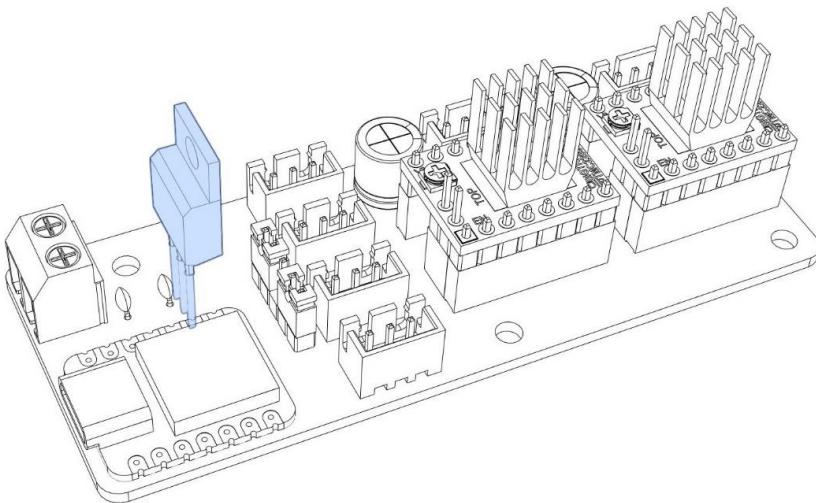
**[1 2] 3 [4 5]** : The extra connector is wired to PA7 and the endstop to PB9. Sensorless homing is not used. This is the most common configuration.

**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.



## ERCF EASY BRD : VOLTAGE REGULATOR

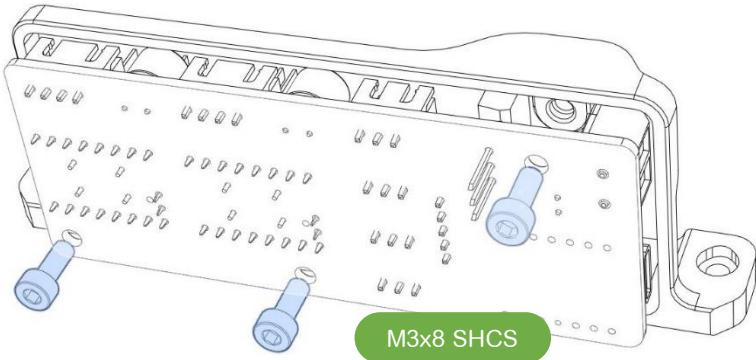


### VOLTAGE REGULATOR

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

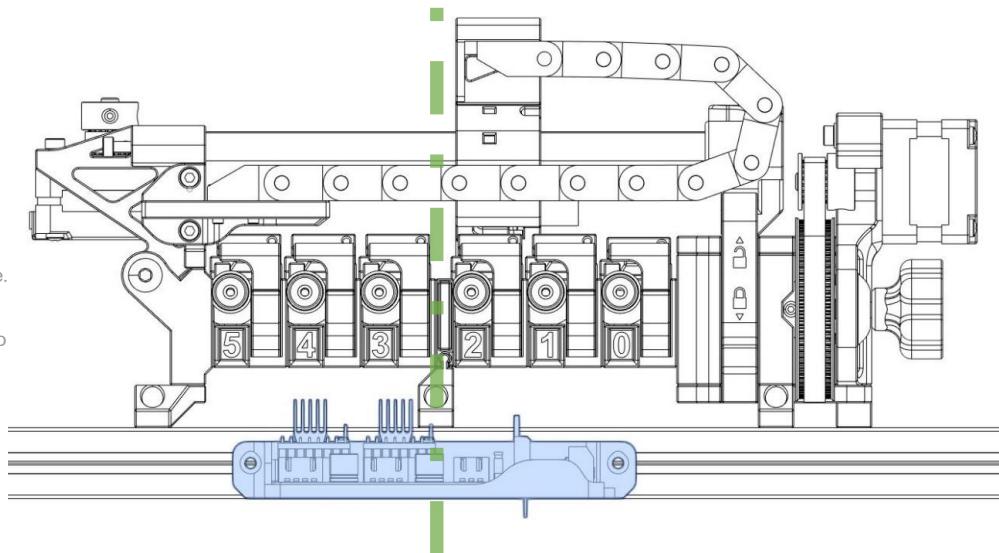
Remove the three built-in supports.

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

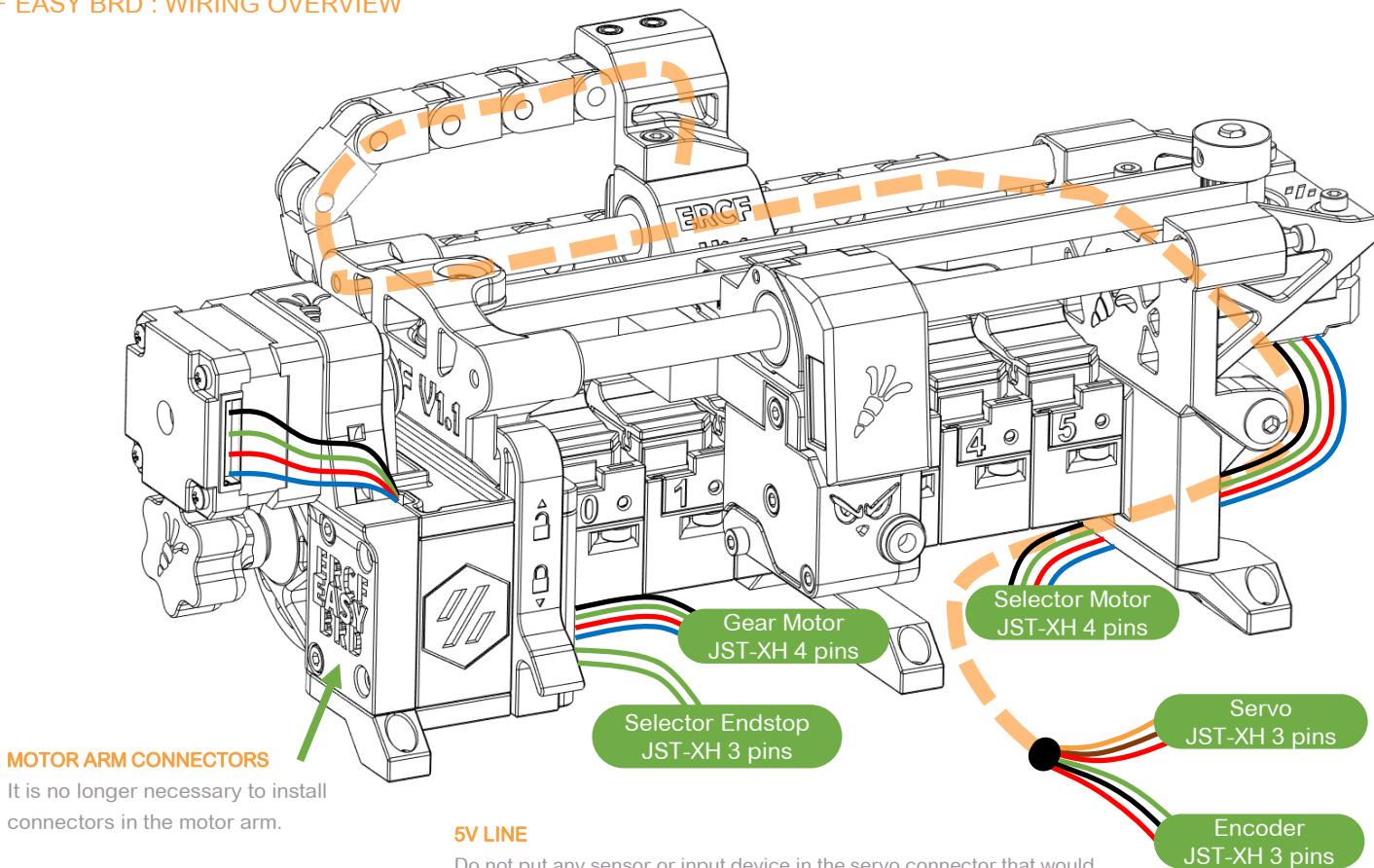
### POSITIONNING

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



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.

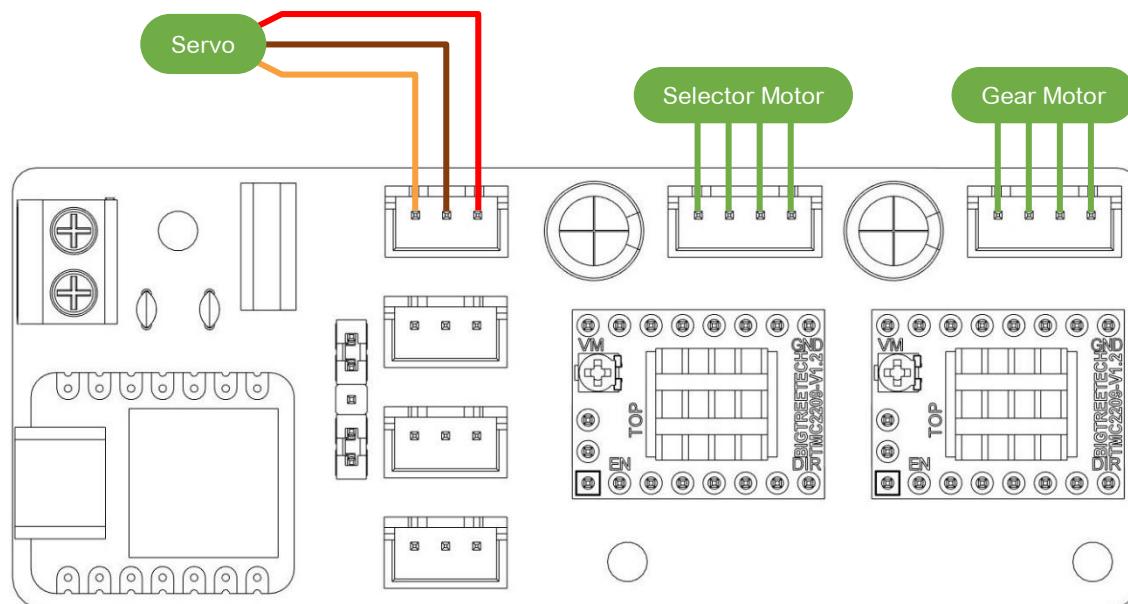
Do not merge together the servo red wire and the encoder red wire!

## ERCF EASY BRD : ACTUATORS WIRING

### 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.

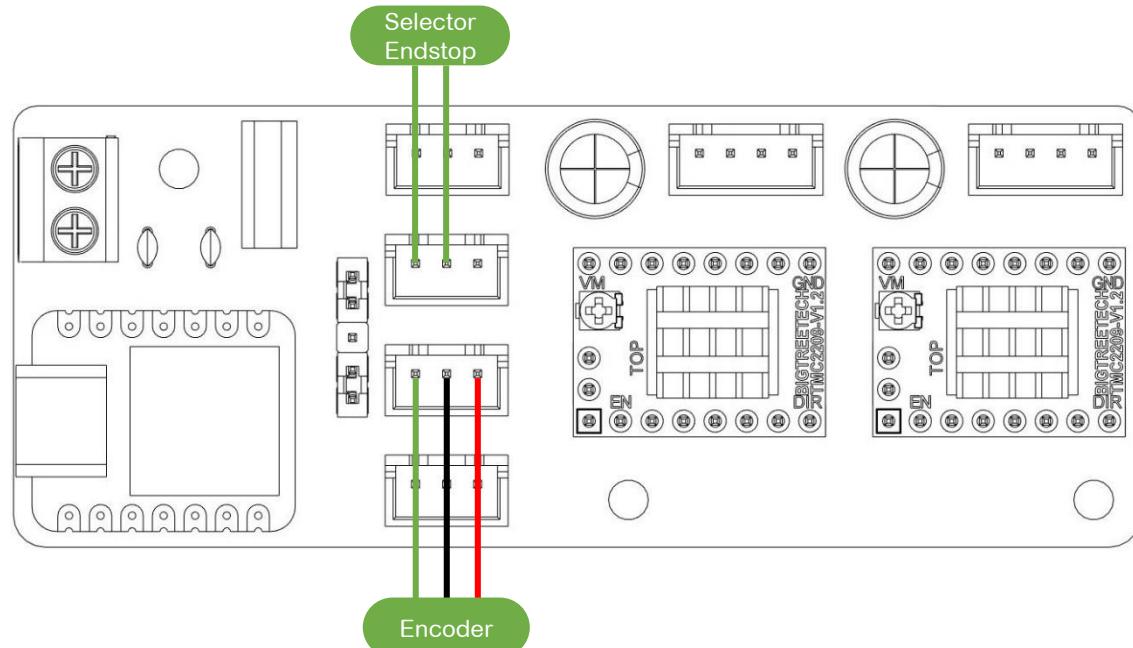
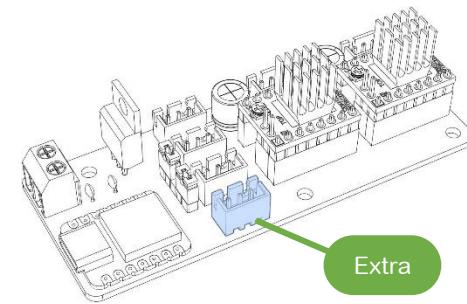
The servo connector is the only one that is powered by +5V.



## 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.



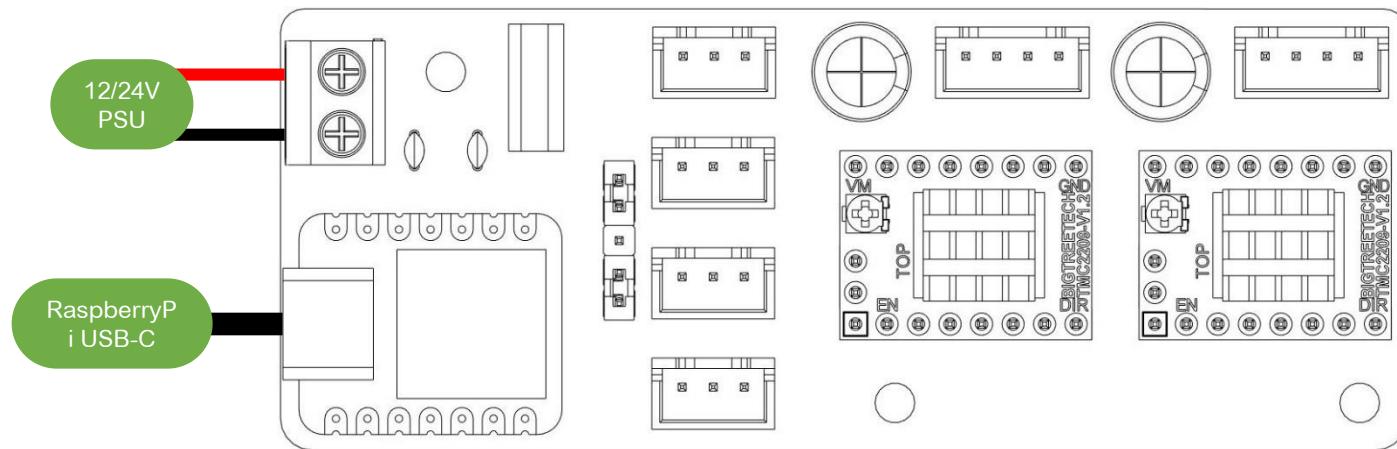
## ERCF EASY BRD : GENERAL WIRING

### 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

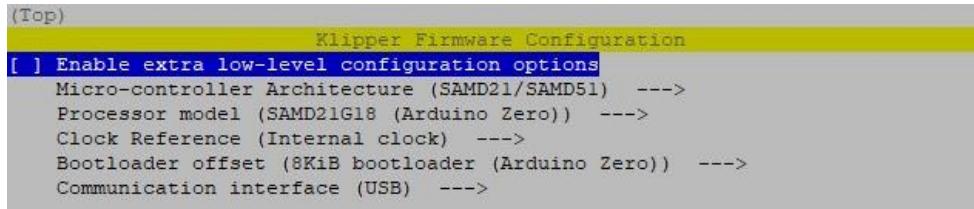
Run the following to install the lastest version of bossac (version  $\geq 1.8$  is required) :

```
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 :



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

Run the command "make".

## ERCF EASY BRD : MICROCONTROLLER

### 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 :

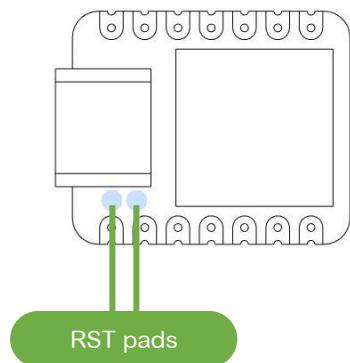
```
sudo /usr/local/bin/bossac -i -d -p /dev/ttyACM1 -e -w -v -R --offset=0x2000 out/klipper.bin
```

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>



## ERCF ON KLIPPER

### 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.

### MAX EXTRUDE DISTANCE

To allow proper operation of the ERCF, we need to increase the max\_extrude\_only\_distance parameter of your extruder section to 200.0

In the extruder.cfg

```
[extruder]
max_extrude_only_distance: 200
```

## ERCF ON KLIPPER

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 specify 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 subtract 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
```

## ERCF ON KLIPPER

### 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

```
[duplicate_pin_override]
pins: P1.0
# Just 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 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.

## FIRST CHECKS

### ENDSTOP AND MOTORS

Use those GCodes to test that :

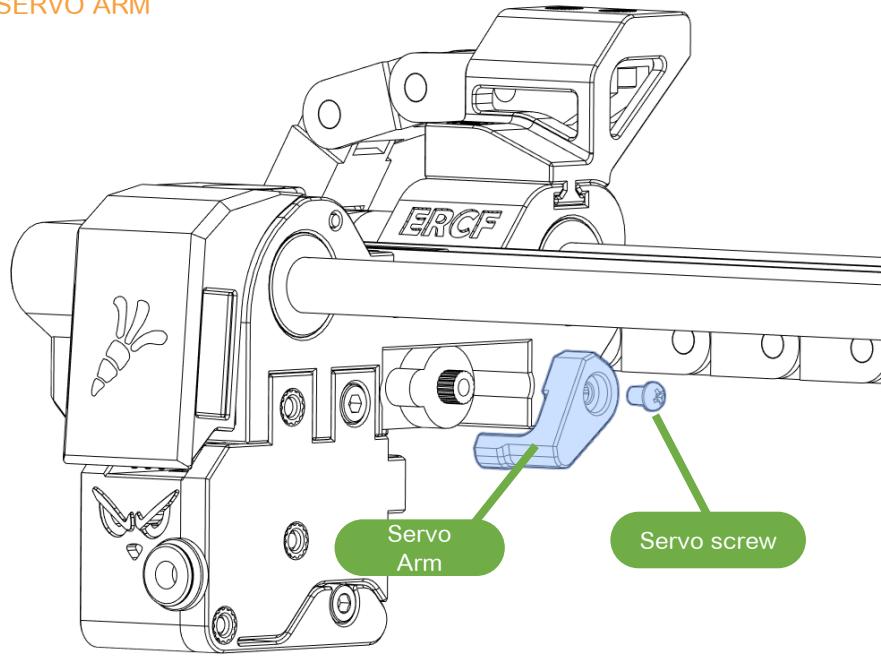
- The endstop works as expected : TRIGGERED when you click it, open otherwise
- Both motors turn. Beware that those GCodes induce slow, almost silent moves

**GCode : QUERY\_ENDSTOPS**

**GCode : STEPPER\_BUZZ STEPPER="manual\_stepper gear\_stepper"**

**GCode : STEPPER\_BUZZ STEPPER="manual\_stepper selector\_stepper"**

## SERVO ARM



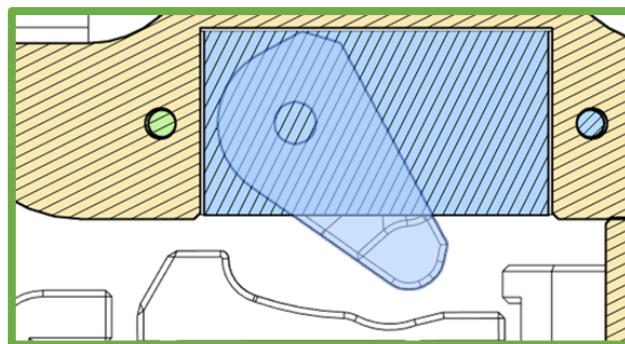
## SERVO ARM

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

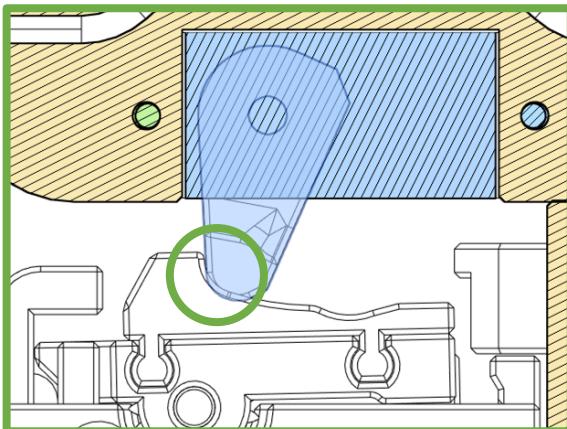
Use **GCode : ERCF\_TEST\_SERVO VALUE=« ANGLE »**

With « ANGLE » being the angle you want to test to finely tune the up and down positions of the servo.

In order not to damage over time the servo arm, it is very important that :

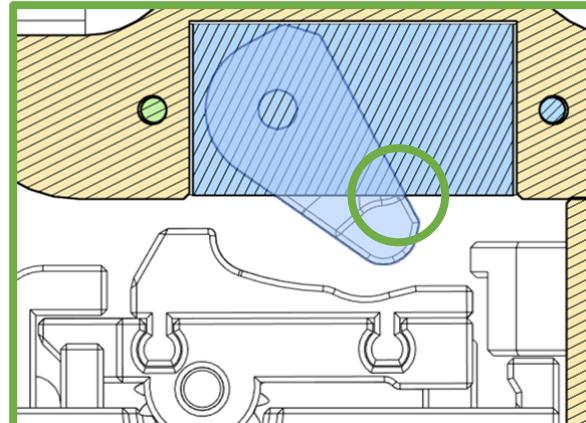
- For the down position, don't make the servo arm push further than the TopHatLocker wall. You want the servo arm to stop right at this wall, or even very slightly before.
- For the up position, don't make the servo arm collide with the servo body. You want the servo arm to stop right at the servo, or even slightly before.

Servo down position, pressing on the gears



**GCode : ERCF\_SERVO\_DOWN**

Servo up position, releasing the gears

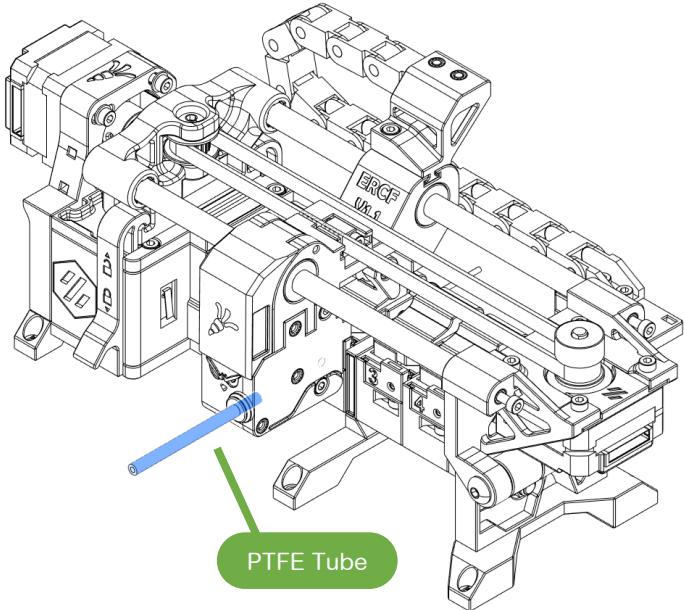


**GCode : ERCF\_SERVO\_UP**

### RELOAD

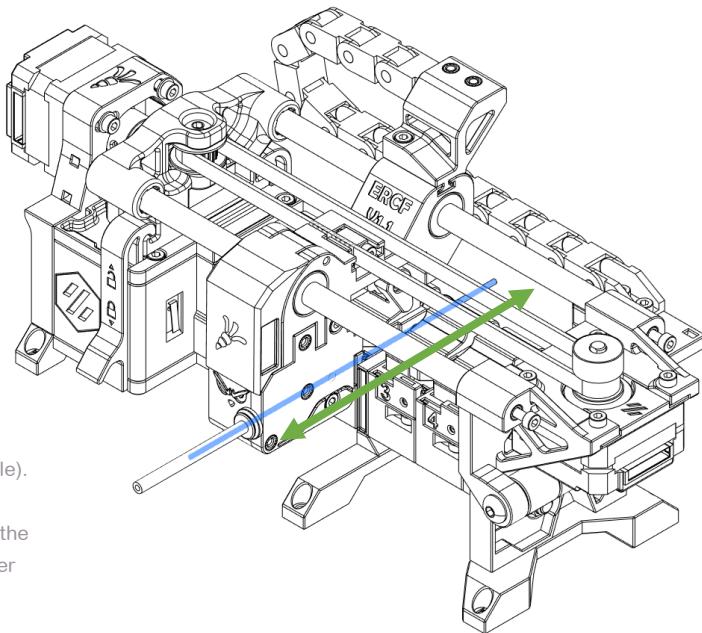
Don't forget to set the final values in the ercf\_software.cfg and reload your firmware so that all changes are accounted for.

## 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

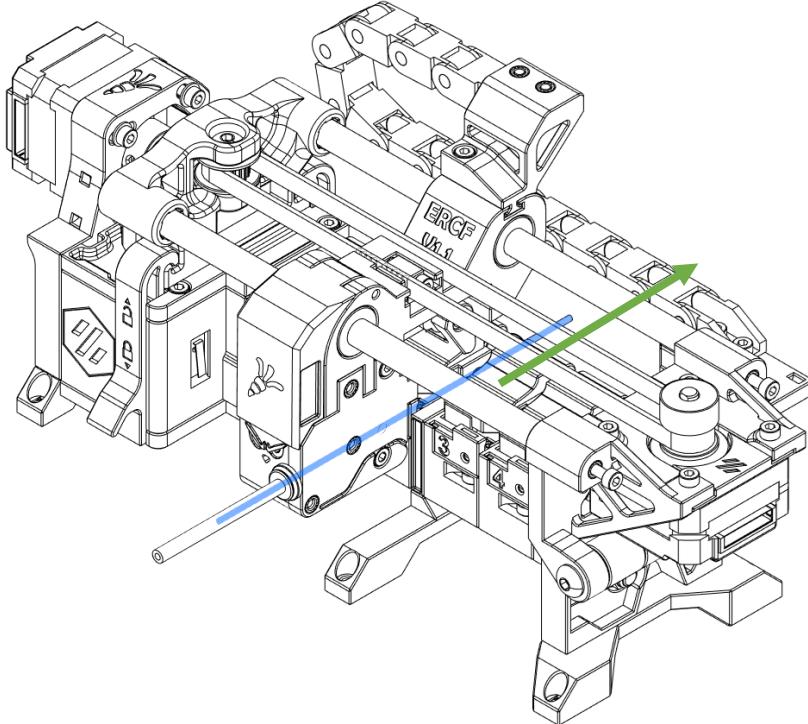
Use **GCode : ERCF\_MOTORS\_OFF**

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]
```

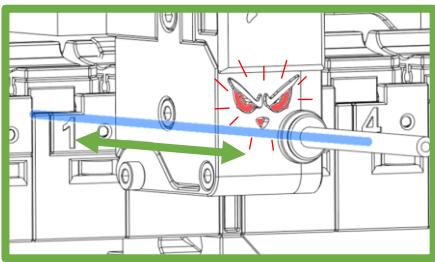
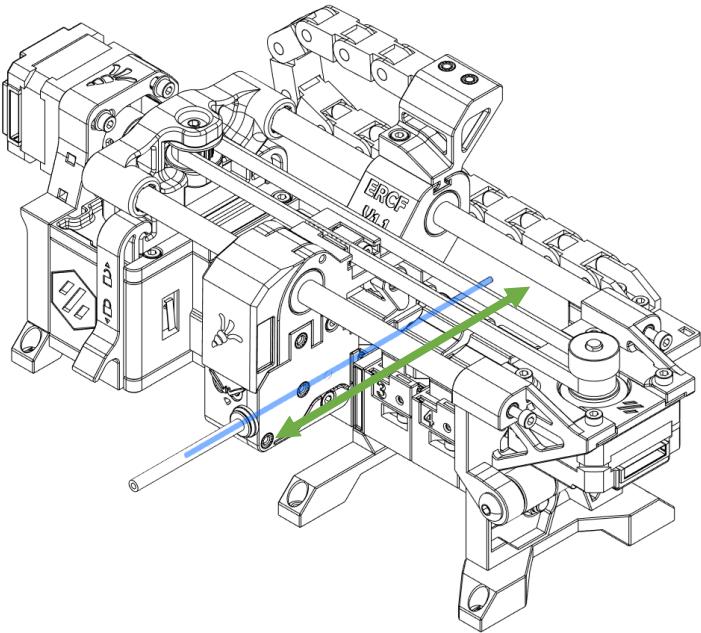
Tool 0

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.

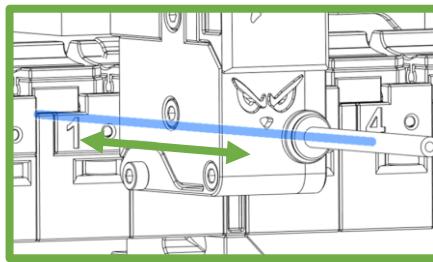
While you move the filament, the encoder LED should blink, making the eyes of the rabbit red.

Make sure that :

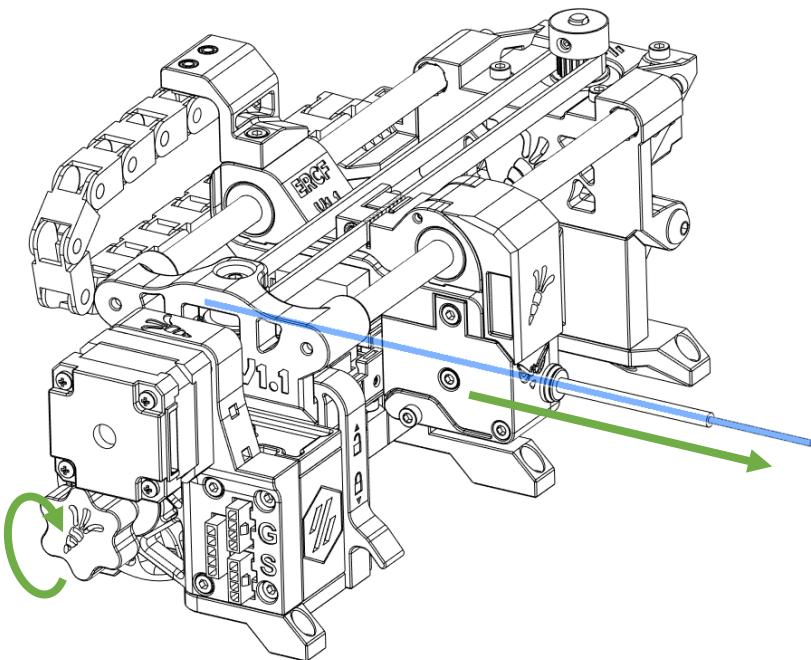
- The LED state stays the same when the filament doesn't move (either ON or OFF)
- When you move slowly the filament, the LED will turn ON and OFF, as a function of the filament position.

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

In case of issue, make sure that the BMG gear can rotate properly, and that the TCRT5000 sensor is properly connected.



## TOP HAT LOCKERS



### 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 repeat this process until you have a proper grip for all tools.

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

### 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)

**GCode : ERCF\_TEST\_GRIP**

Use

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

**GCode : ERCF\_SERVO\_UP**

Use

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

## 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 know 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 :

$$\text{New step distance} = \text{Old step distance} \times \text{measurement [mm]} / 200$$

Update the value in the ercf\_hwconfig.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.

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

Example of an encoder calibration routine

```
// Load direction: mean=727.60 stdev=0.89 min=726 max=728 range=2
// Unload direction: mean=731.40 stdev=0.55 min=731 max=732 range=1
// Before calibration measured length = 492.412500
// Resulting resolution for the encoder < 1.370802
// After calibration measured length = 500.000000
```

Encoder resolution

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.

### EJECT AND RELOAD

Use

**GCode : ERCF\_EJECT**

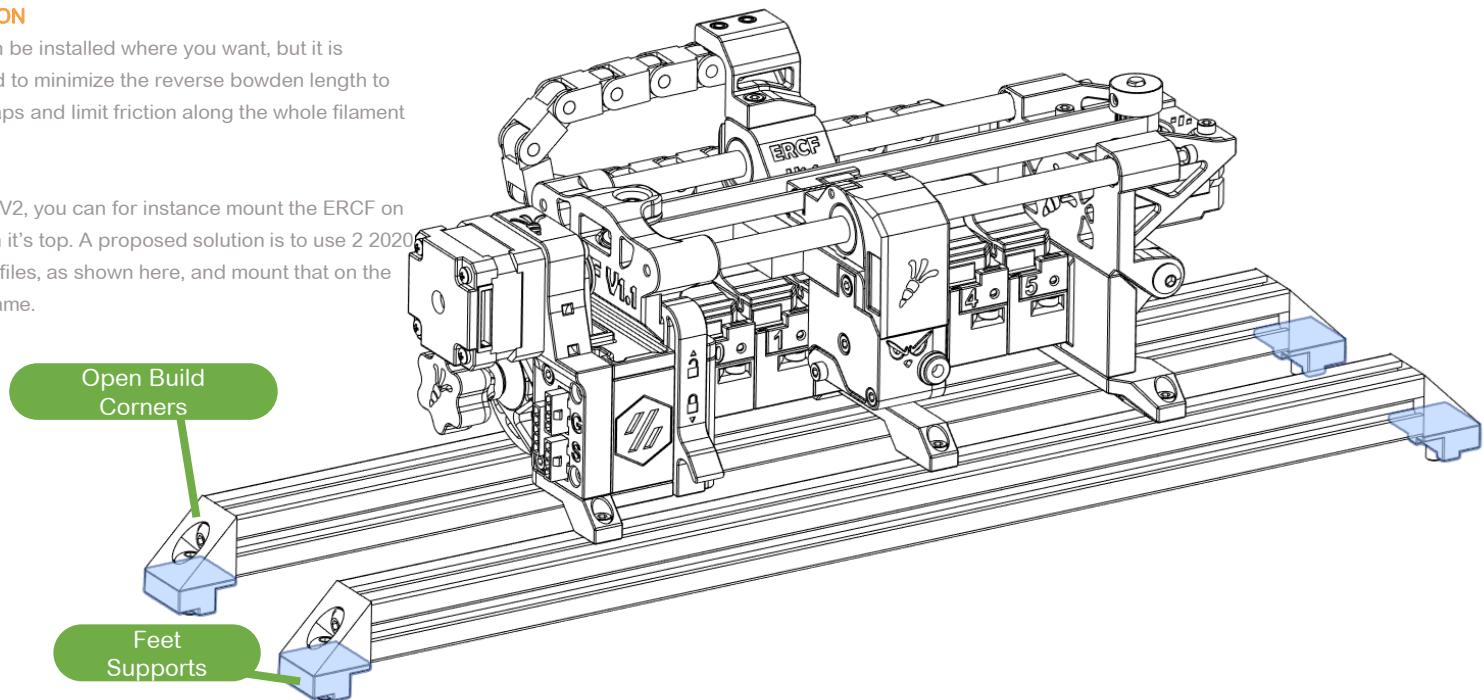
and then reload your firmware so that all changes are accounted for.

## ERCF INSTALLATION ON THE PRINTER

### 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.

On a VORON V2, you can for instance mount the ERCF on its back or on its top. A proposed solution is to use 2 2020 Aluminum profiles, as shown here, and mount that on the existing V2 frame.



### 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.

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

## 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
- 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!

## 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)

### 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](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\_hw.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\_hw.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\_sw.cfg

Note that you should adapt your Print\_Start macro to ensure that :

- The filament sensor is turn OFF at the very beginning 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.

## IMPORTANT NOTES

### GLOBAL INFORMATIONS

This manual is still a work in progress.

Sections like slicer guide, details about all the ERCF Gcode commands and the toolhead sensors will be added in the future.