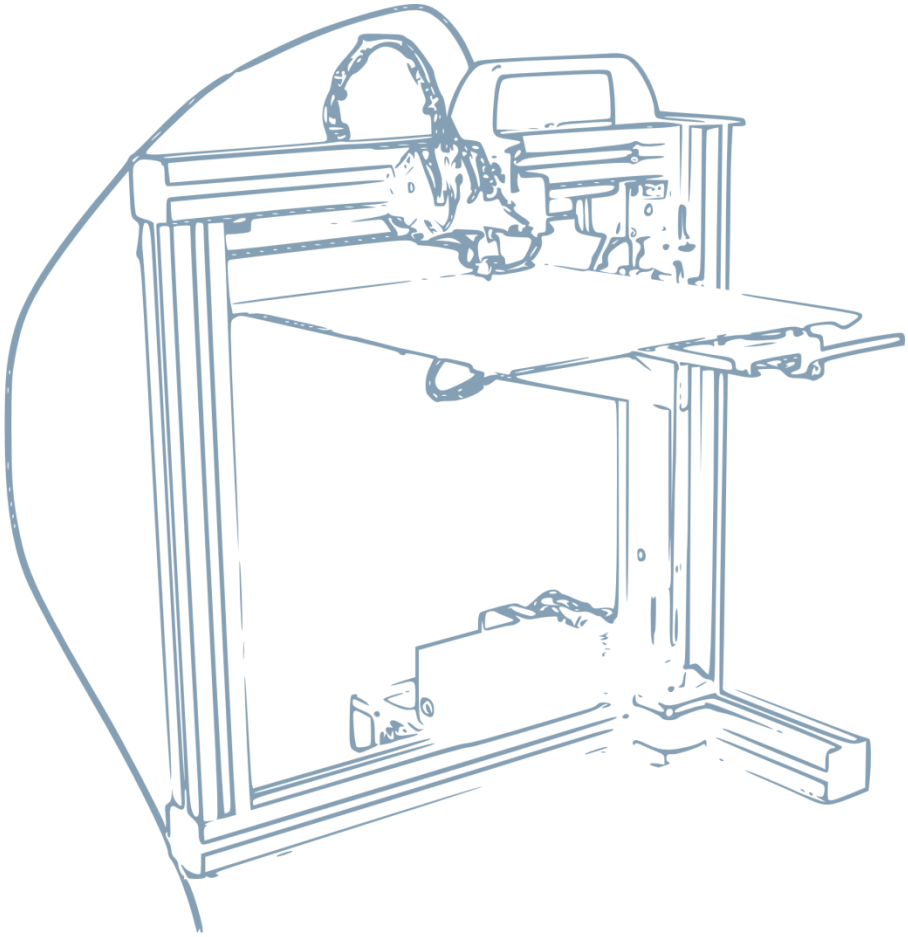
Instruction manual

Felix 1.0 revision D, 3d printer-kit



FelixRobotics

Hoogstraat 421H

5654NE Eindhoven

Netherlands

Table of contents

Contents

1 Introduction

First of all thank you for your purchase of the Felix 1.0 printer. To get your Felix printer up and running as fast and painless as possible please follow this manual. When things are unclear or if you have any remarks or tips, please contact us at info@felixprinters.com.

Depending on your skills this kit will take approximately 6-12 hours to assemble and to make your first print. Please read the manual carefully and follow it step by step. Please don't make any shortcuts unless you know what you're doing. It's better to spend a few minutes extra on reading, than to wait a week for new parts.

The manual is build up as follows: Each module starts with a short introduction. After that a Bill of Materials(BOM) is presented. The BOM doesn't contain the small bolts and nuts, because for the assembly of the printer the assortment box of bolts and nuts is required. Further to not bloat the manual, a picture of each part is only displayed in the complete BOM of the printer. This can be found in the Supplement of the document.

Before starting the build of your printer, it's recommended to check if all parts are present by comparing it with the bill of materials.

2 Required toolset

The following tools are minimally required to assemble and use the Felix printer

- Miniature file set.
- Wrenches 7mm and 13mm.
- Tweezers. (included in kit)
- Nippers.
- Caliper.
- Allen key set. IMPORTANT, the key set needs to have a round head, which makes it able to work under an angle. Also longer keys are recommended.
- Pliers.
- Drill with a variable speed. When plastic parts need to be drilled out, it should be done with care.
- Drills 2mm, 3mm, 4mm, 5mm, 6mm and 8mm.
- Level.
- Hammer
- Soldering iron including flux and soldering tin

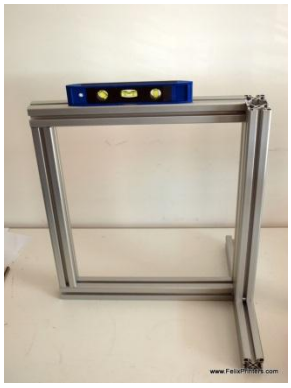
3 Required skills

The following skills are required to put the Felix printer together:

- Basic soldering skills
- Skills to assemble a mechanical construction
- Technical insight
- Common sense

If you lack any of these skills or are unsure please get help from someone who can guide you or do this for you

4 Module 1: Frame (time: 10-30 minutes)



Overview of frame module

Required for this module

Tools

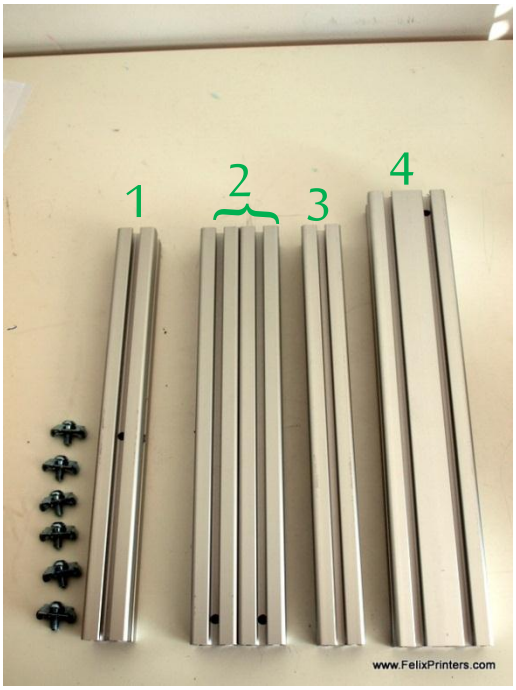
- Allen key set
- Level reference surface
- Level

Parts

- Bag with description 'frame module'.
- Aluminum beams.

The goal of this module is to create the frame on the right. Try to make everything as perpendicular as possible to each other. Let surfaces align as good as possible. A good idea is to use a level tool.

BOM for frame module	
Part	**Amount**
40x40x400 profile, incl 2xM8	1
40x40x400 profile, incl 1xM8, 1xD7	2
40x40x400 profile, incl 3xD7	1
80x40x440 incl work	1
40x40 protective caps	4
80x40 protective caps	1
frame connector set	6
handle incl protective cap	1
hex sockethead bolt M6x1	2
t-slot nut - 8 ST M6	2
t-slot nut - 8 ST M4	22
dampning feet	6
strip for putting away cable pieces of 40 cm	2



Collect the parts shown above. Notice the holes in the beams.

To make it understandable, the beams are described as follows:

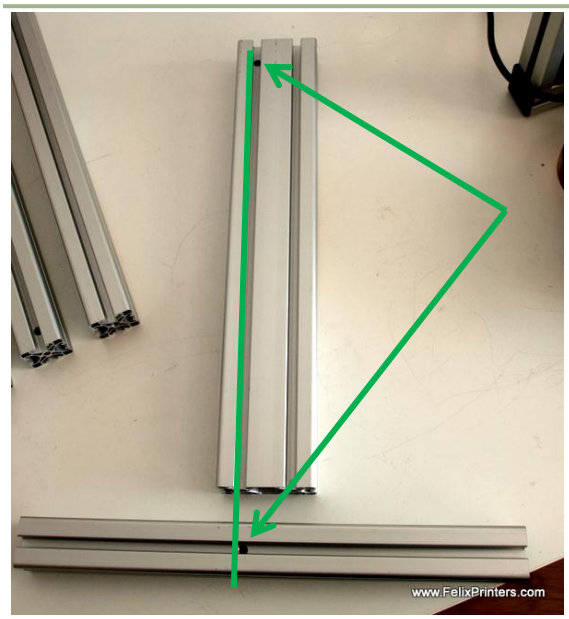
Beam 1: 40x40x400mm beam, has 3 drilled holes

Beam 2: 40x40x400mm beam, has 1 drilled hole and one thread at the far end of the beam

Beam 3: 40x40x400mm beam, has 2 threads at the far ends.

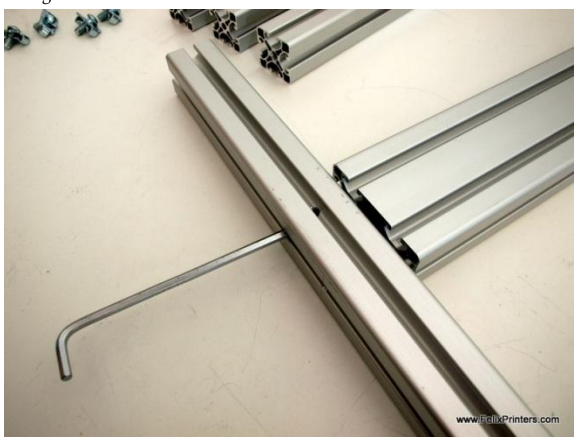
Beam 4: 80x40x440mm beam has one drilled hole and one thread at the bottom.

Some of the beams have a screw thread on the far ends of the beam. These are present for the frame connectors.



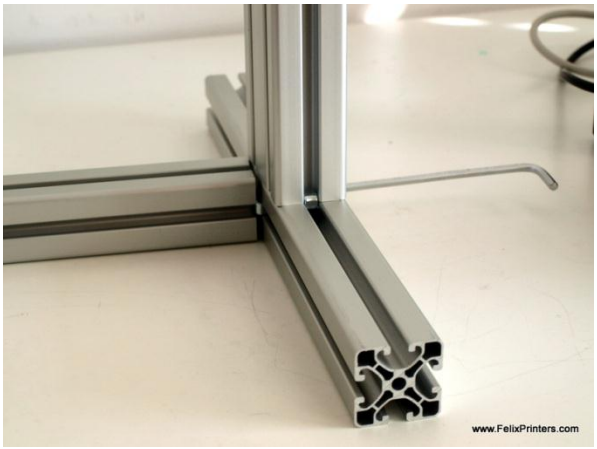
Take beam 4 and 1. They must be connected as oriented in the above picture.

Screw the frame connectors in the bottom of beam 4 as indicated in the figure. Then slide beam 4 onto beam 1.



Slide beam 4 in position. On the side of beam 1 where the hex-key is positioned there are two drilled holes. Tighten the frame connectors by sticking the hex-key through the holes. Do not fixate it too tight because fine-tuning/leveling is needed later on.

Slide one of the two beams number 2 onto beam 1. Watch the orientation of the drilled hole.



Turn the frame and fixate beam 2 onto beam 1. Again not too tight.

Take beam 3. Screw both frame connectors on the far-ends. Slide it onto beam 2 and tighten it.

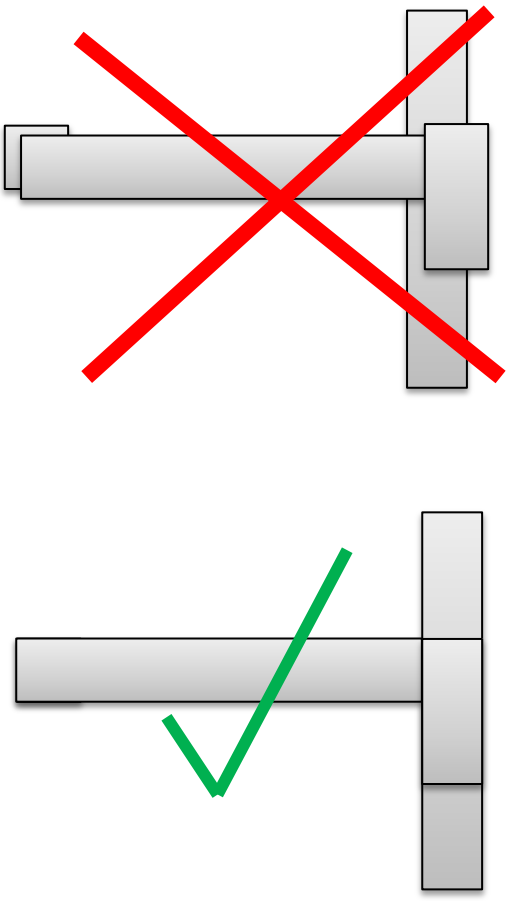
Take beam 2 again and screw the frame connector on it's far end. Then slid it on beam 3 as indicated on the picture.

Next try to slide it also on beam 4.

Thighten the screws, again not too tight.

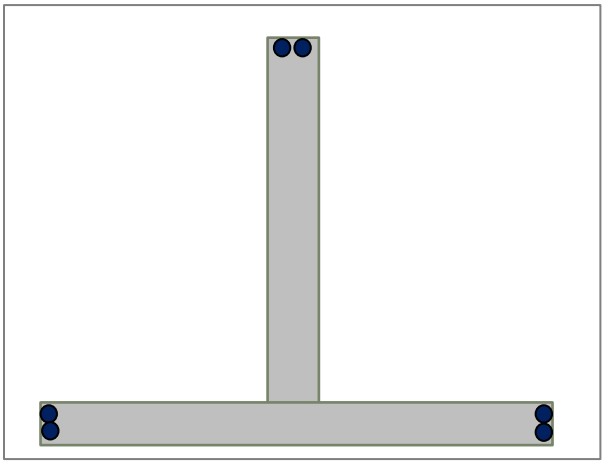
Now it is time for fine-tuning. Try to get every beam as level as possible. Also align the beams as good as possible. See an example in the picture below

Topview of frame



When all the beams are aligned and leveled, it is time to firmly tighten the frame connectors.

Get the protective caps and mount them carefully with a hammer



Put the damping foots underneath the frame near the edge

The handle should be mounted in the final stages of assembly.

5 Module 2: Z-axis (time: 45-90 min.)

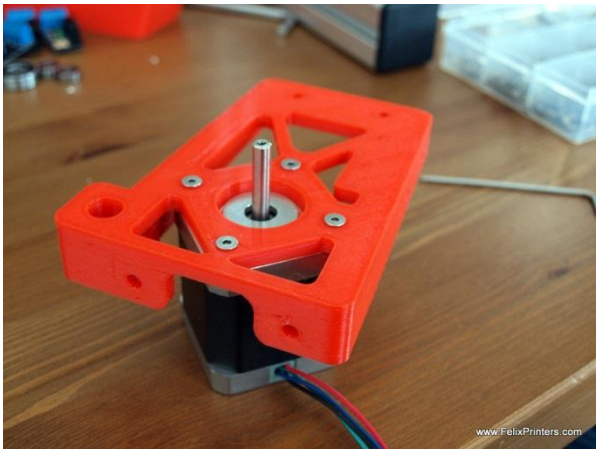
Note: Most holes are designed to minimize the need for any postprocessing, like filing and drilling. Sometimes, however the bolts will not fit and it therefore needs to be drilled out slightly. Required drill sizes can be 3, 4, 5 and 8 mm.

!! Do following steps before starting the rest of the module: !!

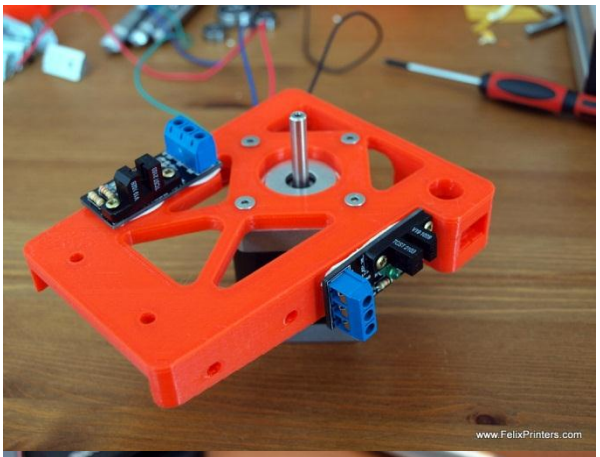
- **File a flat side on the motor for the z-axis motor. This is not required for the y-axis motor.**

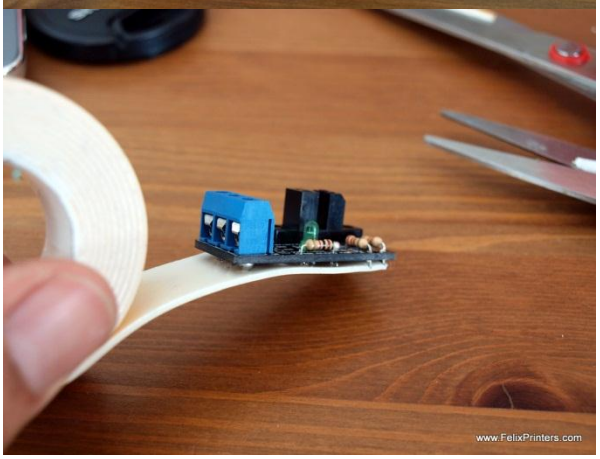
BOM Z-axis	
Part description	**Amount**
Igus GmbH_NS-01-80 - rail	1
Igus GmbH_NW-02-80 - cart	1
z-spindle	1
large bearing	1
motor nema 17	2
z-spindelmount bottom - v2	1
pulley_motor_HTD	1
z_axis_carrier_pt1_v3	1
z_axis_carrier_pt2_v4	1
z-axis-motor-bracket_v8	1
optosensor	2
z-axis-coupling-v10	1
small bearing	2
z-axis-limitswitch_vane_v4	1

Get the parts indicated in the picture above.

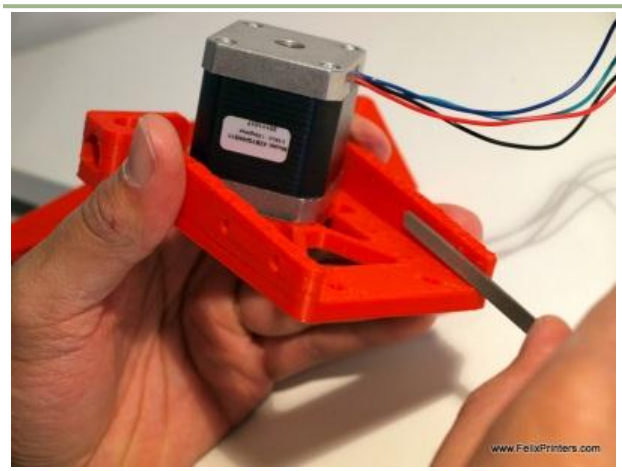


Get the part shown above and mount the motor onto it with the countersunk m3x8 bolts. IMPORTANT: make sure the motor cables are oriented as in the picture.



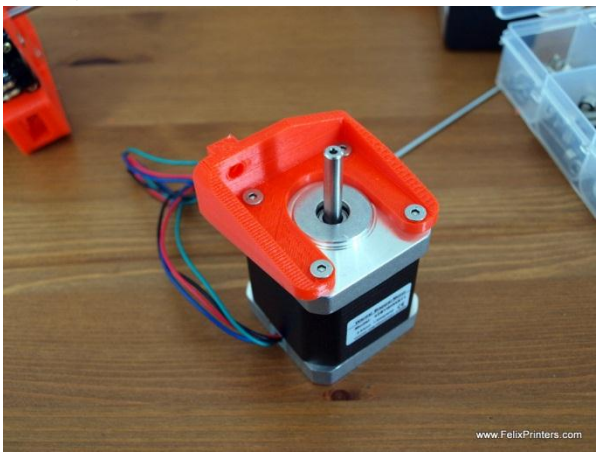


Put the provided double sided tape underneath the opto-sensors and mount them onto the printed part. Mount them with the small bronze screws. NOTE: Don't screw it too tight, because that will deform the opto-sensor.

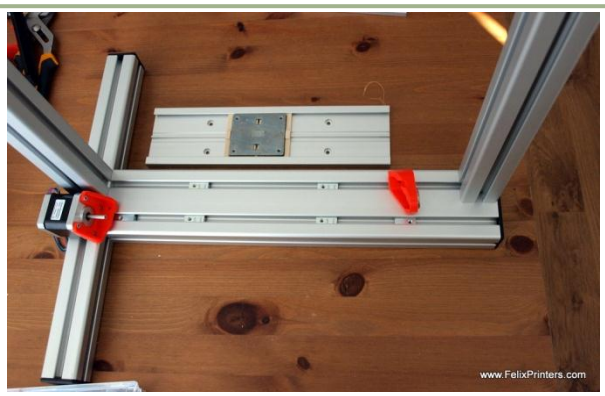


Smoothen the surface a little bit on the inside, with a small file.

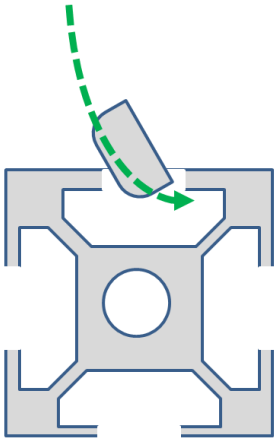
Put the big bearing inside the z-spindle holder. It should be a tight fit and it can be pushed in.



Mount the z-axis motor. IMPORTANT: the cables must be oriented according to the picture.

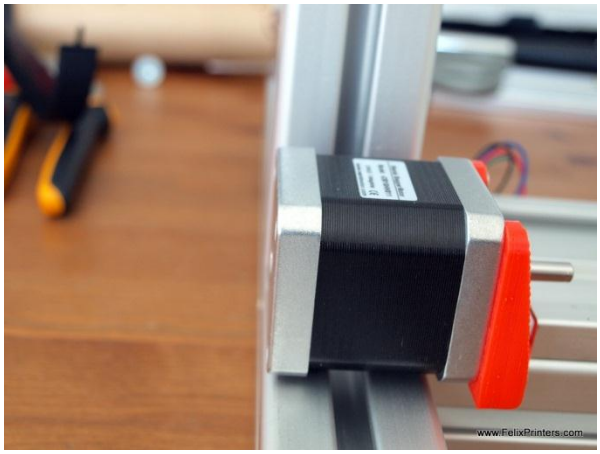


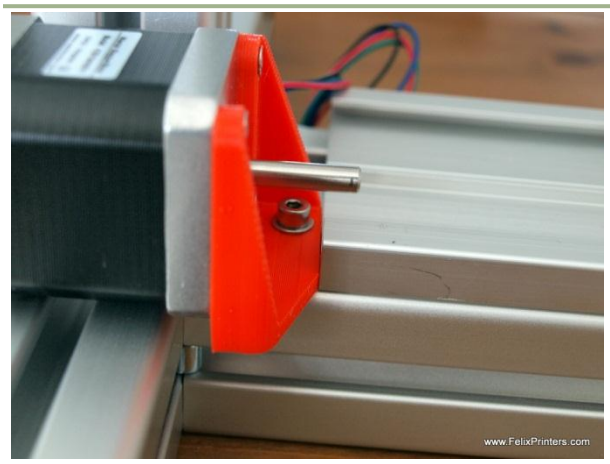
Get the frame and put it on its side as shown in the picture.



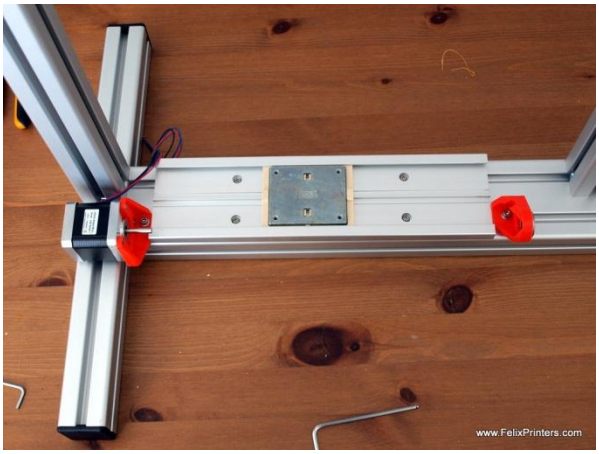
Cross-section of aluminum beam

Insert the t-slot nuts as indicated in the previous picture. Tilt the t-slot nut and push it in the frame approx. at the correct location. So, it is NOT necessary to disassemble the frame, to insert a t-slot nut. Once it is in, you can further position it with a small Allen-key.



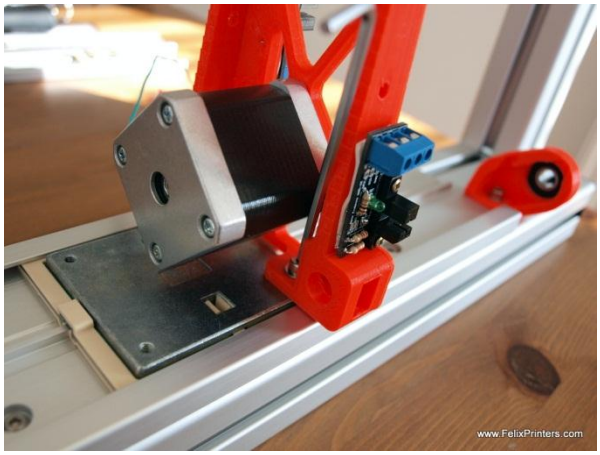


The bottom of the motor should be aligned with the bottom of the frame. Mount the z-motor bracket with a small washer and an M4x12 bolt. Do this correct, because it can save some extra work later on.

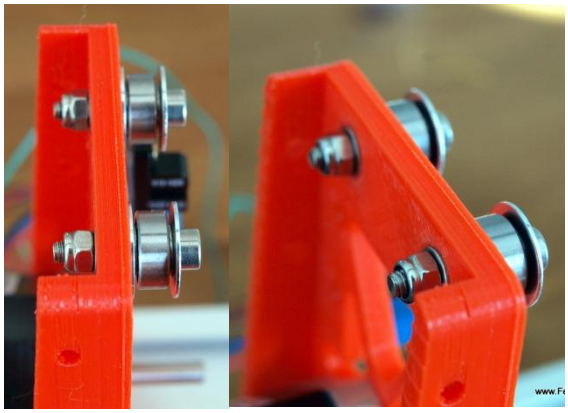


Mount the rail including slide onto the frame with 4 button head m4x12 bolts. Do NOT use washers in this case, otherwise the bolt head will touch the slider. Also important is that the rail should touch the z-motor bracket.

The z-spindle mount should also touch the rail. Use a small washer and an M4x16 bolt



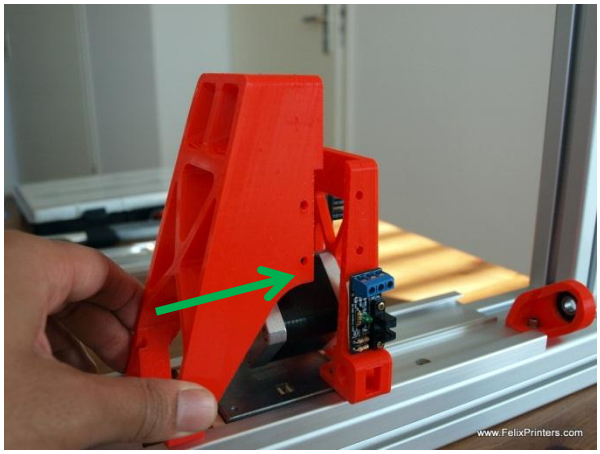
Mount the z-axis part onto the slider with two small washers and m4x12 bolts. Only tighten it loosely.



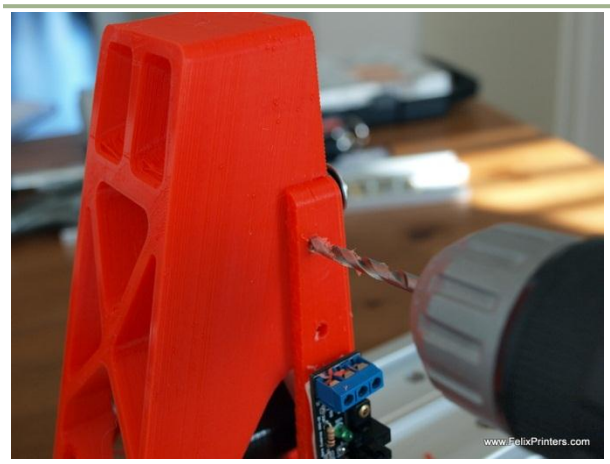
Mount the bearings which guide the *y*-axis tooth-belt. Order of washers and bearings, right to left:

M4x20 bolt, large washer, small washer, bearing, small washer, large washer, plastic part, small washer, self-prevailing M4 nut.

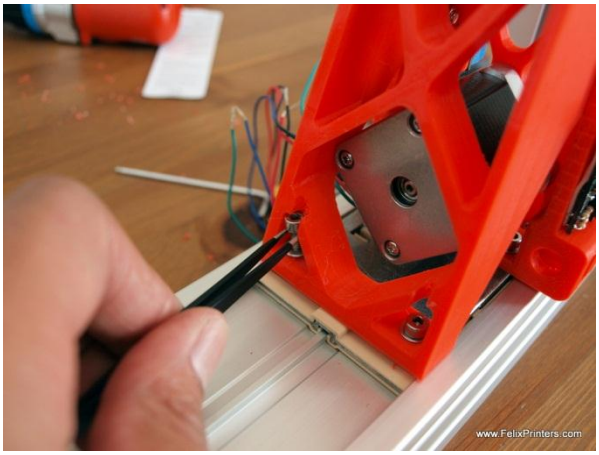
Fixate it tightly, because it is difficult to reach later on.



Slide the big z-axis carrier part onto the smaller z-axis carrier part as indicated in the picture above.

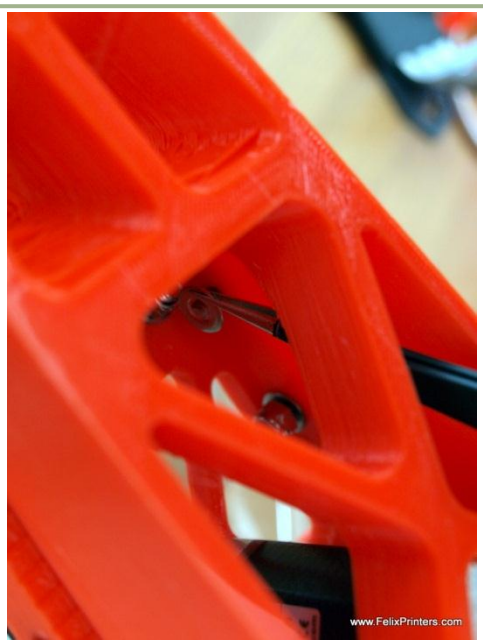


When put in place drill out the holes with a 4mm drill. Just a little material should be removed in order to make a bolt go in there.



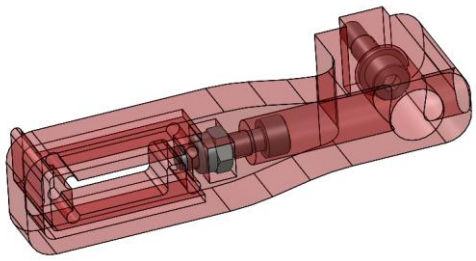
Mount the big part onto the z-axis carrier with small washers and m4x12 bolts. Tip: put the bolts in place with the supplied tweezers.

To further connect the two z-axis carrier parts, turn the frame upside down.

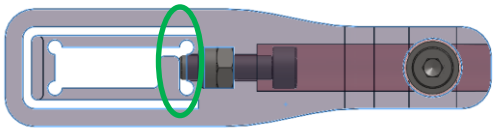


Use 4x M4x16 bolts, on both sides use small washers. Put the washers on the inside of the carrier into place with tweezers.

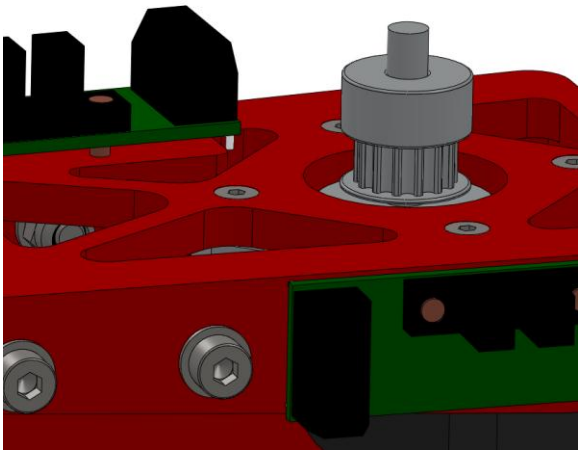
Also do the same with the m4 self-prevailing nuts. When approximately in place, try to keep the nut into place with your finger. Then with the other hand tighten the bolt with an allen key. When the thread of the bolt has catched the nut, then use the 7mm wrench to fixate the nut.



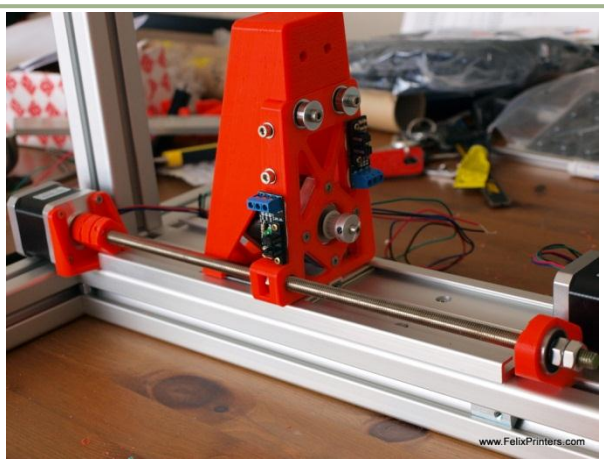
Pre-assemble the z-axis limit switch vane. Use a ring and M4x16 bolt. For attachment to the frame. DO NOT mount it to the frame yet, because it is a delicate part it should be mounted in the final stages of assembly, otherwise the chances of damaging are very high.



Slide in a self-prevailing nut into side. Then mount an M4x16 bolt. Let the tip of the bolt touch the flange as indicated in the picture.



Mount the pulley upside down onto the motor-axis. The distance from the bottom of the pulley to the motor housing, should be approx. 2mm.

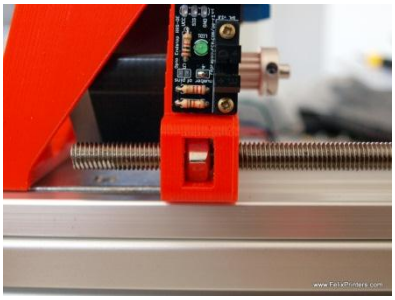


Place the rod with the coupling in place. See below for more instructions.

Do it in the following way:

- 

  File a flat side at one end of the z-axis spindle.

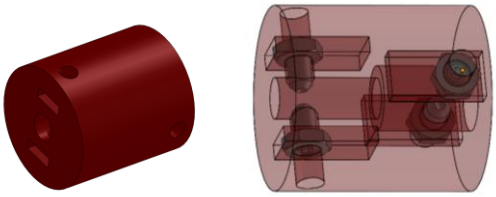
- 

  Slide in the M8 nut into the side of the small z-axis carrier part.

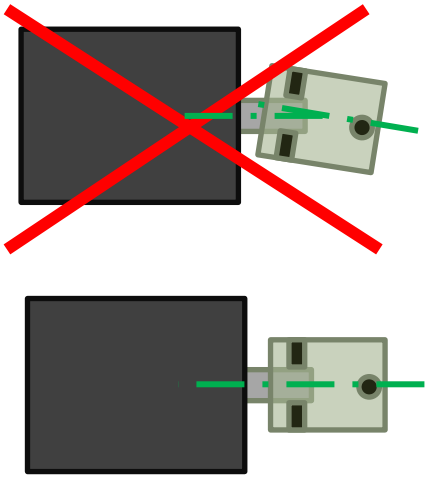
- Guide the spindle through the z-axis spindle mount through M8 nut just inserted in the z-axis carrier. Turn the spindle until the bottom of the spindle has a distance of 2mm from the top of the z-axis motor axis.

- The coupling is printed in such a way that the tolerance with the motoraxis is very tight. It should fit straight away. But

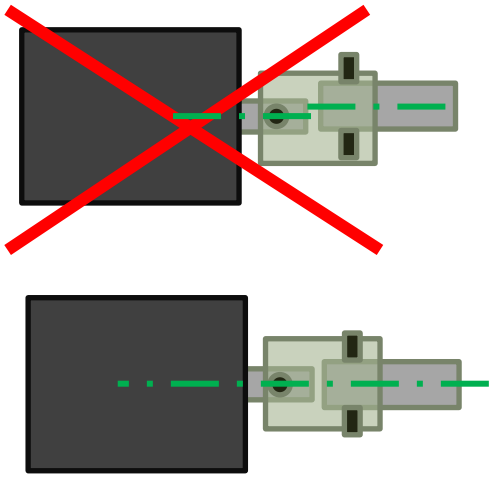
when too much force is required, carefully drill out the holes of the coupling with a 5mm and 8mm on the corresponding sides. Do this as straight as possible.



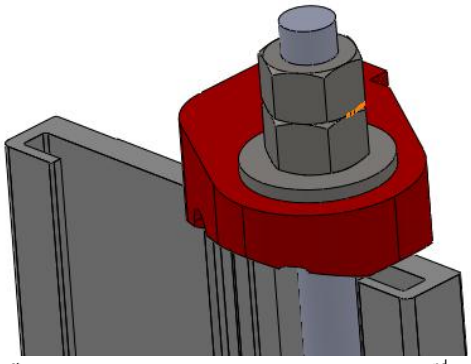
- Remove excess print residu with a file or tweezers where the m3 nuts should be slided in. Then use the setscrews to fixate the coupling onto the motor-shaft and the z-axis spindle.
- First mount the coupling to the motor, by turning the set-screws piece by piece. The goal here when turning the coupling by hand, the coupling stays as straight as possible. If it is not straight try to turn one of the set screws a little more than the other.



- When this is done tighten the screws a little more piece by piece.
- Mount the z-axis spindle onto the coupling. As in the previous step mount the setscrews piece by piece. Turn it by hand and see if the axis wobbles. When it does try to move the axis to the opposite side of the wobble. See picture below for a schematic overview.



-
- Fixate the spindle with two M8 nuts. Turn the first nut by hand against the bearing. When it is touching the bearing turn it 1/8th turn to put a little tension on the spindle.



- Hold the 1st nut in place with a 13mm wrench. Turn the 2nd nut onto the spindle against the 1st nut with a pliers.

You are now done with the z-axis.

6 Module 4: Hot-End (time: 20-45 mins)

Collect the following tools

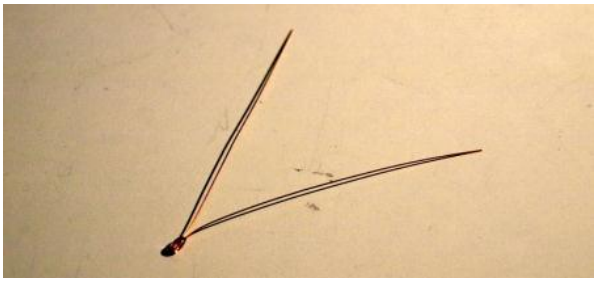
- Solder iron
- Solder
- Flux

Required consumables.

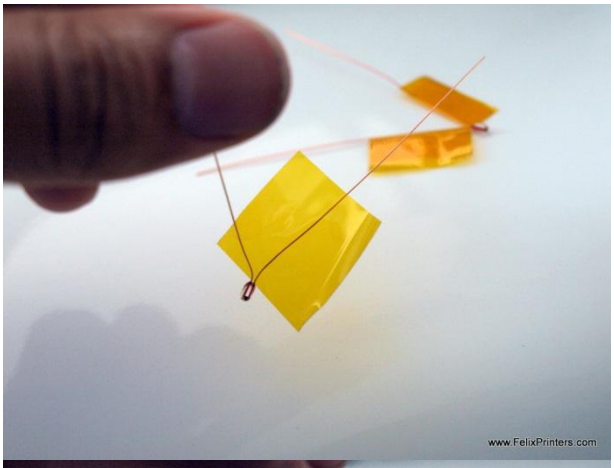
- Kapton tape
- Silicon glue heat resistant up to 300 deg C
- Toilet paper/tissue

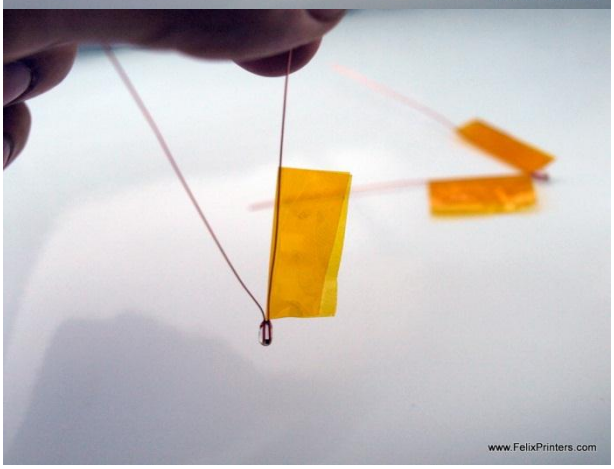
BOM Hot-end	
Part description	**Amount**
Hot_End_base	1
Hot_End_peek_isolation	1
hot_end_heated_nozzle	1
Hot_End_resistor	1
thermistor	1
precrimped cables 2 threads	2
Piece of wire 2m	1
heatshrinks large 50 cm	1
Heatshrinks small 15 cm	1

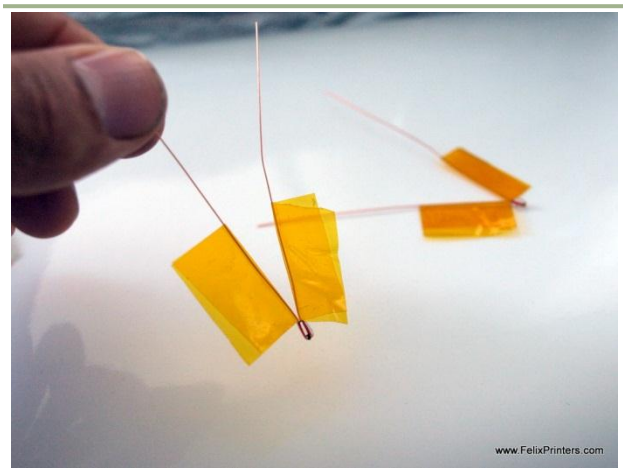
Collect all the parts from the Hot-end bag



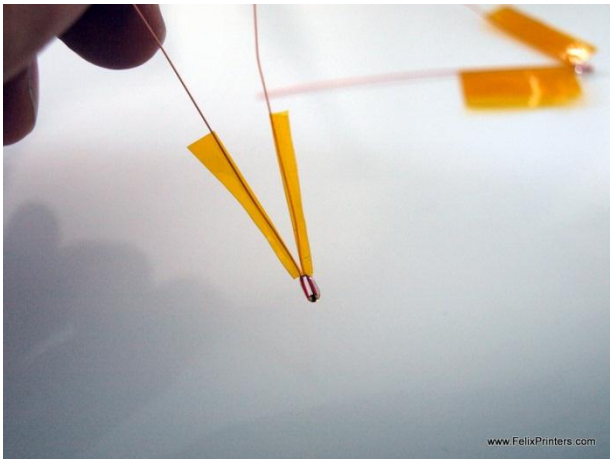
Take out the thermistor. The goal is to isolate the legs of the thermistor with kapton tape. Spread the legs like the picture





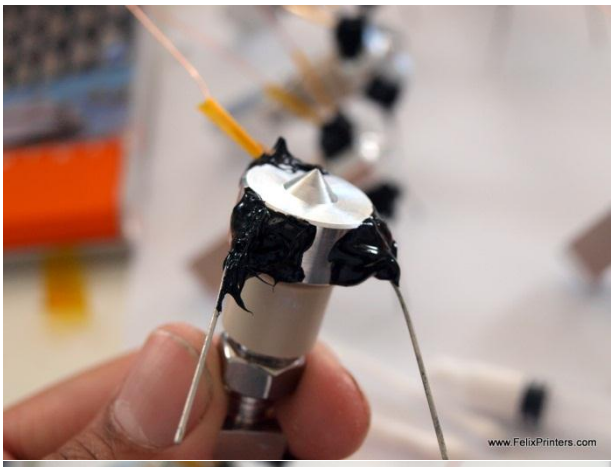


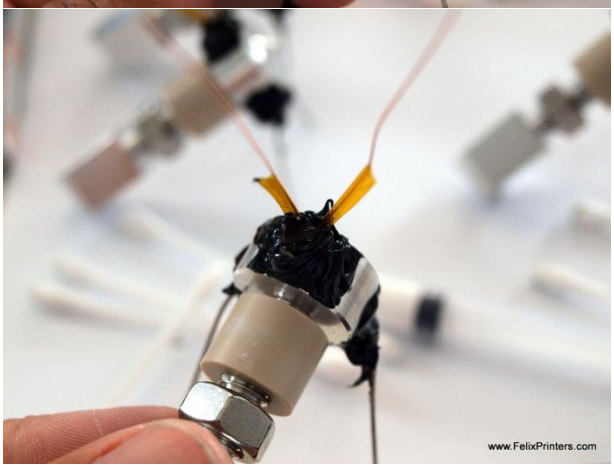
Fold kapton tape around each leg, make sure the tape covers every piece of the metal.



Cut the excess pieces of kapton tape. Make sure the tape near the glass head of the thermistor is as tight as on the picture. Because it partially goes into the hole of the hot-end.

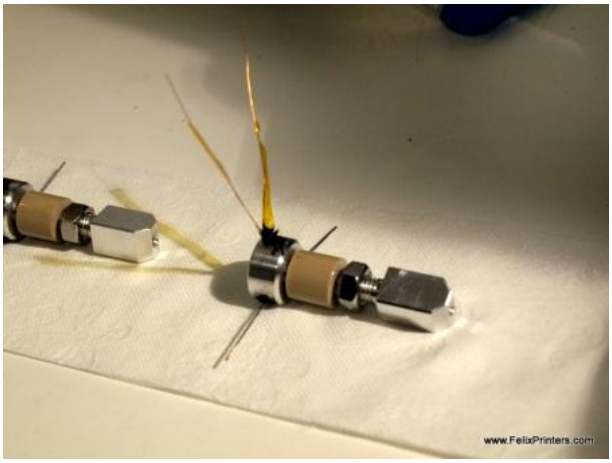
Assemble the hot-end according to the picture above. Don't forget the 8mm bolt.





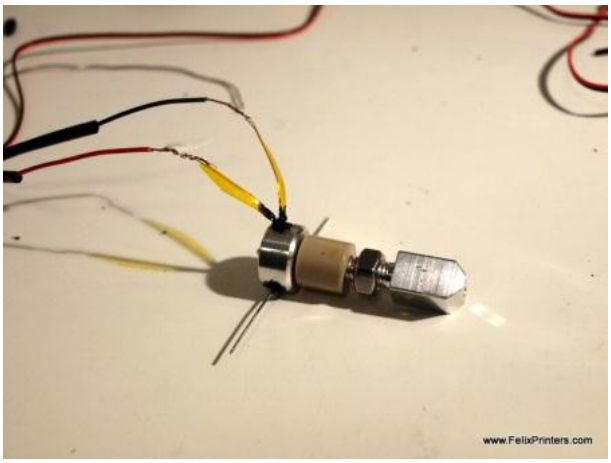
Glue the thermistor and power resistor in the hot-end with high temperature silicone kit. Important! Be careful not to put silicone kit in the small nozzle tip.

Use a large amount of high temp silicone-kit, in the holes. Try to get out all the air out of the holes.



When done it should look like this. Let it dry for a couple of hours. If you are impatient put the complete hot-end in the oven at 100 degrees C for 15 minutes.

When the hot-end is dry, the cables should be soldered. Start with the resistor cables. Take approx 5cm of heatshrink. Let the heatshrink almost touch the hot-end . There should be as low amount of bare metal left.



Now solder the two-cable precrimped wire onto the thermistor legs.

- Partially strip the thermistor legs from the kapton tape. Leave approx 3 cm from kapton per leg.
- Also use 5 cm of the large supplied heatshrinks per leg. The heatshrink should be 1 cm from the hot-end.

You have finished the hot-end.

7 Module 3: The Extruder (time: 30-90 min.)

Collect the following tools

- Allen key set
- Large file

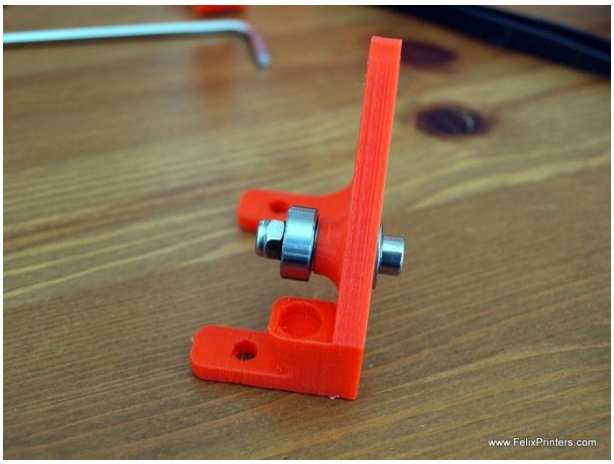
BOM Extruder	
Part description	**Amount**
Extru_base_v7	1
Extru_base_pt2_v4	1
Extru_base_pt3	1
Extru_arm_v2	1
Extru_belt_clamp_v3	1
Extru_airduct_v2	1
motor nema 17	1
Fan 40x40x10mm	2
small bearing	2
extruder_insert_piece	1

We will prepare all the parts before putting it all together. We start with the extruder belt clamp/tensioner. Use m4x30 bolts and self-prevailing M4 nuts. For the top bolt also use a small washer.

Get the extruder arm. Mount an M4x20 bolt. From left to right:

M4x20 bolt, small washer, extruder arm, small washer, small bearing, self-prevailing M4 nut.

Don't worry if the bolt doesn't go fully through the self-prevailing part of the nut.

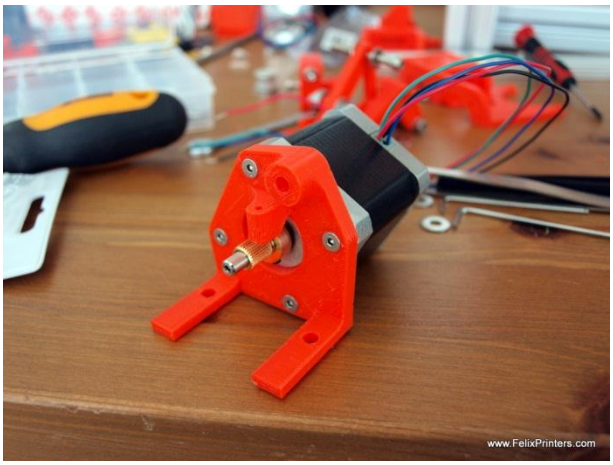


Get the extru_base_pt_3. And mount the bearing: From right to left the parts are:

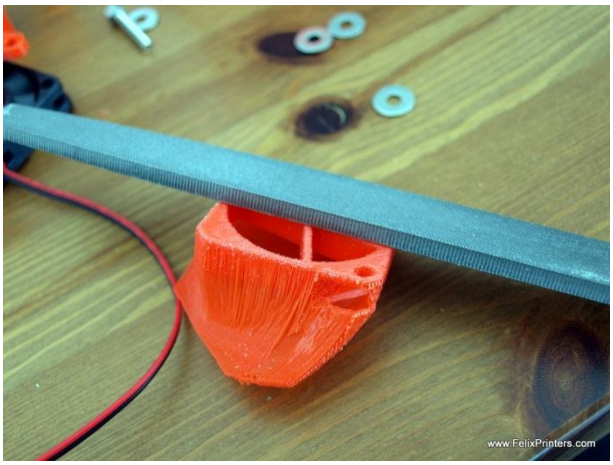
m4x20 bolt, medium washer, plastic part, small washer, bearing, self-prevailing nut.

Again don't worry if the bolt doesn't go fully through the self-prevailing nut.

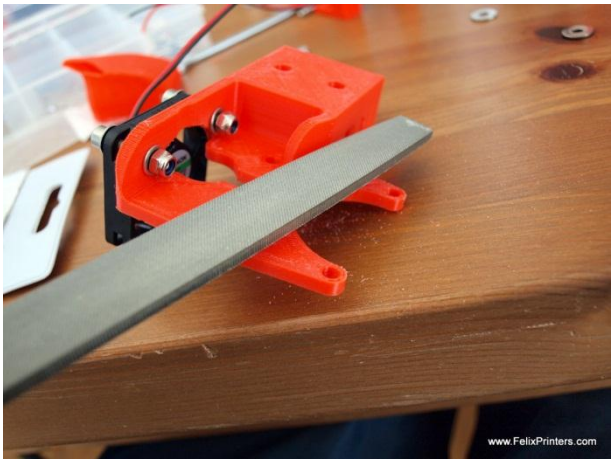
File a flat side to the motor and mount the bronze piece onto the motor. The distance of the motor_face to the bottom of the insert_piece should be approx. 1mm. The top motor axle which comes above the bronze insert_piece should ideally not be filed.



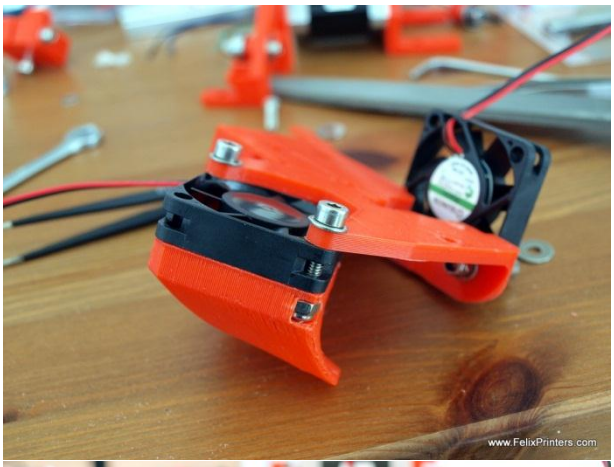
Mount the motor with insertpiece onto the extru_base_pt2 with 4 m3x8 countersunk bolts. IMPORTANT: the orientation of the motor should be the same as on the picture.



Take the extru airduct and make the surface flat with a file. Careful, because it's a delicate part.

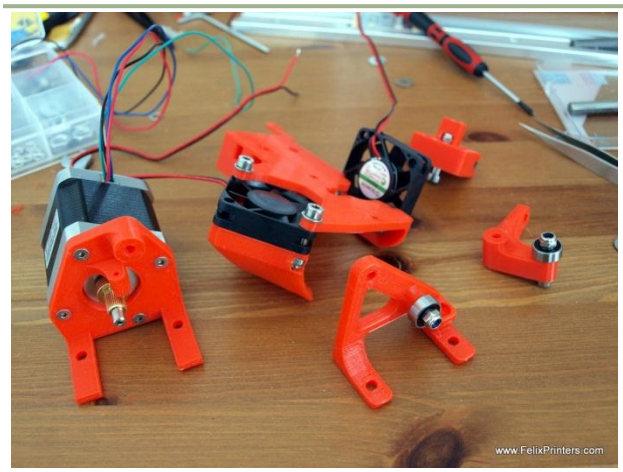


Take the base part and level the surface as indicated on the picture.

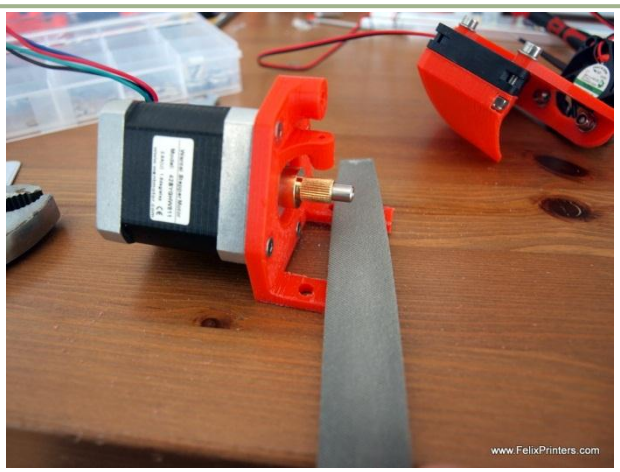


Mount the fans including one airduct. For the fan with airduct use M4x25 bolts including one small washer.

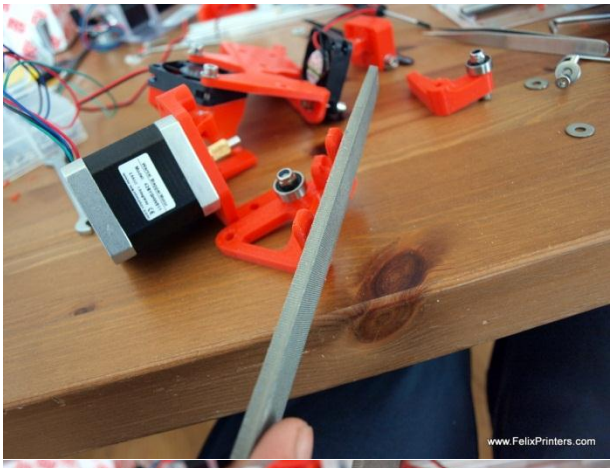
For the other fan, use M4x20 bolts. Use small washers.

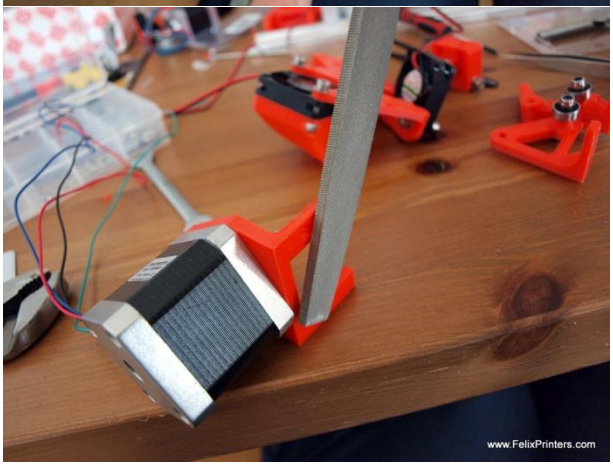


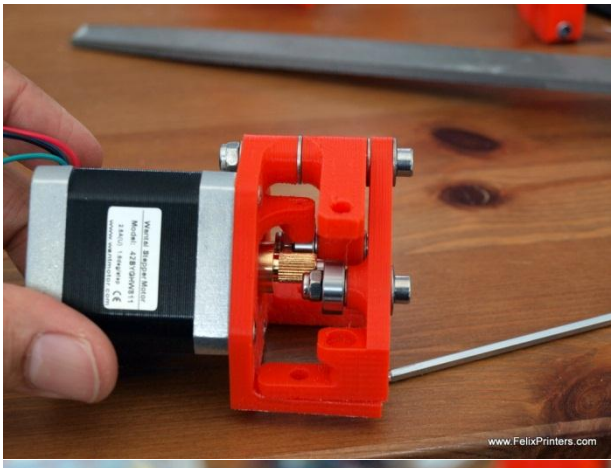
When done it should look like the picture above.

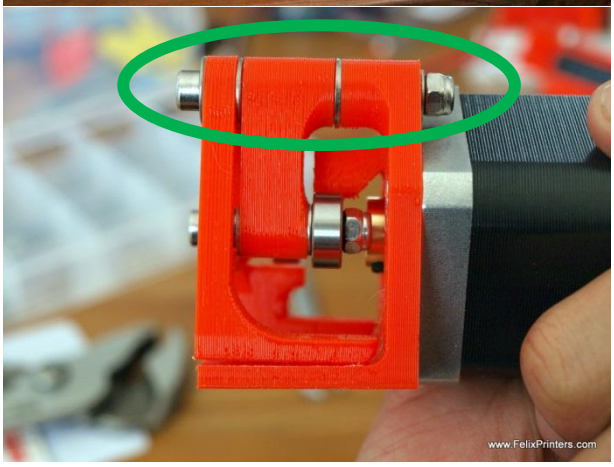


Before combining all the extruder parts, even the surfaces as shown in the pictures.



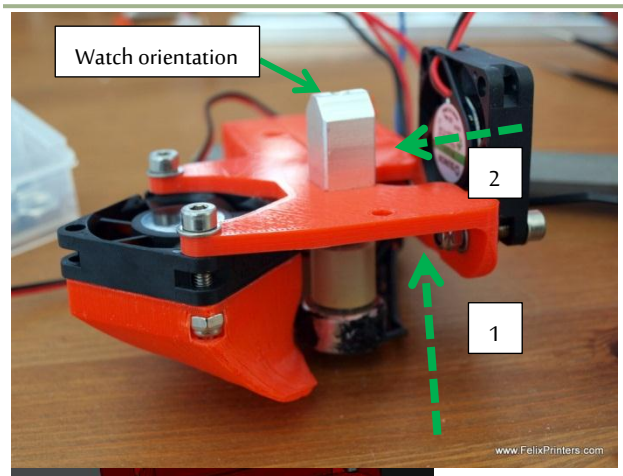


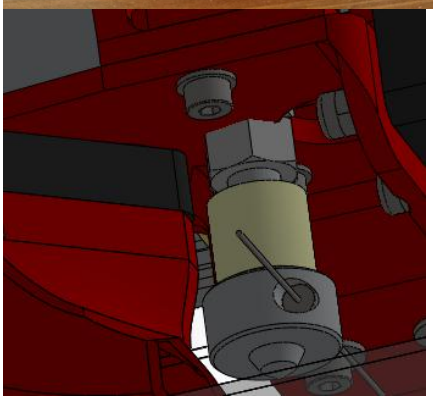




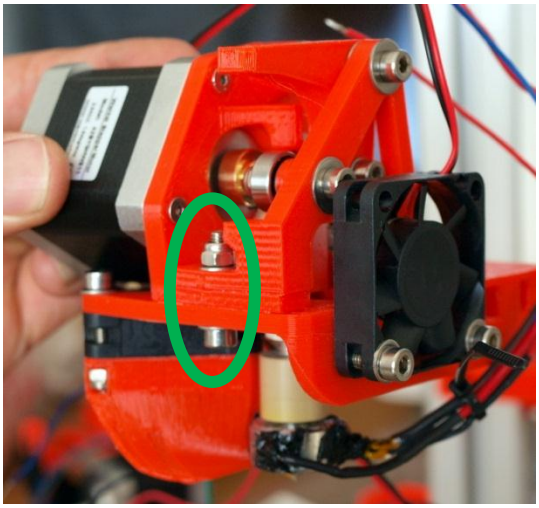
Put the parts together by using a m4x40 bolt shown in the picture. From left to right the encircled parts are:

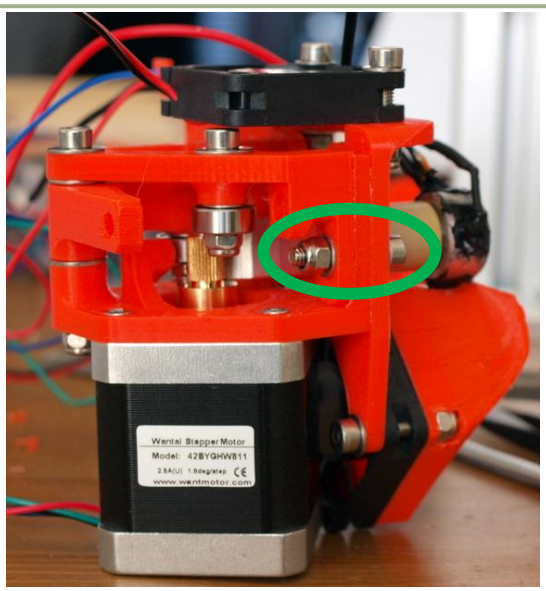
M4x40 bolt, medium washer, plastic part, medium washer, plastic part, medium washer, plastic part, small washer, m4 self prevailing nut.



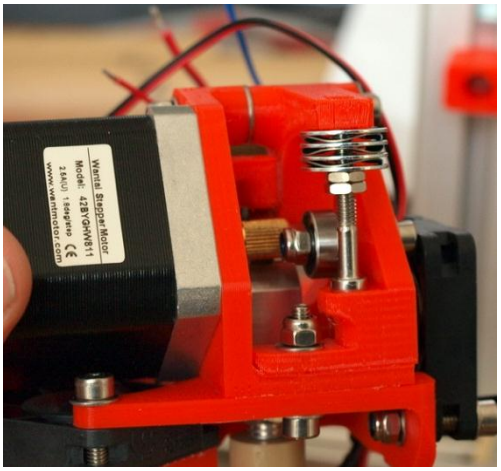


Mount the hot-end. Move it from underneath the extruder base then slide it onto the slotted hole. Finally fixate the hot-end with the m8 nut. The orientation of the top aluminum part is important, make it the same as the picture.

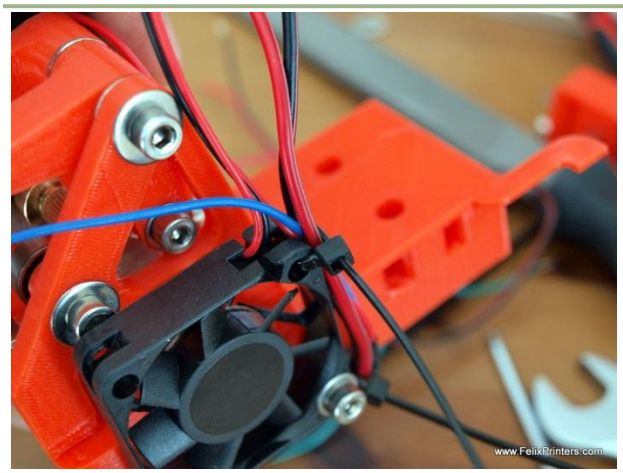




Connect the 2 sub-assemblies to complete the hot-end. Use m4x20 bolts, small washers and selfprevailing nuts.



To put tension on the extruder arm, mount the m4x30 bolt shown above. It seems short, but it is the correct length. Use 2 normal m4 nuts, 4 large washers and 3 crinkled washers. When you have it in place screw the 2 bolts up to put very little to no tension on the arm. Very little because when the filament comes in, the arm will be tensioned. Finetuning comes later.



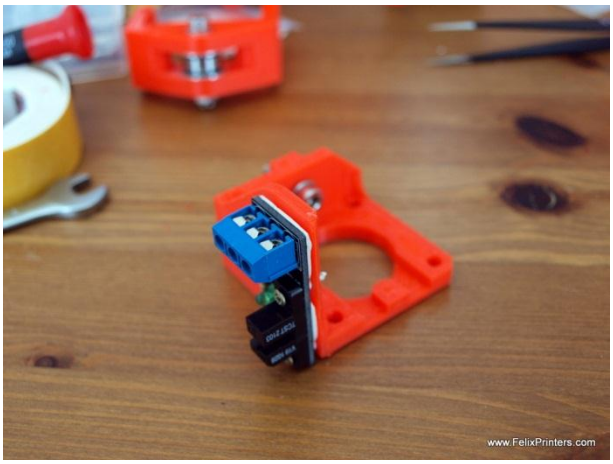
Finally guide the cables of the hot-end next the the fan. Use the hole of the fan and a cable-tie to fixate the hot-end cable.

Congratulations you've finished the extruder module!

8 Module 3: The X-axis (time: 30-60 min.)

Note: Don't waste any belt. There is only one long belt in the kit, which must be divided in such a way that it is usable for the x and y-axis.

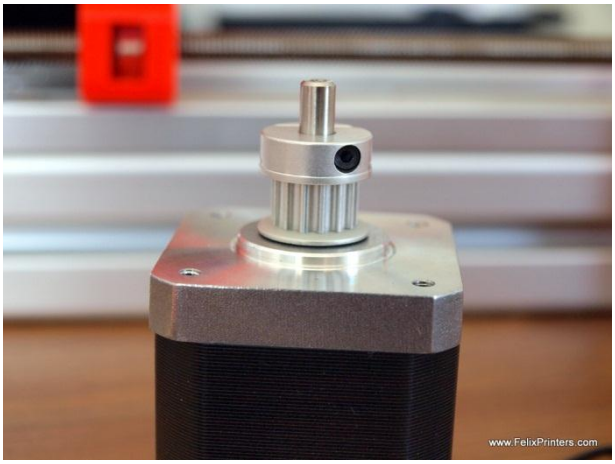
BOM x-axis	
Part description	**Amount**
x-stage-motor-bracket_v5	1
x-axis belt mount_v3	1
Igus GmbH_NS-01-40 - rail	1
Igus GmbH_NW-02-40 - cart	1
pulley_motor_HTD	1
motor nema 17	1
bearing 624	1
optosensor	1



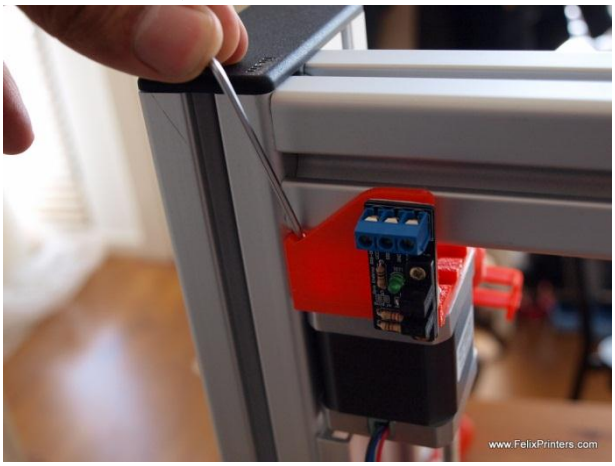
Get the x-axis motor bracket, mount the optosensor don't forget to put the double sided tape underneath. Then mount with the bronze screws.

Mount it to the frame by inserting a t-slot nut and then mount the bracket with a small washer and a M4x16 bolt.

The top of theplastic part should touch the top aluminum beam. Tighten this nut firmly, because it is not possible to move or tighten it later.

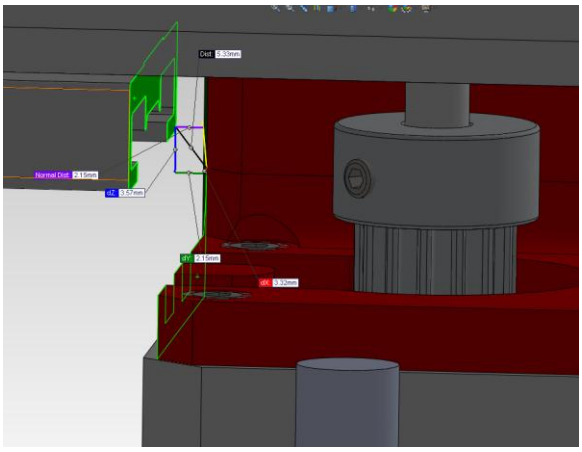


Take a motor and mount the pulley upside down. The distance bewteen the bottom of the pulley and the face of the motor should be approx 0.5mm, this can be adjusted later on.

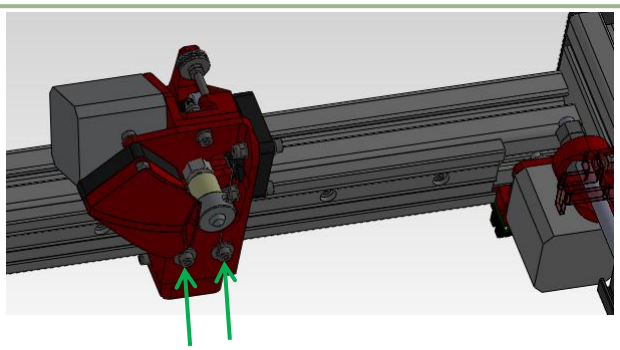


Mount the motor to the x-axis motor bracket with the m3 countersunk bolts. The bolts can be accessed through special holes and edges made.

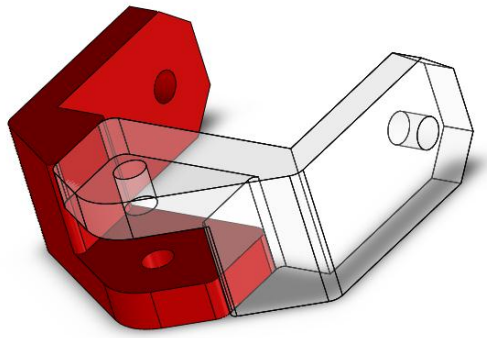
Mount the x-axis rail with corresponding x-axis slider. (there is an "X" drawn on the slider and rail). DON'T take the y-axis rail for this. Only three mounting points are necessary to assemble the x-axis. Use the holes at the far-ends of the rail and the middle one.



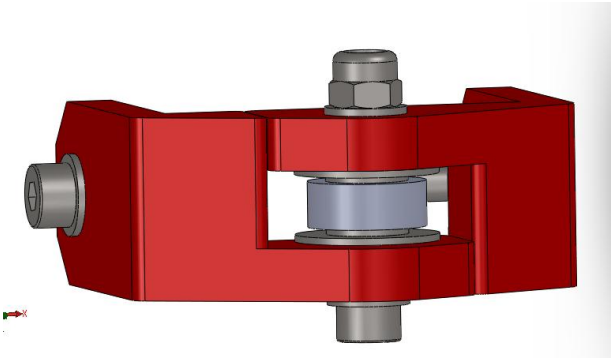
Fixate the x-axis rail. The distance between the highlighted faces should be approx 2mm.



Push the extruder onto the x-axis slider. This can go with some resistance. But no need for drilling any hole out. Then fixate it with m4x20 bolts and medium washers.

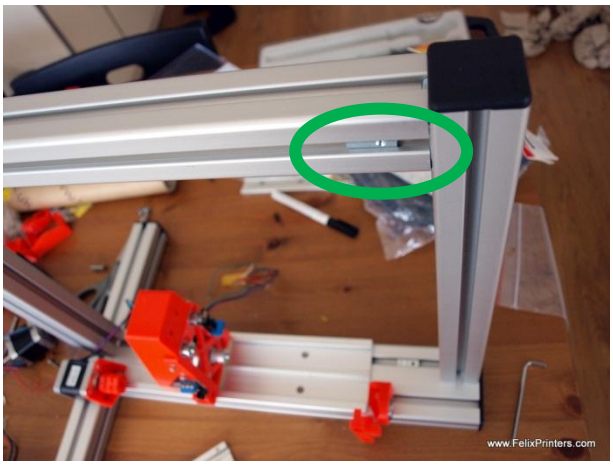


Take the 2 printed x-axis belt mount parts.

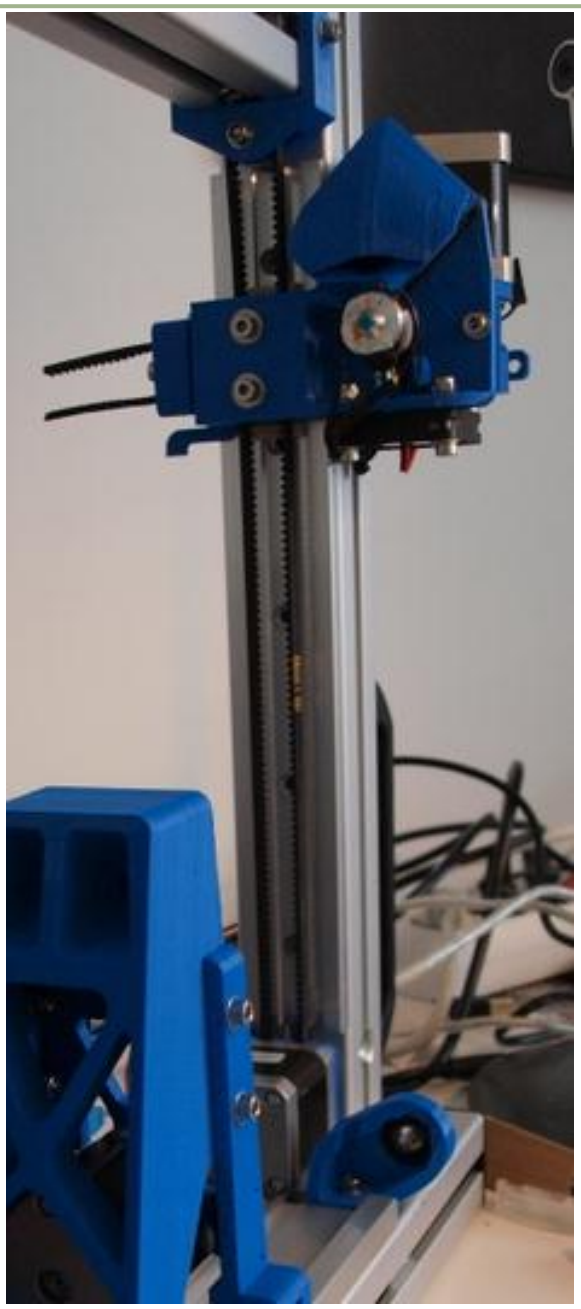


Mount the bearing onto the two parts. From bottom to top:
M4x25 bolt, small washer, plastic part, large washer, small washer, bearing,small washer, large washer, plastic part, small washer, self prevailing nut.

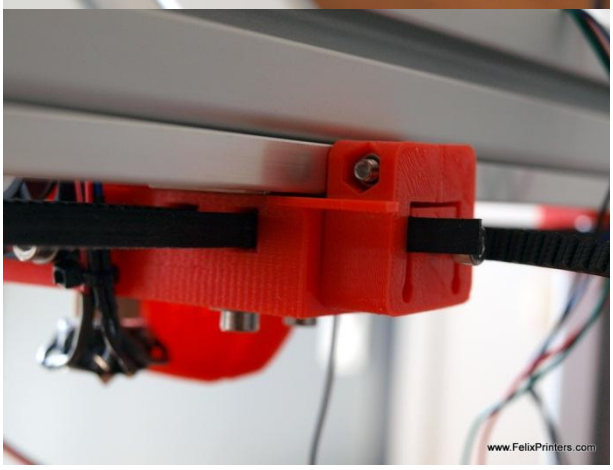
It's now time to mount the *x-axis belt mount* parts onto the frame. Before doing this cut the belt at one point and guide the end over the bearing as indicated above. (The part displayed in the picture above is from an older revision, but instruction are similar.)



Put the t-slot nuts to mount the x-axis belt mount.

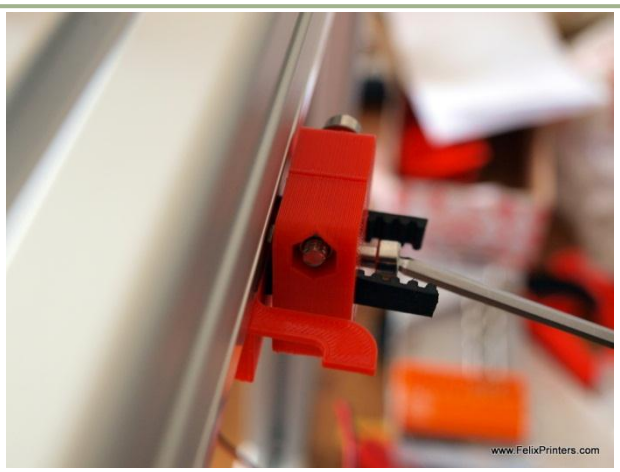


Guide the belt according to the picture above



Finally guide it through the belt-clamp. **Don't waste any belt. There is only one long belt in the kit, which must be divided in such a way that it is usable for the x and y-axis.**

When guiding the belt through the clamp, try to keep approx 2 cm at one end. On the other end leave the remainder of the long belt. Pull on both belt ends by hand to tension the belt, while keeping the belt tensioned, thighten/close the clamp to fixate the belt and keep the tension.



Increase the belt tension by turning the bolt and moving the clamp away from the extruder base. When the belt is tightened normally by hand, the distance between clamp and base should be about 2mm after tensioning. This needs further fine tuning later.

You have now finished the x-axis!

9 Module 5: Table (time: 1-2 hours)

Required tools for this module

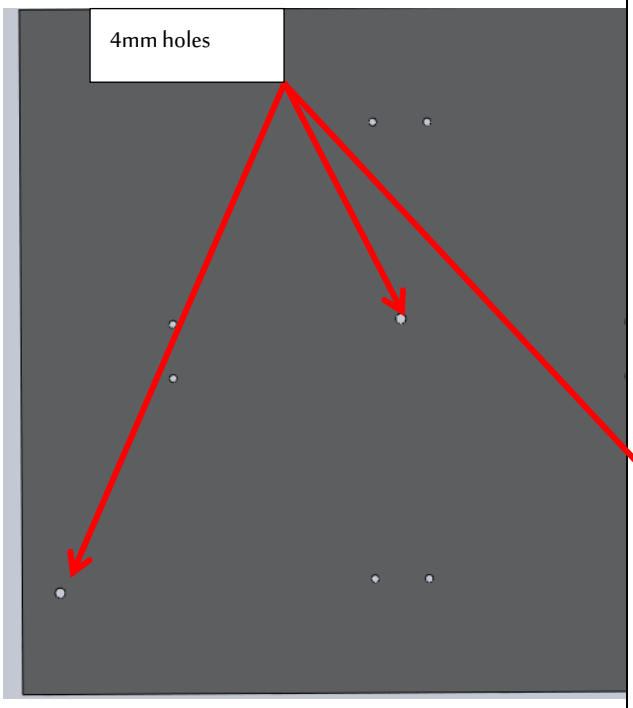
Drill,

Drill bits are: 3, 4, 8.5 and 6.5mm

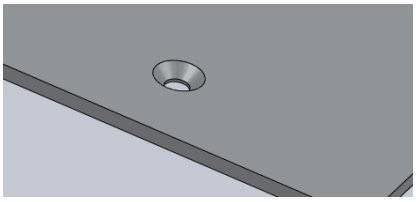
Important notes:

Work carefully; this will benefit the print quality. Make sure that you warp the surface of the table by exerting too much force /weight on the table

BOM table	
Part description	**Amount**
table_2mm	1
Resistor 4.7 Ohm - heated bed	4
precrimped cables 2 threads	1
Piece of wire 2m	1
Silicone kit heat resistant	1
Cooling paste	1



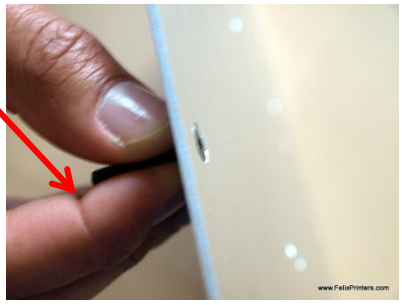
Take the plate. Note that there are three, 4mm holes which are reserved for the black M4 countersunk bolts. Further more there are eight 3mm holes which are reserved for the M3x8 countersunk bolts. These are needed for the power resistors.



The holes must be partially drilled out to look like this.

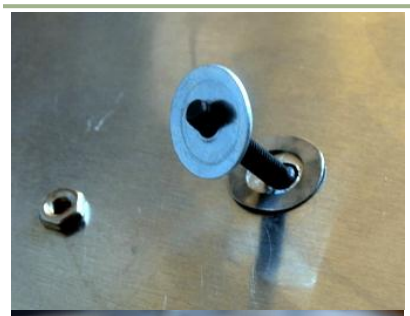
Take an 8.5 mm drill bit and drill three 4mm holes carefully to about half way and always check that the top of the counter sunk bolt is in line with the surface.

Take a 6.5 mm drill and do the same for the other (smaller) holes.



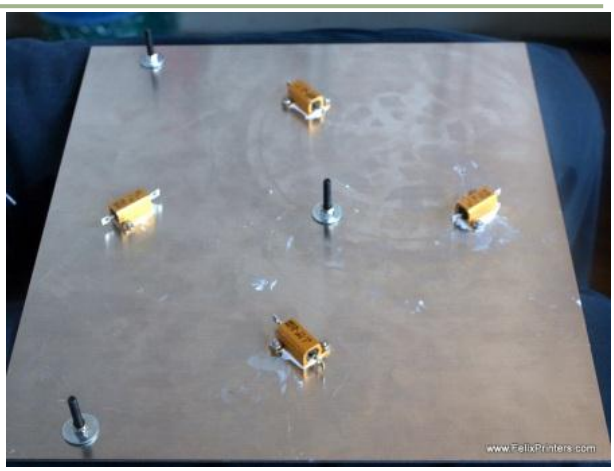
Continuously check if the countersunk hole is deep enough. The top of the head should be level with the bed.

Do the same for the smaller holes.

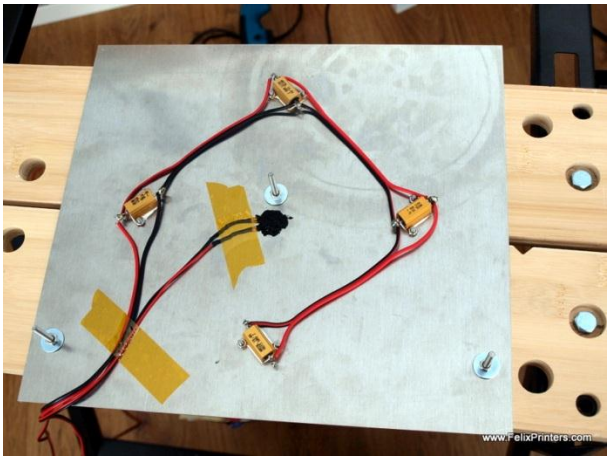


When all the holes are properly sunked. It is time to mount the M4x30 countersunk bolts. The order: bolt, crinkled washer, large M4 washer, M4 nut.

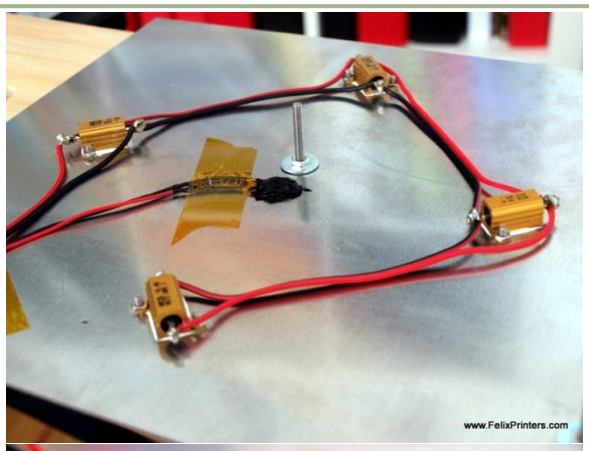
Carefully drill out the holes of the heat resistors. Drill them out in steps. First drill out with an 3mm drill, then with a 4mm

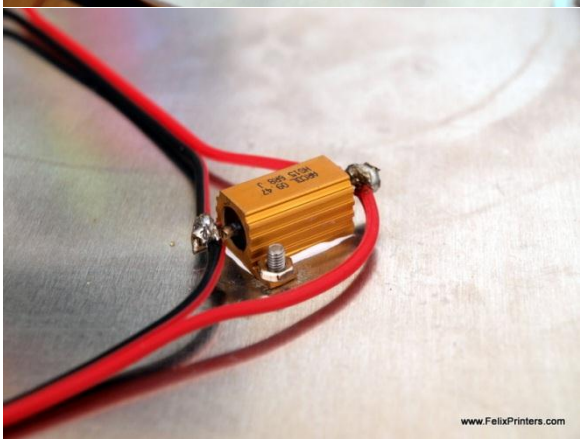


The bed uses 4.7Ohm resistors. When all the resistors are drilled out and they can be placed loosely on the M3 bolts. Put some cooling paste on the flat side of the resistors; mount it as shown on the table.



Now it is time to place the thermistor and solder the wires. How to prepare the thermistor can be seen in the hot-end section.

- 



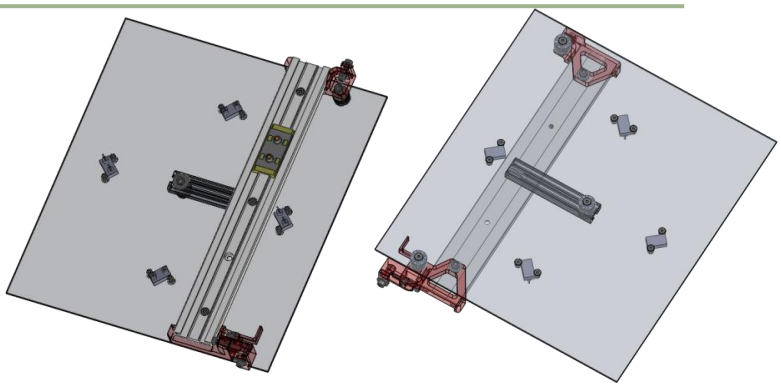
Start by soldering the wires onto the heat resistors:

- From the double wire cut 3 equal pieces of 200 mm. The rest of the wire will go from the bed to the electronics. Don't waste too many, because the rest of the wire goes from the table to the electronics.
- Strip all wire ends, twist the stripped end and guide it through the holes of the resistors.

Steps for thermistor:

- Place kapton tape on the leads of the thermistor to isolate them. See the hot-end section how to do this.
- Solder the pre-crimped cables including heat-shrinks onto the thermistor.
- Fixate the thermistor with Kapton tape
- Glue the thermistor head approx. in the middle of the bed with heat resistant silicone kit or other heat resistant type of glue.
- Let it dry.

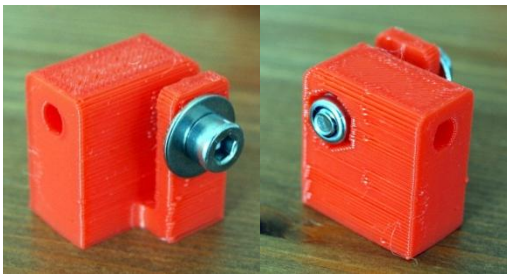
10 Module 6: Y-axis (time: 10-30 min.)



Required tools for this module

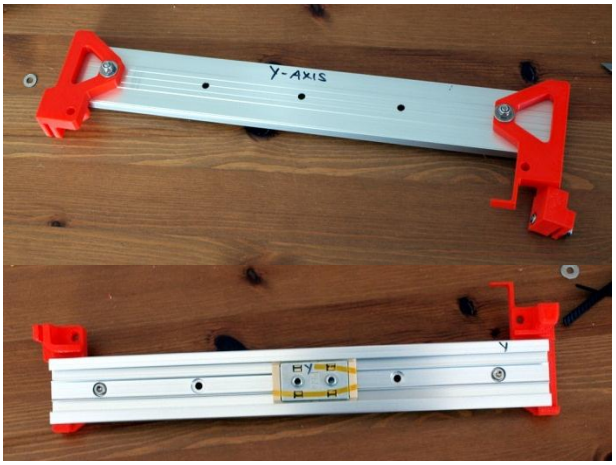
- Drill,
- Drill bits are: 4 mm
- Allen key set.
- Pliers

BOM y-axis	
Part description	**Amount**
y-stage bracket pt1_v2	1
y-stage bracket pt2_v2	1
y-stage bracket pt4	1
Igus GmbH_NS-01-40 - rail	**2**
Igus GmbH_NW-02- cart	**2**
20x10_profile	1
t_slot_nut_5	1



Take the beltclamp part, and insert an selflocking M4 nut. It should fit right in there, othewise try to carefully push it in with a nippers. **DO NOT clamp the nippers on the small flange.**

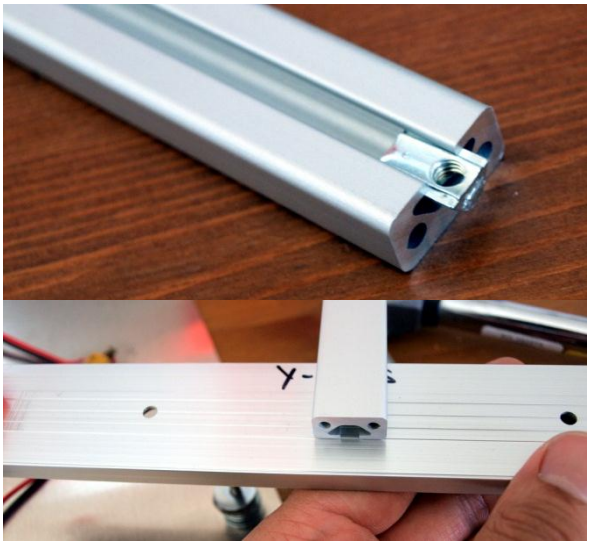
On the side of the small flange, use a medium washer.



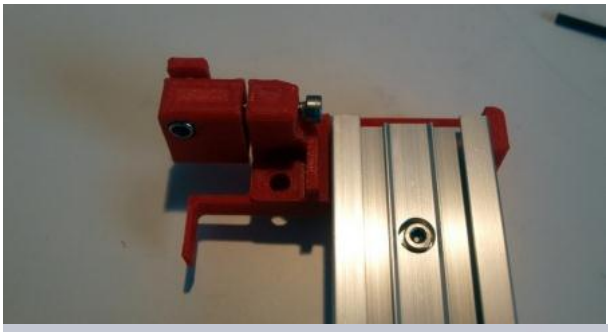
Be sure you have the rail and slider combination with both "y-axis" on it. Use the M4x16 bolts to mount the printed parts to the aluminum rail. Use the selflocking M4 nuts and don't forget to place a medium washer at the plastic part side.

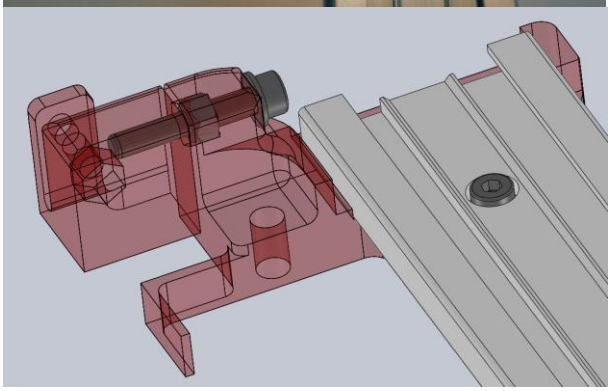
Mount the other parts according to the pictures above,

Get the small aluminum beam, first put the plastic cap on it, next to the drilled hole. This can be done with a hammer.

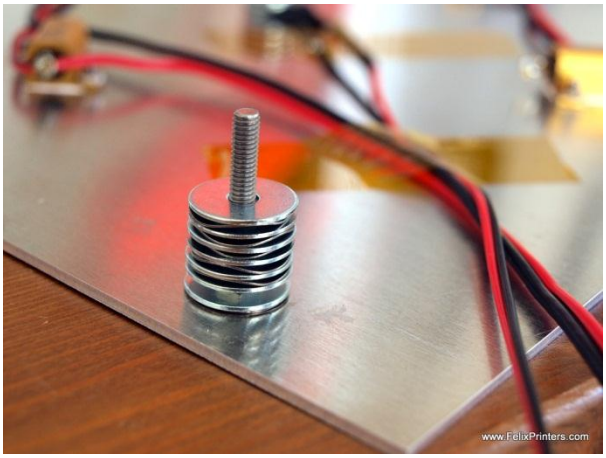


Slide in the small t-slot nut on the other side, and mount this beam onto the middle hole of the y-axis rail with a M4x6 bolt.



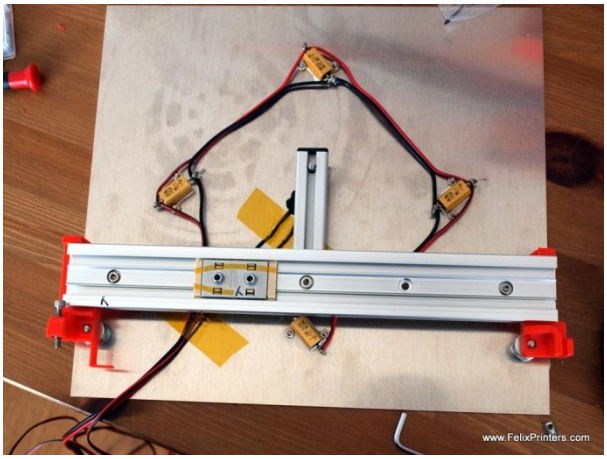


In the printed part with the opto-switch vane, insert a M4 self prevailing nut. Insert a M4x25 bolt. This part is intended to tension the y-axis belt.

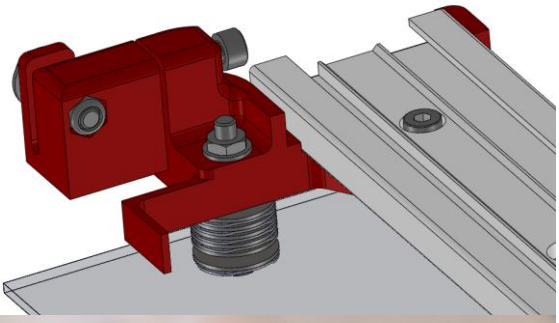


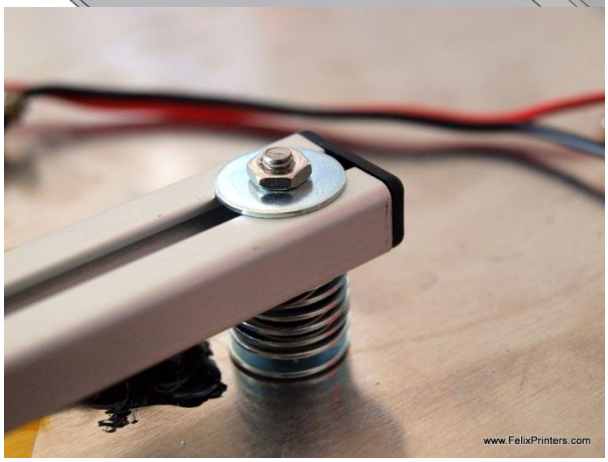
Now it is time to connect the table assembly with the y-axis assembly.

- Take the table.Put it with the face on a flat scratch free surface.
- Put washers and curved rings on m4x30 countersunk bolts. It is important to match the amount of washers on the picture above.
- On the 3 M4 countersunk bolts of the table make sure that on top of the already placed rings from the previous module, there are 6 large M4 washers and 5 curved rings in total. See the illustration above.

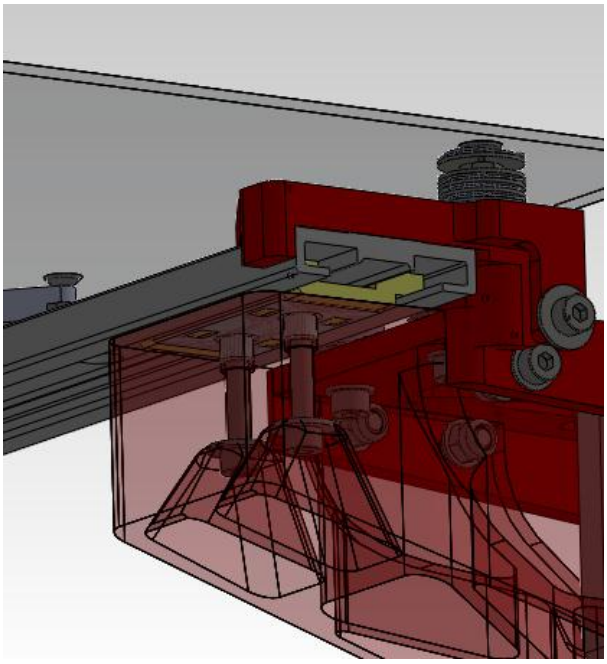


Now place the y-axis onto the table. When it doesn't directly fit, there is no need to file any parts. The three bolts can be slightly re-oriented. This can be done to exert a little sideway force on the bolt. When it still doesn't fit, you could try to adjust the position of the small aluminum beam.

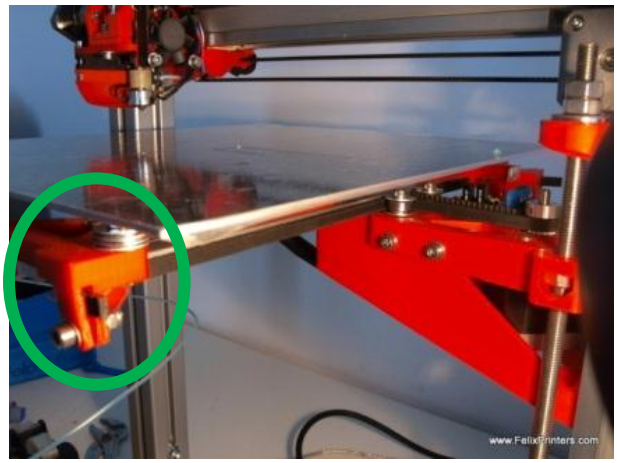




After placement mount table bolts with a normal M4 nut. Use a small washer underneath the m4 nuts at the plastic parts. Use a large washer for the bolt at the small aluminum beam.



Mount the y-axis cart on the z-axis part with two M4x25 bolts with medium washers.



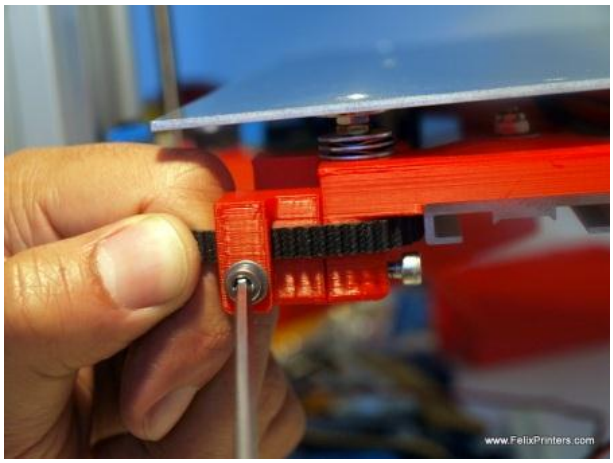
Now it is time to put the left over belt from the x-axis onto the y-axis.

Install the belt, without screwing anything tight. Only let it stick out 1 cm on the side displayed on the picture above.

If you are doing this module before assembling the x-axis module, do not waste unnecessary pieces of belt, because it is needed for the X-axis!!

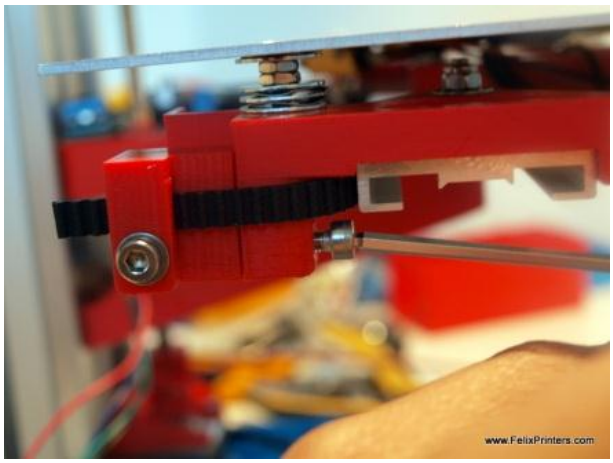
Guide it through the bearings and pulley to the other printed clamp. Now tighten the clamp on the picture above. Use an M4x16 bolt and a self-locking M4 nut.

Important! Make use of washers and DO NOT over tighten the screws, otherwise the clamp could break!

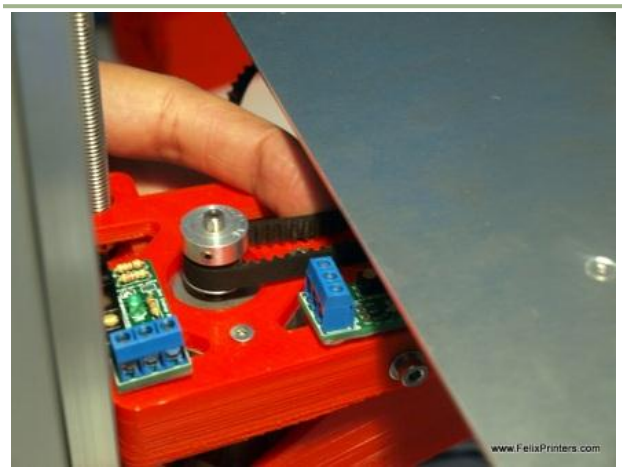


Now we need to clamp the other side of the belt with the tensioning mechanism on the other side with the belt tensioning part.

1. Make sure the tensioning bolt is loosened. The small part must touch the larger printed part.
2. Try to pull the belt with your fingers. And at the same time fixate the clamp as displayed above. **Again not over tighten it because it might break the clamp!!**
3. Optionally cut off excess piecse of belt. 2 cm left should be more than enough

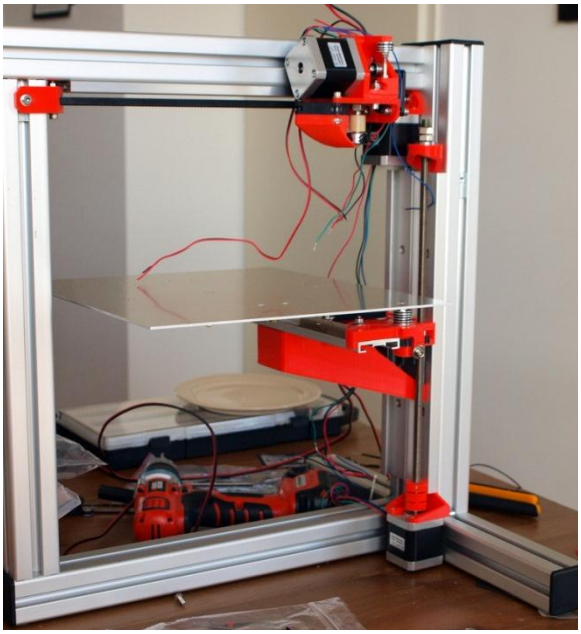


Next step is to tension the belt by turning the tensioning bolt. See picture above. The belt should be tensioned when the distance between the parts is approx. 1 to 2 mm.

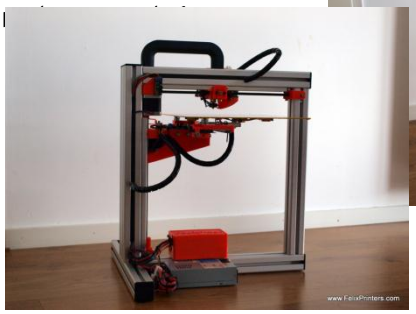


Check if you applied enough tension by pushing the belt as displayed above. It should feel firm.

Congratulations, you are done with this module and the mechanics of the printer and it should look like this:



11 Module 7: Electronics (time: 2-4 hrs.)

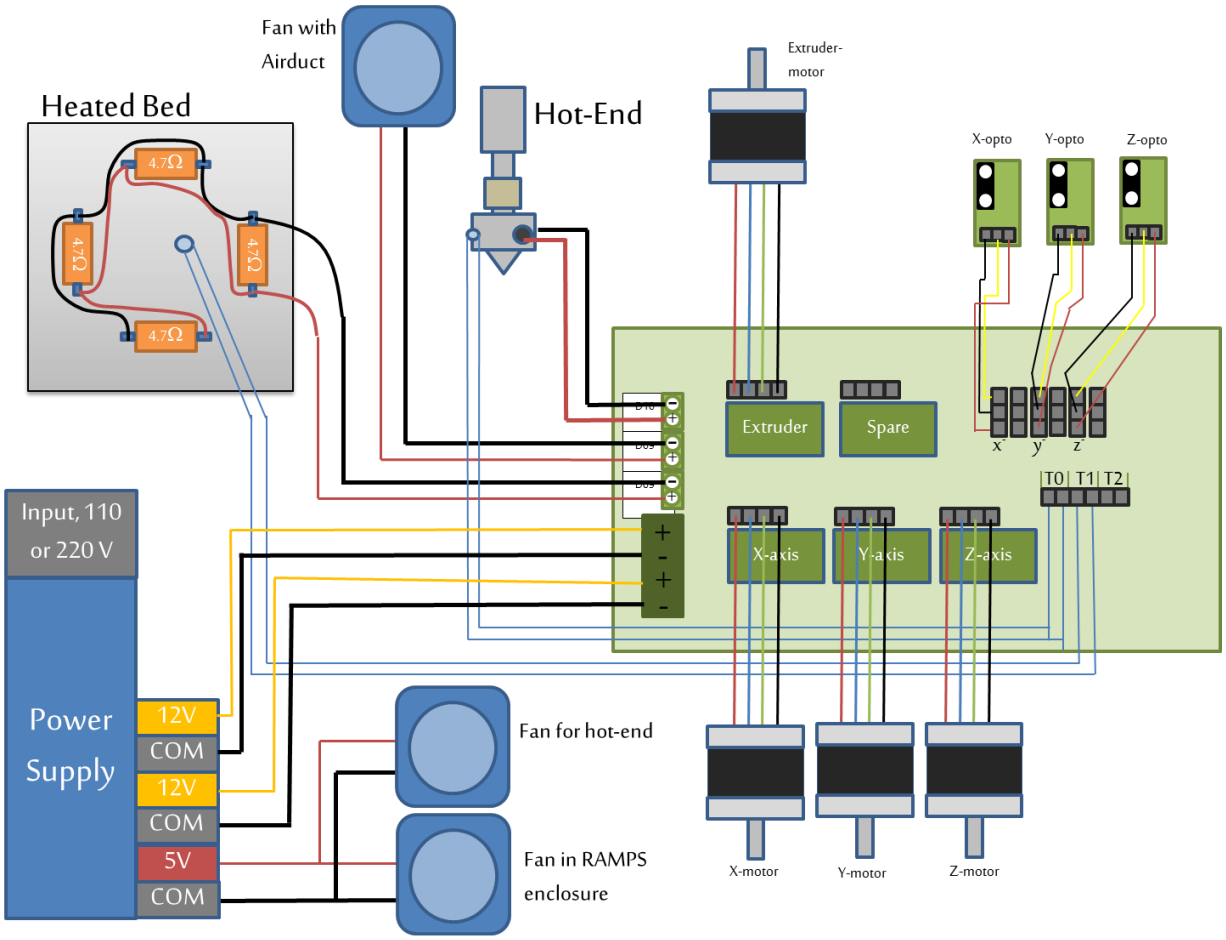


The goal of this module is to install all electric wires and to neatly

The required tools for this module are:

- Soldering iron
- Solder
- Flux
- Allen key
- 7mm wrench

To make the printer work properly the schematics below must be matched.



The description below will guide you step by step to match the schematics above.

NOTE: It is important that the cables are placed as neatly as possible. Placing the wires in a messy way, can lead to EMC problems, which than can lead to unreliable printing. Also the board could become sensitive from outside influences, for instance when a lamp is switched on or off the electronics could stop working until you reset it again.

After building several printers, we found that the best way to neatly do the cabling is to work from the electronics board to the components. We use the following workflow:

1. Mount the power supply to the frame
2. Label all cables
3. Place as much cables as possible to the electronics board.
4. Connect the y-axis table wires to the board.
5. Connect the opto sensors
6. Connect the motor wires
7. Connect the rest of the wires
8. Clean it up and place the wires into the frame and cable spiral.

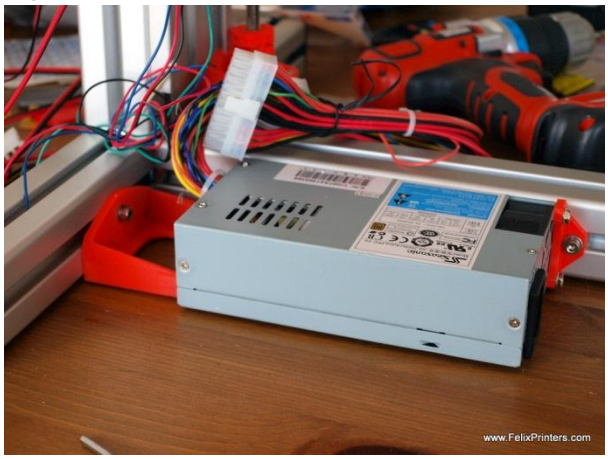
This section will walk through the above steps

11.1 Mount the powersupply.

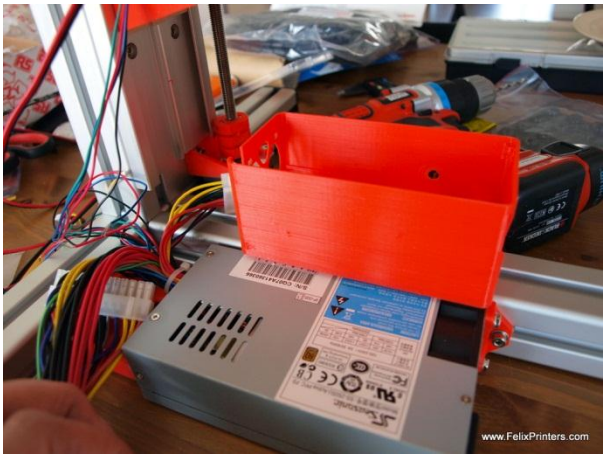
BOM Electronics	
Part description	**Amount**
powersupply_bracket_pt5	**1**
powersupply_bracket_pt4	**1**
ramps_case_pt1_v2	**1**
ramps_case_pt2_v2	**1**
ramps_support	**2**
RAMPS + arduino + steppers fully assembled	**1**
mini-ATX-seasonic	**1**
Power Cable NL,USA,Australian or British	**1**
Fan 40x40x10mm	**3**
heatsinks 10*8	**4**
precrimped cables 4 threads	**4**
precrimped cables 3 threads	**3**
USB cable 1.8m	**1**
heatshrinks large 50 cm	**1**
Heatshrinks small 15 cm	**4**

Get the parts described in the table above.

Place the plastic parts onto the powersupply with the powersupply screws. The head on the screws may look different than on the picture, but they have a phillips head and a courser non metric thread with a length of 6mm and diameter of 3.3mm

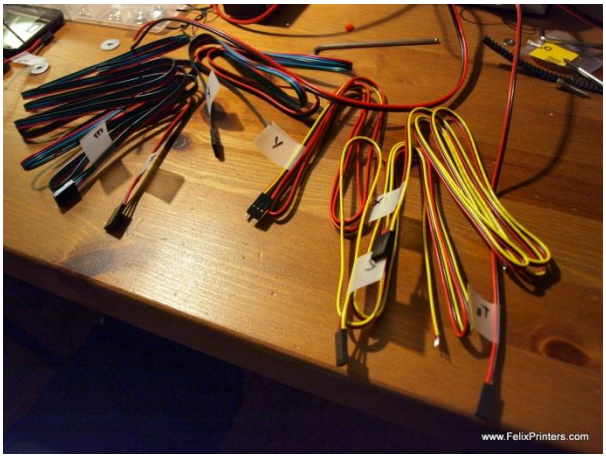


Mount the case also with t-slot nuts and the ramps_support parts. Use the m4x12 buttonhead screws.



IMPORTANT: Align the front face of the ramps case with the front face of the powersupply. When the electronics case is placed too close to the vertical beam, the z-axis carrier will touch the ramps case, before it is at the end of its stroke.

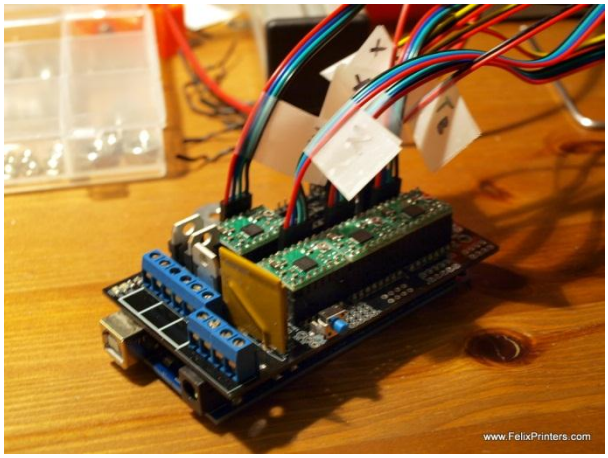
Put labels on all cables



It is very usefull to label all the cables, especially when you want remove a cable in the future for whatever reason. A easy way of labeling is to fold a piece of tape around near the connectors, and write something on it with a permanent marker.

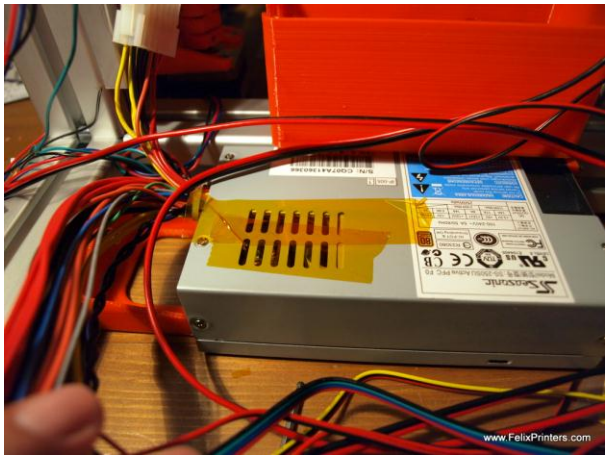
The three wired cables are for the opto sensors, the 4 wired cables are for the motors and the 2 wired cables are for the heated bed and hot-end temperature sensors (these are already mounted onto the parts.).

11.2 Connect all possible wires to the electronics board.

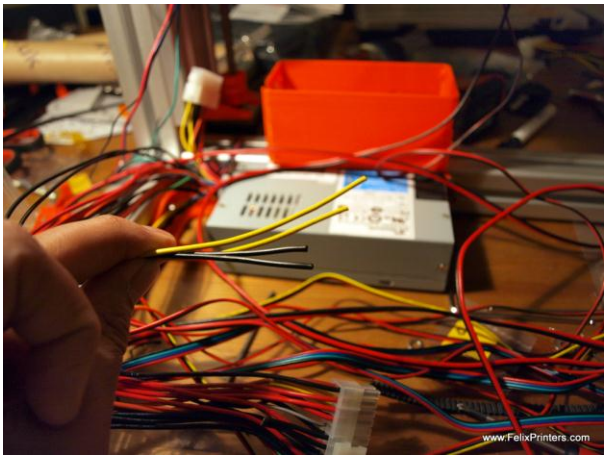


We want to work our way from the electronics board to the components. Connect all the pre-crimped cables, onto the board, the labels should correspond to the position on the board. Try to group the 3wire cable together.

Tip: make good use of the cable ties supplied with the kit. They are great to form nice cable loops. Afterwards, it is easy to remove the unnecessary ones.



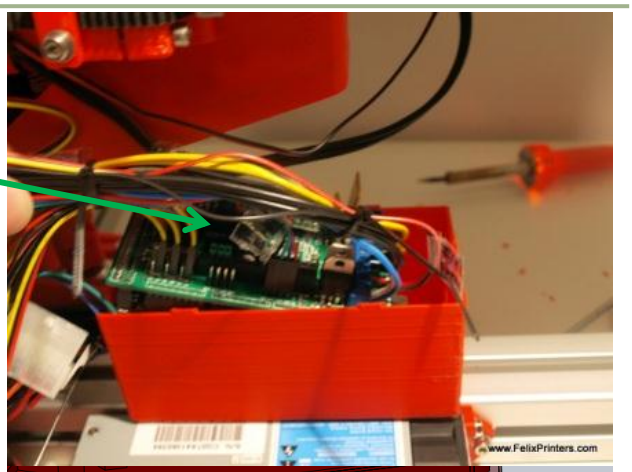
To prevent the power supply from being damaged, place some tape on the grill. Solder residu particles can easily fall in and cause a short.

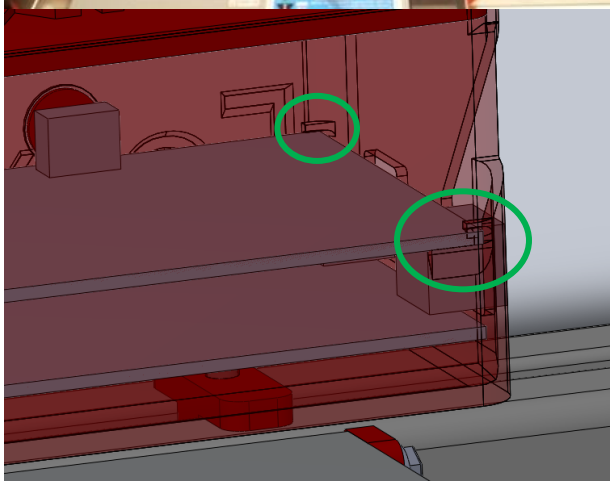


From the big ATX connector, cut 2 yellow and 2 black wires near the connector. (It does not matter which of the black or yellow wire you take.) You need this length to be able to reach the ramps case. Strip the ends and put some solder on it. Then connect them according to the schematics of the ramps electronics.

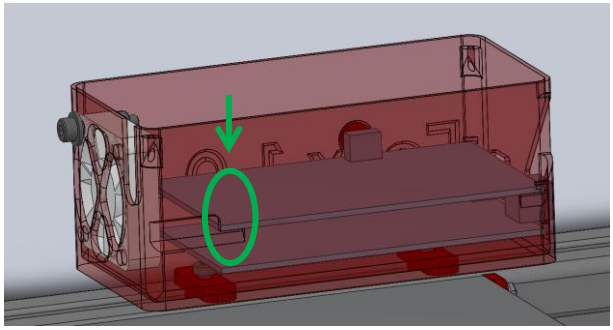
The order of the cables for the screw terminal in more detail.
From left to right.
2x Hot-end powerresistor cables, airduct fan black, airduct fan red, 2x heated bed powerresistor cables, 12V yellow, COM black, 12V yellow, COM black.

The wire colors of the hot-end and heated bed can be different from the wires in the picture.
Make sure the polarity of the fan cables are according to the schematics!!!
Otherwise the fan will be damaged.





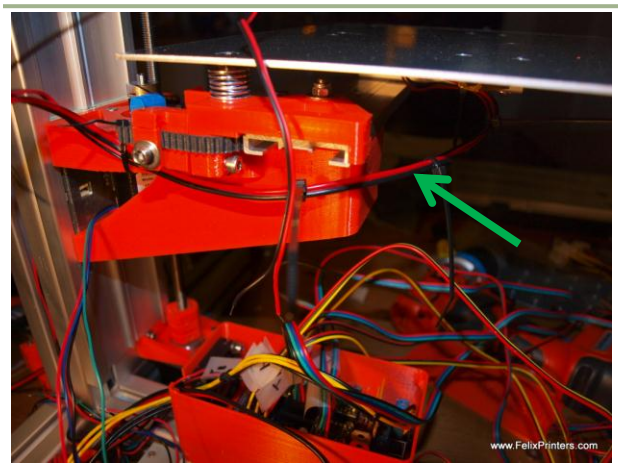
When finished with connecting as much as possible, guide the RAMPS electronics into the casing. Make sure the edges of the RAMPS case slide in the designed slots shown in green.



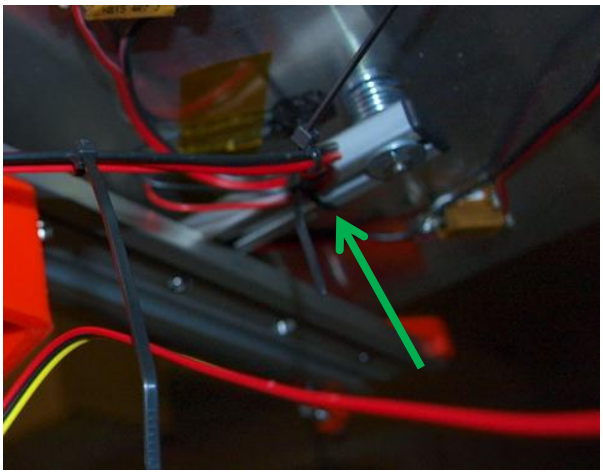
Finally push it down untill the edge to secure it.

11.3 Connect the y-axis table wires to the board.

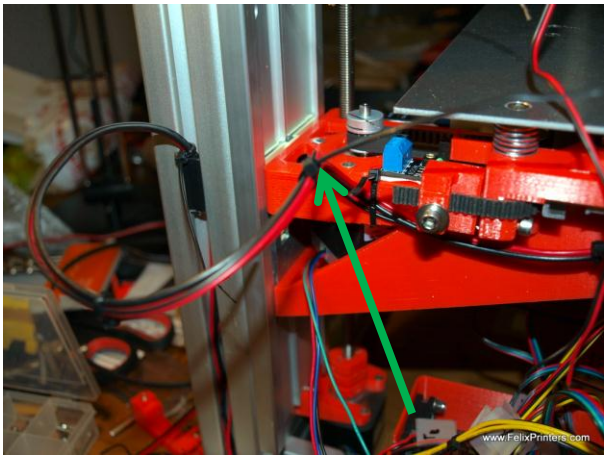
We first connect the cables of the y-axis table to the ramps board. This is because the pre-crimped wire to the thermistor has a leading length for the cable loop.



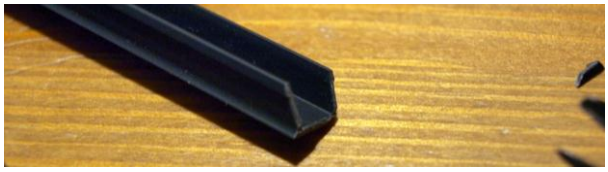
The first loop goes from the heated bed to the top part of the y-axis carrier. The loop should be just big enough for the y-table to move freely. But small enough to have enough wire to go to the ramps electronics. Check the loop when the axis is moved by hand from one extreme position to the other.



Make sure the wires are connected to the small aluminum beam by means of a cable-tie, indicated with the arrow above. It is necessary to prevent any strain on the thermistor cable.

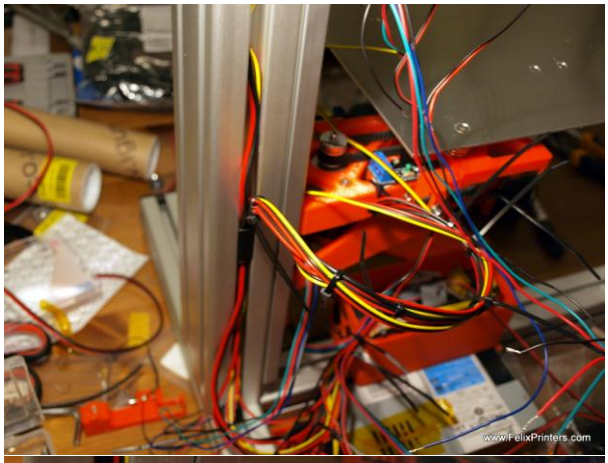


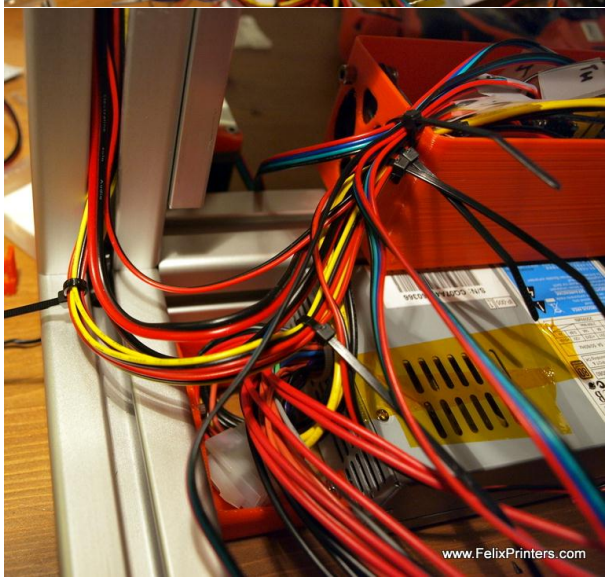
Make sure the loop is intermitted at the top part of the z-axis carrier. Mount it there with a cable tie. Then make the second loop from the z-axis carrier to the vertical beam. The second loop should go into the vertical beam at approx. the middle.



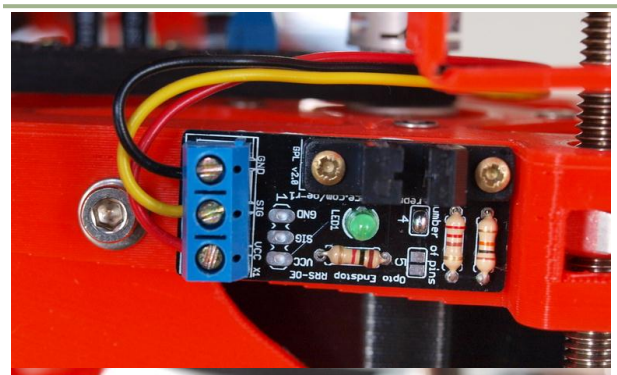
Try to keep it in place with the provided plastic frame strips. Cut off a small piece, remove remaining sharp edges and place it onto the frame.

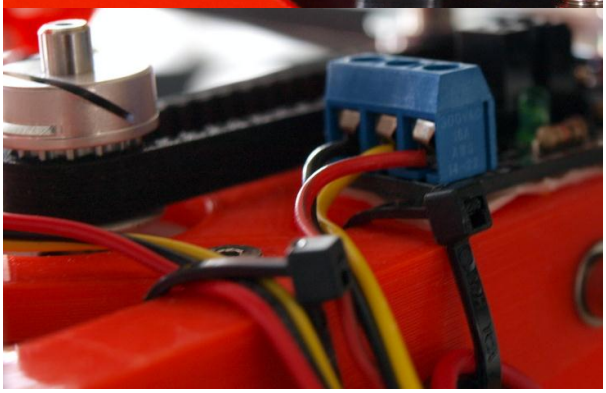
11.4 Connect the opto sensors



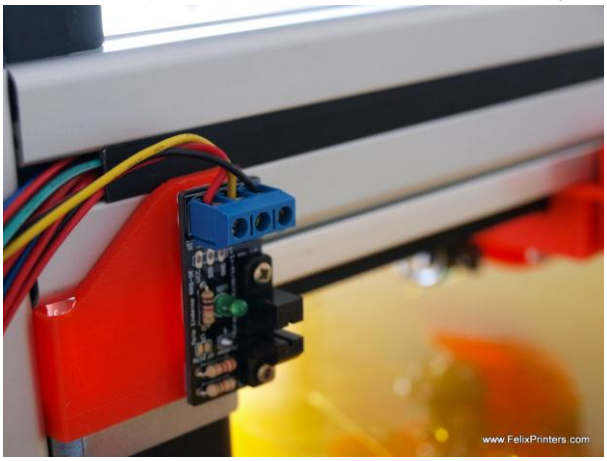


Now we are going to connect all the opto-sensor wires. Start from the ramps case. Try to group the three cables together and try to make a small loop before the cables go into the casing. This could be useful for later use, when possibly to do a printer upgrade, additional cable length is required.



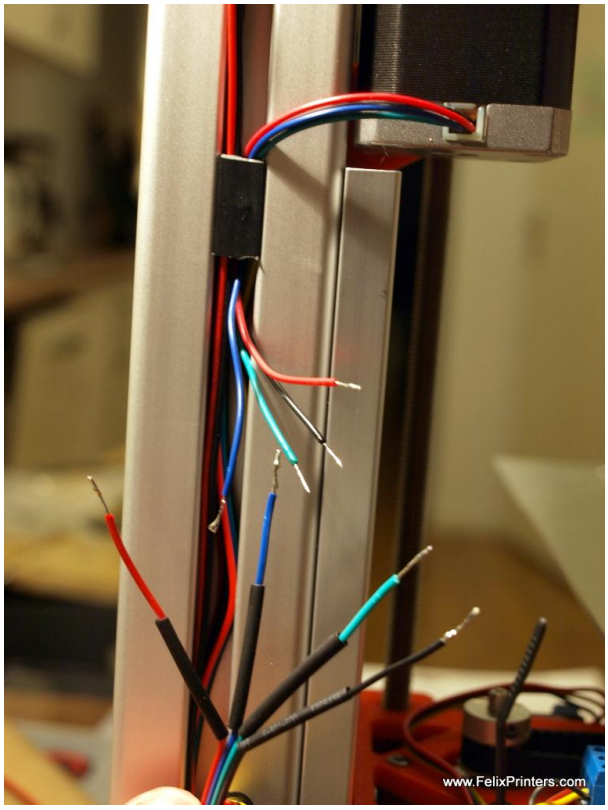


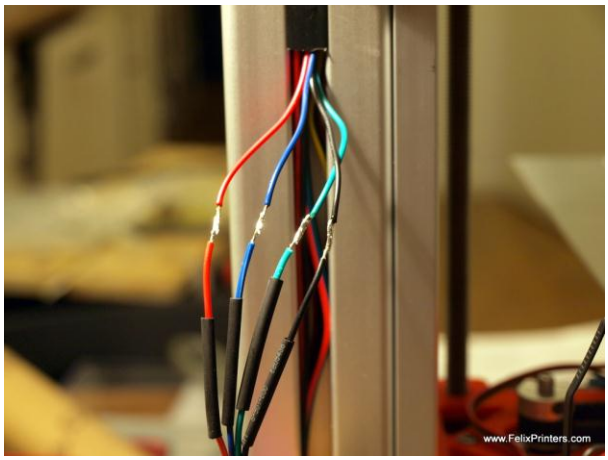
The wires of the opto sensor should look like this on the z-axis carriage.



Like this on the opto switch of the x-axis.

11.5 Connect the motor wires





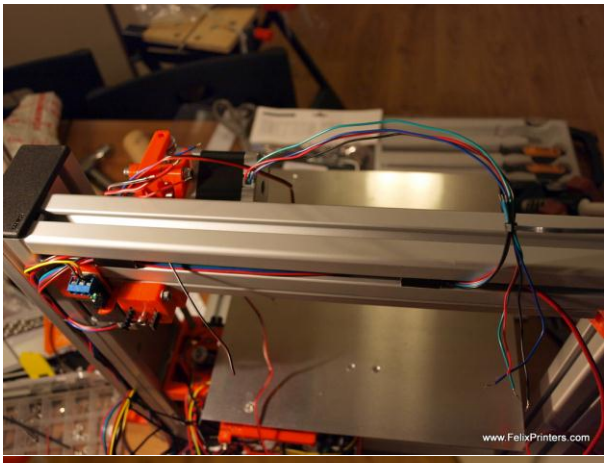
Easiest is to start with the x-axis motor:

- From both ends remove excessive pieces of cable,

IMPORTANT: do not throw away the cut off pieces of cable because it has to be used for later.

- Strip the ends
- Join the ends together, but don't forget to put a piece of heat shrink on each cable. Also make sure the colors match.

Do this for the Y and Z axes and try to follow the loops. The extruder motor however needs extra care.



The loop must be small enough that the cable doesn't get stuck around the far edge of the top beam, when the extruder is at its end position in x-direction.

The rest of the cables which run to the extruder carriage need to follow this just created loop.

11.6 Connect the rest of the wires

After connecting the motor wires the only wires left are the following:

- Wires for the hot-end
- The 3 fans
- Power supply wire, power on/off wire

11.6.1 Wires for the hot-end.

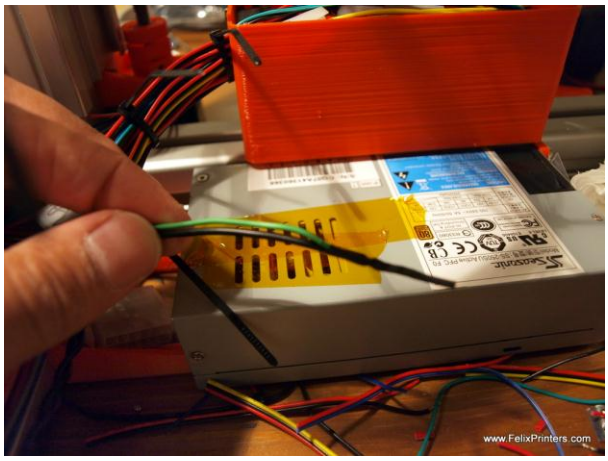
The supplied hot-end contains all the wiring. The pre-crimped wire need elongation in order for it to reach the ramps electronics. It can be elongated with the wires which were cut off for the motors. The power resistor wires are long enough to directly connect to the ramps electronics. Please check the schematics

11.6.2 The 3 fans

1. The fan which is connected to the air duct underneath the extruder motor needs to be connected to the ramps board. It is a switchable fan and should be connected next to the heated bed power resistor connection. Make sure the polarity is the same as in the schematics, because otherwise the fan will be damaged/unusable.
2. The fan which blows cool air to the top part of the hot-end is a non-switchable fan and needs to be connected to a +5 Volt (dark red) cable and a black cable directly from the power supply.. Again watch the polarity, when wrongly connected the fan will be damaged beyond repair.

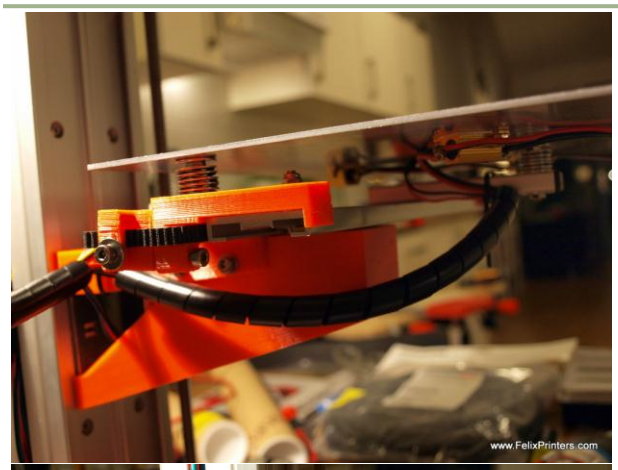
   Note: The fans are rated for 12V, but when connected to 12V it makes a significant amount of noise. Since the cooling capacity at 5V is more than enough. Another benefit is that the fans make virtually no sound at 5V
3. The fan in the ramps electronics case, this is the same as the 2nd fan. It constantly blows cool air and therefore must be connected to a 5V and a 0V cable of the power supply

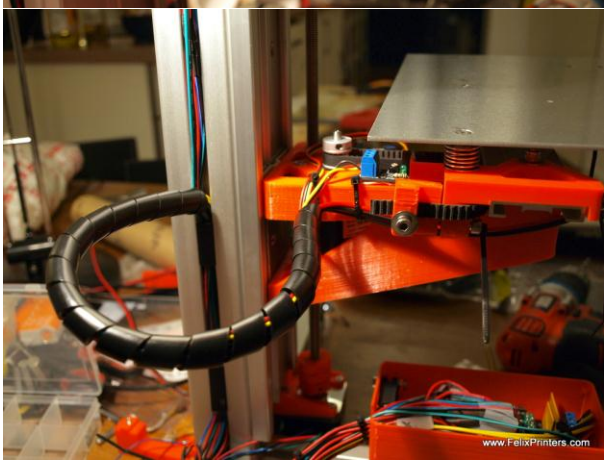
11.6.3 Power supply wire, power on/off wire



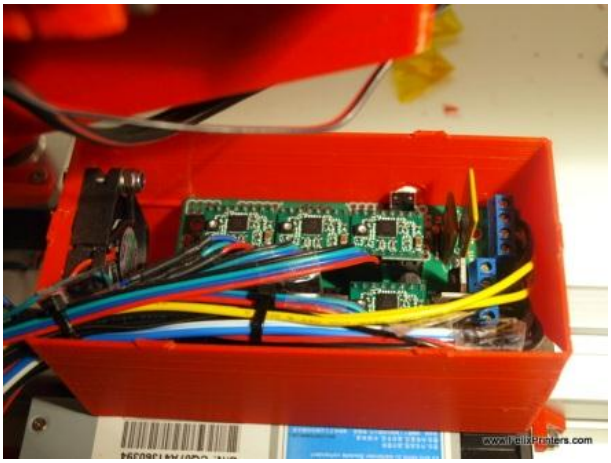
Connect the green wire of the power supply with a black wire. This is required to make the power supply turn on.

11.7 Clean it up.

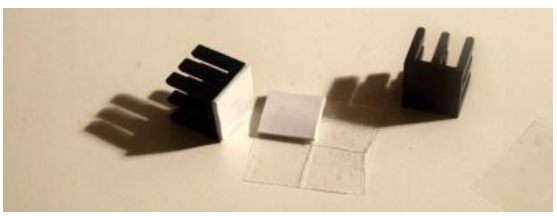




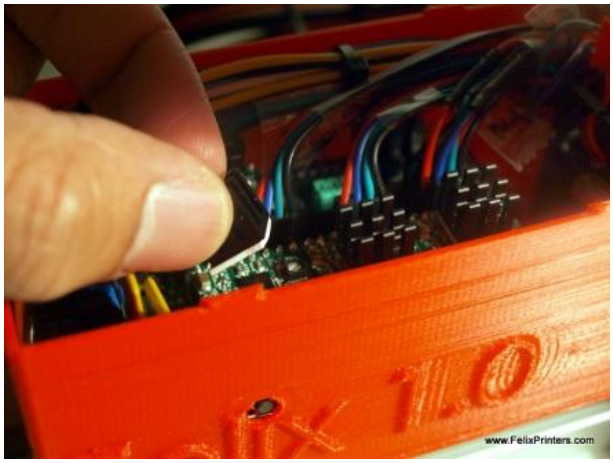
Try to make the loops look nice by putting it in the cable spiral.



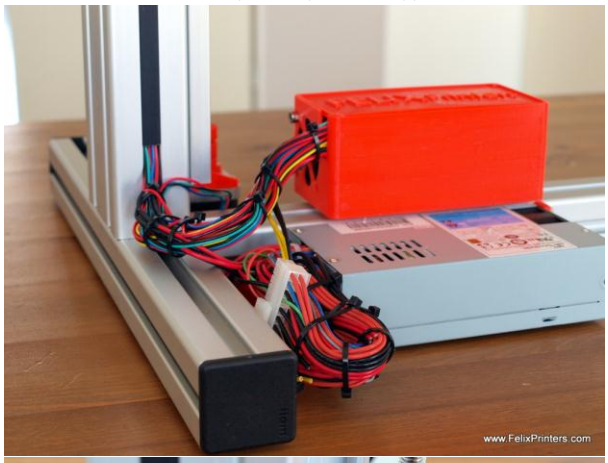
Finally manipulate the bundled cable to let it through the opening. The cables must be pushed flat because the lid of the box must be placed on there.

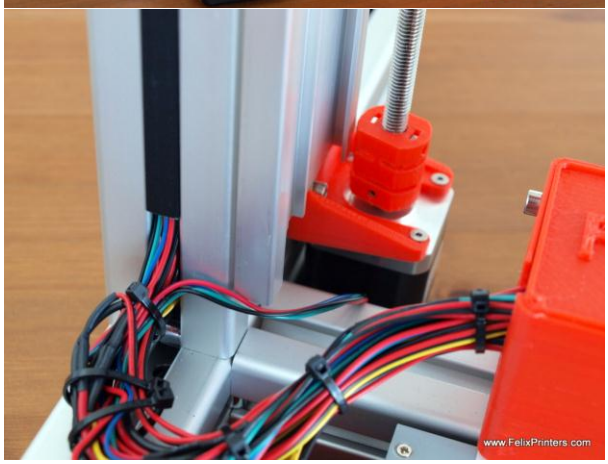


Get the heat sinks and put the self-adhesive conductive tape on it.

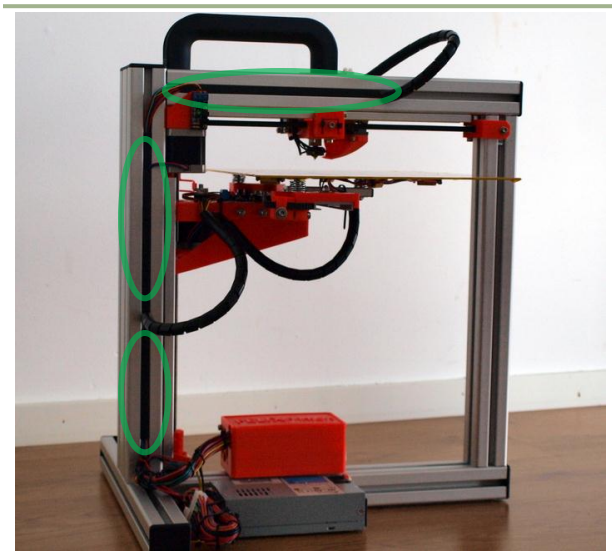


Place the heat sinks on the square chip on the stepper drivers.

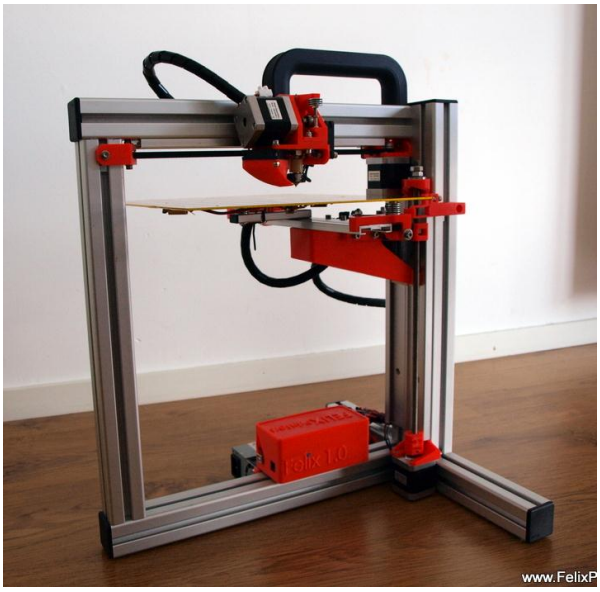




Join the cables near the power supply in an as neat as possible way. You could use cable-ties for that.



Cut of a piece of frame-strip to hide the cables that run through the frame.



Finally the front view of the printer should look like this.

Congratulations you are done with the electronics part and it is time for some finishing touches.

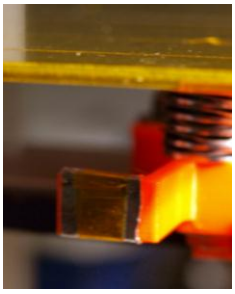
12 Finishing touches (time: 30-45 min.)

1. **Check all the bolts if they are tightened correctly.**

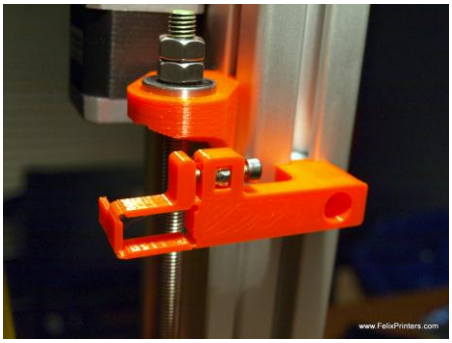
2. **Check if all the axes can move freely, without cables being jammed.**

3. **Put a little bit of oil or grease on the z-spindle, to make it run smoothly. Preferably a thicker kind of grease or oil, we use motor-oil.**

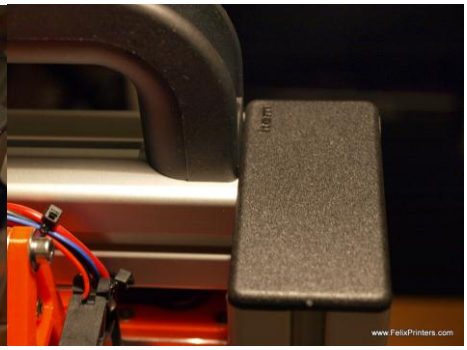
4. **When you have a printer with a shining through color, the opto-sensors might not work. To fix this, put aluminum foil around the switches or something thin and not shining through, otherwise the opto sensors might not work.**



5. Mount the z-axis limit switch. Preferably put it 5 cm below the top edge of the z-axis rail. This way you prevent the hot-end from hitting the table before the switching vane triggers the opto sensor.



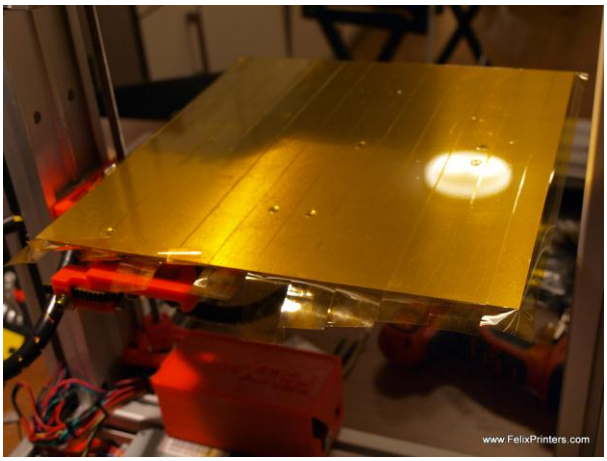
6. Mount the frame handle. Use the supplied M8 frame nuts and bolts to mount it. Place the frame holder as close to the vertical frame beam as possible.



Prepare the heated bed.

In this step the goal is to put a layer of tape on the surface of the heated bed. This layer makes sure the extruded plastic will correctly stick on the bed.

Degrease/clean the bed with some detergent. We use spirit, but alcohol, thinner, nail polish remover will work also.



Put strokes of the supplied tape on the heated bed. Try to do this with as little bubbles and overlap of the strokes as possible. The better you do this the nicer the bottom surface of the printed parts will be.

Fold the overhanging strokes of plastic around the edges. Then afterwards clean the surface with detergent.

Supplied with the kit is kapton or PVC tape this depends on our stock. After several tests with different kinds of tape we at FelixPrinters recommend the following:

- Kapton tape. Very good for printing, but costly
- PVC tape, has the same sticking quality as kapton tape, but significantly lower costs. Downside is the durability of the tape. Needs to be replaced more often.

NOTE: Be careful using painters tape in combination with PLA filament. The combination sticks so well that the printed parts are extremely hard to remove from the bed. To not damage the build platform we had to remove the parts including tape. It however works good when used for parts with a very small connecting surface to the bed. This is also a suitable tape for printing with ABS.

13 Making printer ready for operation.(30 – 60 mins)

The software used to control the printer is open source. It is available for different platforms. This manual currently only covers the WINDOWS version of the print software. For other platforms, guides should be available on the internet.

13.1 Install software on PC

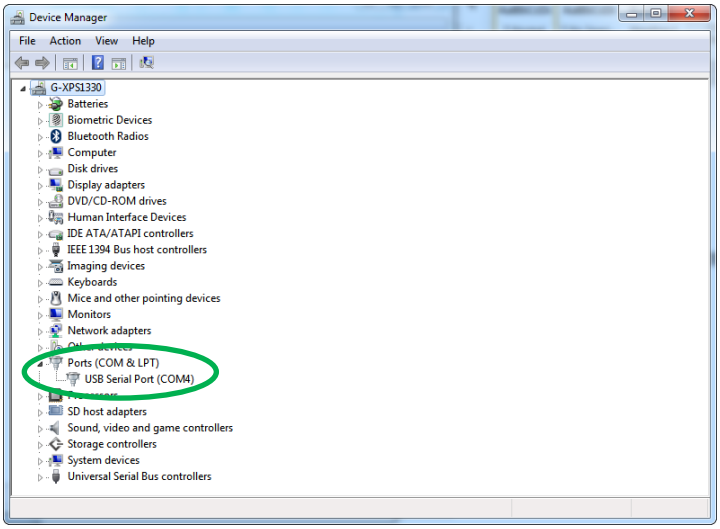
Go to the FelixPrinters http://www.felixprinters.com/support/software.html and follow the download links to get all the required software.

This step requires the following software:

- Arduino, platform to upload firmware to the printer.
- FELIX firmware for RAMPS 1.4,(check the revision of the printer). Contains printer settings for correct operation of your Felix printer.

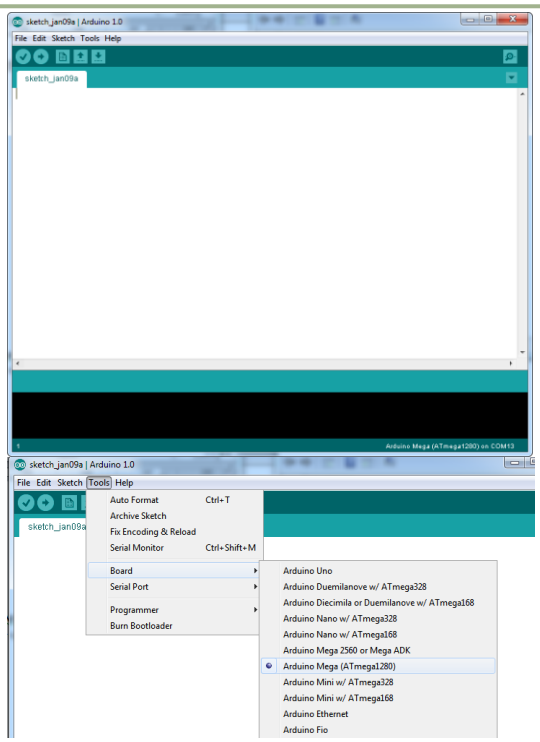
Steps to upload new firmware to the FelixPrinter

1. Make sure the power cable of the power supply is disconnected!!!
2. Plug in the USB cable into the RAMPS electronics and do the following:
    a. Check switching vane operation: Make sure the black slots of the opto sensors are free. Move the switching fanes over them by moving all the axes by hand. If the lights go out, the opto's are installed correctly.
3. When the USB cable was plugged in Windows will normally automatically install the correct drivers. If this is not the case then download drivers from here: http://www.ftdichip.com/Drivers/VCP.htm.
    a. Go to start->right-click on "Computer"-> click properties -> in left pane click "Device Manager"



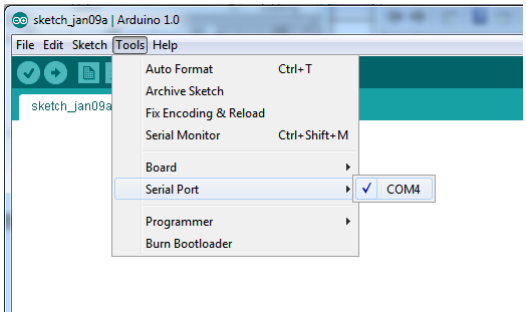
    b. Note what COM-port is present. If there are more than one COM ports available unplug the RAMPS USB cable, and re-plug it again. Check what port number is appearing and disappearing. This port number will be used for the next step.

4. Start Arduino software
   It should look like this:



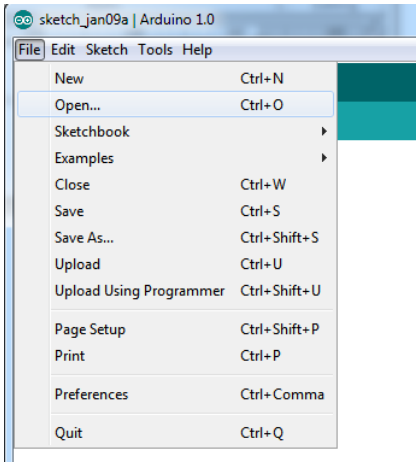
Select the correct platform:

Tools -> Board-> Arduino Mega(ATmega1280)



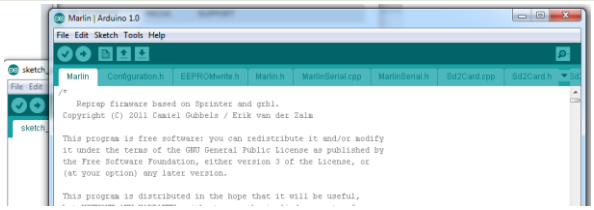
Select the correct Serial Port which you've noted earlier

Tools -> Serial Port -> COM...

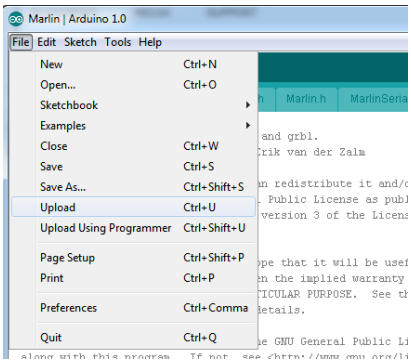


Extract the downloaded FelixPrinter firmware to some folder.

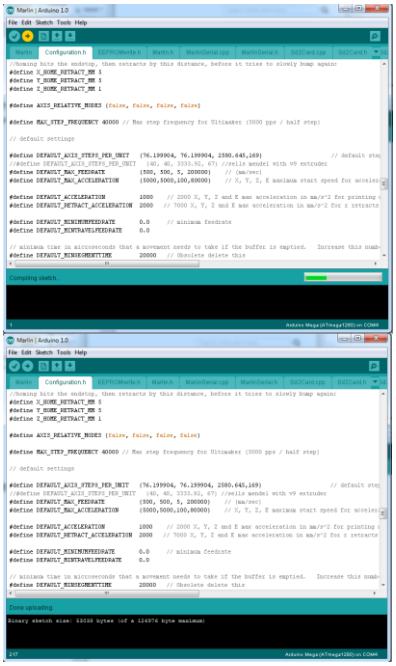
Open this folder through the Arduino interface and click on one of the files in that folder.

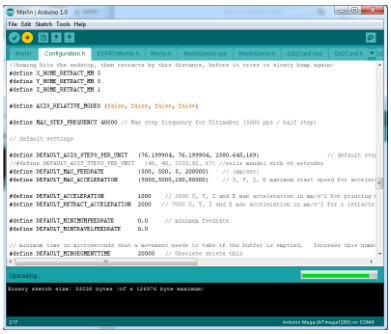


A new window will pop-up, with all the source firmware files. All the settings for the FelixPrinter to work correctly are configured. Feel free to browse around the files to get a better understanding of how it all works.



It is time to upload.





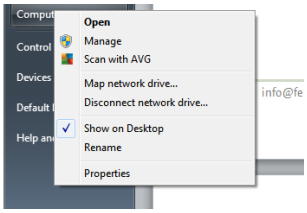
You are done with the firmware upload.

5. Now it is time to install the software required to convert your CAD files to the G-code and control the printer.

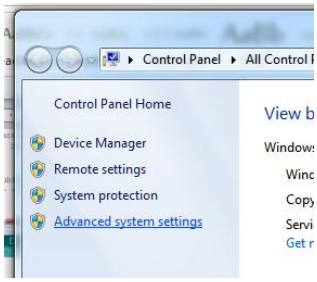
   Again go to the FelixPrinters website and do the following

   a. Download and install latest version of Python 2.x NOTE: Do not install version 3.x it doesn't work with pronterface and SFACT

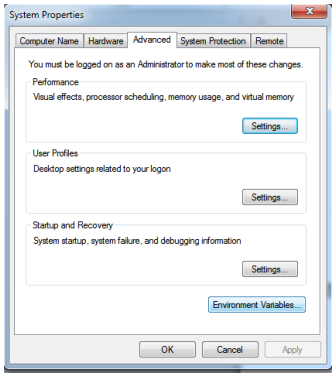
      i. After installing python make sure the python directory is on the windows path. If this is not the case the printer control program will work partially.

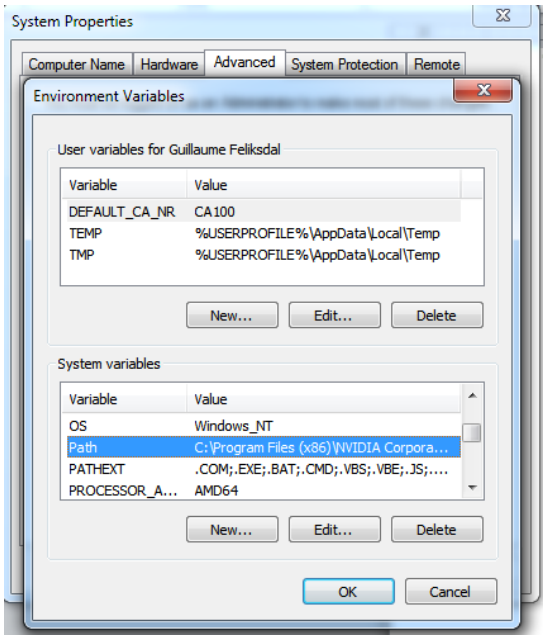
      ii. Goto start menu - >right click on my computer and click properties

iii. 

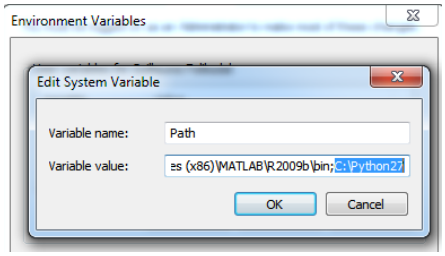
Click "advanced system settings"

iv. 

Click "Environment variables"

v. 

Scroll on the lower part of the window till you see "Path" Click once on the line and then click "Edit …"

vi. 

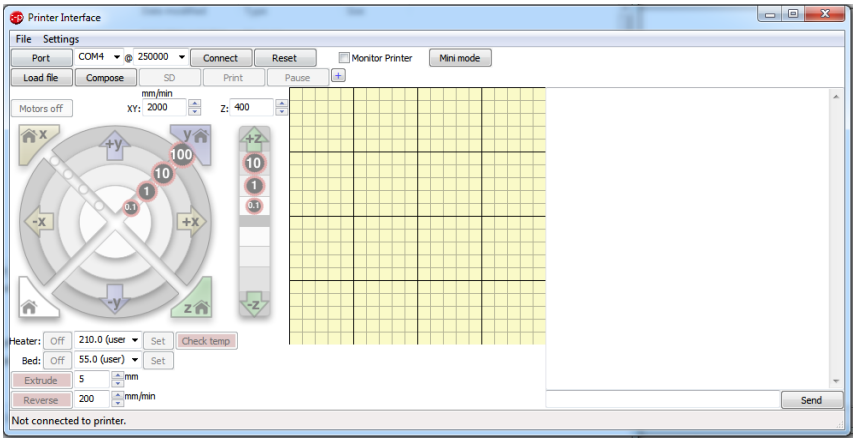
Add the directory name of Python, don't forget to put ";" in front of the name.

vii. Restart pc, to let the new settings become active.

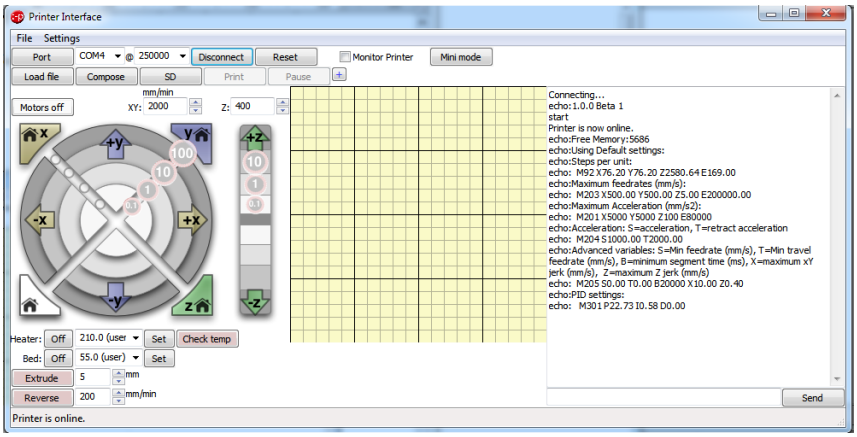
b. Download latest version of printrun software for Felix printer.

c. Extract printrun to a folder.

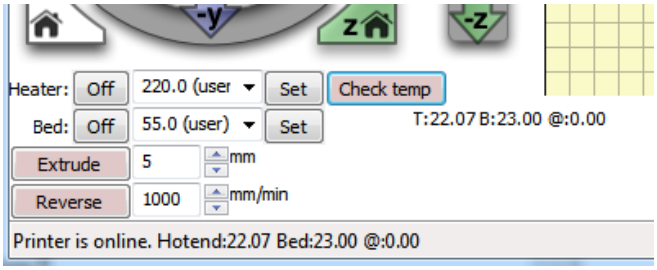
d. Double-click on the "pronterface.exe" file.



This is the printer interface to control your printer.

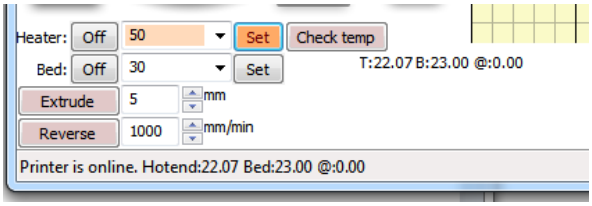
e. 

Select the correct port in our case it is COM4, set baud rate to 250000 and press the "connect" button. The status window should look like the figure above. The buttons to control the axis should not be grayed out anymore.

f. 

Plug in the power cable of the power supply

Check if the temperature control is working correctly. Press the "check temp" button. There should be displayed 2 temperatures. The first one is of the Hot-End, and the second one is of the Bed.

g. 

Now set one of the temperatures and monitor by constantly pressing check temp. See if it stabilizes to the set temperature. It has an overshoot so don't worry if the temperature goes higher than the set temperature. If the temperature however goes more than 30% higher than, there might be something wrong.

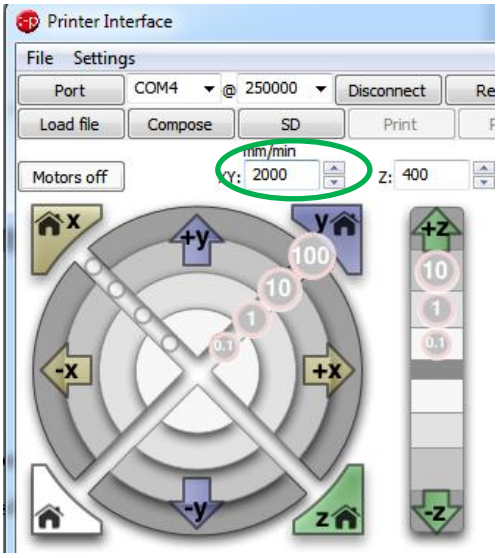
Some fault scenarios:

If you set the heater temperature and the bed temperature increases, then the temperature sensors are not connected correctly.

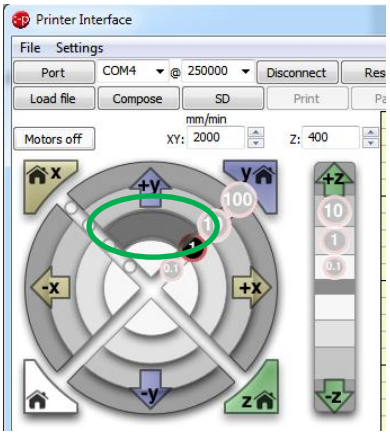
h. Do the same for the Bed, this will take longer because more mass has to be heated.

i. Try to move the axes:

NOTE: keep your hand on the USB connection. Be prepared to pull it out when stuff goes wrong!!



Set the velocity to a slow 2000mm/min.



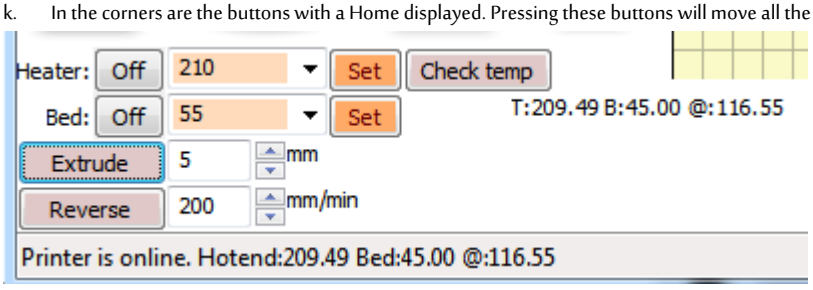
Try to move the Y axis by pressing the inner ring which corresponds to a movement of 1mm.

In case of skipped steps of the motor or loud high frequent noise, the stepper drivers' trim pot should be adjusted. First turn it to 0% by turning it fully counterclockwise. Then start increasing the %by turning it clockwise, 25 to 40% should be enough.

j. Try to move all the axes to their optosensor. Only do small movements of 1 or 10 mm!! Until the limit switch is reached. If the motor cables are installed correctly, a movement in negative direction should cause the axis to move to the optosensor. When the switch vane goes through the slot of the optosensor the axis should not move any further. When this happens, you know that your limit switches are working. When movement in the wrong direction is detected, the motor plug for the corresponding motor must be turned around. Before doing this, unplug the USB cable and power supply!!!!

For the Z-axis you must be extra careful not to let the heated bed and the hot-end collide when going moving the plate up to the optosensor. When close to the hot-end tip, move the axis with 0.1mm steps until you switch the opto-sensor. If the table hits the hot-end before the optoswitch then the switch vane must be moved downwards, either by the adjustment mechanism or by moving the complete z-switch vane.

k. In the corners are the buttons with a Home displayed. Pressing these buttons will move all the axes to their 0 position.



l. Next step is to see if the extruder is working correctly.
   - Move the bed minimally 20 mm downwards from the hot-end tip. Set the temperature of the hot-end to 210 degrees. Wait till the temperature is 210 degrees.
   - Insert the filament in the extruder guiding hole.
   - Set the values next to extrude and reverse to 5 and 200 respectively.
   - Press the Extrude button. The filament should be pulled down.
   - If it gets pushed up, the extruder motor plug should be turned around.
   - Keep pressing the extrude button until filament comes out.

14 Calibration of table (5-15 mins)

For a successful print it is important that the table is properly calibrated, which means it should be level. The table can be leveled by turning the 3 M4 nuts underneath the heated bed.

Steps:

Calibrate the table in y-direction.

1. Move the table up approximately 1mm from the hot-end.
2. Press the HomeX button.
3. Press the HomeY button.
4. Now move the Y-axis to its positive limit by pressing Y+ 100mm twice, while the y-axis is moving check if the distance between the hot-end and the table stays the same.
5. If the distance is not the same adjust one of the 2 nuts of the table along the y-axis. If the distance is too close at one end, turn the screws in such a way that the bed at that end will be lowered and vice versa.
6. Go back to c if the nuts had to be turned, otherwise go to the next step.

Calibration in x-direction

7. Press the HomeX button
8. Press the HomeY button
9. Press the Y+ 100mm button once, so the table is in the middle of the Y-stroke
10. Move down the table 2mm
11. Press the X+10 mm a couple of times till it moved to the end of the stroke. During this process, see if the distance between the hot-end and the table stays the same. Try to adjust the table-height by adjusting the nut underneath the table-support in the middle of the table.

Calibration in Z-direction.

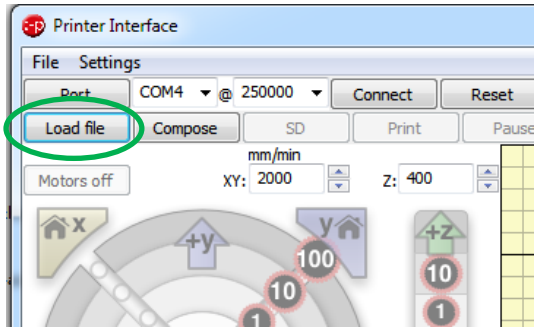
12. After leveling the heated bed, the homing z-position should be correct. This can be adjusted by tweaking the z-axis switching vane.
13. Press the homeZ button
14. After the home movement is finished, check the distance between the hot-end and the table. This should be approximately the layer height of a printed layer. In our case that is 0.32mm. Use a sheet of paper as distance measurement.
15. If it seems ok than you are finished otherwise adjust the z-axis switching vane.

You are done-calibrating the table.

15 It's time for printing! (15- 30mins)

After all the hard work of the assembly and setting up the machine it is time to get some reward by means of your first successful print.

Steps:



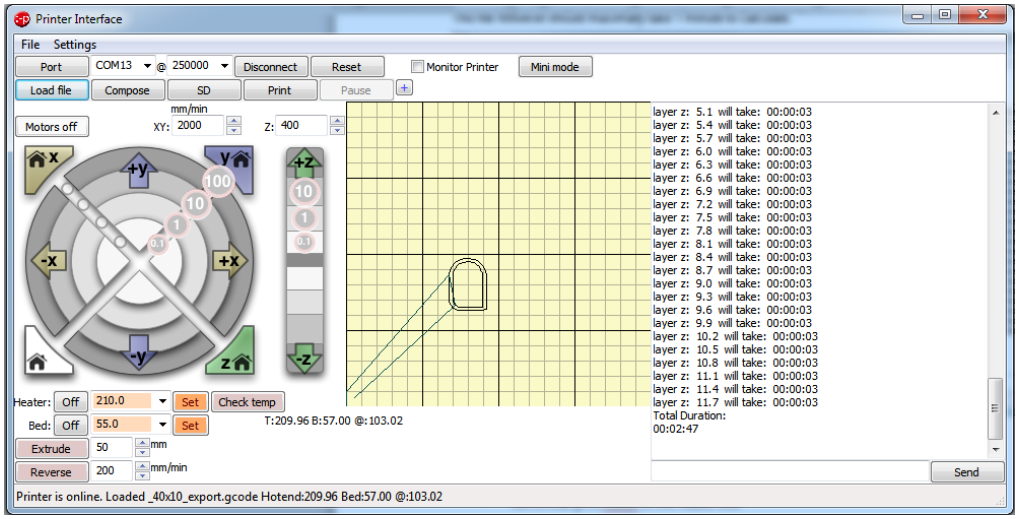
For the first print load a STL-cad file.

Find one in the sub-directory of the printrun program: \Printrun_Felix\skeinforge\calibration

For a quick test, open the "_40x10.STL".

The program will now calculate the movements for the print. Depending on the file-complexity this step could take from 10 seconds to 1 hour or more. To give an indication, the most complex printed part of the Felix-printer takes approximately 15 minutes to calculate on a 2.2 GHz core2duo processor.

The selected sample file should maximally take 1 minute to calculate.



Before pressing the "Print" button make sure of the following:

- Printer axes can move without obstructions
- Remove all plastic residues on the heated bed.
- Degreased heated bed surface
- When all axes are homed the hot-end is not touching the table.
- Make sure there is no left over plastic residue on the table.
- The supplied filament with the kit is PLA. The optimal temperature depends on the type of filament used. When using PLA check if the temperatures of the hot-end and the heater are between 180-210 and 30-60 degrees C respectively. When using ABS these temperatures should be somewhere around 210-250 and 70 – 100 degrees respectively. The heated bed temperatures can be much lower with painters tape.
- To find the correct temperature for optimal extrusion, start with a low temperature. Then go up slightly. When the temperature is too high, you might hear some pops and sisses coming from the hot-end. When the temperature is too low the extruder motor will have a hard time extruding. When printing at high speed, the temperature of the filament should be a little higher.
- Move down the table 10mm and insert the filament in the extruder. Run the extruder until a steady flow of plastic comes out. Remove this with tweezers.

- When there is not a continuous flow coming out of the nozzle, make sure the extruder arm is properly tensioned. Turn the m4 nut counterclockwise to put more tension on the filament, so it will be pulled into the hot-end better. But watch out, too tight and the motor will have a hard time to turn.

When these steps are OK, you are ready to press that print button.

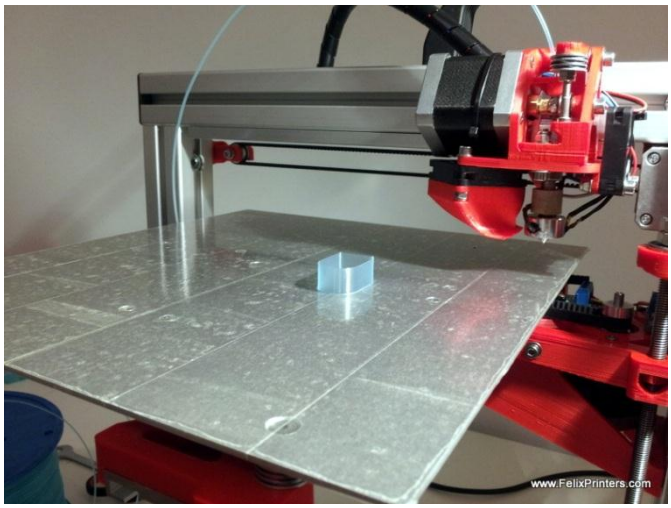
If the calibration was done ok the print should finish without any problem.

The most probable cause of failure could be the wrongly adjusted z-height of the first layer.

Two things can happen:

- The plastic won't stick to the heated bed. This means the distance between the table and the hot-end is too large
- The first layer sticks but seems squashed, compared to the other layers. This means the hot-end is too close to the table.

If one of the above failures happens, adjust the z-axis switch vane accordingly.



If the print looks like the picture above than congratulations your printer is completed!!

IMPORTANT info:

To keep the hot-end running as long as possible, let the filament run through a dust collector like a small piece of sponge. The filament picks quite a lot of dust due to static charge or dirt from the factory. This will all enter the hot-end and partially stick in there and finally clog the nozzle. When this happens the hot-end needs to be drilled out when hot from both sides. A tutorial for this is available on the forum on the website.

When changing different kind of filament it can be done in 2 ways:

1. Just cut the old part just above the extruder and keep running the extruder until you can feed the new filament.
2. Retract the current filament out of the extruder and then insert the new one.
    - To get the old filament out, retract 50 mm with a high velocity (1000mm/min). This is advised because fast retraction reduces stringing to a minimum. The little strings of molten plastic are able to jam the inlet of the hot-end. When this happens, you need to take out the hot-end and remove the plastic.
    - Then feed it again with a low velocity of 200mm/min.

16 Quest to high quality printing

After experimenting a little with the printer, you probably want to get the most out of your printer. This chapter addresses some categories to increase print quality.

16.1 Thermodynamics

Filament printing temperature is an important parameter. There is usually one optimal temperature to print at, this is different for each material type and even for different colors of the same material.
PLA prints somewhere between 180 to 210 degrees C.
ABS from 220 to 250 degrees.

This will happen when printing at too low temperature:

- The printed parts will become brittle, because the printed layers do not stick very well.
- Extruder needs a lot of force to push the filament through the nozzle. It can happen that at high print speeds, the force demand could not be fulfilled, which result in skipped steps of the extruder motor.

When printing at too high temperatures:

- You will experience ooze(little strings) of the filament.
- You could hear bubbles pop, this can be evaporated water inside the filament.
- Printing small prints will be difficult because when printing the next layer, the previous layer could still be soft.

TIP: when printing very small objects try to print at low speed or try to print more at once, this gives to previous printed layers time to cool down a bit.

Heated bed

The first layer which is in contact with the heated bed is the foundation of the printed part. You want to make sure that this first layer is near perfection. Sometimes it can be troubling to get parts to stick to the bed, or parts can come loose at the edges after a while. This can be because of the following:

- Bed surface is not degreased enough.
- Temperature of the heated bed is too low, try increasing it with 5 degrees
- Bed is not level. Make sure the bed is perfectly level, especially for large prints it can be that the distance of the hot-end to the bed is too much at one side of the print, when the bed is not level.
- Print speed of first layer is too fast.
- Hot-end temperature is too low. Try increasing it 5 degrees.

16.2 Mechanics

Bearings.

To further fine-tune the smoothness of the bearings it is recommended to use Teflon/PTFE spray on the sliding bearings.

Spray a little bit of Teflon/spray on a Q-tip. And rub the rail where the drylin parts make contact with the rail.

Note 1: Other oils are not recommended by the manufacturer of the bearings.

Note 2: DO NOT spray it directly on the bearings, because it will make a mess and the chances are that the Teflon fluid will creep underneath the tape, which is placed underneath the Drylin parts. The tape will then come off in time.

Belts/Pulley's

Usually when perimeters ofexperiencing bad print quality, this can mean the followingMake sure the pulley's are tightened.

1: Pulley's are not tightened enough

2: Belt tension is not high enough.

Hot-end

Check that the hot-end is fixed in the extruder carriage. If not, the prints will come out ugly.

16.3 Software.

High print speeds is nice, but you will suffer print quality. To have a good compromise between speed and quality, an infill speed of 80mm/s is a good start, then take the perimeter speed at 30 or 40mm/s.

17 FAQ

Q: Sometimes the extruded filament looks ugly or has a varying diameter:

A: Not homogenous extruded filament can be caused by the following:

- Check the filament quality. Bad quality filament can have a varying diameter from 1.95 to 1.4mm instead of a continous 1.75mm.
- There is not enough tension on the extruder arm. Increase the tension on the extruder arm a little. Be carefull by not to put too much tension, because the extruder motor can have a hard time turning
- Filament gets stuck somewhere. Check if the feed of filament to the extruder is going without any obstructions.

Q: There is vibration during movement in the y-axis table

A:

For the Y-axis(moving table) this can be prevented by doing one of the following

- Screw the bolts which hold the slider into the printed part less tight. When the screws are mounted too tight, the slider deforms a little, this could give stick slip behavior.
- Make sure the belt of the y-axis is tensioned properly. It could happen that when tensioning the belt the clamp slips. When this happens, tighten the clamp more.
- The jerking of the axis could also be because the y-axis stepper drivers should send more power to the y-axis. Try to rotate the trimpot of the y-axis clockwise a little and see what happens. Too much will give some twitching of the motor, when that happens turn the screw back a little.
- To reduce the play in the guides, there is kapton tape underneath the teflon parts of the sliding bearing. It could be that there is too much tape, which causes too much friction.

For the X-axis

- Tension the belt properly, too much tension will give high frequency vibration during a movement.
- Make sure the motors get enough power, try to turn the trimpot clockwise a little.

Q: There is a lot of backlash in the axis-movement:

A: Check the following:

- The belt is tensioned properly
- The set-screw on the motor-pulley is tightened enough

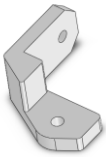
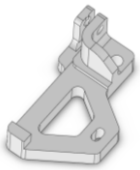
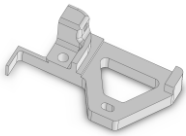
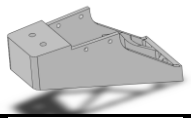
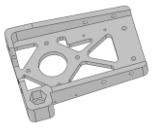
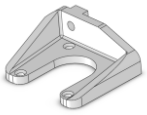
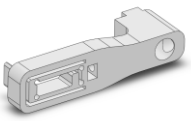
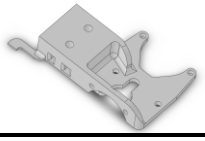
Q: When looking at walls of the printed parts, there are waves noticeable.

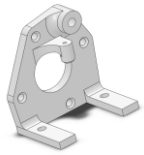
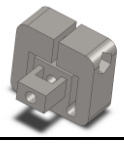
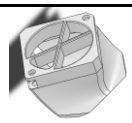
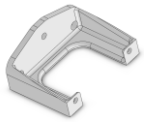
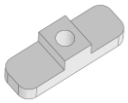
A: The reason for this is that the shaft of the motor, z-axis coupling and z-axis rod are not aligned properly. When the z-axis is rotating there should be a wobble noticeable. Try to do the following:

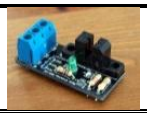
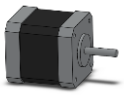
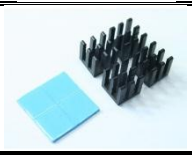
- Remount the z-axis coupling in the following way.
    - Try to turn the screws at the motor side of the coupling one by one and bit by bit. Each turn should by ¼ turn. Try to fixate it loosely and try to keep the bottom of the coupling parallel to the motorface as good as possible
    - Do the same for the top 2 screws of the coupling.
    - Turn the coupling by hand and see what side the wobble goes when turning. Then try to turn the screws in such a way that the spindle is moved in the opposite direction of the wobble.
    - When this seems ok, try to move the axis 10 mm up with pronterface. And see if there is still a noticeable wobble.
- The large M8 nut situated in the z-axis carrier part could be too tight in the slot. Try to file the hole out some more so it can move more freely.

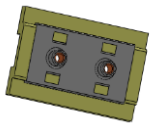
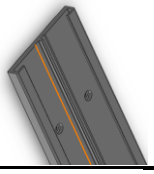
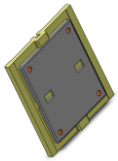
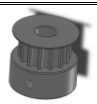
18 BOM Felix 1.0 Revision D

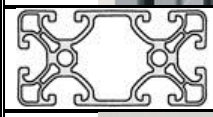
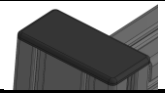
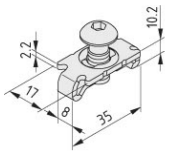
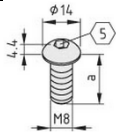
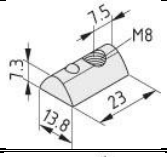
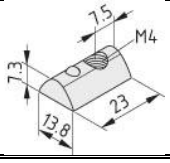
Bolts and screws	Amount	
ISO 4029 - M3 x 6-N - Set screw	10	
ISO 10642 - M3 x 8 --- 8N - Countersunk	28	
ISO 4762 M4 x 6 --- 6N	2	
ISO 4762 M4 x 12 --- 12N	8	
ISO 7380 - M4 x 12 --- 12N button head	15	
ISO 4762 M4 x 16 --- 16N	20	
ISO 4762 M4 x 20 --- 20N	15	
ISO 4762 M4 x 25 --- 25N	9	
ISO 4762 M4 x 30 --- 20N	5	
ISO 10642 - M4 x 30 --- 30N - Countersunk	4	
ISO 4762 M4 x 40 --- 20N	2	
Washer ISO 7093 - 4 (medium washer)	18	
Washer ISO 7089 - 4 - (small washer)	60	
Corrosserie ring - M4 - (large washer)	35	
crinkeled washer	25	
Powersupply screw	6	
bronze small screw	8	
Hexagon Thin Nut ISO - 4035 - M3 - N	15	
Hexagon Thin Nut ISO - 4035 - M4 - N	12	
Hexagon Nut ISO - 4034 - M8 - N	6	
ISO 7040-M4-N - self prevailing nut	30	

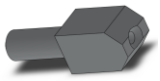
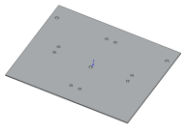
Printed Parts		
x-stage-motor-bracket_v5	1	
x-axis belt mount_v4	2	
y-stage bracket pt1_v3	1	
y-stage bracket pt2_v2	1	
y-stage bracket pt4	1	
z-spindelmount bottom - v3	1	
z_axis_carrier_pt1_v3	1	
z_axis_carrier_pt2_v5	1	
z-axis-motor-bracket_v8	1	
z-axis-limitswitch_vane_v4	1	
z-axis-coupling-v7	1	
Extru_base_v7	1	

Extru_base_pt2_v4	**1**	
Extru_base_pt3	**1**	
Extru_belt_clamp_v3	**1**	
Extru_arm_v2	**1**	
Extru_airduct_v2	**1**	
powersupply_bracket_pt5	**1**	
powersupply_bracket_pt4	**1**	
ramps_case_pt1_v2	**1**	
ramps_case_pt2_v2	**1**	
ramps_support	**2**	

Electronics		
Hot_End_resistor	**1**	
thermistor	**2**	
RAMPS + arduino + steppers fully assembled	**1**	
Fan 40x40x10mm	**3**	
mini-ATX-seasonic, powersupply	**1**	
Power Cable NL(optional)	**1**	
Power Cable USA(optional)	**1**	
Power Cable Australian(optional)	**1**	
Power Cable British(optional)	**1**	
optosensor	**3**	
motor nema 17	**4**	
Resistor 4.7 Ohm - heated bed	**4**	
heatsinks 10*8	**4**	
precrimped cables 4 threads	**4**	
precrimped cables 3 threads	**3**	
precrimped cables 2 threads	**2**	
Shielded USB cable 1.8m	**1**	
heatshrinks large 50 cm	**1**	

Heatshrinks small 15 cm	4	
Piece of 2 thread wire 2m, for heatbed and hot-end	2	
Mechanics		
Igus GmbH_NS-01-40 - rail	2	
Igus GmbH_NW-02- cart	2	
Igus GmbH_NS-01-80 - rail	1	
Igus GmbH_NW-02-80 - cart	1	
pulley_motor_HTD	2	
Toothbelt 1.5m	1	
z-spindle	1	
bearing-8x22x7	1	
bearing 5x12x6	5	
extruder_insert_piece	1	
y-axis mid-table support 20x10_profile	1	
t-slot nut mini	2	

Frame		
40x40x400 profile, incl 2xM8	**1**	
40x40x400 profile, incl 1xM8, 1xD7	**2**	
40x40x400 profile, incl 3xD7	**1**	
80x40x440 incl work	**1**	
40x40 protective caps	**4**	
80x40 protective caps	**1**	
frame connector set	**6**	
handle incl protective cap	**1**	
hex sockethead bolt M8x16 buttonhead	**2**	
t-slot nut - 8 ST M8	**2**	
t-slot nut - 8 ST M4	**22**	
dampning feet	**6**	
strip for putting away cable pieces of 40 cm	**2**	

Fabricated parts		
Hot_End_base_3mm	**1**	
Hot_End_peek_isolation_3_v2	**1**	
hot_end_heated_nozzle_3	**1**	
table_2mm	**1**	
Others		
tweezers	**1**	
tape for heated bed	**1**	
cable ties, set of 100	**1**	
cable spiral 1.25m	**1**	
2m cable	**2**	
piece of selfadhesive tape 10cm	**1**	
Piece of filament to start 5m	**1**	