Zesty Technology Documentation

Release 0.1

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Nimble Extruder

CHAPTER 1

Nimble documentation

1.1 Parts List

Here is a complete list of all the parts of the Nimble including the quantity needed for the Nimble.

Fig. 1: Parts layout

The following parts are not shown in the image:

- F, Drive cable sleeve
- L, Drive cable
- S, M3 nuts

1.1.1 Body

Item	Part name	Qty	Part Number
A	Bottom half	1	Z0N-07-0027
B	Top half	1	Z0N-07-0028
C1	Drive cable clamp Bracket side	1	Z0N-07-0030
C2	Drive cable clamp Nimble side	1	Z0N-07-0029
D	Groove mount adapter	1	Z0N-07-0035

1.1.2 Bearings

Item	Part name	Qty	Part Number
P	Worm bearing 7x13x4	2	Z0N-20-0019
Q	Gear shaft bearing 5x9x3	2	Z0N-20-0020
R	Pressure bearing 3x7x3	1	Z0N-20-0021

1.1.3 Drive System

Item	Part name	Qty	Part Number
E	Breech block	1	Z0N-07-0031
F	Drive cable sleeve	1	Z0N-07-0032
G	Worm gear	1	Z0N-07-0033
H	Gear wheel	1	Z0N-07-0034
J	Gear shaft	1	Z0N-20-0007
K	Pressure shaft	1	Z0N-20-0022
L	Drive cable	1	Z0N-20-0023
M	Stepper bracket	1	Z0N-20-0024
N	Coupler	1	Z0N-20-0025

1.1.4 Fastening

Item	Part name	Qty	Part Number
T	M3 Cap screw x 40	2	Z0N-25-0060
V	M3 Cap screw x 6	4	Z0N-25-0032
Z	M3 Cap screw x 8	2	Z0N-25-0056
W	M3 Jam nut (half height)	2	Z0N-25-0057
Y	M3 Set screws x 6	6	Z0N-25-0004
S	M3 Nut	2	Z0N-25-0061

1.2 Assembling the Nimble

1.2.1 Before we begin

Because of the process used to make the plastic parts (SLS) there is a possibility of powder remaining inside some of the smaller openings. For instance, there might still be a little powder left in the holes for the mounting bolts. This is the moment to inspect the parts and to make sure they are all powder free.

1.2.2 Step 1

Fig. 2: Insert bearings for worm

- You will use the Worm bearings (part P) and both the shell housings (parts A and B)
- Insert one bearing into each of the shell housing.
- This can require a little force. If you cannot get it right, you can use the Worm (part G) to push the bearings in properly.
- Do this for both the bottom and the top shell.

Fig. 3: Insert worm

- Apply grease (10k CST silicon diff lube if you need to replace later) from white tube to the Worm (part G) then insert in the bearing of the Bottom housing.

Fig. 4: Insert hob and place bearings

- To assemble the gear shaft take the following parts:
  - Gear shaft bearings (Part Q) 2x
  - Gear shaft/Hobbed wheel (Part J)
  - Gear wheel (H)
- Notice that on the end of the plastic part of the gear shaft we have included a little indicator to show you that the gear is turning. The shafts are so smooth that you would not be able to see it otherwise. If you want you can use a permanent marker to colour the top surface of the indicator to make it more visible.
- Insert the Gear shaft into the Gear and make sure the flat parts match. This needs a little push as it is supposed to be a close fit.
- Now fit the Gear shaft bearings on both sides and hold it together while going to the next step.

1.2.3 Step 2

1.2.4 Step 3

1.2.5 Step 4

Fig. 5: Mount gear shaft

- Fit the combined gear shaft and hob into the Nimble making sure the teeth of the gear mesh nicely with the worm gear.
- Place a little bit of the grease in the teeth of the gear. Just a few drops is enough.

Fig. 6: Close Nimble

- Close the Nimble by placing the Top shell half. Make sure the worm gear is seated nicely in the bearing and that the seam is completely closed. If not, it probably is caused by the fact that the bearings for the Worm are not properly seated. Press down until it is fully closed.

Fig. 7: Click Breech block

- To keep the Nimble closed and together, you can place the Breech block (part E) into the housing. This will lock into place with a click. To do so, keep the breech block horizontal, place the shafts into the bottom grooves of the housing and rotate the breech block upwards, between the upper "forks" until it clicks into place.

Fig. 8: When mounting on a plate, use the Groove mount adaptor

- Mount the Nimble on your printer. If you are using an adapter, have a look at the adapter page to see if there are any specific instructions for that adapter.
- The overall procedure if using the Groove Mount Adapter (Part D) is to have the Hot end in place, place the Groove mount adapter over the top of the hot end and place the Nimble on top of that, making sure the little tabs fit inside the "forks" of the Nimble. This locks the Nimble to the hot end and keeps it centered.

Fig. 9: Using another mount, check instructions.

- For now use only 1 bolt (part T) to bolt the Nimble to the adapter or printer. This is done to lock it in and keep everything together while you prepare the drive cable and sleeve. You might need the M3 nuts here.

Note: Do not overtighten these M3 bolts. Simply finger tight and then 1/4 turn is enough.

Fig. 10: Mount stepper to Bracket

- Moving to the other end, the stepper. Mounting the Bracket (part M) to your stepper, using the M3 screws (V). The center hole will make sure the stepper is centered in the Bracket. If the center hole is too big, please try to center the Bracket as perfectly as you can.

Fig. 11: Bolt Bracket to printer

- Mount the stepper to your printer frame. The image shows it being mounted to a 20x20 aluminium profile. Other methods can be; mounting it to the base, attaching it to a bracket and mounting that to your printer or any other way of fixing the stepper to your printer.

Note: The mounting hardware is not included with the Nimble.

Fig. 12: Insert Coupler on stepper shaft

- Place the Coupler (part N) on the shaft of the stepper. The Coupler should fit through the top hole of the Bracket. Slide it down until there is approx 1.5 mm space between the stepper base and the Coupler. See step 12

Fig. 13: Tighten bottom set screw

- Rotate the Coupler until the bottom set screws are perpendicular to the flat on the stepper shaft (if there is one). Make sure there still is approx 1.5 mm space between the stepper base and the Coupler and tighten the bottom set screw (part Y).

Fig. 14: Slide Drive Cable Sleeve into Sleeve Clamp (Stepper side)

- Take the Sleeve Clamp (part C) and slide the Drive Cable Sleeve (part F) in the top, as far as it will go. There is a little step in the bottom of the sleeve clamp to make sure the sleeve goes in just to the right depth.
- Clamp the sleeve using the M3 screw (part Z) and the Half nut (part W). Tighten the screw nice and tight. There is a little ridge inside the sleeve clamp to prevent you from squeezing the sleeve too far and jamming the drive cable.

1.2.6 Step 5

1.2.7 Step 6

1.2.8 Step 7

1.2.9 Step 8

1.2.10 Step 9

1.2.11 Step 10

1.2.12 Step 11

1.2.13 Step 12

1.2.14 Step 13

1.2.15 Step 14

Fig. 15: Insert Sleeve clamp into stepper bracket, taking note of the 3 tabs

- Mount the Sleeve Clamp to the Bracket.
- There is a flat tab with a bump underneath, that should line up with the hole after locking the sleeve clamp in place. It should click into the small hole in the bracket.

1.2.16 Step 15

This could need force, we designed it to be tight.

- If it takes too much force, use a adjustable wrench or something for the first time.
- It needs to be tight as the surface of the clamp smooths out over time.

Fig. 16: Slide Drive Cable into Coupler.

- Now, take the drive cable itself (part L), both ends have square sides pressed into it. Even here it is reversible. Slide one end into the Drive Cable Sleeve and thread it all the way through. It will slide into the Coupler. Slide it all the way down and clamp it using the remaining 4 set screws (part Y)

Fig. 17: Slide Drive Cable Sleeve into Sleeve Clamp (Nimble side)

- Back to the Nimble side.
- Slide the Sleeve, now containing the drive cable as well, into the next Sleeve Clamp (part C) and push it down as far as it will go. Use the M3 screw (part Z) and the half nut (part W) to clamp the sleeve.

Note: After mounting the Nimble in place, you can loosen this screw a little to adjust the direction of the drive cable. Allow it to have a relaxed and free arch to the stepper.

1.2.17 Step 16

1.2.18 Step 17

1.2.19 Step 18

1.2.20 Step 19

Using the Nimble

First run the extruder a minute or two, with no filament clamped. Just to bed the gears and drive cable in. Extrude and retract a few times. (You will have to switch off the temperature control as most controllers will not move the extruder stepper unless the hot end it up to temperature) Use M302 P1 on RepRapFirmware to switch cold extrusion on (allow extrusion while cold) and M302 P0 to switch it off again. For other firmware use M302 S0 to switch cold extrusion on and M302 S170 to set extrusion to a minimum temp of 170C.

Insert filament

To insert filament, open the breech block. You do this by squeezing together the "ears" of the breech block and pulling outwards. You can leave the shafts of the breech block in or, for better visibility, take the whole breech block out.

Now you can see the top of the hot end (usually, depends on the adapter used) and slide the filament in. If the hot end is up to the correct temperature, you can purge the old filament by simply pushing down on the filament and feeding it into the hot end. After the old filament is cleared you can close the breech block.

Note: this is is an excellent way to get a sense of the efficiency of your hot end. You can feel the resistance of the hot end and how easy it is to push the filament through.

Fig. 18: Insert square end of Drive Cable into worm gear inside Nimble

- Insert the drive cable into the worm and then slide it down. To place the sleeve clamp correctly, make sure you line up the tabs with the 3 slots on the Nimble and in such a way that when locked, the screw in the next step fits inside the notch. This can take a little push the first time. As long as you make sure it is aligned properly, this is not a problem.

Fig. 19: Use second bolt to affix Sleeve Clamp and Nimble in position

- Now use the remaining screw (part T) and perhaps the remaining M3 nut, to bolt the Nimble to the printhead or effector. The Nimble is now installed. Have a good look to see if it all looks the way you think it should look and correct any things that do not look right.

Note: Do not tighten these M3 bolts too tight. Simply finger tight and then 1/4 turn is enough.

- This is also the moment to adjust the direction of the drive cable, so that it forms a nice arch to the stepper, as mentioned in step 17. So loosen the short M3 screw from the half nut until you can just rotate the drive cable sleeve. Once it is in position, make sure it is seated properly by pressing down and then tighten the screw again.

To close the breech block, place the shafts into the slots of the "forks" on the Nimble, rotate until vertical and the ears click into place. The Nimble is now ready to use.

If the hot end is up to temperature, you can now test the extrusion. Simply extrude about 10 mm and observe how the filament comes out of the hot end. It should be a neat straight line.

Tuning the firmware

Before using the Nimble you need to tune the firmware and calibrate the extrusion. You will need to tune the firmware first, as the Nimble is quite a different type of extruder.

See the *Tuning the Firmware* page.

1.3 Tuning the Firmware

The Nimble is a different beast to standard extruders and therefore requires some quite specific firmware changes if you hope to get optimal performance. We recommend use of a 1.8 degree stepper, 0.9 degree stepers are great for your other axis, but with the Nimble it's just not required or advisable.

Note: For 32 bit boards start at around 2700 steps/mm at 1/16 microstepping.

Note: For 16 bit boards start at around 1200 steps/mm at 1/8 microstepping.

Note: For 8 bit boards start at around 600 steps/mm at 1/4 microstepping.

Your settings will probably be slightly different, so after setting this do the normal extrusion calibration.

1.3.1 Configuring microstepping

Depending on your electronics microstepping will either be changed by altering jumpers, if your driver is configurable via software:

Marlin:

If driver microstepping is settable via firmware.
#define MICROSTEP_MODES {x,y,z,e0,e1}

Repetier:
Usually configured via hardware jumpers.

RepRap Firmware:
https://duet3d.com/wiki/G-code#M350:_Set_microstepping_mode

Smoothieware:
http://smoothieware.org/extruder
Version 1.0 board has microstepping fixed at 1/16
Version 1.1 board fixed at 1/32.
Adjust steps accordingly.

1.3.2 Current for the stepper

The tuning of the stepper driver for efficient extrusion and retraction is a little different, than with a bowden system or other direct drive systems. Because the Nimble has so much torque available, you can/must run a much lower vref for your stepper than normal. This also helps getting the pulses across properly as you are not fighting decay in the pulses caused by too much current. (Yes there is such a thing, have a look at the excellent work Ryan Carlyle has done: https://github.com/rcarlyle/StepperSim)

Start with the suggested vref and go down if needed. Don't be tempted to simply increase vref if the stepper stalls. It feels contra-dictionary, but the science backs it up.

Note: Suggested vref is 0.3V or 500 mA but it depends on your setup and actual voltage supplied.

1.3.3 Acceleration value

For the acceleration settings, let's begin with a low setting and you can increase it later if you want to have a faster retraction. Again, the aim here is to move things as smoothly as possible.

Note: Suggested acceleration setting is 120 mm/sec2

1.3.4 Jerk value

Another aspect you need to reduce is the jerk value as it helps to move the gears and drive cable in a smooth way. The goal here is to get smooth motion, not harsh forced movements. After you adjust the jerk settings, we suggest you leave them as set and do not use them to tune the retraction. They have little if any measurable impact on print speed anyway.

Note: Suggested jerk or instant speed change setting is 0.6 mm/sec or 40 mm/min

Marlin:
DEFAULT_EJERK = 0.6

Repetier:
EXT0_MAX_START_FEEDRATE = 0.6

RepRap Firmware:
M566 should have E value set to E40 (as it is set per minute)

Smoothieware:
http://smoothieware.org/motion-control#junction-deviation
Smoothie does not use jerk, you instead need to alter the Junction deviation setting, we suggest you start at 0.001 and work your way up in 0.001 increments.

1.3.5 Retraction speed

For the normal extrusion and retraction settings in your slicer, please test the settings with the extruder multiplier set to 1 or 100% extrusion. Set the retraction speed to 30 mm/sec. This is the optimal retraction speed for PLA and should be the standard. You can increase retraction speed if you want to, but normally 30 mm/sec is perfect. It will depend on the hotend you are using, but a retraction distance of 1mm is a good starting point.

Note: Suggested retraction speed is 30 mm/sec with retract of 1mm.

1.3.6 Tuning it all

Now comes the fun part. You can start playing with the acceleration and vref settings to get better retraction, if you want to have faster retractions. Please leave the jerk settings as they are. Tuning the retraction is now a matter of give and take by playing with the settings.

- Set the initial desired retraction speed and check to see if it stalls. If it does not, you can increase the acceleration value until your retraction starts to stall.
- **You can now do a few things.**
  - You can decrease the acceleration and leave it at that.
  - Or you can decrease vref a bit further and try again.
  - Or you can reduce the retraction speed.

Up to you and what your situation and printer needs. By playing with these settings you can fine tune the whole retraction process.

1.3.7 Troubleshooting

If these settings do not work for you, the first thing to try is to reduce the jerk setting. You can go as low as 0.1 mm/sec as the jerk setting has virtually no impact on your total print time. If you still find you cannot retract at the speed you need, reduce, let me repeat that, reduce the vref even further. You can go down as low as 0.1V. If it still does not work as you expect, contact us on chat and we will have a lively discussion about it.

One more step, calibrating the extrusion length. Go to the *Calibration of the Nimble* page or click Next.

1.4 Calibrating the Nimble

Because of the gear ratio inside the Nimble, the steps per millimeter are a lot more than your usual number.

Note: Start with 2700 steps/mm with a 1.8deg stepper and 1/16 microstepping

Try tuning without wipe and coast first, there's no bowden tube pressure buildup, so coasting not really needed.

The Nimble has a nice flat surface you can use to set the ruler on, when measuring the filament, simply place it on top of the "ears" of the breech block. Use a light coloured filament, place it in the breech, heat up the hot end and start the process.

- Measure 100 mm on the filament, by holding the filament against the ruler while the ruler stands on the breech block ears.
- Mark the distance with a permanent marker.
- Extrude 50 mm using the firmware controls.
- Measure the remaining length to the mark made.
- Calculate the new number of steps/mm using the following formula:

Note: New steps = current steps * 50/actual mm extruded (50 being the 50 mm of filament you wanted to extrude.)

- enter the new value in your firmware settings.
- Do the whole sequence again, to confirm that the steps per millimeter are now set correctly.
- if not, recalculate and re-confirm.

Done! All the tuning and calibrations are done. You are now ready to start using the Nimble, so go to the *Using the Nimble* page or click Next.

1.5 Using the Nimble

The Nimble is designed to be easy to use. Here are the basic tips to make it even better.

1.5.1 Loading the filament

The filament loading mechanism is based on the breech loading idea of old muskets. Instead of fiddly work trying to insert the filament from the top, guide it past the hob and into a hot end you cannot see, we decided to open it up and show to the whole path.

..note:: It is a lot faster to do that to read about it.

Open it up

Have a look

Insert filament

Close the breech

Fig. 20: Open the breech

- Squeeze the “ears” together.
- Pull the ears forward, away from the Nimble.
- This can require a little force the first few times.
- Now lift the Breech out of the “forks” on the Nimble

Fig. 21: Have a look

- Have a look between the forks
- You can see the hob and the hot end opening
- If you are using PTFE lining, you can see if the lining is tight against the Nimble.

Fig. 22: Insert filament

- It is now easy to slide the filament into the hot end.
- Slide it all the way down, into the melt chamber.

Fig. 23: Close the breech

- Place the prongs into the slots on the bottom forks
- Rotate the breech upwards
- Squeeze the ears in and slide between the upper forks
- the breech will click into place

Great, done. The filament is loaded and ready to print. That took about a minute or so to read, but it will take about 2 seconds to do.

1.5.2 Tips and tricks

When the breech block is open en there is no filament, you have a good opportunity to have a look at the hob, to see if it is clean. Also, have a look at the PTFE lining, if you use it in your situation, to see if it is still tight against the Nimble base.

When inserting the filament and IF the hot end is up to working temperature, you can use the new filament to purge the rest of the previous filament. Simply press the filament down into the hot end, without the breech in place. You can feel the filament melt and be pushed through the melt zone and out the nozzle. Continue pushing gently until all the previous filament is gone.

Note: This is a GREAT way to sense if there is a blockage or another problem in your nozzle or melt zone.

You could even use this to fix two printed parts together. Simply hold the 2 parts together, place them against the hot nozzle and while you feed in some filament, “weld” the 2 parts together. We have done it and admittedly, it is tricky to hold the two parts together properly with one hand, but if the parts are suitable, it works like a charm.

CHAPTER 2

Sidewinder documentation

2.1 Parts List

Here is a complete list of all the parts of the Sidewinder including the quantity needed for the Nimble.

Fig. 1: Sidewinder Parts layout

The following parts are not shown in the image:

- F, 1 x Drive cable sleeves
- L, 1 x Drive cables

2.1.1 Body

Item	Part name	Qty	Part Number
A	Bottom half	1	Z0N-07-0041
B	Top half	1	Z0N-07-0042
C1	Drive cable clamp (Bracket side)	1	Z0N-07-0030
C2	Drive cable clamp	1	Z0N-07-0029
D	Worm lid	1	Z0N-07-0043

2.1.2 Bearings

Item	Part name	Qty	Part Number
P	Worm bearing 7x13x4	2	Z0N-20-0019
Q	Gear shaft bearing 5x9x3	2	Z0N-20-0020
R	Pressure bearing 3x7x3	1	Z0N-20-0021

2.1.3 Drive System

Item	Part name	Qty	Part Number
E	Breech block	1	Z0N-07-0044
F	Drive cable sleeve	1	Z0N-07-0032
G	Worm gear	1	Z0N-07-0033
H	Gear wheel	1	Z0N-07-0034
I	spacer ring	1	Z0N-20-0049
J	Gear shaft	1	Z0N-20-0007
K	Pressure shaft	1	Z0N-20-0022
L	Drive cable	1	Z0N-20-0023
M	Stepper bracket	1	Z0N-20-0024
N	Coupler	1	Z0N-20-0025

2.1.4 Fastening

Item	Part name	Qty	Part Number
T1	M3 Cap screw x 30	1	Z0N-25-0065
T2	M3 Cap screw x 25	1	Z0N-25-0055
T3	M3 Cap screw x 20	1	Z0N-25-0066
T4	M3 Cap screw x 14	1	Z0N-25-0067
Z1	M3 Cap screw x 6	4	Z0N-25-0004
Z2	M3 Cap screw x 8	2	Z0N-25-0056
W	M3 Jam nut (half height)	2	Z0N-25-0057
Y	M3 Set screws x 6	6	Z0N-25-0004
S	M3 Nut	4	Z0N-25-0061

2.2 Assembling a Sidewinder

2.2.1 Before we begin

Because of the process used to make the plastic parts (SLS) there is a possibility of powder remaining inside some of the smaller openings. For instance, there might still be a little powder left in the holes for the mounting bolts. This is the moment to inspect the parts and to make sure they are all powder free.

2.2.2 Step 1

Fig. 2: You will use the Worm bearing (part P) and the Top Housing (part B)

- Insert one bearing into the shell housing.

Note: This can require a little force. If you cannot get it right, you can use the Worm (part G) to push the bearings in properly.

Fig. 3: You will use the Worm bearing (part P) and the Worm Lid (part D)

- Insert one bearing into the shell housing.

Note: This can require a little force. If you cannot get it right, you can use the Worm (part G) to push the bearings in properly.

2.2.3 Step 2

2.2.4 Step 3

Fig. 4: Apply grease (10k CST silicon diff lube if you need to replace later) from white tube to the Worm (part G) then insert in the bearing of the Top Housing.

- Slide the Worm Lid over the Worm and close the top half of the Sidewinder.

2.2.5 Step 4

Fig. 5: To assemble the gear shaft take the following parts: * Gear shaft bearings (Part Q) 2x * Gear shaft/Hobbed wheel (Part J) * Spacer Ring (Part I) * Gear wheel (H)

- Notice that on the end of the plastic part of the gear shaft we have included a little indicator to show you that the gear is turning. The shafts are so smooth that you would not be able to see it otherwise. If you want you can use a permanent marker to colour the outside surface of the indicator to make it more visible.
- Slide the Spacer Ring over the long shaft of Gear Shaft (Part J)
- Insert the Gear shaft into the Gear and make sure the flat parts match. This needs a little push as it is supposed to be a close fit.
- Check to make sure the Spacer Ring is between the Gear Shaft and Gear Wheel
- Now fit the Gear shaft bearings on both sides

Fig. 6: Mount the Bottom Housing (Part A) to the Nimble Sidewinder adapter of your choosing.

- Only use the screw T3 for now. This is done as the screw is not easy to access after the Nimble Sidewinder is completely assembled.

Fig. 7: Fit the combined gear shaft and hob into the Bottom Housing. * Place a little bit of the grease in the teeth of the gear. Just a few drops is enough.

Fig. 8: Fit the assembled upper housing onto the Bottom Housing.

- Make sure the little tabs and extra ridges fit neatly into the Bottom Housing, These are used to lock the shells into the correct position.

Fig. 9: Use the remaining two long bolts (Part T1 and T2) to bolt the complete Sidewinder to the chosen adapter.

- Do not overtighten these M3 bolts. Simply finger tight and then 1/4 turn is enough.

Fig. 10: Place the Breech block (part E) into the housing.

- This will lock into place with a click.
- To do so, keep the breech block horizontal, place the shafts into the bottom grooves of the housing and lever the breech block upwards, between the upper "forks" until it clicks into place.

Fig. 11: Mount stepper to Bracket

- Moving to the other end, the stepper. Mounting the Bracket (part M) to your stepper, using the M3 screws (V).
- The center hole will make sure the stepper is centered in the Bracket.
- If the center hole is too big, please try to center the Bracket as perfectly as you can.

Fig. 12: Bolt Bracket to printer

- Mount the stepper to your printer frame. The image shows it being mounted to a 20x20 aluminium profile.

Note: Other methods can be; mounting it to the base, attaching it to a bracket and mounting that to your printer or any other way of fixing the stepper to your printer. The mounting hardware is not included.

Fig. 13: Insert Coupler on stepper shaft

- Place the Coupler (part N) on the shaft of the stepper.
- The Coupler should fit through the top hole of the Bracket.
- Slide it down until there is approx 1.5 mm space between the stepper base and the Coupler. See step 12

2.2.6 Step 5

2.2.7 Step 6

2.2.8 Step 7

2.2.9 Step 8

2.2.10 Step 9

2.2.11 Step 10

2.2.12 Step 11

2.2.13 Step 12

2.2.14 Step 13

Fig. 14: Tighten bottom set screw

- Rotate the Coupler until the bottom set screws are perpendicular to the flat on the stepper shaft (if there is one).

Note: Make sure there still is approx 1.5 mm space between the stepper base and the Coupler and tighten the bottom set screw (part Y).

2.2.15 Step 14

Fig. 15: Slide Drive Cable Sleeve into Sleeve Clamp (Stepper side)

- Take the Sleeve Clamp (part C) and slide the Drive Cable Sleeve (part F) in the top, as far as it will go. There is a little step in the bottom of the sleeve clamp to make sure the sleeve goes in just to the right depth.
- Clamp the sleeve using the M3 screw (part Z) and the Half nut (part W). Tighten the screw nice and tight.

Note: There is a little ridge inside the sleeve clamp to prevent you from squeezing the sleeve too far and jamming the drive cable.

2.2.16 Step 15

Fig. 16: Insert the Bracket Sleeve Clamp (Part C1) into the Bracket (Part M) and rotate to lock. * The first time you turn the Sleeve Clamp, it might need some force to rotate.

Note: Make sure you insert the Sleeve Clamp in such a way that once rotated in position, the little tab clicks into the small hole on the Bracket.

2.2.17 Step 16

Fig. 17: Slide Drive Cable into Coupler.

- Now, take the drive cable itself (part L), both ends have square sides pressed into it. Even here it is reversible.
- Slide one end into the Drive Cable Sleeve and thread it all the way through. It will slide into the Coupler.
- Slide it all the way down and clamp it using the remaining 4 set screws (part Y)

2.2.18 Step 17

Fig. 18: Slide Drive Cable Sleeve into Sleeve Clamp (Sidewinder side)

- Back to the Sidewinder side.
- Slide the Sleeve, now containing the drive cable as well, into the next Sleeve Clamp (part C) and push it down as far as it will go. Use the M3 screw (part Z) and the half nut (part W) to clamp the sleeve.

Note: After mounting the Sidewinder in place, you can loosen this screw a little to adjust the direction of the drive cable. Allow it to have a relaxed and free arch to the stepper.

2.2.19 Step 18

Fig. 19: Insert the Drive cable into the Worm and slide the Sleeve Clamp into the Worm Lid.

- Rotate to lock Sleeve Clamp into position.
- The first time you turn the Sleeve Clamp, it might need some force to rotate.

Note: Make sure you insert the Sleeve Clamp in such a way that once rotated in position, the bolt hole lines up with the bolt hole on the Worm lid and Upper Housing.

2.2.20 Step 19

Using the Sidewinder

First run the extruder a minute or two, with no filament clamped. Just to bed the gears and drive cable in. Extrude and retract a few times. (You will have to switch off the temperature control as most controllers will not move the extruder stepper unless the hot end it up to temperature) Use M302 P1 on RepRapFirmware to switch cold extrusion on (allow extrusion while cold) and M302 P0 to switch it off again. For other firmware use M302 S0 to switch cold extrusion on and M302 S170 to set extrusion to a minimum temp of 170C.

Insert filament

To insert filament, open the breech block. You do this by squeezing together the “ears” of the breech block and pulling outwards. You can leave the shafts of the breech block in or, for better visibility, take the whole breech block out.

Fig. 20: Insert the Sleeve Clamp screw (Part T4) through the Sleeve Clamp and upper housing of the Sidewinder.

- Use the Nut (Part W) to close it and lock it all in place.

Note: Do not overtighten this M3 bolt. Simply finger tight and then 1/4 turn is enough.

Now you can see the PTFE on the top of your hotend (usually, depends on the adapter used) and slide the filament in. If the hot end is up to the correct temperature, you can purge the old filament by simply pushing down on the filament and feeding it into the hot end. After the old filament is cleared you can close the breech block.

Note: this is is an excellent way to get a sense of the efficiency of your hot end. You can feel the resistance of the hot end and how easy it is to push the filament through.

To close the breech block, place the shafts into the slots of the "forks" on the Sidewinder, rotate until vertical and the ears click into place. The Sidewinder is now ready to use.

If your hotend is up to temperature, you can now test the extrusion. Simply extrude about 10 mm and observe how the filament comes out of the hot end. It should be a neat straight line.

Tuning the Firmware

Before using the Sidewinder you need to tune the firmware and calibrate the extrusion. You will need to tune the firmware first, as the Sidewinder is quite a different type of extruder.

See the *Tuning the Firmware* page or click Next.

2.3 Tuning the Firmware

The Sidewinder is a different beast to standard extruders and therefore requires some quite specific firmware changes if you hope to get optimal performance. We recommend use of a 1.8 degree stepper, 0.9 degree stepers are great for your other axis, but with the Nimble it's just not required or advisable.

Note: For 32 bit boards start at around 2700 steps/mm at 1/16 microstepping.

Note: For 16 bit boards start at around 1200 steps/mm at 1/8 microstepping.

Note: For 8 bit boards start at around 600 steps/mm at 1/4 microstepping.

Your settings will probably be slightly different, so after setting this do the normal extrusion calibration.

2.3.1 Configuring microstepping

Depending on your electronics microstepping will either be changed by altering jumpers, if your driver is configurable via software:

Marlin:
If driver microstepping is settable via firmware.
#define MICROSTEP_MODES {x,y,z,e0,e1}

Repetier:
Usually configured via hardware jumpers.

RepRap Firmware:
https://duet3d.com/wiki/G-code#M350:_Set_microstepping_mode

Smoothieware:
http://smoothieware.org/extruder
Version 1.0 board has microstepping fixed at 1/16
Version 1.1 board fixed at 1/32.
Adjust steps accordingly.

2.3.2 Current for the steppers

The tuning of the stepper driver for efficient extrusion and retraction is a little different, than with a bowden system or other direct drive systems. Because the Nimble has so much torque available, you can/must run a much lower vref for your stepper than normal. This also helps getting the pulses across properly as you are not fighting decay in the pulses caused by too much current. (Yes there is such a thing, have a look at the excellent work Ryan Carlyle has done: https://github.com/rcarlyle/StepperSim)

Start with the suggested vref and go down if needed. Don't be tempted to simply increase vref if the stepper stalls. It feels contra-dictionary, but the science backs it up.

Note: Suggested vref is 0.3V or 500 mA but it depends on your setup and actual voltage supplied.

2.3.3 Acceleration value

For the acceleration settings, let's begin with a low setting and you can increase it later if you want to have a faster retraction. Again, the aim here is to move things as smoothly as possible.

Note: Suggested acceleration setting is 120 mm/sec2

2.3.4 Jerk value

Another aspect you need to reduce is the jerk value as it helps to move the gears and drive cable in a smooth way. The goal here is to get smooth motion, not harsh forced movements. After you adjust the jerk settings, we suggest you leave them as set and do not use them to tune the retraction. They have little if any measurable impact on print speed anyway.

Note: Suggested jerk or instant speed change setting is 0.6 mm/sec or 40 mm/min

Marlin:
DEFAULT_EJERK = 0.6

Repetier:
EXT0_MAX_START_FEEDRATE = 0.6

RepRap Firmware:
M566 should have E value set to E40 (as it is set per minute)

Smoothieware:
http://smoothieware.org/motion-control#junction-deviation
Smoothie does not use jerk, you instead need to alter the Junction deviation setting, we suggest you start at 0.001 and work your way up in 0.001 increments.

2.3.5 Retraction speed

For the normal extrusion and retraction settings in your slicer, please test the settings with the extruder multiplier set to 1 or 100% extrusion. Set the retraction speed to 30 mm/sec. This is the optimal retraction speed for PLA and should be the standard. You can increase retraction speed if you want to, but normally 30 mm/sec is perfect. It will depend on the hotend you are using, but a retraction distance of 1mm is a good starting point.

Note: Suggested retraction speed is 30 mm/sec with retract of 1mm.

2.3.6 Tuning it all

Now comes the fun part. You can start playing with the acceleration and vref settings to get better retraction, if you want to have faster retractions. Please leave the jerk settings as they are. Tuning the retraction is now a matter of give and take by playing with the settings.

- Set the initial desired retraction speed and check to see if it stalls. If it does not, you can increase the acceleration value until your retraction starts to stall.
- **You can now do a few things.**
  - You can decrease the acceleration and leave it at that.
  - Or you can decrease vref a bit further and try again.
  - Or you can reduce the retraction speed.

Up to you and what your situation and printer needs. By playing with these settings you can fine tune the whole retraction process. Do try and keep the settings for both steppers the same.

You are now ready to start using the Sidewinder, so go to the *Using the Sidewinder* page or click Next.

2.3.7 Troubleshooting

If these settings do not work for you, the first thing to try is to reduce the jerk setting. You can go as low as 0.1 mm/sec as the jerk setting has virtually no impact on your total print time. If you still find you cannot retract at the speed you

need, reduce, let me repeat that, reduce the vref even further. You can go down as low as 0.1V. If it still does not work as you expect, contact us on chat and we will have a lively discussion about it.

2.4 Calibrating the Sidewinder

Because of the gear ratio inside the Sidewinder, There are a lot more steps per millimeter than your usual number.

Note: Start with 2700 steps/mm with a 1.8deg stepper and 1/16 microstepping

Try tuning without wipe and coast first, there's no bowden tube pressure buildup, so coasting not really needed.

The Sidewinder has a nice flat surface you can use to set the ruler on, when measuring the filament, simply place it on top of the "ears" of the breech block. Use a light coloured filament, place it in the breech, heat up the hot end and start the process.

- Measure 100 mm on the filament, by holding the filament against the ruler while the ruler stands on the breech block ears.
- Mark the distance with a permanent marker.
- Extrude 50 mm using the firmware controls.
- Measure the remaining length to the mark made.
- Calculate the new number of steps/mm using the following formula:

Note: New steps = current steps * 50/actual mm extruded (50 being the 50 mm of filament you wanted to extrude.)

- enter the new value in your firmware settings.
- Do the whole sequence again, to confirm that the steps per millimeter are now set correctly.
- if not, recalculate and re-confirm.

You have now set the extrusion rate of the Sidewinder correctly and have the nozzles set right. You can now start Using the Sidewinder.

See the *Using the Sidewinder* page or click Next.

2.5 Using the Sidewinder

The Sidewinder is designed to be easy to use. Here are the basic tips to make it even better.

2.5.1 Loading the filament

The filament loading mechanism is based on the breech loading idea of old muskets. Instead of fiddly work trying to insert the filament from the top, guide it past the hob and into a hot end you cannot see, we decided to open it up and show to the whole path.

Note: It is a lot faster to do that to read about it.

2.5.2 Step 1

Fig. 21: Open the breech

- Squeeze the "ears" together.
- Pull the ears forward, away from the Nimble.
- This can require a little force the first few times.
- Now lift the Breech out of the "forks" on the Nimble

2.5.3 Step 2

Fig. 22: Have a look

- Have a look between the forks
- You can see the hob and the hot end opening

2.5.4 Step 3

Fig. 23: Insert filament

- It is now easy to slide the filament into the hot end.
- Slide it all the way down, into the melt chamber.

2.5.5 Step 4

Great, done. The filament is loaded. That took about a minute or so to read, but it will take about 2 seconds to do. Of course the other side is done the same way.

2.5.6 Tips and tricks

When the breech block is open and there is no filament, you have a good opportunity to have a look at the hob, to see if it is clean.

When inserting the filament and IF the hot end is up to working temperature, you can use the filament to purge the rest of the previous filament. Simply press the filament down into the hot end, without the breech in place. You can feel the filament melt and be pushed through the melt zone and out the nozzle. Do so until all the previous filament is gone.

Note: This is a GREAT way to sense if there is a blockage or another problem in your nozzle or melt zone.

Fig. 24: Close the breech

- Place the prongs into the slots on the bottom forks
- Rotate the breech upwards
- Squeeze the ears in and slide between the upper forks
- the breech will click into place

CHAPTER 3

Printer specific instructions

3.1 Installing the Nimble Sidewinder

If you aren't using our CR-10 Kit, you can skip to the section after Step 11 titled Stepper control.

> **Note:** Installing the Nimble, instead of the Sidewinder, you more or less follow the same steps. It is slightly easier to install than the Sidewinder.

3.1.1 Step 1

- Heat up the hot end, when hot remove the filament, then let it cool down again.
- Pull the white PTFE tube out of the bowden connector. (If difficult, you can do this after step 6)
- Unscrew bowden connector and remove it.
- Undo the tape holding the bowden tube to the braided sleeve.
- Keep the tape for the last step.

Fig. 1: Insert 3 x M3 nuts into the nut traps underneath the Nimble Sidewinder mounting block.

Note: Easiest way to do it, is to screw a nut onto the long M3 screw and use that to push the nut in the space.

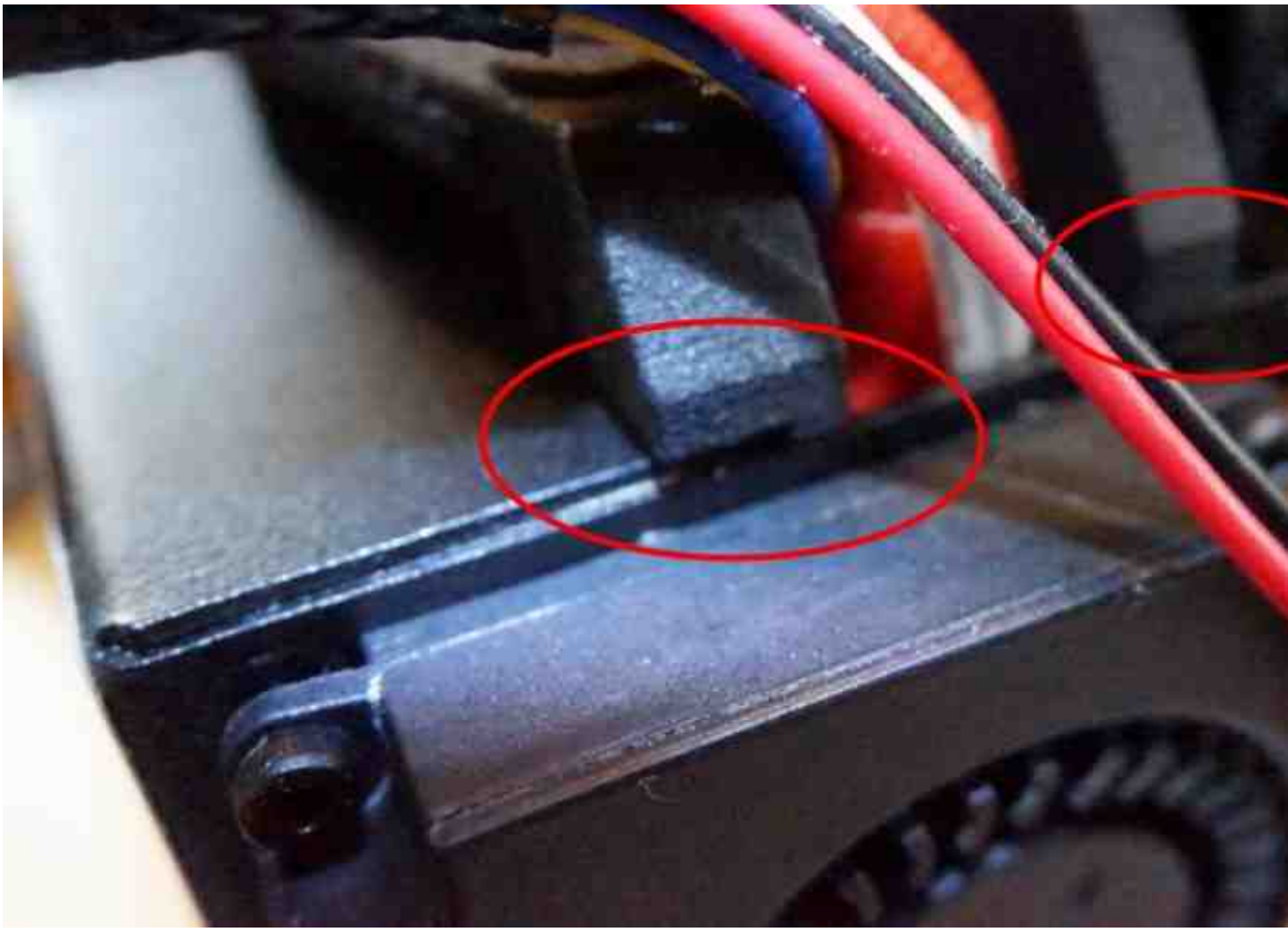

Fig. 2: Slide the mount block in sideways, making sure no wires are trapped on the right hand side.

- Push the block to the left and down, till the right side clicks into the opening.

Fig. 3: Pull the block forward until the mount screw will slide down into the hot end.

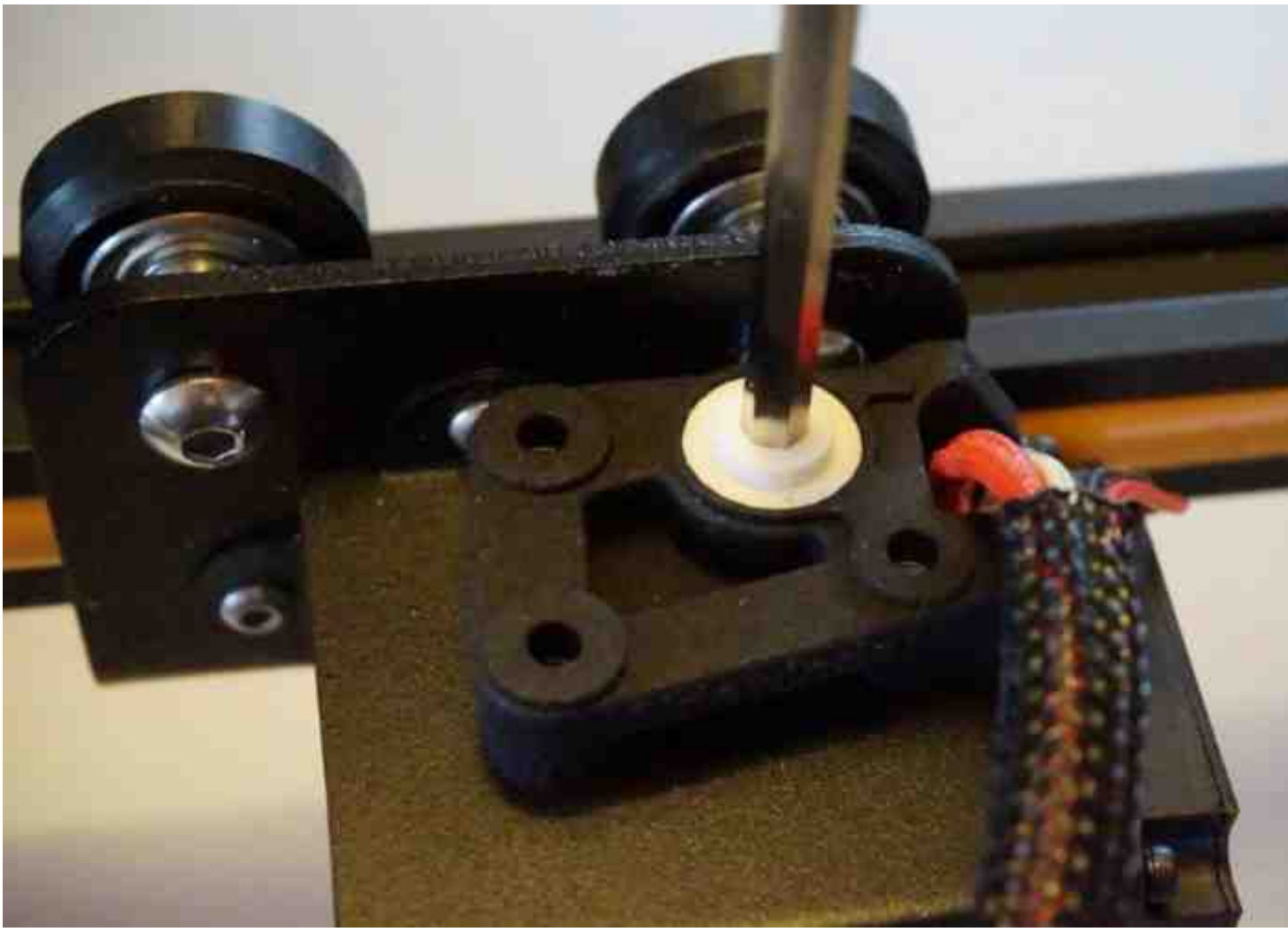

Fig. 4: Use a 4mm allen key to screw in the mount screw.Do NOT overtighten, just finger tight is enough!

- Before installing, make sure the Mount Screw has no powder left inside.

3.1.2 Step 2

3.1.3 Step 3

3.1.4 Step 4

3.1.5 Step 5

3.1.6 Step 6

Slide the PTFE tube all the way down.

- Roughly 50mm into the hot end. Total length of the PTFE tube is 48.8 mm

3.1.7 Step 7

Fig. 5: Slice off the PTFE tube at the top Flush with the top of the mounting screw.

3.1.8 Step 8

Fig. 6: Fit the Bottom half of the Nimble Sidewinder

- Insert and tighten the first M3 screw. Use the M3x16 screw in hole 1
- Do not overtighten these M3 bolts. Simply finger tight and then and additional 1/4 turn is enough.

Note: You do not have to do this with the Nimble. Simply assemble the Nimble and mount it on the block.

3.1.9 Step 9

3.1.10 Step 10

Insert the worm into the top half and close using the Worm lid. Use the M3x30 screw to bolt the top half to the mounting block, in hole 3.

Fig. 7: Insert the gear shaft with bearings, then close with the top half of the Nimble Sidewinder

Fig. 8: Use the next screw, M3x25 to tighten down the top half, in hole 2.

- Do not overtighten these M3 bolts. Simply finger tight and then an additional 1/4 turn is enough.

3.1.11 Step 11

Insert the drive cable, via the connected sleeve clamp, in to the Worm and lock it in by rotating the Sleeve clamp. Place the M3 nut against the hole in the Top Housing and use the last screw, the M3x20, to lock the Sleeve clamp, Worm lid and Top housing together.

Note: You can use the cloth tape that you took off in the second step to keep the drive cable sleeve and the wires in the braided sleeve together, if you want.

3.2 Stepper control

First of all a warning. in Step 16 you will need to work inside the control box while the power is on. So be careful, make sure you know which wires carry the mains and make sure you do not get close to those. Do this carefully and slowly. Just to be clear, there is a small risk of damaging the board if you mess up. So it is you responsibility to do this right, we are not to blame if you don't.

Note: Ideally use a non-conductive screwdriver to adjust the pot.

If, and only if, you are installing the Sidewinder, you need to reverse the direction of the stepper. Do NOT do this if you are installing the standard Nimble. If you have flashed the firmware, you can do that easily in the firmware. If not, you need to switch two wires at the plug going into the extruder stepper.

3.2.1 Step 12

3.2.2 Step 13

At the plug you will see little plastic tabs. One by one, lift these two and gently pull the wire out.

Switch these two wires.

Note: So, counting from the orange tab, the outside wire goes into the second spot and the second wire goes into the fourth spot.

3.2.3 Step 14

Unplug the power supply for now. Place the control box upside down, after removing the spool holder if you use it.

3.2.4 Step 15

Now you see the power unit, this needs to be moved aside, but the wires can all stay connected.

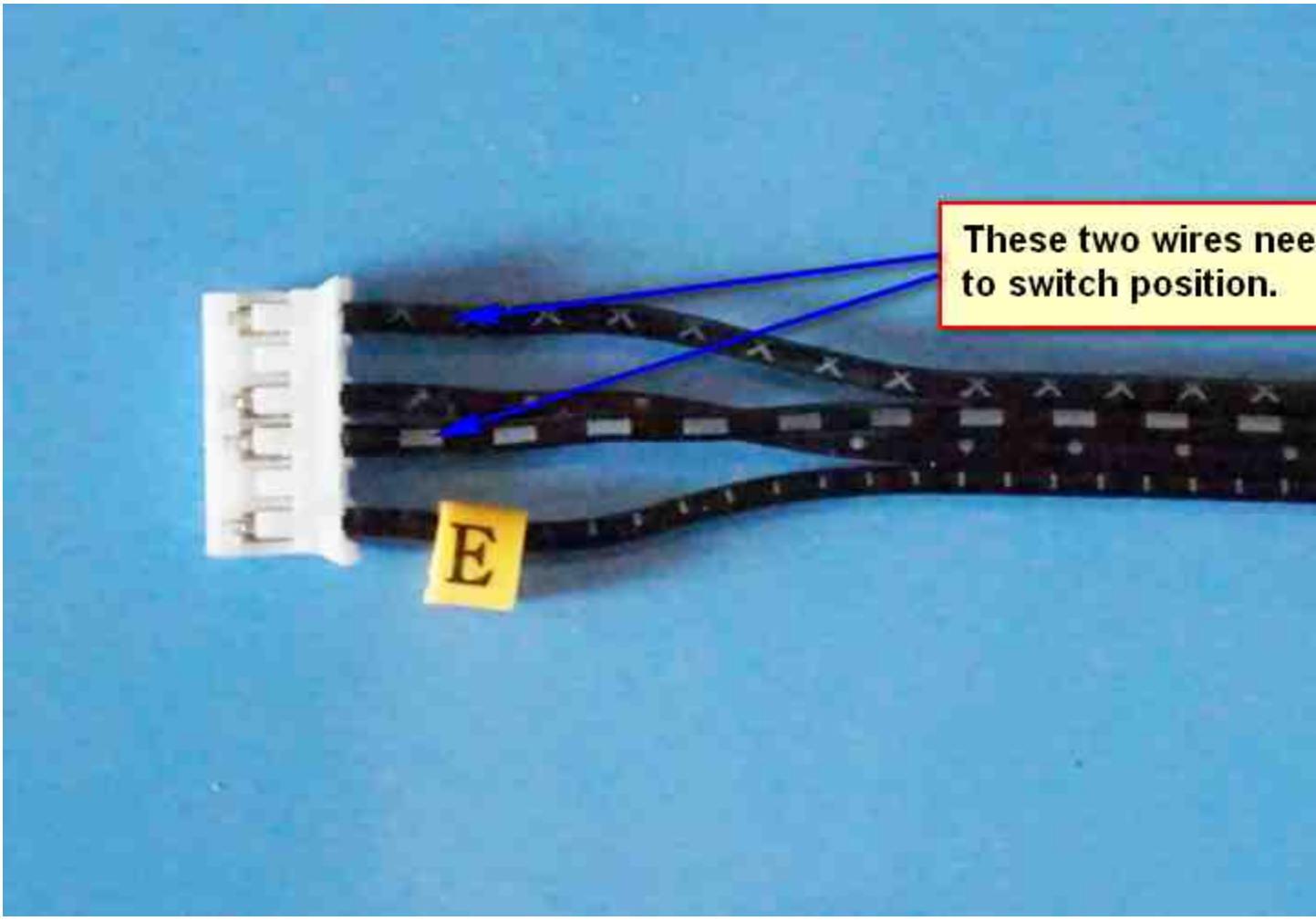

Fig. 9: This is how it looks before modification.

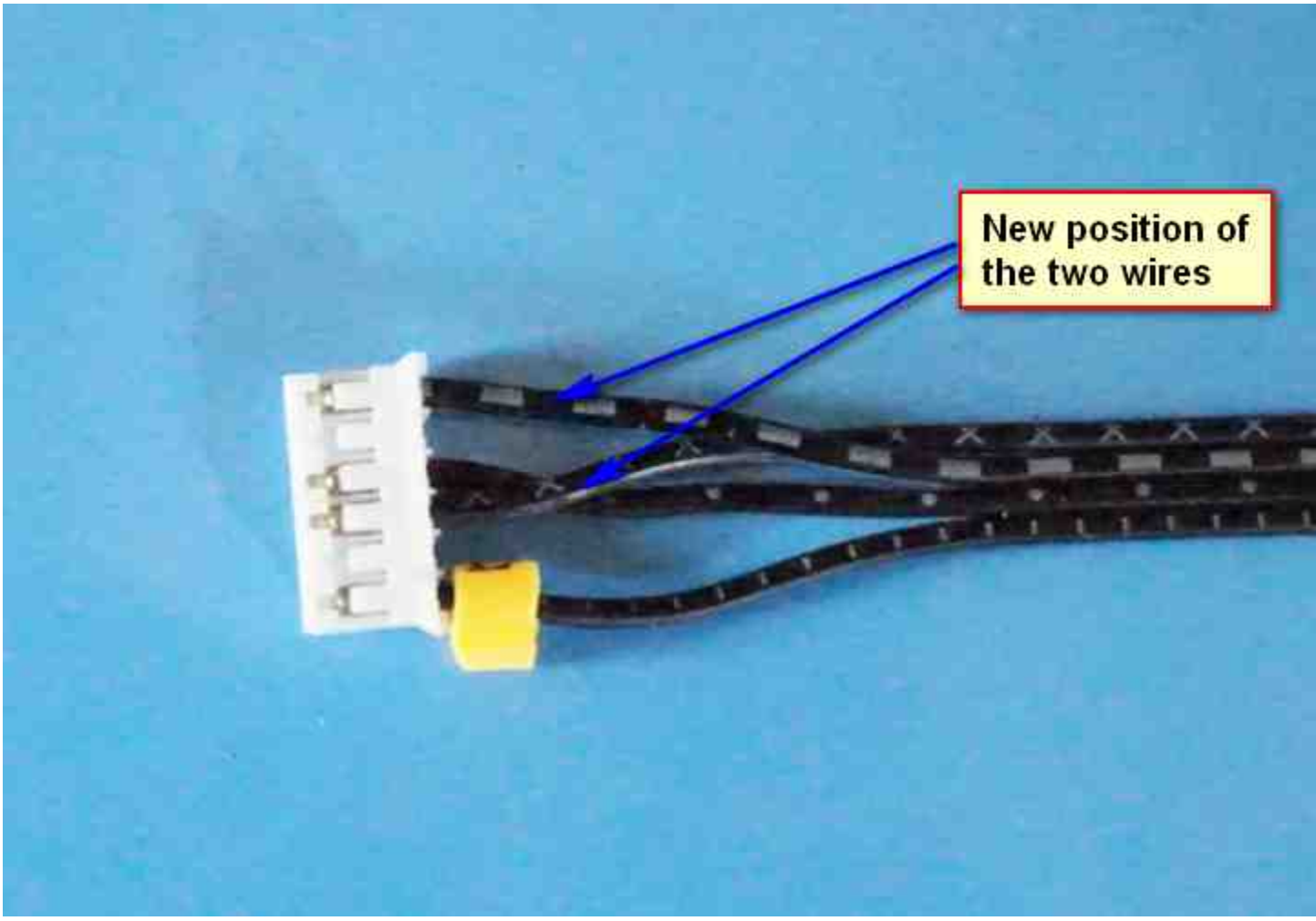

Fig. 10: This is what it looks like after you are done.

Fig. 11: Undo these 5 screws, take off the base plate and put it aside.

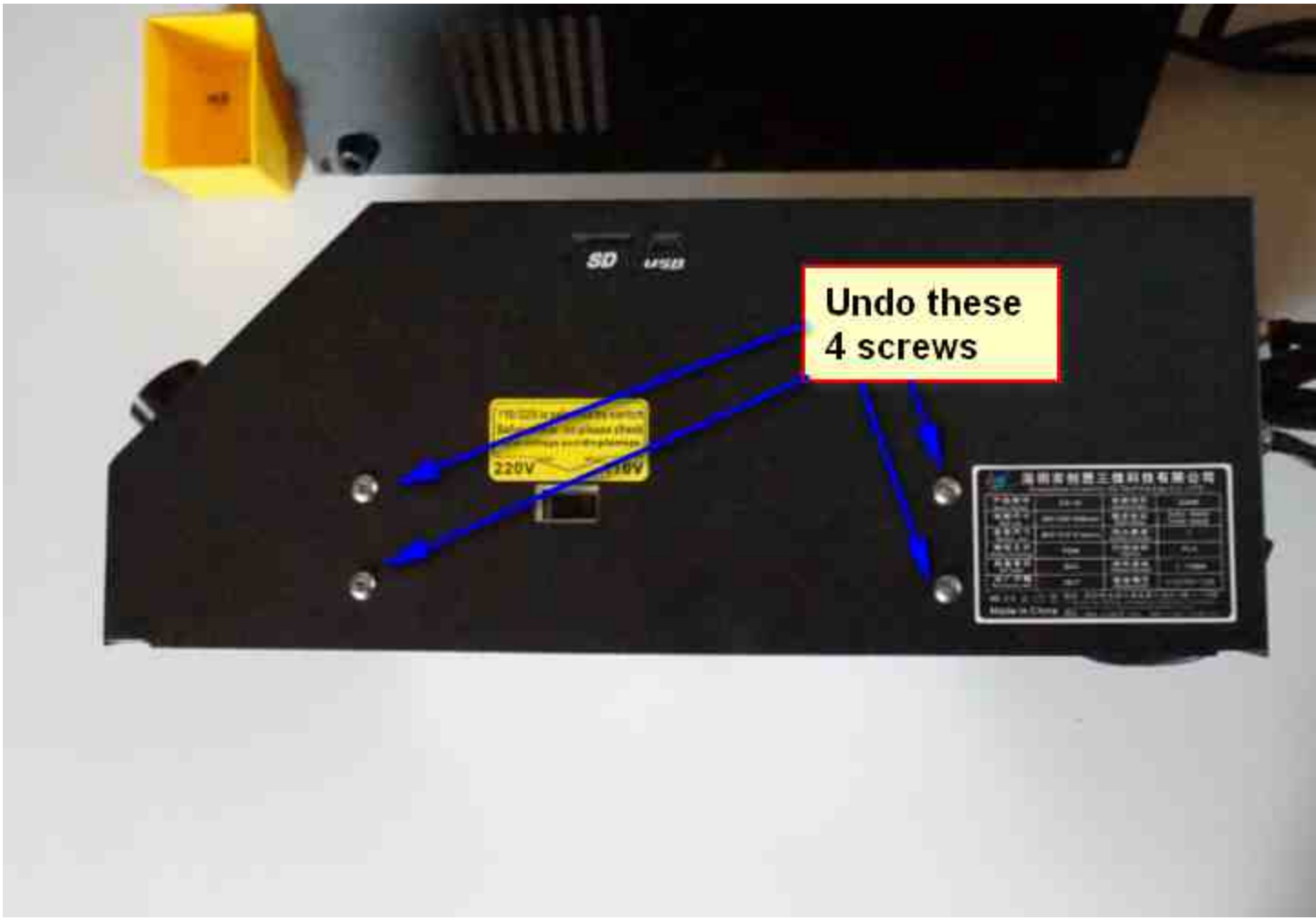

Fig. 12: Undo the four screws on the side. Lift out the power unit and put it on the side where the control cables come out.

Note: Support it with something roughly the same height as the control box.

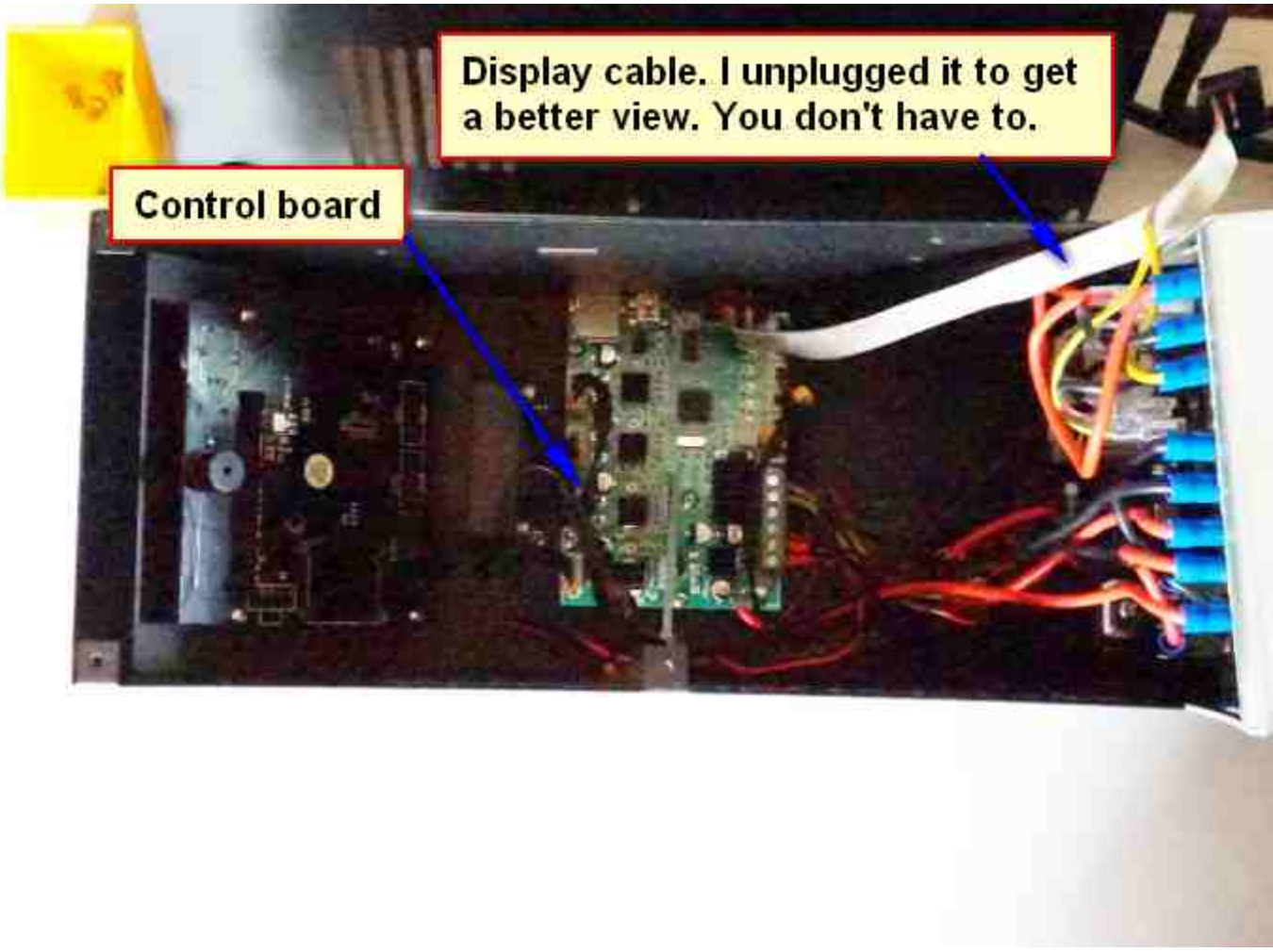

Fig. 13: Now you can see the control board. Isn't small!

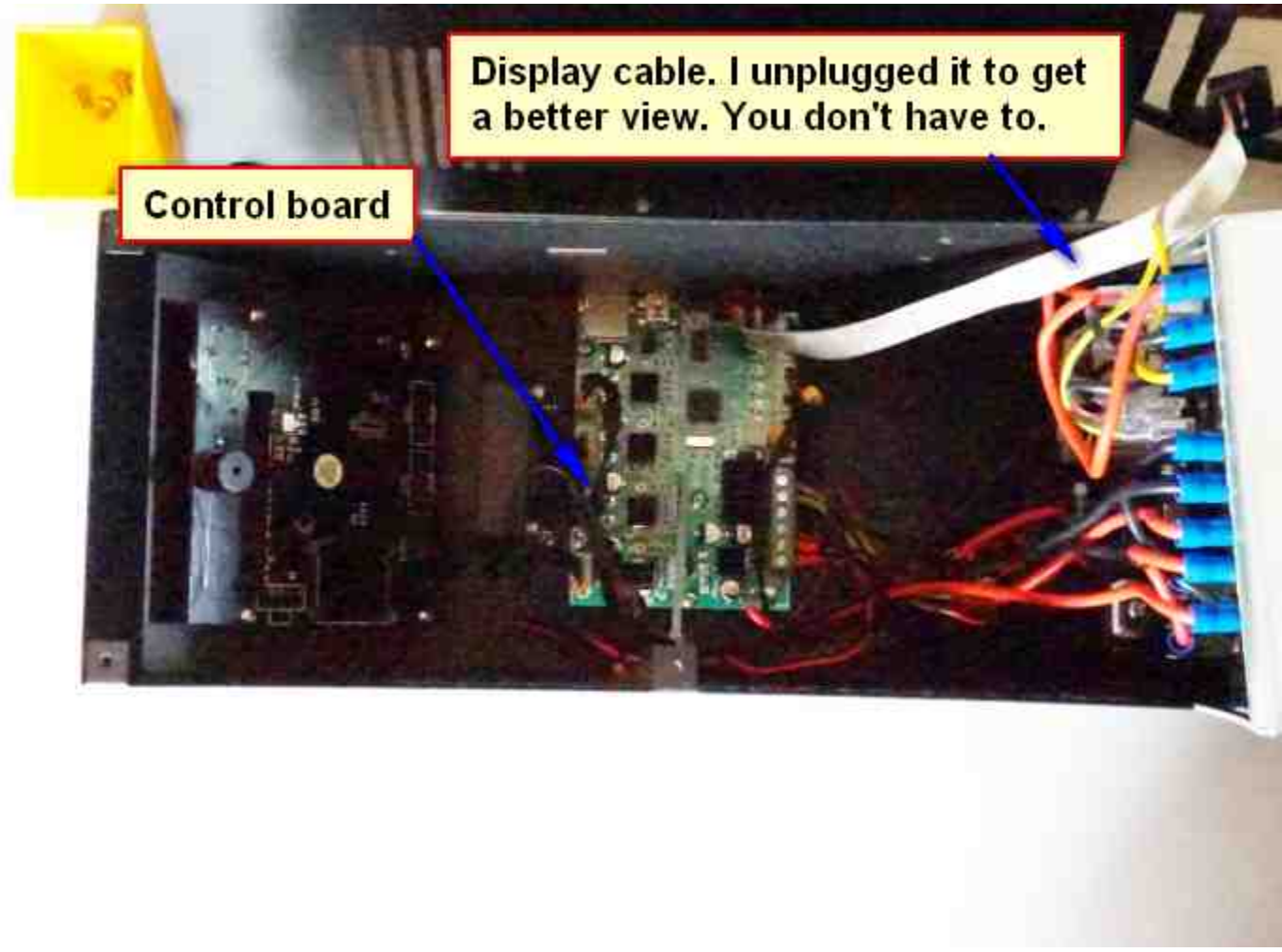

Fig. 14: The POT meter you need to adjust the Vref on is shown as is the Groun point you can use.

- Adjust it to roughly 0.25 V. You do this by measuring the voltage between the center of the POT meter and the Ground using a multimeter.

Note: You will have to plug in the power and switch on the machine to test this, so be careful! Ideally use a non-conductive screwdriver to adjust the pot.

3.2.5 Step 16

3.2.6 Step 17

Done! Put the power unit back, using the four screws and then close the control box with the base plate.

3.3 Using the Sidewinder

3.3.1 Step 1

Fig. 15: Open the Breech block by squeezing the “ears” together.

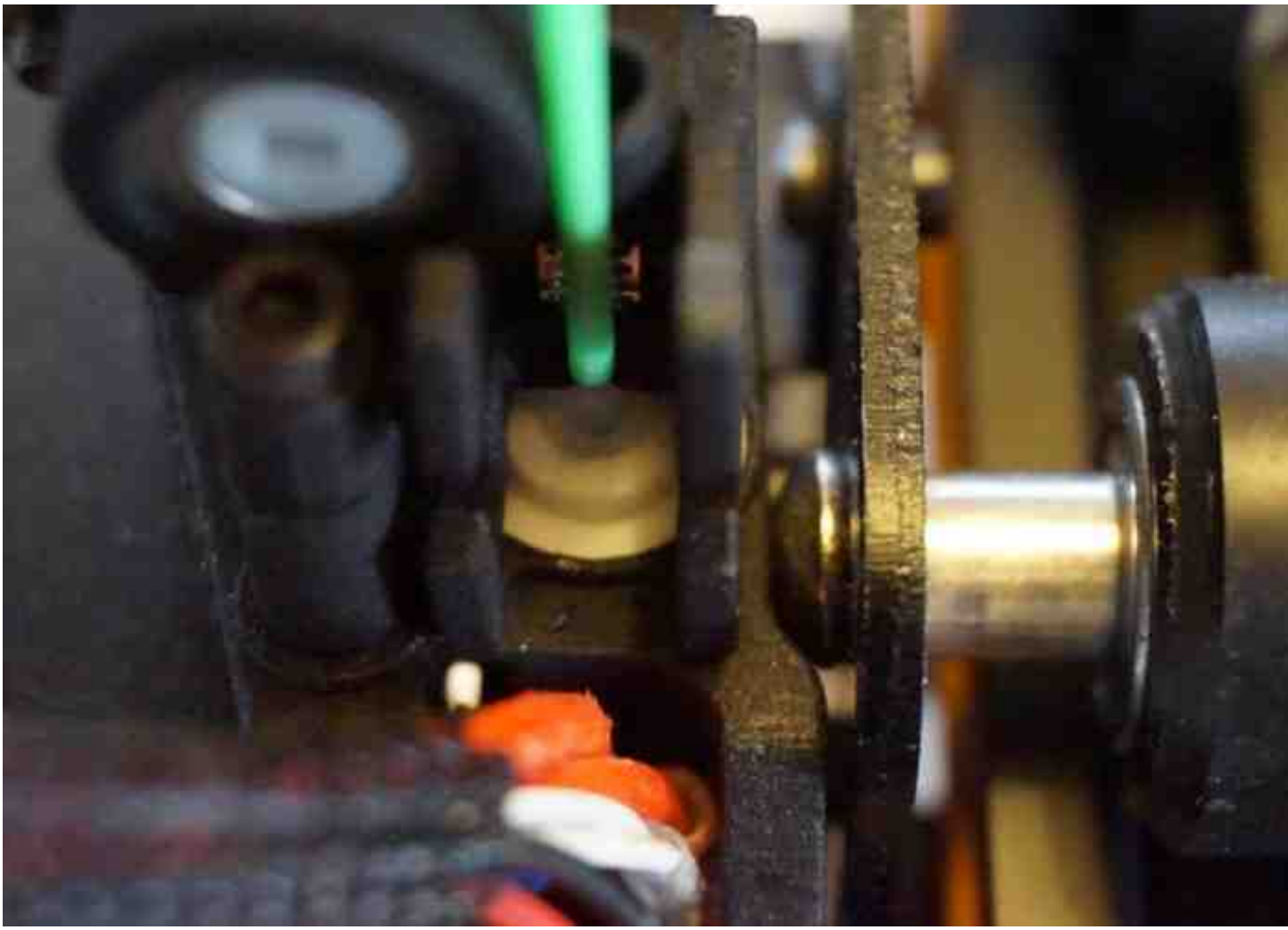

Fig. 16: Insert the filament into the PTFE tube inside the Sidewinder.

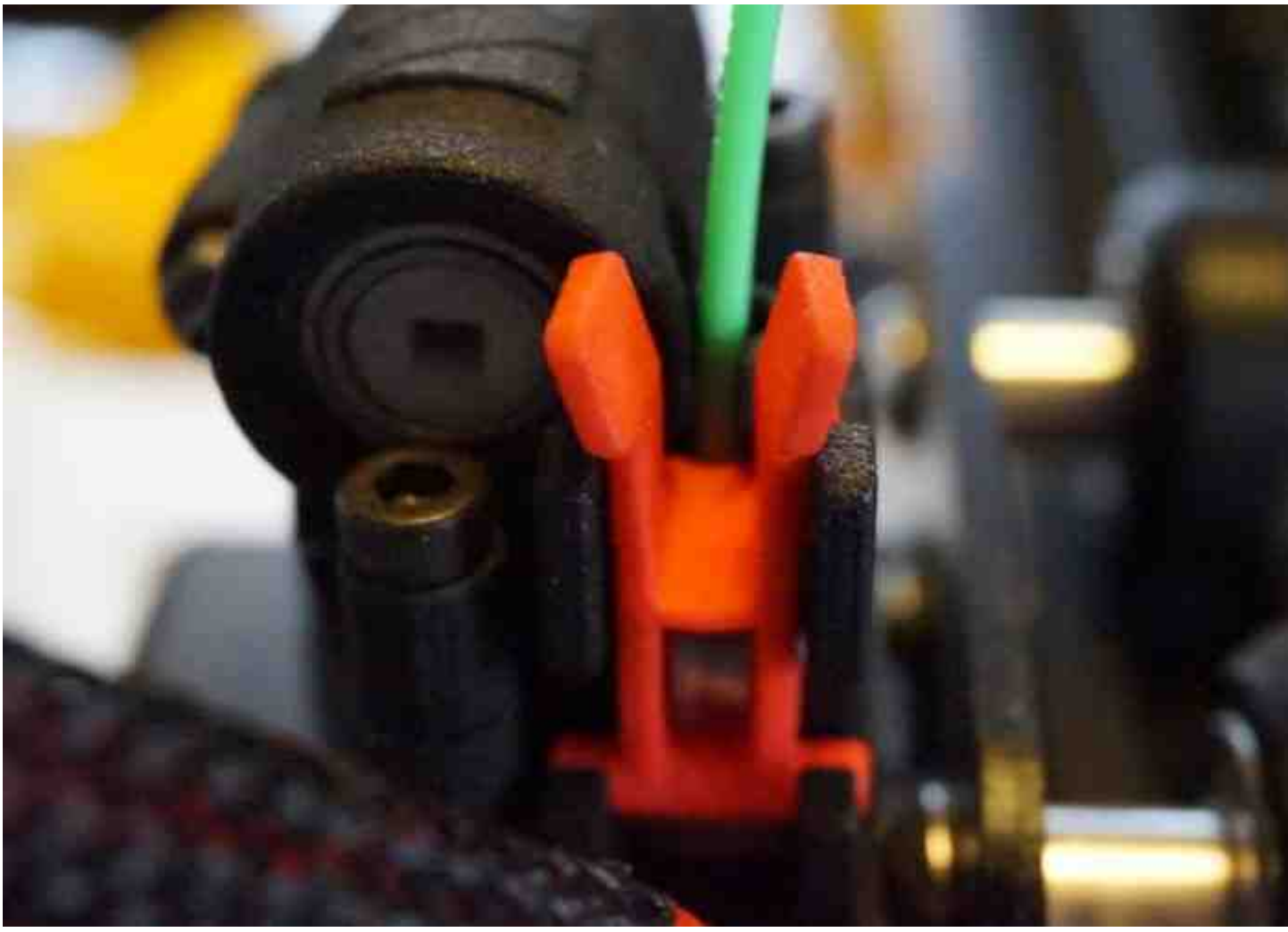

Fig. 17: Close the Breech, making sure it latches properly.

3.3.2 Step 2

3.3.3 Step 3

3.3.4 Step 4

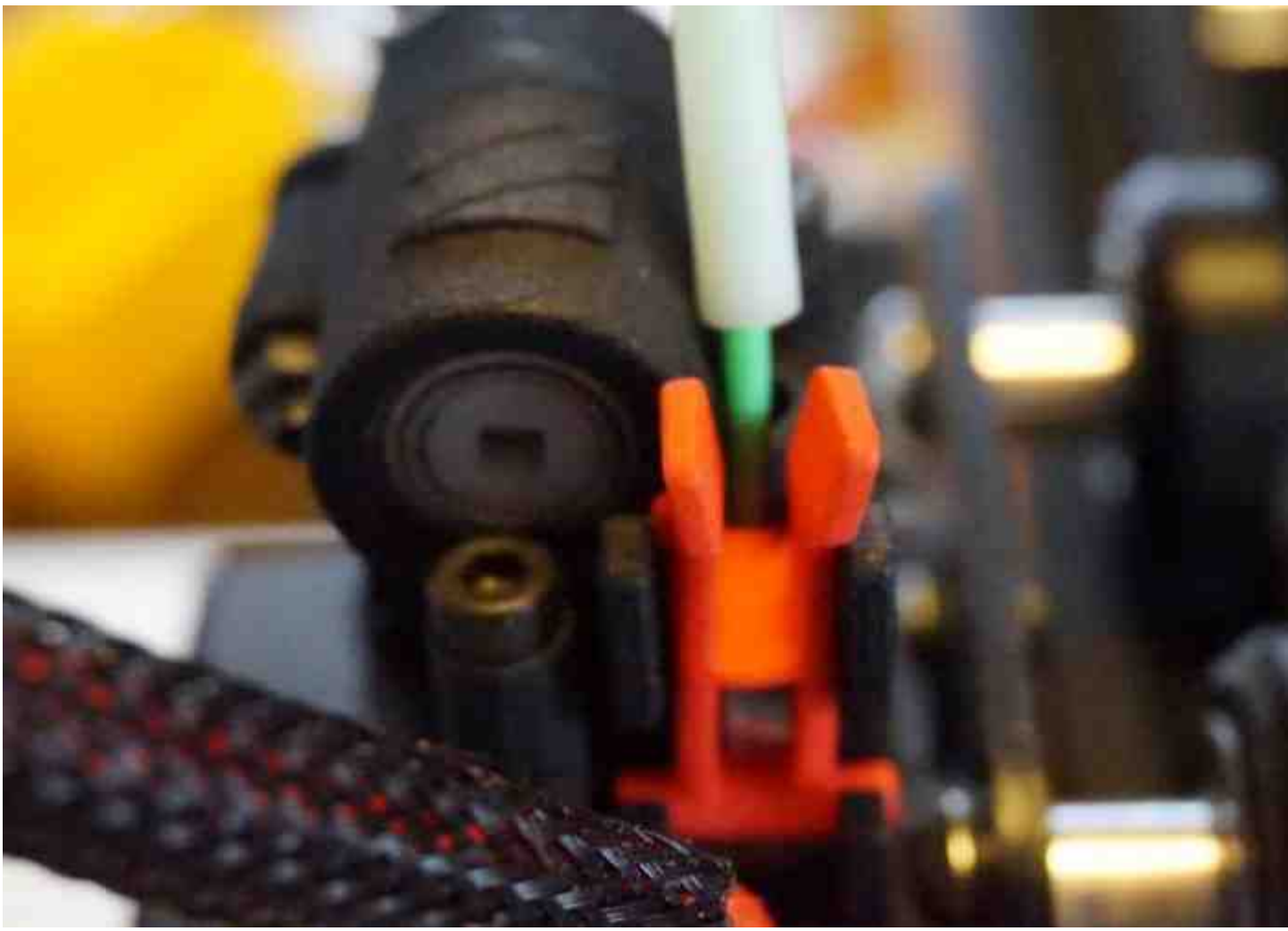

Fig. 18: If you are using the rest of the bodwen tube to guide the filament, slide it down and push it into the Sidewinder.

3.3.5 Step 5

3.4 Configuring the Slicer

You do not need to adjust anything to your material profiles or layer settings. All you need to do is set start commands for your printer. So in your slicer, open the Printer settings and add the following code to your Startup Gcode:

```
;Marlin Setup g.code
M92 E2650   ; Set steps/mm extrusion
```

(continues on next page)

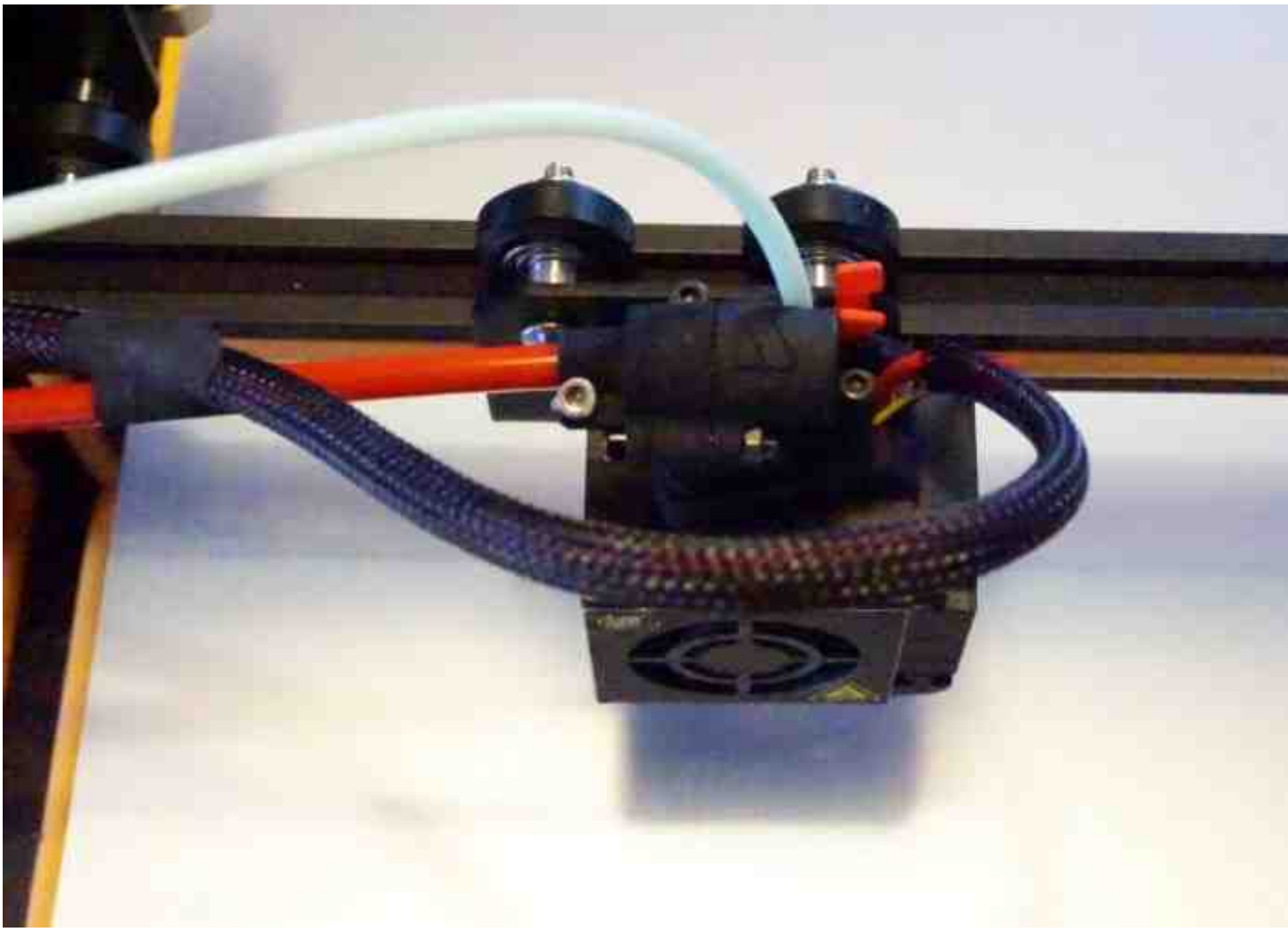

Fig. 19: This is what it looks like as you are ready to print!

- all that needs to be done now is add some start gcode to your slicer.

(continued from previous page)

```
M201 E120   ; Set Extruder acceleration
M204 R120   ; Set Retract acceleration
M205 E3     ; Set Extruder Jerk
M203 E45    ; Maximum feed rate
```

Note: These settings are correct, but it is always a good idea to see them as a starting point and then tweak settings on your system for optimal results.

3.5 Optional extra's

We have a few optional extra's that are available on Thingiverse.

- New air duct for print cooling, using tusks. https://www.thingiverse.com/thing:2772134
- Small tray to support the drive cable above the X stepper. https://www.thingiverse.com/thing:2802704
- Extra mount to hold the bowden tube at the filament sensor.

CHAPTER 4

Nimble Adapters

The Nimble is designed from the ground up to be flexible in mounting. It is ambidextrous, based on an adapter system and light. For this to work there needs to be a list of adapters available. Here is that list.

4.1 Adapter list

Printer name	Type	Remarks
Hypercube	Single Nimble	
Prusa i3 MK2 original	Single Nimble	
Tevo Black Widow	Single Nimble	Quick release
Tevo Black Widow	Single Nimble	
Rostock HE280	Single Nimble	Complete hat replacement
E3D Big Box	Single Nimbles	2 Nimbles side by side.
Chimera Mount plate	Single Nimbles	2 Nimbles side by side.
Kossel mini	Single Nimble	
E3D Big Box IDEX	Single Nimbles	2 Separate Nimbles in IDEX config
Cetus	Single Nimble	
DBot	Single Nimble	
Ultimake MK2	Single Nimble	
Ultimake MK2	Dual Nimble	
Kossel	Single Nimble	With Piezo-electric sensor for bed calibration
Basic Prusa clone	Single Nimble	Like the Geeetech i3
Prusa i3 and clones	Single Nimbles	2 Nimbles side by side.
Diamond Nozzle	Single Nimbles	3 Nimbles
Diamond Nozzle TriumD	Single Nimbles	3 Nimbles
FLSUN Delta	Single	

Most of these adapters are available on our Thingiverse pages and on our Shapeways shop .

If you have developed an adapter for the Nimble, please let us know so we can add it to the list.

CHAPTER 5

Maintenance of your Nimble

The Nimble needs very little maintenance. Just a simple cleaning every now and then. Because it is difficult to measure it in working hours we decided to specify the maintenance per spool printed. Without further ado, for the longevity of your Nimble we recommend you use the following maintenance schedule.

5.1 Every spool

After printing a full spool of 750 gr or 1 kg, we recommend the following actions:

- Blow out chaff from inside, using the vents provided.
- Blow out chaff from breech, when opened.

5.2 Every 5 spools

After printing 5 full spools of 750 gr or 1 kg, we recommend the following actions:

- All of the above.
- Check if the gears are still properly lubed, add a little if needed.
- Open the breech to check the teeth of the hob. They are easy to clean, if needed using a tooth brush. (what else?)

5.3 Overall

For the rest there is very little to do in regards to maintenance. We have tried to make the Nimble as easy to maintain as it is to use, but if you have any suggestions how we can improve and simplify, we would be very happy to hear from you.

CHAPTER 6

Kryo documentation

6.1 Parts List

Here is a complete list of all the parts of the Kryo including the quantity needed for the Kryo.

Fig. 1: Parts layout

The following parts are not shown in the image:

- E, Hose 6 mm OD
- F, Hose 10 mm OD
- G, Hose clamps 6 mm 2x
- H, Hose clamps 10 mm 2x
- , All the parts of the E3D V6

6.1.1 Kryo unit

Item	Part name	Qty	Part Number
A	Kryo Unit	1	Z03-07-0050
B	Groove insert	1	Z03-07-0031
C	M12x1.5 insert	1	Z03-07-0032
D	Stub insert	1	Z03-07-0033

6.2 Assembling the Zesty Kryo

6.2.1 Before we begin

Because of the process used to make the plastic parts (SLS) there is a possibility of powder remaining inside some of the smaller openings. For instance, there might still be a little powder left in the holes for the mounting bolts. This is the moment to inspect the parts and to make sure they are all powder free.

6.2.2 Step 1

Fig. 2: Screw the Groove mount (part B) in the Kryo unit (part A)

- Screw it tight and use a small spanner or pair of pliers to get it tight.

Note: The steps are the same if you are using the M12x1.5 insert (part C) or the Stub insert (part D)

6.2.3 Step 2

Fig. 3: Insert the E3D V6 heat break into the bottom of the Kryo unit.

6.2.4 Step 3

Fig. 4: Slide the hose clamps (parts G) over the ends of the 6 mm hose.

- Slide them at least 20 mm into the hoses

6.2.5 Step 4

6.2.6 Step 5

6.2.7 Step 6

6.2.8 Step 7

Mount the Kryo unit as normal with the groove mount.

Note: To mount the unit use the side mounted holes. These holes are untapped for M3 but the screws will simply screw in.

Fig. 5: Connect the output of the pump to the bottom input nipple.

- Position the hose clip between the two ridges.

Fig. 6: Connect the return hose (that goes to the radiator) to the top output nipple.

- Position the hose clip between the two ridges..

6.2.9 Step 8

6.2.10 Step 9

Guide the hoses to the Pump and Radiator in such a way that the printhead's full range of motion is not restricted by the hoses.

6.2.11 Step 10

Insert the hose reducers to the 10 mm OD hoses coming from the Pump and Radiator and secure with hose clips.

6.2.12 Step 11

Connect the 6 mm hoses from the Kryo unit to the reducers and secure with the hose clips.

6.2.13 Step 12

Fill the pump water tank and switch it on.

- Check carefully for any leaks at every junction or connection.

Wiring up the pump for the Kryo

First run the extruder a minute or two, with no filament clamped. Just to bed the gears and drive cable in. Extrude and retract a few times. (You will have to switch off the temperature control as most controllers will not move the extruder stepper unless the hot end it up to temperature) Use M302 P1 on RepRapFirmware to switch cold extrusion on (allow extrusion while cold) and M302 P0 to switch it off again. For other firmware use M302 S0 to switch cold extrusion on and M302 S170 to set extrusion to a minimum temp of 170C.

Fig. 7: Insert the PTFE tube until it is seated in the heatbreak.

- Leave it longer than needed, so you can trim it to length after mounting.

Note: There is no retaining clips for the PTFE tube, so you will need to provide the clamping force by mounting it in an adapter that holds the PTFE tube or allow the Nimble to clamp down on the PTFE tube.

Fig. 8: Screw in the heat block.

- Follow the standard E3D procedure for installing the heat block and nozzle.

Tuning the firmware

Before using the Nimble you need to tune the firmware and calibrate the extrusion. You will need to tune the firmware first, as the Nimble is quite a different type of extruder.

See the Tuning the Firmware page.

6.3 Assembling the Pump House

The Pump House holds the pump, radiator, fan and all the connectors needed to run the system. Optionally you can install a temperature sensor in the water system and mount the display on the house.

Take the base and mount the pump, making sure the drip tray is between the base and the pump. The pump comes with all the screws needed. Cut off a 30 mm piece of 10 mm hose. (outside diameter) Slide to hose clips to the middle of the hose. Slide the hose over the input pipe of the pump and clamp with a hose clip. Slide the other end over the bottom output pipe of the radiator and clamp with a hose clip. Mount the radiator and fan on the base and fix using the four longer screws. Cut a 5 cm long piece of 10 mm hose. Slide a hose clip over each end. Instert a hose reducer in one end and secure with a hose clip. Slide the other end over the Radiator inlet pipe and secure with a clip. Insert the two reducers into the front panel till they click. Place the front panel in position and fit the cover over the whole unit, while routing the wires out the back, through the cover. Hold it all in position while you screw in the 4 base screws with the rubber feet.

6.4 Wiring it all up

6.4.1 Before we begin

There are various ways to wire it all up. It depends on your control board what the best way is. There are a lot of different boards and capabilities so we can only give you general intstructions.

Note: Remember, the pump and the fan for the radiator are 12V!

6.4.2 The Pump

The pump must be on when the hot end is on. You can decide to switch the pump on and off automatically or simply wire it directly to the PSU, because the pump is so quiet. This means that the pump runs whenever the printer is on.

Switching the pump on only when the hot end is switched on, can be done via the hot end fan control.

Some control boards (like the Duet) can switch fan voltages, so if you can switch the fan control normally used for the heatsink fan of the E3D to 12V, do so. Then simply connect the water pump to that.

If you cannot use 12V on your control board, you can use different ways to control it, for instance use a buck converter, or use the 5V to switch a 12V relay.

6.4.3 The Radiator fan

The water itself has such a heat capacity that you might not need to run the fan for the radiator at all. It is only when you run the Kryo in a heated chamber that you might want to actively cool the water down.

If you want to use automatic temperature control for the radiator fan, you have to connect a temperature sensor to the control board, so it can measure the water temp. Once you have done that, you can program the formware to switch the pump on as soon as the water temperature rises above 40 deg for instance.

One way to connect a water thermometer is to use a standard thermistor, that is taped to the outside of the radiator inlet hose with some electrician tape. Add some insulation around the outside to increase the accuracy.

Alternatively, you can install a thermometer in the water system and connect it to a temperature indicator or to the control board. You will need to adjust the settings of the temp sensor in your firmware to get accurate readings. The temp sensor we sell uses a thermistor that can be used on normal control boards.

6.4.4 Duet WiFi and Ethernet

For the Duet WiFi and Ethernet boards, you can wire the pump into the FAN0 socket. If you don't have other 5V fans, you can switch the fan voltage to 12V on the board using the V Fan Jumper Select. Control the pump with the following Gcode:

- M106 P0 T50 S1 H1

This will switch the pump plugged into FAN0 (P0) to 100% (S1) when the hot end (H1) reaches 50C (T50)

If you cannot switch the overall fan voltage to 12V you can connect the + of the pump (red wire) to the VIN on the board and the - of the pump (black wire) to the GRD of FAN0.

For the Radiator fan you use a similar process, except you use FAN1 and for temperature sensing you use E1 connector. This is the second hot end thermistor control. In this case we use it for sensing the temperature of the water.

The Gcode is as follows:

- M106 P1 T45 S0.5 H2

This will activate the fan plugged into FAN1 (P1) when the temperature reaches 45C (T45) at the thermistor plugged into E1 (H2) and it will run the fan at 50% (S0.5) of full speed.