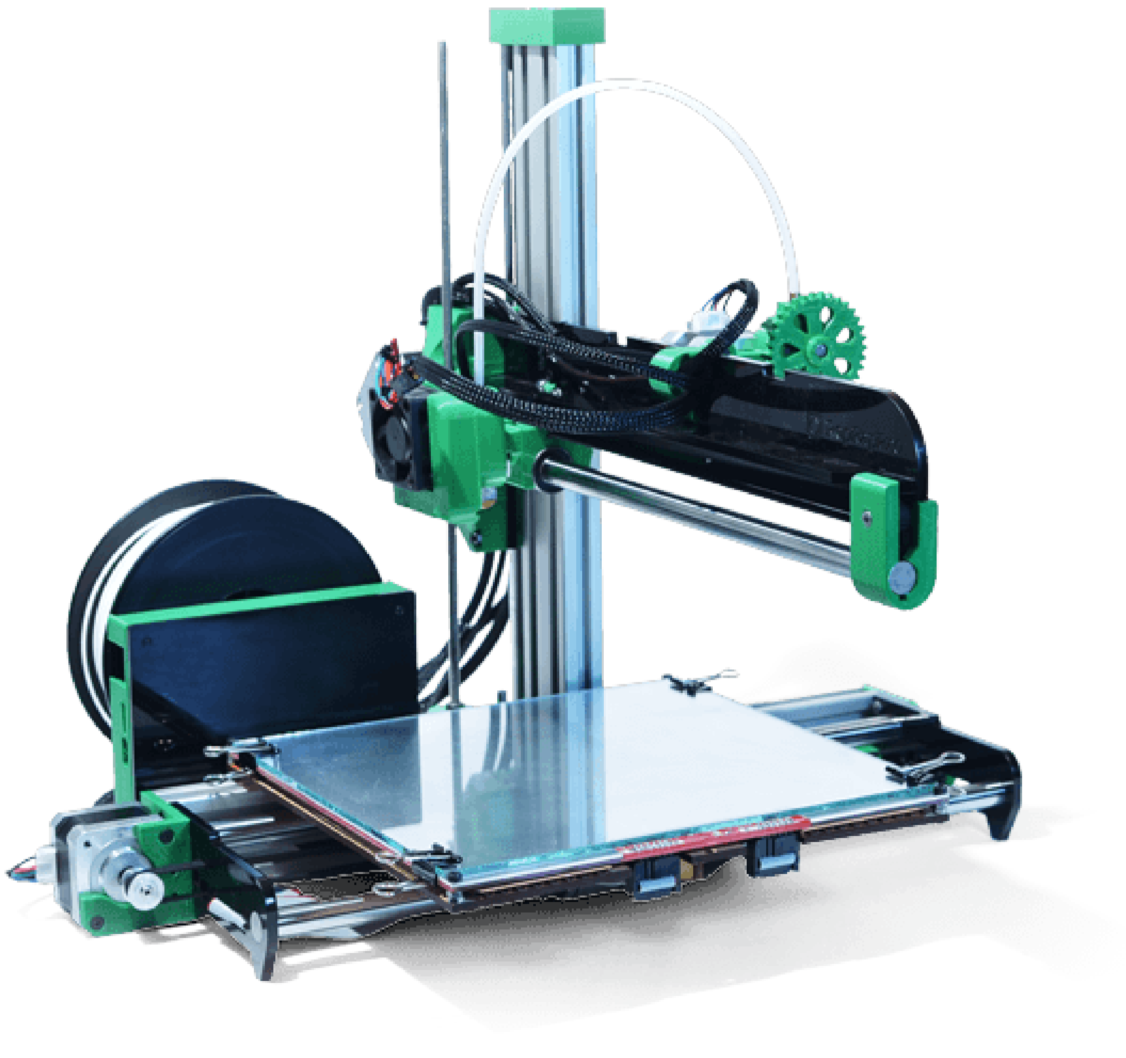
Ormerod

Overview

The RepRap Pro Ormerod design is the latest from RepRap Pro. The machine is a faster to assemble, networked 3D printer with non contact bed probe for full geometric compensation.



RepRapPro Ormerod fitted with [Duet electronics](#).

These pages are the complete instructions for building, commissioning and using the [RepRapPro Ltd](#) version of RepRap Ormerod. Like all RepRap machines, [RepRapPro](#)

Ormerod is fully open-source. It is licensed under the GPL. All the design files and software are available from the RepRapPro Ltd Github repository.

If you want to print the plastic parts for a RepRapPro Ormerod, see this wiki page.

General notes

Give yourself plenty of space and ensure your work area is clean. Dust and dirt are a 3D printer's worst enemy. All printed parts have been printed on various RepRap machines from suppliers within the RepRap community. Despite the fact that these machines are highly tuned RepRap 3D printers, some holes and features may need a little fettling to get the best performance from the RepRapPro Ormerod. There is a video how-to on fettling 3D printed parts here on Vimeo.

Before you start the build, please ensure you have all the components as listed on the packing list included in the kit. If anything is missing, please first contact the company that sold you your 3D printer. Failing that, email us at
support@reprappro.com

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We understand that people may want to change aspects of the machine's design, and in fact we encourage this as it is one of the benefits of open source development. Before changing anything, please be aware that the RepRapPro Ormerod has been designed to maximise the build volume relative to the the machine's footprint, and as such many of its components fit closely to others. So consider your changes carefully before you try to implement them. And when you find improvements, please tell us so that we can include them in future kits, and so that existing owners can upgrade their own machines.

BEFORE YOU ATTEMPT TO ASSEMBLE ANY PART OF THE RepRapPro ORMEROD 3D PRINTER, PLEASE READ THESE BUILD INSTRUCTIONS FULLY AND ENSURE YOU UNDERSTAND THEM. Although all parts are covered by warranty, this will be invalidated by your not following these build instructions. You are building a complex machine; many different skills are required to build, commission and operate a 3D printer. Try not to rush your build, or you may miss out something vital!

The RepRapPro Ormerod is a robust RepRap machine once assembled; however it does require a certain amount of care during assembly. If in doubt, force is usually not the answer! There are many ways to get support and advice; see below.

Get support

If you find you need help or advice with assembling, commissioning or using your RepRapPro Ormerod 3d printer, you can use the following channels:

- Check the instructions again; we are regularly updating them with feedback from our growing user-base.
- Contact the support department of the company that sold you your printer.
- Check the RepRap community forum, [Ormerod section](#).
- Contact us on our irc (internet relay chat) channel [RepRapPro](#) on freenode irc
- Email us at
support@reprappro.com

Archived documents for older versions

If you have an older RepRapPro Ormerod and want a past copy of this documentation see these links:

- N/A

Tool List

Mechanical

Tools required for the mechanical build of the RepRapPro Ormerod 3D printer:

- Allen keys: 1.5mm, 2mm, 2.5mm, 4mm (the long reach type, with a 'ball' hex on the end, are very useful)
- Drills: 2mm, 3mm, 4mm
- Hand chuck, pin vice or small electric drill
- 9mm spanner (M5 nut)
- 15cm adjustable spanner
- File
- Half round needle file
- Craft knife
- Fine tweezers
- 300mm rule
- Vernier or digital callipers
- Square
- Fine nosed pliers
- Pliers
- Adjustable grips, Mole grips or bench vice

Electrical

Tools required for the electrical build of the RepRapPro Ormerod 3D printer:

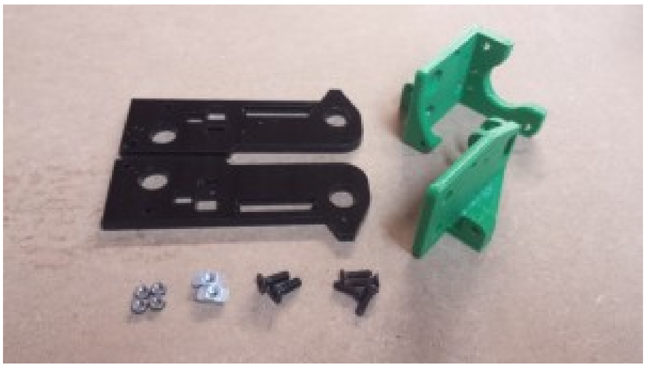
- Digital Multimeter
- Precision screwdrivers
- Hot air gun, or cigarette lighter (or other heat source for heating ptfe heatshrink - a hair dryer is not sufficient)
- Wire strippers/cutters
- Crimping tool (very useful, but not absolutely necessary; you can do it by hand)
    - EITHER Ratchet crimp tool Such as this one, which we use
    - OR Molex crimp tool (such as the 63811-1000, you may also want the extraction tool 11-03-0044, Molexkits.com)
- Scissors

Y axis assembly

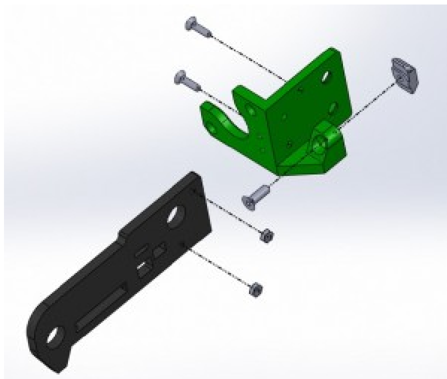
Y axis sub-assemblies

Y-motor-end and Y-idler-end

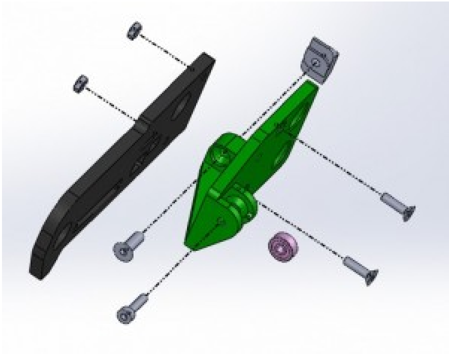
Component	Type	Quantity
y-idler-bracket	Printed	1
y-motor-bracket	Printed	1
y-axis-end-plate	Lasercut	2
M3 Nut	Fastener	4
M4 T-nut	Fastener	2
M4x12mm countersunk socket head screw	Fastener	2
M3x12mm countersunk socket head screw	Fastener	4



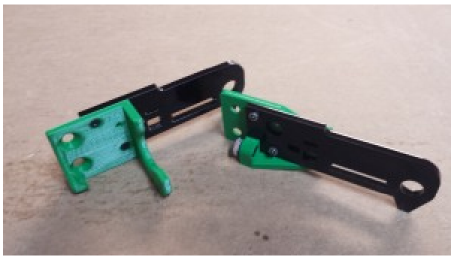
Begin by assembling the Y-motor-end, as shown. Use y-axis-end-plate 'A' with the y-motor-bracket. The 12mm holes will be slightly larger in diameter on one side of the y-axis-end-plate, the side with the letter 'A', which will make it easier to insert the 12mm ground steel bar later.



Repeat with the y-axis-idler-bracket, using y-axis-end-plate 'B', to build the y-idler-end.



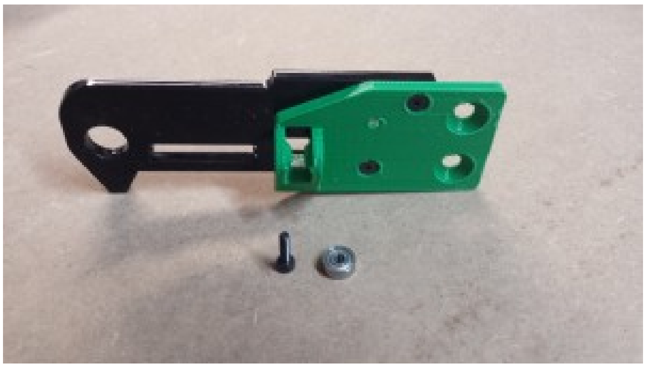
The Y axis ends assembled.



Y-idler-end bearing

Now fit the 623 idler bearing to the y-idler-end, for which the following are required:

Component	**Type**	**Quantity**
y-idler-end	Assembled	1
M3x12mm cap head screw	Fastener	1
623 bearing (10mm diameter)	Hardware	1



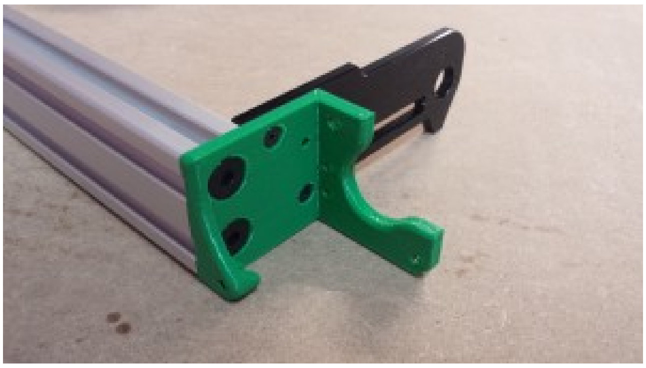
The retaining screw (M3x12mm) should self tap into the printed part, with no need for a nut on the free end. It may require a fair bit of force to push the bearing into position.

Y axis frame

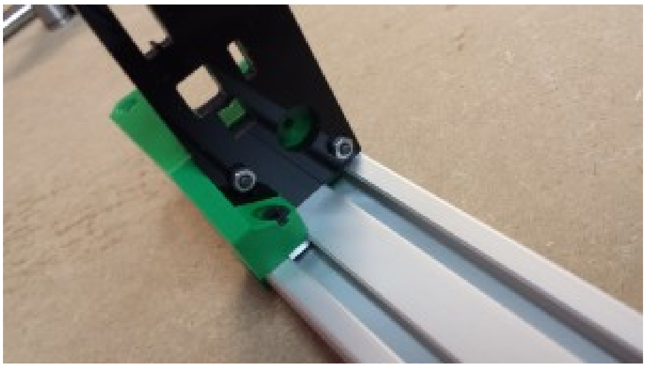
The next step is to assemble the Y axis frame. For this you will need the following:

Component	Type	Quantity
y-idler-end	Assembled	1
y-motor-end	Assembled	1
Alumninium extrusion	Hardware	1
LM12UU Linear bearing	Hardware	3
Smooth rod 12x350mm	Hardware	2
M6x16mm countersunk socket head screw	Fastener	4

Screw one of the Y axis ends onto the Aluminium extrusion, using two M6x16mm countersunk socket screws.



Ensure the M4 T-nut is located in the extrusion slot.



Next you will need to fit the ground rods into the y-axis-end-plate. The 12mm diameter holes are sized to be an interference fit with the rods, and the Acrylic laser cut plates are quite brittle so care must be taken when inserting the rods not to break the end plates.

Place the Y axis assembly on the edge of a flat surface to support the end plate, then press each rod in turn into the plate. Keep the rod perpendicular to the plate whilst pushing. You can use a small hammer on a piece of wood on the end of the rods if necessary.

Before fitting the idler end assembly, slide the linear bearings onto the rods. Press the idler end assembly onto the free ends of the rods, making sure you support the other end so as not to break the idler plates. With the ends pushed home, fix the idler end assembly using two M6x16mm countersunk socket screws, and tighten the M4 T-nut.

Y axis motor

Now you can fit the Y axis motor. For this step you will need the following:

Component	Type	Quantity
y-axis-frame	Assembled	1
NEMA17 stepper motor		1
M3x8mm countersunk	Fasteners	2

socket screw		
M3x40mm socket cap screw	Fasteners	1

One screw needs to be removed from the back of the motor as shown.

Fit the motor into the printed y-motor-bracket. Secure the motor in place with 2 x M3x8mm countersunk socket screws in the front face

Put one M3x40mm socket cap screw in the back, where you took out the motor screw.

Z axis assembly

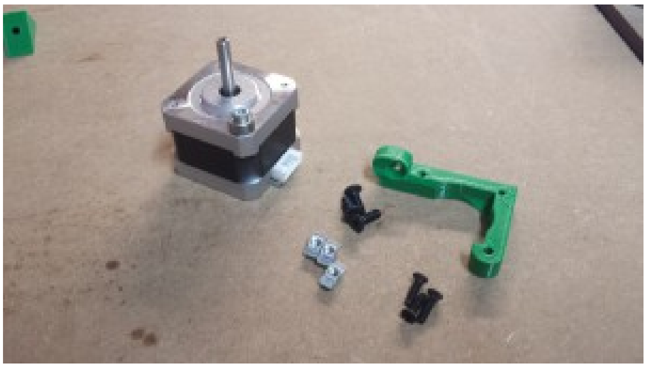
As with the Y axis, the Z axis is assembled in stages, starting with small sub-assemblies which are brought together towards the end.

Z axis sub-assemblies

z-motor-mount

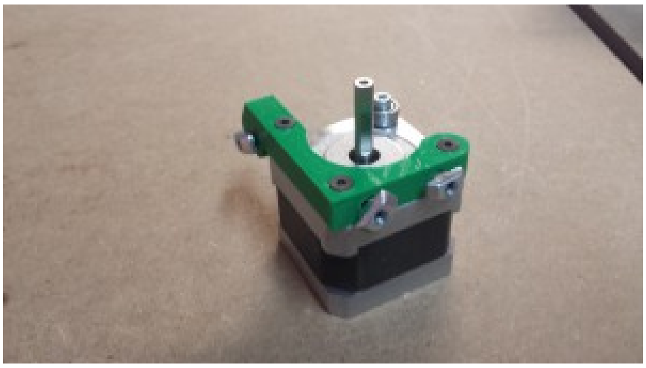
Begin with the z-motor-mount. You will need the following parts:

Component	Type	Quantity
z-motor-brace	Printed	1
NEMA17 stepper motor	-	1
M3x8mm countersunk socket screw	Fastener	1
M3 washer	Fastener	1
623 bearing (10mm diameter)	Hardware	1
M3x12mm countersunk socket screw	Fastener	3
M4x12mm countersunk socket screw	Fastener	3
M4 T-nut	Fastener	3



Begin by securing the 623 bearing on the corner of the Z motor, with an M3x8mm countersunk socket screw. The M3 washer goes between the bearing and the motor body; check the bearing can rotate freely.

Screw the z-motor-brace to the stepper motor using the M3x12mm countersunk screws, then loosely fit the M4 T-nuts with the M4x12mm countersunk screws, as shown.

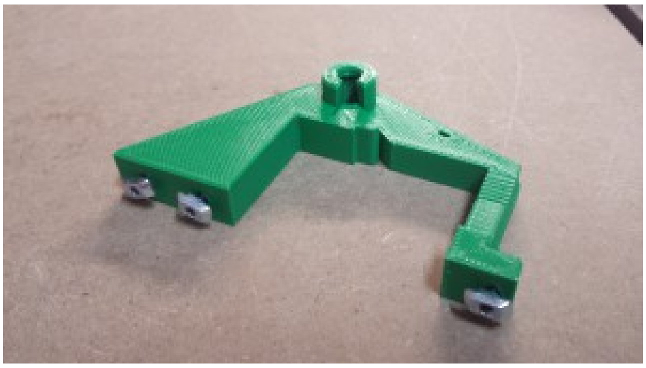


z-lower-mount

The z-lower-mount sub-assembly requires the following:

Component	Type	Quantity
z-lower-mount	Printed	1
M4x12mm countersunk socket screw	Fastener	3
M4 T-nut	Fastener	3

Loosely fit the M4 T-nuts as shown



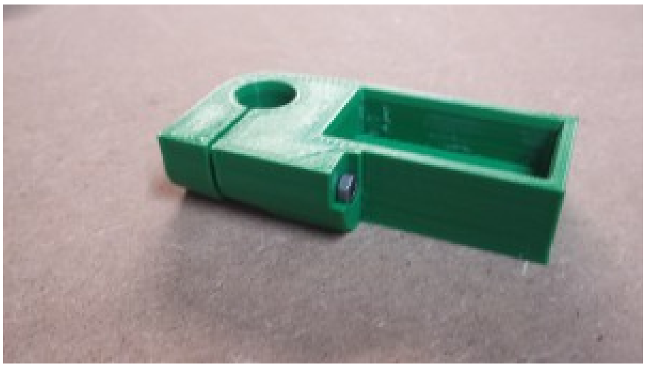
z-upper-mount

The z-upper-mount sub-assembly requires the following:

Component	Type	Quantity

z-upper-mount	Printed	1
M3x35mm cap head screw	Fastener	1
M3 nut	Fastener	1

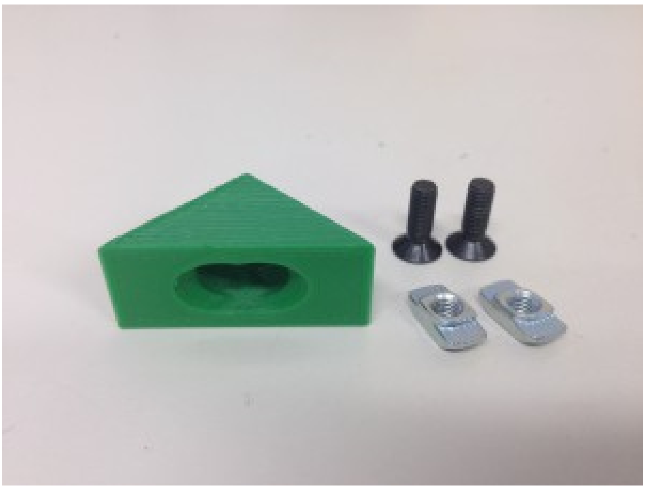
Fit the M3 screw and nut as shown.



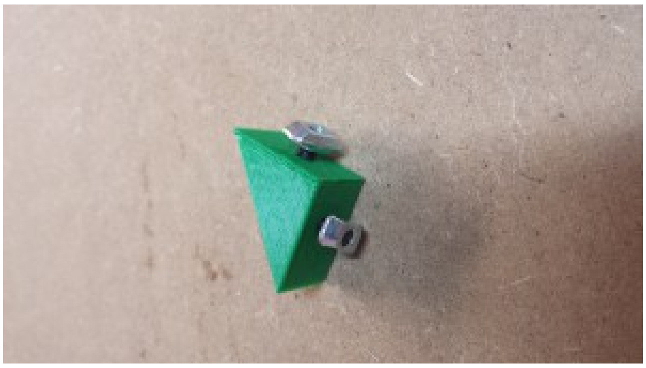
z-corner-bracket

The z-corner-bracket sub-assembly requires the following:

Component	Type	Quantity
z-corner-bracket	Printed	1
M4x12mm countersunk socket screw	Fastener	2
M4 T-nut	Fastener	2



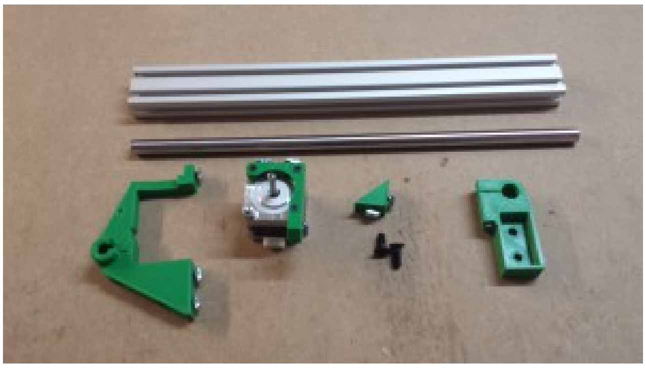
Now loosely fit two M4 T-nuts using M4x12mm countersunk socket screws into the z-corner-bracket.



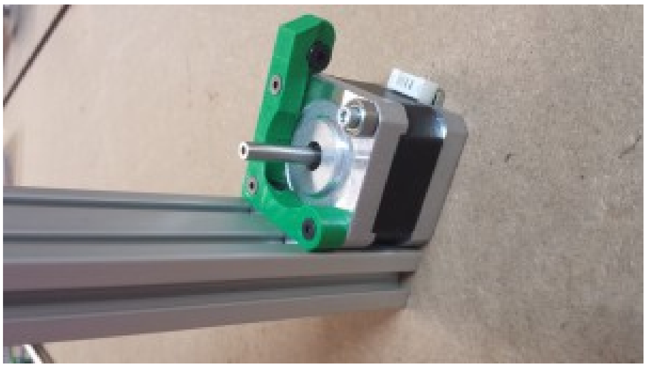
Z axis assembly

You can now bring all of the Z axis sub-assemblies together, using the following parts:

Component	Type	Quantity
z-motor-mount	Assembled	1
z-lower-mount	Assembled	1
z-upper-mount	Assembled	1
z-corner-bracket	Assembled	1
LM12UU linear bearing (not shown)	Hardware	2
Smooth rod 12x350mm	Hardware	1
Aluminium extrusion	Hardware	1
M6x16mm countersunk socket screw	Fastener	2



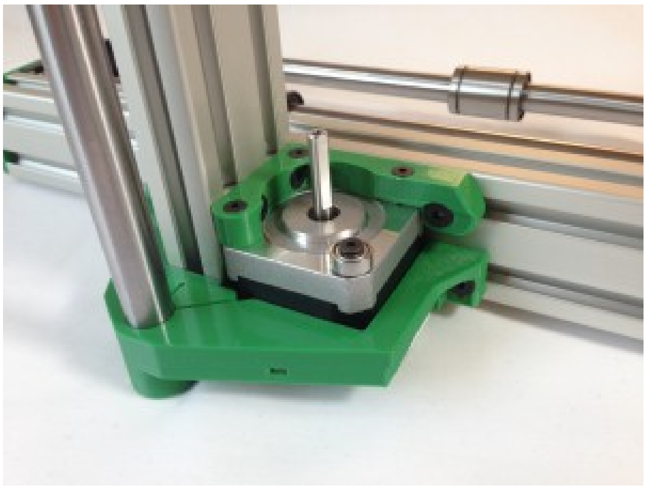
Start by putting the z-upper-mount on the aluminium extrusion - it's a tight fit. Secure it using two M6x16mm countersunk screws. Then fit the Z motor sub-assembly to the extrusion. The M4 T-nuts should not be done too tight at this stage; just enough to hold the Z motor to the extrusion.



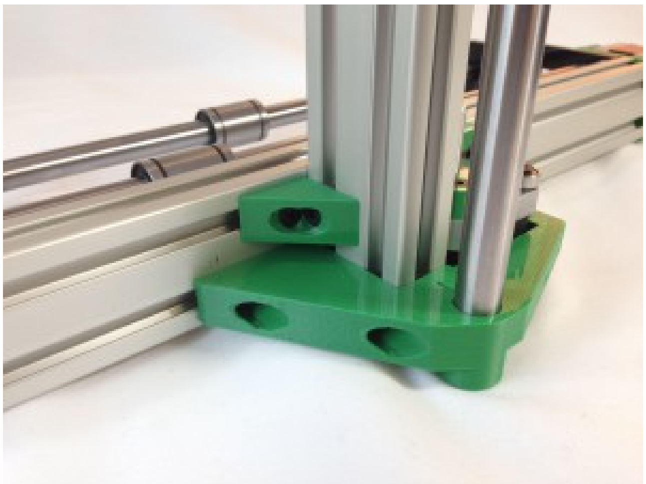
Now fit the rest of the Z axis parts as shown. Fit the 12mm smooth rod into the z-upper-mount, and slide the LM12UU bearings on. Then put on the z-lower-mount and z-corner-bracket. Use the other pictures below for reference.

Connecting the Z axis assembly to the Y axis assembly

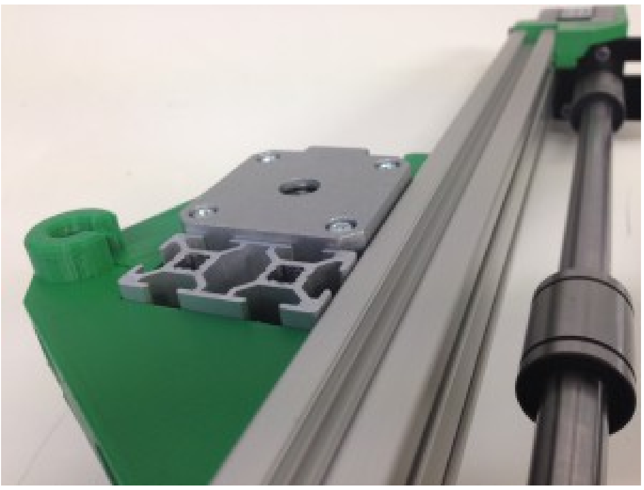
The Z axis assembly can now be attached to the Y axis assembly. Orientate the Z nuts so they drop into the extrusion, you don't need to slide it on from the end.



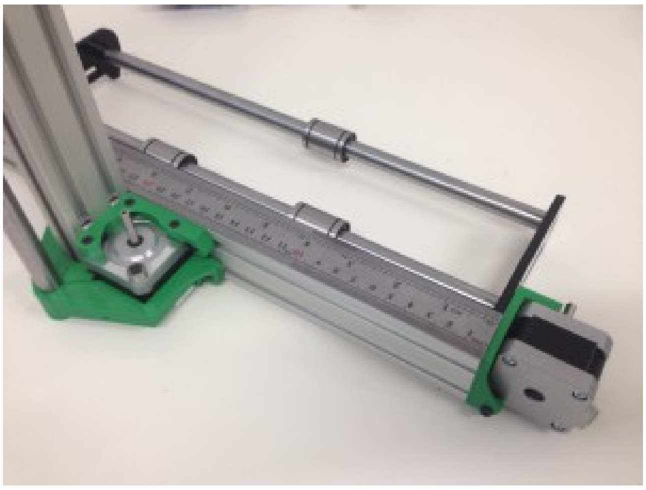
As you tighten the M4 countersunk screws, the T-nut should rotate 90 degrees and catch in the extrusion slot. They may need a wiggle to get them to turn. Assemble loosely to start with, so you can move the components to the correct places.



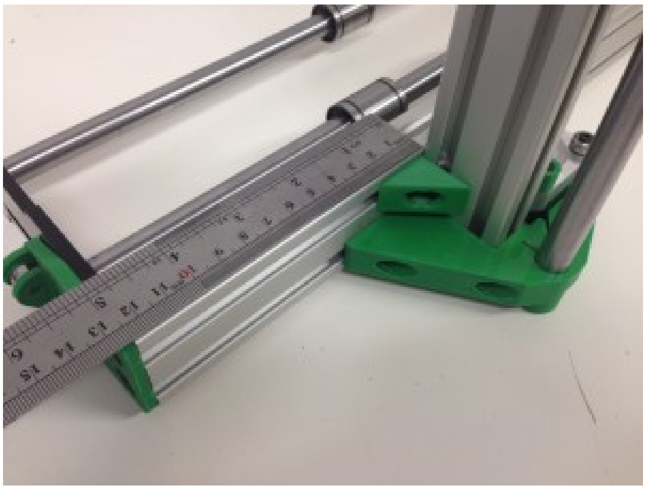
The base of the vertical Aluminium extrusion must be flush with the bottom of the Y axis extrusion. The bottom of the motor will be a little below the level of the extrusions.



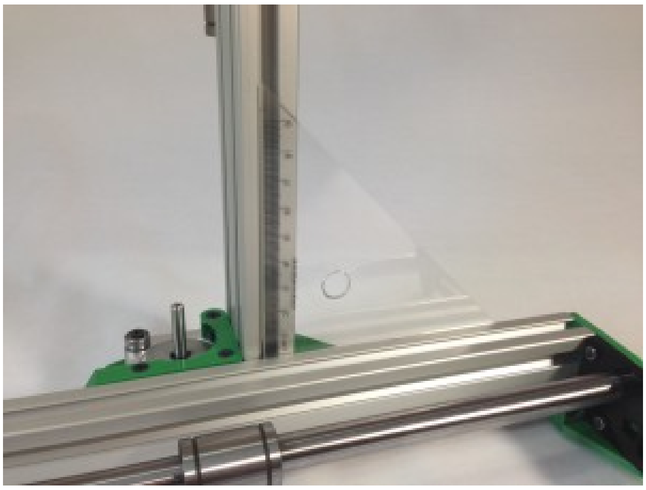
On the Y axis motor side, the face of the Z axis aluminium extrusion should be 210mm from the end of the Y axis aluminium extrusion.



On the Y axis idler side, the face of the Z axis aluminium extrusion should be 120mm from the end of the Y axis aluminium extrusion.

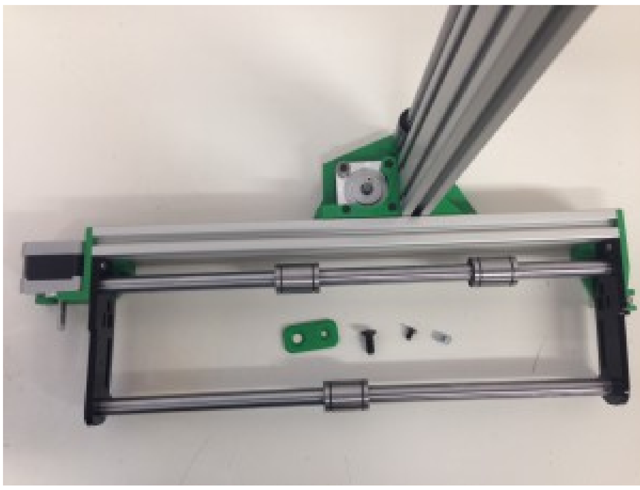


Use the supplied set square to check the Z axis and Y axis extrusions are at right angles to each other, before finally tightening of the screws. Repeat the above alignment steps to confirm they are all correct, before tightening all the fasteners.

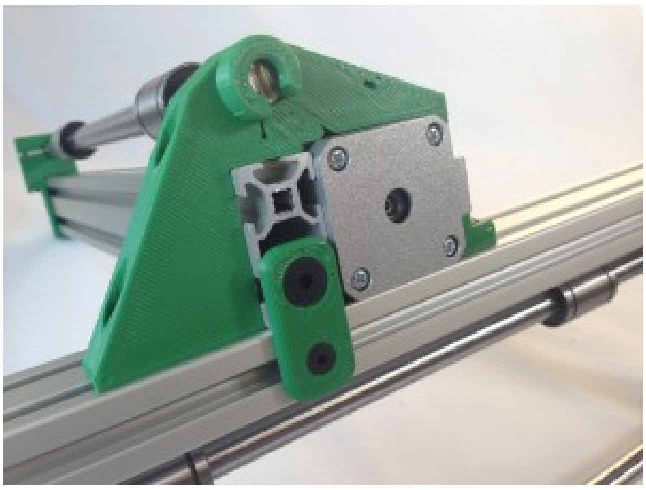


Attaching the Z-foot

Component	Type	Quantity
ZY assembly	Assembled	1
z-foot	Printed	1
M6x16mm countersunk socket screw	Fastener	1
M4x8mm countersunk socket screw	Fastener	1
M4 T-nut	Fastener	1



The base of the vertical Aluminium extrusion must be flush with the bottom of the Y axis extrusion. These two can then be secured using the z-foot, one M6x16mm countersunk socket screw, and an M4 T-nut and M4x8mm countersunk socket screw.

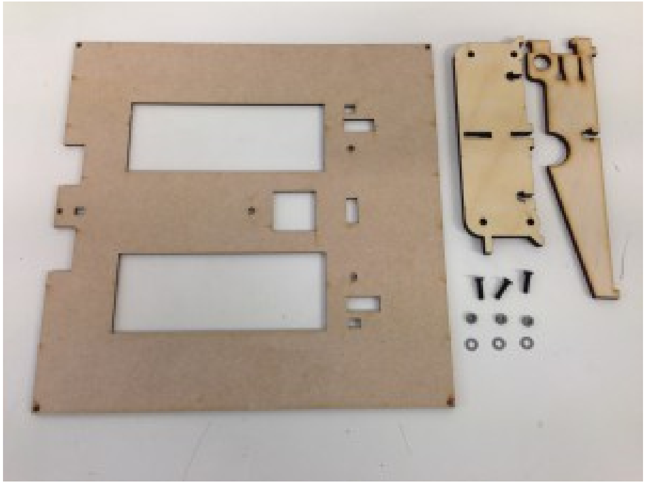


Y carriage

Y carriage assembly

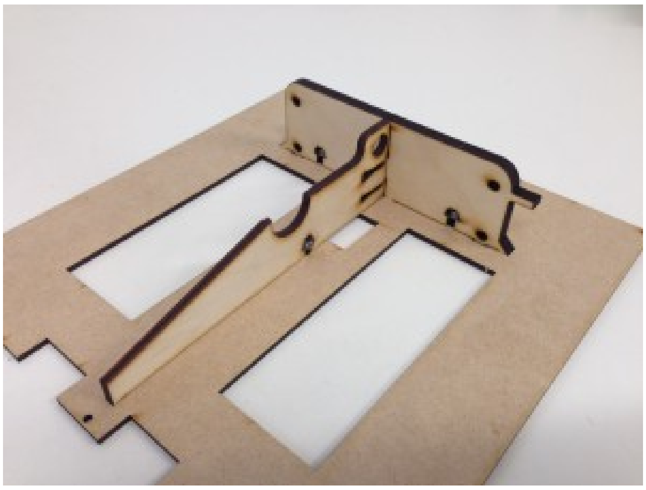
The Y carriage can now be assembled and fitted. You will need the following parts:

Component	Type	Quantity
bed-insulator	Laser cut	1
y-axis-rib - Thickness: 4mm	Laser cut	1
y-axis-cross-rib - Thickness: 6mm	Laser cut	1
M3x12mm countersunk socket screw	Fastener	3
M3 nut	Fastener	3
M3 washer	Fastener	3

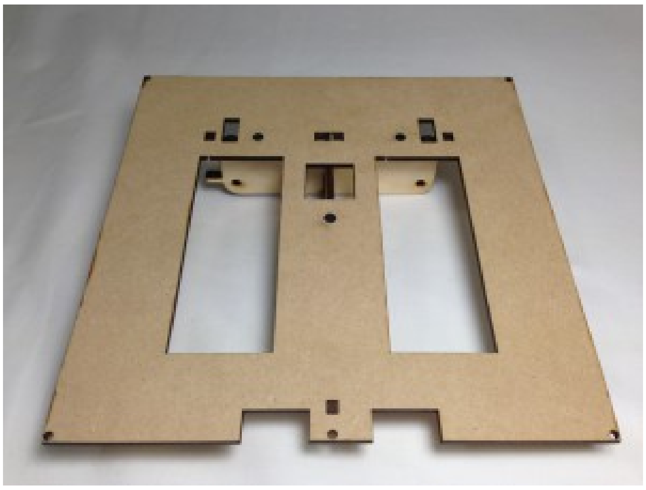


The y-axis-rib slots into the y-axis-cross rib. Make sure the tab on the y-axis-cross rib is on the left side, as shown in the picture. This activates the Y axis endstop, so needs to be on the correct side.

Secure the bed-insulator to the Y axis ribs using the three M3x12mm countersunk socket screws. The washer and nut go in the captive part of the wood.



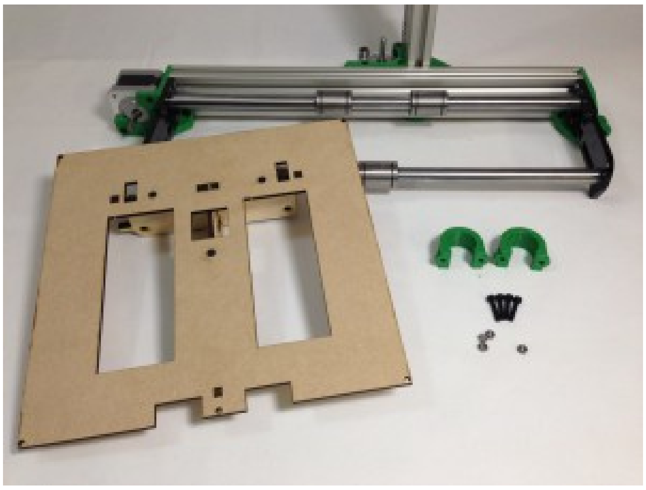
Make sure the bed-insulator is orientated correctly, as shown in the picture. The slots on the outside edge are not symmetrical; the heated bed PCB only fits one way around.



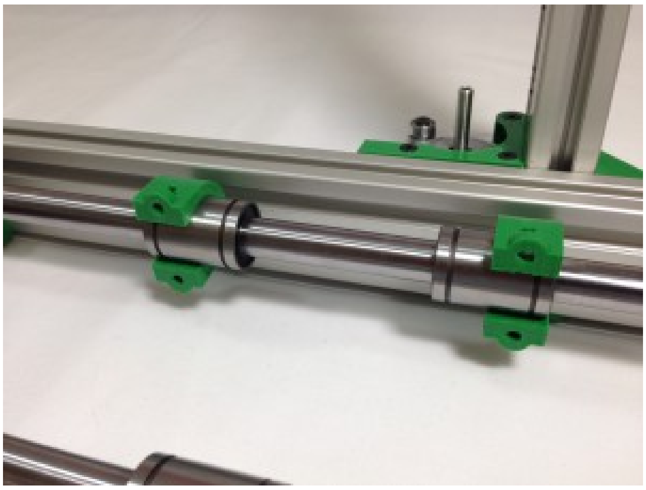
Y-carriage mounting

Fit the y-carriage to the assembled y-z-axis assembly. The following parts are required:

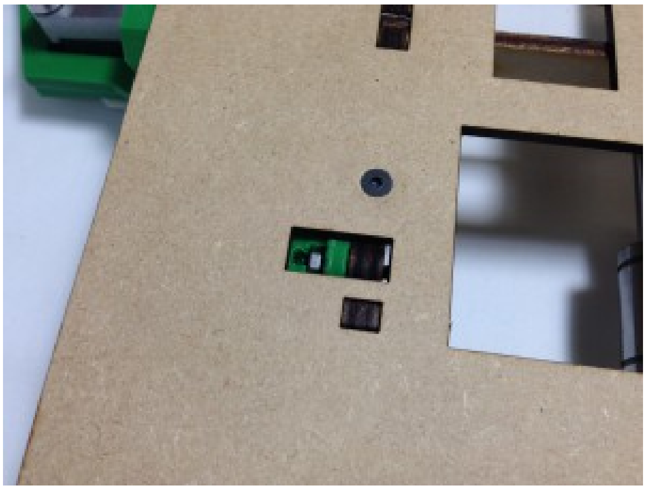
Component	Type	Quantity
y-z-axis assembly	Assembled	1
y-carriage assembly	Assembled	1
y-bearing-clamp	Printed	2
M3x16mm cap head screw	Fastener	4
M3 nut	Fastener	4



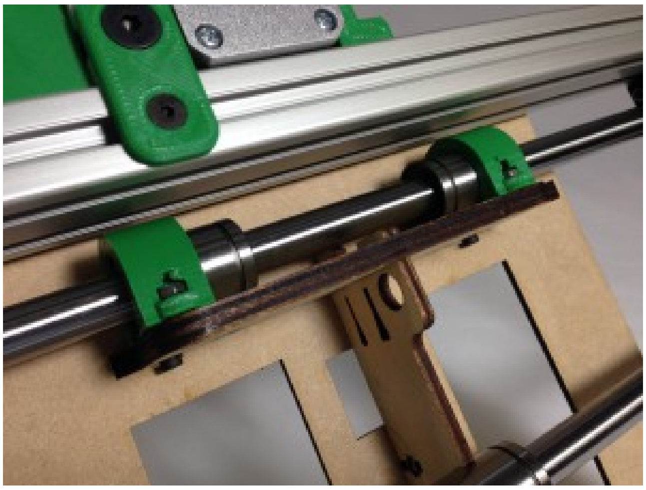
Slide the y-bearing-clamps onto the bearings as shown. Note the position of the mount on the bearing. This is important to allow maximum movement of the Y axis in its frame.



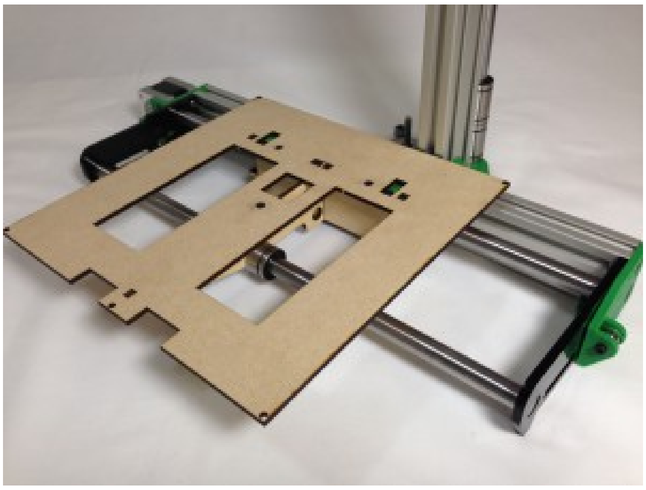
Offer up the y-carriage assembly to the y-bearing-clamps. Drop an M3 nut into the captive hole in the y-bearing-clamp on each side, and screw in the M3x16mm cap head screws.



Turn the machine over, drop an M3 nut into the captive hole in the y-bearing-clamp on each side, and screw in the M3x16mm cap head screws.



Clip the y-axis-rib over the front linear bearing to complete the y-carriage.

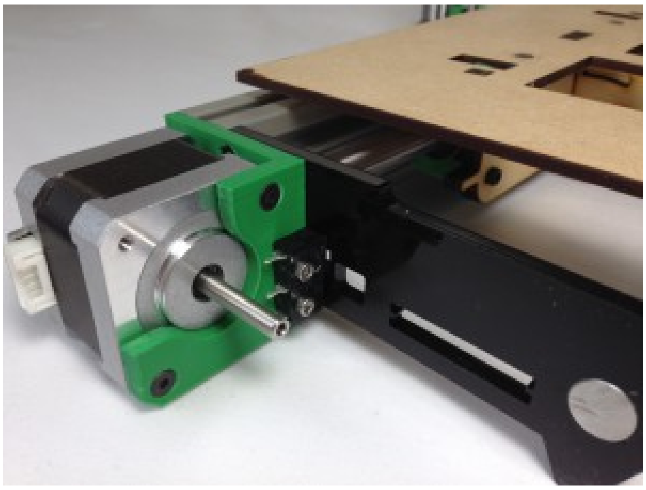


Y axis drive belt

Component	Type	Quantity
1/4" MXL Belt	Hardware	1
MXL pulley	Hardware	1
M3 grub screw	Hardware	1
Microswitch	Y Endstop	1
M2.5x10mm cap head screw	Y Endstop	2

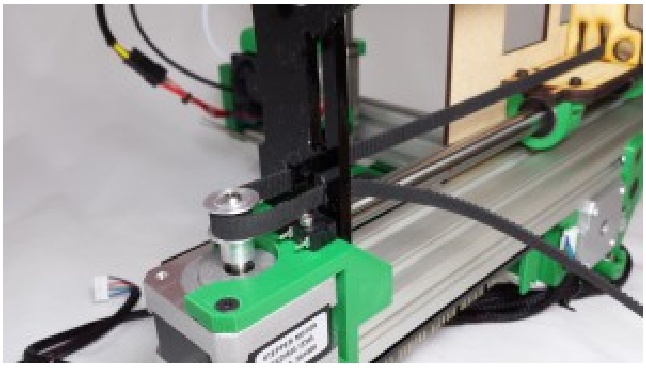
Cut the 1/4" MXL belt to 710mm. This is for the X axis, so set it aside, and leaves approximately 990mm for the Y axis.

Mount the microswitch with the two M2.5x10mm cap head screws. These should self-tap into the plastic of the y-motor-mount. Do not widen these holes with a drill, or the screws won't hold. The switch should align with the hole in the laser cut y-axis-end-plate. Check the Y-carriage tab can hit the switch.

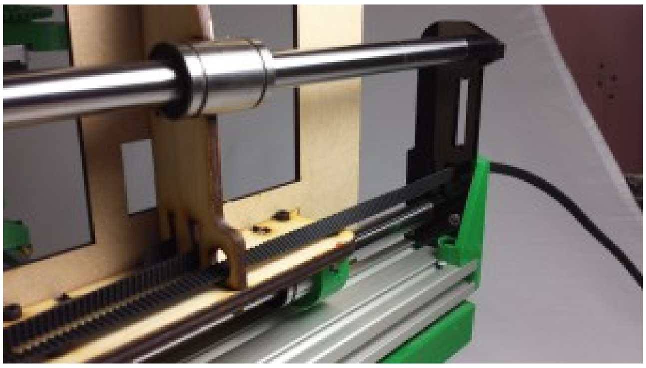


There are two slots and a circular hole in the y-rib. From the Y axis motor end, slide the end of belt through the wide part of lower slot, teeth downwards, and back through the upper slot, as shown. Push the belt back into the narrowing slot to lock it in place.

Put the pulley on the motor shaft, as shown in the picture. The motor shaft has a flat on it; align the grub screw with this, and tighten the grub screw using a 1.5mm Allen key. Thread the belt through the top hole in the y-axis-end-plate, around the drive pulley, and back through the lower slot in the y-axis-end-plate.



Twist the belt 180 degrees before feeding it through the circular hole in the y-rib, then through the lower slot in the idler end y-axis-end-plate.



Pass the belt over the idler bearing, back through the top slot in the y-axis-end-plate, towards the y-rib. The belt should run on the idler bearing on the smooth side of the belt, not the teeth.

Pull the belt tight and lock it by engaging the teeth of the two ends of the belt, then push them both to the back of the lower slot as shown. Trim excess belt, leaving a short length for adjustment. You can adjust belt tension by overlapping the belt ends more, so an extra tooth is engaged.

Y belt tensioning and carriage slipping

The belt tension needs to be quite tight, or the axis will suffer from 'backlash', and you will not get smooth vertical walls in your prints. When you twang the bottom belt, which has the longest uninterrupted span, a just-audible note should be heard. For reference, the note of the lowest string of a bass guitar is suitable. This is the bottom 'E' string; search online for a bass guitar tuner if you need an example. Adjust the belt as required.

The belt needs to be tightly held in the slot. If it is able to move, you will get steps in your prints. To test if it is, hold the y-pulley at the motor, and push the y-carriage each direction. if the doubled-belt is able to move in the clamp, you will get steps in your prints. The belt end that goes through the top slot rarely slips, so you will tend to find it slips in one direction. A number of workarounds exist.

Put a cable tie around the two belts, push it hard up against the y-axis-rib, then tighten. The cable tie in the picture has gone around the belt twice.

Pack under the two belts with a piece of paper, or shim, to hold them tight in the slot.

Picture to come

RepRap Ormerod forum (here) members have come up with a number of designs to help long-term, and RepRapPro are looking at ways to improve this too.

X axis assembly

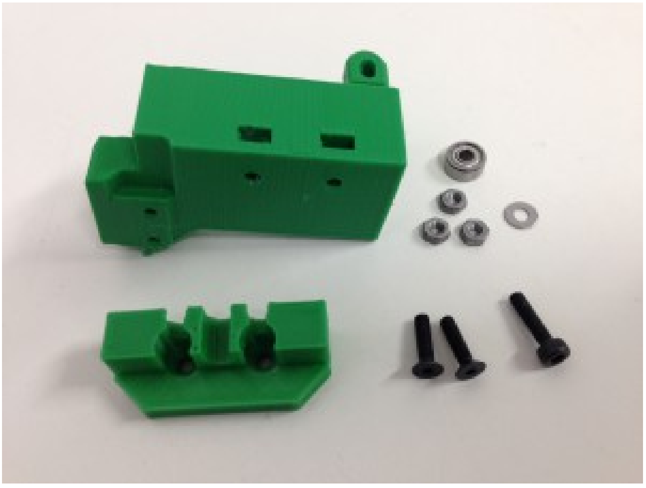
X axis sub-assemblies

The first step is to assemble a couple of sub assemblies.

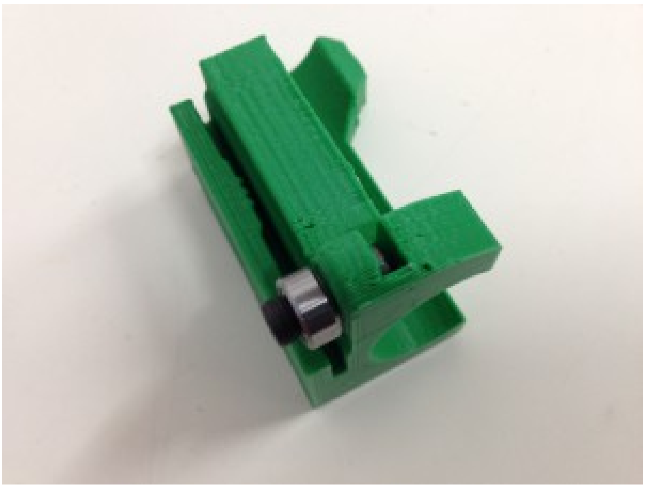
x-carriage

Starting with the x-carriage. You will need the following:

Component	**Type**	**Quantity**
x-carriage	Printed	1
nozzle-mount	Printed	1
MR93ZZ bearing (9mm diameter)	Hardware	1
M3x12mm cap head screw	Fastener	1
M3 washer	Fastener	1
M3 Nut	Fastener	3
M3x12mm countersunk socket screw	Fastener	2



Fit the runner bearing using the M3x12mm cap head screw. The washer should be positioned between the bearing and the x-carriage. Check that the screw can move in the slot; this allow you to adjust the angle of the hot end.

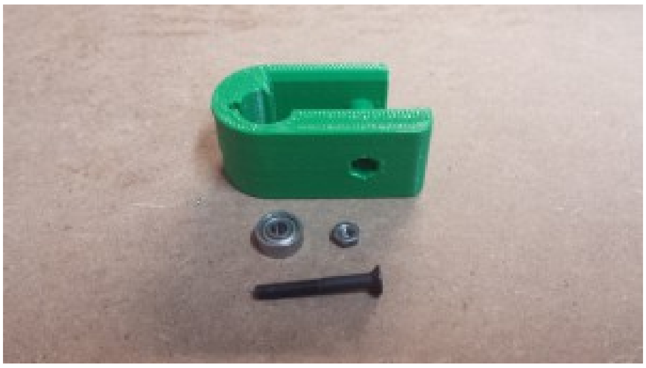


Put an M3 nut in each of the nut traps. Attach the nozzle mount as shown with two M3x12mm countersunk socket screws.

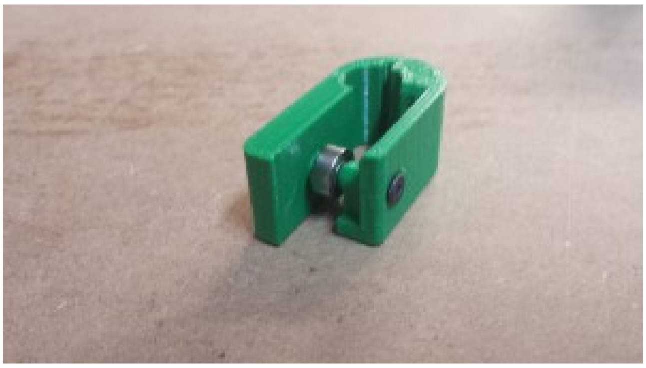
x-idler

Next you should assemble the X-idler sub-assembly. For this you will need the following:

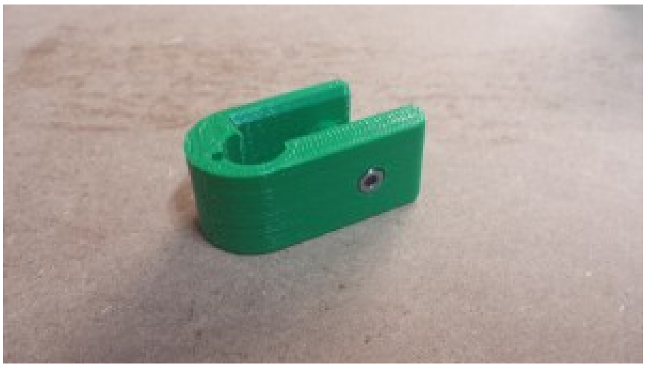
Component	**Type**	**Quantity**
x-idler-bracket	Printed	1
623 bearing (10mm diameter)	Hardware	1
M3x25mm countersunk socket screw	Fastener	1
M3 Nut	Fastener	1



Push the countersunk screw through the x-idler-bracket. The hole may be a little tight where it breaks through to the gap in the middle of the x-idler-bracket. Place the bearing inside the x-idler-bracket and fit the M3 nut to the protruding screw.



Pull the M3 nut into the nut trap, but do not tighten at this stage.

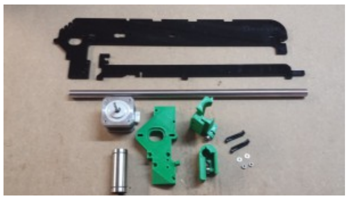


X axis assembly

Now you can start to assemble the X axis.

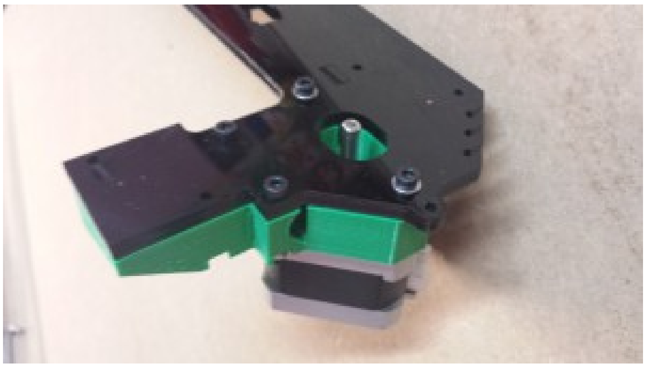
You will need the x-carriage and x-idler sub assemblies, as well as the following parts:

Component	Type	Quantity
x-carriage	Assembled	1
x-idler	Assembled	1
[x-motor-bracket]()	Printed	1
x-axis-plate	Laser cut	1
x-rib	Laser cut	1
NEMA17 stepper motor	-	1
Smooth rod 12x350mm	-	1
LM12LUU linear bearing	Hardware	1
M3x25mm cap head screw	Fasteners	4
M3 Nut	Fastener	2
M3 washer	Fastener	2

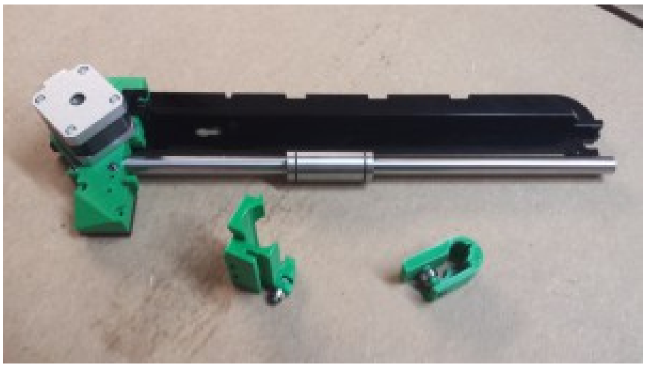


Push the x-rib into place in the slots in the x-axis-plate, which should slot together easily. **DO NOT FORCE!** Acrylic is quite brittle, and you may break the x-rib. Use a file to smooth any rough edges, and ease the tabs of the x-rib, so it goes into the x-axis-plate easily. Slide the x-motor-bracket into place (this may need trimming for a good fit around the x-rib), and put an M3 nut in each nut trap, as shown.

Insert the two of the M3x25mm cap head screws to engage with the M3 nuts in the nut traps. Insert the other two M3x25mm cap head screws, with washers on, to mount the motor, but do not fully tighten. Make sure all the M3 holes in the printed part line up with the laser cut part - trim as necessary.

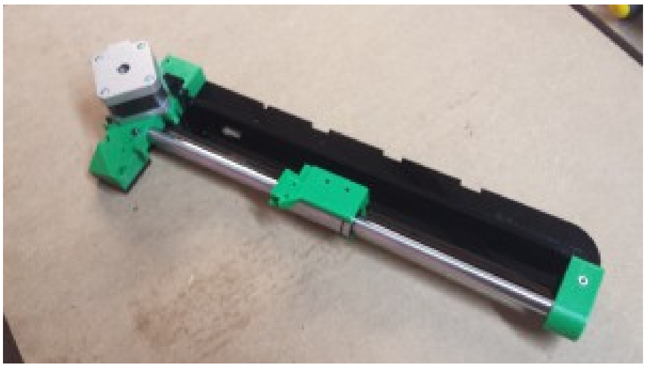


Slide the ground bar into the x-motor-bracket, then the linear bearing onto the bar.



Next slide the x-carriage into place.

Finally, push the x-idler sub-assembly onto the rest of the X axis assembly. Ensure you have the parts lined up before applying too much pressure as the Laser cut parts are not very forgiving. Tighten the countersunk screw in the x-idler-bracket, as well as the screws securing the ground bar at the X motor end.

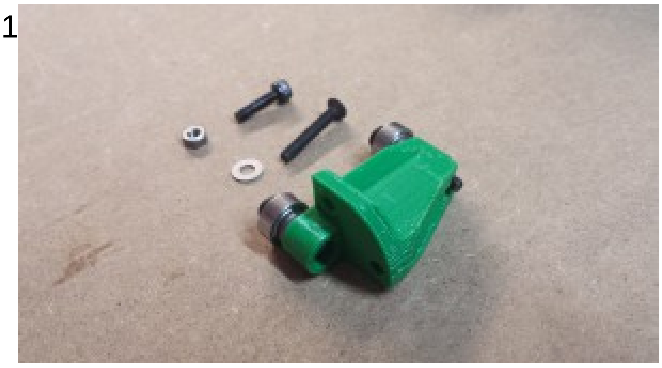


z-runner-mount

To finish the X axis assembly, you need to fit the z-runner-mount sub-assembly. For this you will need the following:

Component	Type	Quantity
z-runner-mount	Printed	1
623 bearing (10mm diameter)	Hardware	2
M3x12mm cap head screw	Fastener	2
M3x20mm cap head screw	Fastener	1
M3x20mm countersunk socket screw	Fastener	1
M3 Nut	Fastener	4
M3 washer	Fastener	1

Pull the nuts into the nut traps with an M3 screw if they don't drop straight in, and make sure they are at the bottom of the nut trap. Using one M3x20mm cap head screw and one M3x12mm cap head screw, attach the bearings. Put one bearing on each screw, then 5 x M3 washers between each bearing and the z-runner-mount.



Mount the z-runner-mount assembly to the x-axis-plate using the remaining M3x12mm cap head screw and nut, which goes through the x-axis-plate and into the top hole of the z-runner-mount ...

... and the M3x20mm countersunk screw, which goes through the x-axis-plate and into the x-rib. The washer and M3 nut go into the cut-out in the x-rib to secure it. Check the bearing is free to rotate; add or remove a washer if it is touching the acrylic.

If you have the updated, adjustable z-runner-mount, it looks like this. Use an extra M3x20mm countersunk socket screw and M3 nut to secure it. **DO NOT OVER-TIGHTEN!** The z-runner-mount should only need to lightly hold the z axis aluminium extrusion.

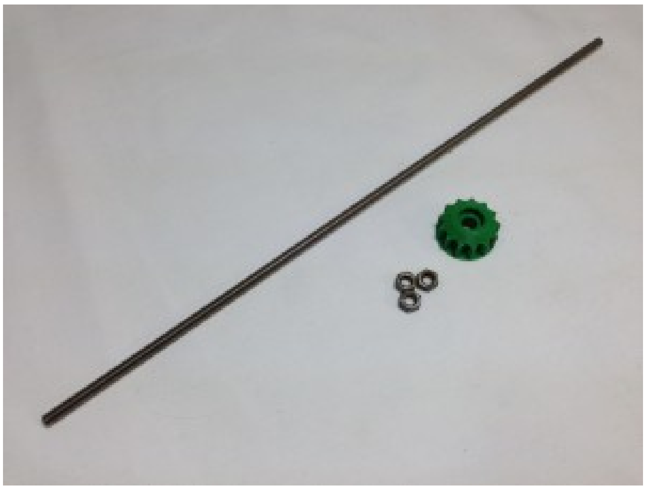
X axis mounting

The X axis assembly can now be mounted to the previously assembled ZY assembly.

Z axis leadscrew

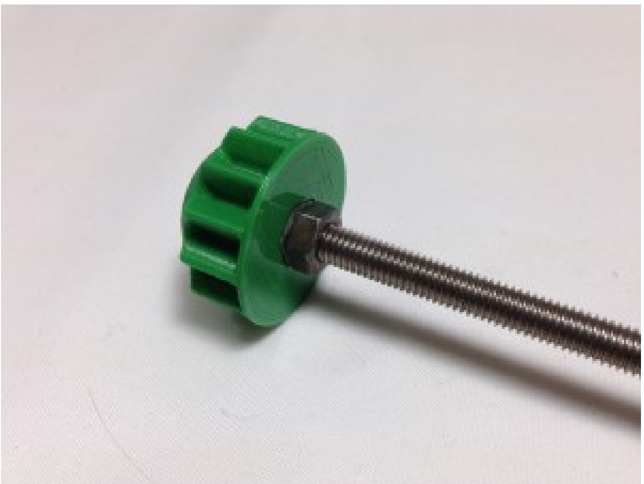
First, prepare the **Z axis leadscrew**, using the following:

Component	Type	Quantity
z-gear-driven	Printed	1
M5 threaded z-rod	-	1
M5 Nut	Fastener	3



Screw two of the nuts onto one end of the M5 threaded z-rod. Lock one nut against the other right at the end of the rod. Screw the third nut onto the other end of the z-rod.

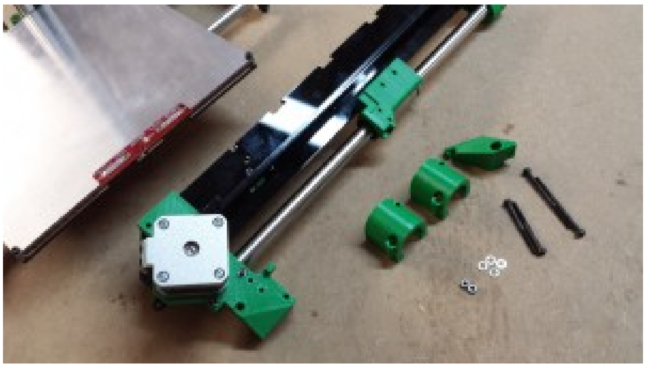
Push the z-gear-driven onto the locked M5 nuts. The bottom nut of the two should fit into the nut trap in the gear.



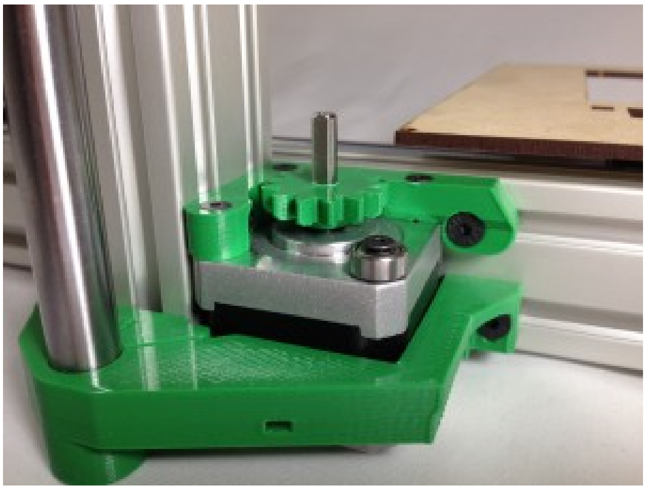
X axis assembly

Now, the x-axis-assembly can be mounted on the z axis. For this, the following parts are required:

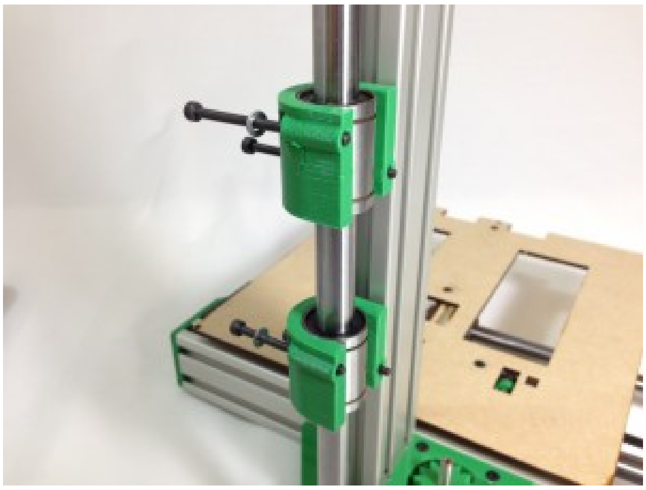
Component	Type	Quantity
x-axis-assembly	Assembled	1
z-axis-leadscrew	Assembled	1
z-bearing-clamp	Printed	2
z-nut-trap	Printed	1
z-gear (not shown)	Printed	1
M3x50mm cap head screw	Fastener	2
M3x40mm cap head screw	Fastener	2
M3 Nut	Fastener	4
M3 washer	Fastener	4



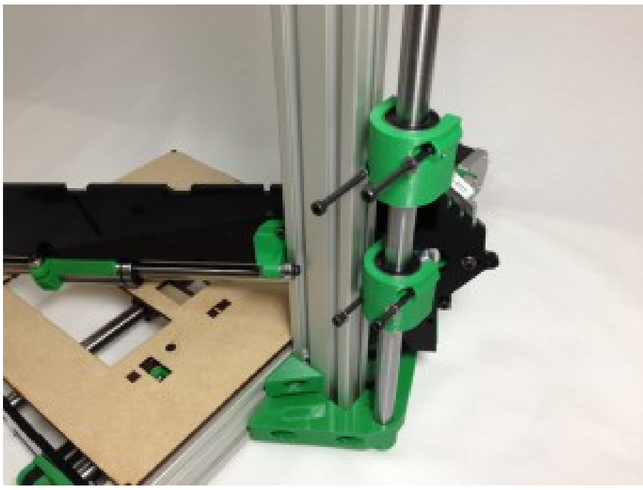
Press the z-gear onto the z-motor shaft, conical side down. The z-gear has a flat in the hole, that should align with the flat on the motor shaft, which stops the gear rotating on the shaft. The gear should be a tight fit, so make sure you line it up before pushing the gear on the motor shaft.



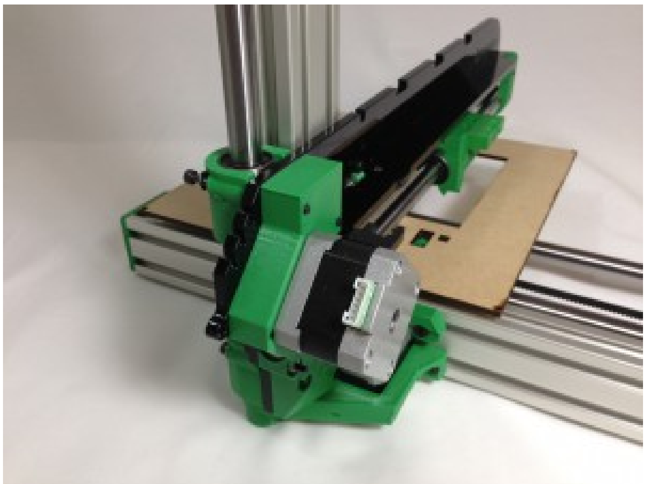
Slide a z-bearing-clamp onto each z axis linear bearing. Place the two M3x50mm cap head screws in the top mount, and the two M3x40mm cap head screws in the bottom mount, with a washer under each head.



Take the x-axis-assembly. Hook the z-runner-mount bearing around the z axis aluminium extrusion.

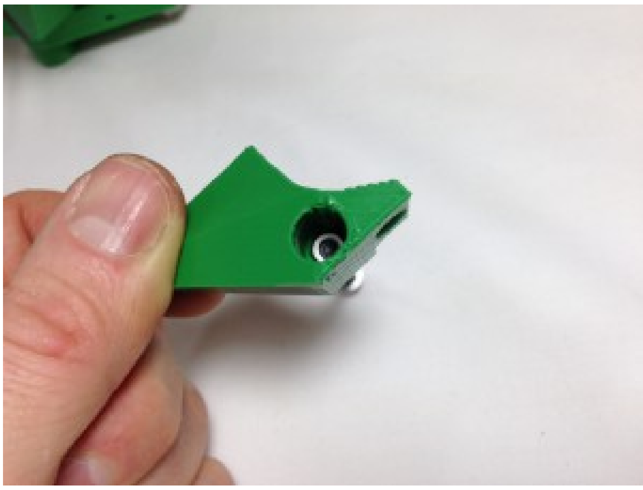


Offer up the x-axis-assembly and push the four z-bearing-mount screws through the X axis. The X axis can now sit at the bottom of the Z axis.

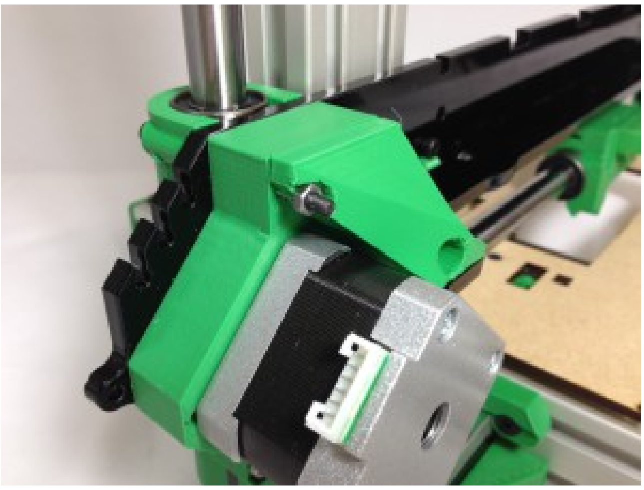


Use two M3 nuts to secure the bottom z-bearing-mount. Don't do them up too tight yet.

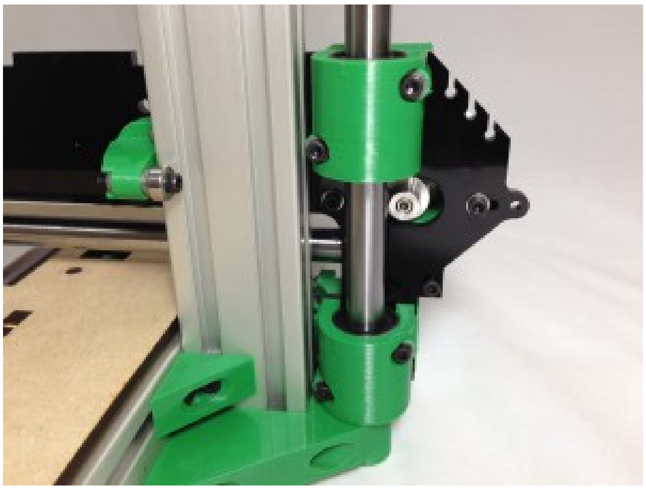
Use a screw to pull an M3 nut into the recessed nut trap, in the z-nut-trap printed part.



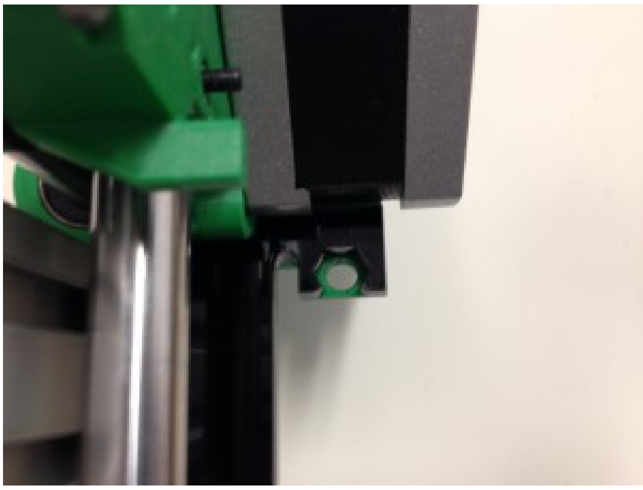
Push the z-nut-trap onto the end of the 50mm cap head screws, add the remaining M3 nut, and do up the screws, but not tight.



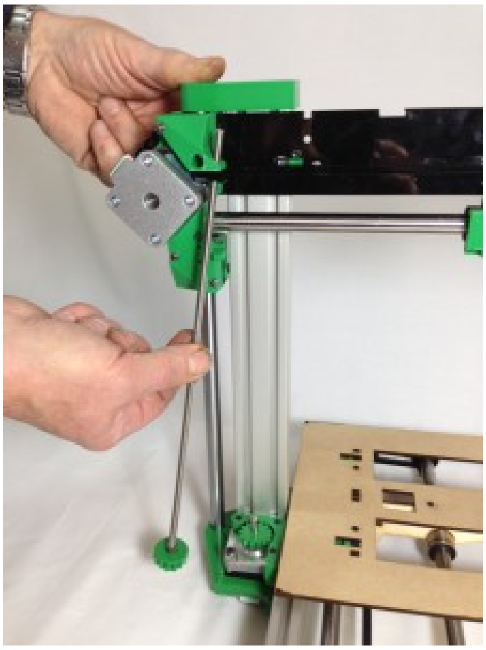
Now tighten the bearing mount screws. The holes in the bearing clamps are clearance for the M3 screws, so keep moving the axis up and down between turns of each screw. This will let the bearings settle in the right place, and ensure the axis runs smoothly.



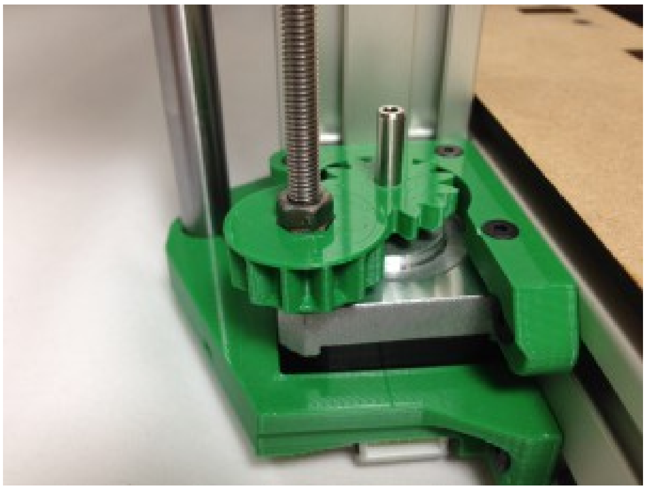
Check that the hole in the z-nut-trap is central in the x-rib laser cut part - if it is not, the Z leadscrew nut may break the x-rib. This picture is looking up the Z axis from the bottom.



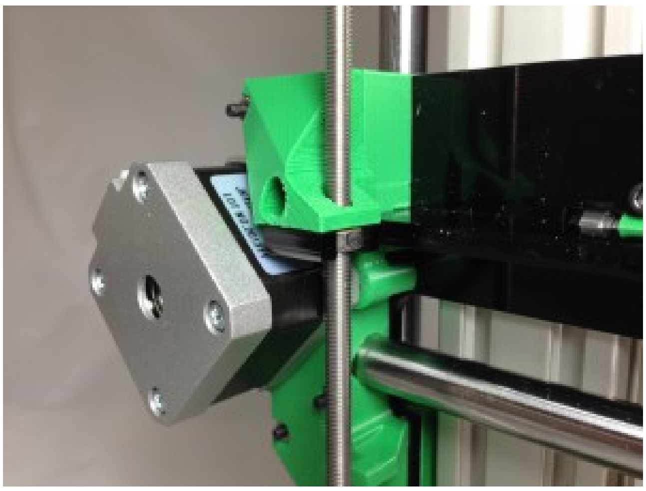
Lift the X axis to the top of the Z axis, and carefully feed the z-axis-leadscrew assembly up through the z-nut-trap.



The z-axis-leadscrew sits on the 623 bearing on the corner of the Z axis motor, engaging with the z-gear on the motor.



The x-axis-assembly can now be supported by the loose M5 nut on the z-axis-leadscrew. Gently lower the X axis onto it, being careful to orientate the M5 nut correctly - see picture. Don't force it - it will break the nut trap on the x-rib.

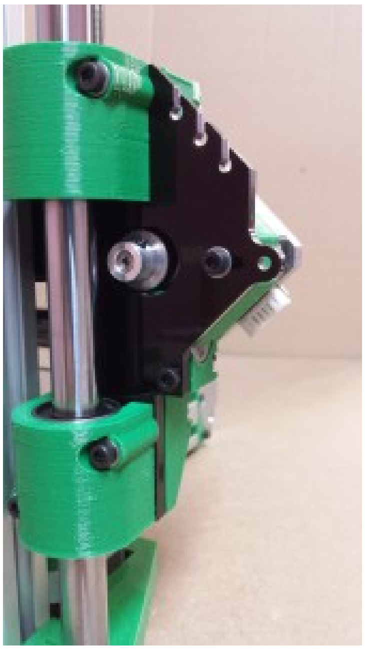


X axis drive belt

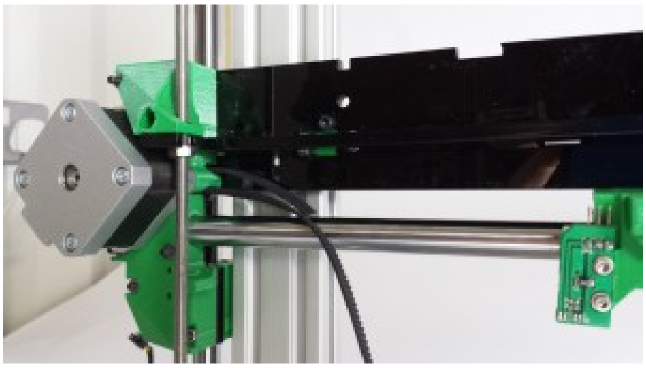
Component	Type	Quantity
1/4" MXL Belt (not shown)	Hardware	710mm
MXL pulley	Hardware	1
M3 grub screw	Hardware	1

The X axis drive belt can now be fitted. The 1/4" MXL belt should be accurately cut to 710mm in length.

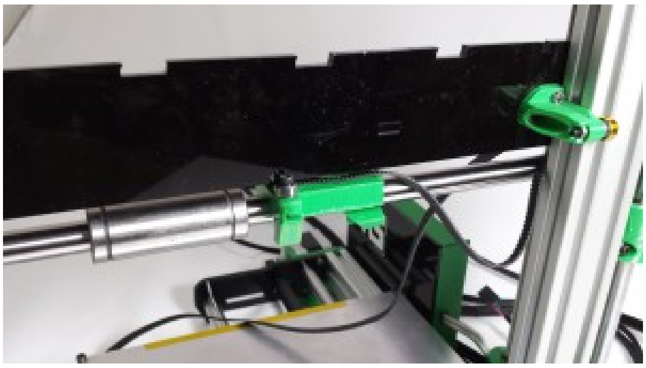
Put the pulley on the motor shaft. Remove the motor to do this. The motor shaft has a flat on it; align the grub screw with this, and tighten the grub screw using a 1.5mm Allen key. The pulley needs to sit right on the very end of the motor shaft, as shown in the picture. Don't tighten the motor mounting screws, so the motor can slide. This allows for belt tension adjustment.



Insert the belt through the slot in the x-motor-bracket, around the drive pulley and back out through the second slot. This is quite fiddly; moving the motor back and forth will help feed the belt through, as will rotating the motor pulley.



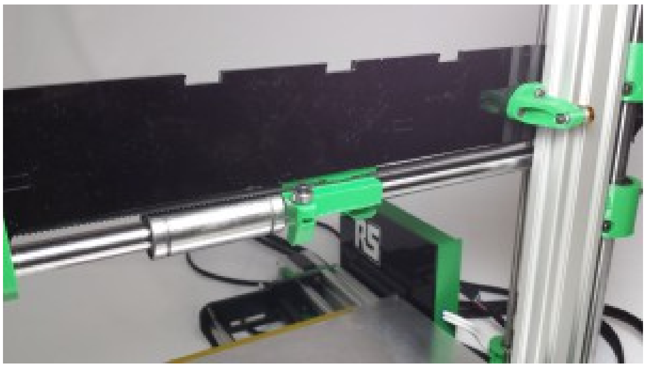
Slide the end of the lower section of belt into the x-carriage. It is easiest to do this with the x-carriage separated from the linear bearing. The end of the belt should be flush with the end of the x-carriage.



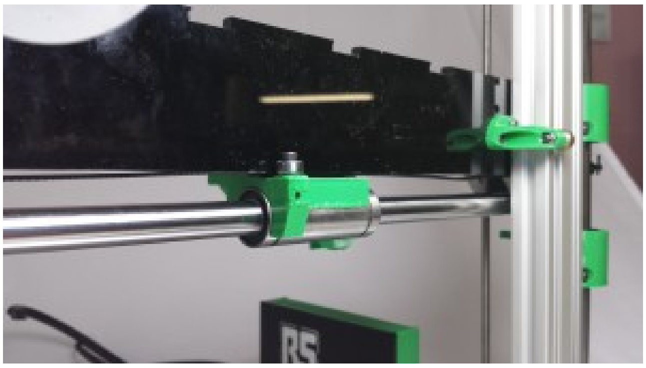
Twist the top section of belt 180 degrees, and pass it over and around the idler bearing. The smooth side of the belt will be in contact with the bearing.

Bring the belt back to the x-carriage and mesh it with the other end of the belt.

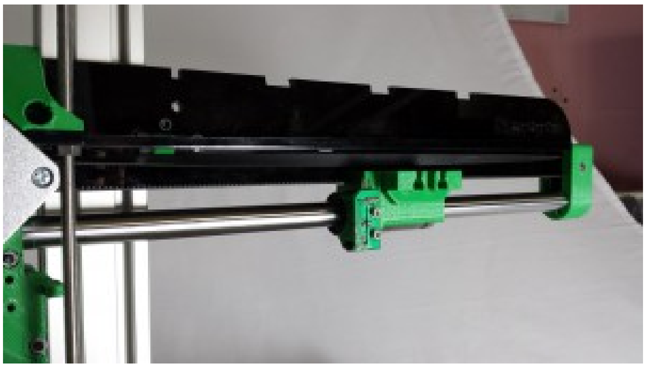
Push the belt into the x-carriage slot.



The linear bearing can now be slid back into the x-carriage.



Tighten the belt by sliding the X axis motor.
Tighten the motor mounting screws.



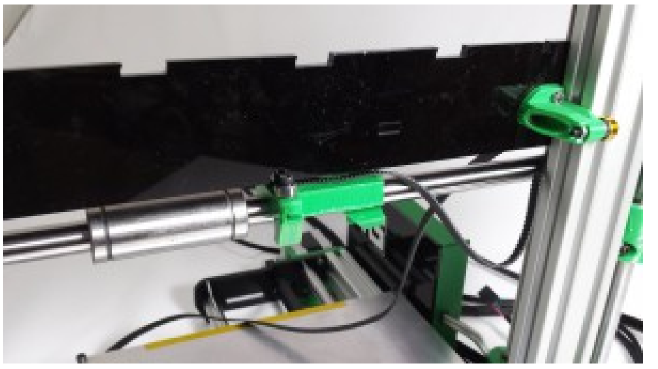
Checking for play in the x axis

Rotation of the x axis around the z axis is prevented by the bearings on the z-runner-mount, mounted on the x axis. It is important it is held securely, but not overly-tight.

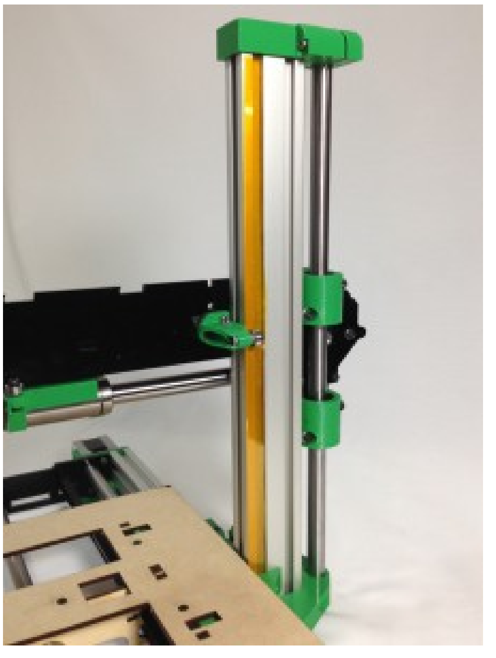
Current kits use an adjustable z-runner-mount, which can be adjusted to tension the bearing onto the aluminium extrusion. Don't overtighten this, or movement of the Z axis may be compromised.

Some customers with the red RS kits, and an non-adjustable z-runner-mount have reported that it is slightly loose, and causes the end of the x axis to wobble a couple of millimetres. To get printing (and then print yourself a new z-runner-mount), there are a couple of workarounds:

Using the supplied Kapton tape, put layers around the z-runner-mount bearing until the play is eliminated. Kapton tape is 50 microns (0.05mm) thick.



Using the supplied Kapton tape, put layers on the aluminium extrusion, between the extrusion and the path of the bearing, until the play is eliminated. It took 3 layers of Kapton on our build of a production printer.

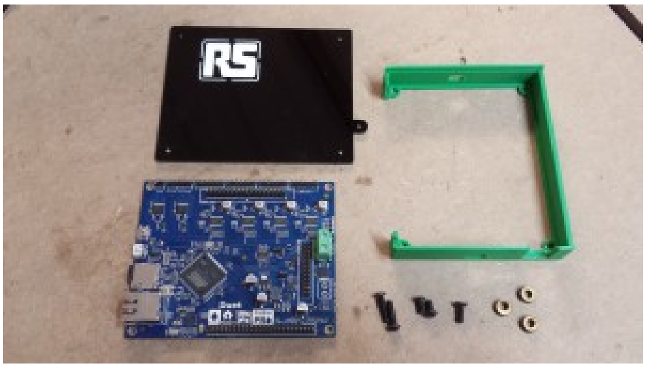


Electronics

Duet electronics enclosure

Mount the electronics enclosure using the following parts:

Component	Type	Quantity
Duet-enclosure	Printed	1
Duet-enclosure-base	Lasercut	1
M4x16mm button head screw	Fastener	2
M4x8mm button head screw	Fastener	2
M4x16mm countersunk socket screw	Fastener	1
M4 T-nut (not shown)	Fastener	3
Spacer	Lasercut	3

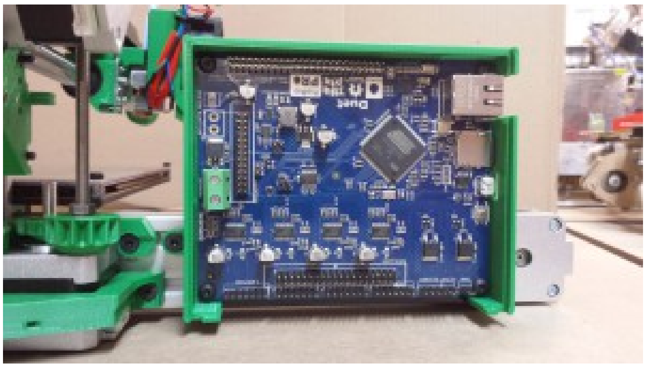


NOTE: Some early Duet boards were shipped with 3.5mm diameter mounting holes. These should be 4.2mm in diameter. If you have one of the affected Duet boards, it is ok to enlarge the holes with a 4-4.5mm drill.

Mount the Duet electronics board in the Duet-enclosure printed part, and put the lasercut Duet-enclosure-base on the back. The two M4x8mm button head screws go in the top mounting holes, and self-tap into the Duet-enclosure-base.

The two M4x16mm button head screws go in the bottom two mounting holes, through the cover, and have a spacer between the cover and the T-nut. The M4x16mm countersunk screw goes through the lug on the side, again with a spacer and T-nut on it.

Mount the Duet enclosure on the end of the Y axis extrusion, near the Y motor. **IMPORTANT** - Make sure the Hot end carriage can pass by it (it will be close), or the X axis will not 'home' properly. You can move the X-carriage by hand to test.

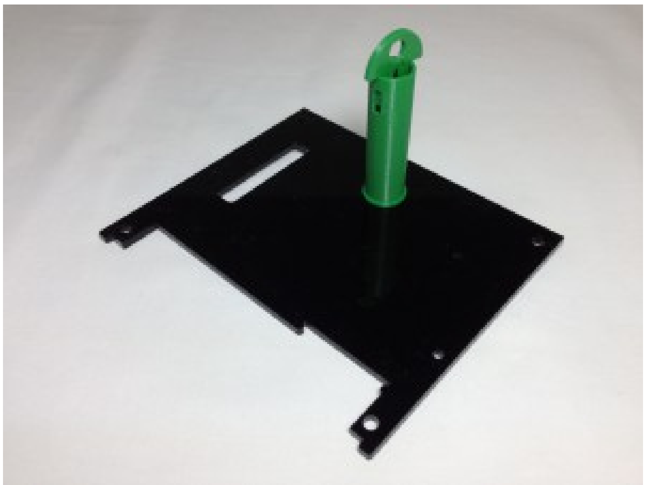


Enclosure rear cover

The rear cover needs the following parts:

Component	Type	Quantity
Duet-enclosure-lid	Lasercut	1
spool-spigot	Printed	1
spool-clip	Printed	1
M3x16mm cap head screw	Fastener	1
M3 nut	Fastener	1

Drop the M3x16mm cap head screw down the spool-spigot, so the thread comes out of the hole in the end. Secure to the Duet-enclosure-lid, through the hole shown, with the M3 nut. The spool clip pushes into the end of the spool-spigot.

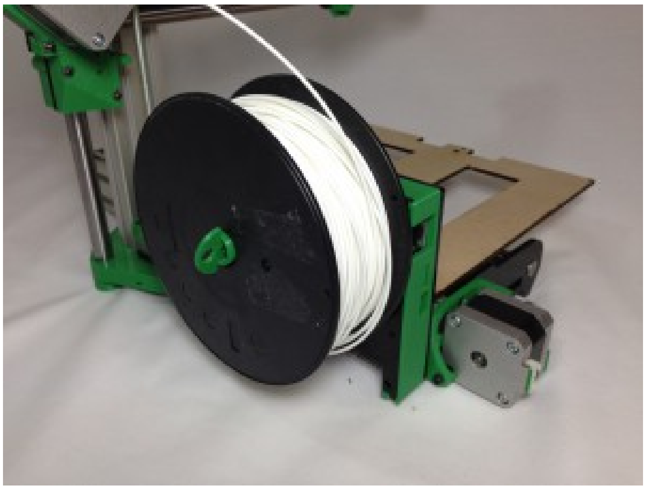


You may need to flatten the two earthing springs on the top of the ethernet connection. To mount the rear cover, clip it into the top securing lugs in the printed enclosure by sliding it up from below.

Slide the cover up, while pushing it flat into the frame, so it rests on the lip of the frame.

Slide the cover down, so the bottom of the cover is secured by the lugs on the printed part. Removal is the reverse of installation.

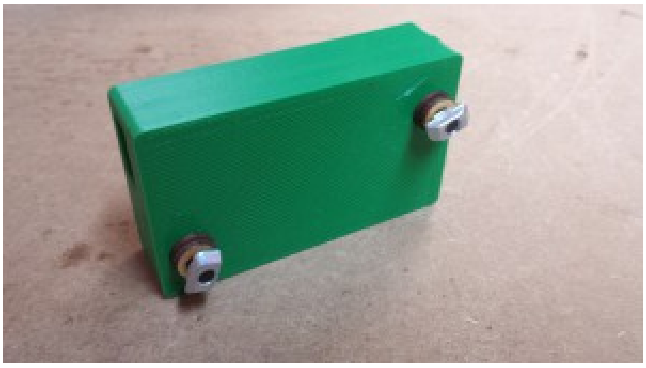
Pull out the spool-clip, slide on the filament spool, and replace the spool-clip. You will need to remove the cover to connect the wiring.



ATX power PCB

Component	Type	Quantity
ATX power PCB	Electronics	1
ATX power PCB enclosure	Printed	1
M4x16mm button head screw	Fastener	2
M4 T-nut	Fastener	2
Spacer	Lasercut	2

Mount the ATX Power PCB in a similar way to the Duet. The two M4x16mm button head screws go in the diagonal two mounting holes, through the enclosure, and have a spacer between the enclosure and the T-nut.



Mount the ATX power PCB enclosure on the end of the Y axis extrusion, near the Y idler. Make sure that there is a jumper on the pair of pins that are closest to the white 4-way connector, not on the pair that is closest to the LEDs. This controls the ATX power supply unit (PSU) - without the jumper, the PSU will not turn on.

Now test the ATX PSU. Plug the large 24-way connector and the 4-way connector into the ATX Power PCB. These are keyed, so you can't put them in the wrong way. Plug the PSU into a wall outlet, and turn on. There is a power switch on the back of the PSU; turn this on too. The ATX fan should spin, and the LEDs on the ATX Power PCB should turn on. Once tested, turn off and disconnect the PSU. Leave the PSU connected to the wall outlet for a few minutes to discharge any capacitance.

Picture to come.

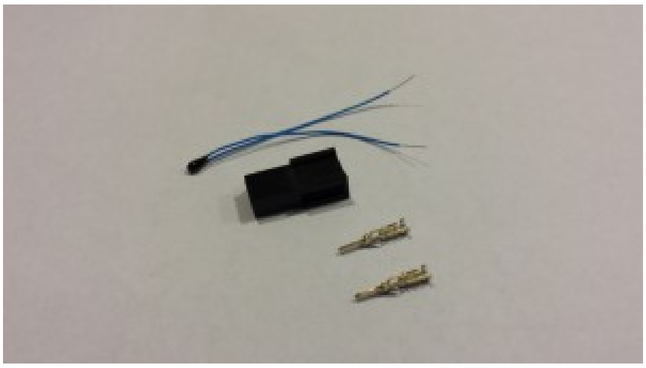
Picture to come.

Heated bed assembly

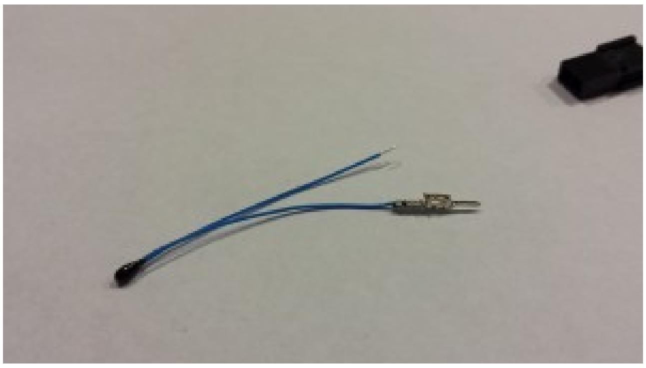
Thermistor assembly

The first step requires assembly of the heated bed thermistor. The following are required:

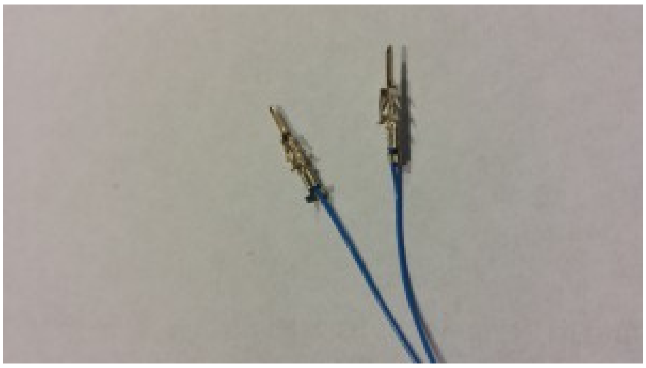
Component	Type	Quantity
10k Thermistor	Electronics	1
2 way female housing	Electronics	1
Male crimp terminal	Electronics	2



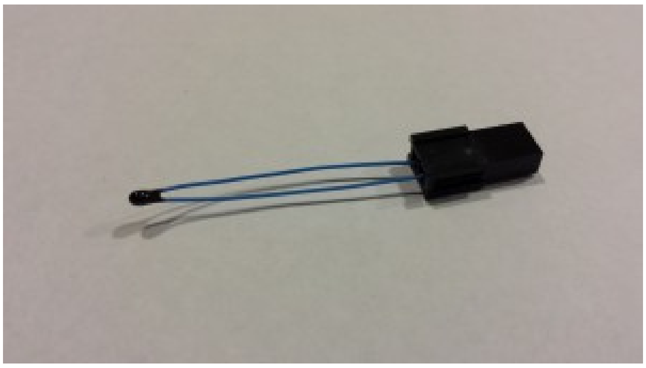
Fold the unsheathed part of one thermistor leg in half (it makes the wire fatter, and more likely to grip), then crimp the terminal onto it. Ensure the sheath is secured by the rear part of the crimp terminal.



Repeat for the other thermistor leg.



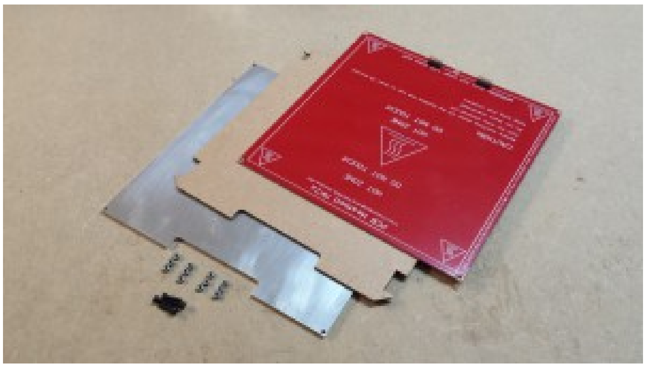
Push the crimp terminals into the 2way female housing.



Heated bed assembly

The heated bed assembly requires the following parts:

Component	Type	Quantity
Thermistor assembly	Assembled	1
PCB heatbed	Electronics	1
Aluminium heat spreader	Lasercut	1
Cardboard insulator	Lasercut	1
M3x12mm cap head screw	Fastener	5
M3 Nut	Fastener	10



The thermistor bead fits into the central hole in the heated bed PCB. Secure it in place with some Kapton tape.

Heated bed wiring

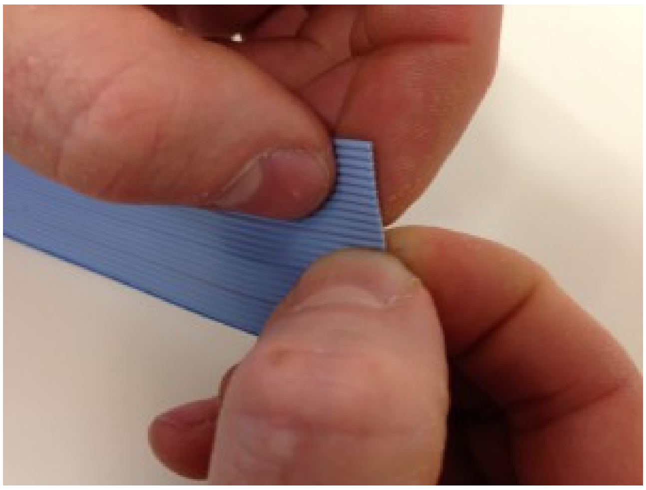
Heated bed wiring harness

The bed wiring harness provides power to the heated bed and carries the signal from the thermistor to the Duet board. You will need these parts:

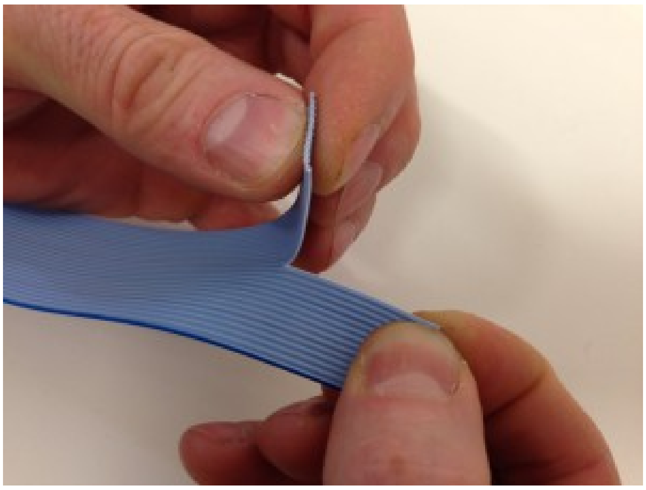
Component	Type	Quantity
Ribbon cable 26-way	Electronics	850mm
IDC 2x13 connector	Electronics	1
IDC 2x6 connector	Electronics	2
Female crimps - 3030T-1	Electronics	2
Male 2-way terminal - 3025-02	Electronics	1

Preparing the heated bed end

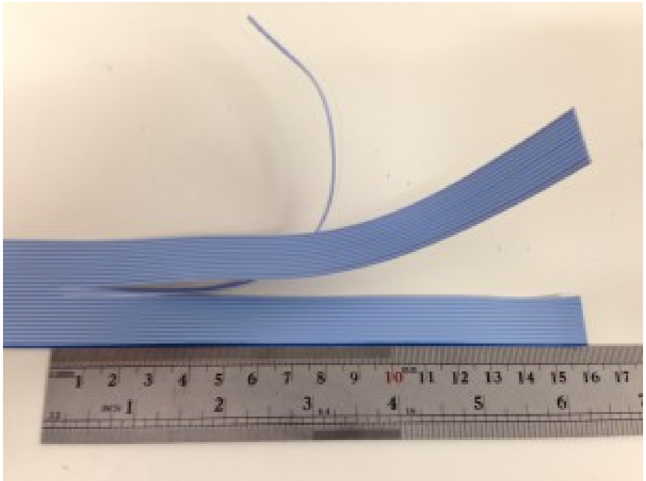
Start by splitting the ribbon cable to the correct lengths.



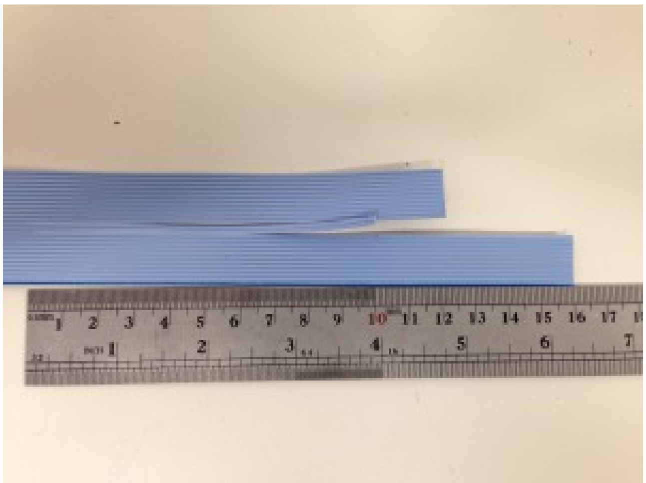
Split one end into 3 parts, down the length of the ribbon cable. You can simply tear the wires apart.



The outside two parts should be 12 wires each, leaving 2 wires in the centre. Split this back 160mm from the end.

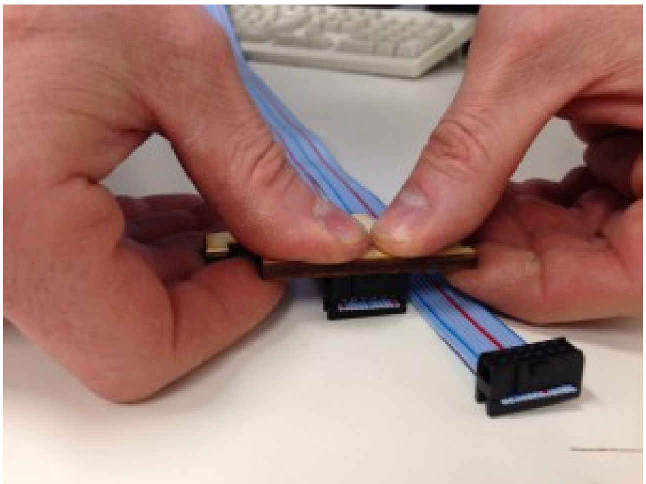


Cut ONE of the 12-wire sections back 40mm. Cut the central 2 wires back 60mm from the end (sharp scissors are easiest for a straight cut).

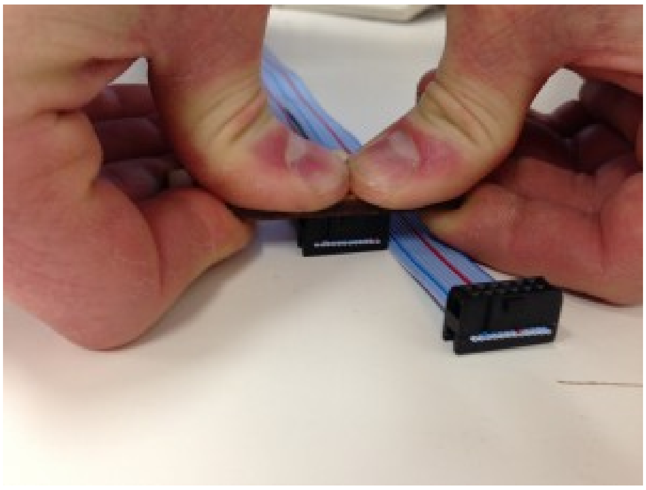


Fitting the heated bed-end IDC connectors

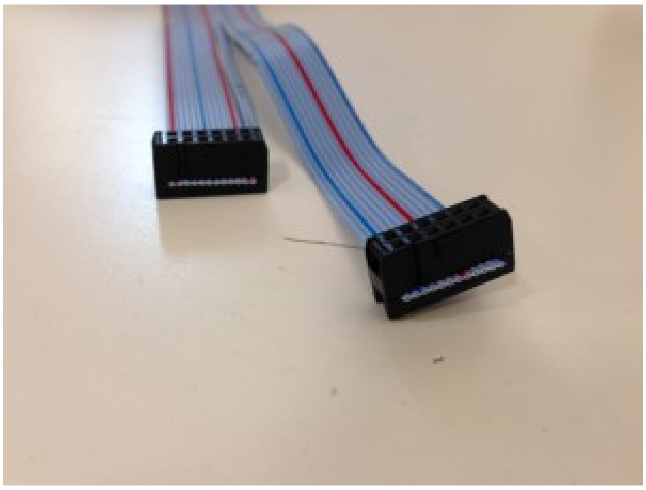
Connect the two IDC 2x6 connectors on the end of the two 12-way ends.



You can do this by hand; make sure the connector is square to the cable, and use a piece of wood to press on - it's easier!

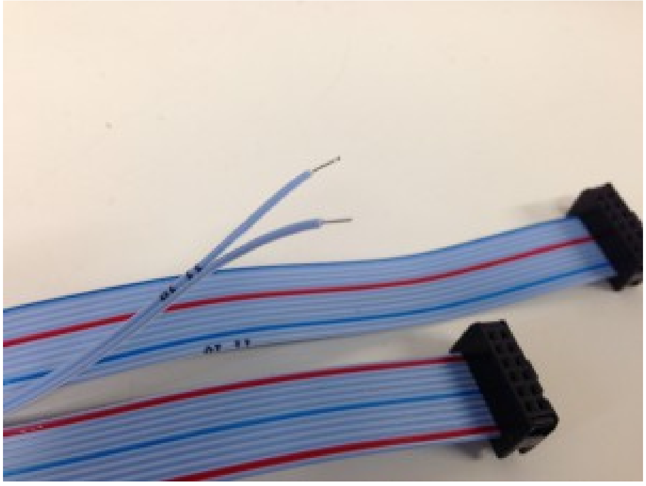


Make sure the connector is fully pushed down.

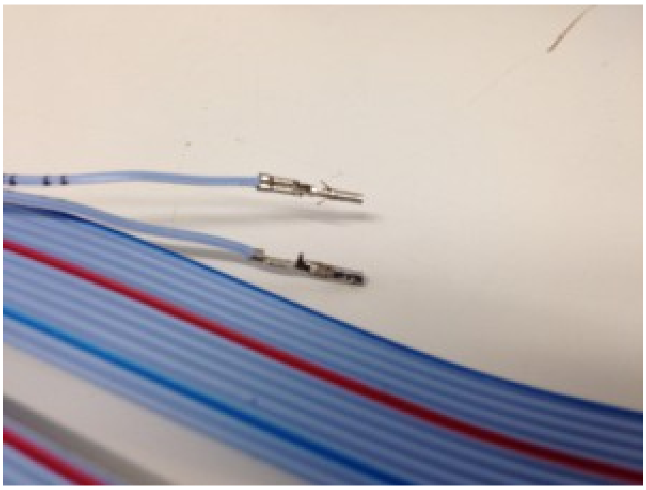


Fitting the thermistor connector

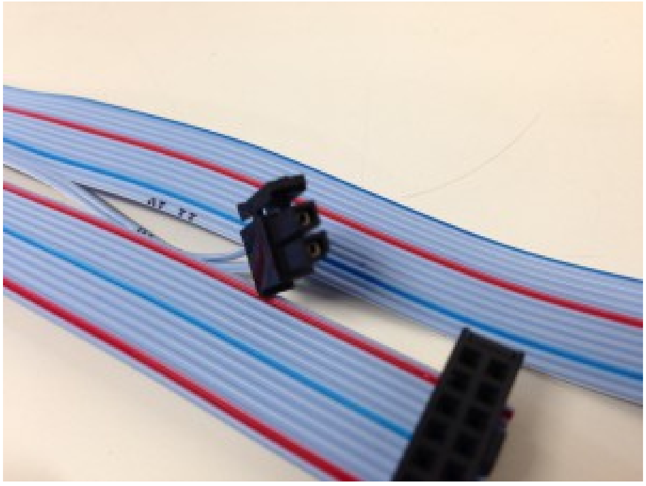
Strip 4mm of insulation from central 2 wires.



Crimp a female connector onto each one.

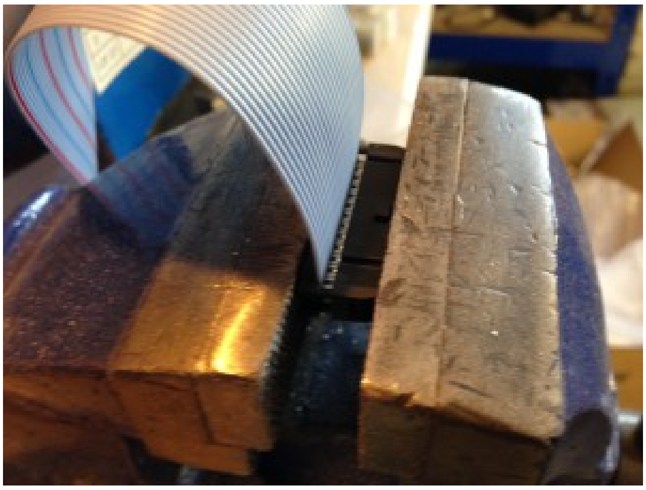


Insert the crimps into the crimp housing. Polarity isn't important for the thermistor.

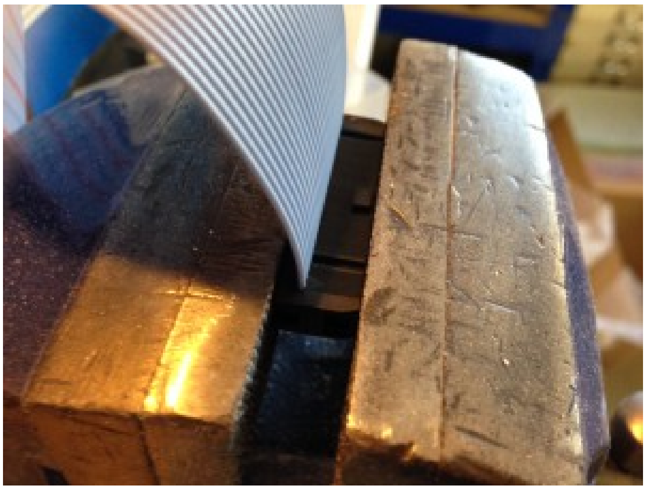


Fitting the Duet-end IDC connector

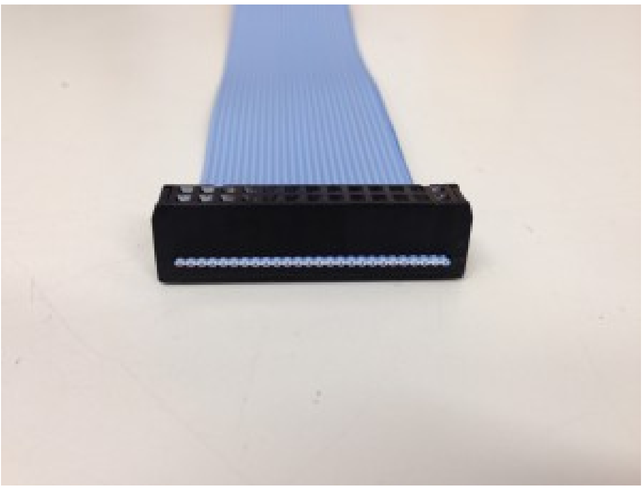
Cut the ribbon cable to 820mm, and connect the IDC 2x13 connector to the other end of the ribbon cable. It should face the other way from the IDC 2x6 connectors.



It's easiest to do this in a vice.

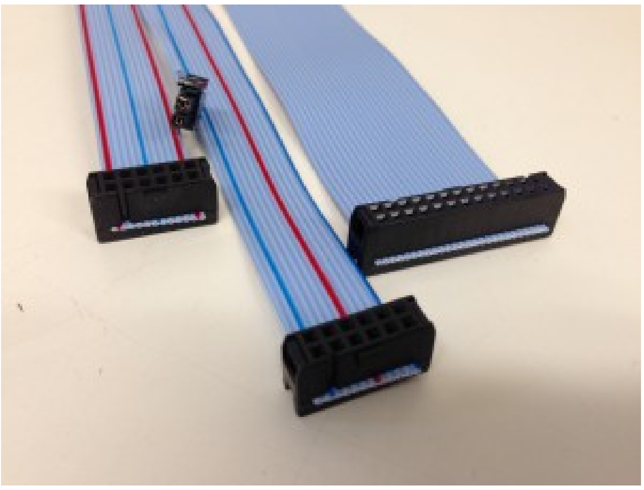


Again, check that the cable is fully pushed into the connector.

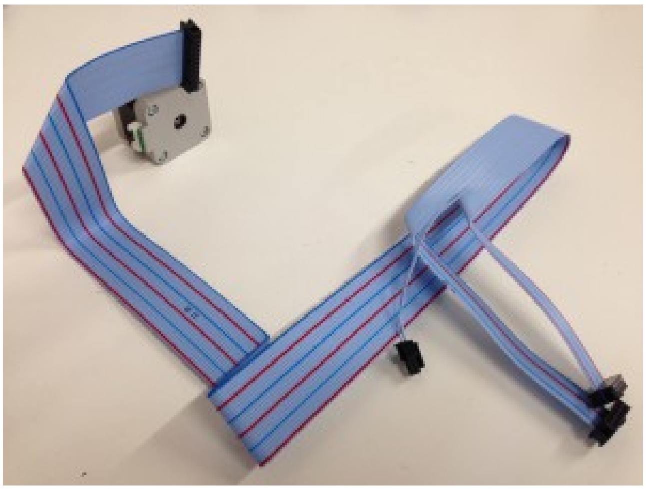


The finished heated bed wiring harness

The finished heated bed wiring.

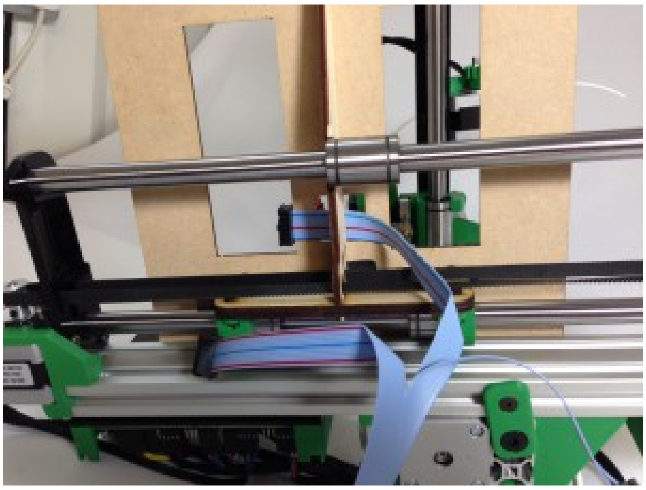


This is the rough layout of the wiring on the printer. The 2x13 IDC connector plugs into the Duet board, the 2x6 IDC connector plugs into the heated bed, and the central connector plugs into the thermistor in the centre of the heated bed.

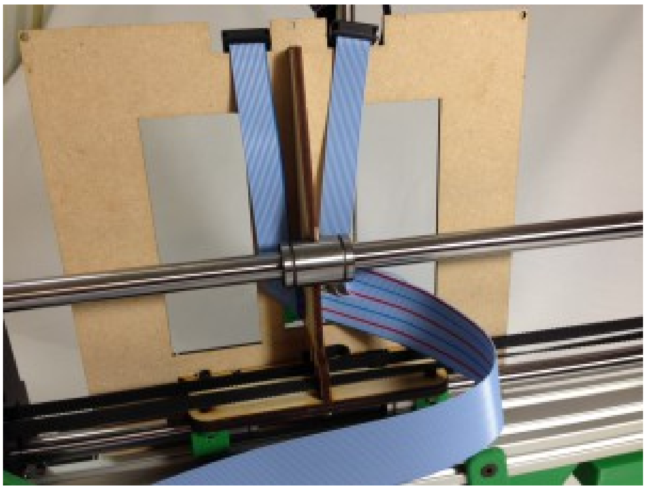


Fitting the bed wiring harness

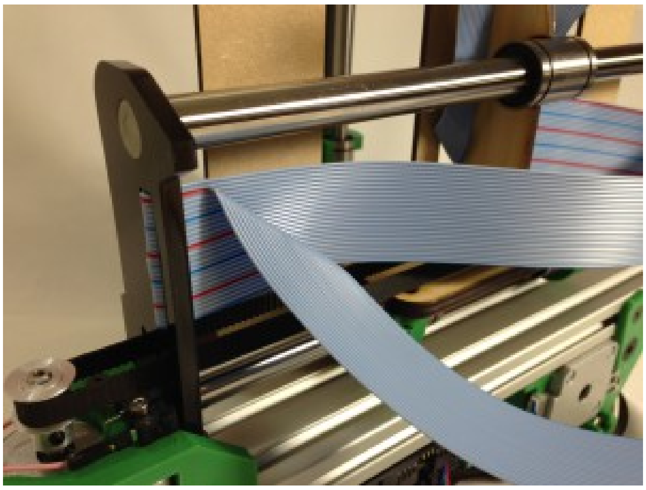
Start by turning over your printer. From underneath, thread the longest 12-way section of the bed wiring harness up through the central slot in the bed, then back down, as shown.



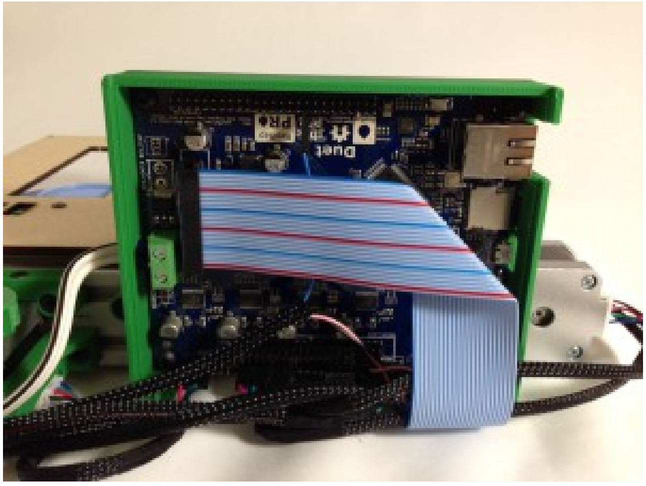
Make sure it reaches the cut out in the MDF bed, that it is designed for. Put a 45 degree bend in the cable. Thread the other shorter side up to the second slot.



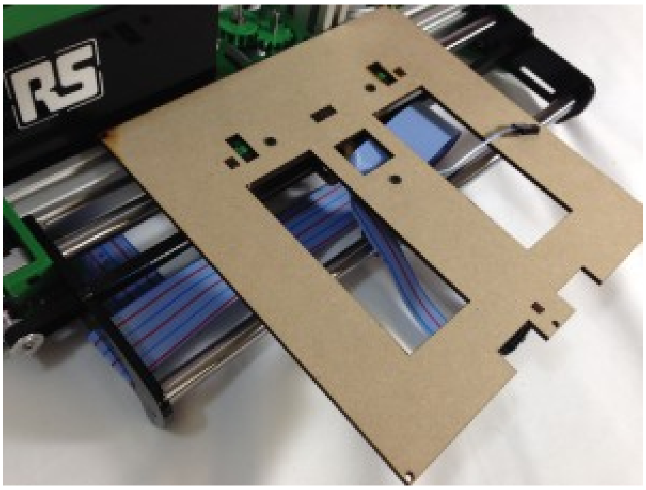
Leave a good length of the main wire under the printer, and clip a loop of the ribbon cable into the slot near the Y axis motor.



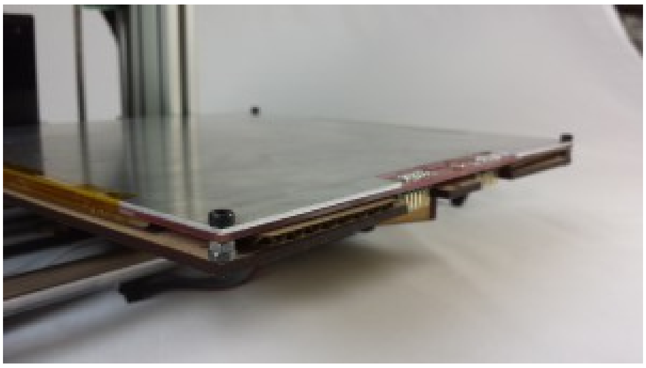
Run the cable up the back of the machine, and bend it over to connect to the bed power pins on the Duet board, as shown.



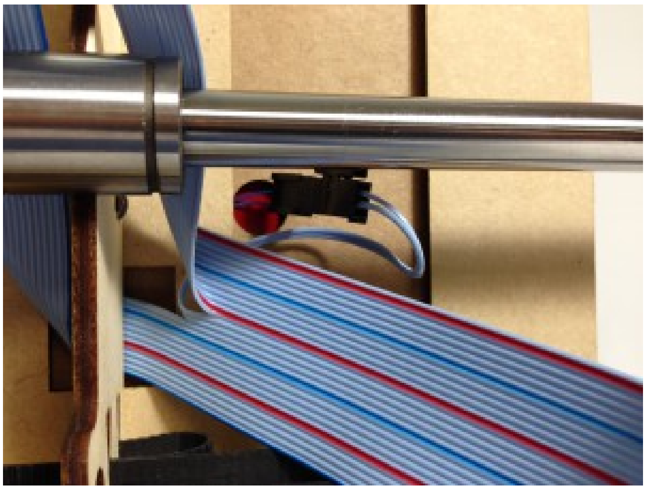
Adjust the ribbon cable as necessary to make it neat.



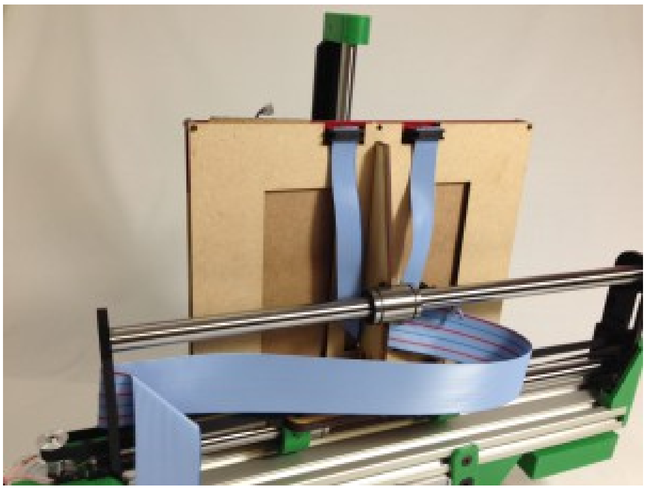
Put the heated bed, which you constructed in an earlier step, on the top of the Y carriage.



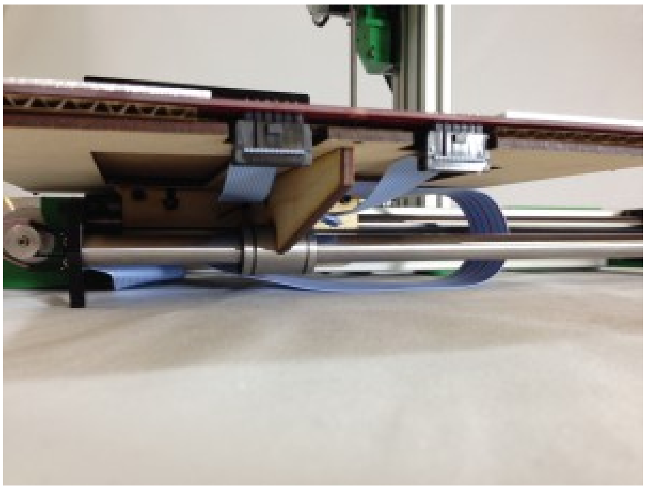
Make sure the thermistor wire is accessible underneath. Yours may be on the other side of the y-axis-rib, but it doesn't matter. Plug the thermistor into the connector, which is attached to the central two wires of the ribbon cable. Tuck it into a position so it doesn't rub on the linear rod.



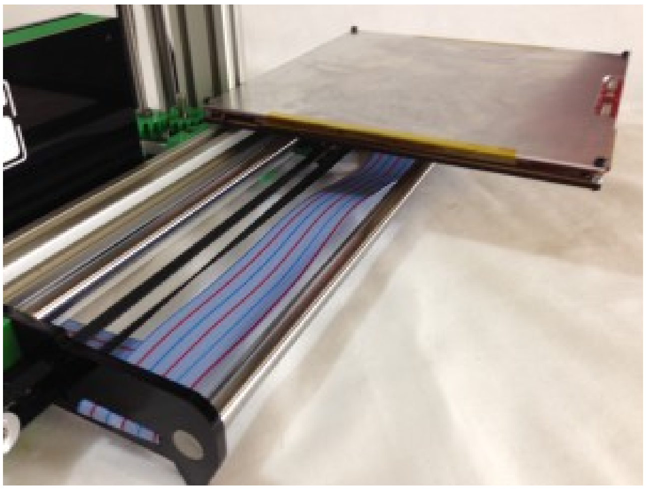
Plug the two IDC connectors into the bottom of the heated bed PCB.



Finally, check that the movement of the Y axis allows the ribbon cable to fold neatly under the bed. Adjust as necessary.

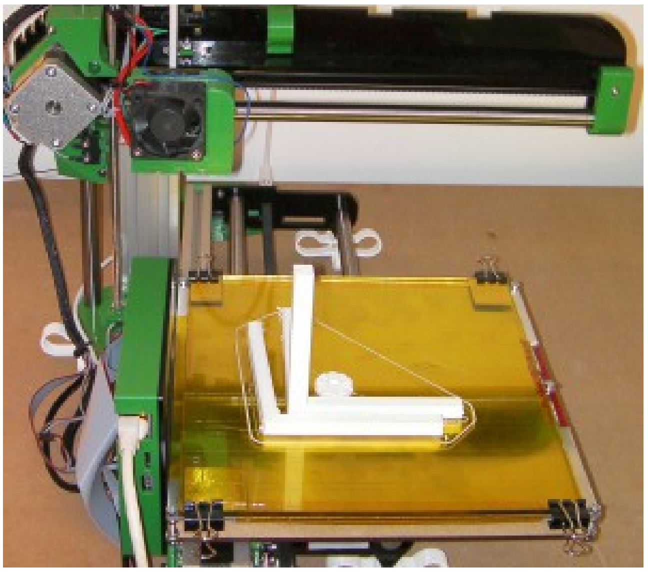


Test with the Y carriage at the extremes of the axis.



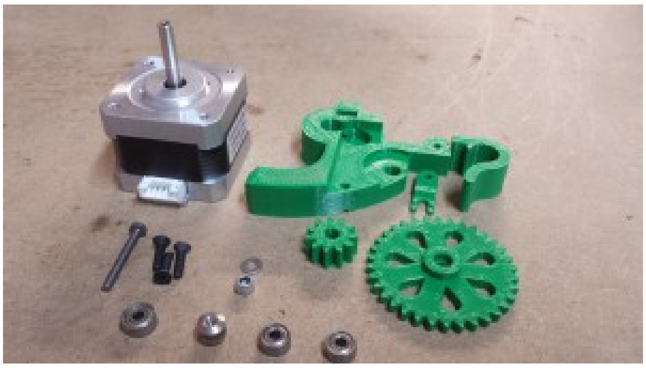
Fit the print surface

The print surface clips onto the heated bed using the four foldback clips. The glass plate is rectangular, not square. Its long side should run along the Y axis, as on the completed printer shown here, otherwise the clips won't hold the glass.



Extruder drive assembly

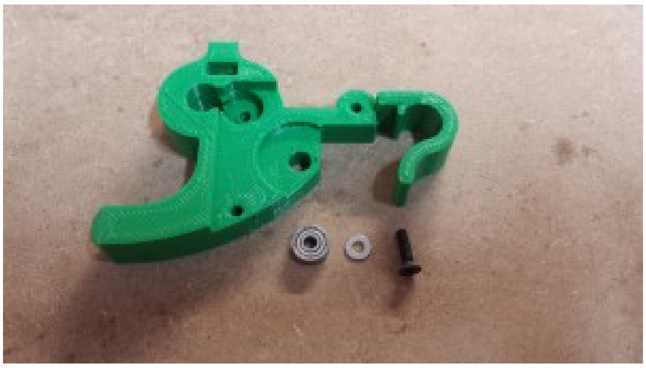
This section shows you how to assemble the extruder drive.



Extruder drive body

To assemble the extruder drive body, you will need the following:

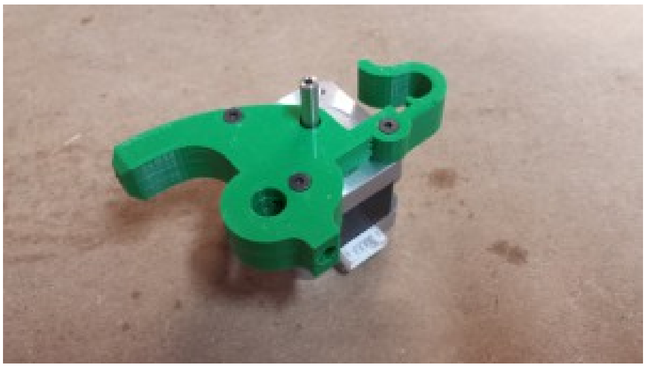
Component	Type	Quantity
NEMA17 motor (not shown)	-	1
Extruder drive block	Extruder drive	1
623 bearing (10mm diameter)	Extruder drive	1
M3 washer	Extruder drive	1
M3x12mm countersunk socket screw	Extruder drive	3
Extruder small gear (not shown)	Extruder drive	1



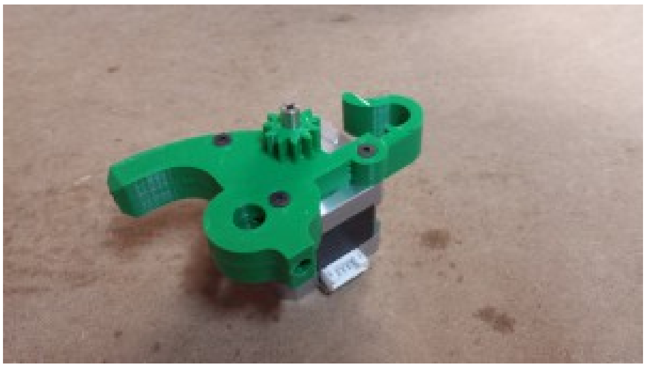
NOTE: The '[retaining tongue]' that is included in the extruder drive set secures the Bowden cable from the hot end into the extruder drive. You'll need it later, so hang on to it.

Take the extruder body, and put the 623 bearing in the hole shown. One M3x12mm countersunk screw goes in from the back, and the washer goes on top of the bearing.

Fit the motor on top of this, then attach the other two M3x12mm countersunk screws, to mount the motor solidly.



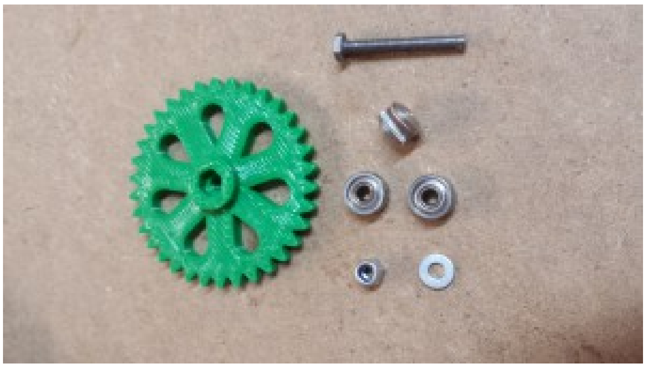
Push the small gear onto the motor shaft. This should be a tight fit. Ensure the flat part of the bore of the gear is aligned with the flat on the motor shaft before applying too much force. The gear has a small lip at the bottom of the teeth. This side must be against the drive block face.



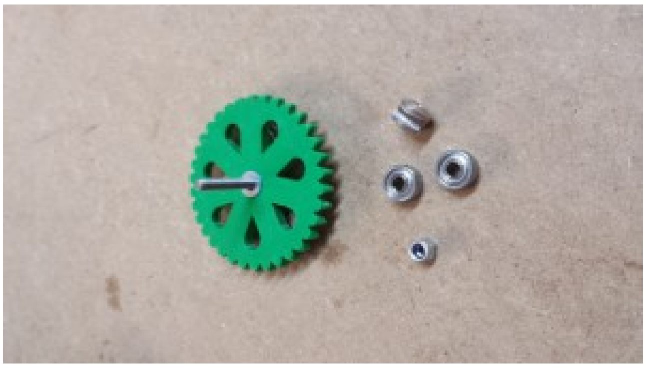
Extruder large gear

Now assemble the large gear drive assembly. For this you will need:

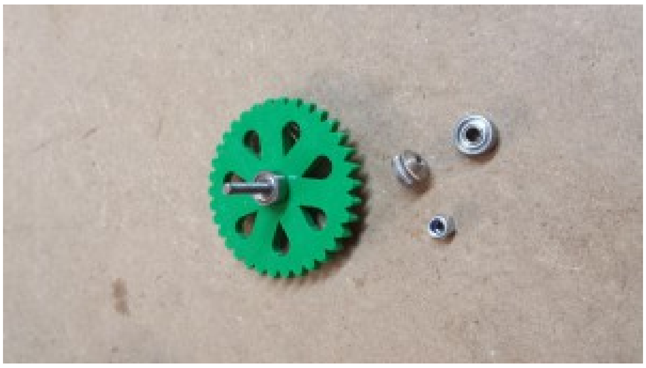
Component	Type	Quantity
Extruder large gear	Extruder drive	1
Hobbed insert	Extruder drive	1
M3 washer	Extruder drive	1
M3 nyloc nut	Extruder drive	1
M3x25mm hex head screw	Extruder drive	1
MR93ZZ bearing (9mm diameter)	Extruder drive	2



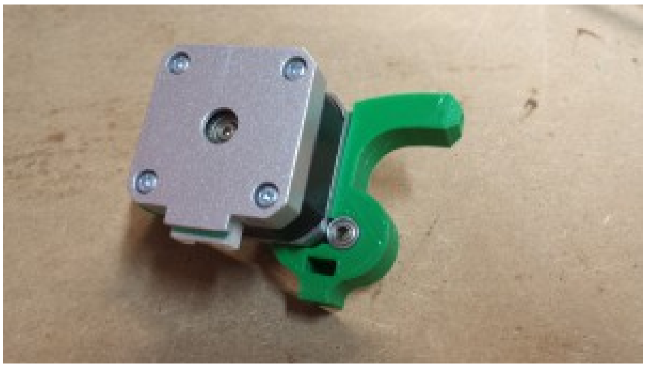
Push the screw through the gear. The hexagon head of the screw should be held tightly by the plastic part. Then slide an M3 washer on to the screw.



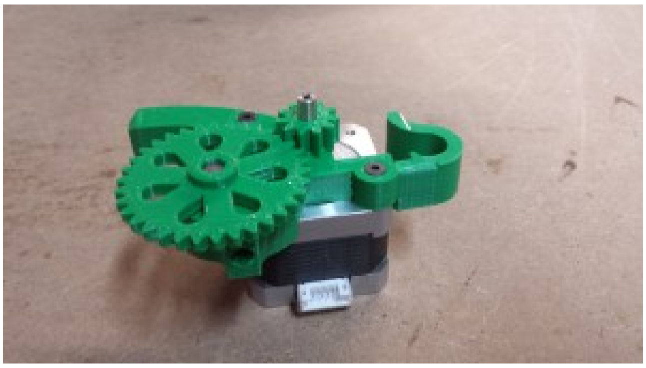
Next slide one of the MR93ZZ bearings on, followed by the hobbed insert. The insert is symmetrical so it doesn't matter which way round it is fitted, but it needs to be screwed tight.



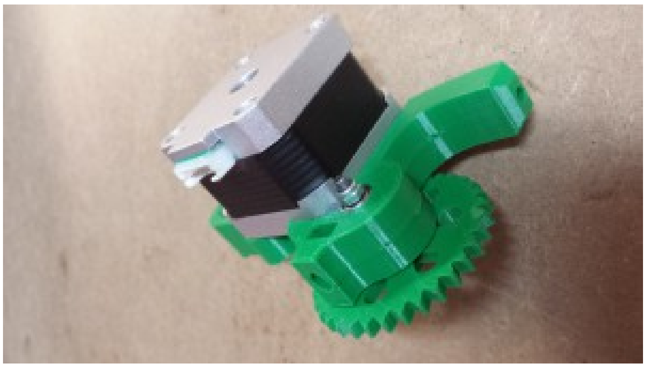
Push the second MR93ZZ bearing into the extruder-drive-block, next to the motor.



Now push the large gear sub-assembly into place ...

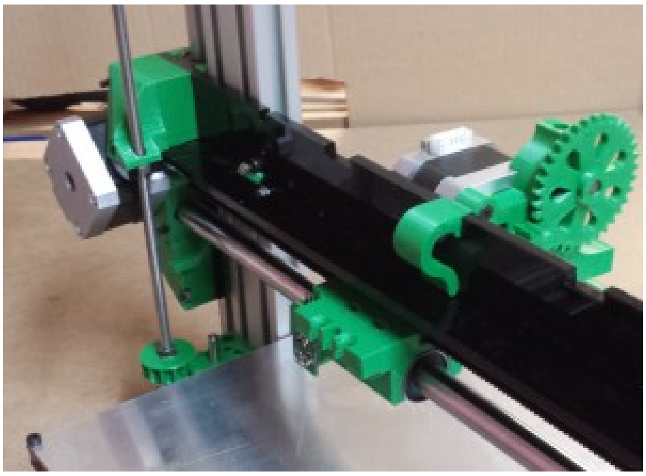


... and secure it there with the M3 nyloc nut.



Mounting the extruder drive

The extruder drive assembly can now be mounted on to the machine.

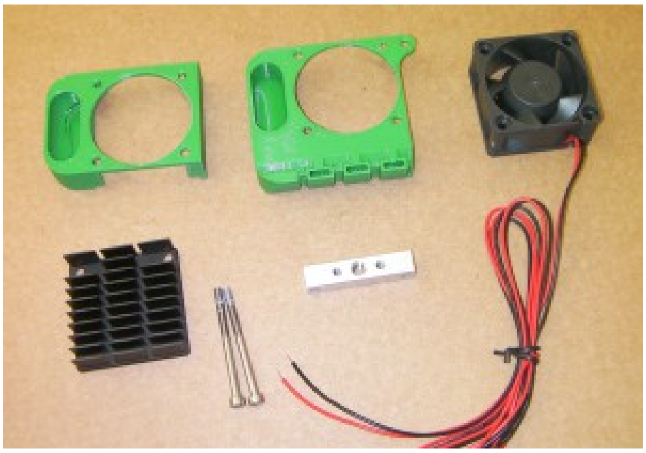


The x-axis-plate is profiled to receive the extruder-drive-block from one side, so push it down with a rotating motion and it will lock into place, using the mass of the motor to keep it there.

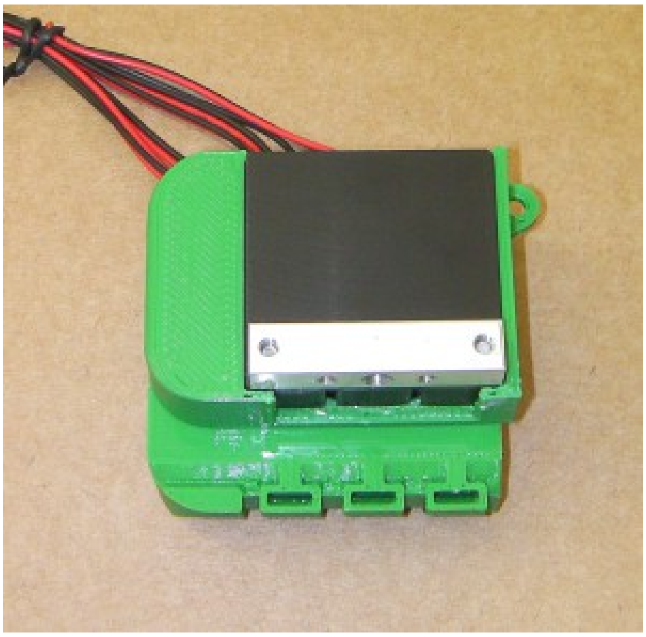
Hot end assembly

The airflow system

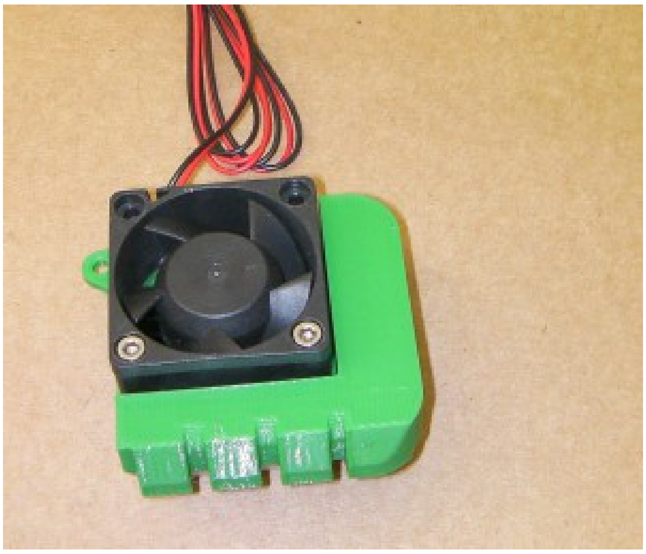
Component	**Type**	**Quantity**
heatsink duct	Printed	1
fan duct	Printed	1
Fan	Hot end	1
Heatsink	Hot end	1
M3 x 40mm cap screws	Fastener	2
Aluminium cooling block	Hot end	1



The wires on the fan in this picture are too long. They will be shorter, and each terminated with a crimp pin.Place the heatsink with its fins inwards and its flat face outwards in the cavity in the heatsink duct. The screw holes are at the bottom in the picture above.

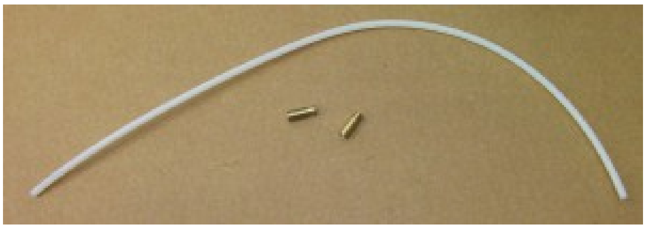


Turn the device over, and add the fan duct then the fan, with its wires coming out the top, and its face with the fan-axis support inwards. Use the two screws into the cooling block to hold all five major pieces together. If you have it you can put a little heatsink compound between the cooling block and the heatsink.

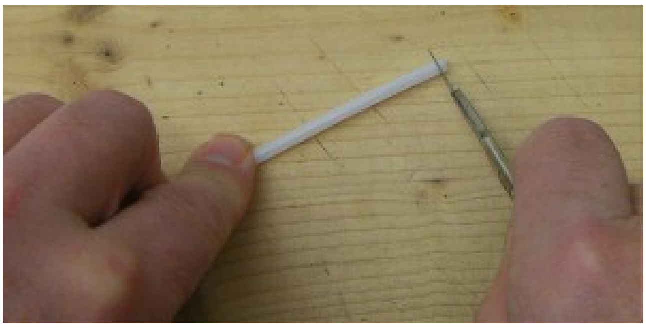


The plastic filament Bowden tube

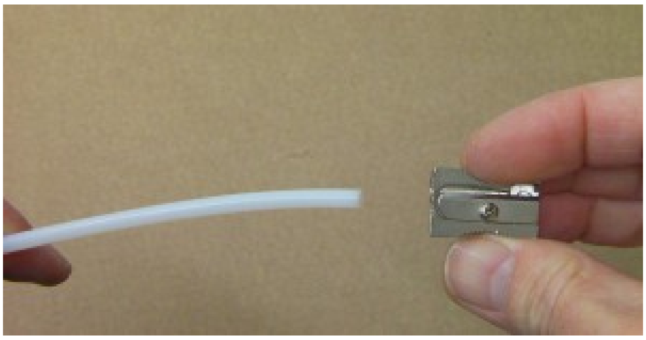
Component	Type	Quantity
PTFE tube	Hot end	1
Threaded brass union	Hot end	1
Notched brass union	Hot end	1



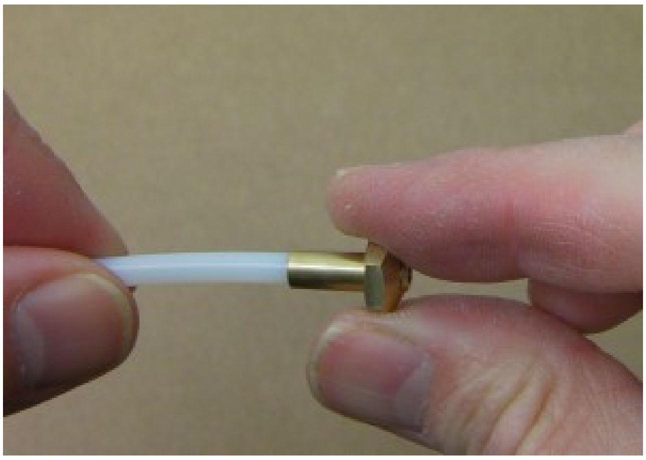
Start by trimming a couple of millimetres off each end of the PTFE tube with a very sharp blade to get the ends clean and square.



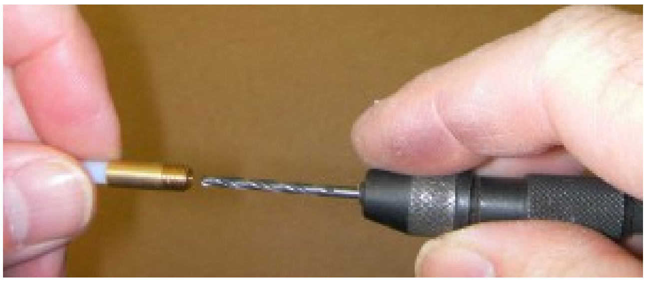
Next use a pencil sharpener to cut the ends of the PTFE tube to a cone. Be very gentle. PTFE is a soft material and it is easy to remove too much. You just want a frustum of a cone at each end that doesn't quite reach the inner hole in the tube.



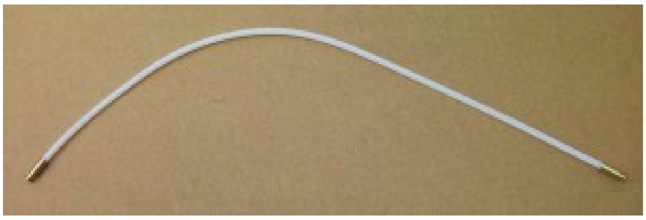
Put the conical brass nut that you will use below on the threaded brass union. This is not its final resting place, but it will make it easier to screw the internal thread on the union over the PTFE tube, by giving you something to grip. Screw the union over one end of the tube. It will cut its own thread. Take care to keep the two parts axially in line. You don't want the brass screwed on at an angle.



Do the brass up until you can see the cone you cut by looking down the free end of the brass. Then, unscrew the brass union, and repeat the thread cutting process at the other end of the tube. The threaded part of the PTFE tube should be about 10mm long, and it will be easier to screw each brass union on, once threaded.
Screw the slotted brass union onto the free end of the PTFE tube. Remove the nut from the other union by gently gripping the brass union (not the PTFE) with a pair of pliers and use a small spanner to remove the nut. Take care not to crush the brass with the pliers - it is quite thin.
Screwing the brass onto the PTFE will have compressed its inner hole. You need to open it out again so that the plastic filament that your Ormerod will print with will run freely in the tube. Use a 2mm drill bit in a small hand chuck. Gently, and twisting clockwise all the time - never anti-clockwise, whether going in or coming out - use the drill bit to enlarge the inner

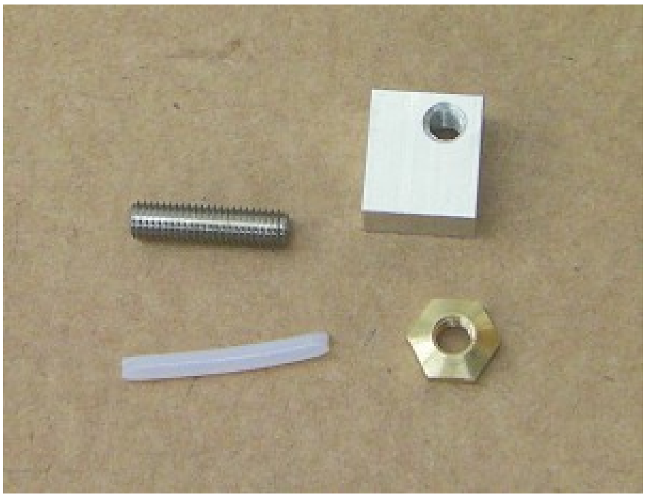


hole in the PTFE where it passes through the brass. Take several goes at it, going a couple of millimeters deeper each time and drawing the PTFE swarf out by keeping twisting clockwise and pulling. Stop when the tip of the drill is about 5mm into the clear transparent PTFE.
The finished Bowden tube



The nozzle and heater block

Component	Type	Quantity
Stainless steel nozzle	Hot end	1
Aluminium heater block	Hot end	1
Small-diameter PTFE tube	Hot end	1
Conical brass M5 nut	Hot end	1

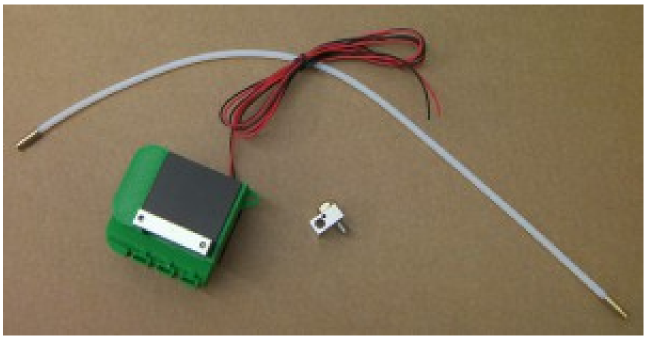


Screw the stainless steel nozzle into the aluminium block. The small nozzle hole should protrude from the face of the block nearest the small (2mm) diameter hole through the block.
Screw the nut onto the nozzle. The cone on the nut points away from the block, and the nut is at the small-hole end of the nozzle.
Adjust the three so that the cone of the nozzle

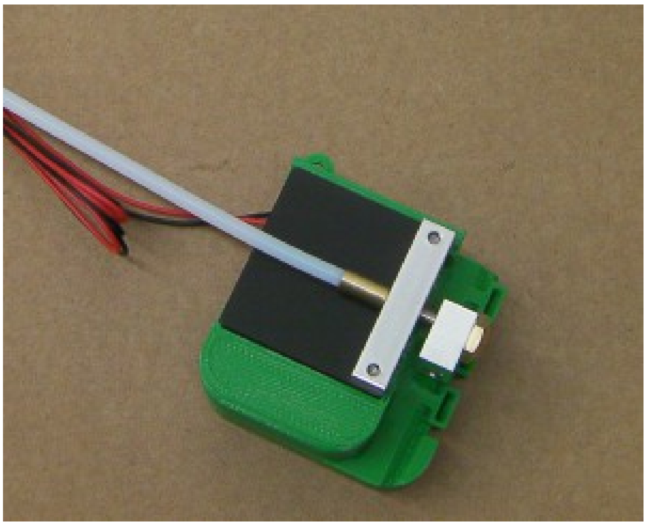
continues the cone of the nut. There shouldn't be a shoulder between the two, nor should the nozzle be down inside the nut.
Hold the aluminium block between folded pieces of paper in the jaws af a vice. (The paper is to stop the jaws damaging the aluminium.)
Tighten the nut against the block with a spanner. It needs to be reasonably tight, but don't force it so hard that you damage anything.
Cut a few millimetres off the end of the small tube with a very sharp blade to get it square and to clean it up, just as you did with both ends of the larger tube above.
Push the end you have cut all the way into the large hole in the longer end of the nozzle sticking out from the block. It may be quite stiff. You may have to put the free end of the tube on the bench and push against that. Be careful - you don't want to buckle the tube.
Use the sharp blade to trim the end of the PTFE tube flush with the nozzle.

Assembling the cooling system, the heater block and the Bowden tube

Take the cooling system, heater block and Bowden tube



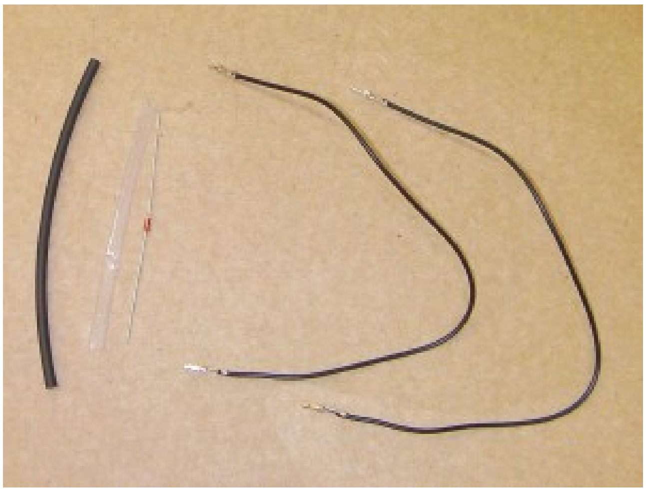
Screw the threaded brass union on the Bowden tube into the cooling block on the cooling system. Screw it in all the way, then back it off half a turn
Screw the nozzle and heater block assembly into the other side of the cooling block. If the small PTFE lining tube in the nozzle is loose, take care not to drop it - make sure it is in there or the hot end won't work.
Get the heater block square with the rest of the assembly, with its longer protruding side pointing away from you in the picture above.
Using pliers, tighten the threaded brass union against the top of the stainless steel nozzle. Again, take care not to grip the brass too tight and damage it, but do the two up as tight as you can.



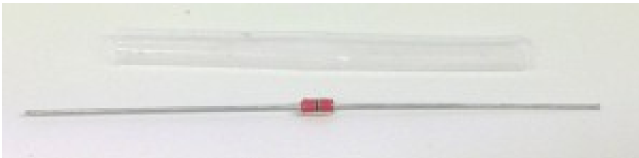
Adding the temperature-measuring thermistor

Component	**Type**	**Quantity**
Transparent PTFE heatshrink	Hot end	about 50mm

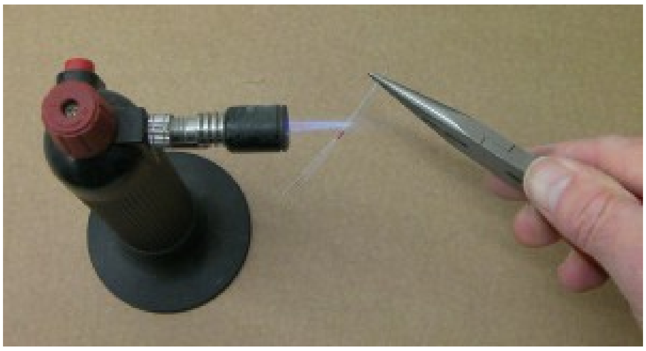
100K thermistor	Hot end	1
Thermistor wiring - 160mm	Hot end	2
Cartridge heater (not shown)	Hot end	1



Cut the transparent PTFE heatshrink about 10mm shorter than the thermistor with its axial connecting wires. Put the thermistor in it so that 5mm of wire protrudes from each end.

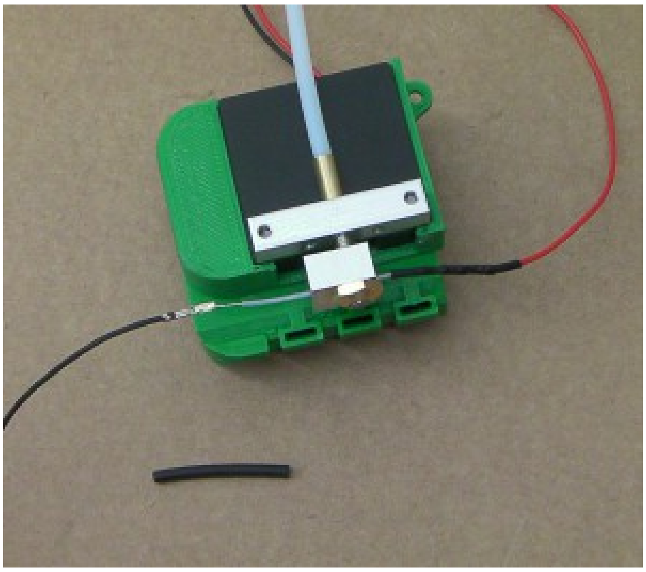


Using a flame (a cigarette lighter, blowtorch, gas hob, or hot air gun work well; a hair dryer does not), shrink the heatshrink over the thermistor. Just waft the thermistor and heatshrink through the flame. You don't want the heatshrink to overheat and burn.

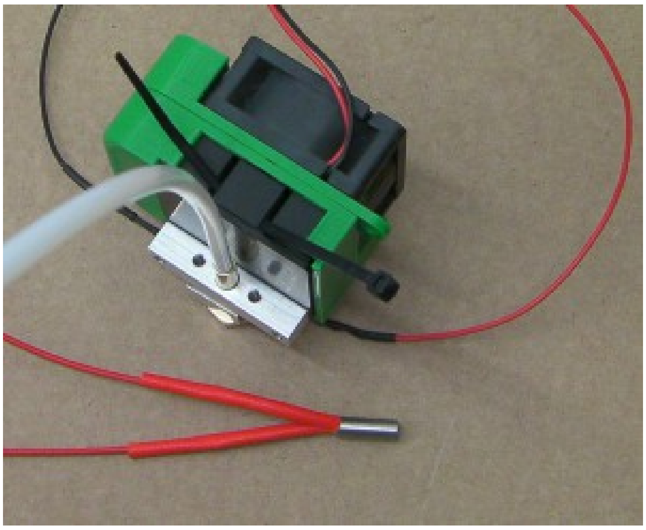


This is how the thermistor should look with the PTFE shrunk onto it. It may even look neater than this!

Pull the thermistor through the small hole in the heater block so that it is about half way through. If you pull it with pliers, be gentle, and grip on the PTFE heatshrink, not the bare wire. Attach the thermistor wiring to each side of the thermistor - it is pre-crimped, and should just push onto the bare ends of the thermistor wire.

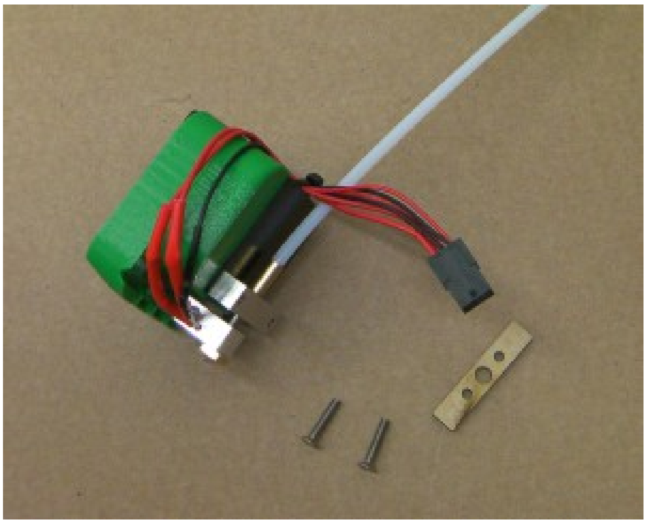


Slacken the two screws that hold the air duct assembly together by a few millimeters, and loop a cable tie through the top two gaps in the heatsink, as shown. Re-tighten the screws. Push the heater cartridge (with the red leads) into the heater block.

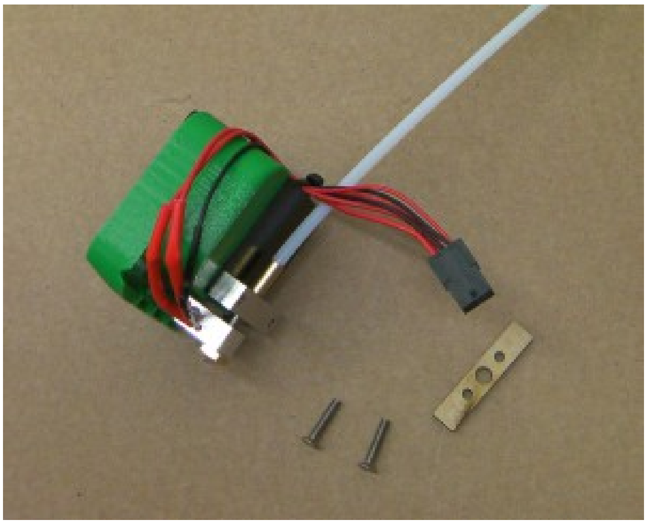


Final assembly

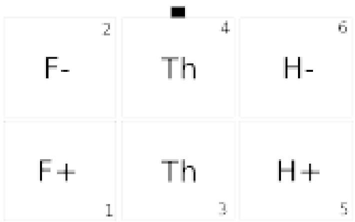
Component	Type	Quantity
2x3 female black crimp socket	Hot end	1
M3x16mm cap head screws	Fastener	2
MDF heat insulator	Hot end	1

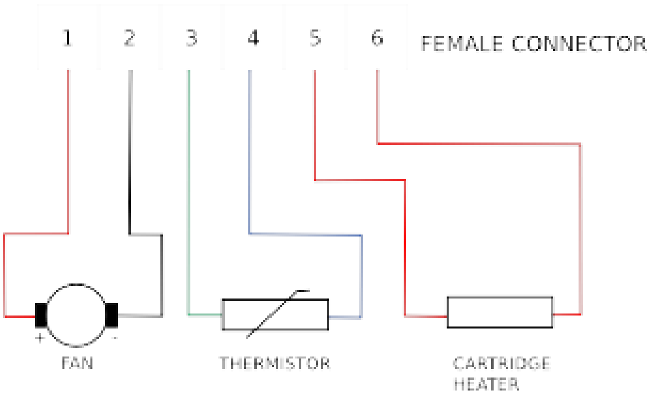


Run all six leads (fan, heater cartridge, and thermistor) up and through the cable tie. Pull the cable tie closed, but not too tight. It doesn't need to squash anything.



CAUTION! The next step describes wiring up the hot end connector. However, GREAT CARE should be taken doing this. The heater cartridge and the fan wires have 12V running through them ALL THE TIME. The thermistor wires are 3.3V, and connect directly to the Arduino chip on the Duet. If you incorrectly wire the plug, a short circuit between the thermistor wires and any of the other wires MAY DESTROY YOUR DUET!


2
F-
4
Th
6
H-
F+
1
Th
3
H+
5

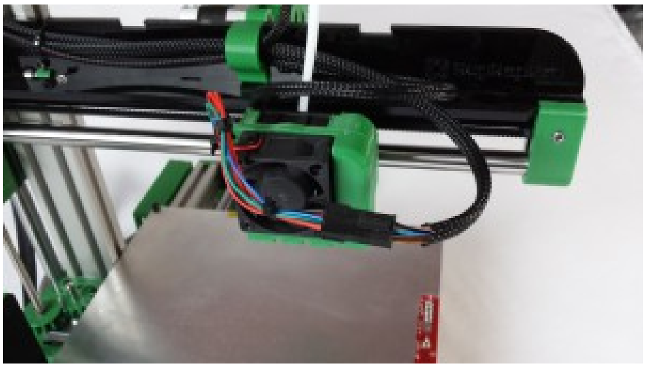

1
2
3
4
5
6
FEMALE CONNECTOR
+
-
FAN
THERMISTOR
CARTRIDGE
HEATER

Wiring

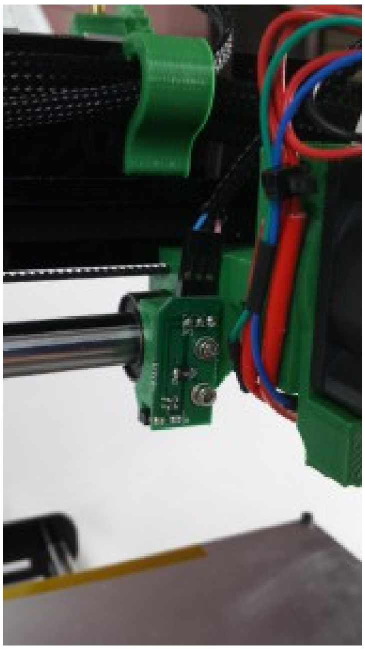
RepRapPro Ormerod 3D printer kits are supplied with pre-assembled wiring looms. The wiring sequence should be to connect all looms to the motors, hot end and sensor board, route them back to the electronics, then make the connections on the board.

Wiring the printer

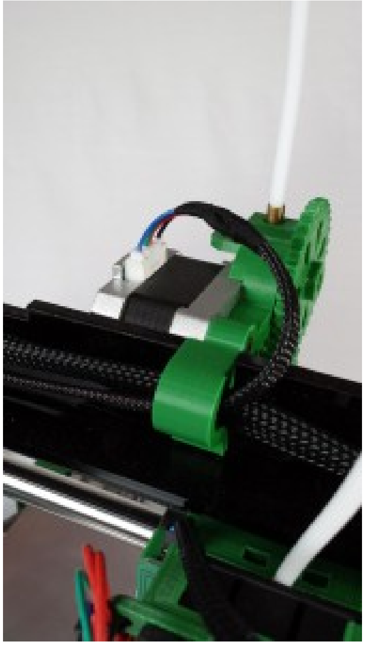
Hot end loom.
Length: 930mm



Proximity sensor: Attach the proximity sensor to the X carriage to the left of the hot end with 2 x M2.5x5mm cap head screws. Connect loom. **NOTE:** the sensor has a polarity; the order of the wires is very important. It should be as the picture; blue, black, red (or pink on some looms).
Loom length: 960mm

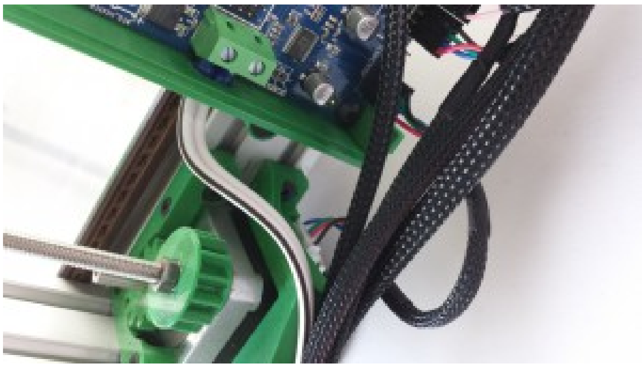


Extruder drive motor loom.
Length: 720mm

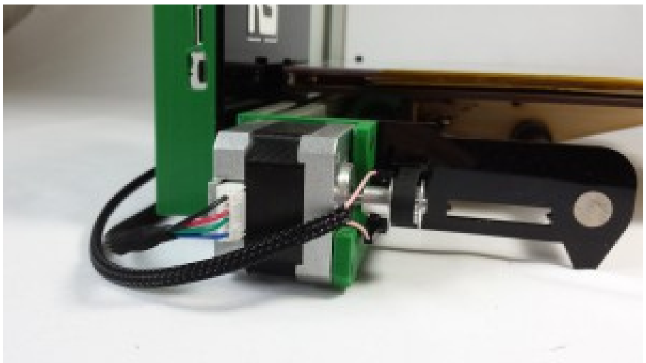


X axis motor loom.
Length: 440mm

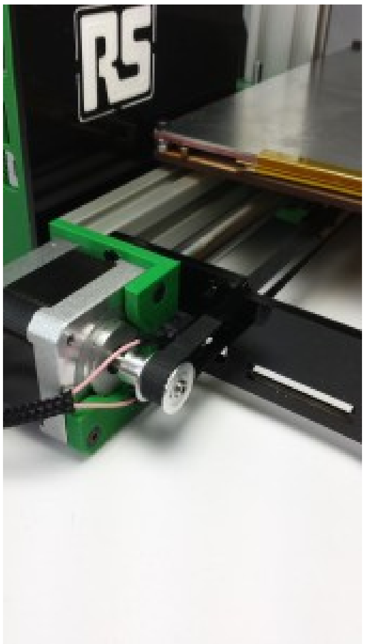
Z axis motor loom.
Length: 90mm



Y axis motor loom.
Length: 160mm

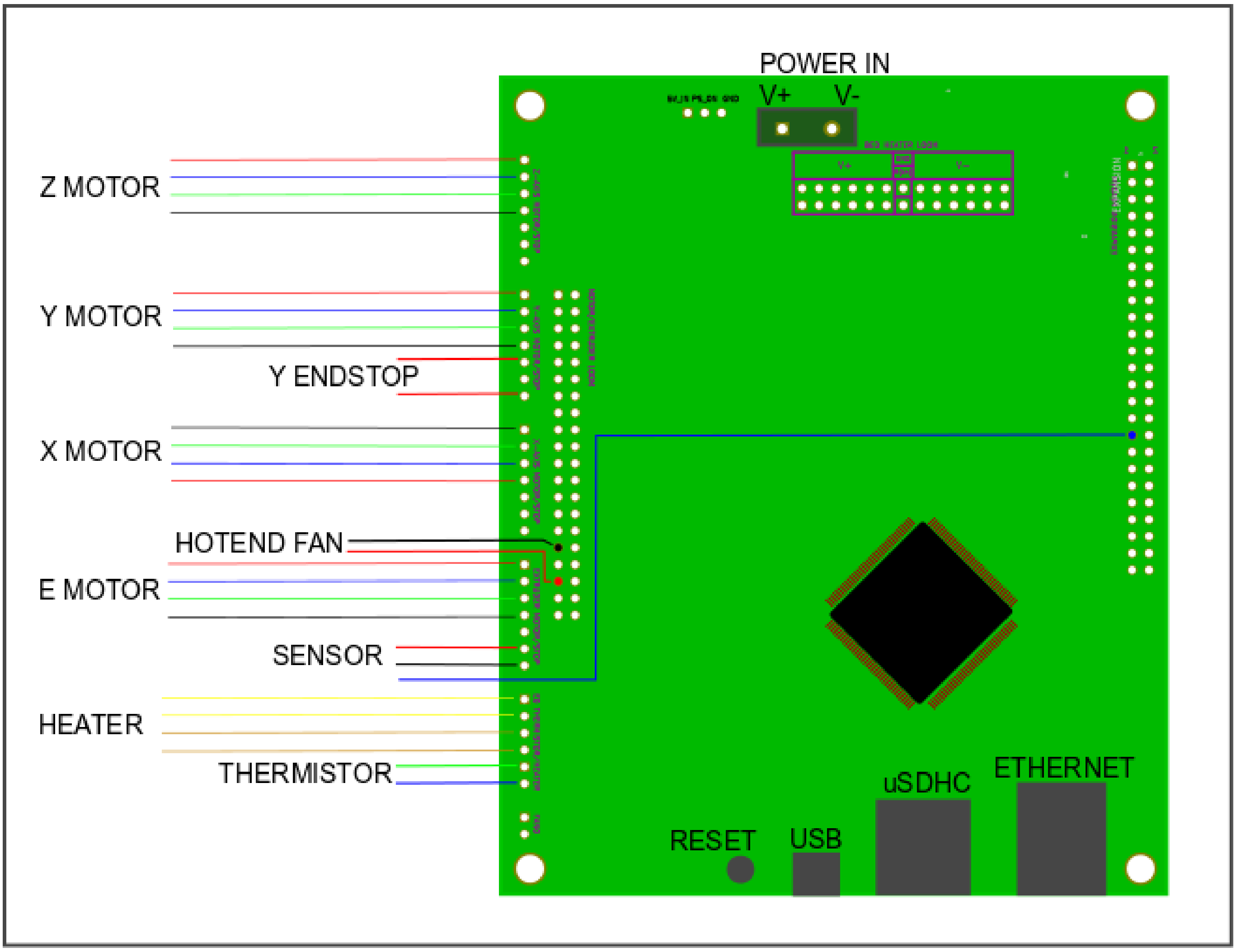


Y axis endstop: The loom connects to the outer two pins of the microswitch. You will need to bend the top pin upwards to 45 degrees, so the wire doesn't foul the Y axis belt pulley.
Length: 260mm

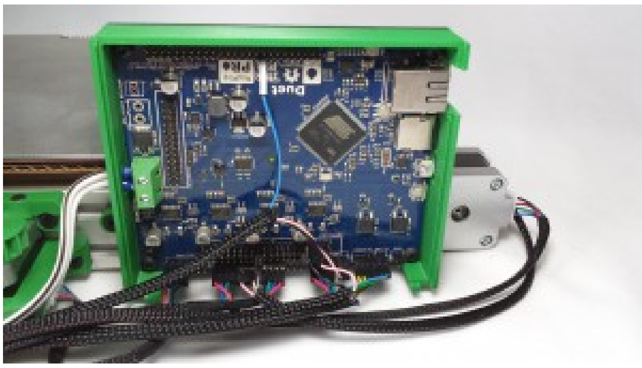


Wiring the Duet

Connect each loom as per the diagram shown:



The wiring should now look like the image below; there is a difference between the hot end fan connections between the picture and wiring diagram, but either works:

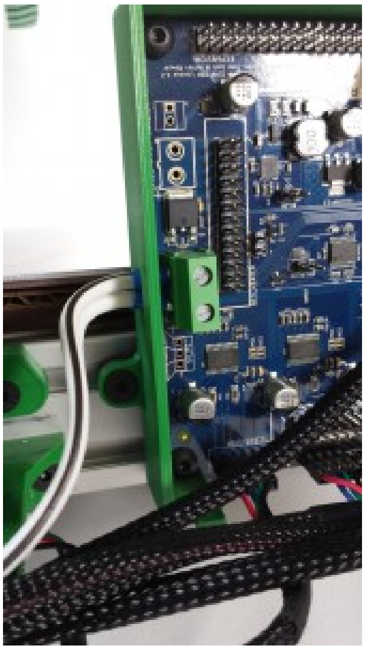


Power wiring

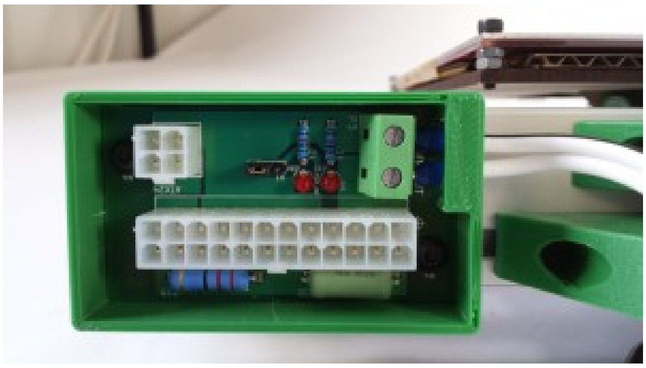
Power to the machine is provided by a standard ATX PC power supply. The 24-pin ATX connector and the 4-pin Aux power connector plug into the ATX-Power circuit board. This breaks out the 12v line to the 2-way screw terminal for powering the machine through the main Duet board.

The two circuit boards are connected by a length of two-core cable, as shown. Polarity is important. It is advisable to use the strand marked with the black line as the negative side. The top screw terminal connection on both boards is the negative terminal (with them fitted as shown).

Four crimps are supplied with the wires, which need to be crimped onto the bare ends of the wires. You need a good, square, crimping tool, or the crimps won't fit well in the terminals. If you don't have the crimp tool, 'tin' the ends of the wires with a soldering iron and solder, for a good connection. Do not put bare wires into the terminals - they can work loose, and generate heat - enough to melt the terminals and destroy the board. The wires carry a lot of current, so make sure the terminals are tight, for a good connection. Pull on the wires to check they are not loose. Check every so often that the screw terminals are still tight.



The ATX-Power circuit board has a 3-way male pin header, which should be fitted with a jumper across the two pins closest to the ATX 4-way connector. There are also two LEDs to indicate correct operation.



DO NOT CONNECT THE ATX POWER SUPPLY YET!

Commissioning

There are six pieces of software required to use the RepRapPro Ormerod:

1. Arduino IDE (Integrated Development Environment) - used for device drivers, basic communication, problem solving
2. The RepRap firmware - this controls the hardware functions of the Duet board
3. Pronterface - used for communication and control over the USB connection
4. Google Chrome - used for controlling the Duet via the web interface
5. Slic3r - used for translating 3D files into the g-code, which controls the movements of the printer
6. The Ormerod files - profiles for Slic3r, and all the files you need to print another Ormerod

IMPORTANT: note about USB 5V power

Establishing communication with the Duet

This first section should be done with the ATX PSU disconnected.

The Duet electronics board is based on the Open Source Arduino Due board, with the addition of ethernet, stepper drivers (to control the stepper motors), SD Card slot, temperature sensing and other inputs and outputs needed by a 3D printer.

First connection

Download Arduino IDE v1.5.5 BETA (with Arduino Due support) for your operating system from: http://arduino.cc/.

Install Arduino IDE

Connect USB cable to Duet, making sure it is pushed all the way in. An LED should light up, near the USB connector. See the important note above about 5V USB power if it does not. If your Y-axis endstop is fitted, a second LED will light up near this connection on the board. It will be lit if the Y carriage is away from the endstop, and will go out if you move the Y carriage until it touches the microswitch.

The device drivers should be found and installed automatically.

Open the Arduino IDE and go to Tools->Board menu and select 'Arduino Due (Native USB)'. If this is greyed out, check the device drivers have been installed.

Then go to Tools->Port menu and select the USB port for your Ormerod.

Then go to Tools->Serial Monitor. Make sure the speed is set to 115200 (bottom right) and that Newline is selected (next to the speed).

Wait for 1 minute (this is normal when no ethernet is connected and the firmware is searching for the network), and following should show:

```
RepRapFirmware is up and running.
```

If no message is received, send the following command:

```
M105
```

And you should get a response from the machine, similar to this:

```
T:5.3 B:18.4
```

or this:

```
serial: M105  ok T:5.3 B:18.4
```

If you get no response, close the Serial Monitor window, unplug the USB, check the Arduino settings and try connecting again. Wait for 1 minute after plugging in the USB.

If you get temperatures of -273.1 on either the hot end or heated bed thermistor, it usually means the thermistor is disconnected, or shorting out. Check your thermistor wiring.

What to do if it isn't working?

See the note at the top of the page 'IMPORTANT: note about USB 5V power'. If the power is low, it can cause strange problems, such as odd temperature readings, failure of SD card, and failure of Ethernet. If you don't have any other USB power source available, turn off the Duet, remove the motor and heater wires from the board, put a jumper on JP9 and connect the ATX power supply. See the later section 'Now connect the ATX power supply unit' for full details, but return to this point, and try connecting again.

It's also possible that the USB socket on the Duet is loose, and the USB lines have broken. Check the USB socket; it has 4 legs that go through the board. All four of these should be soldered, to hold the socket firmly on the board. If they are not, you can solder them yourself; this is easier from the back of the board. If you still get no response, contact support.

Check SD card Settings

Your Ormerod was supplied with an SD card, and a USB adapter. Put the SD card in the USB adapter, and into your computer - it should appear on your desktop. The SD Card is used for storing settings, serving the web pages of the web interface, and has some test gcode files for printing.

Download the RepRap firmware from our [Github repository](). Do this by going to the page, and clicking the 'Download ZIP' button on the right hand side. Extract the ZIP file once downloaded.

In the extracted directory is a directory called 'SD-Image'. Open this, and copy the contents (three directories - gcodes, sys and www) to the root of the SD card, so that they are the first thing you see when you open the SD card.

Eject the SD card, remove it from the adapter, and put it into the SD card holder on the Duet. It should click in.

Is the SD card being read?

Connect the USB cable to the Duet, and connect to it using the Arduino Serial Monitor, as above. Wait for 1 minute, and you should then see (again):

```
RepRapFirmware is up and running.
```

In the top part of the Serial Monitor window, type, without quotes 'M503' and press 'Send'.

The response should be similar to:

```
; RepRapPro Ormerod  ; Standard configuration G Codes  M111 S1; Debug
on  M550 POrmerod; Set the machine's name  M551 Preprap; Set the passw
```

```
ord  M552 P192.168.1.14; Set the IP address  M553 P255.255.255.0; Set
netmask  M554 P192.168.1.1; Set the gateway  M555 P2; Emulate Marlin U
SB output  M92 E420; Set extruder steps/mm  G21 ; Work in mm  G90 ; Ab
solute positioning  M83 ; Extrusions relative  M558 P1 ; Turn Z Probe
on  G31 Z0.5 P500 ; Set Z probe height and threshold  M906 X800 Y800 Z
800 E800 ; Motor currents (mA)  T0 ; Select extruder 0
```

If the SD card is not inserted, or not being correctly read (the error code may be different), you get:

```
Can't open 0:/sys/config.g to read from. Error code: 12  Configuration
 file not found
```

Check that you have inserted the SD card properly. Some customers have reported problems with the supplied SD cards and/or the USB adapter. If you can, try a different SD card, and writing files to it with a different adapter. SD cards come in a variety of sizes; we have tested cards up to 8GB. They should be a FAT32 formatted disk.

Is the SD card being read AT STARTUP?

The easiest way to test if the card is being read at startup is to open the Arduino Serial Monitor, connect, and then send a command, like M105. The correct response should be:

```
serial: M105  ok T:-273.1 B:-273.1
```

The important thing is the 'ok', which means the M555 P2 (Emulate Marlin USB output) command has run. If you send M105 and get:

```
T:-273.1 B:-273.1
```

(without the command echoed, and no 'ok') the config.g has NOT been read at start up.

What to do if it isn't working?

Update your firmware (see next section); there are some fixes in it to improve the chances of the SD card being read.

Replace the SD Card with a better or known-working card.

For some people, it helps to apply power to the board, then after a couple of seconds press the reset button on the Duet, then the SD card gets read.

Update your firmware!

Your Ormerod will have been supplied with firmware flashed in its microcontroller. Now you have established communication with the Duet, it's a good idea check you have the latest version, and update the firmware on the Duet if not. See here for how to do that. We will be adding features and squashing bugs regularly, to improve the usability of your printer, so check often.

No, really, update your firmware!

Recent updates have improved network connectivity, improved USB communication, improved accuracy of thermistors, improved the SD card reading, fixed homing problems, fixed printer stopping problems, and many others. So please, to save yourself potential frustration, update your firmware.

To check your firmware version, connect to your Duet board via the Arduino IDE Serial Monitor and send the 'M115' gcode. The response should be something like:

```
FIRMWARE_NAME:RepRapFirmware FIRMWARE_VERSION:0.57a ELECTRONICS:Duet D
ATE:2014-01-16
```

If the response is:

```
Error: invalid M Code: M115
```

You have an very old version of the firmware, and should definitely update!

Compare the firmware version information from your response to M115, with the file name of the file in this link, which is on our github page. But DO NOT DOWNLOAD THIS FILE DIRECTLY! See here for the full firmware update instructions.

Following updating the firmware, don't forget to update the SD Card with the latest files from the 'SD-Image' folder.

Connect via Pronterface

Pronterface is used to control the printer's basic functions, via USB. Any version of Pronterface should work with the Duet, though we supply a customised version for our customers.

Two installation methods are available:

- **Easy** - download the pre-compiled version here, Windows or Mac, and extract the zip file.
- **Advanced** - For Windows/Mac/Linux - download the zip file from our Github repository here, installation instructions HERE. This is slightly modified version of Pronterface, enhanced for the Duet.

Once installed, close the Arduino Serial Monitor if it is still open, connect the USB cable to the Duet, then run Pronterface.

Select the USB port that your computer has allocated the Duet in Pronterface's 'Port' box, select a communication speed of 115200, and click the **Connect** button.

As before, wait for about a minute, and the software will confirm when the printer is online.

Press the GET POS button, and if the machine returns a position of X0.00 Y0.00 Z0.00 your serial communication is functioning correctly.

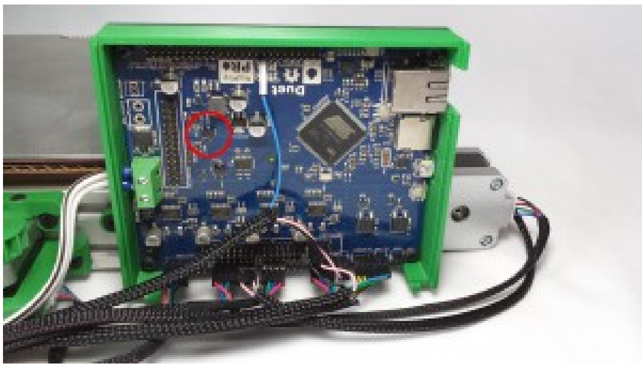
If a temperature is too high then there is probably a short circuit in the corresponding thermistor circuit. If it is too low, then there may be an open circuit. In either case, find the fault and fix it before you go on.

Check the settings by sending 'M503' by typing it into the command line in the bottom right hand side of the Pronterface window. The settings will scroll above the command line, in what we call the log window. This establishes that Pronterface is talking correctly to the Duet, and it is responding correctly.

Now close Pronterface, and disconnect the USB lead, to turn off the Duet.

Now connect the ATX power supply unit

The PSU will supply the motors and heaters with 12V, while the logic is supplied with 5V. Make sure that there is a jumper on the JP9 (5V_EN) pins (see picture below for location of jumper). With no USB lead connected, a light should turn on on the board, near the reset button.



NOTE: The first 220 Ormerod (red plastics) printers supplied by RS Components need the USB lead to be connected **at all times**, to supply the logic side of the board with 5V. If they wish, buyers of the initial 220 machines with this restriction can return their Duet electronics to RepRapPro Ltd for an updated Duet without this restriction. Email support to arrange this.

Testing machine control

Checking the heaters

Plug in the USB and run the Pronterface program. Click "Connect" and wait for your RepRap to appear online.

The heated bed and the hot end are the two parts of the printer that may cause damage as they are high-current devices; we check them first, in case there are any problems that have caused a fault.

Tick the 'Watch' check box (or 'monitor', depending on Pronterface version) to report the temperatures of your heatbed and nozzle. Ensure that the readings are similar to the ambient temperature of the room. If they are not, check connections. Usually, if they are very low (-273), this indicates the thermistors are not connected.

Hot end

Command the nozzle to 100C, by typing '100' in the box next to 'Heater', and watch the temperature rise, overshoot and eventually settle around 100C. Keep an eye on the nozzle during this test. If you see lots of smoke come out of the hot end, turn off the heater and check your wiring. You may have a short on the heater wires, or to the heater block, or there may be some contamination around the heater block.

Repeat the test with a target temperature of 200C. The nozzle should reach the target temperature in about 1 minute or less and settle within a couple of degrees of 200C. Some smell of oil burning off is not unusual - it's the oil from machining the parts - but should dissipate after a minute.

Press 'Off' next to 'Heater' to turn off the hot end.

Heated bed

Command the heatbed to 45C (warm), by typing '45' in the box next to 'Bed', and click 'Set'. Verify that the heatbed temperature reading rises and stabilises around 45C, and that the heatbed is actually warm.

The heated bed will heat up more slowly than the hot end.

Press 'Off' next to 'Bed' to turn off the heated bed.

Test axis movement

Now type in the following command in the command line:

G1 X5 F500

in the field below the log window and click Send. The X-carriage should move to 5mm in the positive direction (X5) at 500mm/min (F500).

Now type:

G1 X0 F500

and send. The X-motor should move back to its starting location (X0).

Repeat the above test for the Y axis, replacing the 'X' in the above command with 'Y'.

For Z, make the feedrate 200 mm/minute:

G1 Z5 F200

You can use the 'jog dial' on the left hand side of the Pronterface window.

NOTE: When you turn on the printer, where each axis is, is where the printer thinks X=0, Y=0 and Z=0 are.

Homing

'Homing' sends an axis to the end of its travel, and hits an endstop, which gives the printer a reference point. Then it will know where the bed is.

Send a homing command for the Y axis first. Either press 'Y' homing button in Pronterface (above the 'dial' on the left of the Pronterface window), or use the homing command: for example

G28 Y0

The Y carriage should move towards the Y motor, hit the microswitch, then reverse to the other end of the Y axis. The Y endstop is a 'MAX' endstop; it records the point where the Y axis is at its maximum point, ie 200mm, then moves to 0, at the other end of the axis.

If the wiring for the microswitch is not connected properly, it will start by moving towards the idler end, eventually clattering off this end! This will stop after a few moments. Don't worry, no damage will be done. Check the wiring for the microswitch, it is possibly disconnected. There is an LED on the Duet above the Y motor connection. It will normally be on, and will go out when the Y endstop switch is hit.

The X axis endstop is not a microswitch; the Ormerod uses the proximity sensor for X homing. This is triggered by the bar that sticks out from the x-motor-bracket. It is important that the X carriage can pass by the electronics housing; this should have been checked earlier in the build. Check that the polarity of the wires connected to the sensor are correct - see the 'Wiring' instructions. Also, depending on lighting conditions where the printer is, you may need to add a piece of silver foil (like that used on the bed) to the top of the bar for the sensor to work consistently.

Press 'X' homing button in Pronterface, or use the homing command:

G28 X0

The X carriage should move up 5mm, and towards the Z axis. It should stop before it hits the end.

Finally, home the Z axis. Again, this uses the proximity sensor. Press the 'Z' homing button in Pronterface, or use the homing command:

G28 Z0

The X carriage should move out, to be over the corner with the aluminium foil underneath, then move down and stop. Initially, the nozzle will be some way from the bed; you will correct this by following the 'Axis compensation' instructions.

Pronterface - RepRapPro Duet features

Use of the RepRapPro version of Pronterface, with extended features for the Duet, is documented here**.**

Connect via web interface

To use the web interface, you need to connect an ethernet cable from the Duet to your ethernet hub, switch or router. The Duet will need to be powered, either by USB or the ATX PSU - it cannot be powered by the Ethernet cable.

It is also possible to connect the Duet directly to your PC via Ethernet, but you will need to set up the ethernet port of your PC to match the Duet (or the Duet to the ethernet port of your PC). You PC will still need to have access to the internet (via another ethernet port or wifi) for the RepRapPro web interface to work.

You need three pieces of information to set up the Duet for your network; ip address, netmask, and gateway ip address. Often, small networks are setup using DHCP, which assigns ip addresses automatically to the devices that connect to the network. The Duet, at the moment, can't use this; you need to set the ip address manually.

By default, the settings in sys/config.g on the SD card are:

```
IP address: 192.168.1.14  netmask: 255.255.255.0  gateway: 192.168.1.1
```

If you're on a Windows PC, check that the settings you use on your network by opening a Command Prompt and sending 'ipconfig'. This should respond with something that includes:

```
Wireless LAN adapter Wireless Network Connection:  Connection-specific
 DNS Suffix . : lan    Link-local IPv6 Address . . . . . : fe80::45dc:
fdd3:67dd:db47%11  IPv4 Address. . . . . . . . . . . : 192.168.1.66  S
ubnet Mask . . . . . . . . . . . : 255.255.255.0  Default Gateway . .
. . . . . . . : 192.168.1.254
```

On a Mac OS X, look at the 'Network' preferences panel to get the information. On Linux, look in the Network Manager, or in a terminal window type 'ifconfig'.

This will show the settings you need to put in config.g for these two settings:

```
M553 P255.255.255.0; Set netmask (Subnet Mask)  M554 P192.168.1.254; S
et the gateway (Default Gateway)
```

For the last setting, the ip address, choose a number that is 10 higher or lower than the address listed by ipconfig. In the example above, it lists 192.168.1.66, so set:

```
M552 P192.168.1.76; Set the IP address
```

If you need to edit these settings, edit the config.g file in RepRapFirmware/SD-Image/sys/ that you downloaded earlier. Then copy the new config.g onto the SD card.

Connect the ethernet cable to the Duet, and the hub/router/switch at the other end. The GREEN LED on the ethernet connector should light up, and flicker. The Orange LED is a indicator light for 10base-T connections - most ethernet hubs/routers/switches are 100base-T or gigabit, so it will stay switched off.

At the moment, only Google Chrome **is supported. Other browsers will be added with later firmware releases. Download and install** Google Chrome**.**

Run Google Chrome, and enter the ip address you set in config.g into the address bar; for example, 192.168.1.76 (from the example above)

If the web interface is correctly set up, you should be presented with a login screen. The default password is 'reprap'; you can change this in the config.g file, too.

More in-depth use of the web interface is documented here**.**

Problems?

If you have problems with any of the steps on this page, particularly connecting to the Duet, see the 'troubleshooting' section of the instructions.

If you spot any mistakes in these instructions, please email your feedback to the support email address.

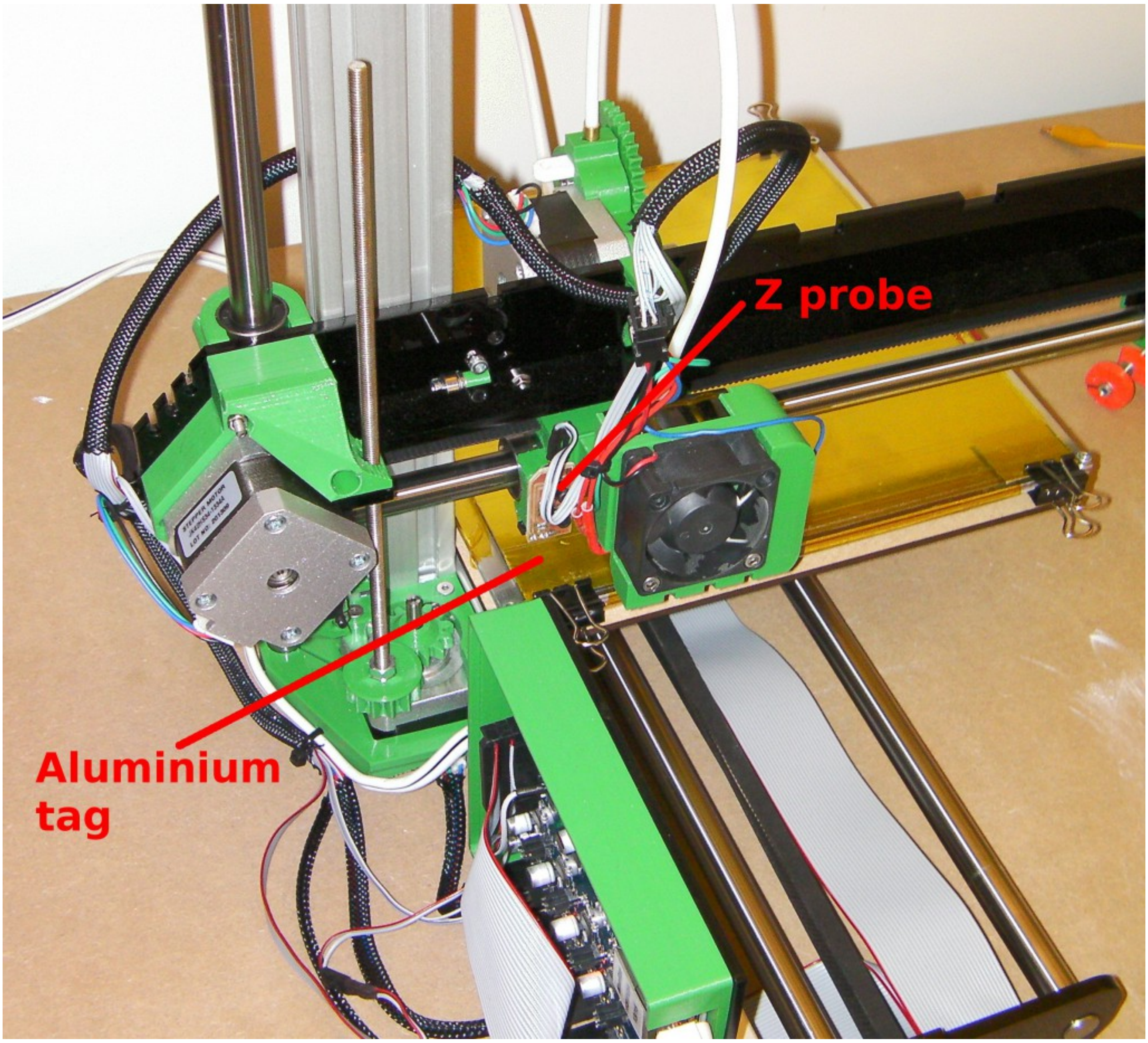
Axis compensation

Introduction

This page tells you how to set up the axis compensation of your Ormerod, so that it can print accurately. You should have covered basic communication in the 'Commissioning' section.

Ormerod supports both a USB interface, via the RepRap utility Pronterface, and a new ethernet/web interface the a web browser. At the moment only the Google Chrome web browser is supported. This restriction will be removed in future firmware releases.

Setting the Z Probe



The proximity sensor (also known as the Z probe) uses an infra-red sensor to detect the aluminium foil tags that you put under the Kapton tape on the bed glass.

Plug both the USB and ethernet cables in and turn on the power.

Now a useful thing: you can use both interfaces at the same time - the RepRap Firmware in the Duet controller will sort everything out for you. Open the Arduino IDE and go to Tools->Port and select the USB port for your Ormerod. Then go to Tools->Serial Monitor.   Make sure the speed is set to 115200 (bottom right) and that Newline is selected (next to the speed). Now type an M105 GCode command to your Ormerod in the Send bar and send it:

```
serial: M105  okT:16.3 B:18.9
```

Ormerod is saying it got a command on its serial (i.e. USB) interface, and is reporting its temperatures to you. You are talking directly to the USB interface, something that is normally mediated by Pronterface. You can actually do the whole of this section just by typing commands at this interface. but things will be quicker if you also use the network interface at the same time. Open a browser and log in. You will see the web requests reported in the USB window:

```
HTTP request: GET / HTTP/1.1  HTTP request: GET /rr_name HTTP/1.1  JSO
N response: {"myName":"Ormerod"} queued
```

This is either interesting or tiresome, depending on your point of view, but anyway it's probably best to turn all this USB reporting off. Do that by sending M111 S0 (debug off; you can either use the Serial Monitor or the Send G Code box on the web Control page).

On the web control page lift the Ormerod's Z axis by +10mm to make sure the nozzle is well clear of the bed, then select **Home X** and **Home Y**. Those two axes should zero themselves.

Now use the controls to move the Z probe over the aluminium tag in the bed corner. (X = 55, Y = 0) should be about right:

Send the command M558 P1. This activates the Z probe. This should already be in your **config.g** file, but make sure it loads on startup (see the section in the commissioning instructions).

Make sure the tag is well under the probe - you don't want the probe near its edge.

Now move the Z axis down so that the nozzle is a tiny bit above the bed and you can just see light between the two. Take care - you don't want to crash the nozzle into the bed. When you get near, move in 0.1mm increments.

Send a G92 Z0 command. You should see the Z position on the Control page go to 0.0. G92 tells the RepRap Firmware that an axis is at whatever position you specify. As the nozzle is almost touching the bed, we want this to be Z = 0.

Next send a G31 command. This fires the Z probe and reports the measurement it makes in the Serial Monitor window. The measurement should be about 950 or so.

(What's going on? The Z probe works by reflected IR light. The closer it gets to the aluminium the more light is reflected, and this sends back a bigger voltage to the Duet controller, which converts the voltage into a number. The biggest possible voltage is 3.3 volts, which the Duet would convert to $1023 = 2^{10} - 1$. So the 950 means "pretty close".)

Now. It is not a good idea to zero the Z axis by driving it down and looking for this value for two reasons: 1. the probe is not very accurate or sensitive at the very top end of its range, and 2. it gives us no room for error - we might crash the bed.

So, raise the Z axis in small increments and send a G31 after each movement. As you start, you will see almost no change (not very accurate or sensitive at the top of its range, remember?), but then the readings will start to drop. Stop when they are somewhere between 700 and 600. Suppose the value is 656. Look at the Z position box. Z will probably be between 1 and 2mm off the bed - say it's 1.8mm.

Now send G31 Z1.8 P656

This use of G31 sets values, rather than reporting them to you. It tells the Duet that a reading of 656 corresponds to Z = 1.8 mm off the bed.

Now when you select **Home Z**, Z will drop until the Duet detects a probe reading of 656. It will then lower by a further 1.8mm, and you will be at Z = 0. Try it: raise Z to about 10mm, then select Home Z. Ormerod will home its Z axis.

This is all very well, but you don't want to go through this rigmarole every time you turn on the machine. So put the G31 Z1.8 P656 (with your numbers, obviously) in the Ormerod's **config.g** file. That will set these values every time you reset the machine. See here for how to edit the **config.g** file**.**

As mentioned above, the position X=55, Y=0 should be about right for the IR probe to be above the aluminium foil. But if your position is significantly different you will also want to record that permanently so that your RepRap always homes its Z axis in the right X,Y position. The axes are all homed by *macros*. These are little G Code files stored in the **sys** folder on the SD card, and are described here. There is one called **homez.g**. As supplied it looks like this (with comments for explanation):

```
M120 ; Push - save the current feedrate and relative/absolute move sta
```

```
tus  G91 ; set movements relative  G1 Z5 F200 ; move upwards 5mm at 20
0 mm/min to make sure we don't hit anything  G90 ; set movements absol
ute  G1 X55 Y0 ; Move to the X, Y point at which to probe the bed over
 the foil  G30 ; Move down until the probe is triggered (i.e. move dow
n until the IR voltage is 656, which automatically sets Z = 1.8mm).  G
1 Z0 F200 ; Move down to Z=0 (i.e. move down the last 1.8mm)  M121 ; P
op - restore the feedrate and relative/absolute move status
```

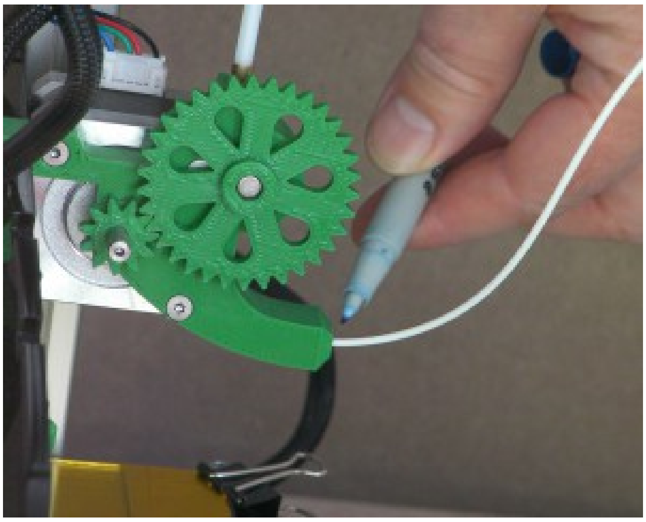
If your foil is in a different place, change the **G1 X55 Y0** line to the appropriate X and Y coordinates.

Finally, as you would expect the IR probe will be affected by infra-red light. If this changes (such as the sun falling on your Ormerod at one time but not another) the probe readings will change.

Getting Extrusion Just Right

To get the best quality prints, you need to make fine adjustments to the filament feed to make it as accurate as possible.

Using Pronterface for this is best, as in a moment you'll want to see what happens on the USB interface in its window.



Select **Motors Off**, so that you can turn the extruder mechanism by hand. Feed filament into the input of the filament drive, and wind the big gear until the filament is just visible in the PTFE Bowden tube. (Don't pinch your finger in the gears...) Then use a felt-tipped pen carefully to mark the filament just where it enters the mechanism.

Now tell Ormerod to feed 100mm of filament. Mark the filament again.

Reverse the filament by 110 mm, so you can see both marks. Using a ruler carefully measure between them. The measurement probably won't be exactly 100mm. Suppose it is 97mm.

Now send an M92 command. The result in the USB interface window will be something like:

```
Steps/mm: X: 87, Y: 87, Z: 4000, E: 420
```

These numbers are the number of pulses sent to each stepper motor to drive it 1mm. Because you only got 97mm and you wanted 100mm, the E420 needs to change to 420x(100/97), which is to say 433. Do that calculation for the length you measured, then add a line saying

M92 E433

but with your number in place of the 433 to your **config.g** file. (M92 reports the values with no arguments; if you give it a value, it sets it.)

Now your Ormerod will extrude precisely the right amount of filament when it's printing.

Finally, set the temperature of the hot end to 205^{o}C for PLA or 250^{o}C for ABS. When it gets to temperature feed the filament all the way to the nozzle. You can run it fast when the end is still visible in the tube (800 mm/minute in Pronterface). But make sure you slow down before the filament enters the hot end.

Bed Plane Compensation

Ormerod has several ways to allow you to compensate for the fact that the plane of its printing surface may not be exactly at right-angles to its Z direction. This section tells you how to implement your choice among these.

1 - Bed Plane Compensation - setting by hand

This is quite simple and gives good results. It is most easily done using the web interface.

First make sure that your Ormerod has no compensation set already. Send it an M561 command. This will reset the bed plane transform to the identity transform, which is mathspeak for not doing any compensation.

Then send M556 S100 X0 Y0 Z0. This resets all orthogonal axis compensation to zero (see below). Don't forget the S100, or nothing will change.

Now decide on a rectangle, at the four corners of which you are going to measure the Z height of the bed. You want this to be as big as reasonably possible without colliding with anything. Good values of X and Y might be X = 60 and 180, Y = 20 and 180. Let's assume you are going to work with those.

Raise the nozzle to around 10mm above the bed, home the X and Y axes, then

move to X=60, Y=20. (You can either use the move buttons to move, or send the command G1 X60 Y20 to go there directly.)

Now lower the nozzle until it is almost touching the bed, but you can just see light under it. Send a G92 Z0 command to set this point as Z=0. Jot down Z = 0.

Send the command G30 P0. This records the current nozzle position as the first point for the bed compensation calculation.

Raise Z by two or three mm, and move to X = 60, Y = 180. Repeat the procedure, moving the nozzle to just above the bed then this time sending G30 P1. this sets the second bed point. Look at the Z coordinate value (if you're doing this in Pronterface rather than the web interface, press 'GET POS' or send M114) and jot it down.

Lift the nozzle, go to X = 180, Y = 180, and repeat, this time sending G30 P2. Jot down the Z value.

Finally go to X = 180, Y = 20, lower the nozzle, and type G30 P3 S. This will record the position of the fourth and final point, and the 'S' tells the system to calculate the equation to do the bed compensation. Again, note the Z value.

To test what you have done, leave the nozzle just above the bed and run the G Code file CIRCLE.G, which should be on the SD card. This will run the machine in a big circle at the current height. If you watch the nozzle it should just skim over the surface of the bed. There may be small variations in height (the Kapton tape may not be perfectly flat, for example), but it should follow the bed closely. You will see the Z axis drive screw rotating a small amount as the circle is described - this is the compensation in action.

When doing this procedure always put the points in in clockwise order round the rectangle, as above, starting with the point nearest the origin.

A useful M code when you are experimenting with bed plane compensation is M561. This removes the compensation and sets the machine's idea of what the bed plane is like to what it was when it was powered on.

Bed Plane Compensation - recording hand settings

You can put the Z readings you jotted down in **a** file so you don't have to do this every time the machine is run. Say the Z readings were 0.0, -0.3, 0.2, -0.5. Then use a text editor to create a file called **setbed.g** containing:

G30 P0 X60 Y20 Z0.0

G30 P1 X60 Y180 Z-0.3

G30 P2 X180 Y180 Z0.2

G30 P3 X180 Y20 Z-0.5 S

(Note that if you do anything that raises or lowers the bed, like changing its adjustment screws, you will have to re-do these numbers.)

Put **setbed.g** in the **gcodes** folder on your SD card. (It is best not to put the G30s in **config.g**. If you do that the machine won't be in its standard state when it powers up.)

To set the bed compensation, just run **setbed.g** as if it were a file to print.

2 - Bed Plane Compensation - fully automatic

Fully automatic bed plane compensation is a very easy process, but it is a bit experimental at the moment. It uses the IR Z probe to probe the bed in four places automatically.

As before choose a rectangle of (X, Y) points at which to probe. Make sure that when the nozzle is at each point, there is piece of the sticky-backed aluminium foil under the Z probe between the Kapton tape and the glass. Good coordinates are X = 60, 220, and Y = 0, 180. But move your own machine around and check against the aluminium tape. You need the IR Z probe to be roughly over the middle of the tape.

Now record the points at which you want automatic probing to take place. You can either put these in a short G-code file that you run, or add them to **config.g**.

M557 P0 X60 Y0

M557 P1 X60 Y180

M557 P2 X220 Y180

M557 P3 X220 Y0

Make sure you set them in clockwise order round the rectangle, starting near the origin.

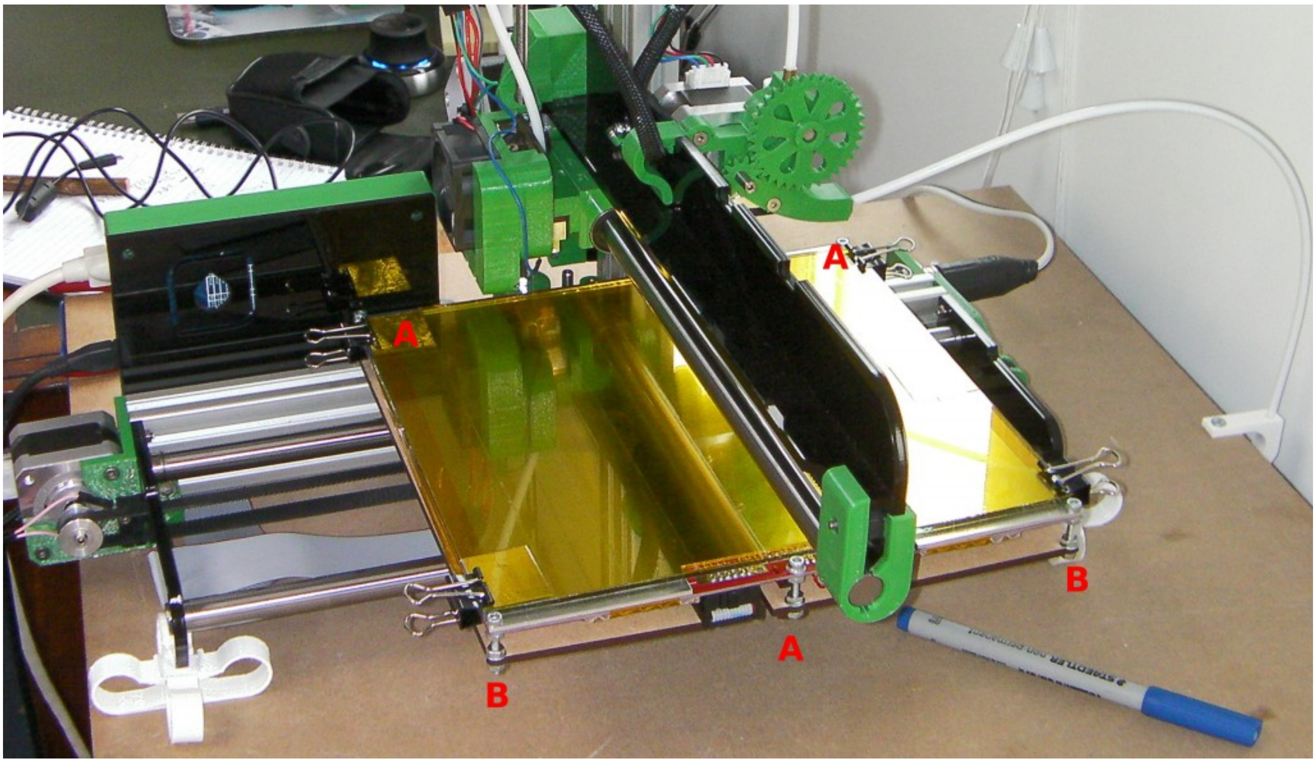
Set the Z Probe correctly (see the section above).

Now sending a G32 command will cause Ormerod to probe all four points and set the bed compensation automatically. Note that there is no problem with putting these commands in **config.g**. They will have no effect until you execute the G32.

3 - The old-fashioned way; by hand!

In an ideal world, you could build a machine that was perfectly square and needed no compensation. The Ormerod should be fairly square anyway, but getting the bed plane reasonably flat before doing either Bed Plane Compensation described above may improve the results.

To allow for more adjustment, you will need to replace the five M3x12mm cap head screws with longer, 20mm cap head screws (to allow for adjustment), and add 5 more M3 nuts. These are not supplied with the kit.



For this it is useful to have a drill bit of known diameter - say 3mm. You are not going to make any holes. But you can use the cylindrical drill shank as a 3mm reference. Home the X and Y axes, as described above. Then move over the aluminium tab nearest the origin and home Z. Now raise Z by 3mm. You should find that the drill shank will just roll under the nozzle.

The main adjusting screws are the three As in the picture.

Now slacken the nuts that hold the bed on the two corner screws furthest from all the mechanics of the machine - the corners on edge that sticks out (B). These corners do not supply a lot of supporting force to the bed, and so we want the screws there to move freely for the moment while we adjust the more important other three.

Move the Y axis to about Y = 190. Roll the drill under the nozzle. You will probably find that the bed is either too high or too low. Adjust the screw in that corner so that the drill just rolls under the nozzle. If you have to adjust too far, it may be better to go back and do some adjustment at the Y = 0 end. The important thing is not to achieve any particular height - it is to get both ends the same. Take care when making the adjustments that you don't cause the ends of the screws to scrape on the aluminum extrusion beneath them.

Now move to X=190 Y = 100 and adjust the height over the screw in the middle of the far edge - the edge that sticks out.

Finally tighten the to corner nuts that you loosened at the beginning to whatever position their screws lie in.

The bed will now be much more accurately flat. Now run one of the Bed Plane Compensation options.

Orthogonal Axis Compensation

Before doing the compensation described in this section, first do the Bed Plane Compensation described above. Orthogonal Axis Compensation depends on having the bed plane right.

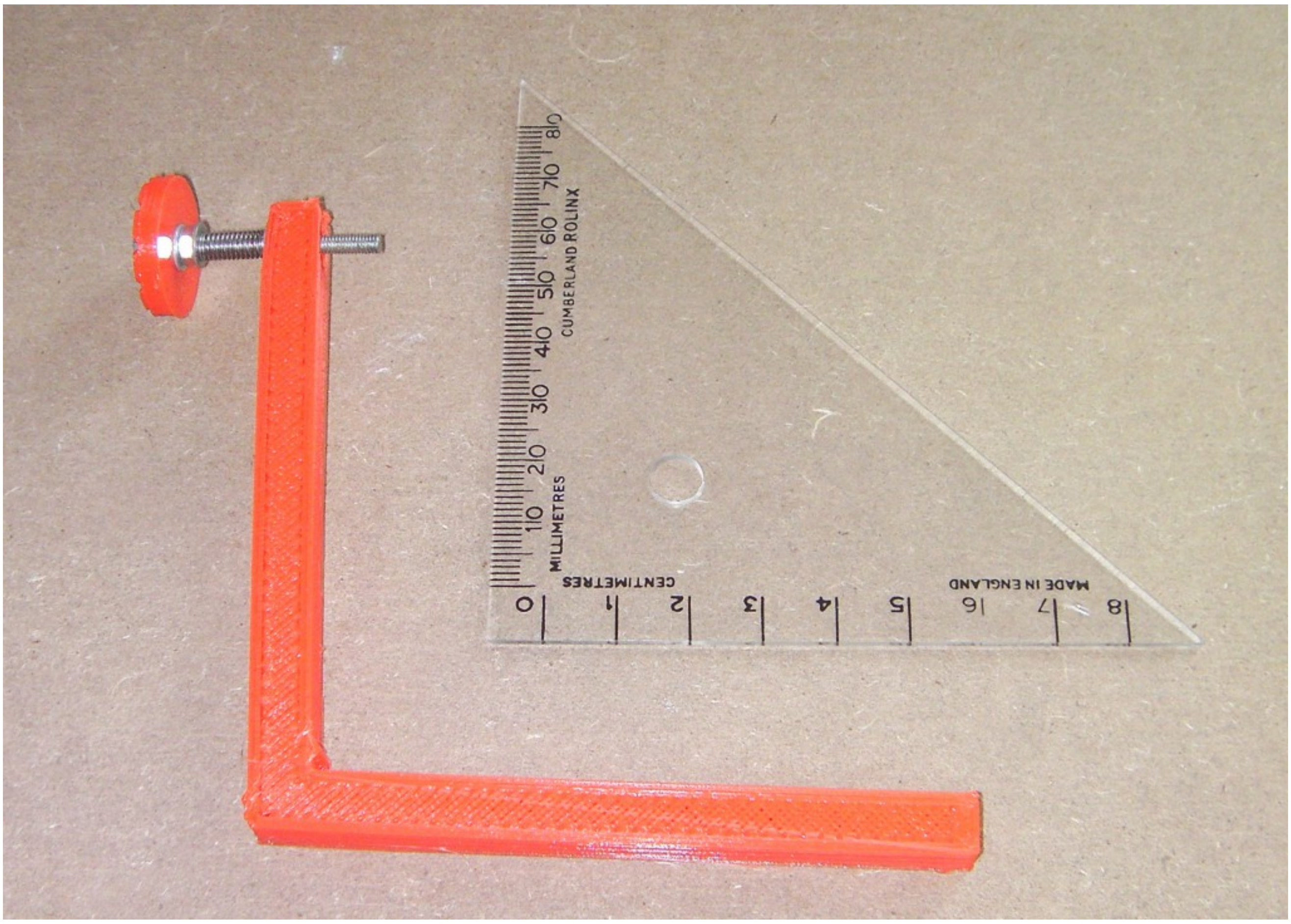
This compensation is not intended to avoid all the effort in getting the axes at right angles. Use a set-square on the bed to set the vertical Z pillar at right angles to the bed.

Now skip to the [Printing Instructions](). They tell you how to do your first print, which you will need to set the orthogonal axis compensation. Then come back and do the rest of this section....

Setting the compensation from the printed test parts

Ormerod allows you to compensate for the fact that its X, Y, and Z axes may not have been assembled at perfect right angles. This section tells you how to implement this.

First clean any extraneous wisps of filament or small lumps on the surface of the printed parts away. When you get used to printing these won't happen anyway, but this was your first print, and so it would be unreasonable to expect it to be perfect.

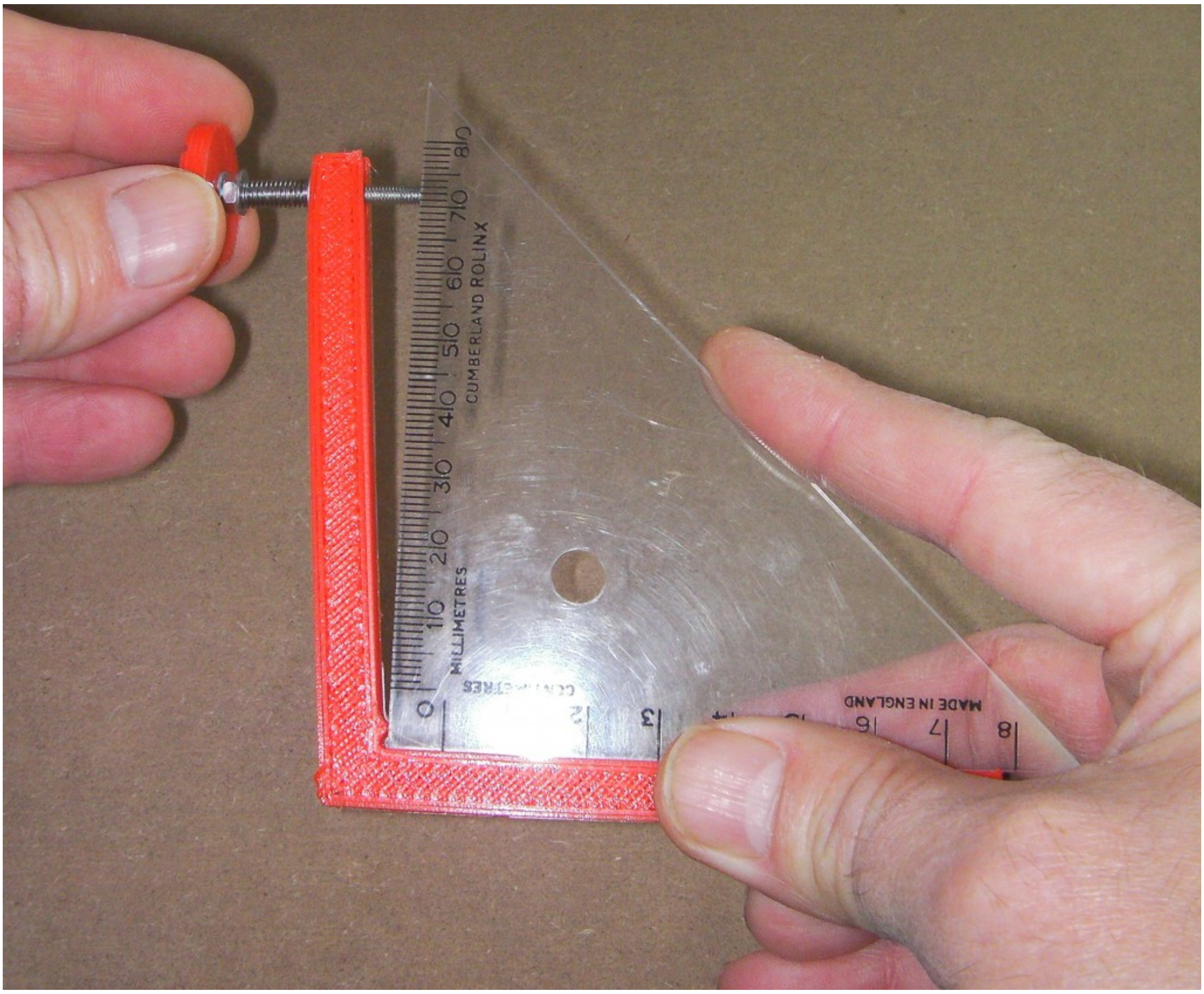


The thumbwheel in the test print has 10 radial indentations to allow you to count turns of it. Use a felt-tipped pen to mark one indentation so you can identify it as the wheel turns. Then assemble the gauge shown above.

Start by using a short M3 screw to draw an M3 nut into the hexagonal cavity in the angled part. Put an M3 washer under the head of the screw. Take care as you tighten the screw that the flats on the nut are aligned with the hexagon of the cavity. You will feel the tightening force increase as the nut reaches the bottom of the cavity.

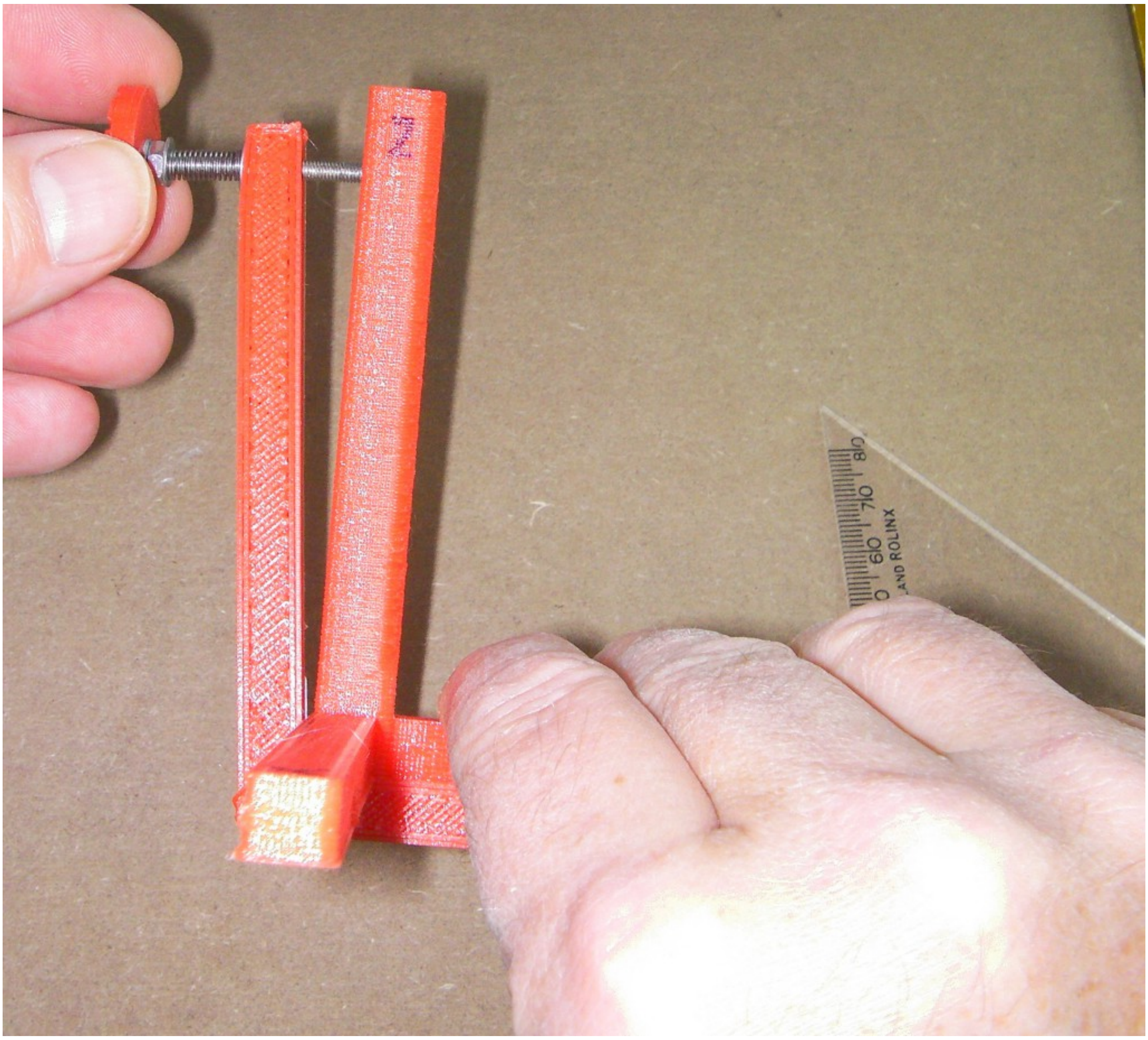
Then assemble the measuring screw. A 35mm hex-headed screw fits in the cavity in the top of the thumbwheel. Secure it there with a nut with a washer under it on the other side of the wheel. Then put a washer, a spring, and another washer on the screw and screw it into the nut embedded in the cavity of the angled piece as shown above.

The order goes: hex-head 35mm M3 screw, thumbwheel, washer, nut, washer, spring, washer, angled piece, nut embedded in the angled piece.



Now use a set square to set the screw at just the right position for a right-angle, as shown above. Push the set square against the small projection near the angle. But don't force things or push too hard. You don't want to distort the pieces.

Note the position of the mark you made on the thumbwheel.



Now take the three-legged test piece that you printed. Hold it in the same place as the set square, and see how much (if at all) you have to turn the thumbwheel to just touch it. Note down the turns, and whether they were clockwise/inward/acute-angle/negative or anti-clockwise/outward/obtuse-angle/positive.

Suppose you need 1.3 clockwise turns. The pitch of an M3 thread is 0.5mm, so this means that the axis pair you have measured is -0.65mm away from a true right angle.

You can take several readings and average them - always more accurate. If you do, re-zero with the set square before each reading.

Measure all three pairs of axes: XY, YZ and XZ and write down the measurement for each.

Finally, measure the distance between the tip of the projection near the angled corner and the center of the end of the screw. This should be 78mm, but it is best to measure it than to rely on the accuracy of your first print.

Suppose the XY, YZ and XZ measurements are XY = -0.65, YZ = 0.9, XZ = 0.2, and the screw distance is that 78mm. Then sending

M556 S78 X-0.65 Y0.9 Z0.2

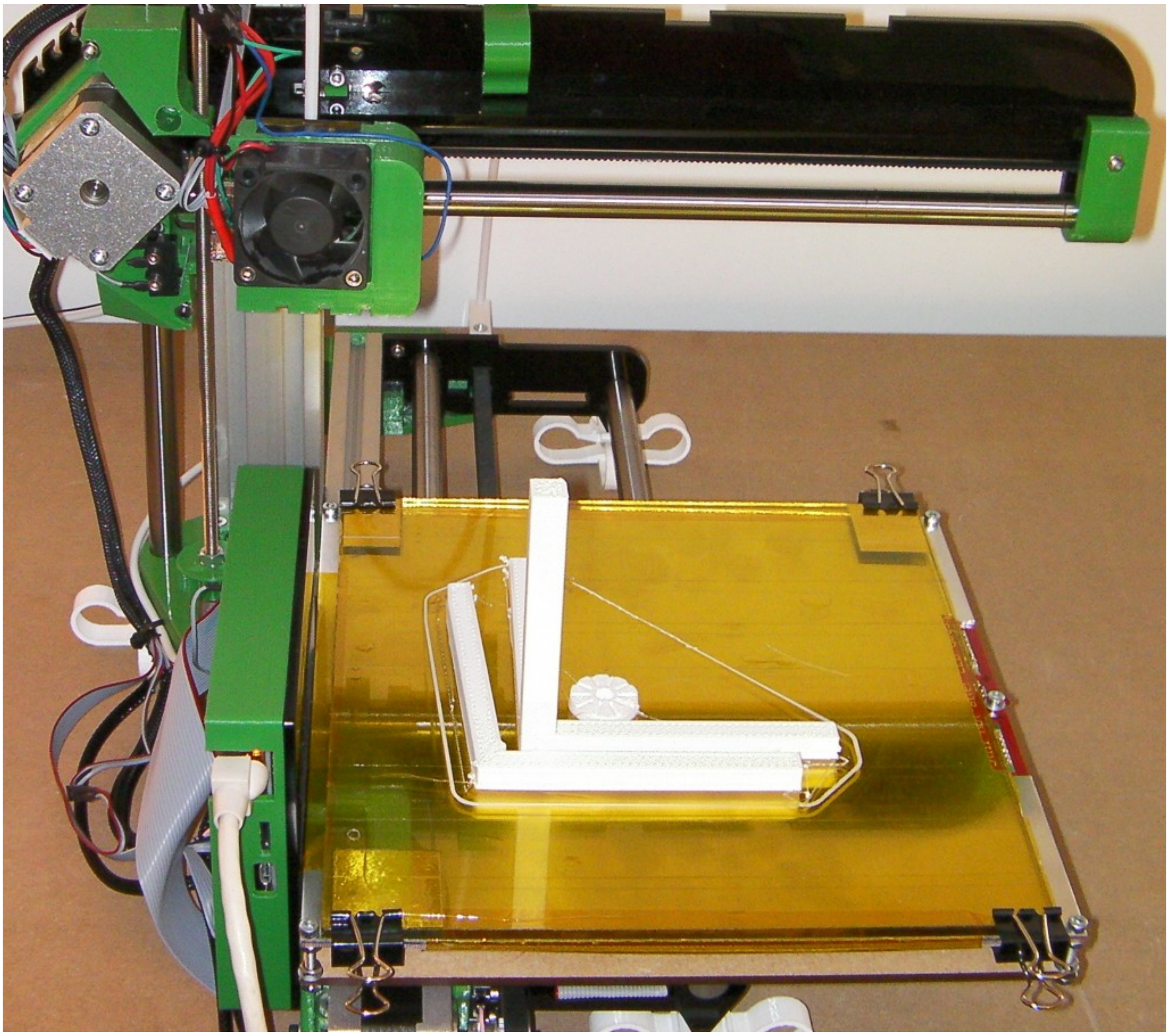
to your Ormerod will cause it to correct for those angles between the axes when it prints.

It is best not to put the M556 command in your **config.g** file. That way your Ormerod will always start up in a raw uncompensated state. Instead put it at the end of the **setbed.g** file that you created above. Then, when you run that file, it will both set your bed plane compensation and axis compensation.

To check that the axis compensation has worked, apply it, print the test pieces again, and check them with the set-square and gauge. This time you should find that all three legs of the largest test piece are at right angles to each other.

Printing

Printing the Orthogonal Axis Compensation Test Pieces



The first thing to print is the orthogonal axis compensation test pieces, as in the picture above. The G Codes for this are in a file called ORMAXIS.G on the SD card.

(The 3D models for the test pieces are in the **Data** folder of the RepRap Firmware download, incidentally: **gauge.stl**, **thumbwheel.stl**, **testpiece.stl**, and **calibration.scad**.)

For help on the Ormerod user interface, see here.

Plug in the USB and power, power on your Ormerod, wait a short time for it to connect to the network, open the browser, and type the IP address of the Ormerod in the address bar.

Log in, and go to the **Control** page.

If the nozzle is low, lift it with the up-Z buttons to about 10mm above the bed.

Now home the X and Y axes.

Normally, we would use the Z probe to home the Z axis as well, but as this is the first print we will home Z by hand. Move to the first point you used for setting the Z probe (in the Axis Compensation Instructions).

Lower the nozzle using the small-increment Z move buttons until it is just clear of the bed. You want it as near touching as possible, but so you can just see light in the gap.

Send a G92 Z0 command to set this as Z=0.

Now run your bed plane compensation. If you recorded it in a **setbed.g** file, simply go to the **Print** page and run that.

Go back to the Control page and check all the numbers for position and temperature look as you would expect.

Now run the ORMAXIS.G file. It should print the objects above. Before you take them off the bed, use a felt-tipped pen to label the axes of the three-legged piece. In the picture above, X runs left-right, Y runs front-back, and Z runs down-up.

You can now go back to the Axis compensation instructions and set the orthogonal axis compensation.

The G Code files for printing a snowman Christmas tree decoration and the traditional RepRap coathook are also on the SD card. You can print those in just the same way as above.

Converting CAD files for printing

File formats

Most CAD software can output files that can be used for 3D printing. There's a useful list of free CAD systems here on the RepRap website. Professional software like SolidWorks and Autocad, as well as free options such as RS DesignSpark Mechanical, Sketchup, Blender,Sketchup and OpenSCAD (as well as many others) can export stereolithographic (STL) files. They use the file extension '.stl'.

An STL file is a list of triangles completely covering every surface of a 3D object. This is not a very robust way of representing a solid, but it has become a universal standard.

Slicing software

Like all 3D printers, Ormerod is actually controlled by G Codes - low-level instructions that say things like *go-to-this-point*, or *print-filament-in-a-line-from-this-point-to-that*. We need a program to convert STL files into G Codes. A very good program to do that is called Slic3r. It is open-source and free, and it is available here. There is also documentation on Slic3r available here, so that is not reproduced here.

Slic3r profiles

Slic3r needs to be set up for each type of 3D printer for which it translates STL files into G Codes. We have performed that set-up for you for Ormerod. To get it you need to download the main Ormerod repository (if you haven't already), which is stored here on Github. As with downloading the RepRap Firmware, click on the **Download ZIP** button with the little cloud and arrow. In the download is a folder called **Slic3r-settings** that contains the files Slic3r needs to convert STLS to G Codes for Ormerod.

To use our profiles with Slic3r, the contents of the 'Slic3r-settings' folder that is in our github repository here [github.com] needs to replace the contents of the default Slic3r profiles folder. The location of this folder depends on which operating system you are using. You need to run Slic3r once, so it creates the 'Slic3r' folder that holds the profiles.

On **Windows 7/8,** the profiles are stored in folders under
c:\Users{username}\AppData\Roaming\Slic3r

AppData is a hidden folder; you will need to change the View settings to see System folders, so you can find it.

On **Windows XP,** the profiles may be stored in the same folder as above, or in C:\Documents and Settings{username}\Application Data\Slic3r

On **Ubuntu**, the profiles are stored in an invisible .Slic3r folder, in /home/{User}/.Slic3r

On **Mac OS X**, the profiles are stored in /Users/{username}/Library/Application Support/Slic3r

This is a hidden folder, but you can get to it by going to the main menu option 'Go' then 'Go to Folder...' and typing '~/Library/Application Support/'

After replacing these files, when you open Slic3r the next time, there should be three 'Ormerod-0.5' (for Print settings, Filament and Printer) options at the bottom of the Slic3r application window.

Printing from the SD card

You may have noticed that, so far, all printing is done from the SD card. This is the preferred way of printing. It is possible to print directly from Pronterface (ie load gcode files into Pronterface and press print), but the serial communication is slow. The printer will pause a lot during printing, and the printed part will not be of good quality.

Always copy gcode to the 'gcodes' folder of your SD card to print. This is where the firmware looks for files. There are currently two ways to transfer files to the printer:

1. Turn off the printer, remove the SD card from the Duet, insert it into the USB adapter, then into your computer. Copy the gcode file from your PC to the SD card, then eject the USB adapter. Wait for it to finish writing, then remove the SD card. Reinsert it into the Duet. Restart the printer. Your gcode file should be accessible from the Pronterface 'SD' menu.
2. In Pronterface, click the 'SD' button, and click 'SD upload'. You can then upload the gcode file to the SD card while it is still in the Duet. This is quite slow, and is suitable for small files only (1MB will take a couple of minutes).

Future firmware updates will improve the speed of serial communications, and give more options for uploading files to the SD card.

Print an Ormerod

Ormerod is a RepRap - a *Replicating Rapid Prototyper*. So, to experiment, why not print out some of Ormerod's own parts? These are available in the folder **stl/individual parts** in the Ormerod download. When Slic3r has generated a G Code file for you from an STL file, you can put it in the **gcodes** folder of Ormerod's SD card and then print it. Either put the SD card in your computer to copy the file (remember not to take it out of Ormerod unless all power including the USB is off), or you can upload G Code files using Pronterface. The Duet controller in Ormerod expects file names to be in 8.3 format at the moment. This restriction will be removed on a future release.

And, now you have started, why not print out a full set of Ormerod parts for a friend? Hardware-only kits for Ormerod will soon be available, giving all the things you will need other than the printed parts to build another complete Ormerod.

Happy 3D printing!

Troubleshooting

Duet problems

Duet hardware problems

There have been a couple of issues with the construction of the Duet board.

- The Duet boards that were supplied with the first 220 red RS kits have a mistake in manufacture, which means that a USB cable needs to be attached to the board to supply 5V to the board logic all the time. The mistake is the resistors that allow 12V power to be fed to the 5V power regulator are incorrectly mounted. These are R60 (3k92) and R61 (750R), near the JP9 (5V_EN) pins, which have been soldered to the board at 90 degrees to where they should be. These resistors are next to capacitor C5; if they are the same orientation as C5, they are the wrong way around. The Duet schematics are HERE. If you feel confident in your abilities to remove and replace SMT components, please feel free to try. Otherwise, contact support for a warranty board exchange.
- The first 800 boards did not have their USB sockets soldered correctly. Looking at the USB socket, it has 4 pins that go through the board. All four of these should be soldered, to support the USB socket. Boards had only two soldered, or none, so inserting the USB cable can cause the fine connections to the board to break. Please solder up all four contacts, if you feel it is within your ability. Please contact support if you have intermittent or no USB connection for a warranty board exchange.

Power problems

When power is applied to the board, you should see at least one LED light. With USB, it should be the one next to the USB socket. With ATX PSU power, it should be the on below this; this is the LED for the MOSFET that controls the FAN0 output. It is on by default. You may also get the Y endstop LED. When powered by ATX PSU and with the USB connected, you should get all three LEDs switched on.

Problem

- No light turns on next to the USB socket on the Duet, when Duet plugged into USB
- No light when jumper JP9 (5V_EN) is enabled, and ATX PSU is turned on
- No USB or COM port appears on PC
- Duet is listed as a USB or COM port, but can't connect

Test voltage

Test the voltage of the 12V, 5V and 3.3V. Test 12V at the large green screw terminals; using a multimeter, put the probes on the two screw terminals. If connected by USB, you will get 0V here, otherwise 12V. Test the 5V by using the probes between ground (the top of the SD Card holder is useful for this) and pin 1 of the expansion header, then 3.3V on pin 3 – these are the pins closest to the heated bed connection, just under the ‘SION’ of ‘EXPANSION’.

Solutions

1. If no light appears on the Duet next to the USB socket when plugged in via USB, check the cable, then check the USB socket. Some boards have loose sockets due to insufficient soldering of the socket, which may cause the board to get no power. See 'Duet hardware problems', above.
2. If the voltage is not as expected on 12V, 5V and 3.3V, contact support with your readings; your Duet board may have a fault with the 5V or 3.3V rectifier, or some other fault
3. If the voltage checks are correct, but no USB or COM port appears on your PC, check the USB socket soldering. It may be disconnected.

If a USB or COM port does appear on your PC, but you can't connect, this may be a hardware, firmware or software fault:

1. Hardware fault - the USB socket may be disconnected
2. Firmware fault - if you've tried flashing the firmware and the port still says 'bossac programming port', see below 'Firmware update problems'
3. Software fault - Particularly Windows 7 and 8, check the drivers have installed correctly , see below 'Check software installation'

Firmware update problems

Problem

- Can not update firmware
- After firmware update, Duet no longer visible
- Printer stops at the beginning of the print, even with the gcode supplied on the SD card

Solution

1. Check the instructions, and follow them carefully
2. If the 'bossac' command fails, make a note of the error, and contact support
3. If the error is to do with the port not being found, try sending the command without this part: '--port=COMxx -U true'
4. If the board is inaccessible following a firmware update, but then does reappear after the 'erase' and 'reset' buttons are pressed - we are testing a fix for this. When you send the

bossac command, leave the '-R' off the end. Once the flash has completed, wait for 10 seconds, then press 'reset' button on the board, and see if the board shows up correctly

5. 'Printer stops at the beginning of the print' - this problem has been solved with a firmware update.

Duet software connection problems

If you are having trouble communicating with your Duet board, follow this troubleshooting guide to narrow down where the problem is.

USB connection

Check software installation

1. Download Arduino IDE v1.5.5 BETA (with Arduino Due support) for your operating system from: http://arduino.cc/en/Main/Software
2. NOTE: if you are using a Windows PC, use the .zip file, NOT the 'Windows Installer'. The 'Windows Installer' may not have the up to date 'bossac' command in it (to be confirmed)
3. Install Arduino IDE
4. Connect Duet via USB
5. On Windows computer, open the Device Manager. It should show up as 'Arduino Due'. If it shows as 'bossac programming port', the firmware has been erased, and you will need to flash the firmware. Follow the instructions here: http://www.reprappro.com/documentation/RepRapPro_Firmware#Installation
6. NOTE: Windows 7 and 8 users - the Arduino device driver has to be installed manually. See the note under 'First connection' in the 'Commissioning' intructions
7. Open the Arduino IDE and go to Tools->Board menu and select ‘Arduino Due (Native USB)’ at the bottom of the list. If this is greyed out, check the device drivers have been installed.
8. Then go to Tools->Port menu and select the USB port for your Duet board; it's usually named ‘Arduino Due (Native USB)’
9. Then go to Tools->Serial Monitor. Make sure the speed is set to 115200 (bottom right) and that Newline is selected (next to the speed).
10. Wait for 1 minute (this is normal when no ethernet is connected and the firmware is searching for the network), and following should show:

```
RepRapFirmware is up and running.
```

The above steps should diagnose that the Arduino driver is installed, the USB is functioning correctly.

Check Micro SD card is functioning correctly

Some customers have reported problems with the supplied SD cards and/or the SD card to USB adapter. If you can, try a different SD card, and writing files to it with a different adapter. SD cards come in a variety of sizes; we have tested cards up to 8GB. They should be a FAT32 formatted disk. It's also possible you have a faulty Duet board, but please do the tests on this page before returning your Duet board for a warranty replacement; it will be quicker for you than a miss-diagnosed problem with the Duet board when the real problem is, for example, with the SD card.

- Test the SD Card as described in the Commissioning instructions HERE
- If it's working at startup, it's generally safe to assume it will work the rest of the time.
- If it isn't working, update your firmware if it is an old version (we have improved the firmware to help with the problem of slow cards)
- If it STILL isn't working, replace the supplied Micro SD Card with a better quality card

You should now be able to connect using Pronterface, as described in the main instructions.

Ethernet connection

Physical connection problems
If you get no green light on the ethernet connector, either there is no power to the Duet board (via USB or from the ATX PSU - it can't be powered from the ethernet connection), or the ethernet cable is not making contact/isn't working, or there is a problem with the Duet board. Check power and the ethernet cable.

Testing the connection
For testing, you can connect an ethernet lead directly from your computer to the Duet, so long as your computer's ethernet port is setup with an ip address (eg 192.168.1.12) and netmask (eg 255.255.255.0) in the same range as the Duet.

Duet Firmware ip defaults - line 170-172, Platform.h, here: github.com

```
#define IP_ADDRESS {192, 168, 1, 10} #define NET_MASK {255, 255, 255,
0} #define GATE_WAY {192, 168, 1, 1}
```

Even without an SD card, you should be able to ping 192.168.1.10 and get a response from the Duet. However, you won't be able to access the printer web interface.

The following instructions assume you have a working SD card (see HERE). The standard SD card ip defaults - from sys/config, SD-Image here github.com are:

```
M552 P192.168.1.14; Set the IP address M553 P255.255.255.0; Set netmas
k M554 P192.168.1.1; Set the gateway
```

Edit the config.g on the SD card to suit your network, as described in the commissioning instructions HERE.

Establishing connection

1. Connect ethernet cable to router, then to the Duet.
2. Connect USB lead to Duet (this is needed for power, and can help with diagnosis), or turn on the ATX PSU, and check that JP9 has a jumper on it
3. The GREEN LED on the ethernet connection should light up on the Duet. The ORANGE LED is a indicator light for 10base-T connections – most ethernet hubs/routers/switches are 100base-T or gigabit, so it will stay switched off.
4. If you don't get a green light, check the Duet board is getting power (by USB or ATX PSU), check your ethernet cable is okay by testing it in a known working ethernet port. We have had a couple of reports of the ethernet not working at all on the Duet; contact support for a warranty replacement.
5. You should be able to ping the Duet, on the ip address you set.
6. If you ping 192.168.1.10 and get a response, this is the firmware default; the network settings are not being loading at startup, and the web interface will not respond correctly. Check the Duet is loading config.g at start up; see HERE
7. You should then be able to connect to the web interface, using Google Chrome, by typing the ip address you set in the address bar.

If you are having problems during connection, you could try the version of the web interface that has been developed by Ormerod owner Matt Burnett; see http://forums.reprap.org/read.php?340,290811,301393#msg-301393 and https://github.com/iamburny/OrmerodWebControl

This doesn't use password control, so is perhaps more reliable at connecting, if more insecure.

Random disconnections during printing

If the printer is resetting, and stopping mid-print, the cause is likely to be related to power to the printer. Double-check that the 12V power input wires and the heated bed power wires are well-seated in the screw terminals; they should be really solid. They have to carry a lot of current, and a loose connection here will generate heat, and possibly cause a disconnection/reset if the contact is poor. Once you are satisfied with this, check that you are getting 12V from the power supply when under load. Test at the 12V power input screw terminals, turn on the bed, and see if the voltage drops. A small voltage drop of 0.5 to 1V is to be expected, but more than that can cause a problem.

If the printer is loosing the USB connection, check the soldering on the USB connector. See 'Duet hardware problems' above.

If the printer is loosing the USB connection and the soldering is okay, there can be a variety of causes. USB is quite prone to Electro Magnetic Interference (EMI), via the power line. Large motors (in air conditioning, fridges, fans, drills and other hand tools etc) starting and stopping on the same ring main can cause power spikes, while other high current devices, unstable mains supply, or poor USB power connectivity on the host PC can knock out the USB connection. If the printer seems to continue working without resetting (for example, if you are printing from SD card, it continues to print), this is the most likely source of the problem. Check that the USB cable is connected properly, and for any damage - a poor connection will be more susceptible. Customers have found that adding a surge suppressors, power conditioners and/or UPSs to smooth the mains supply, and/or using a USB cable with a ferrite core, can help.

Proximity sensor problems

Problem

- Homing of X and Z axis does not work properly
- Response from G31 is inaccurate, or varies, or doesn't change

Solution

1. Check your wiring of the proximity sensor, at the sensor end and the Duet end. See: http://www.reprappro.com/documentation/ormerod/wiring/
2. Updated your firmware, and update the files on your SD card, with the files from 'SD-Image' in the firmware folder. These should be kept on the same version. This should update any firmware behaviour that may be causing homing problems. See: http://www.reprappro.com/documentation/RepRapPro_Firmware#Installation
3. Check that your SD card is working AT STARTUP. This is crucial, because it effects the behaviour of the proximity sensor: http://www.reprappro.com/documentation/ormerod/commissioning/#Is_the_SD_card_being_read_AT_STARTUP
4. Check that there is no big Infra Red source near the printer, this will upset the proximity sensor. See the noted below the picture here: http://www.reprappro.com/documentation/ormerod/axis-compensation/#Setting_the_Z_Probe
5. Check the values you get from the probe. With axis a long way from the bed, send G31. The result should be a low number, like 10. Put a piece of white paper under the sensor, very close, and send G31. The result should be a very high number, like 950. This is the normal range for the sensor.
6. If you get a constant value from G31, the board may be damaged. If you get 1023 from G31, check your wiring.

If the homing seems inaccurate after all of the above, check that the Z axis is moving correctly; there could be backlash that is causing problems. Check:

- look for binding or stalling in the z-gears
- stiff movement of the Z axis up and down

- If you have an adjustable z-runner-mount, it should only be lightly gripping the extrusion, or that will cause problems for the Z axis movement

Printing problems

Poor or no extrusion

Problem

This could be due to a number of reasons:

- Initial construction problems (if the nozzle has never successfully extruded)
- The nozzle is partially or fully blocked
- Extruder motor does not move much but makes a squeaking noise.
- Extruder motor rotates, but the gears do not.
- Extruder drive motor and gears rotate, but the filament does not feed.
- The extruder gears squeak, rub and/or get stuck as the big gear turns.
- The Bowden tube comes out of the brass unions

Solutions

Construction problems

- Hot end cooling: Check that the hot end fan is on ALL THE TIME. If the hot end fan turns off, heat can travel higher up the nozzle, and the force of extrusion increases, eventually stopping extrusion. The hot end fan MUST run all the time (it should be wired to the +12V directly), and there should be good contact of the heatsink to the heatsink block.
- Hot end cooling: Make sure the heatsink is installed so that the fan can blow air through it!
- Hot end construction: Check that the brass tapered nut is tight against the heater block on the nozzle. Tighten with spanners - more than finger tight! This will ensure the threads make good contact with the nozzle, and heat transfers well.
- Hot end construction: If the ptfe nozzle liner is not cut square, or cut too short, and there is sufficient gap that fills with molten filament, again the force of extrusion increases. Cut a new piece of ptfe tube, 8mm long, with square ends.
- Bowden tube: If the Bowden tube is tight into the brass unions, and the filament has difficulty moving through the tube, this increases the force needed for extrusion. The tube should be 10mm into the brass unions, then run a 2mm drill into the ends to clear them. Push a piece of filament through to check it is smooth, and to clear out any debris.
- Extruder: If the teeth of the hobbed insert has slipped on the filament, there may be pieces of plastic in the teeth, which the filament will slip on. Remove the filament, take out the big gear with the hobbed insert, then check and clean the teeth of the hobbed

insert - a small wire brush is good for this.

- Extruder: Check the idler bearing has a washer on it between the bearing and the motor, or the bearing will have difficulty turning

Nozzle blockage (also for changing filament)

To ensure the nozzle and melt zone are free from contamination, follow these steps:

1. Heat nozzle to operating temperature (200C for PLA)
2. Extrude a little filament, like 10mm (if possible) by hand or via Pronterface, then set temperature to 100C
3. Wait for the temperature to drop to 100C, then reverse filament until it comes out of the extruder drive (about 380mm). You can do this at 600mm/min, or by hand if you wish.
4. This should pull out the filament from the melt chamber, hopefully down to the nozzle, along with any contamination.
5. Cut the contaminated end from the filament, and drive or feed the filament to just before the hot end.
6. Set temperature to operating temperature
7. Command the filament to extrude short lengths, 5mm at 200mm/min, until it squirts out of the nozzle.
8. Only in the worst case will you need to disassemble and clean the hot end.

Extruder problems

If the extruder motor does not move as expected, but makes a squeaking noise or just vibrates, it may mean it does not have enough torque to drive the extruder feed mechanism, because it is stuck or jammed.

1. Check that the nozzle is not blocked (see solution above)
2. Check that the idler bearing can rotate freely (there should be an M3 washer between the bearing and the motor)
3. Check the diameter of your filament is not too wide (over 2mm in diameter will not feed through the extruder)
4. If the motor vibrates rather than turning, even with no load on it, the stepper driver chip may be damaged

Extruder gear rotates, gears do not

1. It is unlikely the small gear will rotate on the motor shaft. If it does, contact RepRapPro support for a replacement.
2. On the big gear, check that the hex head bolt is not rotating in the hex hole. If it is, again, you will need a replacement. As a temporary fix, you may be able to use epoxy glue or superglue to get the hex head to hold again.

Extruder drive motor and gears rotate, but the filament does not feed. There are a number of potential reasons for this:

1. The teeth of the hobbed insert have plastic in them. This will cause the teeth to slip on the filament. Clean the teeth with a pointy tool.
2. The nyloc nut on the back of the large gear has come loose, and the hobbed insert is unwinding
3. The filament may be to thin, or it is trying to grip on a section where filament has been worn away. Remove filament and check diameter.

The extruder gears squeak, rub and/or get stuck as the big gear turns:

1. There may be printing artefacts on the large and small gear, or they have been printed too 'full', so that they mesh very tightly. You can use sandpaper to improve the fit, or contact support to send you new gears.
2. There is no other adjustment available

The Bowden tube comes out of the brass unions

1. If the ptfe tube pushes out of the brass union, it is probably not screwed in far enough into the union. It should have about 10mm of thread. Remember to drill, with a 2mm drill, into the brass union with the ptfe in place, or there may be a tight spot that the filament can't push past.

Filament doesn't stick or parts warp

Problem

- If the first layer does not adhere well enough to the heatbed, there is a chance the component(s) will warp during printing.

Solutions

Bed surface: Some people are lucky, and seem to be able to print directly onto the glass bed, and the PLA sticks. Most, it seems are not so lucky; for them we provide a roll of Kapton tape. Kapton can be applied to the glass surface in strips - try to keep the air bubbles out, and put the strips as close together as possible. Kapton is durable: we use it in the production of kits, and will last at least a couple of months of 24/7 printing. Usually it peels up before the PLA won't stick to it. Blue painter's tape can also be used. PLA doesn't stick as strongly to it, and the surface isn't as flat or durable as Kapton, but it is more widely available, and often in wider widths.

Cleanliness of build surface: The bed surface needs to be completely free of all oil and grease (including finger marks), otherwise your prints won't stick to it. Set the heatbed to a temperature of 45C and wait for it to settle there. Clean the surface with nail polish remover (containing acetone, glycerine, and as few other ingredients as possible, and definitely '''not''' lanolin or any other oil or grease) using a lint free cloth. Set your heatbed to your print temperature ready for printing. Other products that also work include pure Acetone, Isopropyl Alcohol, White Methylated Spirits, White Vinegar. All of these are acidic, and dissolve oil and grease before evaporating. Don't use Windex/Windowlene or polish; they often have a non-stick component!

Setting Z zero: At the Z 'home' position, where Z=0, the nozzle should be just touching the bed. Follow the instructions laid out in the Commissioning and Axis Compensation instructions

Bed temperature: For PLA, try a setting of 50-60C. If you go too hot, the PLA will stay liquid and can be pulled away from the bed by the cooling of subsequent layers. Too cold, and it won't stick. For ABS, the bed temperature needs to be much higher, at around 100C. See the ABS printing guide later.

Hot end parts hit print and bed fold-back clips

Problem

- Fan/nozzle duct is closer to the bed than nozzle
- Proximity sensor is closer to the bed than nozzle
- Parts that are being printed are knocked off the bed

Solution

This can have a number of causes, in construction, and set up/adjustment. The bottom of the cooling nozzles and the proximity sensor should be about 1mm ABOVE the tip of the nozzle. To achieve this, a number of things need to be set correctly.

1. When constructing the hot end, the brass Bowden tube union that screws into the aluminium cooling block needs to screw ALL THE WAY IN. If it is not, the nozzle will be lifted slightly, in relation to the sensor and the fan duct.
2. The hot end need to sit on the x-carriage so it is vertical. If it leans forward, the fan duct will be lower. Change this angle by adjusting the bearing on the back of the x-carriage. If there is not enough adjustment, you can elongate the adjustment slot that the bearing sits in, or replace the bearing with a larger one (the standard is a 9mm bearing, replace with a 10mm 623 bearing if available), or put a 'runner' on the back of the x-axis plate for the bearing to run on - some people have used a hacksaw blade.
3. If the hot end changes angle as it moves along the X axis, the x-axis-plate may be twisted, so the whole x axis arm has a twist along it's length. Look along the arm, and rotate it until it is straight. Tighten the 8 screws in the x-motor-mount, and the screw in the x-idler to hold it in position.
4. If the proximity sensor is too low, check that the mdf spacer is inserted between the nozzle-mount and aluminium cooling block. You can add an extra couple of washers if

you need more clearance.
5. It's also possible that the y carriage bed is a long way out of level with the x-axis. You may need to adjust the corner screws of the heated bed to get it more level with the x-axis.

Axis sticking problems

Problem

- Axis doesn't move smoothly
- Motor stalls when moving (sometimes okay at low speed, doesn't move far enough at high speed)

Solution

1. Make sure rods are clean and linear bearings run smoothly. A little light oil (like 3-in-1 oil) will help lubricate the bearing seals. Smooth rods can be cleaned with wire wool or kitchen scourer to remove stubborn lumps
2. Check stepper motor voltage is not set too low in config.g. As standard this is set to 800 milliamps by this line:

   ```
   M906 X800 Y800 Z800 E800 ; Motor currents (mA)
   ```

3. Check that belt alignment is correct, and the belt is not rubbing unduly on belt guides or anything else.
4. Check there is no mechanical obstruction to the movement of the belt, or bearings on the smooth rods.

Wobbly Z walls and non-circular circles

Problem

- Vertical walls are not accurately printed on top of each other
- Variability in layer height causes vertical walls not to be smooth
- Circular objects print out square

Solution

Generally we lump these problems together under the term 'backlash'. This can happen on any of the axes, or a combination of them.

1. Check belts are tight enough. On the longest free length, ie the side not attached to the carriage, pluck the belt. It should make a just audible, low pitch, twang. Tighten or loosen as needed.
2. Check pulleys are not loose on stepper motor shafts (X and Y axis) - hold the motor shaft with pliers, then try moving the carriage, while looking at the pulley
3. Check that the axes are moving freely: see 'Axis sticking problems' above
4. Check extrusion is consistent: see 'Poor or no extrusion' above

Stepped layers

Problem

Partway through a print, the next layer appears to have slipped by a millimetre or two (or much more) causing a step which should not be there. This can be caused by:

- Axis belt slipping where it is attached to the carriage.
- Print head snags on part of the print, usually the print curling up or lifting off the bed. This can cause the belt to skip on the pulley, or the motor to stall.
- Axis snags on something. For example, the wiring catching/getting in the way of movement. This can cause the belt to skip on the pulley, or the motor to stall.
- Stepper driver overheats and temporarily shuts down.

Solution

Belt slipping in carriage

1. This usually happens on the y-carriage. To test, hold the motor pulley tight and try and move the carriage. If it slips, secure it in place more positively. The quickest fix is to put a cable tie around the two ends of the belt, on the left side of the y-rib, push it up against the y-rib, and tighten it.

Nozzle hitting printed part

1. The printer should generally have the power to overcome hitting a part while printing, and the hot end can flip up a little. However, if printed parts are curling up, particularly on overhangs or bridging, reducing the extrusion temperature 5°C at a time will usually help.
2. If the parts are curling up from the first layer, see 'Filament doesn't stick or parts warp' section above

Belt skipping on pulley

1. Check belts are tight enough. The actual tension required comes with experience, but

should be at least tight enough to produce a low frequency, just audible 'twang' on the longest section of belt. Over-tensioning the belts can also be detrimental, as the motors will have to work harder.
2. Check that the belt is running smoothly and in line, and the edge of the belt is not snagging on the motor and idler ends. With the motors off, check the axis moves smoothly - if not, see the 'Axis sticking problems' section above.
3. Check all wires, pulleys and belts whilst printing and reposition/realign anything impeding the smooth movement on all axes.

Stepper motor stalling

This is a result of the motor not having enough torque to move the axis (temporarily, since the print continues at the new position).

1. Check that the motors are being supplied with sufficient current to meet the demand; check the setting in config.g
2. Use secondary cooling fan to cool the electronics if they are getting too hot.

Printing ABS

Problem

- Concerns about printing ABS
- Heated bed takes a long time to get up to 100C, or never reaches it
- ABS doesn't stick

Advice

Important: all the supplied printer parts are made from PLA. Long term exposure to the heat of ABS printing will cause some of them to fail. If you plan to print a lot of ABS, you should first remake some of the parts from ABS, specifically (and in this order) the x-carriage, z-runner-mount, extruder-body and the rest of the extruder parts, nozzle-duct, fan-duct.

When printing ABS without upgraded parts, at the start of the print leave the x-axis high above the bed (at least 100mm) so that it is not getting hot while the bed heats up.

Heated bed

Check the voltage of the power supply, particularly under load. Ormerod PSUs should supply around 12V, but may be supplying a voltage below this. Some customers have replaced the supplied PSU with ones that can supply 13V, which allows the heated bed to heat up quicker and get to a higher temperature. However, don't go beyond 13.5V, or the heated bed will draw too much current.

The heated bed can max out at around 100C, due to the thermal mass of the aluminium and glass. This is a designed limit, and is generally okay for the ABS we have tested. You can increase this to around 110C by covering the bed with an insulator while it heats up. In the past, we've used a foil-fronted piece of MDF, which reflected heat back onto the bed, but was held off the surface by the clips, so didn't heat up. Remove it to start printing; the first layer will then be a bit hotter, so should stick better if it's being difficult, and the temperature will drop during printing to hold at around 100C. Another improvement suggested by a customer is to put aluminium/kitchen foil between the heatbed PCB and MDF insulator. This also decreased warm up time. Be VERY careful not to short the main power connections through the silver foil! ABS shouldn't need heating to more than 110C anyway, as this is beyond it's glass transition temperature; it's like printing PLA onto a bed at 80 degrees - the PLA stays so soft it gets pulled off the bed. ABS generally does this above 110C.

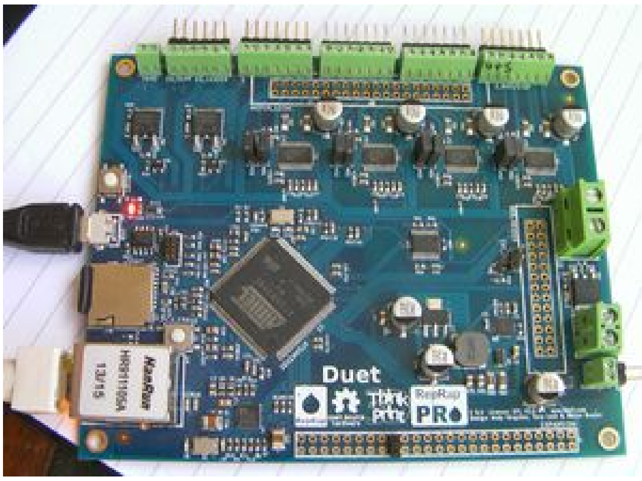
Other considerations

Also, keep draughts to a minimum, and try to keep the area around the printer at a reasonable temperature - above 25C minimum. This should help to prevent the part warping as it prints. You can build a small 'greenhouse' to cover the printer, but be careful it doesn't get so hot (over 45C) that the PLA parts of the printer melt!

It should be noted there are plenty of other problems getting ABS to stick at any temperature, and there are quite a few workarounds; the favourite around here are super strength hold hairspray (it can contain both PVA and acrylic) or making a slurry of some ABS dissolved in Acetone, applied to the bed at 50C, and wait for it to dry before printing. Joseph Prusa shows how he does it HERE (follow the pictures in the 'Older' direction). And then some people have no problem with ABS at all! It's a bit of a dark art, but probably depends on the quality of your ABS filament.

Maintenance

RepRapPro Firmware



RepRap Firmware was written to allow RepRap machines (and other 3D printers) to be driven by more powerful controllers, such as the Arduino Due-compatible RepRap Duet (illustrated above). It permits the RepRap machine to be controlled either using a traditional USB connection with software such as Pronterface, or over a network. To control the RepRap machine over a network all that is needed is a web browser. These instructions describe how to use the RepRap Firmware on the Duet.

RepRap Firmware is available on Github here. Select the master branch, then use the Download Zip button (with the little cloud and arrow) on that page to download it. The master branch is the stable branch for the duet. The duet branch is also for the duet, but is the development branch for that board. You can use the duet branch if you wish - it will be more up-to-date and have more features; but it may also contain unfixed bugs.

Installation - Flashing the Firmware

Your Duet will have been supplied with a copy of the RepRap Firmware installed. But upgrades and enhancements will be made available regularly, and you will want to upload or *flash* these to your Duet.

Check your firmware version

Connect to your Duet board via the Arduino IDE Serial Monitor, or Pronterface, and send the

'M115' gcode. The response should be something like:

FIRMWARE_NAME:RepRapFirmware FIRMWARE_VERSION:0.39 ELECTRONICS:Duet DATE:2013-12-14

If the response is:

Error: invalid M Code: M115

You have an old version of the firmware, and should definitely update!

Compare the firmware version information from the M115 command above, with the file name of the file in this link, which is on our github page. But DO NOT DOWNLOAD THIS FILE DIRECTLY! This file is the latest binary image of the RepRap Firmware for the Duet. The name of the firmware reflects the version number, eg **RepRapFirmware-XXX-DD-MM-YYYY.bin**, where XXX is the version, and DD-MM-YYYY is the date of the firmware.

If your firmware version is the same as the github version, there is no need to update. If not, read on...

Download the latest firmware

In the RepRap Firmware folder that you downloaded in the Commissioning instructions, there is a folder called **Release**.

If the version on our github page is newer, download the WHOLE firmware folder from Github; click **Download ZIP**, on the right hand side of THIS PAGE. Extract it to a sensible place on your computer.

Required Software

You will need a copy of the Arduino IDE for the Arduino Due microcontroller. You should have already downloaded this, earlier in the commissioning instructions. It is available for download here: http://arduino.cc/en/Main/Software. Download and install from the link appropriate to your computer and operating system.

Once installed, in the Arduino application folders there is an application called **bossac**. This is the program that flashes firmware to the Duet (or Arduino Due).

On a Windows system, the Ardiuno IDE is installed in **C:\Program Files (x86)\Arduino-1.5.5** (or something similar). The **bossac.exe** program will be in **C:\Program Files (x86)\Arduino-1.5.5\hardware\tools**

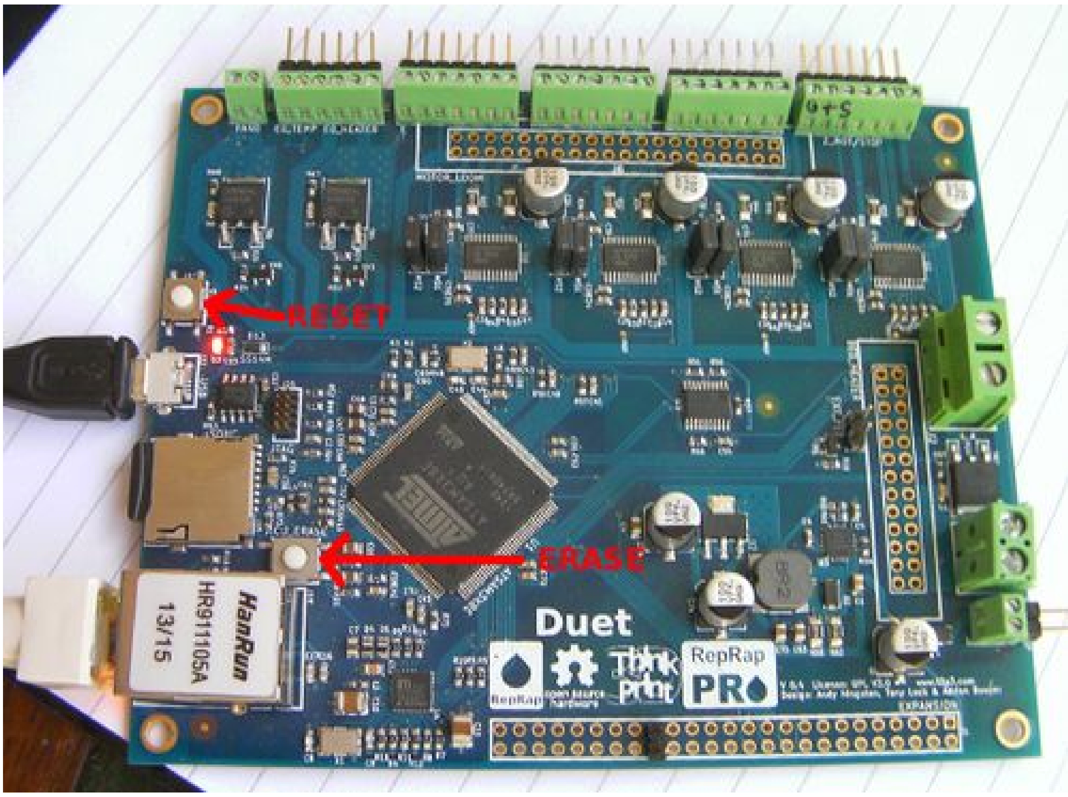
On a Linux system, you might install the Arduino IDE in **/usr/local/arduino-1.5.5/**. The **bossac** program will then be in **/usr/local/arduino-1.5.5/hardware/tools/**

On a Mac, bossac is part of the Arduino application package; install the Arduino application in your Applications folder.

Updating the firmware

Leave the main power to your RepRap off, and connect the Duet to your computer with a USB cable. Make sure that the Arduino IDE Serial Monitor or Pronterface are NOT connected to the Duet board.

Press the ERASE button on the Duet. Then press the RESET button.



Wait at least 10 seconds for the Duet board to start up.

Windows

Find out which USB port on your computer the Duet has been allocated. On Windows it will be something like **COM4:** - you can check this by looking in the Device Manager (how to). The Duet may be listed as an 'Arduino Due', or 'bossac programming device', in the list of USB devices.

It will be easier if you copy 'bossac.exe' (from the Arduino\hardware\tools\ folder) and the **RepRapFirmware-XXX-DD-MM-YYYY.bin** file to a simple C:\Temp\ folder.

Open a Command prompt (How to), then type (without quotes) 'cd C:\Temp\' and press return to change directory (or change directory to wherever you put bossac and the firmware). Assuming the port for the Duet is COM4 (change this to what is reported by the Device Manager), the command entered into the Command Prompt window will look like:

```
  bossac --port=COM4 -U true -e -w -v -b RepRapFirmware-XXX-DD-MM-YYYY.bin -R
```

Send the command. You should see bossac report the upload/flash progress then tell you that it has verified the process.

If it doesn't work, press 'erase' and 'reset' again, and wait a little longer. The system does take a while to stabilise after the ERASE button has been pressed. If you get a 'no device found' error, check the COM port number in the Device Manager again, in case it has been reassigned.

Mac

Find out which port on your computer the USB has been allocated. Get the port address from system profiler, or send 'ls /dev/cu.*' in a Terminal window for a list of ports; it will be something like **cu.usbmodemfa131**.

Open a Terminal window (how to), cd (change directory) to the folder where you have put **RepRapFirmware-XXX-DD-MM-YYYY.bin**. Assuming the Arduino application is in the Applications folder, the command will be similar to:

```
/Applications/Arduino.app/Contents/Resources/Java/hardware/tools/bossac --port=cu.usbmodemfa131 -U true -e -w -v -b RepRapFirmware-XXX-DD-MM-YYYY.bin -R
```

Send the command. You should see bossac report the upload/flash progress then tell you that it has verified the process.

If it doesn't work, press 'erase' and 'reset' again, and wait a little longer. The system does take a while to stabilise after the ERASE button has been pressed.

Linux

Find out which port on your computer the USB has been allocated. This will be something like **/dev/ttyACM0**. Open a terminal windows (xterm, gnome-terminal etc.) and cd (change directory) to the folder where you put **RepRapFirmware-XXX-DD-MM-YYYY.bin**. Assuming arduino is installed in /usr/local/ :

```
/usr/local/arduino-1.5.5/hardware/tools/bossac --port=ttyACM0 -U true
-e -w -v -b RepRapFirmware-XXX-DD-MM-YYYY.bin -R
```

Send the command. You should see bossac report the upload/flash progress then tell you that it has verified the process.

If it doesn't work, press 'erase' and 'reset' again, and wait a little longer. The system does take a while to stabilise after the ERASE button has been pressed. Check the port number again, in case it has been reassigned.

Update the SD Card files

IMPORTANT: Finally, you need to keep the files on the SD card ON THE SAME VERSION as the firmware you just updated to. Copy the contents of the **SD-Image** folder from firmware folder (the .zip file you downloaded) to the root of your SD Card, as you did in the Commissioning instructions. If you have created a custom config.g or setbed.g file on your SD Card, copy them off the card first, then replace them after you have updated the contents of the SD Card.

SD Files

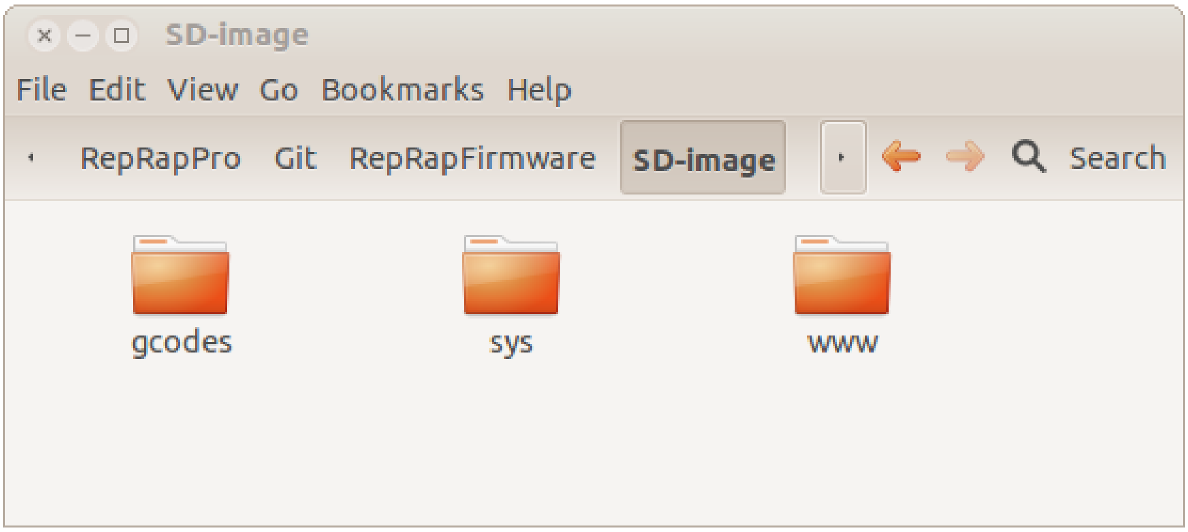
The Duet needs to store RepRap Firmware configuration files on an micro SD card. It needs those files to be present all the time that the firmware is running, so **don't unplug the SD card while power is applied**, either from the RepRap's main power supply, or just from the USB.

Your Duet should have been supplied with a micro SD card. You will need to copy the configuration files to this. You will also need to set your network addresses in the configuration files, if you plan to access the printer via the ethernet port.

Take the SD card, put it in a computer adapter, and plug it into your computer.

Download the RepRap Firmware files from the Git repository here. Use the Download Zip button (with the little cloud and arrow) on that page to download all the files.

There is a folder in the Github repository you downloaded called **SD-Image**. It has three sub-folders:



You can put any GCode files you want to print in the **gcodes** folder. For the moment file names are restricted to [8.3 format](). This restriction will be removed in a future upgrade.

Remove any old versions of these folders from the SD card, then copy the **gcodes**, **sys**, and **www** folders onto it.

In the **sys** folder on the SD card there is a file called **config.g**. This special G Code file is run whenever the RepRap Firmware is restarted. It is described in detail below. For the moment you just need to set appropriate values in it for your network. Open a text editor (such as gedit or Notepad) and read in the file **config.g**. Near the top are three lines like this:

```
M552 P192.168.1.14; Set the IP address  M553 P255.255.255.0; Set netma
sk  M554 P192.168.1.1; Set the gateway
```

Change the numbers after the capital letter "P" to the values for your network. If you don't know these, your network administrator will be able to tell you. Save the edited file.

Unmount or eject the SD card and its adapter from your computer. If it asks you if you want to erase any deleted files, say yes.

Put the SD card in your Duet's SD card slot. It has a bistable click action - push it in and it will click in. To get it out, push it again and it will spring out. A short length of RepRap 1.75mm diameter filament makes a good tool to push with.

The configuration file

As has already been mentioned, RepRap Firmware can run a configuration file when it starts to set it and your RepRap up in the way you want. This is the file **config.g** in the **sys** folder on the SD card. This is an ordinary file of G Codes, but it is saved in a separate folder so that it can't be deleted by accident.

The contents of **config.g** will look something like this:

```
; RepRapPro Ormerod  ; Standard configuration G Codes  M111 S1; Debug
on  M550 POrmerod; Set the machine's name  M551 Preprap; Set the passw
ord  M552 P192.168.1.14; Set the IP address  M553 P255.255.255.0; Set
netmask  M554 P192.168.1.1; Set the gateway  M555 P2; Emulate Marlin U
SB output  M92 E420; Set extruder steps/mm  G21 ; Work in mm  G90 ; Ab
solute positioning  M83 ; Extrusions relative  G31 Z0.5 P500 ; Set Z p
robe height and threshold  M906 X800 Y800 Z800 E800 ; Motor currents (
mA)  T0 ; Select extruder 0
```

Anything including and after a ";" is a comment and will be ignored. As you can see you can give your machine any name you like, and any password. If you have several machines you can be talking to them with multiple tabs in a web browser, so giving them unique names obviosly helps to keep track. There is a complete list of all the RepRap G, M and T codes on the RepRap website here. RepRap Firmware does not (nor does it need to) implement them all, but if you send it one that is not implemented it will output a short error message on its USB connection, which you can see in the Pronterface monitor window.

You can edit **config.g** with an ordinary text editor (gedit, Notepad etc.), then upload it using Pronterface as described above.

Generally speaking, it is a bad idea to put anything in **config.g** that will cause the RepRap machine to move, or its heaters to heat up. This is because it will do this every time it is switched on or rebooted.. Moving and heating G Codes are much better put at the head of individual G Code files for printing things, as described here.

Other sys files

RepRapFirmware allows subprograms or *macros* to be programmed and placed in the **sys** folder. There are standard ones in there for doing things like homing the axes, but you can write your own too. Simply place a GCode file in the **sys** folder called, say, **mymacro.g**. You can then run it from Pronterface or the web interface or from within a GCode file by giving the command:

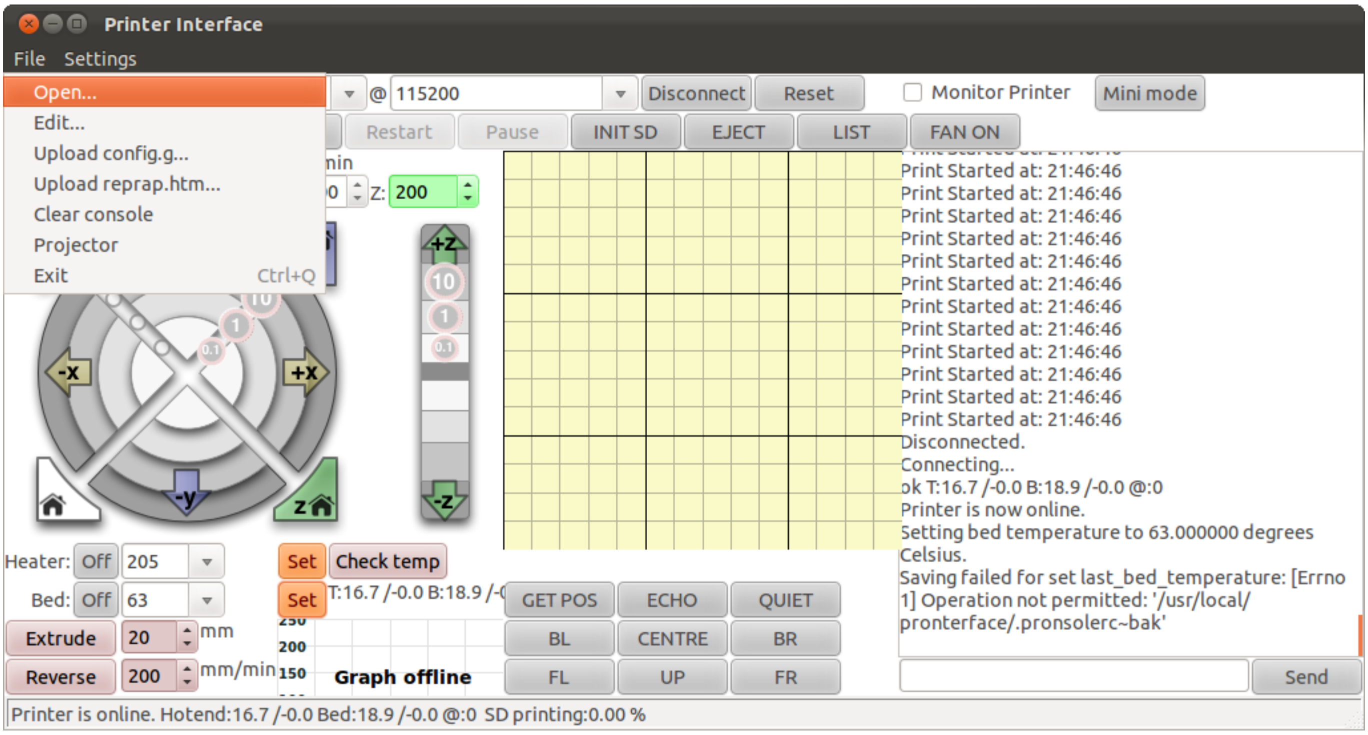
```
M98 Pmymacro.g
```

Macros can run macros from within them up to a depth of about 5 before you run out of stack. Recursion will give you an infinite loop, of course, and so is probably best avoided...

Here is the macro that homes the X axis as an example, with comments:

```
G91 ; set movements relative  G1 Z5 F200 ; move upwards 5mm at 200 mm/
min to make sure we don't hit anything  G90 ; set movements absolute
G1 X-240 F2000 S1 ; Move X a long way negative while checking the ends
top  G92 X0 ; The endstop will have been hit.  Set the X coordinate to
 0  G1 X3 F200 ; Move a little away from the endstop more slowly  G1 X
-30 S1 ; Approach the endstop more slowly to get a more accurate 0  G9
2 X0 ; Set the X coordiante to 0  G91 ; set movements relative  G1 Z-5
 F200 ; Go down 5mm to reset the upward movement at the beginning
```

Using Pronterface to Control your RepRap Firmware



One of the strengths of RepRap Firmware is that it has the ability to emulate other existing RepRap Firmware in the way that it outputs information to its USB interface. This makes it possible to use it with a variety of software intended for that other firmware. We often use [Pronterface](#) to talk to a Duet running RepRap Firmware.

Download our version of Pronterface and its associated software [from github here](#). See the README.md file on that page for installation notes.

To use Pronterface you first need to set the Firmware output to emulate [RepRap Marlin firmware](#) - the firmware that Pronterface expects to talk to. This can be achieved by including the line

```
M555 P2
```

in the file **config.g** in the **sys** folder on the Duet's SD card. See the section on **config.g** below. This line may already be in the file; lots of distributions include it.

Connect the Duet to your computer with its USB cable, and also - if you can - connect the Duet's ethernet cable. When the RepRap Firmware reboots it tries several times to establish a network connection. If it can't find one, this can delay the boot process (sometimes by up to a minute). So if you plug in an ethernet cable (even if you don't intend to use it) this will speed things up.

Run Pronterface.

Select the USB port that your computer has allocated the Duet in Pronterface's Port box, select a communication speed of 115200, and click the **Connect** button.

You should now be able to control your RepRap/Duet from Pronterface in the usual way. This includes uploading files to the SD card for printing. If you do this, these files will also be available when you use the web interface described below.

Finally, there are two special additions to our distribution of Pronterface just for RepRap Firmware. You can see them in the File dropdown menu in the picture above. **Upload config.g...** allows you to upload a new version of the config.g file (see below) to your Duet without unplugging then plugging in the SD card. **Upload reprap.htm...** allows you to upload a new version of the web page that the RepRap firmware serves to the web interface described below. So - if you want to personalize the appearance of the web interface, go ahead. If you make a mess, you can always recover the original from the Github repository download.

Changes to these files will not come into operation until you next reboot your Duet.

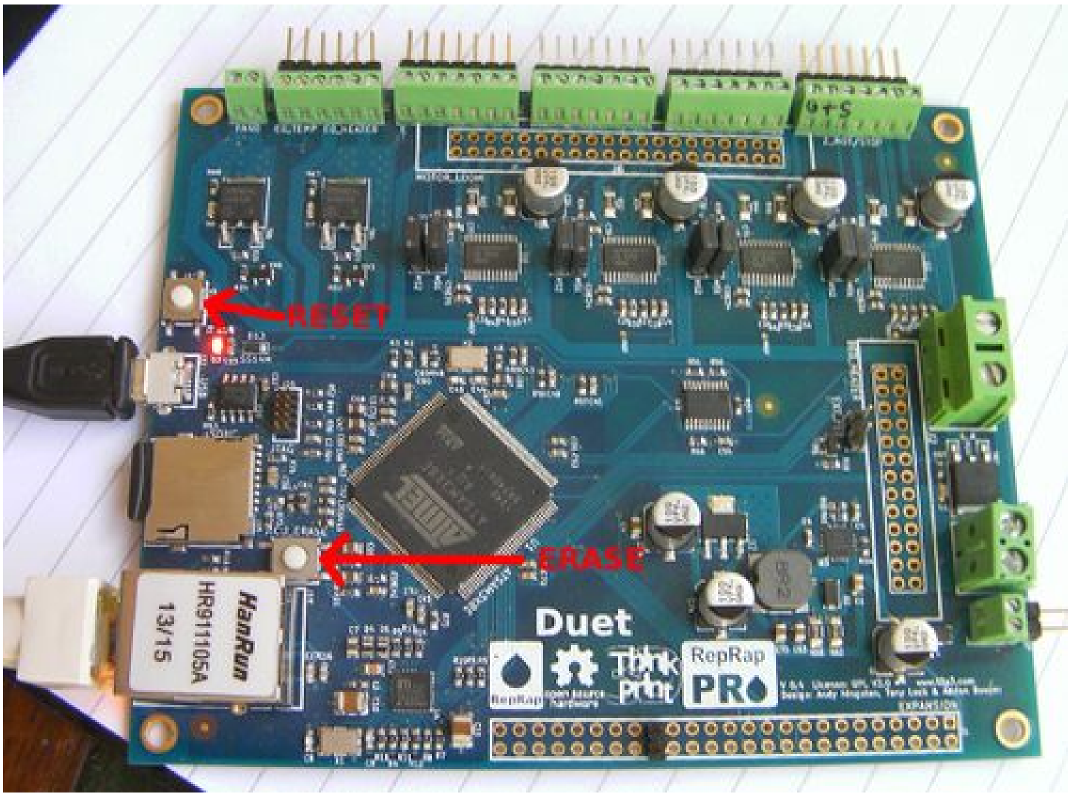
Using a Web Browser to Control your RepRap Firmware

At the moment the RepRap Firmware is configured to use the Google Chrome browser, which is available to download from that link. Other browsers will be supported soon.

Make sure that your network addresses in your Duet are set correctly - see the SD Files Section below.

Plug an RJ45 network cable into the socket on your Duet and plug the other end into your network hub or router.

Turn on the power to your RepRap. The green LED on the Duet's network socket should come on, go out briefly, and then come on again, and may flicker. The orange LED may come on, or not, depending on the router it is attached to. Don't worry about it if it doesn't come on.



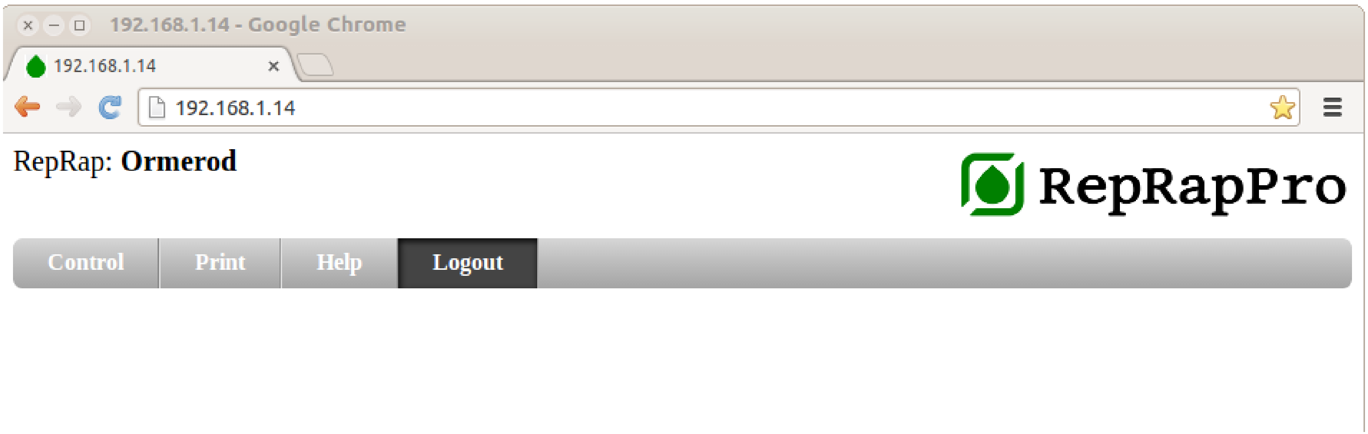
To double check, press the Duet's RESET button. The LEDs should go through the sequence above. Don't press the ERASE button by mistake. If you do, you will then have to re-flash the firmware (see below).

Give it a few moments to settle down.

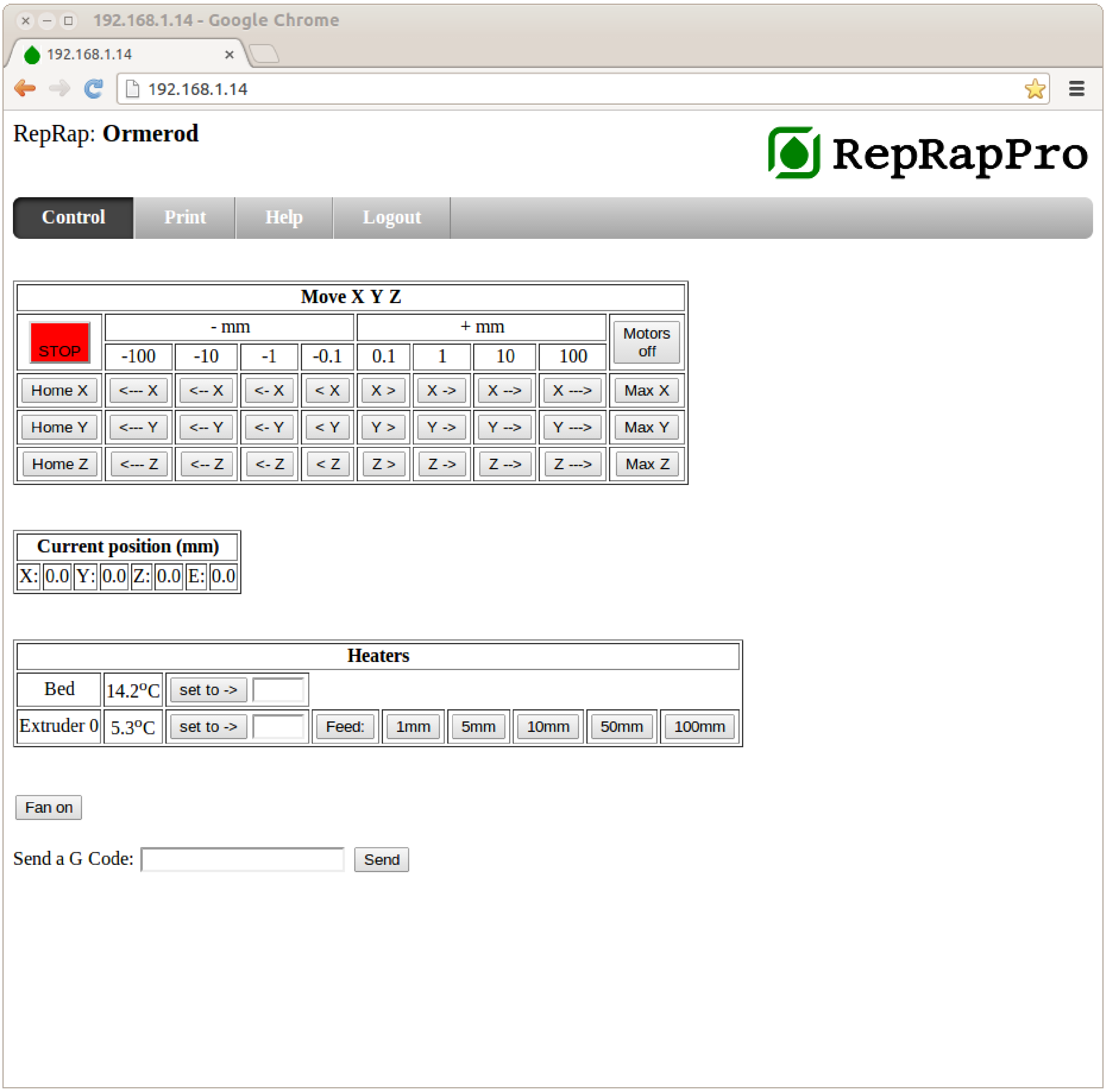
Open the browser on your computer, and type the IP address (see SD Files below) of the Duet into its address bar. The following page will be displayed:

If the machine's name is not displayed top left, then close the browser, press the RESET button, and try again.

The default password is "reprap" in lower case and without the quotes. Type that and click **Submit**. The page displayed will change to:



Click the **Control** link. You will now get:



The controls should be reasonably self-explanatory.

The **STOP** button is an emergency stop. It immediately stops all motors and turns off all heaters. After stopping the RepRap the only way to restart it is to press the Duet's reset button. It will continue to talk to the USB and ethernet interfaces after stopping, but you won't be able to move the machine automatically or turn on any heaters.

The **Move** box allows you to move the axes of the machine is small or large increments, and to home them to their zero positions.

The **Motors Off** button turns the motor currents off so you can move the RepRap by hand (especially useful for loading and unloading the extruder). There is no **Motors On** button - using a motor turns it on automatically.

The **Current Position** box displays where the RepRap is. These boxes are updated about once every two seconds. And the RepRap Firmware only updayes these values internally at the end of every move - they don't track the progress of each individual move.

The **Heaters** box displays the RepRap's temperatures (updated at the same time as the positions) and allows you to set them.

PLA printing temperatures: Extruder 200^{o}C, Heatbed 60^{o}C

ABS printing temperatures: Extruder 240^{o}C, Heatbed 110^{o}C (Don't touch!)

To turn a heater off set its temperature to 0.

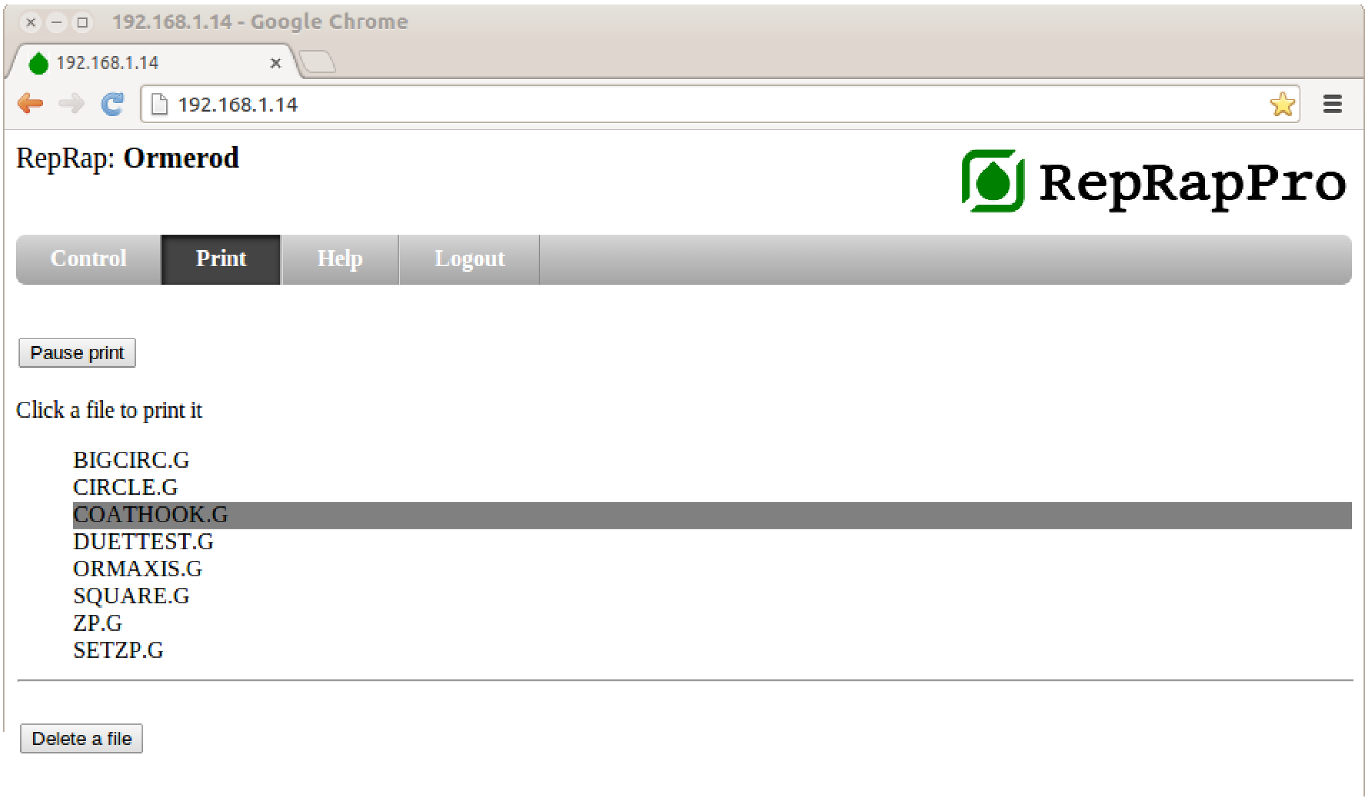
The **1mm**, **5mm** etc buttons after the **Feed** label extrude that input length of filament. **If the extruder isn't hot, don't move the filament -** it will be frozen in the nozzle and unable to move.

If you click on the Feed label it will cycle through **Feed**, **Fast**, and **Reverse**. **Fast** and **Reverse** are to allow you to load and unload filament quickly. Take care not to drive filament right into the RepRap's nozzle at **Fast** speed. Rotate back to **Feed** when it has 30 or 40 mm to go.

In RepRaps with a controlled fan the **Fan on** button turns it on and off.

Finally, there is a panel that allows you to type any G, M or T code then send it to the RepRap. For a list of RepRap G Codes (not all of which are, or need to be, implemented in RepRap Firmware), see here.

Next click on the **Print** link in the menu bar. You will get this page:



Though the list of G Code files may be different.

To print a file on your RepRap, simply click on it. The print will start immediately. If you press **Pause print** the print will continue for a few moves (RepRap Firmware has an internal print buffer that has to be exhausted) then pause.

You cannot use the other controls to the machine while a print is running, as this would spoil the print. But if you pause the print, then move to the control page you will be able to use the controls after the second or so that it takes the temperatures and positions to update (whether the machine is paused or not is also sent with that update signal). Note that a side effect of this is that the web page does not know that a print is finished until you move back to the control page. This will be fixed in a future release.

To delete a file, select the **Delete a file** button then click on the file you wish to delete. The display will not update immediately; to force it to do so, go to the **Control** page then come back again.