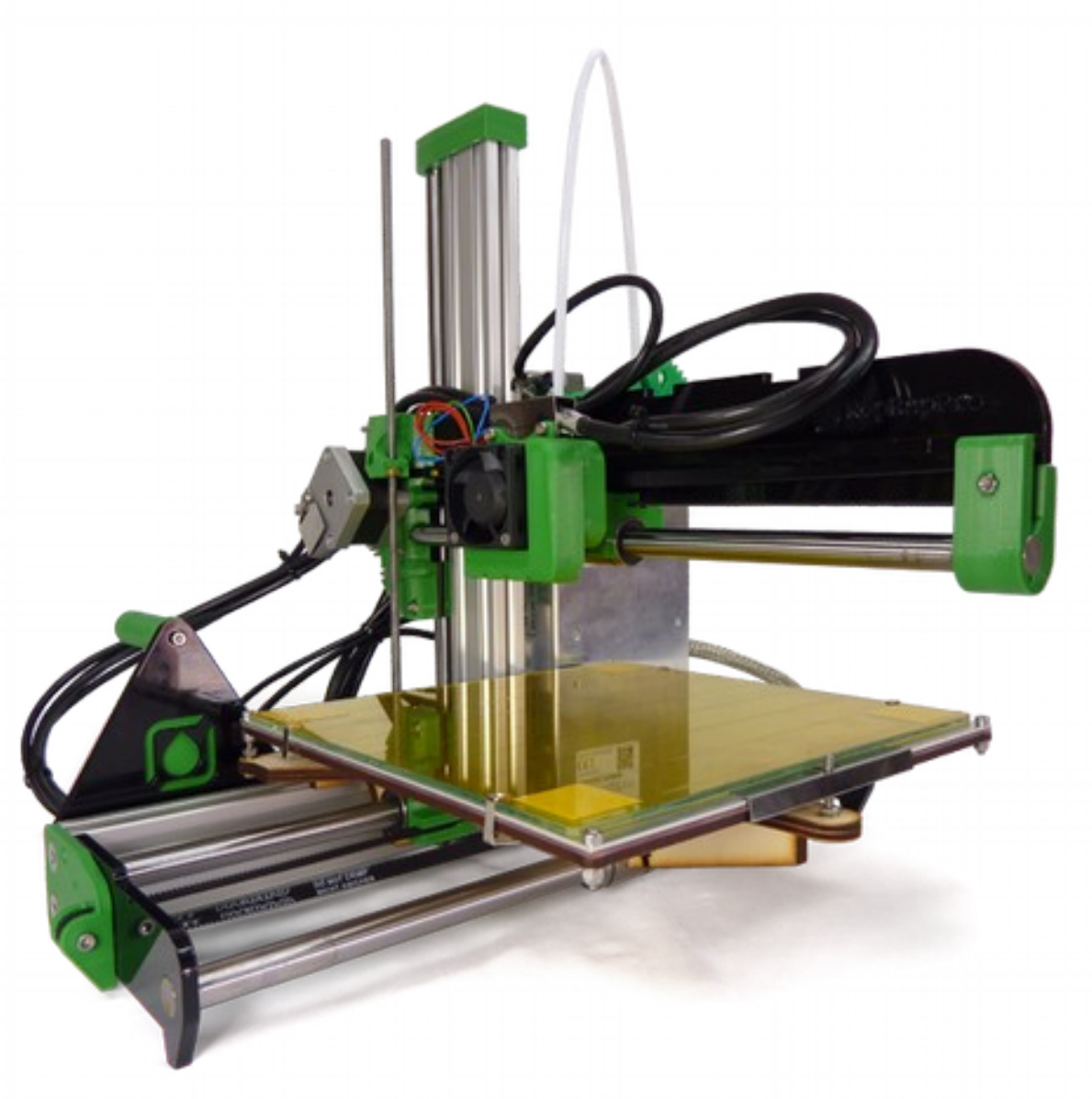
Ormerod 2 Build Manual



Forward

Credits & License

Original Machine Design:	Jean-Marc Giacalone Adrian Bowyer
Original Documentation:	Ian Stratford
Documentation Conversion to ODT/PDF:	Wesley Brooks
License:	GPL

Original Documentation Hosts:

Web Archive	https://web.archive.org/web/20160106171632/https://reprappro.com/documentation/ormerod-2/
cheeseandham (RepRap Forum)	http://reprappro.cheeseandham.me.uk/reprappro.com/documentation/index.html

This Documentation Iteration Host:

DocTrucker GitHub	https://github.com/DocTrucker/Ormerod/tree/master/Documentation

Table of Contents

Ormerod 2

Overview

The RepRap Pro Ormerod 2 is the latest RepRap self-replicating 3D printer from RepRap Pro. The machine is a faster to assemble, networked 3D printer with non-contact bed probe for full geometric compensation.

These pages are the complete instructions for building, commissioning and using the RepRapPro Ltd version of RepRap Ormerod 2. Like all RepRap machines, RepRapPro Ormerod 2 is fully open-source. It is licensed under the GPL. All the design files and software are available from the RepRapPro Ltd Github repository.

The RepRapPro Ormerod 2 is fitted with the open-source Duet electronics.

If you want to print the plastic parts for a RepRapPro Ormerod 2, see this web page.

General Notes

BEFORE YOU ATTEMPT TO ASSEMBLE ANY PART OF THE RepRapPro ORMEROD 2 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 complicated machine; many different skills are required to build, to commission and to operate a 3D printer. Try not to rush your build, or you may miss out something vital!

- 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 RepRapPro's own machines. 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 2. 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 or damaged, please contact us through our contact page.
- 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 2 has been designed to maximise its 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 and the world so that we can include them in future kits, and so that existing owners can upgrade their own machines.

- The RepRapPro Ormerod 2 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.

Ormerod 2 Versions

Some sections of the instructions are arranged in tabs, with alternate parts and instructions, depending on the version of your kit. Below is the changelog, which shows the differences between kit versions. The tabs refer to the version number of the Ormerod kit. Your Ormerod kit version number is marked on the sticker on the power supply (on 528.2 and later kits), or on the x-rib (for earlier kits). Use the LATEST version number – some kits have the 528.2 PSU, but the 528.1 x-rib. Use the set of instructions that relate to your printer.

528.0	Sept 2014: Original shipping version of Ormerod 2.
528.1	Oct 2014: Changes to packing. Acrylic fan spacer replaces printed fan-duct and nozzle-duct.
528.2	Dec 2014: Change to supplied power supply, and added lasercut acrylic parts to mount Duet on new PSU.
528.3	Feb 2015: Changes to packing.
528.4	New heated bed design, new bed wiring loom.
528.5	Ships with new Quick-set nozzle. Separate hot end and fan looms. Cooling fan and duct supplied. Small updates to some printed parts (x-carriage, z-upper-mount, y-motor-mount). Changes to packing.

Printing Parts for Ormerod 2

If you have bought the hardware-only version of the Ormerod 2 kit, you will want to print the parts. You may also want to print spare parts for your printer. The list below shows the part number, part name, quantity and location of the parts. Parts are available as STL and SolidWorks files, and there should also be a STEP assembly of the whole printer.

For Ormerod 2, part number 528.0 to 528.4, the easiest place to get the parts is here: https://github.com/reprappro/Ormerod/releases

For 528.5 onwards, we use the part number, rather than the name of the part, for the file name. For the latest version of the parts, which should be backwards compatible with all the previous versions, see the Ormerod github repository. Some parts common to all our machines are in the Library github repository.

You can download the whole github repository, or download the parts individually; the ‘Location’ in the link below links to the stl page. This will also help you identify the parts. If you download the parts individually, make sure you download the ‘RAW’ version of the file; if you right-click on a link and download, you will end up with a file with the right name (with .stl on the end), but it will actually be an html document!

#	Description	Qty	Location
547	y-idler-bracket	1	Ormerod/STLs
548	y-motor-bracket	1	Ormerod/STLs
469	z-motor-brace	1	Ormerod/STLs
437	z-lower-mount	1	Ormerod/STLs
438	z-upper-mount	1	Ormerod/STLs
527	z-corner-bracket	1	Ormerod/STLs
503	z-foot	1	Ormerod/STLs
549	y-bearing-belt-clamp	1	Ormerod/STLs
550	y-bearing-clamp-tagged	1	Ormerod/STLs
462	x-idler-bracket	1	Ormerod/STLs
546	x-carriage	1	Ormerod/STLs
501	nozzle-mount (one-piece nozzle, 528.4 and before)	1	Ormerod/STLs
1079	nozzle-mount (Quick-set nozzle, 528.5 onwards)	1	Ormerod/STLs
473	x-motor-bracket	1	Ormerod/STLs
407	z-runner-mount	1	Ormerod/STLs
441	z-gear-driven	1	Ormerod/STLs
440	z-gear	1	Ormerod/STLs
492	z-bearing-clamp	2	Ormerod/STLs
425	z-nut-trap	1	Ormerod/STLs
554	Extruder drive block	1	Ormerod/STLs
446	Extruder small gear	1	Ormerod/STLs
447	Extruder large gear	1	Ormerod/STLs
152	Tongue	1	Library/STLs
820	PSU cover	1	Library/STLs
821	PSU brace	1	Ormerod/STLs
442	Spool spigot	1	Ormerod/STLs
525	Spool clip	1	Ormerod/STLs
1123	Cooling fan duct	1	Ormerod/STLs

Get Support

If you find you need help or advice with assembling, commissioning or using your RepRapPro Ormerod 2 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
- Contact us via email; see our contact page.

Archived Documents for Older Versions

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

- RepRapPro Ormerod 1 Instructions

Tool List

Tools required for the build of the RepRapPro Ormerod 2 3D printer:

Required

Allen keys: 1.5mm, 2mm, 2.5mm, 4mm (the long reach type, with a ‘ball’ hex on the end, are very useful)

- Medium, cross-head screwdriver
- 8mm (M5) socket and/or spanner
- 15cm adjustable spanner
- Fine tweezers
- Ruler, at least 300mm
- Fine-nosed pliers
- Scissors
- Drill: 2mm
- Hand chuck, pin vice or small electric drill
- Small, flat-bladed, electrical screwdriver
- Pencil sharpener
- Digital Multimeter
- Hot air gun, or cigarette lighter (or other heat source such as a gas cooker ring for heating PTFE heatshrink; a hair dryer is not sufficient)

For Adjusting Plastic Parts, if Necessary

- Drills: 3mm, 4mm
- File
- Half round needle file
- Sharp craft knife

Nice to Have, But Not Necessary

- 5.5mm (M3) socket and/or spanner
- Vernier or digital callipers

Y Axis Assembly

Y axis sub-assemblies

Y-idler-end

TIP: There's a list of the Ormerod printed parts on THIS PAGE. Click on the 'Location', to see a preview of the printed part, if you're not sure what it is.

#	Component	Qty	Type
	y-idler-bracket	1	Printed
	y-axis-end-plate 'A'	1	Lasercut
	M4x12mm countersunk socket head screw	1	Fastener
	M4 T-nut	1	Fastener
	M3x12mm countersunk socket head screw	2	Fastener
	M3 Nut	2	Fastener
	M3x12mm cap head screw	1	Fastener
	623 bearing (10mm diameter)	1	Fastener

TIP: Click on pictures in the instructions to see a larger version. Right-click and select 'Open link in new Tab' to see the full size image.

Fit the 623 idler bearing to the y-idler-end. It may require a fair bit of force to push the bearing into position. It is held in place by a M3x12mm cap head screw. This should self-tap into the printed part, with no need for a nut on the free end.

Using the M3x12mm countersunk socket head screws, assemble the y-axis-end-plate ‘A’ with the y-motor-bracket, with an M3 nut on the back of each screw.

The M4x12mm countersunk socket-head screw goes through the y-idler-mount as shown, with the T-nut on the other side. Leave the T-nut loose – it connects with the aluminium extrusion.

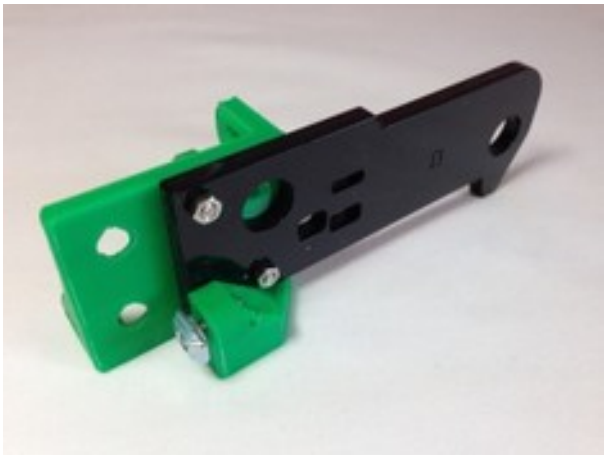
Y-motor-end

#	Component	Qty	Type
	y-motor-bracket	1	Printed
	y-axis-end-plate ‘B’	1	Lasercut
	M4x12mm countersunk socket head screw	1	Fastener
	M4 T-nut	1	Fastener
	M3x12mm countersunk socket head screw	2	Fastener
	M3 Nut	2	Fastener

Begin by assembling the Y-motor-end. Use y-axis-end-plate ‘B’ (there is a small ‘B’ engraved on one side of the plate) with the y-motor-bracket. As the y-axis-end-plate is laser-cut acrylic, the 12mm holes will be slightly larger in diameter on one side of the y-axis-end-plate (the side with the letter ‘B’) which will make it easier to insert the 12mm ground steel bar later.

Using the M3x12mm countersunk socket-head screws, connect the two parts together as shown, with an M3 nut on the back of each..

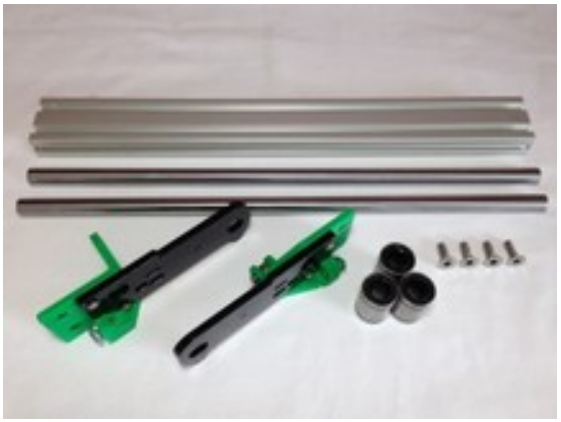
The M4x12mm countersunk socket-head screw goes through the y-motor-mount as shown, with the T-nut on the other side. Leave the T-nut loose – it connects with the aluminium extrusion.



Y axis frame

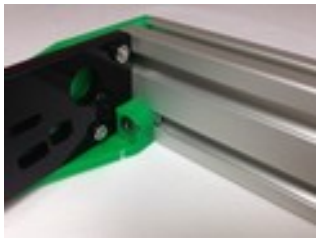
The next step is to assemble the Y axis frame. For this you will need the following:

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

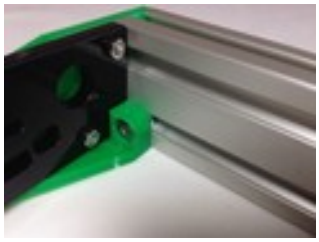


Screw the y-idler-end onto the aluminium extrusion, using two M6x16mm countersunk socket screws. These screws need to be tight – if they are loose, the Y-ends will move in relation to the aluminium extrusion, and the X axis will not be level to the bed.

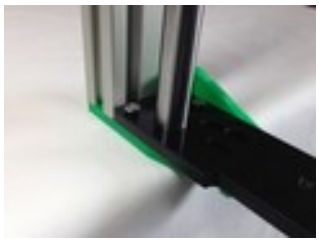
On the inside of the y-idler-end, check that the M4 T-nut is located in the extrusion slot.



As you tighten the screw, the T-nut should rotate 90 degrees in the extrusion, from horizontal to vertical. It may need a little help! If it can't rotate, it may have started too close to the printed part; loosen the screw off a couple of turns, then try tightening again. Once it has rotated so that it is vertical, fully tighten the screw.



With the y-idler-end supported by the edge of a table, take one of the 12x350mm smooth rods and push it into the hole in the acrylic end piece that is closest to the aluminium extrusion. 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. You can use a piece of wood, or soft-faced hammer, to tap gently on the end of the rod, if necessary.



NOTE: Some 12x350mm smooth rods may be a little longer, due to variability in manufacture. The y-idler-end printed part can accommodate this, with a pocket. The other places that the rods are used can similarly accommodate these rods (Z axis), or it doesn't matter (X axis, Y axis front rod) – the longer rod will simply poke out the end a millimetre or so.

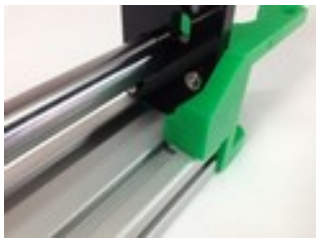
With the acrylic supported, push the second 12x350mm smooth rod into the hole in the end of the plate. Keep the rod perpendicular to the plate whilst pushing. Try to keep both rods upright, so they do not stress the holes in the Acrylic.

Slide the LM12UU Linear bearings onto the smooth rod. Put two onto the rod closest to the aluminium extrusion, and one on the front rod. Check they slide smoothly and freely.

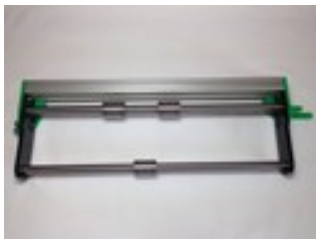
Push the y-motor-end onto the smooth rods at the other end. This may be easiest with the Y axis vertical. Make sure the acrylic part is supported when pushing the rods in. Try and keep the smooth rods as straight as possible, to avoid damaging the acrylic parts. Push them home, so that the motor mount is flush with the aluminium extrusion. Again, only tap them in with a piece of wood, or soft-face hammer, to avoid damaging the parts.

Screw the y-motor-end onto the aluminium extrusion, using two M6x16mm countersunk socket screws. These screws need to be tight – if they are loose, the X axis will not be level to the bed.

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



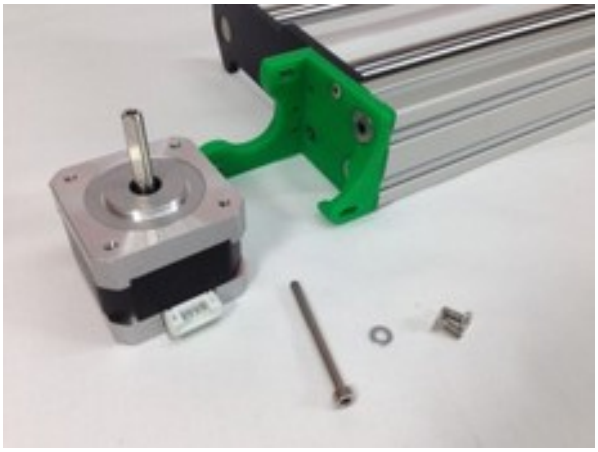
The completed assembly. Check all screws are tight.



Y Axis Motor

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

#	Component	Qty	Type
	y-axis-frame	1	Assembled
	NEMA17 stepper motor	1	Hardware
	M3x8mm countersunk socket screw	2	Fasteners
	M3x40mm cap head screw	1	Fasteners
	M3 washer	1	Fasteners



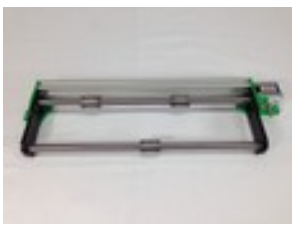
One screw needs to be removed from the back of the motor, as shown. Don’t lose this M3x26mm crosshead screw; we’ll be using it for the y-carriage.

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 cap head screw with an M3 washer, in the back of the motor, where you took out the motor screw.

The three screws of the motor are mounted in slots, so you can slide the motor a small distance. This allows you to adjust the belt tension, once the belt is fitted. Leave the screws hand tight with the motor at the right-hand end of the slots in the picture.

The completed y axis assembly.



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

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

Loosely fit the M4 T-nuts with the M4x12mm countersunk screws to the z-motor-brace. Then screw the stepper motor to the z-motor-brace using the M3x12mm countersunk screws, as shown.

Z-lower-mount

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

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

Loosely fit the M4 T-nuts as shown

Z-upper-mount

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

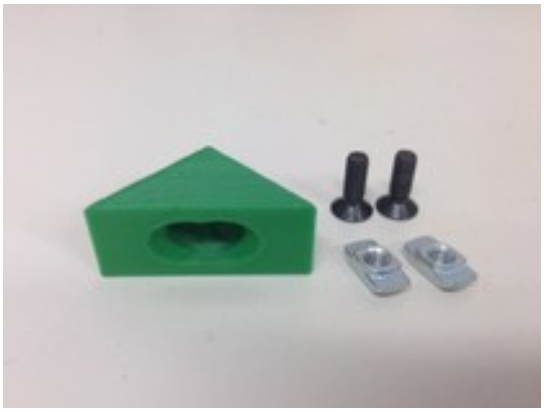
#	Component	Qty	Type
	z-upper-mount	1	Printed
	M3x35mm cap head screw	1	Fastener
	M3 nut	1	Fastener

Fit the M3 screw and nut as shown.

Z-corner-bracket (528.5 onwards)

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

#	Component	Qty	Type
	z-corner-bracket	1	Printed
	M4x10mm countersunk socket screw	2	Fastener
	M4 T-nut	2	Fastener

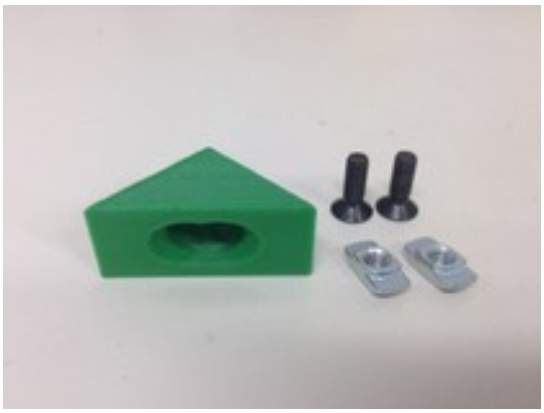


Now loosely fit two M4 T-nuts using M4x10mm countersunk socket screws into the z-corner-bracket.

Z-corner-bracket (528.0 to 528.4)

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

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



Now loosely fit two M4 T-nuts using M4x10mm countersunk socket screws into the z-corner-bracket.

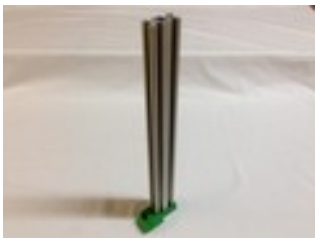
Z axis assembly

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

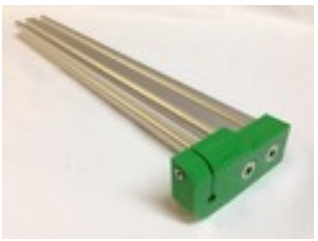
#	Component	Qty	Type
	z-motor-mount	1	Assembled
	z-lower-mount	1	Assembled
	z-upper-mount	1	Assembled
	z-corner-bracket	1	Assembled
	LM12UU linear bearing	2	Hardware
	Smooth rod 12x350mm	1	Hardware
	Aluminium extrusion	1	Hardware
	M6x16mm countersunk socket screw	2	Fastener

NOTE: THERE IS NO NEED TO SLIDE THE T-NUT IN FROM THE END OF THE ALUMINIUM EXTRUSION!
The M4 T-nuts are designed to drop into the extrusion slot. As the retaining screw is tightened, the T-nut rotates 90 degrees in the slot and locks into place.

Start by putting the z-upper-mount on the aluminium extrusion – it's a tight fit. Try to put it on as squarely as possible, to avoid damaging the printed part. If you need to, use a wooden block or soft-faced hammer if you're going to tap the aluminium extrusion, to avoid damage to the aluminium!



Check the aluminium extrusion is all the way in to the z-upper-mount. Secure the z-upper-mount with two M6x16mm countersunk screws.



Fit the 12x350mm smooth rod into the z-upper-mount. You may need to slacken off the clamp screw to get it in. Make sure it is pushed in as far as it will go; it should be level with the end of the aluminium extrusion. Tighten the clamp screw.

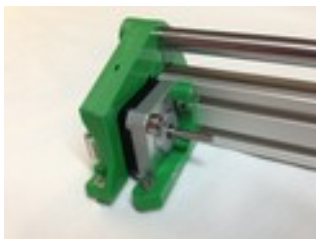
Slide the LM12UU Linear bearings onto the smooth rod. Check they slide smoothly and freely.

Slide the z-motor-mount sub-assembly onto the end of the extrusion. Keep all of the M4 T-nuts loose to allow for moving the motor around.

The z-lower-mount goes around the motor, and it’s easiest to put them on together.

Hook the z-lower-mount over the motor, and move them together up the aluminium extrusion. The smooth rod should engage in the hole of the z-lower-mount; make sure it is pushed on as far as possible.

Lightly tighten the two M4 T-nuts on the z-motor-mount that are engaged in the aluminium profile slot. The M4 T-nuts should not be done too tight at this stage; just enough to hold the Z motor to the extrusion.



The assembly from another angle. Try to orientate the T-nuts horizontally, so they can drop into the Y axis aluminium extrusion easily.

The complete Z axis assembly.

Connecting the z axis assembly to the y axis assembly

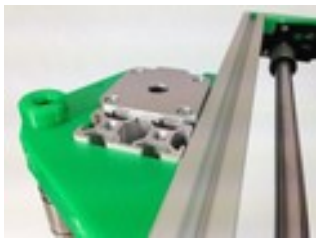
On the Y axis idler side, measure 210mm from the end of the Y axis aluminium extrusion without the Y axis motor, and mark with a pencil. This is to mark where the Z axis will be connected.

On the Y axis motor side, measure 120mm from the end of the Y axis aluminium extrusion, and mark with a pencil. The Z extrusion will sit between these two marks.

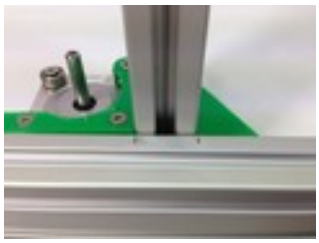
The Z axis assembly can now be attached to the Y axis assembly. Orientate the Z nuts so they drop into the extrusion; you don’t need to slide them on from the end.

Tighten the three M4 countersunk screws on the z-lower-mount first. As you tighten them, the T-nuts should rotate 90 degrees and catch in the extrusion slot. They may need a wiggle to get them to turn. Do the middle one shown in the picture first; it's the most difficult, as you can't see if it catches, but the axis will hold when it does. Assemble loosely to start with, so you can move the components to the correct places.

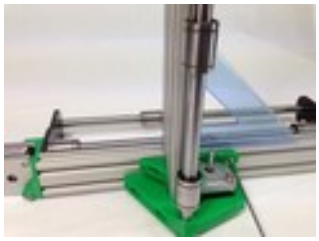
The base of the vertical aluminium extrusion must be flush with the bottom of the Y axis extrusion. The bottom of the motor will be a couple of millimetres below the level of the extrusions.



Try to get the extrusion between the two marks on the Y axis aluminium extrusion, so it's in the right place.

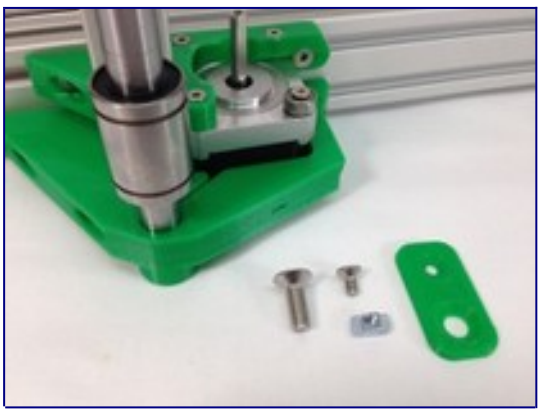


Use the supplied set square to check the Z axis and Y axis extrusions are at right angles to each other. Tighten the z-motor-mount to the two extrusions, then attach and tighten the z-corner-bracket, which gives additional support (shown on the left side of the Z extrusion). Repeat the above alignment steps to confirm they are all correct, before fully tightening all the fasteners.



Attaching the z-foot

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



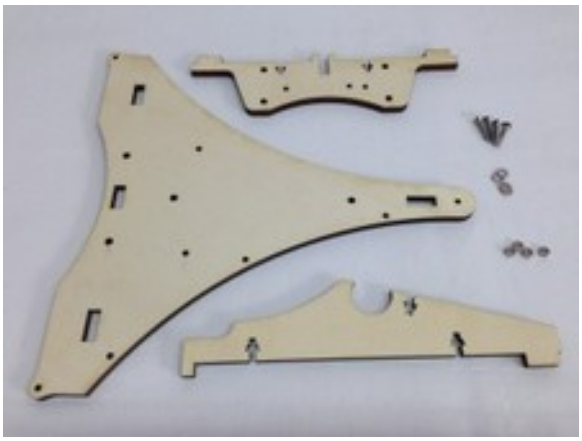
The base of the vertical aluminium extrusion should be flush with the bottom of the Y axis extrusion. These two can then be secured using the z-foot, one M6x16mm countersunk socket screw, and an M4 T-nut and M4x8mm countersunk socket screw.

Y Carriage

Y carriage assembly

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

#	Component	Qty	Type
	bed-support (6mm ply)	1	Laser cut
	y-axis-rib (6mm ply)	1	Laser cut
	y-axis-cross-rib (6mm ply)	1	Laser cut
	M3x16mm countersunk socket screw	4	Fastener
	M3 nut	4	Fastener
	M3 washer	4	Fastener



The y-axis-rib and y-axis-cross rib slot into the bed-support. Make sure the holes in the edge of the bed-support are on the left; these are used to attach the bed wiring later.

Secure the bed-support to the Y axis ribs using the four M3x16mm countersunk socket screws. An M3 washer and M3 nut go in the captive holes of the Y axis ribs. The easiest way to do this is to hold the bed vertically, and put your finger under the hole. Drop the washer in, then the nut.

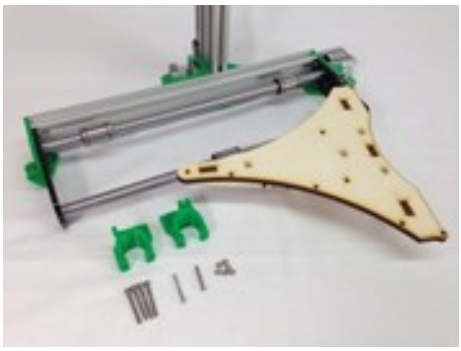
Then thread the M3x16mm countersunk socket screw through from the top of the bed-support, so it engages with the nut. Repeat for the other three nut traps between the ribs and bed-support. Tighten all of them.

Make sure the bed-insulator is orientated correctly, as shown in the picture. The holes for the wiring are on the right-hand side when the y-carriage is the correct way up as in this picture.

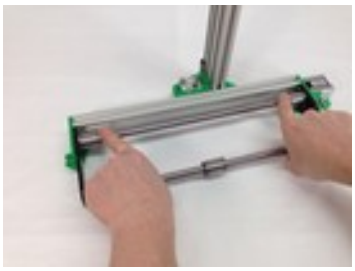
Y carriage mounting

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

#	Component	Qty	Type
	y-z-axis assembly	1	Assembled
	y-carriage assembly	1	Assembled
	y-bearing-belt-clamp	1	Printed
	y-bearing-clamp-tagged	1	Printed
	M3x30mm cap head screw	4	Fastener
	M3x25mm countersunk socket screw	1	Fastener
	M3x26mm crosshead screw (removed from NEMA17 motor)	1	Fastener
	M3 nut	6	Fastener

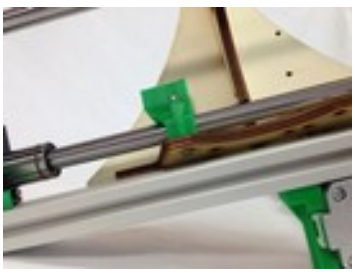


Push the two bearings on the back Y rod to the extreme ends of the carriage. This gives you the space you need to mount the y-carriage.

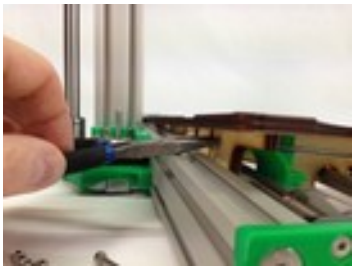


Take an M3x30mm cap head screw, and thread it through the lower hole of the y-bearing-clamp. Note the orientation of the y-bearing-clamp in the picture. Using a pair of pliers (or fingers if they are small enough!) with an M3 nut, mount the clamp on the y-carriage, around the back smooth rod, as shown.

This can be quite fiddly! But it’s much easier without the bearings in the y-bearing-clamps. Lightly tighten the screw, as it will be easier to push the bearing in.



Lift the y-carriage up to allow you to hold an M3 nut in position, with pliers, to fix another M3x30mm cap head screw through the top hole in the y-bearing-mount.

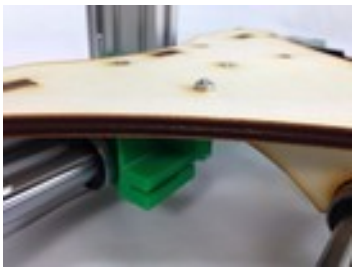


Repeat the process for the y-bearing-mount on the other side, noting the orientation. Slide the back bearings into the y-bearing-clamps.

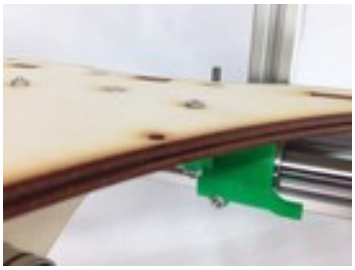
Note the position of the mount on the bearing. This is important to allow maximum movement of the Y axis in its frame. Slide the front bearing sideways into the notch in the Y carriage.

Using the M3x26mm crosshead screw your removed from the y-axis NEMA17 motor, push this up through the y-bearing-clamp-. If you put it in from the top, it will get in the way of the belt.

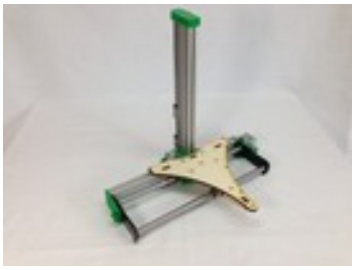
Secure with an M3 nut on top of the bed-support.



On the other side, thread a M3x25mm countersunk screw down through the bed-support, through the y-bearing-clamp, and secure with an M3 nut.

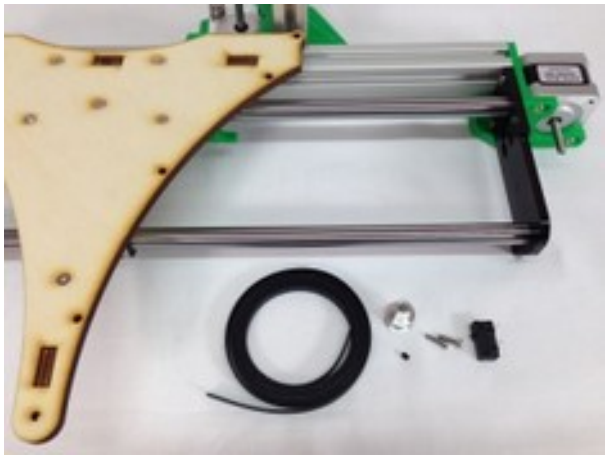


Tighten all six clamp screws. While doing this, slide the y-carriage up and down the smooth rods; this help centre the bearings, and lets the carriage slide smoothly. The picture shows the finished assembly.



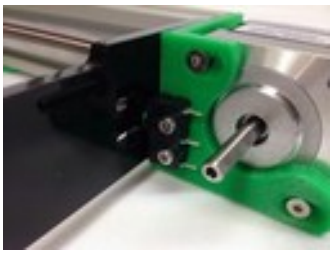
Y axis drive belt

#	Component	Qty	Type
	1/4″ MXL Belt	1	Hardware
	MXL pulley	1	Hardware
	M3 grub screw	1	Hardware
	Microswitch	1	Electronics
	M2.5x10mm cap head screw	2	Electronics



The 1/4″ MXL belt is supplied as one piece. Measure it with a tape measure, and cut the MXL belt to at least 710mm for the X axis, making sure you have at least 830mm left for the Y axis. There should be more belt than you need, but DO NOT just cut it in half – it may leave with you with too little 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 tab on the y-bearing-clamp hits the switch at the end of its travel.

Screw the grub screw partially into the pulley. The motor shaft has a flat on it; align the grub screw with this.

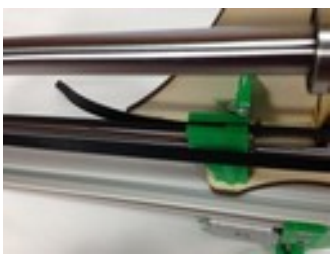
Put the pulley on the motor shaft, and tighten the grub screw using a 1.5mm Allen key.

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. The teeth of the belt should mesh with the teeth of the pulley.

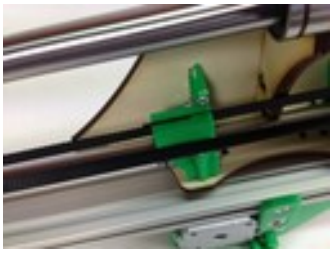
Thread the belt along the length of the Y axis. Twist the belt 180 degrees before feeding it through the through the lower slot in the idler end y-axis-end-plate, around the bearing, and back through the top slot. The twist in the belt means it will run on the bearing on the back of the belt.

The twist in the belt also means the teeth of the belt can interlock. This is used to join the belt, and fix it to the y-carriage. Pull the belt tight, interlock the teeth, then push the two belt ends into the y-bearing-clamp, as shown.

One end of the belt should finish in the clamp, while any extra belt is free to come out the end of the clamp. Adjust the belt until it is as tight as possible. It will probably still be a little loose; don’t worry, you will be able to adjust the tension.



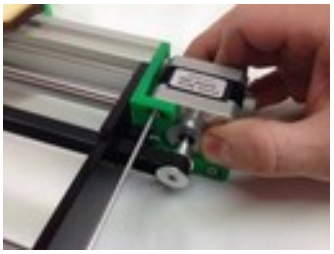
Cut off the excess belt. Leave about 10mm projecting; you may need to remove and re-fit it one day.



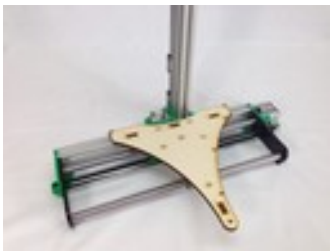
Y belt tensioning

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. But the belt should not be too tight, or the motor will struggle to move the axis! To adjust the belt tension, the y-axis motor is mounted in slots. Loosen the three screws, and pull the motor away from the mount to increase the belt tension. Re-tighten the screws, keeping the motor square to the axis. It is sometimes easier to get someone to help you with this, as more than two hands are useful.

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 another audio example for reference, if you need it. Adjust the belt as required.



The completed assembly.



X Axis Assembly

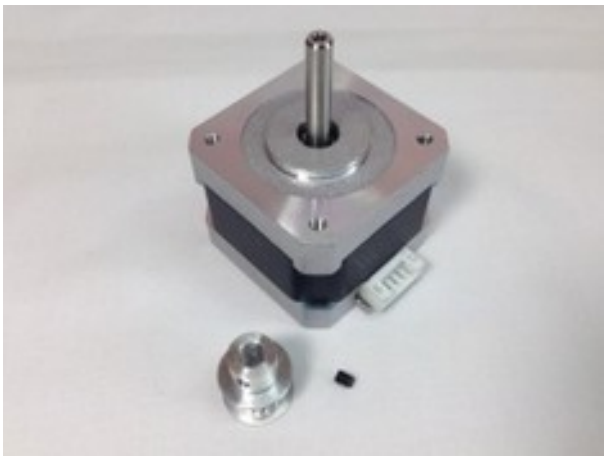
X axis sub-assemblies

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

X-axis-motor

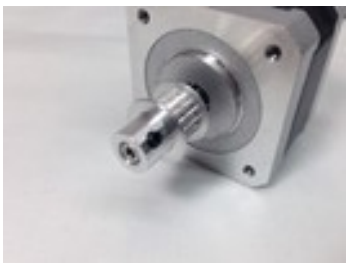
The x-axis-motor moves the x-axis belt.

#	Component	Qty	Type
	NEMA17 motor	1	Hardware
	MXL pulley	1	Hardware
	M3 grub screw	1	Hardware



Screw the grub screw partially into the pulley. The motor shaft has a flat on it; align the grub screw with this. For the X axis, the pulley goes on the shaft with the pulley teeth closest to the motor body.

Put the pulley on the motor shaft, 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.



X-idler

The x-idler is at the other end of the x-axis from the x-motor, and carries the bearing for the x-axis belt.

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

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 leave the assembly loose at this stage. A ‘nut trap’ is a hole in a printed part that is designed to hold a nut ‘captive’.

X-carriage (528.5 Onwards)

The x-carriage is connected to the x-axis belt, and travels along the X axis, carrying the hot end.

#	Component	Qty	Type
546.1	x-carriage	1	Printed
1079	Quick-set nozzle-mount	1	Printed
423	MR93ZZ bearing (9mm diameter)	1	Hardware
257	M3x12mm cap head screw	1	Fastener
212	M3 washer	1	Fastener
258	M3 Nut	3	Fastener
466	M3x12mm countersunk socket screw	2	Fastener

Fit the bearing using the M3x12mm cap head screw. IMPORTANT: use a 3mm drill to clean the slot that the screw goes through; this allows you to adjust the angle of the hot end. When it is loosened off the screw needs to be able to slide in the slot.

The M3 washer should be positioned between the bearing and the x-carriage.

The M3 nut is quite fiddly to fit. It should be possible to tighten it without using a tool on it, as the flat of the nut rests against the shoulder in the printed part.

Put an M3 nut in each of the nut traps.

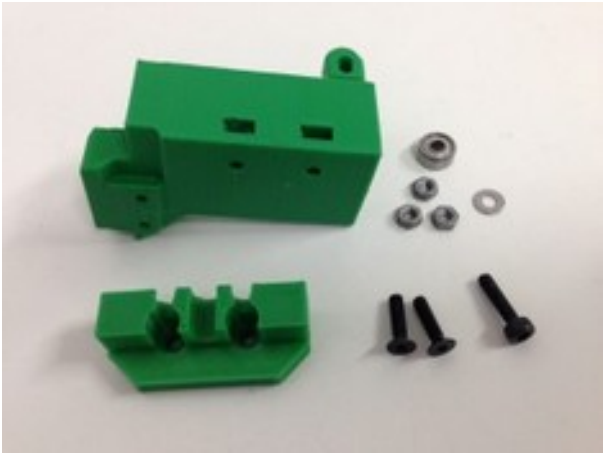
Attach the nozzle mount as shown with two M3x12mm countersunk socket screws.

With this version of the x-carriage, the bearing runs on the underside of the x-axis plate, rather than on the back of it. This reduces the amount of flex of the x-axis-plate.

X-carriage (528.0 to 528.4)

The x-carriage is connected to the x-axis belt, and travels along the X axis, carrying the hot end.

#	Component	Qty	Type
546	x-carriage	1	Printed
501	nozzle-mount	1	Printed
423	MR93ZZ bearing (9mm diameter)	1	Hardware
257	M3x12mm cap head screw	1	Fastener
212	M3 washer	1	Fastener
258	M3 Nut	3	Fastener
466	M3x12mm countersunk socket screw	2	Fastener



Fit the bearing using the M3x12mm cap head screw. The M3 washer should be positioned between the bearing and the x-carriage. IMPORTANT: use a 3mm drill to clean the slot that the screw goes through; this allows you to adjust the angle of the hot end. When it is loosened off the screw needs to be able to slide in the slot.

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

X axis assembly

Now you can start to assemble the X axis.

#	Component	Qty	Type
	x-carriage	1	Assembled
	x-idler	1	Assembled
	x-axis motor	1	Assembled
	x-motor-bracket	1	Printed
	x-axis-plate	1	Laser cut
	x-rib	1	Laser cut
	Smooth rod 12x350mm	1	Hardware
	LM12LUU linear bearing	1	Hardware
	M3x25mm cap head screw	4	Fasteners
	M3 Nut	2	Fasteners
	M3 washer	2	Fasteners

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. The x-axis-plate should be perfectly flat; if it is bowed or twisted, the x-carriage will not run straight and true.

Make sure the screw through the x-idler sub-assembly is loose. Push the x-idler onto the end of the x-axis-plat and x-rib as shown, making sure it goes on straight.

Slide the smooth rod into the x-motor-bracket.

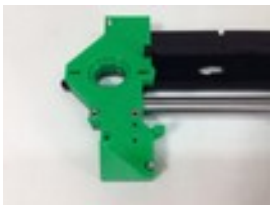
Then slide the linear bearing onto the bar, then the x-carriage. You need to fit the x-carriage now, as it won't fit on once the smooth rod is connected to the x-idler (next step). Don't push the x-carriage onto the bearing yet, as it needs to be off the bearing to attach the x-axis-drive-belt.

Push the smooth rod into the x-idler. Be careful not to bend or twist the acrylic parts.

Push the x-motor-bracket until it buts up to the x-rib. Ensure you have the parts lined up before applying too much pressure as the acrylic parts are not very forgiving. You may find this easier if you do it vertically, with the x motor bracket supported by the edge of a bench just under the smooth rod, but don't let the assembly drop to the floor…

The x-carriage runner bearing should be behind the x-axis plate for the old version of the x-carriage (528.4 and earlier). If you're using the newer version of the x-carriage (528.5 onwards), the bearing runs on the underside of the x-axis-plate. See last picture in the preceding section.

Insert two of the M3x25 screws in the top and bottom holes in the x-motor-bracket, to act as guide screws, and to hold the x-motor-bracket in place. Check that the x-motor-bracket fits in place; it may need trimming for a good fit around the x-rib. Make sure all the M3 holes in the printed part line up with the laser cut part – trim as necessary. Put an M3 nut in each nut trap, as shown.

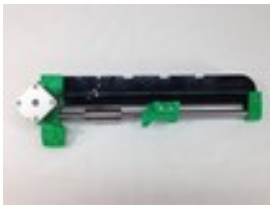


The smooth rod should butt up to the end of the x-motor-bracket, as shown. Insert two M3x25mm cap head screws to engage with the M3 nuts in the nut traps. Tighten the screws.

Remove the two M3x25mm screws that you put in as guide screws. Insert them, with washers on, to mount the motor. Orientate the motor as shown, with the wiring connector pointing out and down from the axis. Do not fully tighten the screws; the motor is mounted in slots to allow for tensioning the x-axis-drive-belt. Slide the motor to the end of the slots nearest the x idler bracket.

Tighten the countersunk screw in the x-idler-bracket.

The completed assembly.



Z-runner-mount

The z-runner-mount sub-assembly stops the x-axis rotating around the z-axis.

#	Component	Qty	Type
	z-runner-mount	1	Printed
	623 bearing (10mm diameter)	2	Hardware
	M3x20mm cap head screw	1	Fastener
	M3x12mm cap head screw	2	Fastener
	M3x20mm countersunk socket screw	1	Fastener
	M3x16mm countersunk socket screw	1	Fastener
	M3 Nut	5	Fastener
	M3 washer	9	Fastener

Put an M3 nut in each nut trap. Make sure they are at the bottom of the nut traps. If they don’t drop straight in, pull them into the nut traps with an M3 screw. Using one M3x20mm cap head screw and one M3x12mm cap head screw, attach the bearings. Put one bearing on each screw, then 4 x M3 washers between each bearing and the z-runner-mount.

Assemble as shown in the picture.

Put the M3x20mm countersunk screw through the recessed hole in the z-runner-mount.

Put your finger under the captive hole in the x-rib, and drop an M3 washer and M3 nut into it. Mount the z-runner-mount assembly to the x-axis-plate, putting the M3x20mm countersunk screw through the x-axis-plate and into the x-rib, where it is secured by the captive M3 nut and washer.

Use the M3x12mm cap head screw, which goes through the x-axis-plate and into the top hole of the z-runner-mount, and is secured with an M3 nut. Check both bearings are free to rotate; add or remove a washer if the bearing in the x-axis-plate is touching the acrylic.

Use an M3x16mm 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, or the axis will be difficult to move.

X axis drive belt

To finish the X axis, attach the drive belt.

#	Component	Qty	Type
	x-axis assembly	1	Assembled
	MXL belt	710mm	Hardware

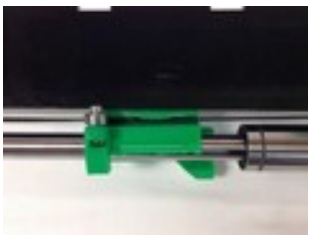
The X axis drive belt can now be fitted. The 1/4″ MXL belt should be accurately cut to 710mm in length. Insert the belt through the slot in the x-motor-bracket, around the drive pulley and back out through the second slot.

This is quite fiddly; moving the motor back and forth will help feed the belt through, as will rotating the motor pulley. You can also push the belt around the back of the pulley, with a small Allen key or screwdriver.

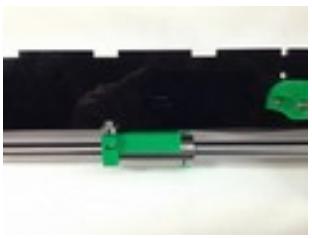
Twist the top section of belt 180 degrees, and pass it over and around the idler bearing. The smooth side of the belt will be in contact with the bearing.

Slide the end of the lower section of belt, from the motor end, into the x-carriage. The end of the belt should be flush with the end of the x-carriage if your belt has been cut to 710mm. Mesh the teeth of the two ends of the belt, and push it into the slot in the x-carriage.

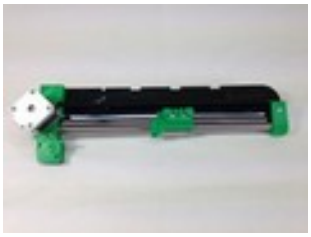
Make sure the belt is pushed fully back in the slot, and that there is as much engagement of the teeth as shown.



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



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



The completed assembly. Check the x-carriage runs smoothly by moving the x-carriage up and down the smooth rod. If it sticks, the bearing may need lubricating. It’s actually the rubber seals on the bearing ends that need lubrication; use a drop of light oil (like 3-in-1 oil or similar) on each side of the bearing and run it up and down. A remaining film of oil on the rod is good. But make sure there are no drips. Also check the belt doesn’t rub at either end; this is usually signified by a little black ‘dust’, which is where the edge of the belt is rubbing. Check the alignment of the motor pulley. If you do the x-idler up very tight, you may need to put an M3 washer on one side of the bearing, to give the belt a little more space.

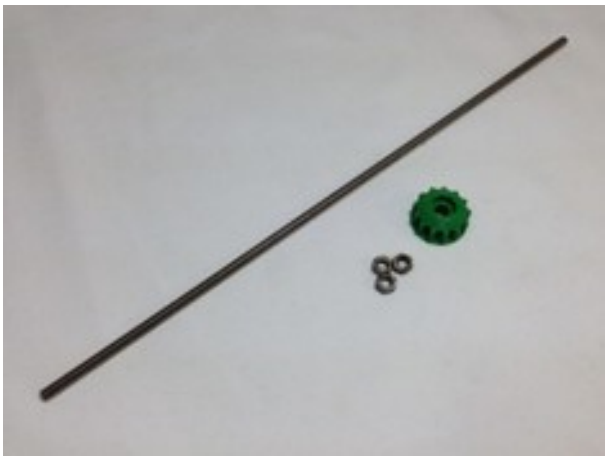
X Axis Mounting

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

Z axis leadscrew

The Z axis leadscrew moves the X axis up and down.

#	Component	Qty	Type
	z-gear-driven	1	Printed
	M5 threaded z-rod	1	Hardware
	BZP M5 nut	3	Fastener



Make sure the M5 threaded z-rod is clean, with no swarf or other debris in its threads. Screw two M5 nuts onto one end of the M5 threaded z-rod. Tighten one nut against the other, so that they are locked in place, right at the end of the rod.

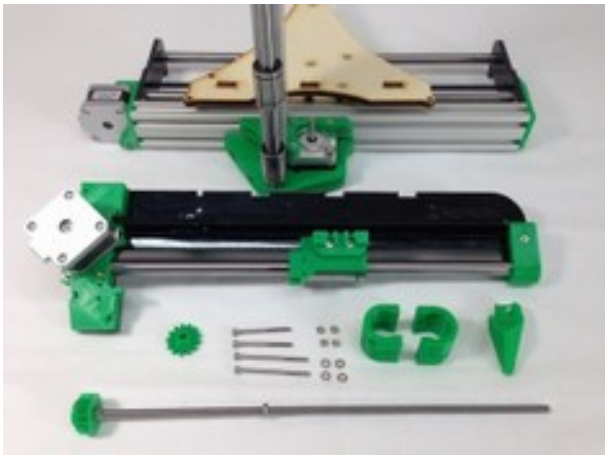
Push the z-gear-driven onto the locked M5 nuts. The bottom nut of the two should fit into the nut trap in the gear.

Screw the last M5 nut onto the z-rod. It should look like this, when assembled. You can lightly oil the threaded rod; see the Maintenance section later in the instructions for guidance.

X axis assembly

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

#	Component	Qty	Type
	x-axis-assembly	1	Assembled
	y carriage and z axis	1	Assembled
	z-axis-leadscrew	1	Assembled
	z-bearing-clamp	2	Printed
	z-nut-trap	1	Printed
	z-gear	1	Printed
	M3x50mm cap head screw	2	Fastener
	M3x40mm cap head screw	2	Fastener
	M3 Nut	4	Fastener
	M3 washer	4	Fastener



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.

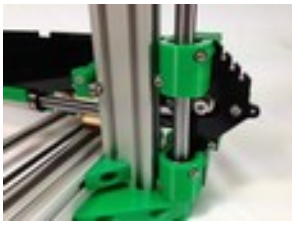
Use two M3 nuts to secure the bottom z-bearing-mount. Don’t do them up too tight yet.

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

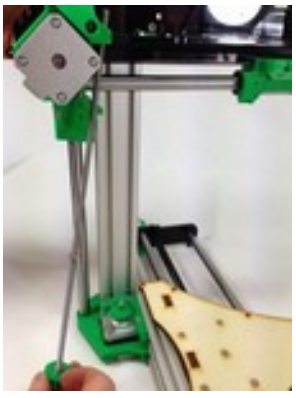
You may need to push the M3 nut into the nut trap with a screwdriver, but the screw will help to align it correctly. Remove the screw once it is held in place.

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.

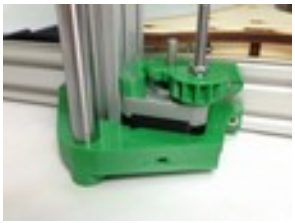
Now tighten the bearing mount screws. The holes in the bearing clamps are clearance for the M3 screws, so keep moving the axis up and down between turns of each screw. This will let the bearings settle in the right place, and ensure that the axis runs smoothly.



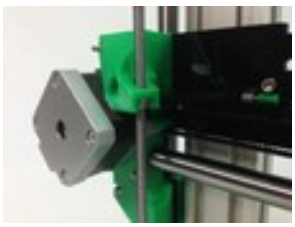
Lift the X axis to the top of the Z axis, and carefully feed the z-axis-leadscrew assembly up through the z-nut-trap.



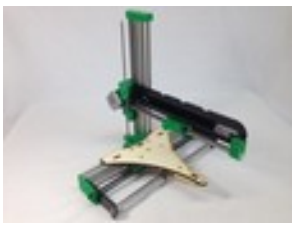
The z-axis-leadscrew sits on the 623 bearing on the corner of the Z axis motor, engaging with the z-gear on the motor.



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.



The completed assembly. Put a little light oil on the Z-axis M5 screw using a cloth. An thin even spread without drips is best.



Checking for play in the x axis

Adjusting the z-runner-mount.

Rotation of the x-axis around the z-axis is prevented by the z-runner-mount. It is important that the z-axis aluminium extrusion is held securely by the bearings in the z-runner-mount. The outer bearing on the z-runner-mount is mounted on a hinged clamp, which allows the tension to be adjusted. However, don’t over-tighten this, or movement of the Z axis may be compromised.

Heated Bed Assembly

Bed thermistor assembly

The bed thermistor measures the temperature of the heated bed.

#	Component	Qty	Type
	10k (bed) Thermistor	1	Electronics
	Black heatshrink	As required	Electronics

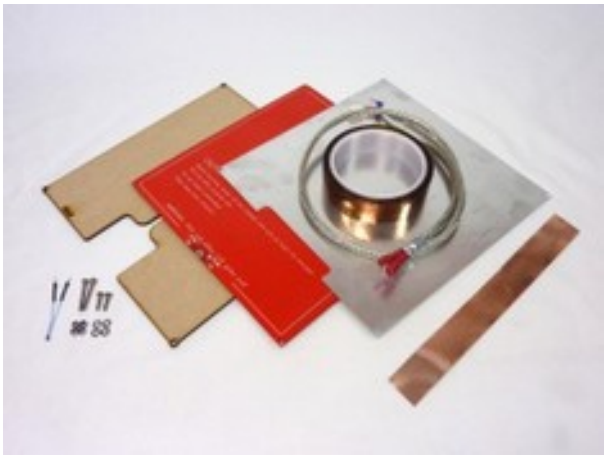
Cut two pieces of heatshrink, about 20mm in length.

Fold the sharp parts of the crimp, on the sides, in with a pair of pliers; this ensures that they do not cut through the heatshrink, and cause a short circuit later. Cover each crimp with a short piece of heatshrink, and use a hot air source or cigarette lighter to shrink it into place, leaving the pins exposed. If you use a flame, waft the shrink above the flame. Don’t play the flame directly on the shrink, or you will burn it. Check that the crimp, except for the pins, is insulated.

Heated bed assembly (528.4 Onwards)

The heated bed helps the extruded plastic stick to the build surface, and improves the print quality.

#	Component	Qty	Type
	Heated bed wiring loom	1	Heated bed
	MDF bed insulator	1	Heated bed
	PCB heated bed	1	Heated bed
	Aluminium heat spreader	1	Heated bed
	Kapton tape	As required	Hardware
	Metal tape	1	Heated bed
	Thermistor assembly	1	Assembled
	M3x25mm cap head screw	2	Fastener
	M3x12mm cap head screw	2	Fastener
	M3 washer	4	Fastener
	M3 nyloc nut	4	Fastener



Bend the thermistor bead at 90 degrees to the wire.

The thermistor bead fits into the central hole in the heated bed PCB. Secure it in place with some Kapton tape, with the legs of the thermistor pointing towards the PCB contacts.

Make sure the thermistor protrudes through the hole in the PCB a little. It will then have good contact with the aluminium heat spreader, and temperature readings will be more accurate.

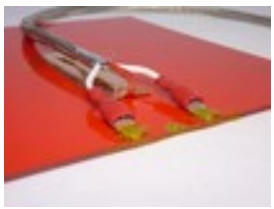
It’s a good idea to put a piece of Kapton tape over the bed contacts, so you cannot inadvertently short circuit the bed.

Put heatshrink on the female crimps of the two smaller wires of the wiring loom, if there is none. Covering any exposed metal, but leave the hole in the end of the crimp clear. These wires connect to the thermistor and have to be insulated from each other, and any other part of the heated bed, or you will get incorrect temperature readings, or possibly short circuit the thermistor.

Connect the wiring loom to the thermistor. The thermistor has no polarity, so it doesn’t matter which way around you connect them. The thermistor wires need to sit in the slot of the MDF bed insulator. Hold It in place with a piece of Kapton tape. Put this over the connection between the thermistor and the loom; it’s extra insulation in case there is metal poking through, that could come in contact with the metal tape, which is fitted in the next step.

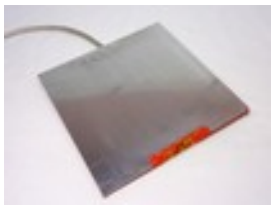
Tape the wires in place with the metal tape, checking the wires sit between the MDF bed insulator. This shields the thermistor wire from Electro Magnetic Interference (EMI).

Push the bed wiring loom crimps onto the tabs on the heated bed. Make sure they are pushed fully on. The bed has no polarity, so they can go on either way around. The wires will be closer to the bed if you put the flat side of the crimp towards the bed, as shown.



CAUTION!
Wipe the aluminium heat spreader with a paper towel, to remove any metal swarf, and carefully check it for damage, burrs or projections before final assembly. Any scrapes or sharp protrusions from the aluminium heat spreader may scratch the PCB, and short circuit through the aluminium heat spreader, which may result in damage to the electronics.

Line up the aluminium heat spreader with the PCB, making sure that it doesn’t touch the contacts.



Turn the bed over, and put the MDF bed insulator in place.

Now assemble the heated bed by putting two M3x12mm cap head screws through the two corners of the bed at the connector end, each side of the PCB contacts. The order should be aluminium heat spreader, PCB, MDF, M3 washer, M3 nyloc nut.

Put two M3x25mm cap head screws through the back corners of the bed. The order should be: aluminium heat spreader, PCB, MDF, M3 washer, M3 nyloc nut.

Test the thermistor wiring at the end of the wiring loom; the resistance should be around 10k ohms. It was a warm day when we took this picture, around 28C, so the reading is lower, at 8.48k ohms. Remember that you have a resistance, which will become apparent with a wrong value if you hold both wires in your fingers…

Test the heated bed power wires are making a good connection by testing the resistance. This measures the resistance of the heated bed, and it should be around 1.3 ohms. You may need to wait for a few seconds for the figure to stabilise. Make sure you have a good battery in your multimeter and check that when you short its leads it reads 0 ohms, or your reading may be inaccurate.

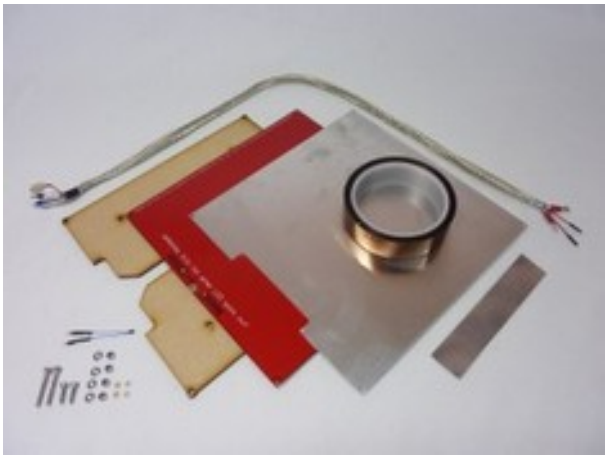
Finally, test there is NO continuity (i.e. infinite resistance) between the aluminium heat spreader and the contacts of the heated bed. If there is continuity, there is a connection between them somewhere, and possibly the heated bed PCB has been damaged. See the earlier warning in red in this section.

The completed heated bed assembly.

Heated bed assembly (528.0 to 528.3)

The heated bed helps the extruded plastic stick to the build surface, and improves the print quality.

#	Component	Qty	Type
	Heated bed wiring loom	1	Heated bed
	MDF bed insulator	1	Heated bed
	PCB heated bed	1	Heated bed
	Aluminium heat spreader	1	Heated bed
	Kapton tape	As required	Hardware
	Aluminium tape	1	Heated bed
	Thermistor assembly	1	Assembled
	M2 spring washer	2	Fastener
	M2 nut	2	Fastener
	M3x25mm cap head screw	2	Fastener
	M3x12mm cap head screw	2	Fastener
	M3 washer	4	Fastener
	M3 nyloc nut	4	Fastener



The thermistor bead fits into the central hole in the heated bed PCB. Secure it in place with some Kapton tape, with the legs of the thermistor pointing towards the PCB contacts.

Make sure the thermistor protrudes through the hole in the PCB a little. It will then have good contact with the aluminium heat spreader, and temperature readings will be more accurate.

It’s a good idea to put a piece of Kapton tape over the bed contacts, so you cannot inadvertently short circuit the bed. (The rest of the pictures in this sequence do not show this, but fit it now.)

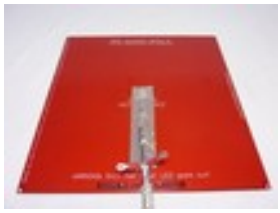
Put heatshrink on the female crimps of the two smaller wires of the wiring loom, if there is none. Covering any exposed metal, but leave the hole in the end of the crimp clear. These wires connect to the thermistor and have to be insulated from each other, and any other part of the heated bed, or you will get incorrect temperature readings, or possibly short circuit the thermistor.

Connect the wiring loom to the thermistor. The thermistor has no polarity, so it doesn't matter which way around you connect them. The thermistor wires need to sit in the slot of the MDF bed insulator.

IMPORTANT: Hold the thermistor wires in place with a piece of Kapton tape. Put this over the connection between the thermistor and the loom; it's extra insulation in case there is metal poking through, that could come in contact with the metal tape, which is fitted in the next step.

PICTURE TO COME

Tape the wires in place with the metal tape, checking the wires sit between the MDF bed insulator. This shields the thermistor wire from ElectroMagnetic Interference (EMI).

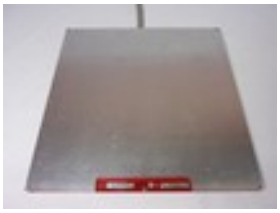


Connect the crimped eyelets to the M2 brass screws. The sequence should be eyelet – spring washer – M2 nut. Make sure the crimped eyelets are flat against the bed; they won't fit on the brass screws if they are the other way up.

The power terminals should fit into the MDF bed insulator as shown. Get them in the correct place before fully tightening.

CAUTION!
Wipe the aluminium heat spreader with a paper towel, to remove any metal swarf, and carefully check it for damage, burrs or projections before final assembly. Any scrapes or sharp protrusions from the aluminium heat spreader may scratch the PCB, and short circuit through the aluminium heat spreader, which may result in damage to the electronics.

Line up the aluminium heat spreader with the PCB, making sure that it doesn't touch the contacts.



Now assemble the heated bed by putting two M3x12mm cap head screws through the two corners of the bed at the connector end, each side of the PCB contacts. The order should be aluminium heat spreader, PCB, MDF, M3 washer, M3 nyloc nut.

Put two M3x25mm cap head screws through the back corners of the bed. The order should be: aluminium heat spreader, PCB, MDF, M3 washer, M3 nyloc nut.

Test the thermistor wiring at the end of the wiring loom; the resistance should be around 10k ohms. It was a warm day when we took this picture, around 28C, so the reading is lower, at 8.48k ohms. Remember that you have a resistance, which will become apparent with a wrong value if you hold both wires in your fingers…

Test the heated bed power wires are making a good connection by testing the resistance. This measures the resistance of the heated bed, and it should be around 1.3 ohms. You may need to wait for a few seconds for the figure to stabilise. Make sure you have a good battery in your multimeter and check that when you short its leads it reads 0 ohms, or your reading may be inaccurate.

Finally, test there is NO continuity (i.e. infinite resistance) between the aluminium heat spreader and the contacts of the heated bed. If there is continuity, there is a connection between them somewhere, and possibly the heated bed PCB has been damaged. See the earlier warning in red in this section. You can cover any exposed copper on the heated bed with a small piece of Kapton tape, then re-assemble the bed and test again.

The completed heated bed assembly.

Mounting the heated bed

The heated bed can now be mounted on the x-carriage.

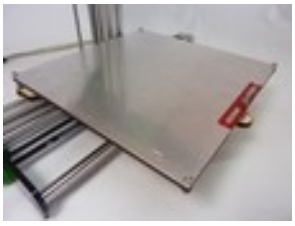
#	Component	Qty	Type
	Printer assembly	1	Assembled
	M3x25mm cap head screw	1	Fastener
	M3 washer	3	Fastener
	M3 nut	4	Fastener
	M3 nyloc nut	3	Fastener

Put the M3x25mm cap head screws up through the end of the y-carriage, as shown. Put an M3 washer on, then an M3 nut, and tighten. The M3 nyloc nut goes on part-way. The heated bed will sit on this, and it will provide adjustment for levelling the heated bed manually.

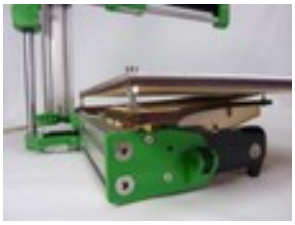
Put the other two M3 nyloc nuts on the M3x25mm cap head screws on the heated bed. These will provide levelling adjustment for the back of the bed.

Use two cable ties to loosely attach the heated bed wiring to the edge of the y-carriage. This is important; it stops the hot end cable moving at the connections. The cable will bend along it’s length as the y-carriage moves, not at one point.

Place the heated bed assembly on the y-carriage. It is mounted on three points, and the nyloc nuts provide manual height adjustment. Put the two M3 washers on top of the y-carriage, so that the two M3 nyloc nuts at the back of the bed rest on them.

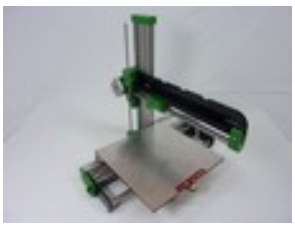


Use two M3 nuts as lock nuts under the y-carriage. You can move the y-carriage to the far end to make it easier to put them on.



Slide the y-carriage to the other end of the axis to put the other M3 nut on.

The final M3 nut fits on top of the heated bed PCB, on the M3x25mm screw that points upwards through the end of the y-carriage. It holds the front of the heated bed down. The M3 nut is not shown in this picture, but put it in it's place!

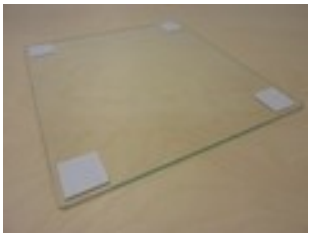


Print surface

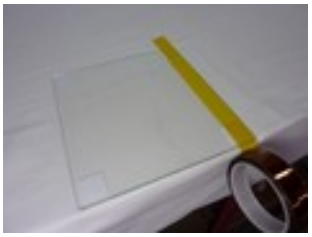
The glass print surface must be prepared before fitting onto the machine.

#	Component	Qty	Type
	Glass plate standard float glass, 200mm x 214mm x 3mm	1	Heated bed
	Plain white paper or adhesive labels	1	not supplied
	Kapton tape	1	Consumable
	Picture frame clips	4	Hardware

Cut the plain white paper into four 25mm x 25mm squares. Alternatively, you can use white adhesive labels, which makes it easier to stick them on the glass before covering them with Kapton. Stick the paper squares to the four corners of the glass plate, roughly 5mm from the edge. These will act as targets for the proximity sensor, for homing the Z axis, and for bed levelling. The paper targets are on top of the glass, not underneath, so we can use the close accuracy of the proximity sensor.

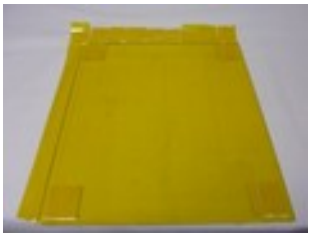


Cover the glass plate and paper targets with one layer of Kapton tape. We stick the Kapton tape to the top edge of the glass, then pull enough out to cover one length. Put a ***little*** tension on the tape to keep it straight, then lower it onto the glass. Work down the tape with your finger, flattening it onto the glass, and pushing out any air bubbles.

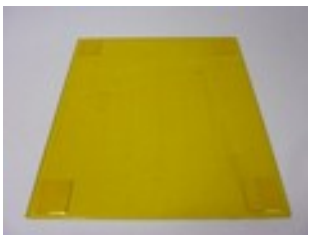


We find it easiest to work on the edge of the table, to drop the Kapton tape roll over the edge. Trim the excess off as we go. Take care to exclude bubbles; working on a white surface helps to spot them. Don’t pull the tape too taught before you lay it down. Gaps between the strips are preferable to overlaps.

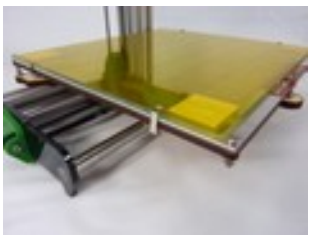
Completely cover the glass, then trim any excess off flush with the edge. Try not to wrap the Kapton tape under the glass. Another way to apply the Kapton tape is to slide it on with soapy water, move it into position, then squeegee out the water. You have to wait for it to dry out before use.



The Kapton is used as the print surface, so the bed should be installed Kapton-side-up. The other side is plain glass, and sits against the aluminium heat spreader. The paper targets should be on top of the glass, and the Kapton on top of the paper targets and glass.

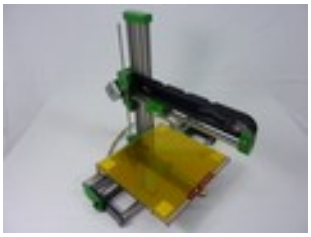


Install the print surface on the heated bed with the clips provided. The glass side should be in contact with the aluminium heat spreader. The clips go around the glass and the heated bed.



Locate the tab on the end of the clip in the hole in the MDF, which will hold the clip in place.

It is important that the print surface is kept free from dirt and oil, including fingerprints; these will stop your prints sticking to the bed. Wipe it clean with a paper towel and acetone (commonly found in nail polish remover, though be careful that does not contain lanolin or any other oil or grease – read the ingredients on the label). isopropyl alcohol, white methylated spirits and white vinegar should also work – all of these are organic solvents, and dissolve oil and grease into the towel before the residue evaporates. Don’t use Windex/Windowlene or polish; they often have a non-stick component!



The completed assembly.

Extruder Drive Assembly

This section shows you how to assemble the extruder drive. All the parts for the extruder drive, except for the NEMA17 motor, should be in the bag labelled ‘Extruder drive set’.

Extruder body

The extruder body holds the stepper motor, which drives the plastic filament.

#	Component	Qty	Type
	NEMA17 motor	1	Hardware
	Extruder drive block	1	Extruder drive
	Extruder small gear	1	Extruder drive
	Retaining tongue	1	Extruder drive
	623 bearing (10mm diameter)	1	Extruder drive
	M3 washer	1	Extruder drive
	M3x12mm countersunk socket screw	3	Extruder drive

Take the extruder body, one M3x12mm countersunk screw, the 623 bearing and an M3 washer.

Put the screw in from the back, in the hole in the corner of the extruder block. Put the 623 bearing in the hole, on the screw. Put the washer on top of the bearing, as shown. This washer is sandwiched between the bearing and the motor; without it, the bearing will bind on the motor and not turn, and the extruder drive will function poorly.

Fit the motor on top of the washer and bearing. Do the screw up loosely.

Screw the other two M3x12mm countersunk screws through the extruder body and into the motor, to mount the motor solidly. Tighten all three screws. Check that the bearing can turn freely.

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. There should be a small gap (0.5mm to 1mm) between the gear and the face of the extruder body. If you put a piece of folded paper under the gear when you push it down this will set that gap. Pull the paper out. Check the motor turns freely.

Large extruder gear

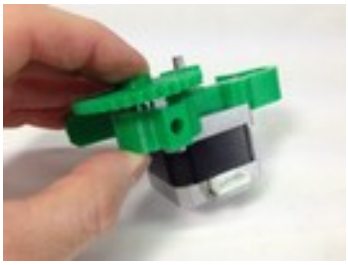
The large extruder gear drives the filament through the Bowden tube and into the hot end.

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

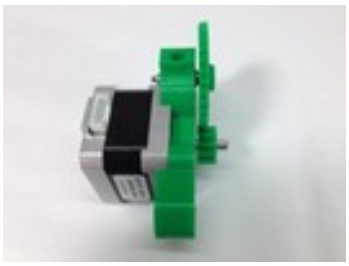
Push the M3x25mm hex head screw through the gear. The hexagon head of the screw should be held tightly by the plastic part. Slide the two M3 washers on to the screw, followed by one MR93ZZ bearing, then the hobbed insert. The insert is symmetrical so it doesn't matter which way round it is fitted, but it needs to be screwed tight. Most pairs of pliers have half-round holes in their jaws; use these to grip the hobbed insert. Tightening the insert pulls the hex head screw into the gear, and locks the bearing and hobbed insert in place.

Slide second MR93ZZ bearings on, followed by the M3 nyloc nut. Tighten the nut hard against the bearing. Don’t hold the hobbed insert to tighten this nut, as that will tend to loosen the insert. Hold the gear instead.

Now push the large extruder gear sub-assembly into place in the extruder body. With filament loaded, the gear can’t come out, but without filament, you should be able to pull the gear off for easy cleaning of the hobbed insert.



Make sure the gap behind the gear is correct, and turn the large gear a few times to check it is meshing smoothly with the small gear. If it isn’t, check that the large gear isn’t too close to the extruder body; it may bind with the lip on the bottom of the small gear. You may also need to file the teeth of the small or large gear, if there are any inconsistencies due to manufacture. Feed a short length (200 mm or so) of filament into the drive. When it is engaged with the hobbed insert and you hold the large gear still it should be impossible to pull the filament out of the drive using your fingers. Wind the test filament out.



The retaining tongue

This secures the Bowden cable from the hot end into the extruder drive.

The retaining tongue that is included in the extruder drive set.

For safe keeping, insert it in the drive. It goes in with the forks of the tongue upwards.

It should hold itself in the drive.

The finished assembly.

Mounting the extruder drive on the printer

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

The x-axis-plate has three slots that the extruder drive can fit into. The standard wiring will reach to the first or second slot. Drop the drive into the first slot, then the end of the extruder body fits into a slot in the x-rib. It is held in place by the weight of the motor.

Hot End Assembly (Quick-set)

Which hot end?

All Ormerod 2 528.5 and onwards kits ship with the new ‘Quick-set’ nozzle. This page has the instructions for that nozzle.

This is the Quick-set nozzle, supplied with Ormerod 2 528.5 and onward kits. If your nozzle looks like this, please use the instructions on this page.

This is the one-piece stainless steel nozzle. If you nozzle looks like this, please use the instructions on the ‘Hot end assembly‘ page.

Building the hot end

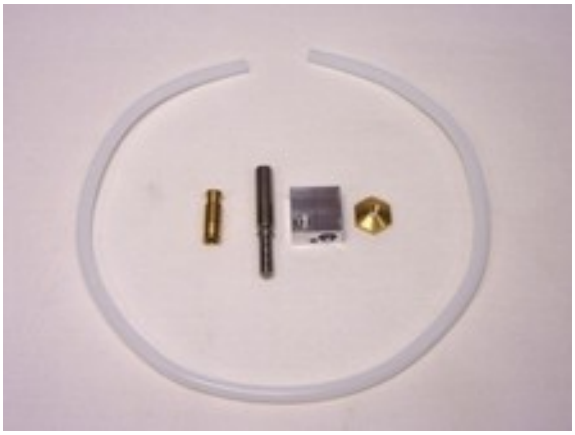
Assembling the hot end parts

All the parts for the hot end, like the extruder, come in one bag.

The Bowden tube and nozzle

The Bowden tube guides the filament from the extruder to the hot end, where the filament is melted and extruded through the nozzle.

#	Component	Qty	Type
1055	4mm PTFE Bowden tube	1	Hot end
106.1	Brass Bowden start	1	Hot end
738	Quick-set nozzle (0.5mm)	1	Hot end
739	Quick-set heater block	1	Hot end
794	Quick-set Tapered brass M4 nut	1	Hot end



Start by building the hot end. Take the nozzle, aluminium heater block and tapered brass nut. Screw the heater block onto the nozzle, as tight as you can, but with fingers only. If you use pliers to hold the nozzle, and a spanner on the heater block, you may break the nozzle at it's thinnest part! Note the small hole in the heater block is towards the tip of the nozzle.

Holding the heater block in a 14mm spanner (or an adjustable spanner), screw on the tapered brass nut. Tighten the tapered brass nut against the heater block, with a 10mm spanner. This DOES need to be done up tight; the heater block and tapered brass nut lock together, tight on the thread of the nozzle, to ensure good heat transfer from the heater block into the nozzle. The heater block may unscrew a fraction on the nozzle as you do this, but that's okay.

The cone of the nozzle should continue the cone of the nut, or as close as possible. There shouldn't be a shoulder between the two, nor should the nozzle be down inside the nut.

Take the PTFE tube. Make sure the ends of the PTFE tube are cut square. (Filament has been inserted into tube just to show the tube against the background.)

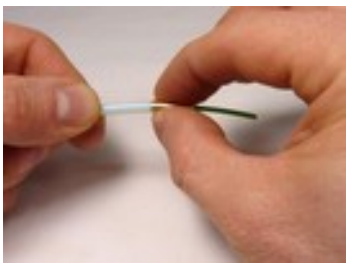
You are going to screw the brass Bowden start and the nozzle onto each end of the tube. This will compress the PTFE tube's inner hole. To allow the filament to run freely in the tube, you need to open out the ends of the PTFE tube first. Use a **2.5mm** (2mm is too small, 3mm is too big) drill bit in a small hand chuck, or a slow electric drill.

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, to a depth of around 15mm. Try to keep the drill as straight as possible into the tube.

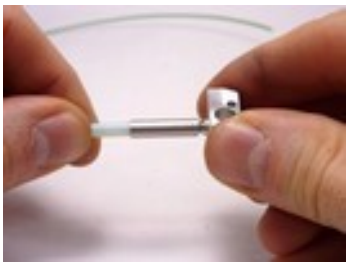
Take several goes at it, going a couple of millimetres deeper each time and drawing the PTFE swarf out by keeping twisting clockwise and pulling. The drill should pull the PTFE swarf out with it. Repeat the process at the other end of the PTFE tube.

IMPORTANT! The PTFE tube MUST BE CLEAR OF ALL PTFE SWARF before screwing the nozzle on! Push a piece of filament (use the 50cm piece you cut for the extruder testing) through the tube, which should push out any remaining PTFE swarf. Blow down the tube, from both ends, as well. It is very important to get any PTFE swarf out of the tube, otherwise this will end up in the nozzle the first time you print, blocking it!

Now you're going to screw the brass Bowden end and the nozzle onto the PTFE tube. To help guide them onto the tube straight, put a piece of filament into the PTFE tube. This will keep the brass Bowden end (and nozzle) and PTFE tube axially in line; you don't want them screwed on at an angle. Push the brass Bowden end up to the PTFE tube, and push while turning it clockwise. It will start to cut its own thread into the PTFE tube.



If you have difficulty gripping the brass Bowden end, you can use the nozzle instead. With the heater block on it, it is easier to turn. You will have to remove it afterwards, and put the brass Bowden end back on, but it will be much easier the second time.

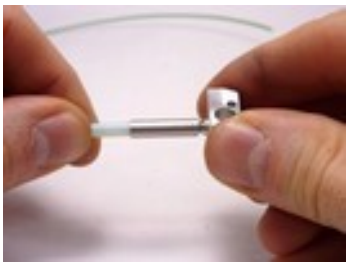


If you have trouble getting the brass Bowden end started on tube, you can use a pencil sharpener to make a cone on the end of the tube.

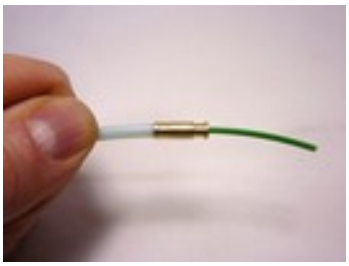
Don’t cut too deeply with the pencil sharpener, which will make the cone too deep and long, or it will compress onto the filament when the brass Bowden end, or nozzle, are screwed on.

Keep turning until the Bowden end will not screw on any further. If you then remove the brass union, you should see that the Bowden tube end has been threaded, to a depth of around 8mm.

Using the same process, put the nozzle on the other end of the PTFE tube.



Push a piece of filament through the tube, to check that it moves smoothly, with little or no friction. Check it goes all the way down into the nozzle. It should move nearly as freely as when the brass Bowden end and nozzle were not fitted. If the filament is sticking, you may be able to release it by unscrewing the brass Bowden end and/or nozzle one turn.



The finished Bowden tube and nozzle.

The cooling system

It’s very important that the top of the nozzle remains cold; if filament melts too high up, the pressure required to extrude will increase, and the nozzle will block and stop extruding.

#	Component	Qty	Type
	Bowden tube and nozzle	1	Assembled
736	Quick-set cooling block	1	Hot end
357	Heatsink	1	Hot end
741	Quick-set hot end fan spacer	1	Hot end
	Fan	1	Hot end
520	M3x35mm cap head screw	2	Hot end
Fan is 12V (#953) for Ormerod/Mendel, 19V (#846) for Huxley			

Take the fan, and push the two M3x35mm cap head screws through the holes in the fan furthest from the fan wire.

Remove any protective film from the acrylic fan spacer.

Place the fan on the fan spacer. Orient the fan spacer as shown. The sticking out part of the fan spacer is used to mount the proximity probe, which sets the nozzle height from the bed, and can automatically compensate for the bed level.

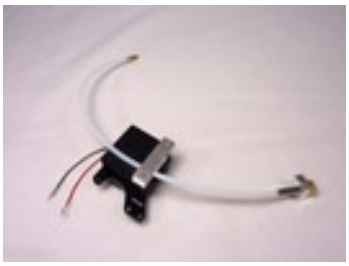
The heatsink goes on next, behind the fan spacer. It only has two holes in it; make sure the M3x35mm cap head screws go through. The fins of the heatsink should face the fan; the solid part is to the back.

Next is the aluminium cooling block. The orientation of this is critical. The heatsink mounting holes are off-centre; orient the block so the holes are closest to the bottom. The long side of the aluminium cooling block will be in contact with the heatsink.

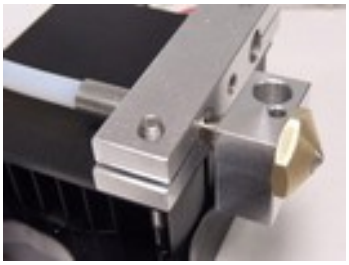
The cooling block mounting holes are only threaded on one side of the block; the cooling block also clamps the hot end in place. The threaded part should be AWAY from the heatsink. The M3x35mm cap head screws will push through the first half of the cooling block, before engaging the thread.

Push the two M3x35mm cap head screws through the four parts, and lightly screw it into the aluminium cooling block. Don’t tighten this up yet; it needs to clamp the nozzle in place. The bottom edge of the heatsink should line up with the bottom edge of the aluminium cooling block, and the solid part of the heatsink should be in good contact with the cooling block.

Now mount the Bowden tube and nozzle. Thread the slotted brass Bowden end up through the aluminium cooling block, followed by the Bowden tube, and then thread the nozzle into cooling block.



The hot end should be aligned with the bottom of the cooling block as shown, with the ‘neck’ of the nozzle just below the cooling block. Orient the heater block so it is under the heatsink and fan, rather than sticking out the back. Tighten the M3x35mm cap head screws, to sufficiently clamp the nozzle in place and pull the heatsink onto the aluminium cooling block, but do not over-tighten them – you will break the fan.



The hot end assembly so far.

Wiring the hot end

Thermistor wires

Older kits have the thermistor wiring pre-made. We changed the crimp on the current kits to improve the grip on the thermistor wire, but you'll need to do the following.

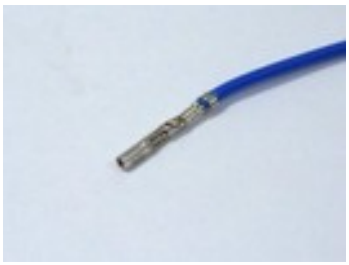
#	Component	Qty	Type
433	Thermistor wiring – 160mm	2	Hot end
197	2.4mm Black heatshrink	as needed	Hot end

New picture to come

If your thermistor wiring is supplied without heatshrink on both ends, and the female end looks like this, do the following.

Fold in the two barbs that stick out the side, as shown in the first picture; a small screwdriver or tool with a point is easiest. They need to fold into the crimp, as they will hold the thermistor wire.

Also flatten the top two tabs, so the crimp is smooth. If you put the heatshrink on with them sticking up, they can cut through the heatshrink, and cause a short circuit if they touch other metal.



Put the heatshrink on the end of the wire, covering the crimp but leaving the end open.

Check that it holds the thermistor firmly. You will cover the thermistor with high temperature PTFE heatshrink in the next step; you want as little metal showing as possible between the PTFE heatshrink and the black heatshrink, to avoid short circuits to metal parts of the printer.

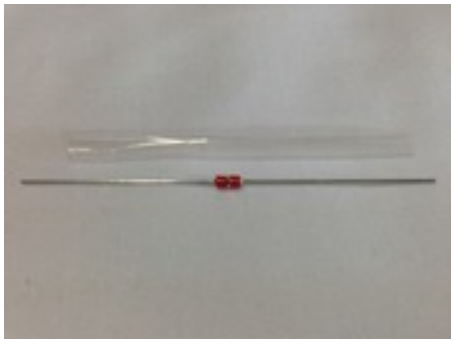
Heater block wiring

The heater block heats the nozzle up to the melting point of the plastic filament, typically around 200C.

#	Component	Qty	Type
	Hot end assembly	1	Assembled
430	100K thermistor	1	Hot end
167	Transparent PTFE heatshrink	about 50mm	Hot end
841	3mm P-clip	1	Hot end
242	M3x16mm cap head screw	1	Hot end
212	M3 plain washer	1	Hot end
433	Thermistor wiring – 160mm	2	Hot end
445	Cartridge heater (red wires)	1	Hot end

New Picture(!)

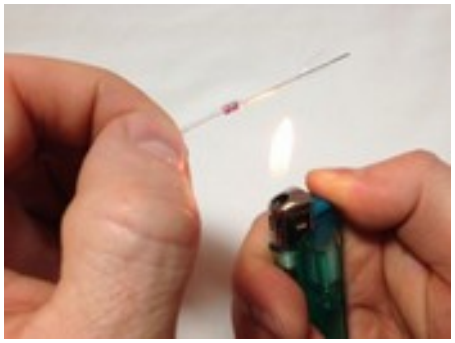
Cut the transparent PTFE heatshrink about 8mm shorter than the thermistor with its axial connecting wires. Put the thermistor in it so that 4mm of wire protrudes from each end.



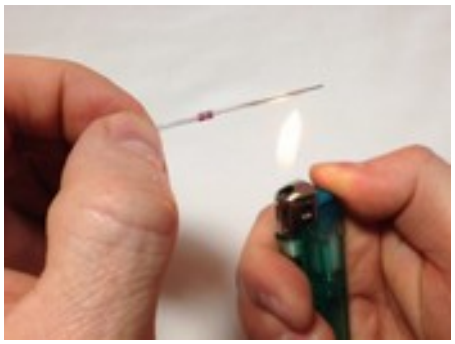
Using a flame (a cigarette lighter, blowtorch, gas hob, or hot air gun work well; a hair dryer does not), shrink the heatshrink over the thermistor. Just waft the thermistor and heatshrink through the flame. You don’t want the heatshrink to overheat and to burn.

If you’re doing this with a cigarette lighter, hold the thermistor at one end, and heat the heatshrink from the middle out to the other end. The heatshrink will be transparent when it has fully shrunk, and will then go back to opaque when the heat is removed. Keep it above, not in, the flame, so it doesn’t overheat and go black.

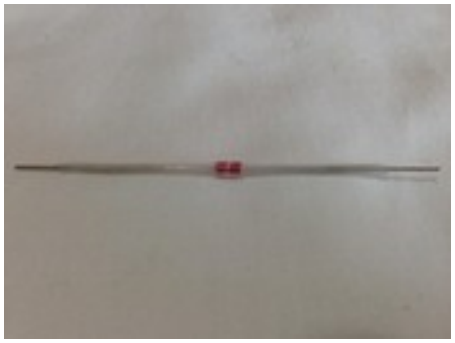
Let it cool for a few moments, then turn it around and do the other side. Rolling the thermistor between your fingers while heating will improve the consistency of the heatshink.



Turn it around again and heat the first side, rolling it in your fingers, to get a really good, even heatshrink. Make sure it has shrunk properly around the central bulge, or it won’t fit easily into the heater block.



This is how the thermistor should look with the PTFE shrunk onto it.



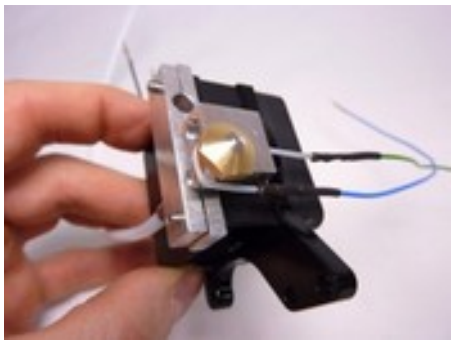
Test the resistance of the thermistor with a multimeter. It should be around 100k ohms at an ambient temperature of 25C. Like the heated bed thermistor, the resistance will be greater if it is colder, and less if hotter.

Check the resistance of the heater cartridge. It should be around 3.0 ohms.

New picture (!)

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. If it doesn't want to go through, try reheating the heatshrink, for a tighter fit.

To stop the thermistor falling out, turn the thermistor wire around the back of the heater block as shown. This also means that all the wires go up one side of the hot end. Attach the thermistor wires.



Push the heater cartridge into the heater block. Bend the wires up the side of the heatsink duct. Secure the cables into the p-clip and attach it loosely to the laser cut fan spacer using an M3x16mm cap head screw and M3 washer. We will be adding a shielding part to this later, when we connect the loom.

New picture

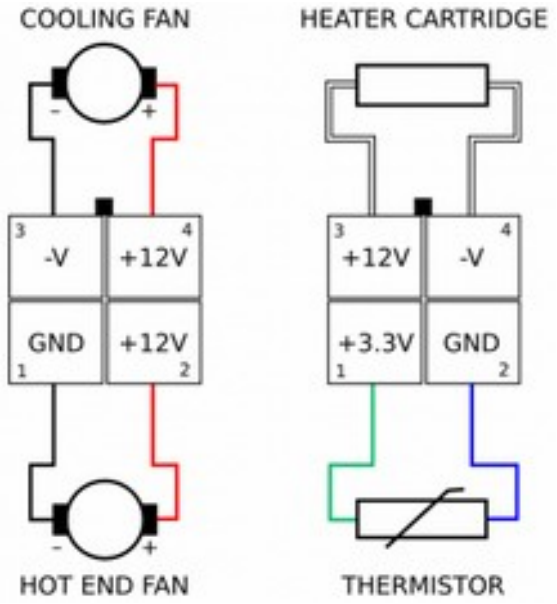
Wiring the hot end connector

#	Component	Qty	Type
	Hot end assembly	1	Assembled
847	2×2 female black crimp socket	2	Hot end

Picture to come

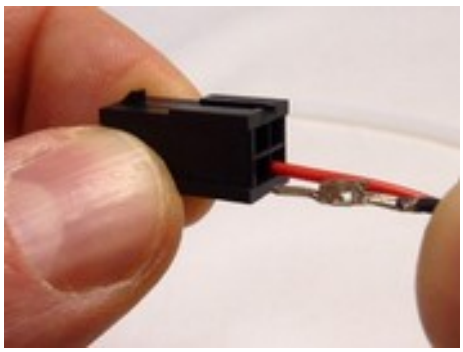
CAUTION! The next step describes wiring up the hot end connector. **GREAT CARE** should be taken doing this. The heater cartridge and the fan wires have 12V running through them **ALL THE TIME**. The thermistor wires are 3.3V, and connect directly to the Arduino chip on the Duet. If you incorrectly wire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

Wiring diagram

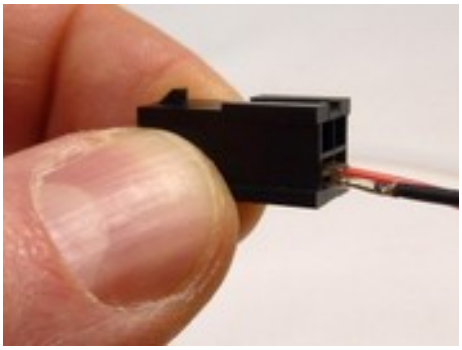


Note: the ‘cooling fan’ wiring is not connected until the hot end is mounted on the printer.

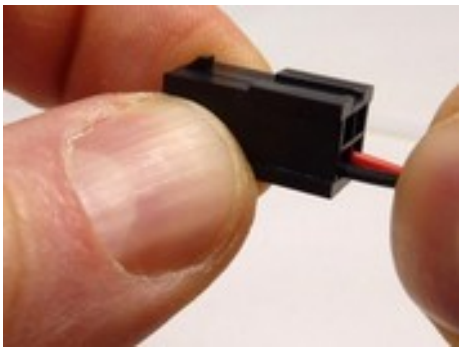
Put the pins on the ends of the hot end wires into the four-way female sockets. The wiring diagrams, above, are looking into the back of the socket, where you insert the crimps. The little black rectangle is the locking tab, and the housing has small embossed ‘1’ and ‘4’ numbers on it, so you can orientate it as the diagram. The pins are crimped on one side, and smooth on the other. The smooth sides go downwards in the diagram.



Neither the thermistor nor the heater cartridge have a polarity so it doesn't matter which way round their wires go. (Though the labels are the way that the machine will apply power.) Make sure to get the polarity of the fans right. These pictures show one of the hot end fan wires being put into the housing, but it is not fully in yet; you can't see the crimp easily when it is.



Check that the pins are all the same depth into the housing. The pins are very difficult to remove without damaging them, so check twice, plug in once! They should click into place, and then shouldn't easily push further through, or pull back out.

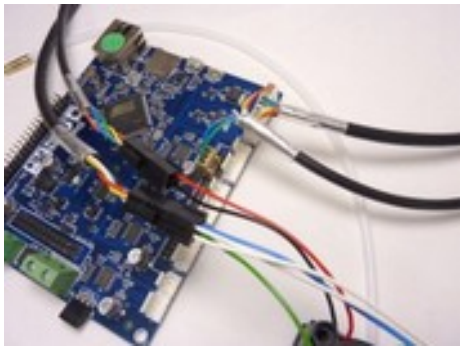


If you need to remove the pins, the easiest way is with the correct tool. However, this is rather expensive! We usually find the crimps come out fairly easily if you use a pair of very fine, pointed tweezers. You need to clip these (or any other narrow, thin metal shim) up each side of the crimp, from the open end of the housing (not the end the wire goes into), to flatten the sprung tabs on the side of the crimp. You can see the tabs in the picture. Both hot end and loom sides are effectively the same.

The hot end with the wiring in place in the crimp housings. (Picture shows a Huxley heater cartridge, with white wires; Ormerod and Mendel 3 use a heater cartridge with red wires.)

Wire colours, related to hot end wiring loom

You can check the wire order by comparing it to the hot end loom, which the hot end plugs into.



Fan wiring loom (4 wires)

Fan wiring loom	Fan wires
1 Green (GND)	Hot end fan BLACK wire
2 Blue (+12V)	Hot end fan RED wire
3 Yellow (FAN GND)	Cooling fan BLACK wire
4 Red (FAN +12V)	Cooling fan RED wire

Note: the ‘cooling fan’ wiring is not connected until the hot end is mounted on the printer.

Hot end wiring loom (6 wires)

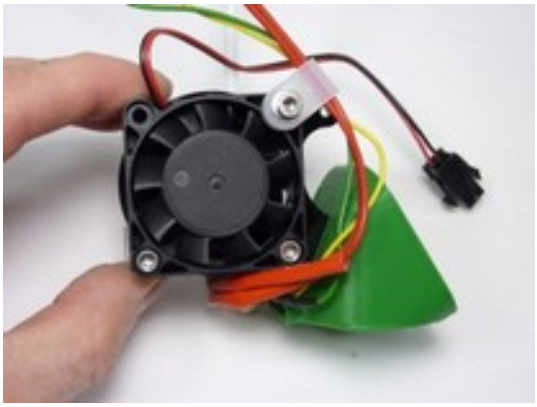
Hot end wiring loom	Hot end wires
1 Green (3.3V)	Thermistor wire (green/blue)
2 Blue (3.3V)	Thermistor wire (green/blue)
3 Black (Hot end heater +19V)	Thick red heater wire
3 Yellow (Hot end heater +19V)	
4 Red (Hot end heater GND)	Thick red heater wire
4 White (Hot end heater GND)	

Final assembly and mounting

#	Component	Qty	Type
	Hot end assembly	1	Assembled
953	12V Fan	1	Hot end
1123	Cooling fan duct	1	Hot end
461	M2.5x10mm cap head screw	2	Hot end
160.1	MDF heat insulator	1	Hot end

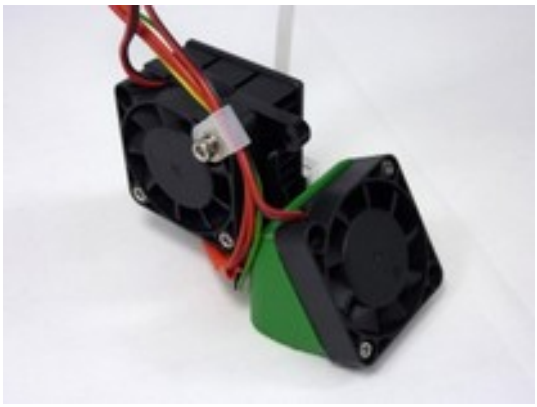
242	M3x16mm cap head screw	1	Hot end

NOTE: You may want to connect the cooling fan and duct at a later point (i.e. once you have got the printer printing), as it requires the bed to be level first, and may, initially, get in the way.

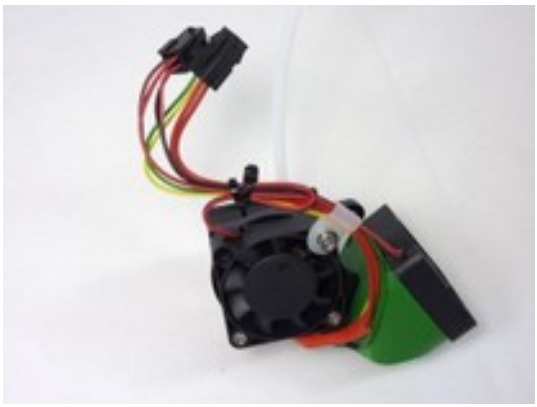


The fan duct pushes onto the arm of the acrylic spacer. Make sure it is fully engaged, or it will be lower than the nozzle.

Screw the 12V fan on to the duct with the M2.5x10mm cap head screws.



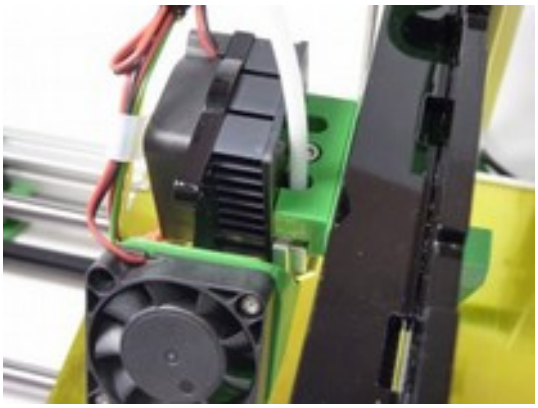
Connect the cooling fan wires to the 2×2 female fan housing. See the wiring diagram above for correct position.



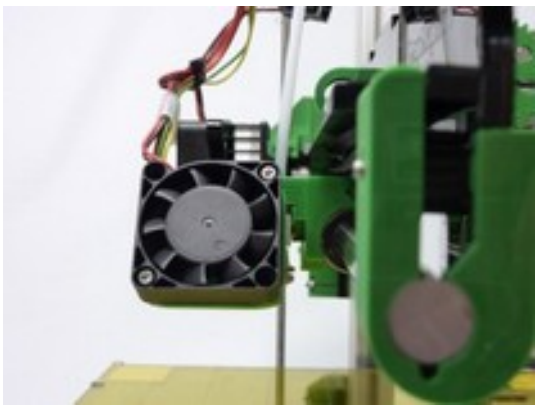
Thread the MDF insulator onto the Bowden tube, and slide it down the tube until sits on top of the aluminium cooling block. Thread the M3x16mm screw through the MDF insulator and into the aluminium cooling block, as shown. Just put the screw in a couple of turns.

The hot end mounts onto the x-carriage via the nozzle-mount.

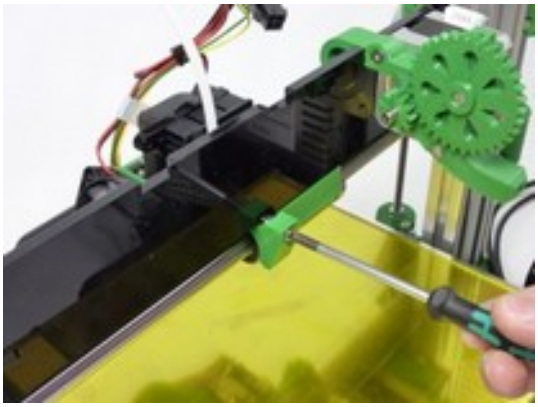
It should push on sideways, and you can then fix it into place using the two screws. The MDF insulator should sit UNDER the nozzle mount, but on top of the aluminium cooling block, so it is sandwiched between them.



The hot end should be mounted vertically. If the hot end is leaning forward, the fan duct may be lower than the nozzle. If it leans back, the proximity sensor may be lower. Check that it is seated correctly in the nozzle-mount.

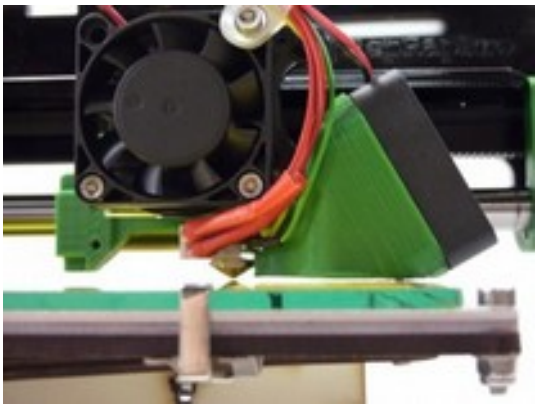


The angle of the hot end can be changed, by adjusting the x-carriage idler bearing on the back of the x-axis-plate. It is mounted in a slot (this may need cleaning to allow the bolt to slide in it), so loosen it, hold the hot end where you want it, then push the bearing against the x-axis-plate and re-tighten. Check that the hot end is vertical.

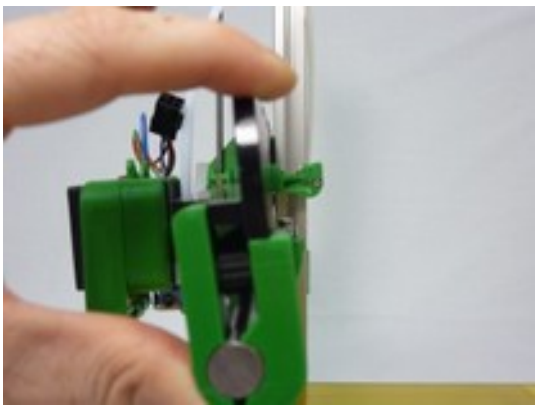


Wind down the X axis by turning the Z leadscrew, until the nozzle is just above the bed. The nozzle should be a couple of millimetres lower than the fan duct.

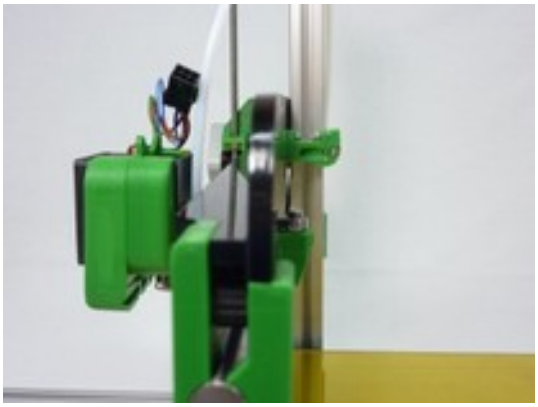
The bed may not be level yet. Check if the nozzle is the same height at the other end of the X axis. If the nozzle isn't lower than the fan duct, it's possible that the nozzle is set too high in the aluminium cooling block.



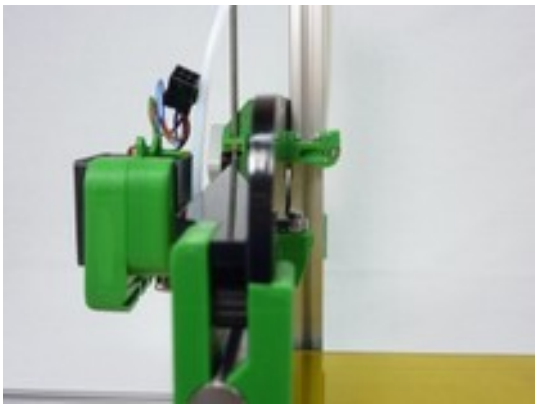
If the nozzle seems to drop, or rise and fall, as it moves along the X axis, check that the x-axis plate is straight, flat, and vertical along it's length. Remove the extruder, and look along the back of the x-axis-plate. It can twist around the x axis smooth rod; twist it back vertical, and tighten the screw in the x-idler, and the screws in the x-motor-mount.



A view along the back of the x-axis-plate, checking it is straight and flat.



Finally, once printing, the nozzle may droop forward. This usually means that the cooling of the hot end has not been working correctly. Heat may have been getting through the screws and melting the nozzle-mount, which may distort it. Check the hot end construction, that the cooling fan is working, and the bolts holding the fan to the aluminium cooling block are tight.

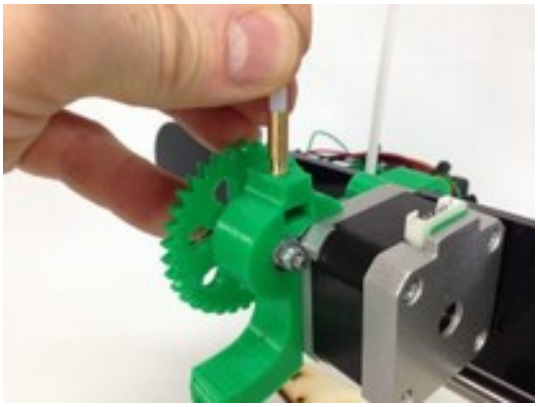


The tongue

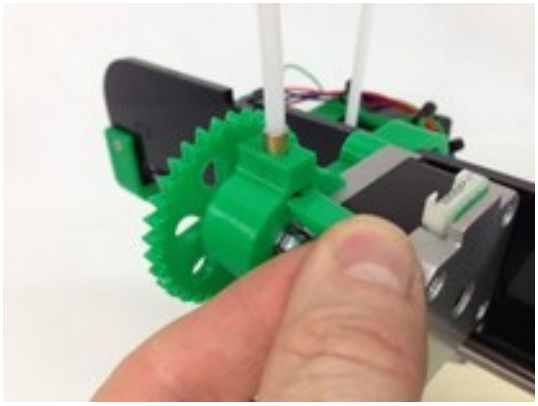
This holds the Bowden tube in the extruder drive.

Now take the retaining tongue out of the drive.

Push the free end of the Bowden tube, with the slotted brass connector, into the hole in the top of the extruder drive. The slot in the brass connector should be visible in the slot in the printed part; ensure the brass connector is pushed all the way in.



The retaining tongue fits in the printed slot as shown, with the flat side of the tongue going upwards. Push the retaining tongue in, until it is firmly engaged with the slotted brass connector. The hole in the end will help you to remove it, if you need to.



Hot End Assembly

Which hot end?

Ormerod 2 kits up to 528.4 ship with the one-piece stainless steel nozzle. This page has the instructions for that nozzle.

This is the one-piece stainless steel nozzle. If you nozzle looks like this, please use the instructions on this page, below.

This is the Quick-set nozzle, supplied with Ormerod 2 528.5 and onward kits. If your nozzle looks like this, use the instructions on the ‘Hot end assembly – Quick-set‘ page.

The Bowden tube

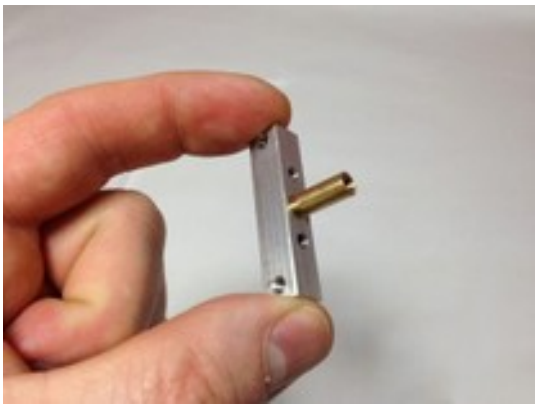
The Bowden tube guides the filament from the extruder to the hot end.

#	Component	Qty	Type
	4mm diameter PTFE tube	1	Hot end
	Bowden end (threaded)	1	Hot end
	Bowden start (grooved)	1	Hot end

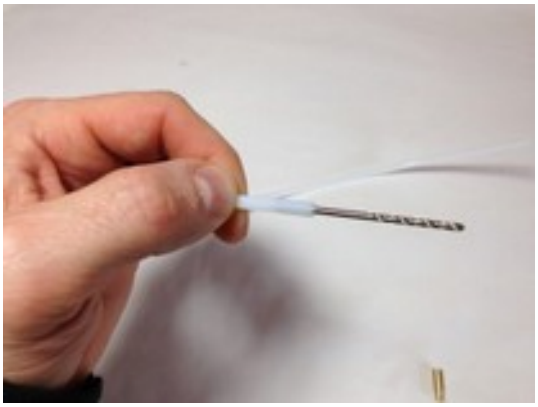
Start by trimming a couple of millimetres off each end of the PTFE tube with a very sharp blade to get the ends clean and square.

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.

To help fit the brass unions on the PTFE tube, you can use the aluminium cooling block (also in the hot end kit). Take the aluminium cooling block and screw the threaded brass union into it. This it will give you something to grip, when you screw the brass union onto the PTFE tube.

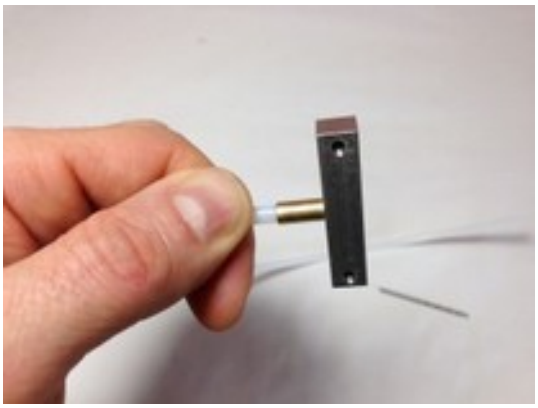


To help guide the brass union onto the PTFE tube straight, put a 2mm drill into the end of the PTFE tube. This will keep the brass union and PTFE tube axially in line. You don’t want the brass screwed on at an angle.



Thread the drill through the brass union and aluminium cooling block. Push the brass union up to the PTFE tube, and push while turning the aluminium block clockwise. It will start to cut its own thread into the PTFE tube.

After a couple of turns to get the thread started, pull out the drill, or the compression of the PTFE tube will not let you pull it out. Also, you won’t be able to screw the union on all the way; there will be too much resistance with the drill still in the tube.



Do the brass union up until it won’t turn any further. Then, unscrew the brass union. 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 end of the PTFE tube that you have just threaded, taking care not to cross the threads. Repeat the thread cutting process at the other end of the tube, this time leaving the threaded brass union on the other end of the PTFE tube.

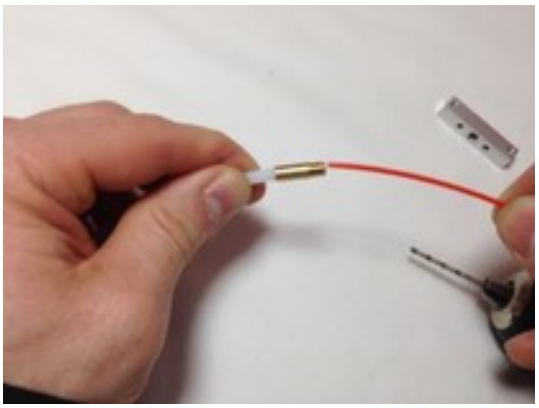
Screwing the brass unions onto the PTFE tube will have compressed its inner hole. You need to open it out again so that the plastic filament that your Ormerod prints with will run freely in the tube. Use a 2mm drill bit in a small hand chuck, or a slow electric drill.

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.

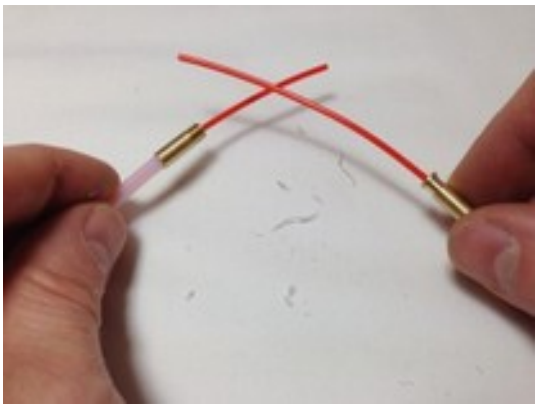
Take several goes at it, going a couple of millimetres deeper each time and drawing the PTFE swarf out by keeping twisting clockwise and pulling. Stop when the tip of the drill is about 5mm past the brass union, and visible in the clear transparent PTFE.

The drill should pull the PTFE swarf out with it. Repeat the process at the other end of the PTFE tube.

Push a piece of filament (at least 50cm long, to go all the way through) through the tube, to check that it moves smoothly, with little or no friction. Push the filament into the tube from both ends to make sure it's clear.



The filament should push out any remaining PTFE swarf. Blow down the tube, from both ends, as well. It is very important to get any PTFE swarf out of the tube, otherwise this will end up in the nozzle the first time you print, blocking it!



The finished Bowden tube.

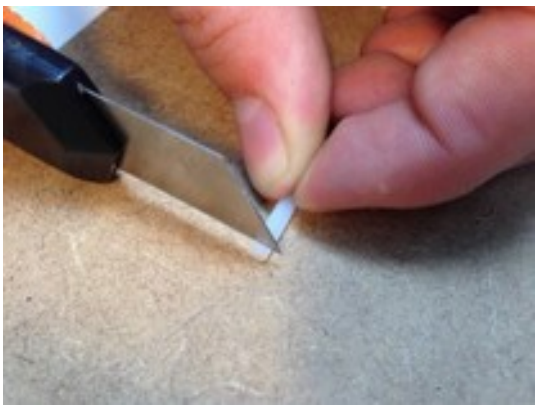
Preparing the nozzle

The nozzle is the most important part of the printer; the molten filament is extruded out of this.

#	Component	Qty	Type
	Stainless steel nozzle	1	Hot end
	3mm diameter PTFE tube	1	Hot end

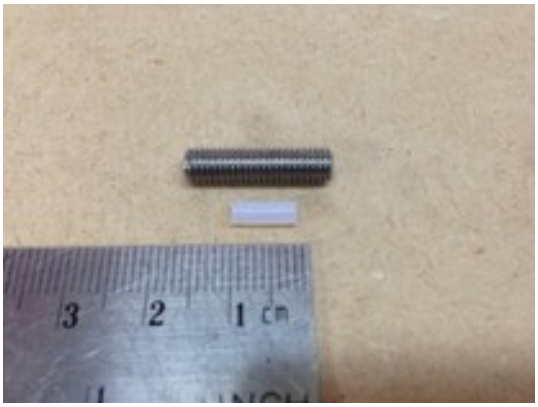
NOTE: Your kit should have the PTFE tube already cut and inserted into the stainless steel nozzle. It should look like the last picture in this section, below. Follow these instructions if you ever need to replace the PTFE tube.

Using a sharp blade, cut one end of the PTFE liner. Try to make the cut as square to the axis of the tube as possible. Push the square-cut end of the tube into the end of the one-piece nozzle.



Again using a sharp blade, cut the PTFE liner flush with the end of the one-piece nozzle. This should also be cut as square as possible, flush with the end of the nozzle.

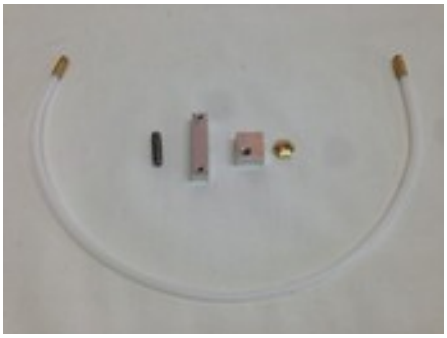
If you can remove the PTFE liner tube, it should measure 8mm long, with straight cut ends. If they are cut at an angle, it creates a gap that may fill with molten plastic, and cause the nozzle to block.



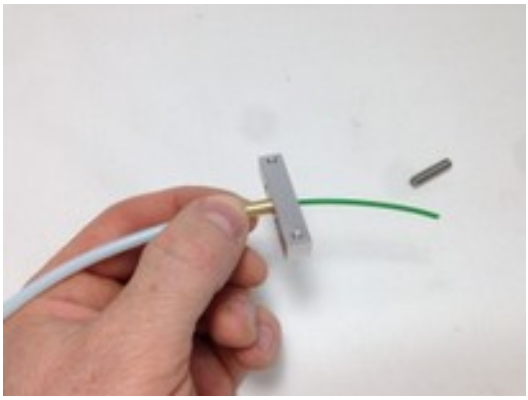
The nozzle with the PTFE nozzle liner installed.

Assembling the Hot End metal parts

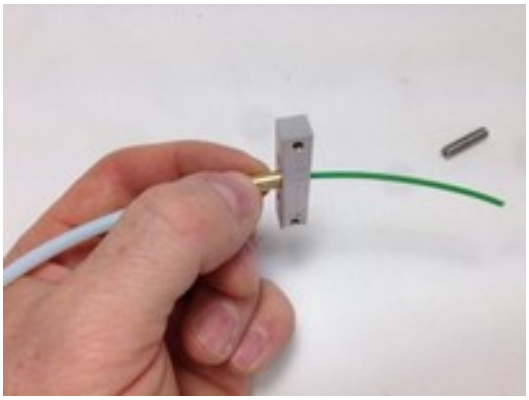
#	Component	Qty	Type
	Bowden tube	1	Assembled
	Nozzle assembly	1	Assembled
	Aluminium heatsink block	1	Hot end
	Aluminium heater block	1	Hot end
	Tapered brass nut	1	Hot end



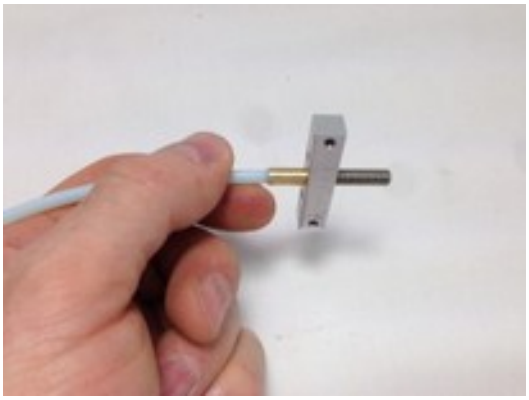
Take the Bowden tube, aluminium cooling block and nozzle assembly. Screw the Bowden tube end with the threaded brass union into the aluminium cooling block, all the way on. If you leave a piece of filament in the tube (the 50cm long piece you used to clear the PTFE tube earlier), it will help align the parts of the nozzle.



Unscrew the aluminium cooling block a quarter turn from the threaded brass union.

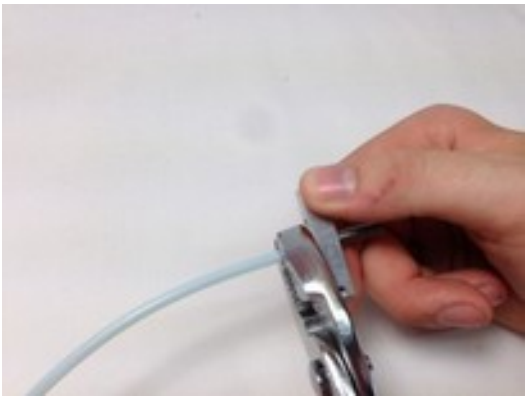


While holding the brass union and cooling block in this position, screw the nozzle into the cooling block, and up tight against the brass union. Make sure the PTFE liner is still in place in the nozzle before screwing it in.



Use a pair of pliers or adjustable wrench to firmly grip the brass union, close to the aluminium cooling block. You can hold the brass union between a folded piece of paper in the jaws of the pliers, to stop the jaws damaging the brass. Don’t grip too tight; the brass union is a quite thin.

Turn the aluminium cooling block clockwise to lock the whole assembly in place. Do it as tight as you can. The brass union should be locked against the top of the one piece nozzle. Remove the filament.

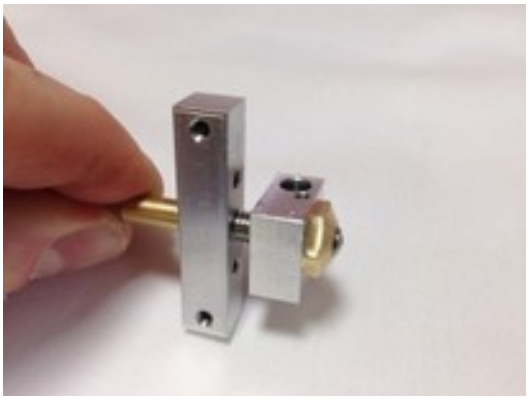


Check that the brass union is close to the aluminium cooling block; no thread should be showing. Check the nozzle is not loose. The whole assembly should be rigid. You can push a piece of filament down the Bowden tube, to check it goes all the way through to the tip of the nozzle easily.

Take the aluminium heater block, and screw it onto the nozzle. The small hole through the heater block should be closer to the tip of the nozzle, as shown.

Put the tapered brass nut on the nozzle. Adjust the heater block so it is square with the aluminium cooling block. Adjust the tapered brass nut, so that the cone of the nozzle continues the cone of the nut, or as close as possible. There shouldn't be a shoulder between the two, nor should the nozzle be down inside the nut. Tighten the nut against the block with a spanner, while holding the aluminium heater block. It needs to be reasonably tight, but don't force it so hard that you damage anything.

The hot end with the metal parts assembled.



The cooling system (528.1 onwards)

It’s very important that the top of the nozzle remains cold; if filament melts too high up, the pressure required to extrude will increase, and the nozzle will block and stop extruding.

#	Component	Qty	Type
	Hot end hardware	1	Assembled
781	Fan spacer	1	Laser cut
400	Fan	1	Hot end
357	Heatsink	1	Hot end
380	M3x40mm cap screws	2	Fastener

Picture to come

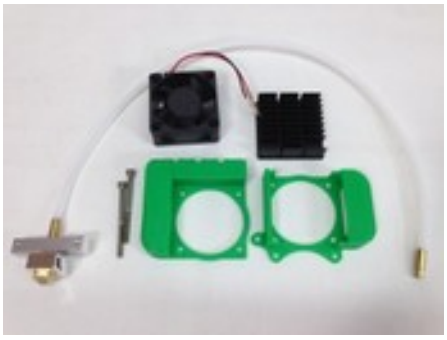
528.1 kits and later (produced after 28th October 2014) have a laser cut fan spacer. Follow the instructions on the other tab, but replace the green fan-duct and nozzle-duct with this acrylic fan spacer.

The laser cut fan spacer replaces the heatsink-duct and fan-duct in the hot end assembly, and is sandwiched between the fan and the heatsink. Make sure it is orientated as shown in the picture, with the extra lug sticking out the side; it is used to mount an optional cooling fan, which will be released shortly.

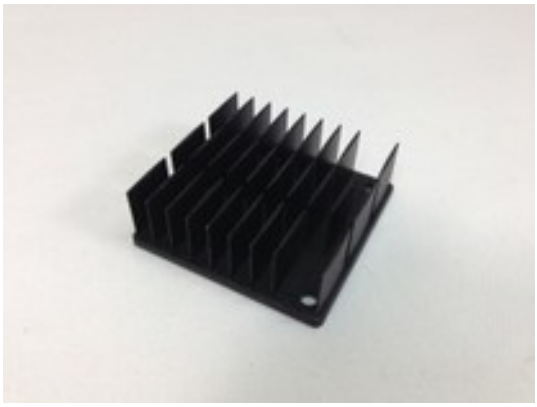
The cooling system (528.0)

It’s very important that the top of the nozzle remains cold; if filament melts too high up, the pressure required to extrude will increase, and the nozzle will block and stop extruding.

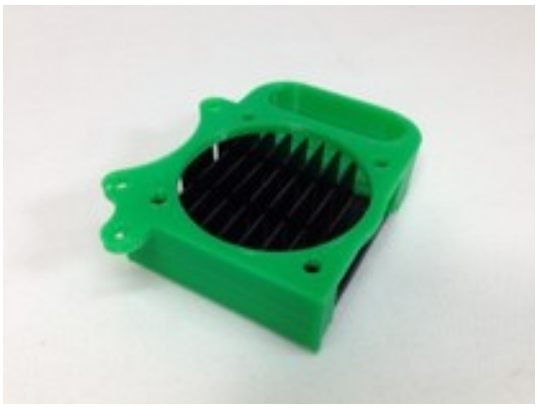
#	Component	Qty	Type
	Hot end hardware	1	Assembled
	heatsink duct	1	Printed
	fan duct	1	Printed
	Fan	1	Hot end
	Heatsink	1	Hot end
	M3x40mm cap screws	2	Fastener



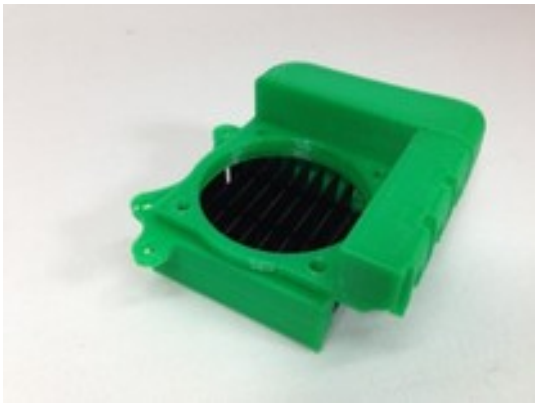
Start with the heatsink. Note it has two holes in it.



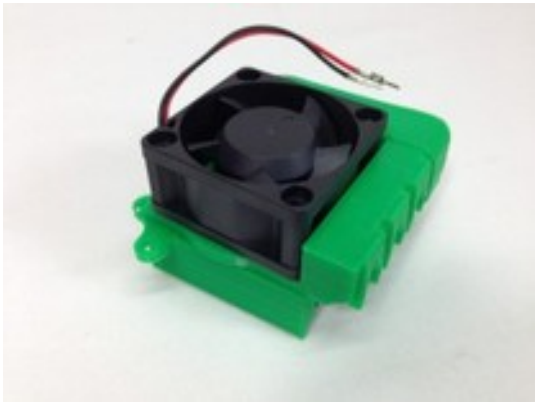
Place the heatsink duct on the heatsink, as shown.



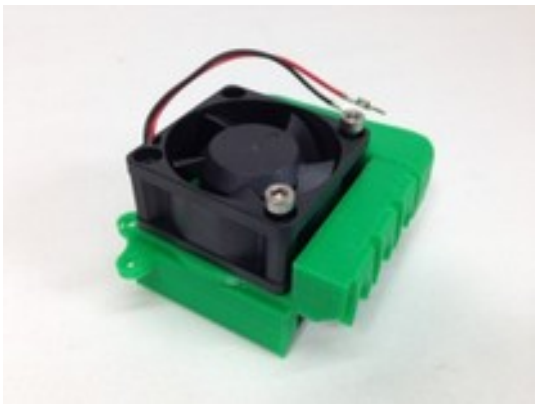
Add the fan duct on top, as shown.



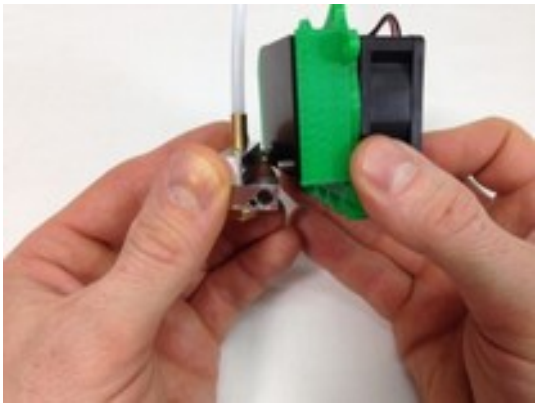
Then add the fan with its wires coming out the top, and the side with the label on it facing inwards.



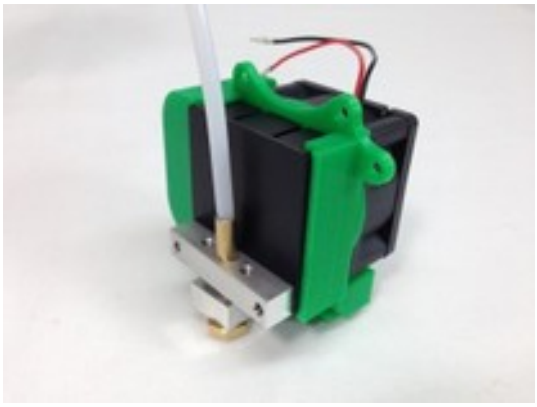
Push the two M3x40mm cap screws through the four parts.



Using the two screws, bolt the heatsink onto the aluminium cooling block firmly. If you have some, you can put a little heatsink compound between the cooling block and the heatsink. Make sure that the heater block is under the heatsink, not sticking out.



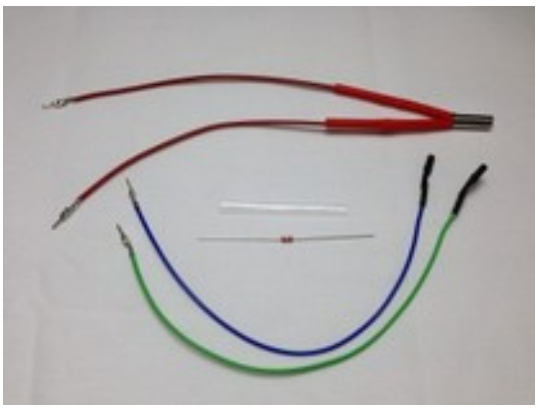
The hot end assembly so far.



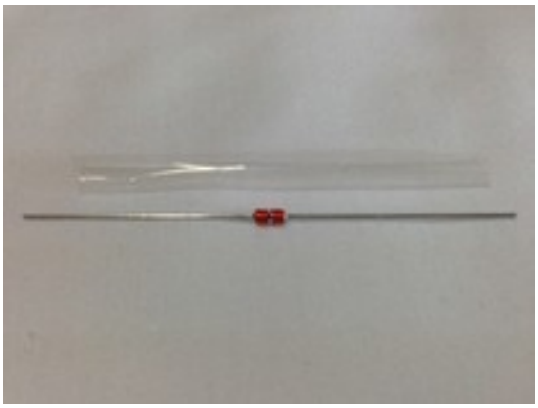
Heater block wiring

The heater block heats the nozzle up to the melting point of the plastic filament, typically around 200C.

#	Component	Qty	Type
	Transparent PTFE heatshrink	about 50mm	Hot end
	100K thermistor	1	Hot end
	Thermistor wiring – 160mm	2	Hot end
	Cartridge heater	1	Hot end

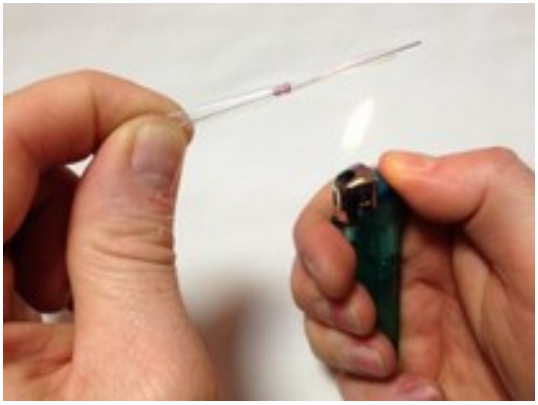


Cut the transparent PTFE heatshrink about 8mm shorter than the thermistor with its axial connecting wires. Put the thermistor in it so that 4mm of wire protrudes from each end.

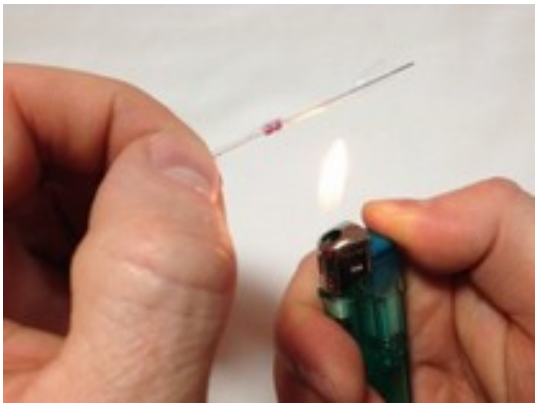


Using a flame (a cigarette lighter, blowtorch, gas hob, or hot air gun work well; a hair dryer does not), shrink the heatshrink over the thermistor. Just waft the thermistor and heatshrink through the flame. You don't want the heatshrink to overheat and to burn.

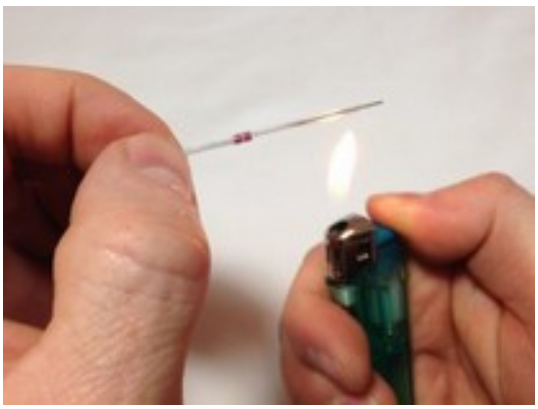
If you're doing this with a cigarette lighter, hold the thermistor at one end, and heat the heatshrink from the middle out to the other end. The heatshrink will be transparent when it has fully shrunk, and will then go back to opaque when the heat is removed. Keep it above, not in, the flame, so it doesn't overheat and go black.



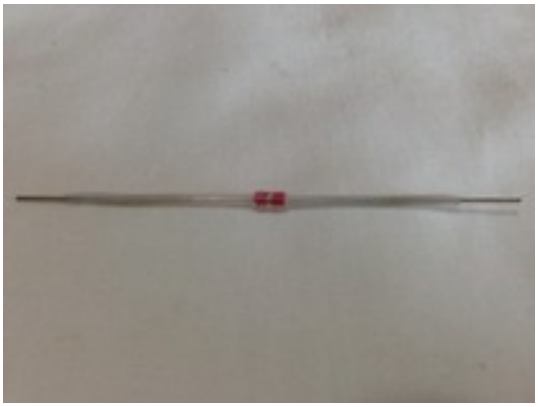
Let it cool for a few moments, then turn it around and do the other side. Rolling the thermistor between your fingers while heating will improve the consistency of the heatshink.



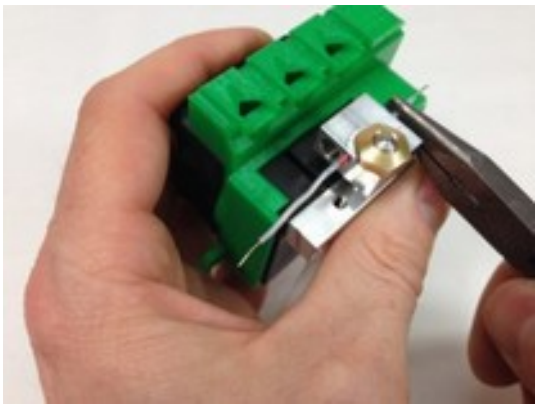
Turn it around again and heat the first side, rolling it in your fingers, to get a really good, even heatshrink. Make sure it has shrunk properly around the central bulge, or it won't fit easily into the heater block.



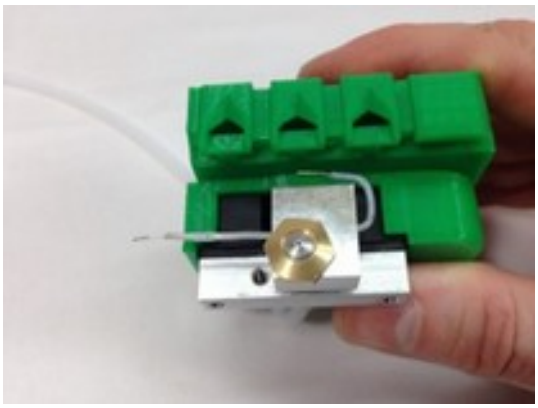
This is how the thermistor should look with the PTFE shrunk onto it.



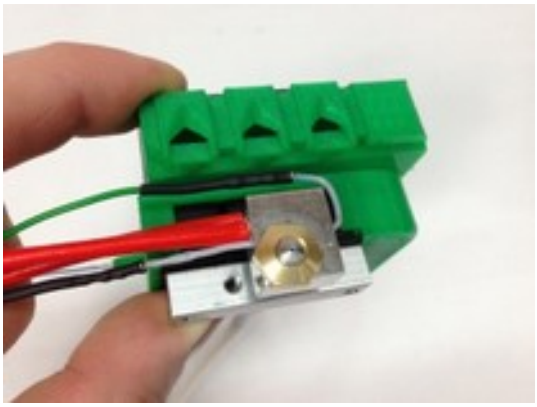
Pull the thermistor through the small hole in the heater block so that it is about half way through. If you pull it with pliers, be gentle, and grip on the PTFE heatshrink, not the bare wire. If it doesn't want to go through, try reheating the heatshrink, for a tighter fit.



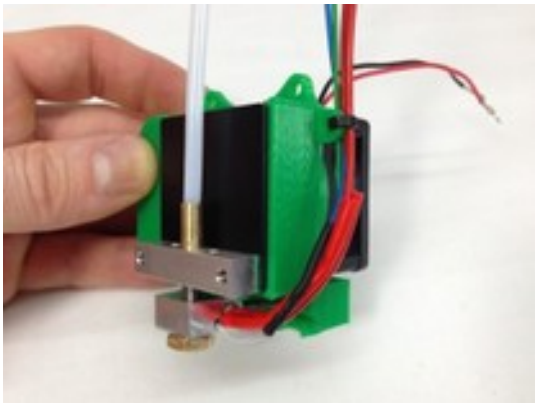
To stop the thermistor falling out, turn the thermistor wire around the back of the heater block as shown. This also means that all the wires go up one side of the hot end.



Attach the thermistor wires, and push the heater cartridge into the heater block.



Bend the wires up the side of the heatsink duct. Put a good, right hand bend in the heater cartridge wire, then secure the thermistor wiring and heater cartridge wires with a cable tie to the loop. Pull it tight, so the wires can't move, and cut the end off the cable tie. The bend in the heater cartridge wire will stop the heater cartridge falling out of the heater block.

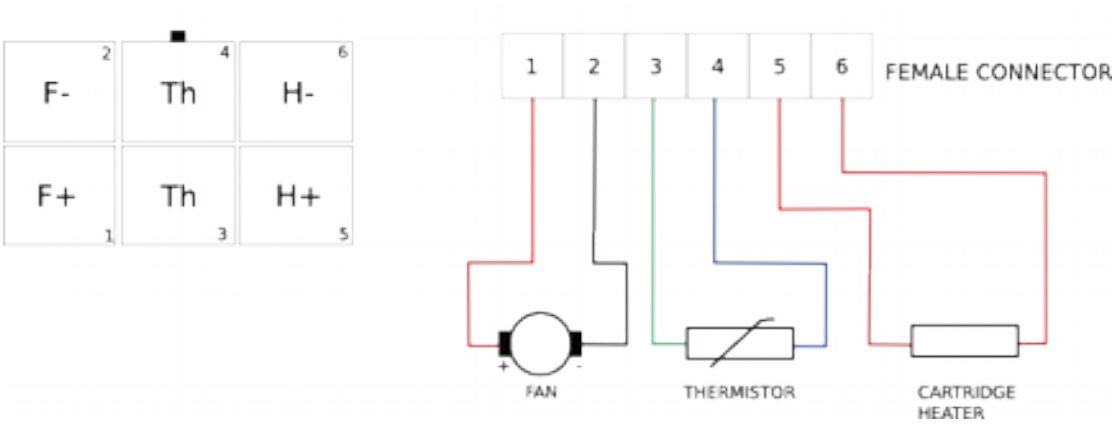


Wiring the hot end connector

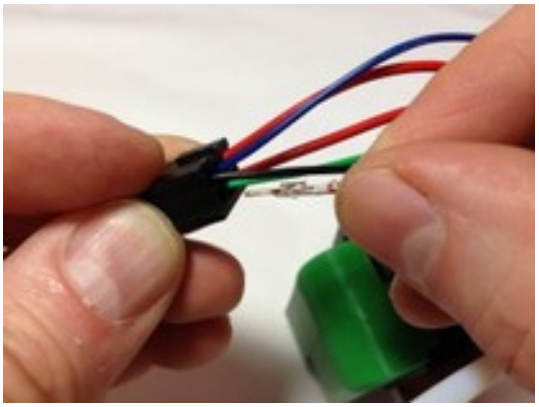
#	Component	Qty	Type
	Hot end assembly	1	Assembled
	2×3 female black crimp socket	1	Hot end

CAUTION! The next step describes wiring up the hot end connector. **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!**

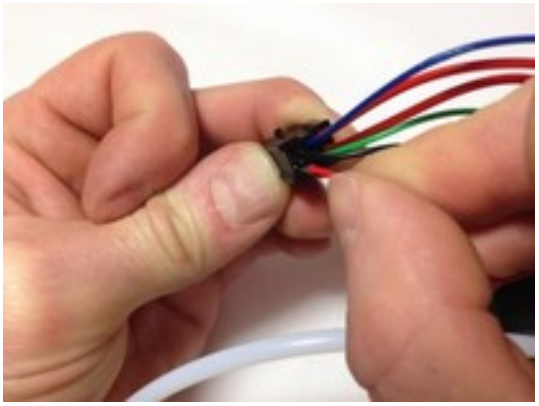
Wiring Diagram



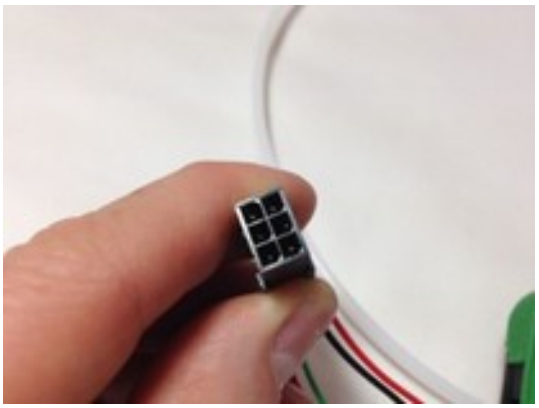
Put the pins on the ends of the wires into the six-way female socket. The wiring diagram, above, is looking into the back of the socket, where you insert the crimps. The little black rectangle is the locking tab, and the housing has small embossed ‘1’ and ‘6’ numbers on it, so you can orientate it as the diagram. The pins are crimped on one side, and smooth on the other. The smooth sides go downwards in the diagram.



Neither the thermistor nor the heater cartridge have a polarity so it doesn’t matter which way round their wires go. (Though the H+ and H- are the way that the machine will apply power – hence the labels.) Make sure to get the polarity of the fan right. This picture shows one of the fan wires being put into the housing, but it is not fully in yet; you can’t see the crimp easily when it is.



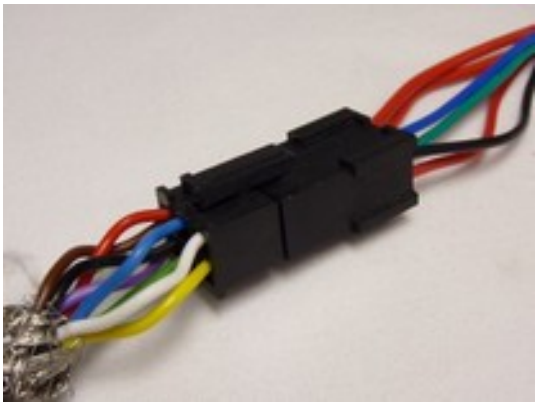
Check that the pins are all the same depth into the housing. The pins are very difficult to remove without damaging them, so check twice, plug in once! They should click into place, and then shouldn’t easily push further through, or pull back out.



Wire colours, related to hot end wiring loom

Wiring loom	Hot end wires
Yellow	Red FAN wire (+12V)
White	Black FAN wire (ground)
Green	Thermistor wire (green/blue, 3.3V)
Blue	Thermistor wire (green/blue, 3.3V)
Purple	Thick red heater wire (+12V)
Black	
Red	Thick red heater wire (ground)
Brown	

You can check the wire order by comparing it to the end of the hot end loom, which the hot end plugs into.



Final assembly and mounting

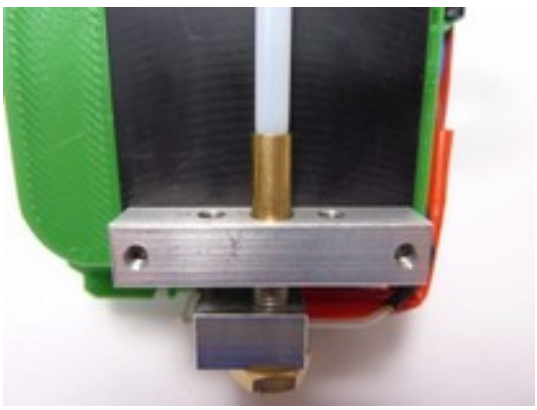
#	Component	Qty	Type
	M3x16mm cap head screws	2	Fastener
	MDF heat insulator	1	Hot end

We usually put a twist in the wiring, so that there is no pulling on any of the wires.

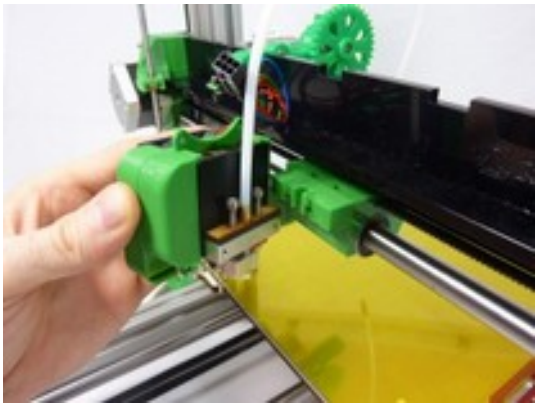
Thread the MDF insulator onto the Bowden tube, and slide it down the tube until sits on top of the aluminium cooling block. Thread the two screws through the MDF insulator and into the aluminium cooling block, as shown. Just put the screw in a couple of turns.

The nozzle should be a couple of millimeters lower than the fan duct when you hold the hot end vertically on a surface.

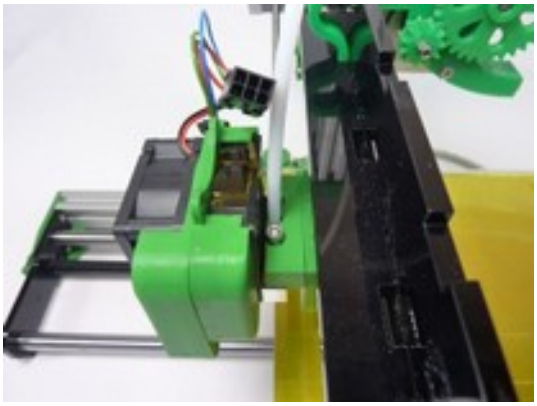
If the nozzle isn’t lower than the fan duct, it’s possible that the nozzle is set too high in the aluminium cooling block. Check that there is very little or no thread showing on the brass union that screws into the aluminium cooling block – this sets the height of the nozzle relative to the fan duct.



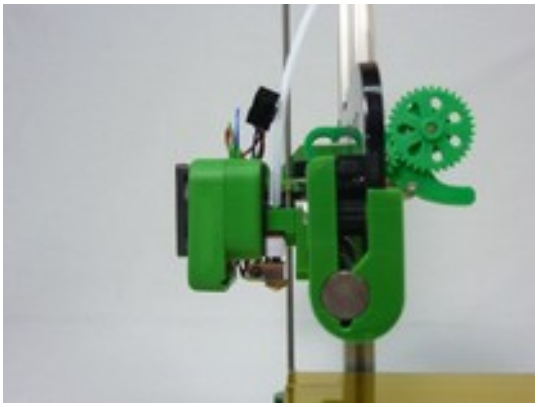
The hot end mounts onto the x-carriage via the nozzle-mount.



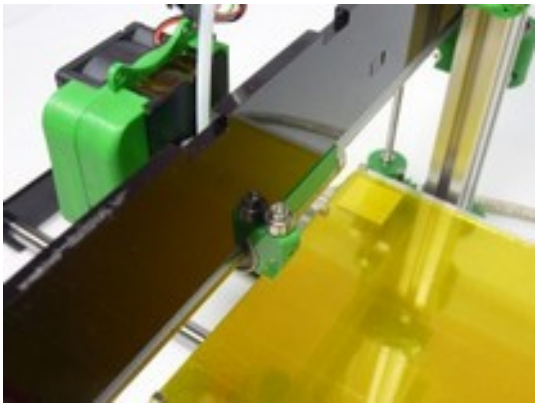
It should push on sideways, and you can then fix it into place using the two screws. The MDF insulator should sit UNDER the nozzle mount, but on top of the aluminium cooling block, so it is sandwiched between them.



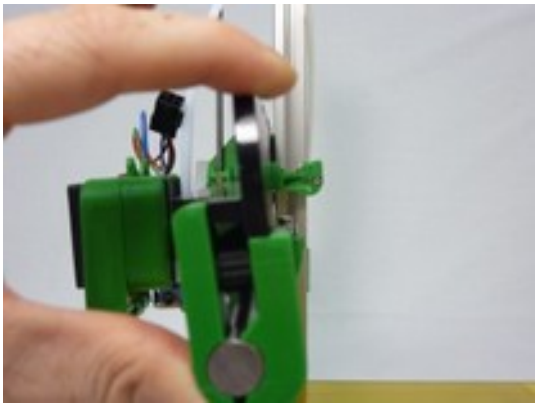
The hot end should be mounted vertically. If the hot end is leaning forward, the fan ducts may be lower than the nozzle. If it leans back, the proximity sensor may be lower. Check that it is seated correctly in the nozzle-mount.



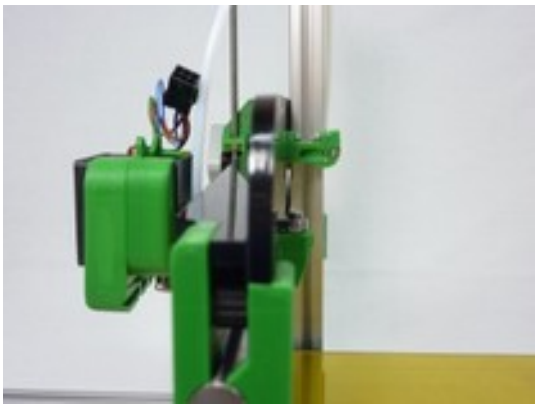
The angle of the hot end can be changed, by adjusting the x-carriage idler bearing on the back of the x-axis-plate. It is mounted in a slot (this may need cleaning to allow the bolt to slide in it), so loosen it, hold the hot end where you want it, then push the bearing against the x-axis-plate and re-tighten. Check that the hot end is vertical.



If the nozzle seems to drop, or rise and fall, as it moves along the X axis, check that the x-axis plate is straight, flat, and vertical along it's length. Remove the extruder, and look along the back of the x-axis-plate. It can twist around the x axis smooth rod; twist it back vertical, and tighten the screw in the x-idler, and the screws in the x-motor-mount.



A view along the back of the x-axis-plate, checking it is straight and flat.



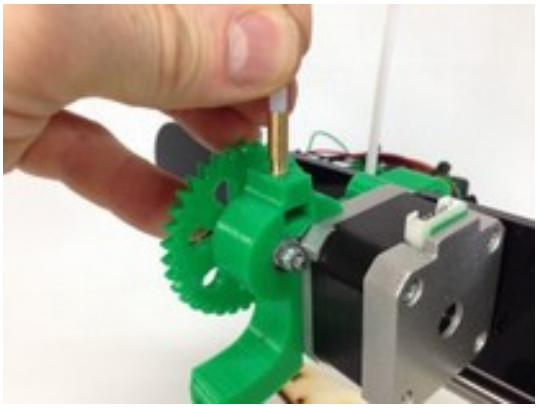
Finally, once printing, the nozzle may droop forward. This usually means that the cooling of the hot end has not been working correctly. Heat may have been getting through the screws and melting the nozzle-mount, which may distort it. Check the hot end construction, that the cooling fan is working, and the bolts holding the fan to the aluminium cooling block are tight.

The tongue

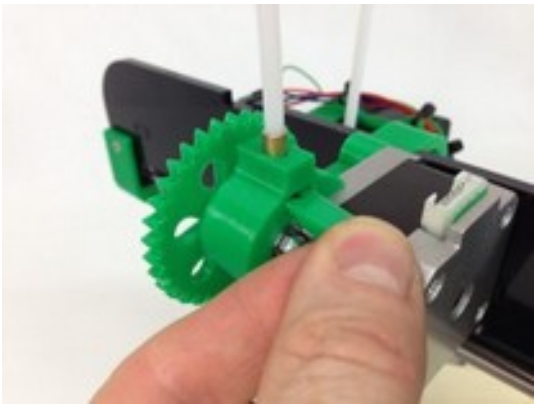
This holds the Bowden tube in the extruder drive.

Now take the retaining tongue out of the drive.

Push the free end of the Bowden tube, with the slotted brass connector, into the hole in the top of the extruder drive. The slot in the brass connector should be visible in the slot in the printed part; ensure the brass connector is pushed all the way in.



The retaining tongue fits in the printed slot as shown, with the flat side of the tongue going upwards. Push the retaining tongue in, until it is firmly engaged with the slotted brass connector. The hole in the end will help you to remove it, if you need to.



Electronics

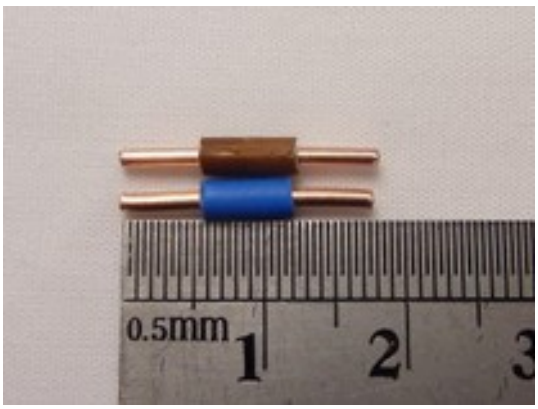
Wiring the Duet

The Duet electronics board controls all the functions of the printer. We use an external 5V regulator board to provide good, clean 5V power.

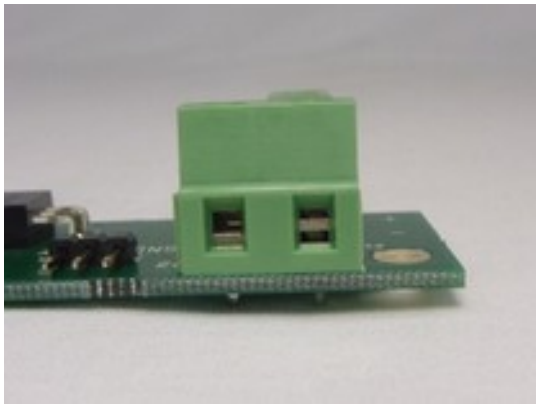
#	Component	Qty	Type
394	Duet PCB	1	Electronics
597	5V regulator PCB	1	Electronics
677	DC power link wire	1	Electronics

Cut open the length of 2-core and earth copper cable and extract the blue and brown cores.

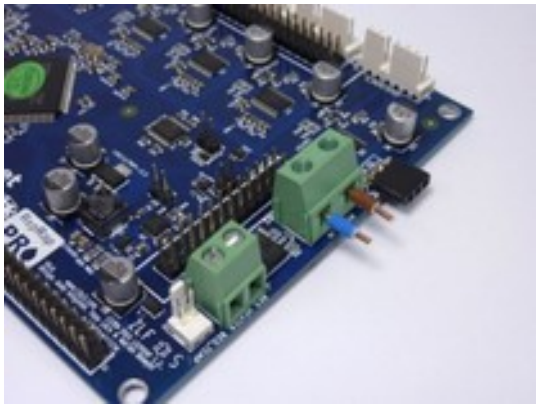
Strip both ends of each core as shown. These dc-power-links should be about 18mm long, with 6mm of exposed wire each end, and 6mm of insulation. You can slip the brown and blue insulation off the copper wires, cut it to length, and slip it back on.



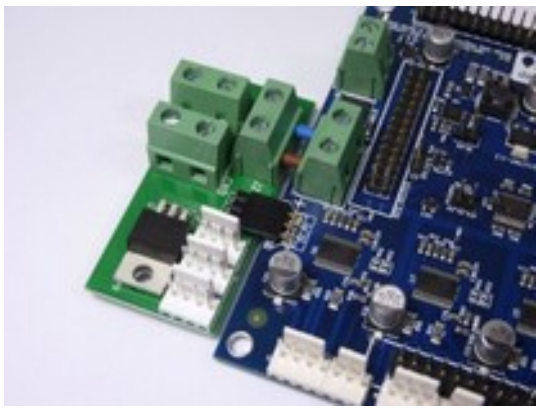
Make sure that the screw gates of all the screw terminals are OPEN. The gate on the left is open, the one on the right is only partially open. They are usually supplied closed, so unscrew them first, before inserting any wire. The screw terminal is tightened by turning the screw clockwise. If the wires are not tight in the terminals, they will not make a good connection, and possibly cause heat to be generated.



Insert the dc-power-links into the Duet's POWER IN screw terminals, and tighten the screw terminals. Make sure the blue and brown wire insulation **IS NOT TRAPPED** by the screw terminals, or you will have a poor connection. These wires carry a lot of current (for the heated bed), so poor connections can get hot. Cut the insulation shorter, or leave it off, if you need to.



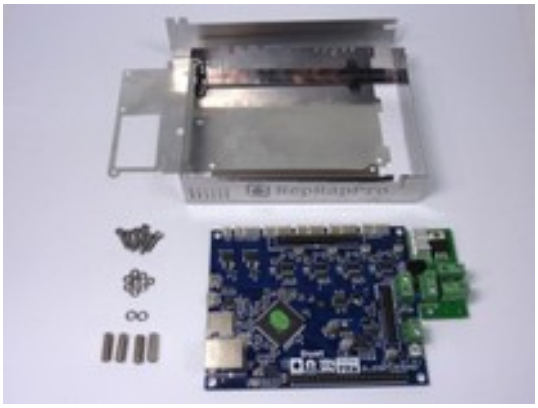
Push on the 5v regulator PCB and secure to the Duet by tightening the screws of the 5v regulator PCB's power output terminal. Again, make sure the blue and brown wire insulation **IS NOT TRAPPED** by the screw terminals, or you will have a poor connection. The three pins on the 5V regulator board should engage in the housing on the Duet.



Mount the Duet in the enclosure

Assemble the electronics enclosure using the following parts:

#	Component	Qty	Type
	Duet board assembly	1	Assembled
578	enclosure-perimeter	1	Sheet metal
576	enclosure-base	1	Sheet metal
257	M3x12mm cap head screw	6	Fastener
258	M3 nut	8	Fastener
212	M3 washer	2	Fastener
581	Hexagonal stand-offs (VBFS-M3-5-16)	4	Fastener

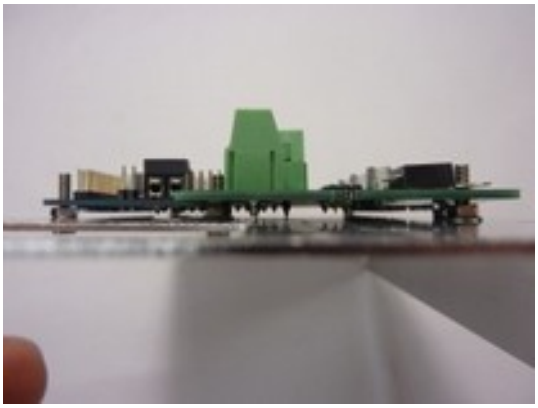


Start by taking the enclosure-base. All the aluminium parts may have oil on them; wipe them over with a paper towel to remove the oil, and any swarf that may be left over from the cutting process. Take 2 x M3x12mm cap head screws, 2 x M3 washers and 2 x M3 nuts, and mount them LOOSELY, as shown. These two screws hold the 5V regulator PCB.

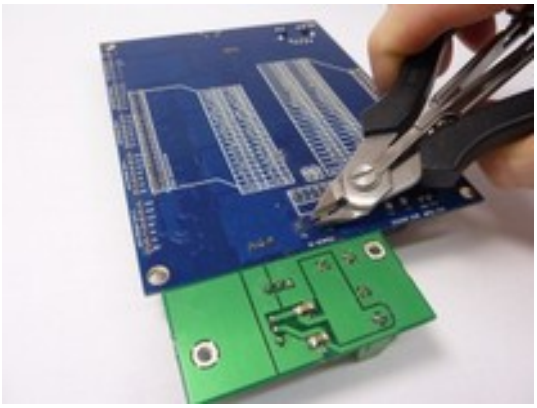
We’re going to trial mount the Duet PCB, to check that there are no short circuits under boards underneath. Mount the other four M3x12mm cap head screws with an M3 nut each, again LOOSELY, as shown.

Place the Duet board on the screws. The nuts act as spacers between the Duet board and the enclosure base.

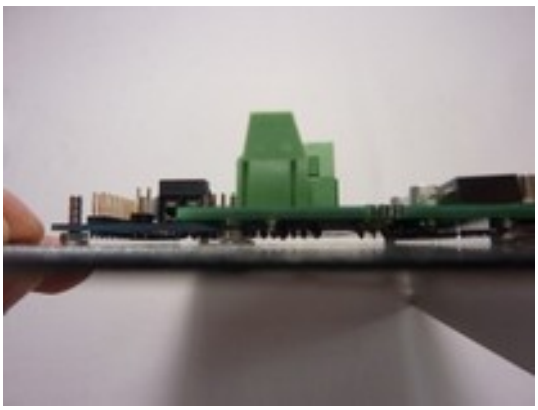
IMPORTANT: Look between the Duet board and the enclosure base. **You do not want any of the soldered pins on the back of the board to touch the metal of the enclosure base.** If they are touching and power is applied to the board, it will short circuit, and potentially damage the board.



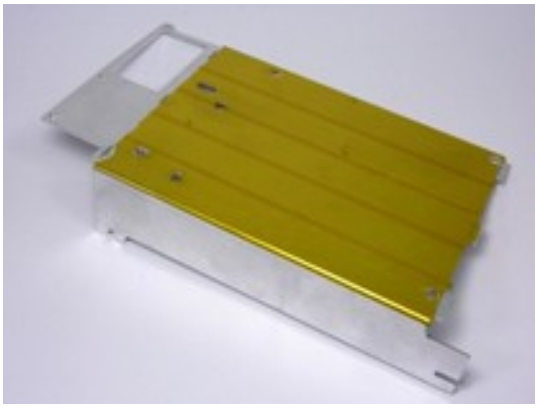
Trim any long pins with a pair of side cutters.



Check again that there is nothing in danger of contacting the enclosure base. Once you are happy nothing is touching, remove the Duet assembly, and remove the four cap head screws with just a nut holding them (no washer).

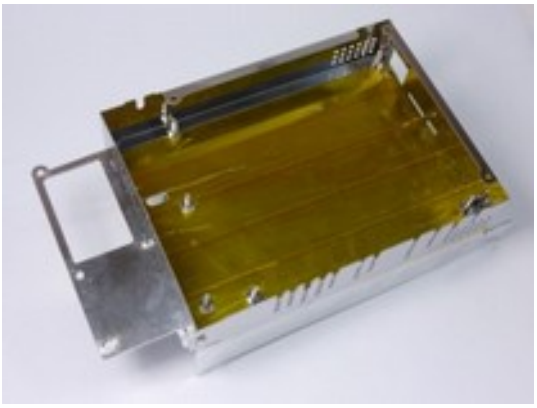


If you wish, you can also put strips of Kapton tape (which is electrically insulating) on the enclosure base, under the Duet.

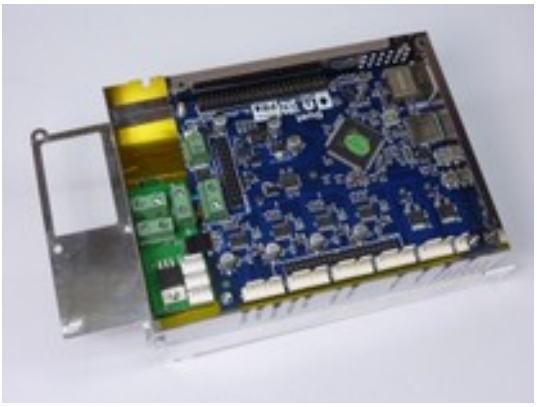


528.3 Onwards (sub-section)

Take the Duet enclosure perimeter. CARE SHOULD BE TAKEN WITH ITS SHARP EDGES. There are three slots in the enclosure base at each end, which correspond to the tabs in the enclosure perimeter. Make sure they are aligned, then slot the two parts together as shown; a fair amount of pushing force can be required to push the tabs into the slots. Secure the Duet perimeter with the four M3x12mm cap head screws, each with an M3 nut. Assemble LOOSELY; the screws need to be able to move a little, to make it easier to fit the Duet board.



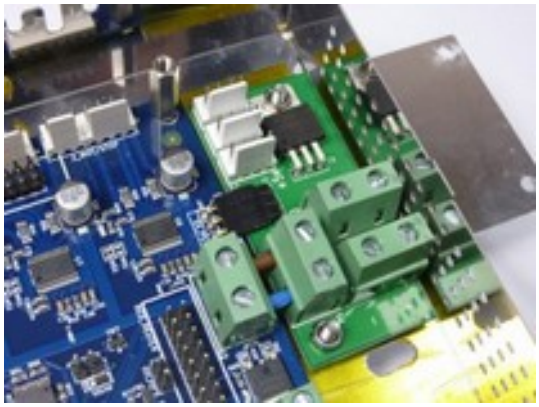
Place the Duet assembly in the enclosure. Line up the screws, so it goes on the mounting holes. Bend over the tab that connects the two ends of the perimeter.



The USB connector is the longest part. Check it comes through the hole at the end, and that the SD card socket and ethernet socket line up. Once the Duet is in place, tighten the six mounting screws; if you push down on the board, the M3 nuts should bite enough to tighten.

Fit the four hexagonal stand-offs on the ends of the mounting screws. This can be quite fiddly, particularly the one by the ethernet socket. To help, screw an M3x8mm countersunk screw into one end of the stand-off, and position the stand-off on the mounting screw with long nosed pliers. Tighten by using an Allen key in the countersunk screw, through the hole in the metal perimeter. Remove the countersunk screw from the stand-off by holding the stand-off with long nosed pliers. Repeat the process until you have tightened all of them.

The last two M3 nuts secure the 5V regulator PCB. The one that goes through the component (the 5V regulator) is particularly important; it is used to heatsink this to the enclosure back. Make sure it is securely fixed.



Check all the M3x12mm cap head screws are tight underneath, and the Duet board is securely held, and the stand-offs are screwed down fully too. The completed assembly is shown here.

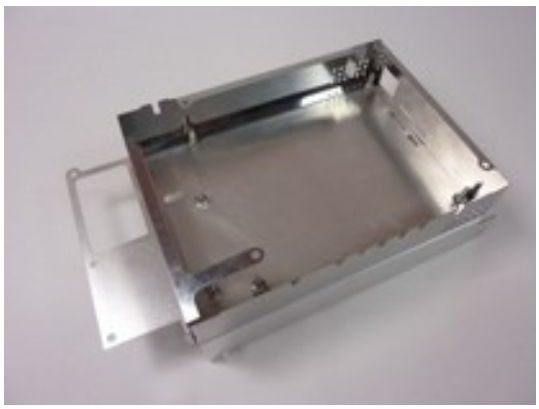
IMPORTANT!

With a multimeter, check the resistance between the screws of the Duet's POWER IN terminal (between +12V and ground). Except for the charging of capacitors (which will take a few seconds), this should be open circuit. If there is a short circuit (no resistance), double-check no pins of the Duet or 5V regulator board are touching the metal enclosure. Much easier to check now than later!

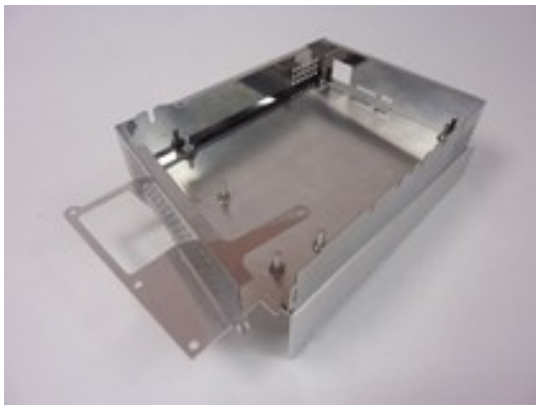
528.0 – 528.2 (sub-section)

Take the Duet enclosure perimeter, and fold it until the semi-circular external tag passes through the small slot. CARE SHOULD BE TAKEN WITH ITS SHARP EDGES. Do not bend the tab over yet! There are three slots in the enclosure base at each end, which correspond to the tabs in the enclosure perimeter. Make sure they are aligned, then slot the two parts together as shown; a fair amount of pushing force is required to push the tabs into the slots.

Secure the Duet perimeter with the four M3x12mm cap head screws, each with an M3 nut. Assemble LOOSELY; the screws need to be able to move a little, to make it easier to fit the Duet board.



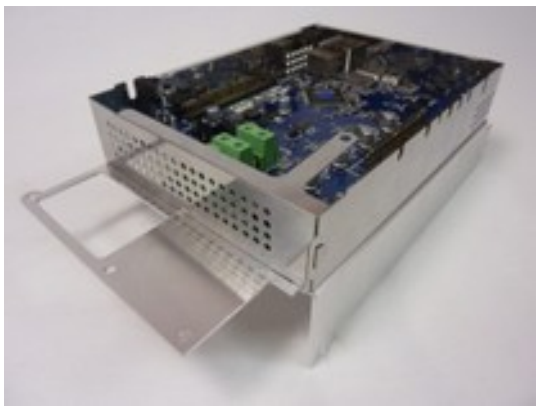
Unhook the part of the Duet perimeter with the external tab, and release the three tabs where it goes into the enclosure base. This should give you the space to put the Duet board in.



Place the Duet assembly in the enclosure. Line up the screws, so it goes on the mounting holes.

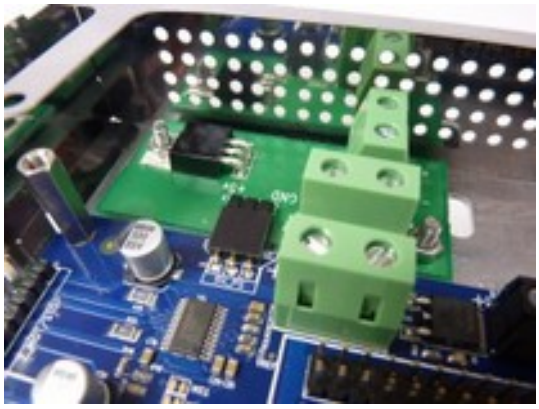
The USB connector is the longest part. Check it comes through the hole at the end, and that the SD card socket and ethernet socket line up.

Once the Duet is in place, refit the enclosure perimeter in the tab slots. Bend over the external tab to secure it. Tighten the six mounting screws; if you push down on the board, the M3 nuts should bite enough to tighten.



Fit the four hexagonal stand-offs on the ends of the mounting screws. This can be quite fiddly, particularly the one by the ethernet socket. To help, screw an M3x8mm countersunk screw into one end of the stand-off, and position the stand-off on the mounting screw with long nosed pliers. Tighten by using an Allen key in the countersunk screw, through the hole in the metal perimeter. Remove the countersunk screw from the stand-off by holding the stand-off with long nosed pliers. Repeat the process until you have tightened all of them.

The last two M3 nuts secure the 5V regulator PCB. The one that goes through the component (the 5V regulator) is particularly important; it is used to heatsink this to the enclosure back. Make sure it is securely fixed.



Check all the M3x12mm cap head screws are tight underneath, and the Duet board is securely held, and the stand-offs are screwed down fully too. The completed assembly is shown here.

IMPORTANT!

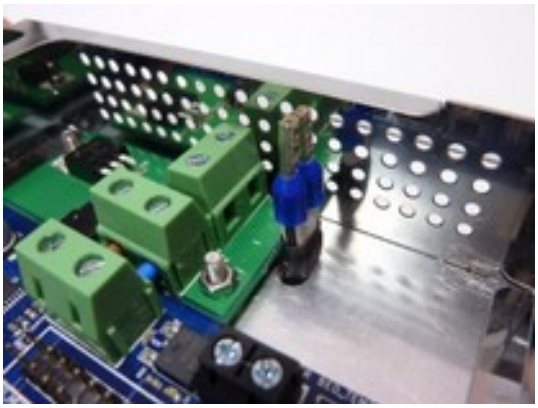
With a multimeter, check the resistance between the screws of the Duet's POWER IN terminal (between +12V and ground). Except for the charging of capacitors (which will take a few seconds), this should be open circuit. If there is a short circuit (no resistance), double-check no pins of the Duet or 5V regulator board are touching the metal enclosure. Much easier to check now than later!

Power supply wiring (528.2 onwards)

TIP: Some sections of the instructions are arranged in tabs, with alternate parts and instructions, depending on the version of your kit. Below, the tabs are marked '528.2 ONWARDS' and '528.0, 528.1'. These refer to the version number of the Ormerod kit. Your Ormerod kit version number is marked on the sticker on the power supply (on 528.2 and later kits), or on the x-rib (for earlier kits). Use the LATEST version number – some kits have the 528.2 PSU, but the 528.1 x-rib. Use the set of instructions that relate to your printer.

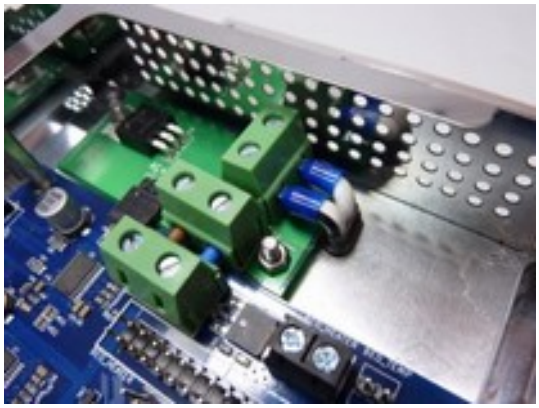
#	Component	Qty	Type
831	12V Power supply	1	Hardware
	Duet assembly	1	Assembled
592	AC power cable – 90mm	3	Wiring
668	Earth loop wire	1	Wiring
591	DC power cable	1	Wiring

Pass the ends of the DC power cable up through the slot in the enclosure-base to come out near the power input terminal of the 5v regulator PCB. The wire with the black stripe is used for the V- (ground) terminal. The heat shrink on the cable can act as protection for the wires where they pass through the metal enclosure.



Check the screw gates are open, then insert the DC power cable ends into the screw terminal. A pair of long-nosed pliers helps. **Ensure that the positive (no stripe) and ground (black stripe) wires are the correct way round.**

Tighten the screw terminals on the DC cable ends.

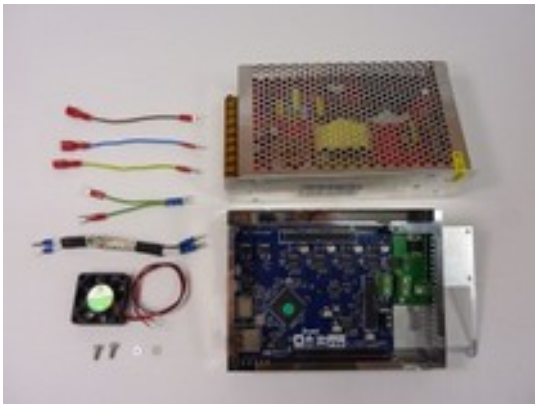


All of the wires connect to the PSU through insulated spade terminals. Open the small clear connector cover, to access the screws. The brown wire goes to Live, the blue to Neutral, and the green and yellow stripe to Ground/Earth. The Y-shaped earth loop goes from Ground/Earth to the next connector along (COM or Negative/V-). Make sure the screw terminals are tight, and the wires are secure.

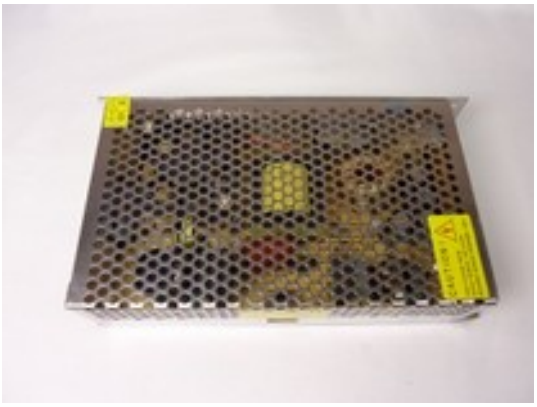
Power supply wiring (528.0 & 528.1)

TIP: Some sections of the instructions are arranged in tabs, with alternate parts and instructions, depending on the version of your kit. Below, the tabs are marked ‘528.2 ONWARDS’ and ‘528.0, 528.1’. These refer to the version number of the Ormerod kit. Your Ormerod kit version number is marked on the sticker on the power supply (on 528.2 and later kits), or on the x-rib (for earlier kits). Use the LATEST version number – some kits have the 528.2 PSU, but the 528.1 x-rib. Use the set of instructions that relate to your printer.

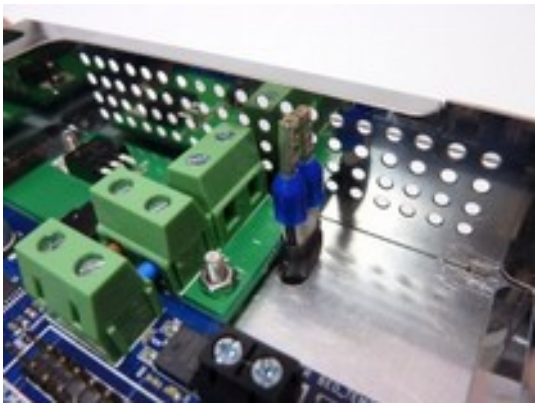
#	Component	Qty	Type
218	12V Power supply	1	Hardware
	Duet assembly	1	Assembled
592	AC power cable – 90mm	3	Wiring
668	Earth loop wire	1	Wiring
591	DC power cable	1	Wiring
953	12V fan (if supplied)	1	Electronics
111	M3x8mm cap head screw	2	Fastener
212	M3 washer	2	Fastener



Since mid-October 2014, we now ship PSUs with an integrated fan, which is just visible in the picture, inside the PSU in the upper left hand side, secured by two screws to the top of the case. If you have one of these, you do not need to fit the extra PSU cooling fan.

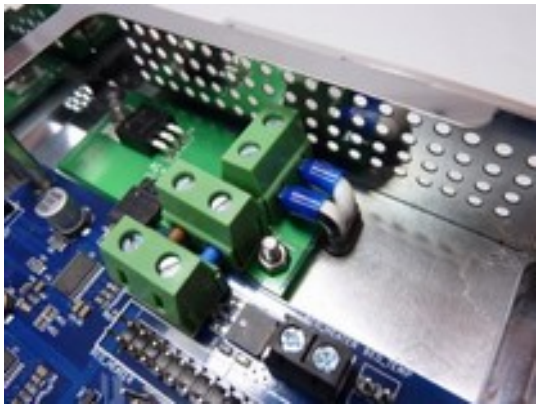


Pass the ends of the DC power cable up through the slot in the enclosure-base to come out near the power input terminal of the 5v regulator PCB. The wire with the black stripe is used for the V- (ground) terminal. The heat shrink on the cable can act as protection for the wires where they pass through the metal enclosure.



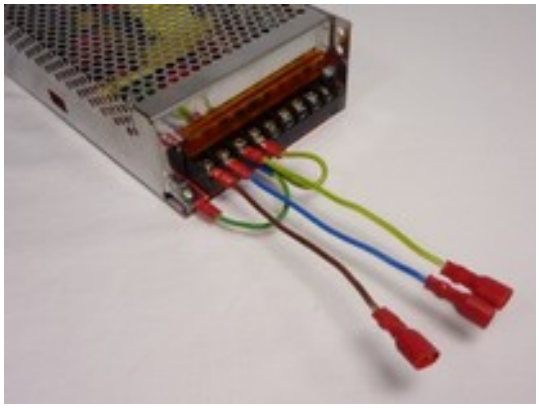
Check the screw gates are open, then insert the DC power cable ends into the screw terminal. A pair of long-nosed pliers helps. **Ensure that the positive (no stripe) and ground (black stripe) wires are the correct way round.**

Tighten the screw terminals on the DC cable ends.

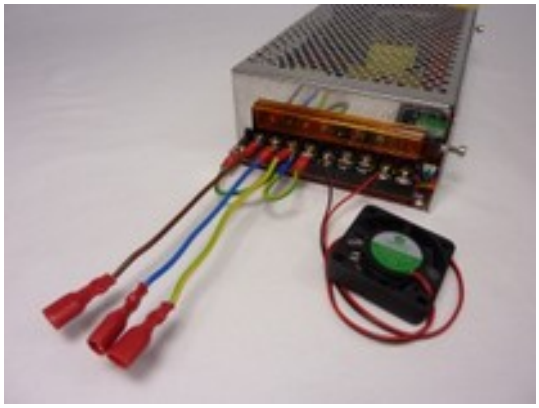


Take the power supply, and screw the M3x8mm cap head screws into the side of the power supply unit, with an M3 washer on each screw, leaving them loose as shown.

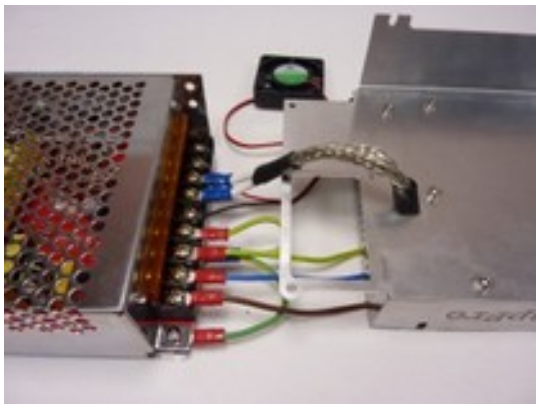
All of the wires connect to the PSU through insulated spade terminals. Lift the small orange connector cover. The brown wire goes to Live, the blue to Neutral, and the green and yellow stripe to Ground/Earth. The Y-shaped earth loop goes from Ground/Earth to the next connector along (COM or Negative/V-) and to the corner of the case, under the tab (closest to the camera in the picture). Make sure the screw terminals are tight, and the wires are secure.NOTE: Ormerod 2 kits shipped before November 2014 will have a single earth loop, not a Y-shaped one. Either add a second earth wire, or contact RepRapPro support for the correct wire.



(Ignore this step if your PSU has an integrated fan.) Cut the fan wire to about 30cm long. Strip about 8mm of insulation from the end, and tin them with solder if you wish. There are three V- terminals, next to the AC power input terminals, then three V+ terminals. There is diagram of the inputs and outputs on the back of the PSU, but it may not line up with the terminals, so be careful! Connect the black wire to V- on the PSU, and the red wire to V+.



Connect the DC power cable from the Duet to the 12V PSU. The wire with the black stripe should be negative; connect it to V-, and connect the other wire to V+.



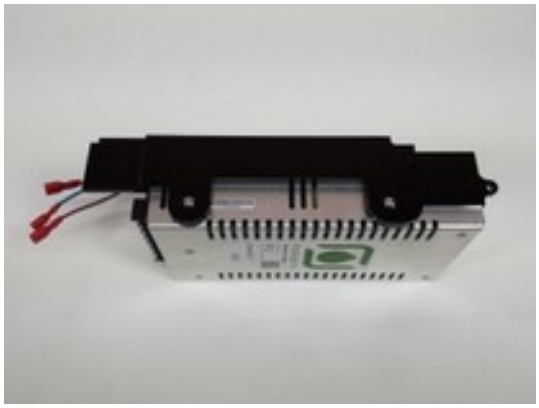
Power supply covers (528.2 onwards)

Note: There are no equivalent cut acrylic parts for the earlier revisions!

#	Component	Qty	Type
	Power supply assembly	1	Assembled
	Duet assembly	1	Assembled
825	Inner PSU plate (5mm acrylic)	1	Laser cut

826	Inner PSU spacer (3mm acrylic)	1	Laser cut
823	PSU spacer (5mm acrylic)	1	Laser cut
824	PSU Cover spacer (3mm acrylic)	1	Laser cut
818	M3 standoffs	3	Fastener
111	M3x8mm cap head screw	2	Fastener
651	M4x12mm button head screw	2	Fastener

Fit the inner-psu-spacer and inner-psu-plate to the PSU using two M4x12mm button head screws as shown. DO NOT use screws longer than 12mm! They may come in contact with components inside the power supply!



Flip the PSU over and fit the psu-spacer using two M3x8mm cap head screws.

Screw the three M3 standoffs through the psu-cover-spacer and into the psu-spacer. The standoffs should self-tap into the acrylic of the psu-spacer.

Mounting the Duet on the power supply (528.2 onwards)

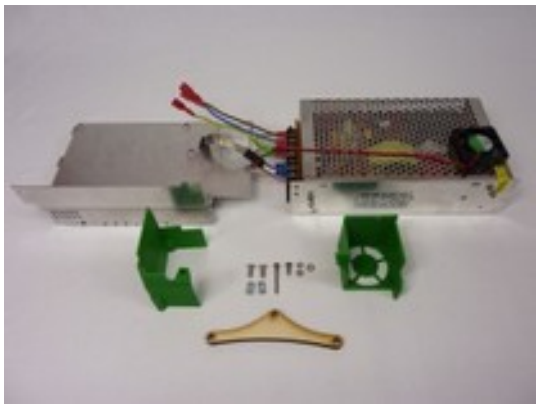
#	Component	Qty	Type
	Power supply assembly	1	Assembled
	Duet assembly	1	Assembled
111	M3x8mm cap head screw	2	Fastener

Screw the 12v power cable into the PSU V+ and V- terminals. Ensure to fit the wire with the black line along its length to the V- terminal.

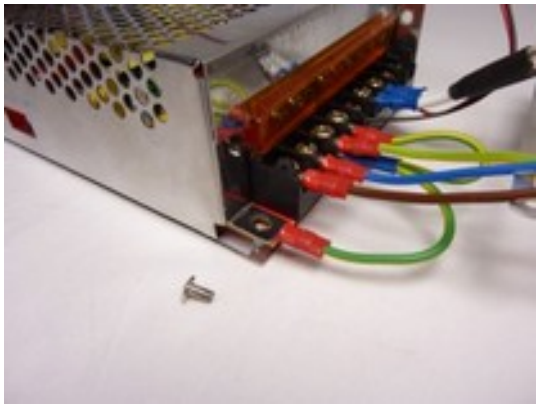
Mount the Duet enclosure to the PSU assembly using the M3x8mm cap head screws as shown.

Mounting the Duet on the power supply (pre 528.2)

#	Component	Qty	Type
	Power supply assembly	1	Assembled
	Duet assembly	1	Assembled
	ac-cover	1	Printed
	fan-housing (if supplied)	1	Printed
	Spacer (6mm ply)	1	Lasercut
112	M3x25mm cap head screw	1	Fastener
111	M3x8mm cap head screw	1	Fastener
212	M3 washer	1	Fastener
258	M3 nut	2	Fastener
651	M4x10mm button head screw	2	Fastener
497	M4 T-nut	2	Fastener



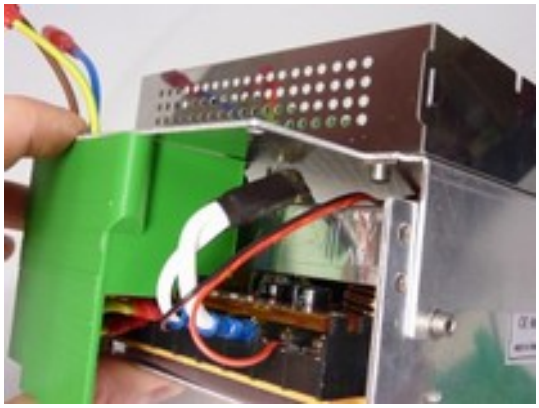
On the corner of the PSU next to the AC power connections, remove the screw fixing the case to the PCB.



Attach the ac-cover using the M3x25mm cap head screw in the place of the screw you removed. Make sure the orange terminal cover on the PSU is closed! Also check that the screw firmly holds the earth wire.

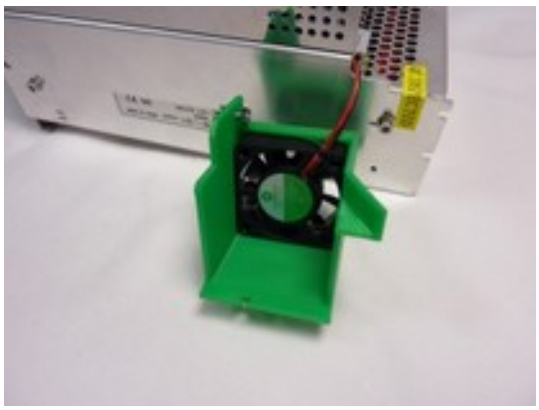
Fold the Duet enclosure over, on top of the PSU. Thread the mains wires through the hole in the enclosure base. Slide the enclosure under the washers and tighten the screws to secure it. Make sure the fan wire runs underneath the Duet enclosure (Ignore this if your PSU has an integrated fan).

The 12V wiring should be kept separate from the AC input wires.

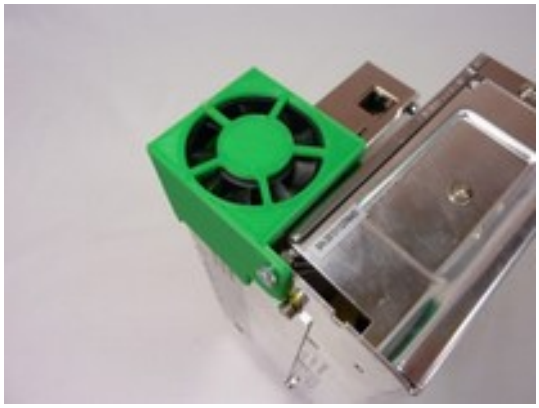


Connect the lasercut spacer to the PSU. Use the M3 nut and M3 washer to hold it at one end, and one M4 button head screw and one M4 T-nut at the other end. Fit the other M4 button head screw through the middle, lower hole of the spacer and loosely screw on the T-nut.

(Ignore this step if your PSU has an integrated fan.) Clip the 12V fan into the fan-housing printed part, with the label showing. This ensures the fan is blowing into the PSU.



(Ignore this step if your PSU has an integrated fan.) Attach the fan housing on the PSU with an M3x8mm cap head screw and M3 nut. The tab sits under the Duet enclosure-base, to help support it.



Fitting the IEC socket (528.2 onwards)

#	Component	Qty	Type
	PSU and Duet assembly (not shown)	1	Assembled
598	IEC fused and switched socket	1	Electronics
599	Fuse	1	Electronics
651	M4x10mm button head screw	2	Fastener
497	M4 T-nut	2	Fastener

Push the fuse holder out of the socket. There is a hole in the bottom of the socket; use an Allen key to push it out.

Insert the fuse into the holder as shown. There is space to put a second, spare, fuse in the square hole.

Push the fuse and fuse holder back in. There is a tab on one side, which fits in a slot in the socket. This means the fuse cannot be removed with the power cord plugged in.

Push the fuse holder down until it is flush with the surface.

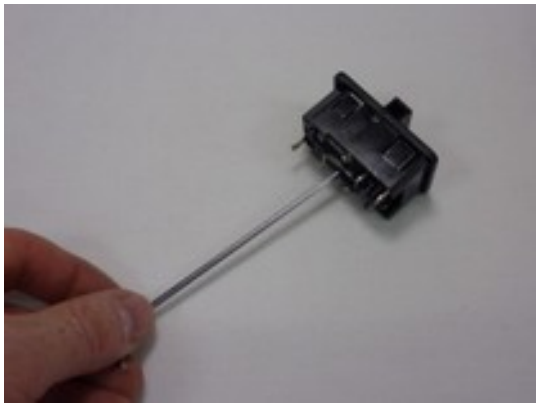
Connect the mains wires to the spade terminals on the back of the IEC socket as shown.

Loosely fit two M4x10mm button head screws and M4-T-nuts into the psu-spacer.

Fitting the IEC socket (pre 528.2)

#	Component	Qty	Type
	PSU and Duet assembly (not shown)	1	Assembled
598	IEC fused and switched socket	1	Electronics
599	Fuse	1	Electronics
	psu-brace	1	Printed
242	M3x16mm cap head screw	2	Fastener
650	M4x35mm button head screw	1	Fastener
497	M4 T-nut	1	Fastener

Push the fuse holder out of the socket. There is a hole in the bottom of the socket; use an Allen key to push it out.



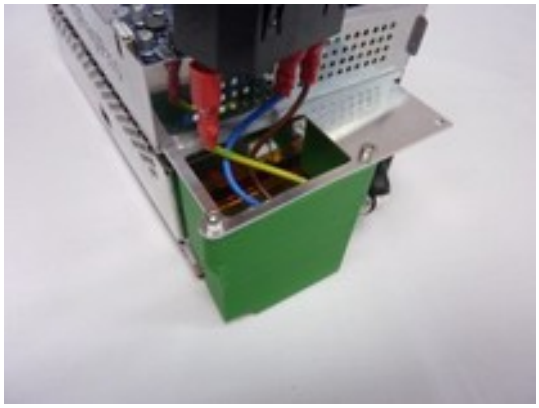
Insert the fuse into the holder as shown. There is space to put a second, spare, fuse in the square hole.

Push the fuse and fuse holder back in. There is a tab on one side, which fits in a slot in the socket. This means the fuse cannot be removed with the power cord plugged in.

Push the fuse holder down until it is flush with the surface.

Connect the mains wires to the spade terminals on the back of the IEC socket as shown.

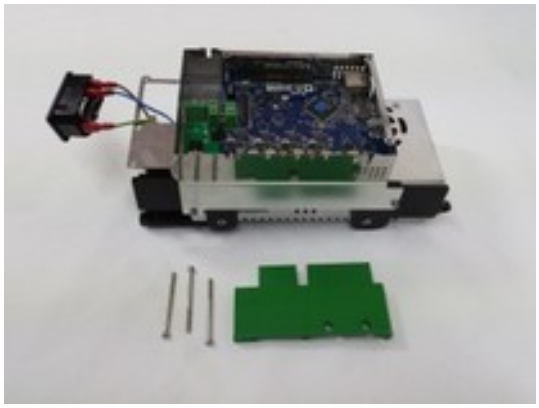
Secure the enclosure-base to the ac-cover using two M3x16mm screws.



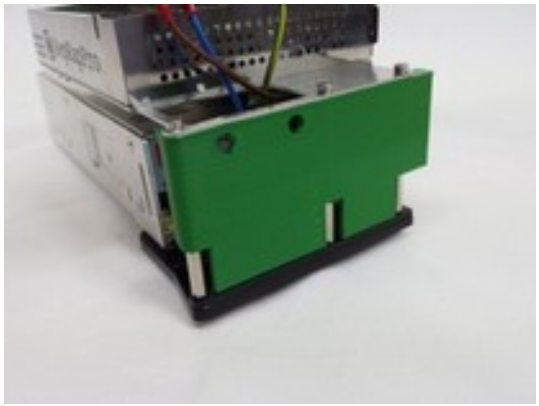
PSU lower cover (528.2 onwards)

Note: There are no equivalent cut acrylic parts for the earlier revisions!

#	Component	Qty	Type
	PSU and Duet assembly	1	Assembled
820	psu-cover	1	Printed
465	M3x50mm cap head screw	3	Fastener



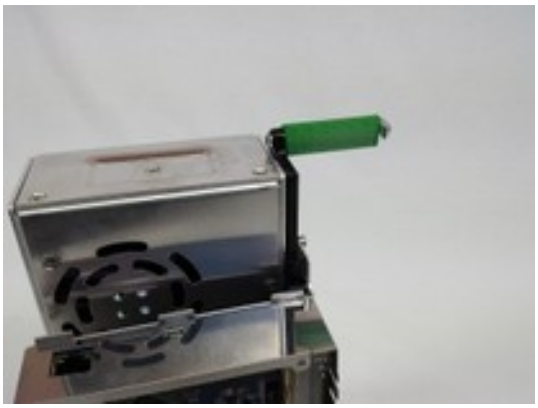
Fit the psu-cover using the M3x50mm cap head screws.



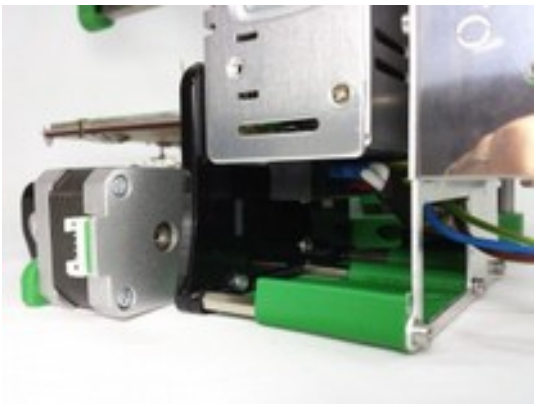
Final mounting (528.2 onwards)

#	Component	Qty	Type
	PSU and Duet assembly	1	Assembled
821	psu-brace	1	Printed
822	outer-psu-plate (3mm acrylic)	1	Laser cut
829	M4x50mm button head screw	2	Fastener
651	M4x10mm button head screw	2	Fastener
497	M4 T-nut	1	Fastener

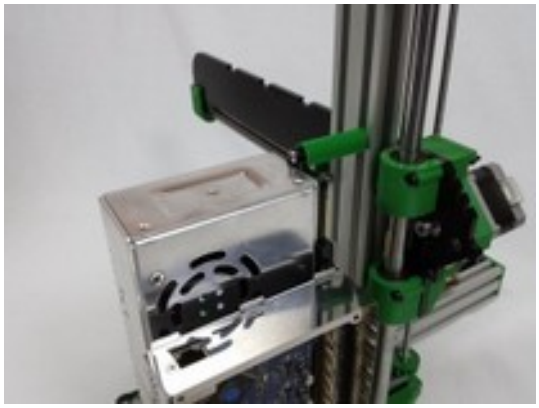
Fit the psu-brace using the M4x50mm button head screw and T-nut.



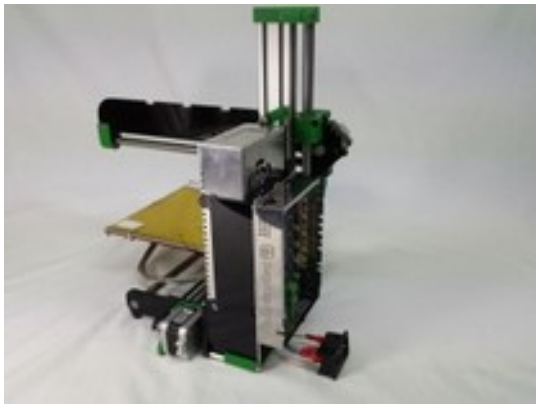
Before fitting the PSU, remove the M3x40mm cap head screw that holds the Y motor. Engage the two T-nuts in the Y axis aluminium extrusion, through the IEC socket hole, but do not fully tighten, so you can adjust the position of the PSU assembly. Use the M3x50mm cap head screw with an M3 washer, through the two acrylic laser cut parts, and screw into the Y motor.



Slide the PSU assembly to engage the T-nut of the psu-brace into the Z axis aluminium extrusion. Adjust the position of the PSU assembly, then tighten the two lower T-nuts and the psu-brace mounts as necessary.



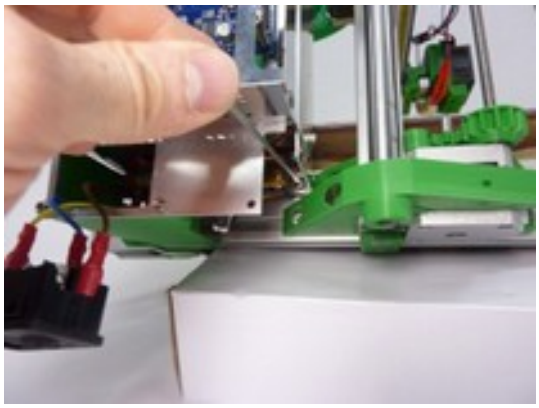
Screw the outer-psu-plate to the PSU using the M4x10mm button head screws.



Finally, push the IEC socket into the aperture in the enclosure base, with the power cord socket on the outside edge. Push the wires back into the housing and push the IEC socket into the aperture until it clicks.

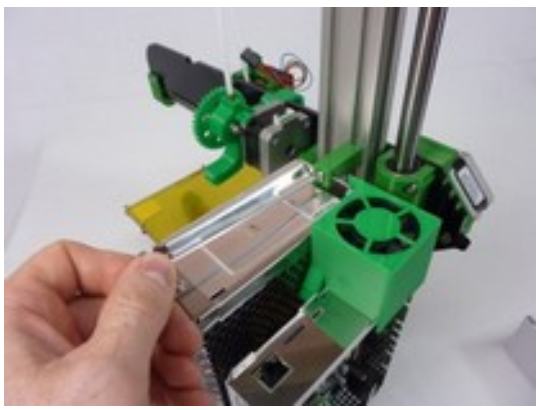
Final mounting (pre 528.2)

Mount the power supply assembly to the y-axis aluminium extrusion. The T-nut on the right-hand-side is the most fiddly; secure this one first, so that the T-nut has turned and engaged, but don’t fully tighten it, so the position of the PSU assembly can be adjusted.



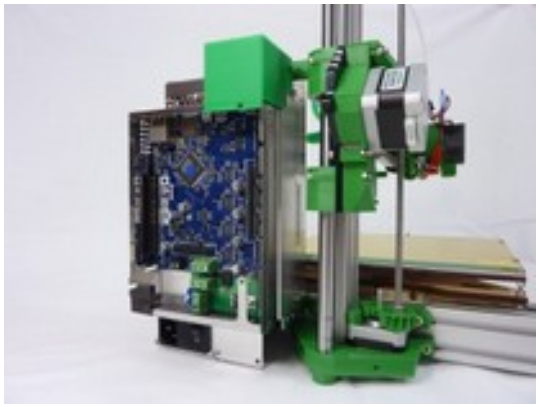
Engage the second T-nut, through the IEC socket hole.

Put the M4x35mm button head screw though the psu-brace printed part, and put an M4 T-nut on the end. The psu-brace can then be slid onto the top of the power supply unit, and secured into the Z axis aluminium extrusion. Adjust then tighten the two lower T-nuts mounts as necessary.



Finally, push the IEC socket into the aperture in the enclosure base, with the power cord socket on the outside edge. Push the wires back into the housing and push the IEC socket into the aperture until it clicks.

The completed, and mounted, PSU and Duet assembly.



Wiring

Wiring the printer

CAUTION: Never plug in or unplug motors or heaters when the power is on or the USB is plugged in.

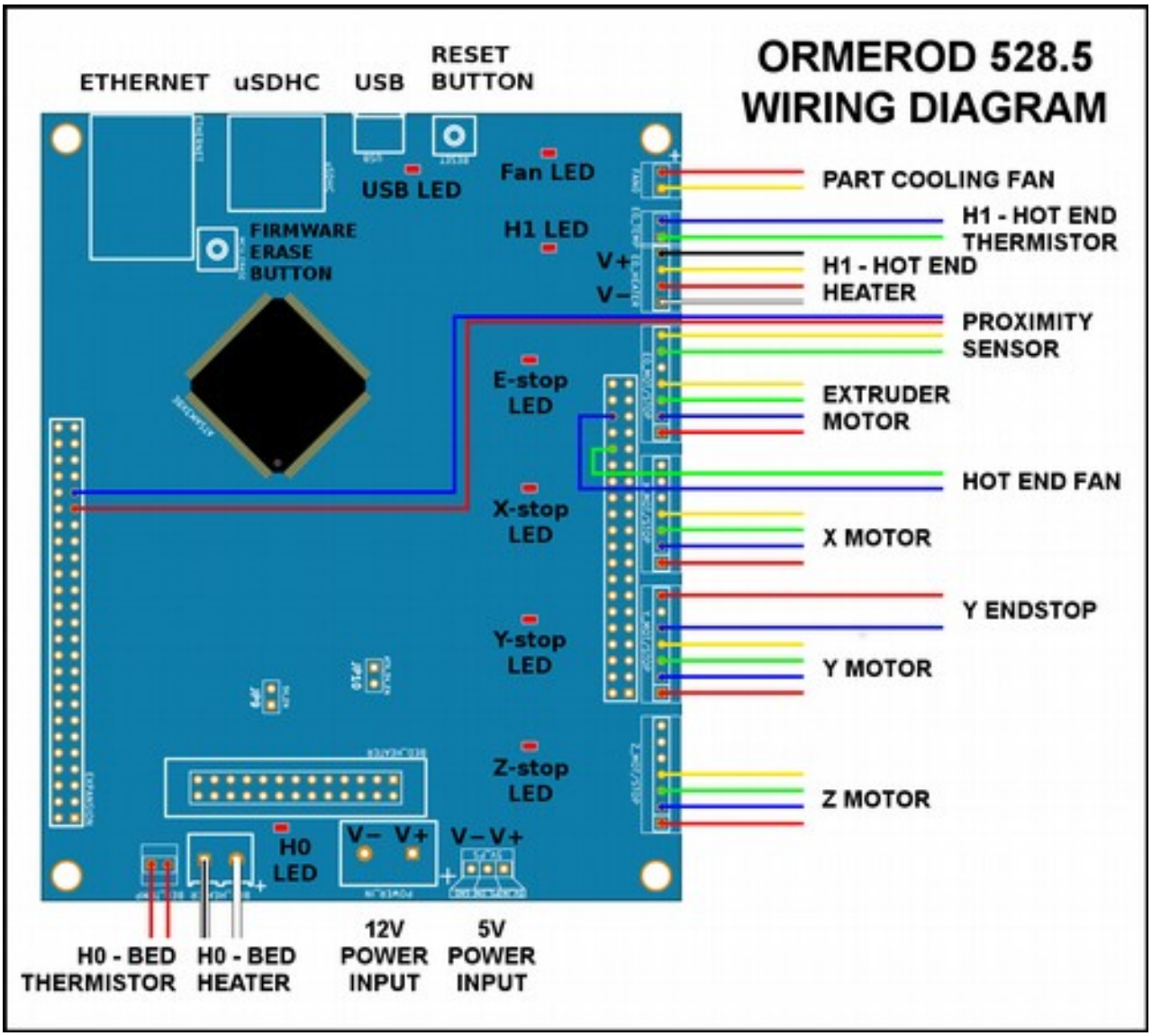
Especially with the motors, you risk damaging the motor driver chip, and rendering the whole Duet board useless.

This includes unplugging the motor end of the loom, too.

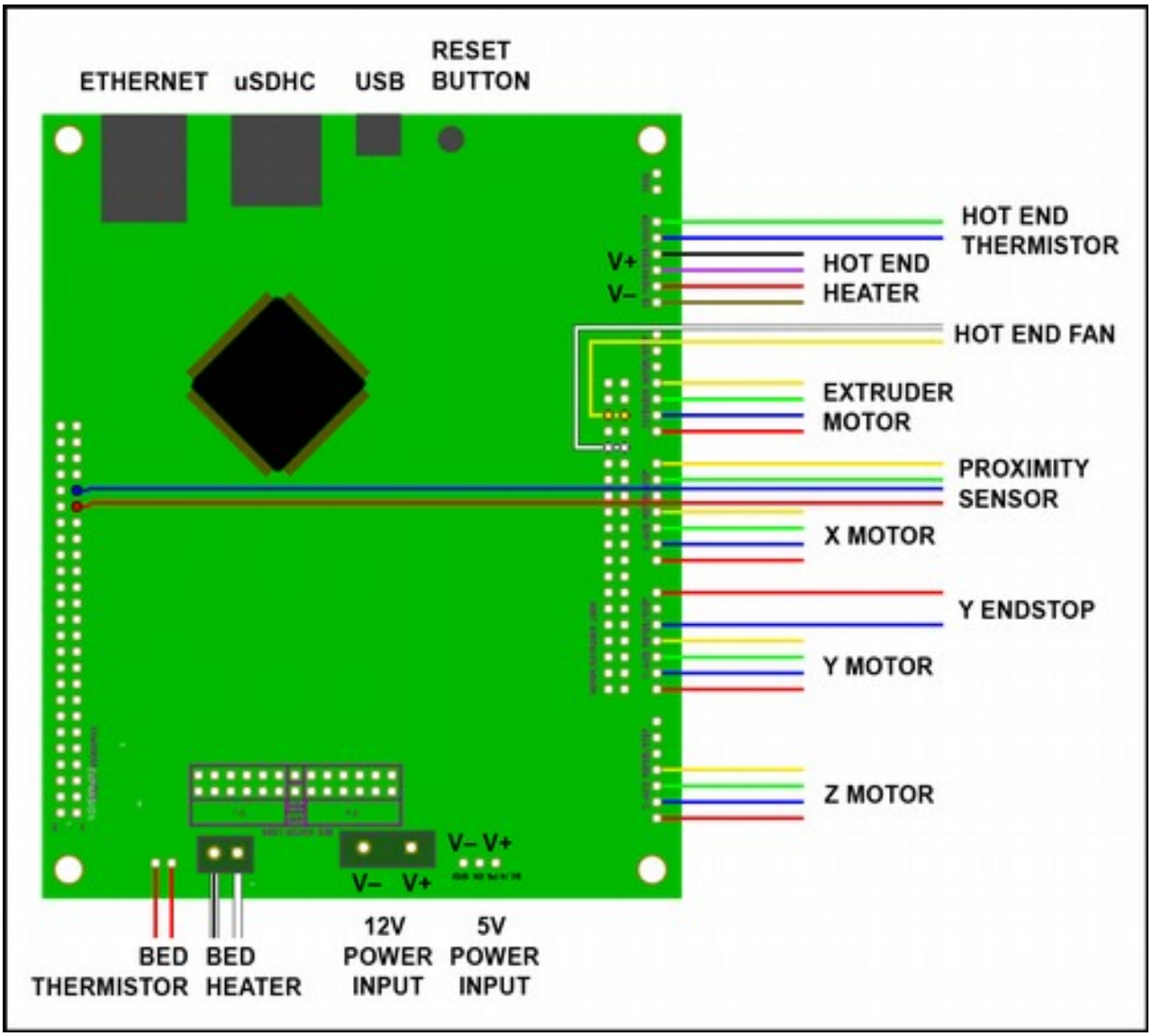
A good rule is ALWAYS to turn off the power and to unplug the USB when connecting or disconnecting ANYTHING from the board.

The instructions below show the fitting of the wiring. If in doubt, refer to this wiring diagram.

Wiring diagram (528.5 onwards)

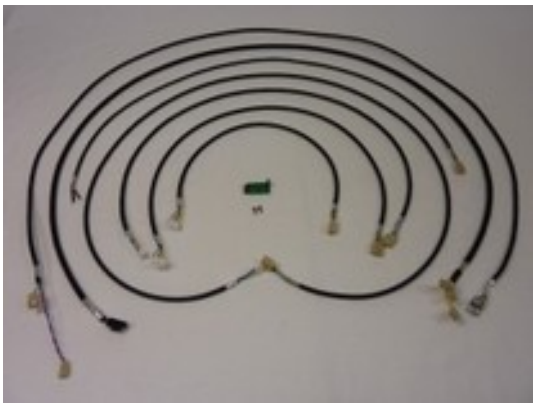


Wiring diagram (pre 528.5)



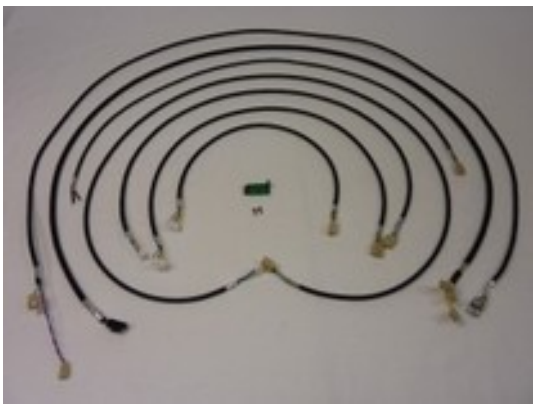
Fitting the wiring looms (528.5 onwards)

#	Component	Qty	Type
589	Motor wiring loom – 410mm (Z)	1	Wiring
588	Motor wiring loom – 570mm (Y)	1	Wiring
587	Motor Wiring loom – 700mm (X)	1	Wiring
586	Motor wiring loom – 1100mm (E)	1	Wiring
552	End stop loom – 665mm	1	Wiring
1034	Hot end loom – 1190mm	1	Wiring
1033	Dual fan loom – 1190mm	1	Hot end
584	Proximity sensor loom 1340mm	1	Wiring
545	Proximity sensor PCB	1	Electronics
110	M2.5x5mm cap head screw	2	Fasteners
285	2-way PCB jumper (not shown)	1	Electronics
285	Cable tie 2mm	as needed	Hardware



Fitting the wiring looms (pre 528.5)

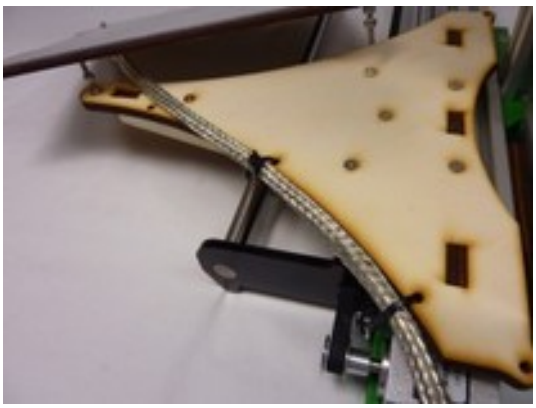
#	Component	Qty	Type
589	Motor wiring loom – 410mm (Z)	1	Wiring
588	Motor wiring loom – 570mm (Y)	1	Wiring
587	Motor Wiring loom – 700mm (X)	1	Wiring
586	Motor wiring loom – 1100mm (E)	1	Wiring
552	End stop loom – 665mm	1	Wiring
585	Hot end loom – 1190mm	1	Wiring



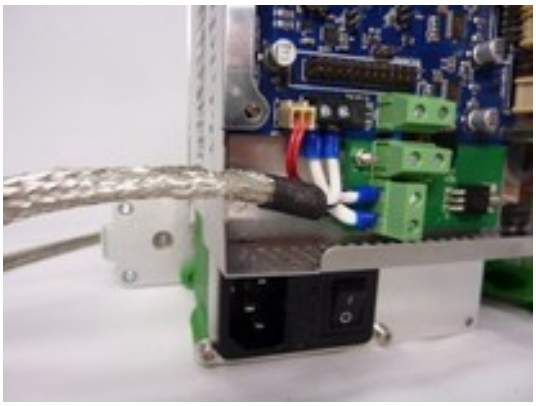
584	Proximity sensor loom – 1340mm	1	Wiring
545	Proximity sensor PCB	1	Electronics
110	M2.5x5mm cap head screw	2	Fasteners
285	2-way PCB jumper (not shown)	1	Electronics
285	Cable tie 2mm	as needed	Hardware

Heated bed wiring

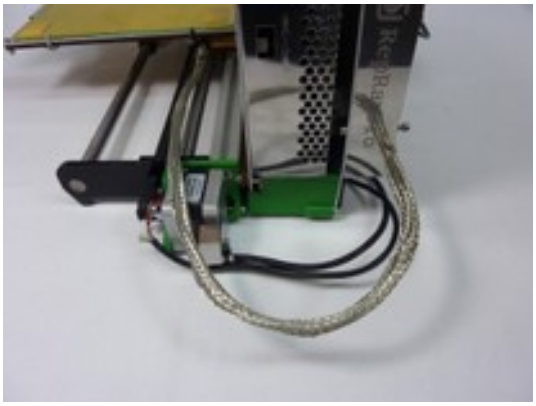
If you have not done so already, use two cable ties to loosely attach the heated bed wiring to the edge of the y-carriage. This is important; it stops the hot end cable moving at the connections. The cable will bend along it's length as the y-carriage moves, not at one point. You can do this without removing the heated bed.



The heated bed wiring connects to the screw terminal in the left-hand bottom corner of the Duet. Make sure the screw gates are open before putting the pre-crimped wires into the screw terminals, then tighten firmly. The heated bed doesn't have any polarity; it doesn't matter which way around they go. The thermistor wire plugs into the pins next to the screw terminal. Again, it has no polarity, it can plug in either way around. If you have a Duet with keyed header pins, it will only go on one way around.

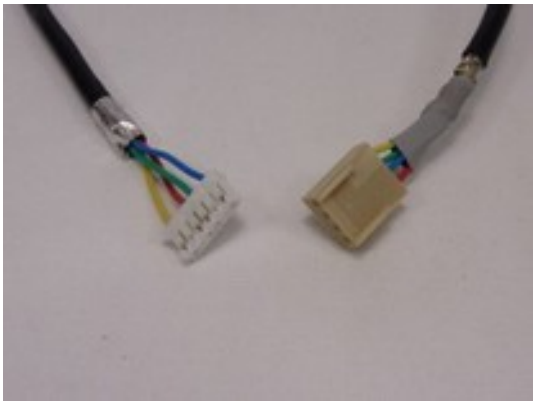


Make sure there is plenty of room for the heated bed wire to move without kinking. (Ignore the y-motor wires, they are fitted in the next section.)

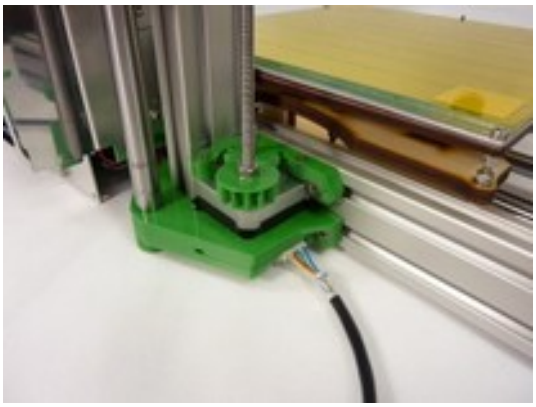


Motor wiring looms

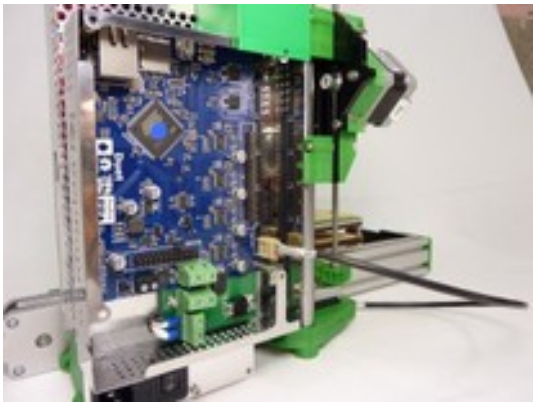
Take the four motor looms. Each has connectors that look like this picture. Check the wiring order of the wires in the housings; if they have been assembled incorrectly, the motor will not run correctly.



The z-axis motor loom is the shortest. Connect the loom to the motor.



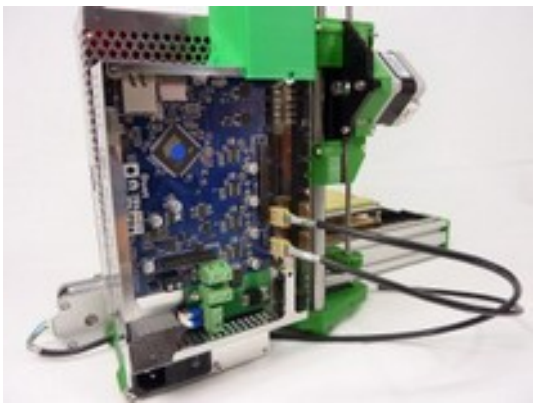
The Z axis plugs in on the lowest pins on the Duet. We'll be plugging in the motors, in order, from bottom to top. Each axis has 7 pins; 4 for the motor, three for the endstop (when needed). Check with the wiring diagram at the top of the page the orientation of the motor wire, and the exact pins it plugs into.



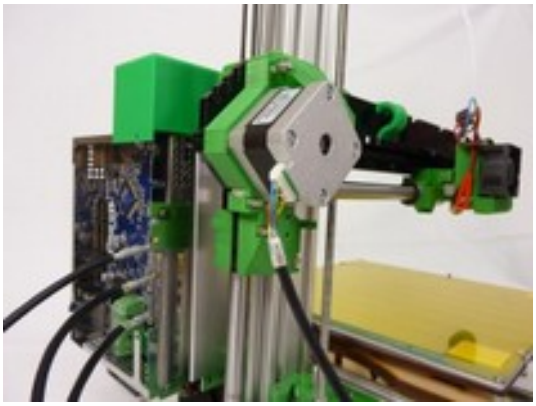
The next shortest motor wiring loom is for the y-axis motor. Connect it to the motor and run it between the PSU and the Y axis aluminium extrusion.

If you have the newer PSU (528.2), there is a small gap in the side cover. Remove the side cover, run the Y motor wires through the PSU assembly. Leave the side cover off for the moment, as you will run the Y endstop wires through the same way, in a minute.

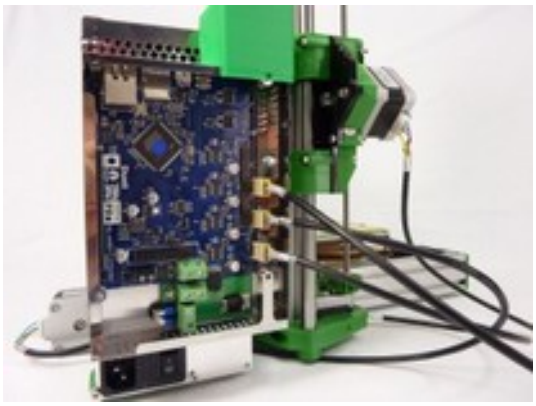
It connects to the Duet on the next set of pins, above the z-axis. Again, check with the wiring diagram above to get the correct pins. There are labels for each axis, marked on the Duet.



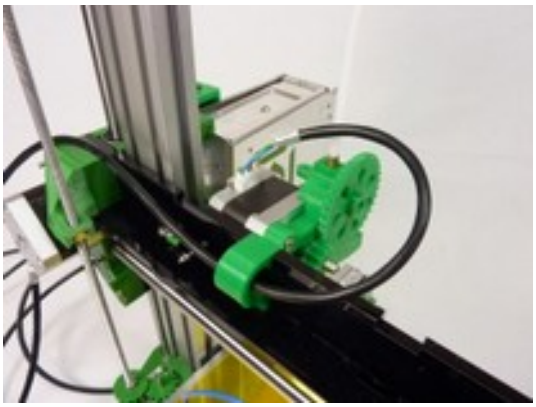
The x-axis motor loom is the next shortest.



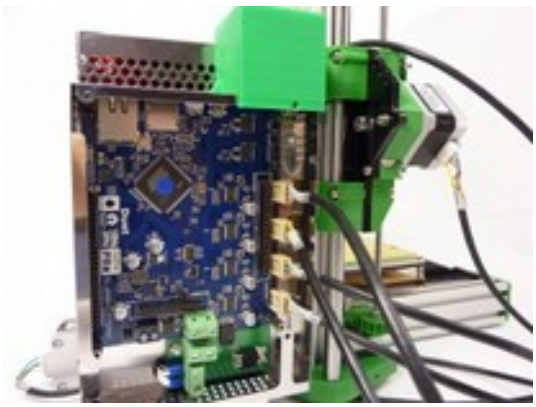
Connect it to the set of pins above the y-axis.



The extruder motor loom is the longest motor loom. You can run the wire through the hook of the extruder motor, and back along the x-axis.

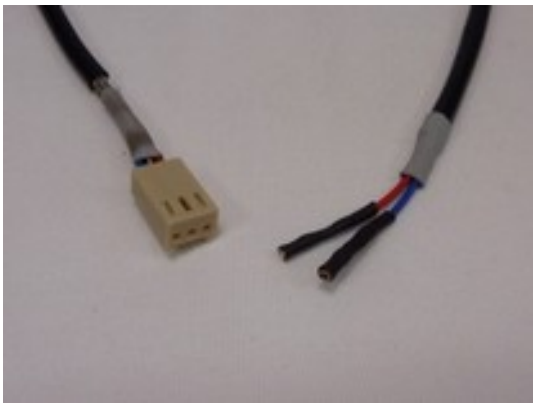


It connects to the next set of pins up from the x-axis.

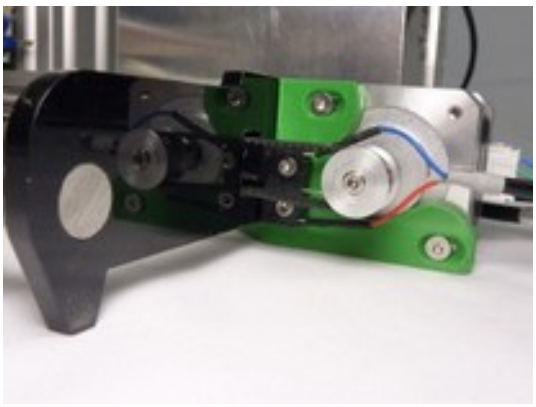


Y-endstop loom

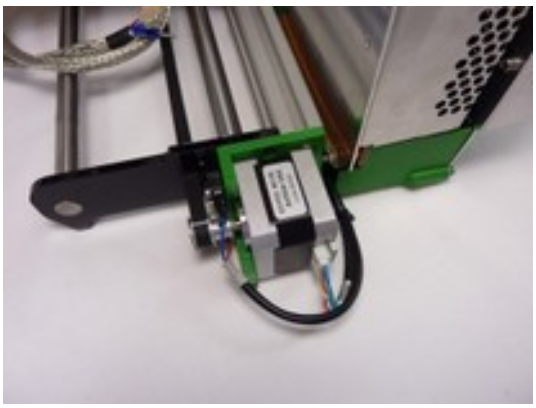
The y-endstop loom is a two-wire loom. The two crimps that connect to the microswitch may be uncovered; if so, put heatshrink on them, as shown.



The loom connects to the outer two pins of the microswitch, around the Y axis belt pulley. You will need to bend the top pin upwards to 45 degrees, so the wire doesn’t foul the pulley.

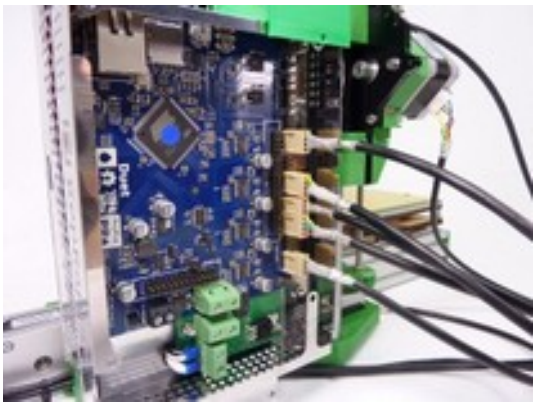


Run it behind the PSU, as with the y-axis motor loom.



If you have the newer PSU (528.2), there is a small gap in the side cover. Remove the side cover (if you haven't already when fitting the Y motor loom), and run the Y endstop wires through the PSU assembly. Replace the side cover, with the Y motor and Y endstop looms coming through the gap.

We only use a microswitch endstop for the y-axis; the x- and z- axis use the proximity sensor to sense where the end of the axis is (the 'home' position). Connect it to the pins next to the y-axis motor.



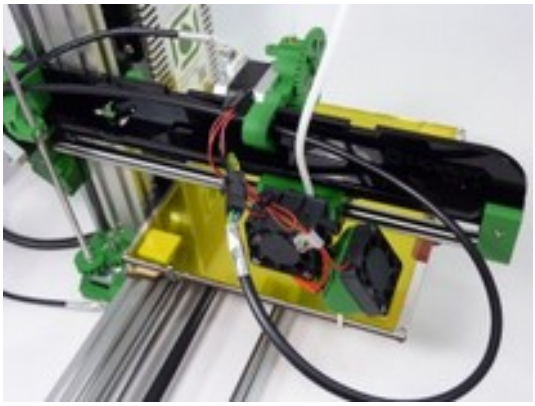
Hot end and fan loom (528.5 onwards)

Pay particular attention when connecting the hot end heater and hot end thermistor connectors. If you put them in the wrong place, 12V can run down the 3.3V line of the thermistor, and will immediately destroy the main processor chip. We regard this mistake as a user error, and is NOT covered by the warranty.

Ormerod 528.5 has two looms; one for the hot end (heater and thermistor), and one for the fans (hot end fan and part cooling fan).

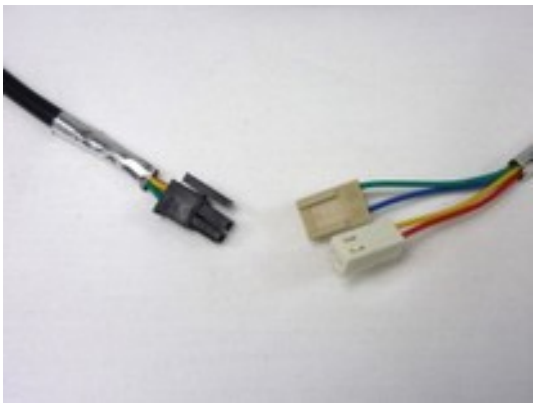
The hot end loom is a 6-wire loom, with two different connectors on the end that connect to the Duet. The plug that connects to the hot end is 4-way; the hot end heater uses two pairs of wires, to carry the current the heater requires. The thermistor uses the other two wires.

Plug the hot end loom into the hot end connector. Loop it back along the x-axis arm, and through the hook in the extruder drive.

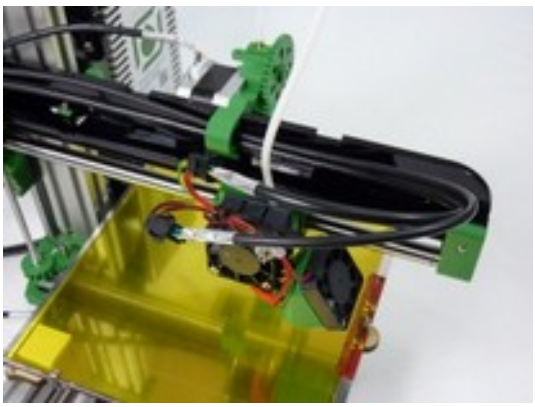


Connect the hot end loom to the Duet. Pay close attention when connecting the hot end loom to the Duet. The thermistor wires (blue/green, 2-way) connects to the 2-pin ‘E0_TEMP’ header. The heater wires (black/yellow/red/white, 4-way) connect to the 4-pin ‘E0_HEATER’ header. **DO NOT** connect these to the ‘FAN0’ pins, at the top right of the Duet board. Check your wiring carefully with the wiring diagram.

The fan loom is a 4-wire loom, with two different connectors on the end that connects to the Duet. The plug that connects to the hot end is 4-way; two for each of the hot end fan and the part cooling fan.



Connect the fan loom to the hot end and part cooling fans’ plug. Loop it back along the x-axis arm, and through the hook in the extruder drive, as you did with the hot end loom.

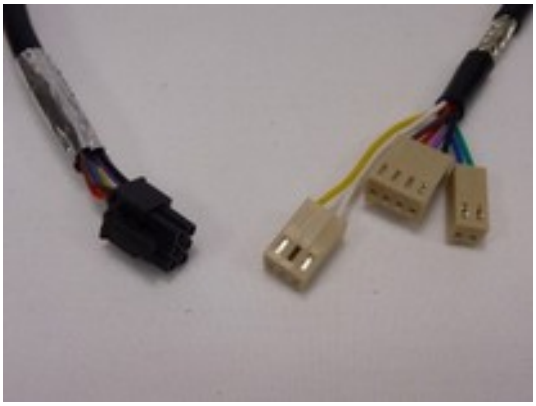


The part cooling fan (red/yellow, 2-way) plugs into the 2-pin ‘FAN0’ header. This is controlled by gcode, and turns on during a print. The hot end fan (blue/none/green, 3-way) connects to the double row of pins, to provide it with 12V pins all of the time; see picture for correct placement. From the left, there should be two clear pins, then the yellow wire, another pin (covered by the housing, but not connected), then the white wire. Check your wiring carefully with the wiring diagram.

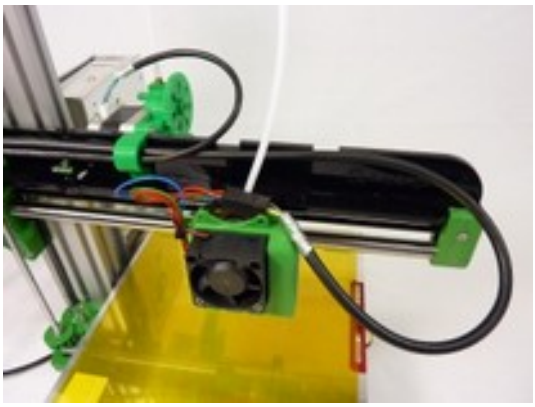
Hot end and fan loom (pre 528.5)

Pay particular attention when connecting the hot end heater and hot end thermistor connectors. If you put them in the wrong place, 12V can run down the 3.3V line of the thermistor, and will immediately destroy the main processor chip. We regard this mistake as a user error, and is NOT covered by the warranty.

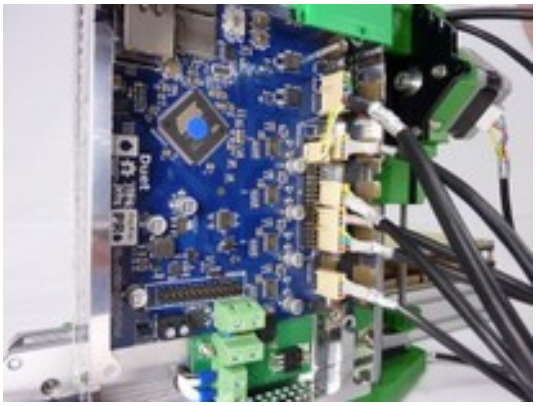
The hot end loom is an 8-wire loom, with a number of different connectors on the end that connects to the Duet. The plug that connects to the hot end is 6-way; the hot end heater uses two pairs of wires, to carry the current the heater requires. The thermistor uses two wires, as does the hot end fan.



Plug it into the hot end connector. Loop it back along the x-axis arm, and through the hook in the extruder drive.



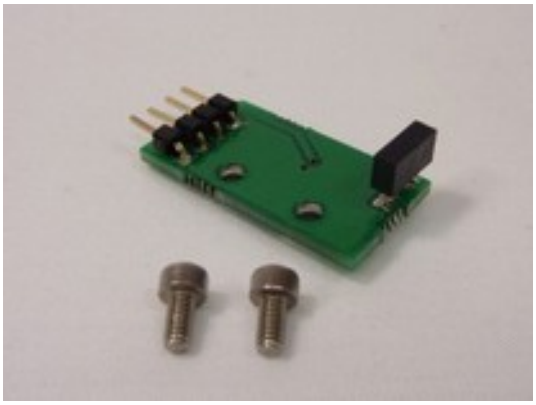
Pay close attention when connecting the hot end loom to the Duet. **DO NOT** connect anything to the ‘FAN0’ pins, at the top right of the Duet board; this is for any additional, controllable fan you may choose to fit, and it is **NOT** for the hot end fan. The hot end fan connects directly to the 12V pins, on the separate double row of pins; see picture for correct placement. Check your wiring carefully with the wiring diagram.



Proximity sensor and loom (528.5 onwards)

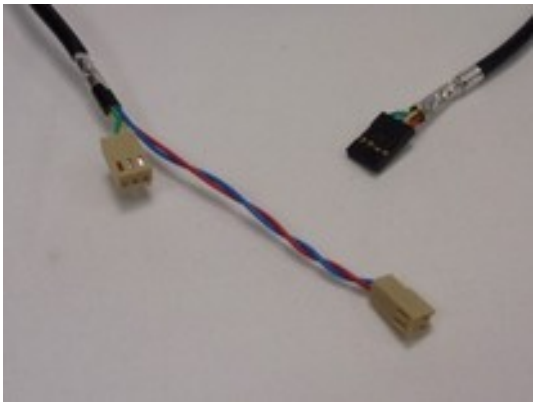
Take care with the extruder motor and proximity sensor connections. It is possible to incorrectly connect these, and short the extruder motor voltage through the proximity sensor connection, potentially damaging the Duet.

The proximity sensor is a small PCB, with four pins on the end of the board. Make sure the sensor itself, the black part at the other end from the pins, is standing perpendicular to the board; they can get bent over in transit.



Attach the proximity sensor to the X carriage to the left of the hot end with the two M2.5x5mm cap head screws. These self-tap into the X carriage, so don’t enlarge the holes with a drill.

The proximity sensor wiring is the longest wiring loom. It has four wires, with the Duet end having two wiring blocks.



Connect the loom. The wire can tuck backwards under the x-rib. **NOTE:** the sensor has a polarity; the order of the wires is very important. It should be as the picture, from left to right: red, yellow, blue, green.

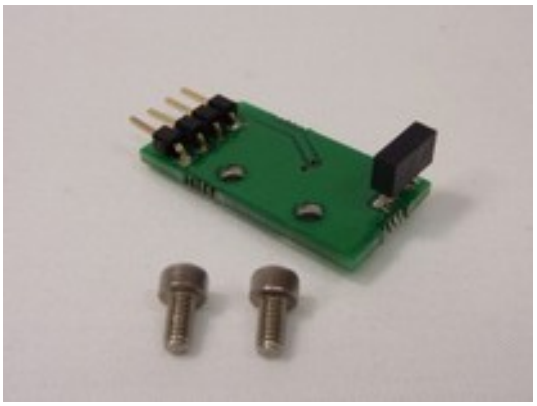
The proximity wiring loom can follow the hot end wiring loom; it needs a loop, to allow the x-carriage to move back and forth along the axis, then back along the x-axis arm, and through the hook in the extruder drive.

The short end of the proximity sensor wire connects to the Duet board next to the extruder motor. The long part goes across the board to the other side, and connects to two pins on the ‘expansion’ header. It is important to get the orientation correct; check the wiring diagram.

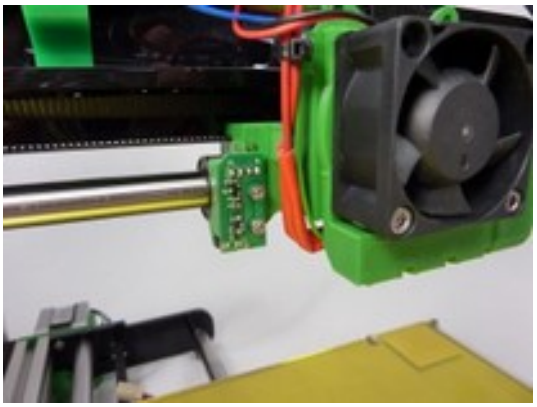
Proximity sensor and loom (pre 528.5)

Take care with the extruder motor and proximity sensor connections. It is possible to incorrectly connect these, and short the extruder motor voltage through the proximity sensor connection, potentially damaging the Duet.

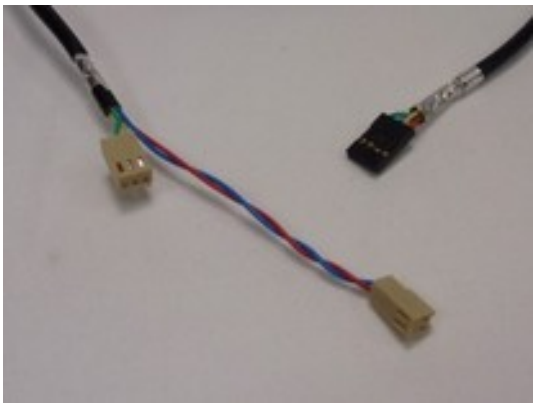
The proximity sensor is a small PCB, with four pins on the end of the board. Make sure the sensor itself, the black part at the other end from the pins, is standing perpendicular to the board; they can get bent over in transit.



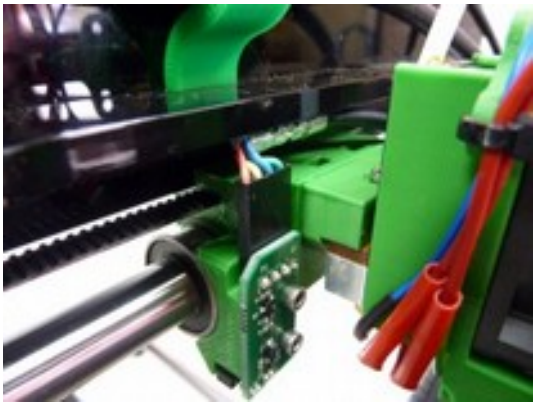
Attach the proximity sensor to the X carriage to the left of the hot end with the two M2.5x5mm cap head screws. These self-tap into the X carriage, so don’t enlarge the holes with a drill.



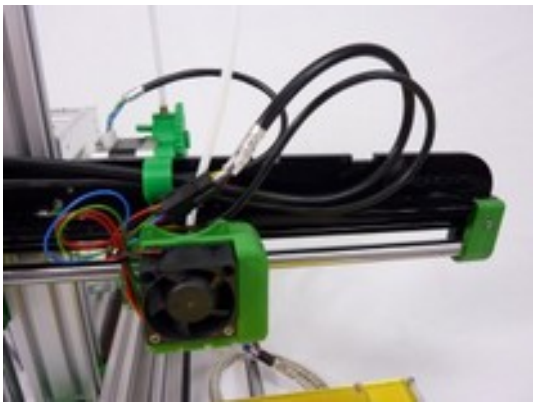
The proximity sensor wiring is the longest wiring loom. It has four wires, with the Duet end having two wiring blocks.



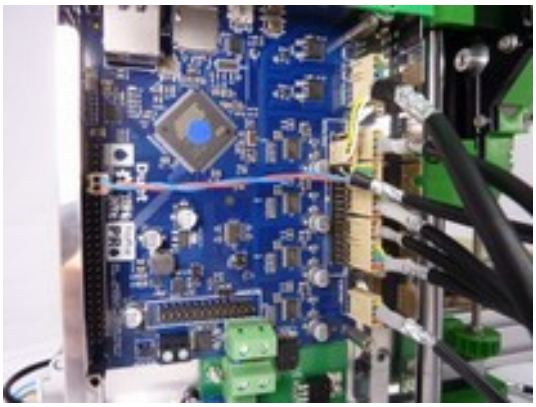
Connect the loom. The wire can tuck backwards under the x-rib. **NOTE:** the sensor has a polarity; the order of the wires is very important. It should be as the picture, from left to right: red, yellow, blue, green.



The proximity wiring loom can follow the hot end wiring loom; it needs a loop, to allow the x-carriage to move back and forth along the axis, then back along the x-axis arm, and through the hook in the extruder drive.

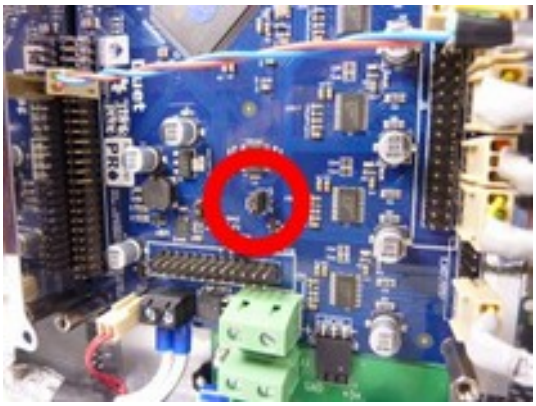


The proximity sensor loom has two connectors. The short wires plug in to a free endstop connection. You can use either the X endstop pins (above the X motor connection), or the extruder endstop pins (above the extruder motor connection), depending on where the gap in metal perimeter is. There have been a couple of different versions of the perimeter; the current version uses the extruder endstop pins (as shown in the picture), older versions use the X endstop pins.
The longer wires reach across the board, and plug into two pins in the expansion header. Check the wiring diagram at the top of the page to see exactly which pins.



IMPORTANT: 5V JUMPER

Fit the 2-way PCB jumper (a small, black, jumper block) on the two pins in the centre of the board, labelled ‘J10’ and ‘ATX_5V_EN’. Without this, the Duet board will not be supplied with power without the USB connected!



Fitting the cover and wire routing

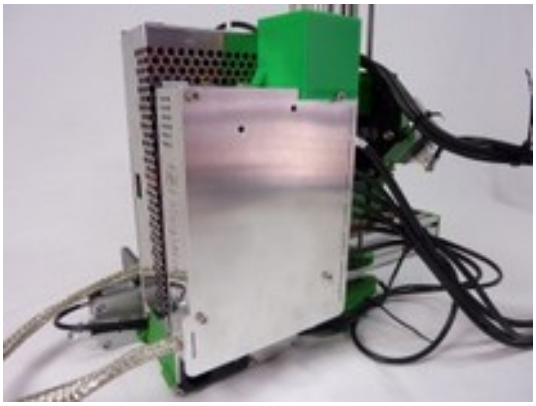
You may want to do this section after the commissioning stage (the next page of the instructions), as it is useful to be able to access the Duet board, ie to press ‘reset’, or check your wiring, during commissioning.

#	Component	Qty	Type
577	enclosure lid	1	Sheet metal
257	M3x12mm cap head screw	4	Fastener

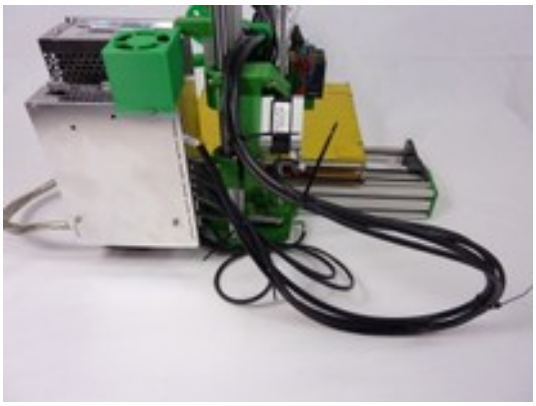
PICTURE TO COME!

All the wiring looms use shielded cable, to reduce the effects of Electro-Magnetic Interference (EMI). It is important that the shielding makes contact with ground, by earthing them through the metal case. Each wire has a slot in the case; bend each cable so it sits in the slot. Make sure that there is not sideways pressure on the housings, where they are plugged onto the pins of the Duet; they can loose their contact with the pin, and make a faulty connection.

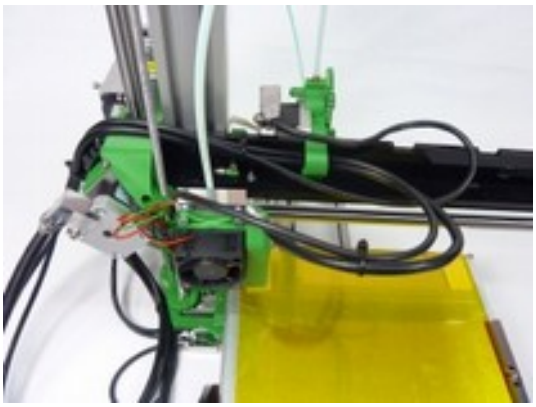
With all of the wires in their slots, attach the enclosure cover with 4 x M3x12mm cap head screws. There are a number of slots in the cover; make sure the tabs of the enclosure line up and can pass through. They can be quite tight.



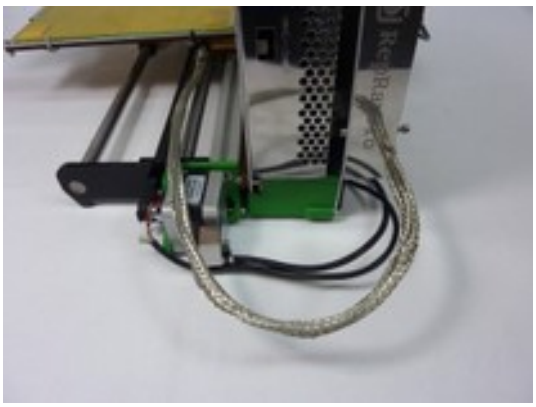
The wires on the x-axis need to be able to move up and down with the z-axis. They can be attached at the bottom of the Z axis, and cable tied there.



Extruder and hot end. The wires clip under the extruder mounting bracket, and can be cable-tied to the x-axis arm. Make sure there is enough slack in the hot end wires to allow the x-carriage to move the full length of the x-axis.



Make sure there is plenty of room for the heated bed wire to move without kinking.



Spool mount

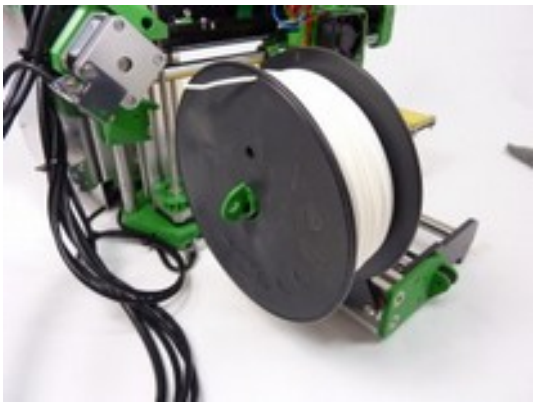
#	Component	Qty	Type
642	spool plate	1	Lasercut
641	spacer	1	Lasercut
442	spool-spigot	1	Printed
525	spool-clip	1	Printed
424	M4x16mm button head screw	3	Fastener
497	M4 T-nut	3	Fastener
241	M3x20mm cap head screw	1	Fastener
258	M3 nut	1	Fastener
190	PTFE tube 3mm OD x 400mm	1	Wiring

Loosely attach the spacer to the spool plate with 3 x M4x16mm button head screws, with the 3 x T-nuts.

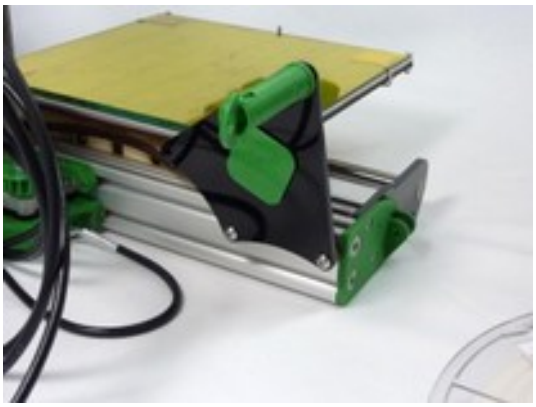
The spool-spigot attaches to the top of the spool plate. Drop the M3 nut down the spool-spigot, and screw the M3x20mm cap head screw in from the other side. This can be fiddly; you can always do it the other way around, with the M3x20mm cap head screw going into the spool-spigot, and the nut on the outside.

Attach the spool mount to the y-axis extrusion, as shown.

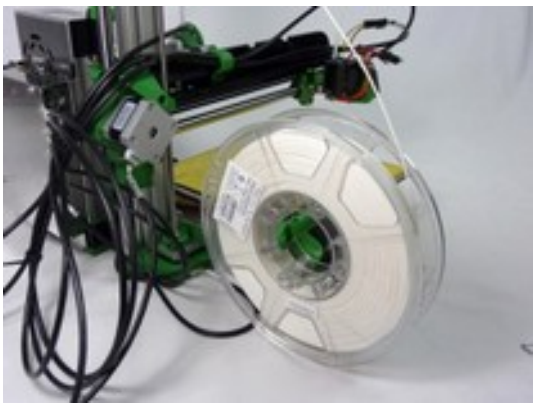
The spool mounts on the spigot, and the spool-clip holds it in place.



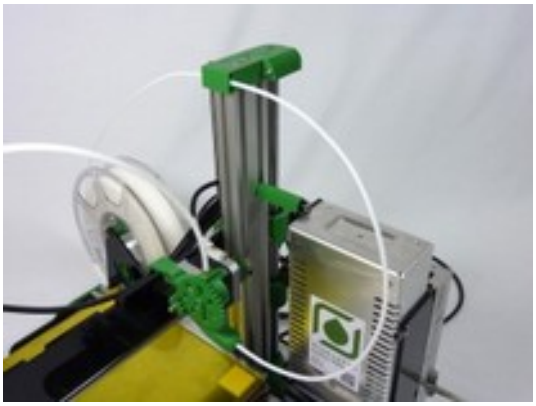
You can adjust the position of the spool mount to accommodate larger spools. Unfortunately, there is no standard in spool size, so it may not be able to accommodate all spools! Use just two of the M4x16mm button head screws, and locate them in the top slot of the Y axis extrusion. This will lift the spigot up and away from the Z axis.



The spool mounts in the same way as before.



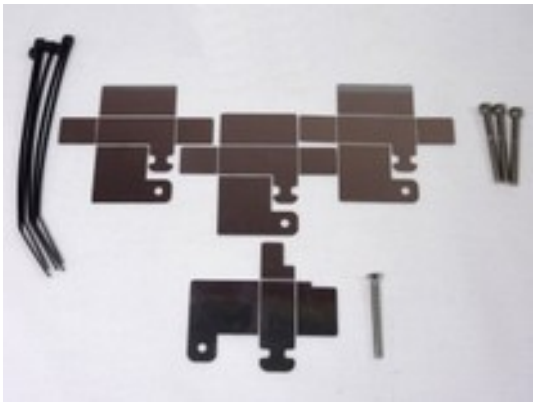
Finally, fit the filament guide tube. This will allow filament to be fed into the extruder drive. There are three holes in the Z axis upper mount (Ormerod 528.5 version). Feed one end of the tube into this, and the other end into the extruder drive. Filament is then fed into the Z upper mount, through the tube, and into the extruder drive. If you feed filament directly into the drive, without using the tube, filament may pull on the X axis as it is drawn into the extruder, causing the X axis to wobble in the Y axis direction.



Fitting the shielding (528.2)

For CE compliance, shields need to be fitted to the hot end, motor and heated bed connections. Again, it may be better to fit these shields, if required, after the commissioning stage, as you may need access to the motor wiring.

#	Component	Qty	Type
582	Motor Shield	3	Shielding
579.1	Motor Shield (Z axis)	1	Shielding
891	Hot end enclosure (not shown)	1	Shielding
575	Bed cable shield (not shown)	1	Shielding
543	M3x30mm cap head screw	3	Fastener
713	M3x30mm countersunk screw	1	Fastener
133	Cable tie 2mm	4	Fastener

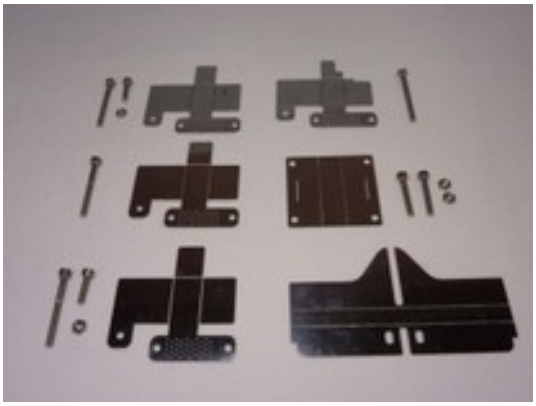


Note the z-motor-shield is different from the other three.

Fitting the shielding (pre 528.2)

For CE compliance, shields need to be fitted to the hot end, motor and heated bed connections. Again, it may be better to fit these shields, if required, after the commissioning stage, as you may need access to the motor wiring.

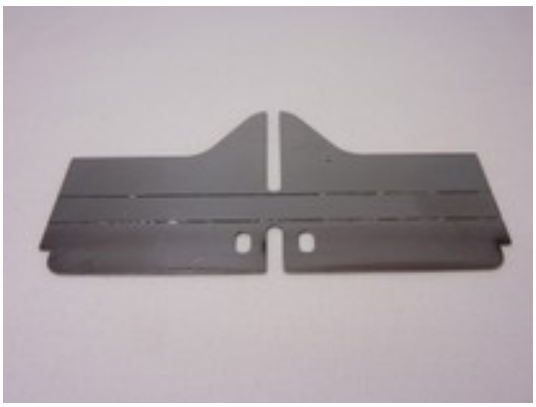
#	Component	Qty	Type
644	motor-shield	3	Shielding
579	z-motor-shield	1	Shielding
580	hotend-shield	1	Shielding
575	heated-bed-shield	1	Shielding
543	M3x30mm cap head screw	3	Fastener
257	M3x12mm cap head screw	3	Fastener
241	M3x20mm cap head screw	2	Fastener
713	M3x30 countersunk screw	1	Fastener
258	M3 nut	5	Fastener



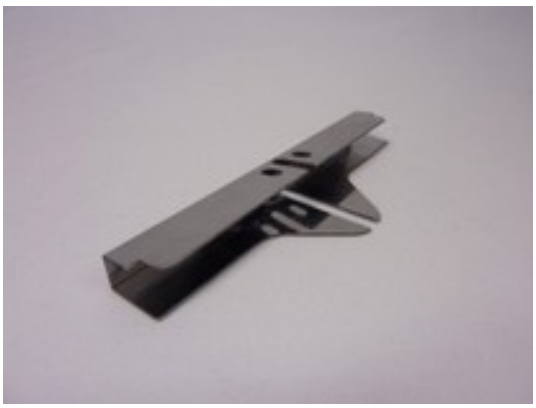
Note the z-motor-shield is different from the other three; it has an extra notch in it.

Heated bed shield

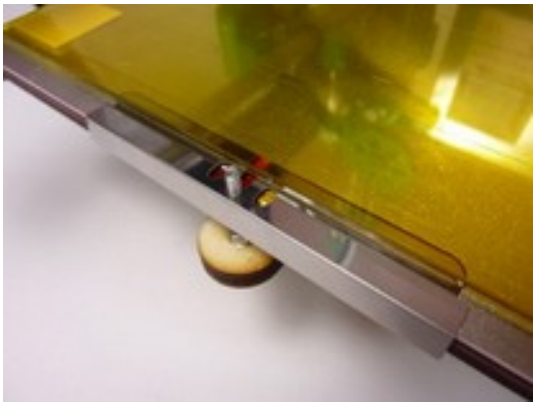
The heated bed shield covers the connections on the heated bed.



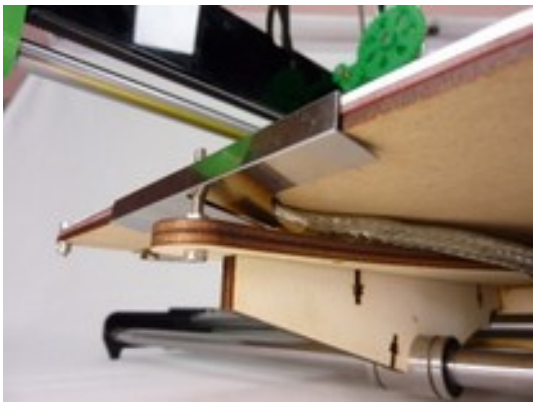
Fold it as shown. The bends are not quite 90 degrees.



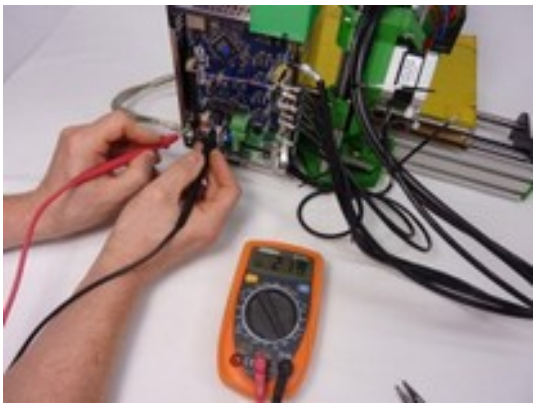
The top tab of the bed shield slides under the glass, but is supported at the sides by the aluminium heat spreader. It is designed so it should not touch the heated bed terminals.



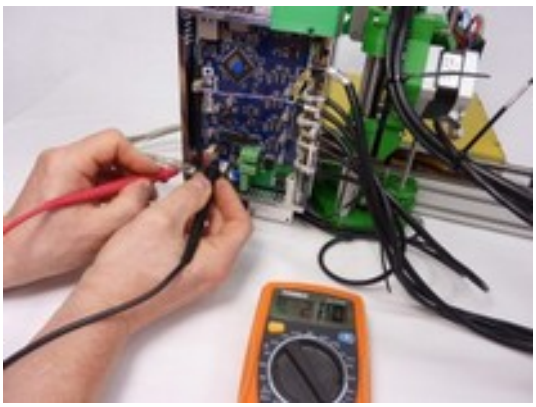
Underneath, it touches the shielding of the heated bed wiring loom.



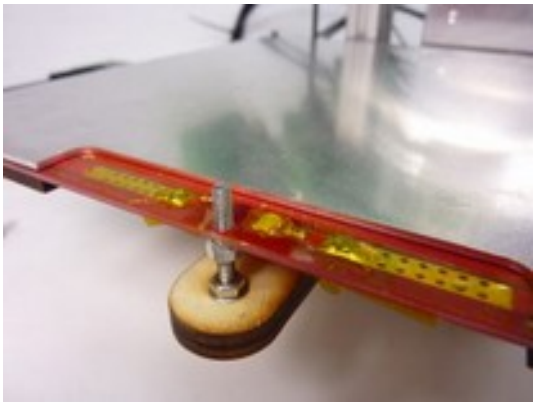
Check there is no continuity between the shielding and the bed +12V and ground screw terminals.



Make sure you check both!

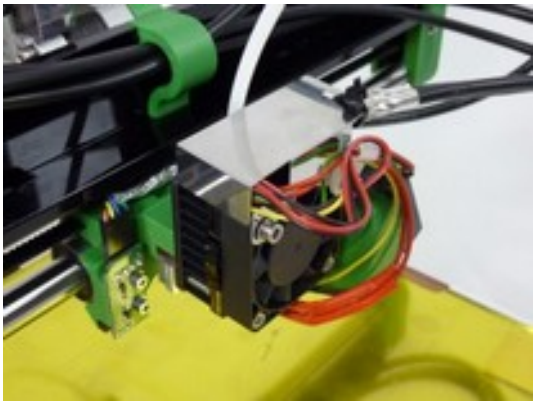


If you have any problems, cover the heated bed connections with Kapton tape. This is a very effective insulator – it was designed by NASA!

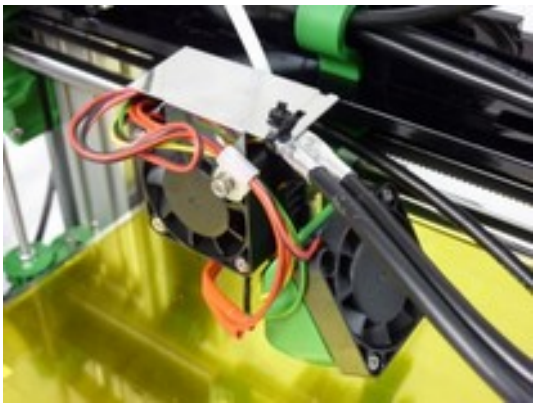


Hot end enclosure (528.5 onwards)

The hot end enclosure covers the hot end wiring connections, and provides strain relief for the looms. Use 2 x M3x??mm cap head screws to hold it in place; there should already be an existing M3 cap head screw in place, securing the P-clip and hot end wires. The M3 cap head screws self-tap into the acrylic fan spacer.



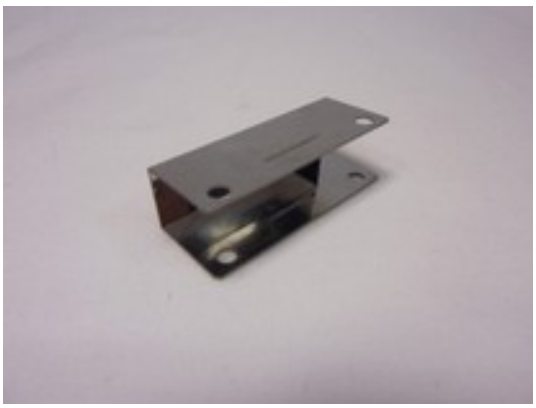
Cable tie the looms to the end of the hot end enclosure to secure them.



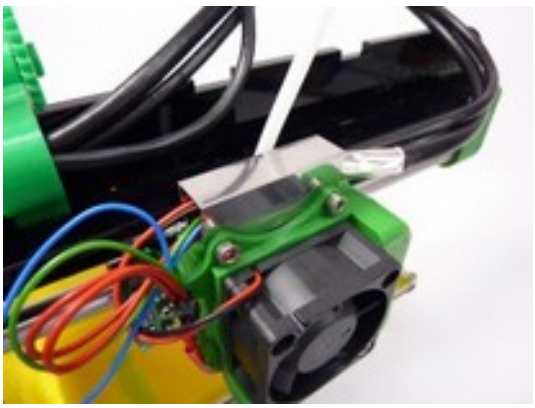
Hot end enclosure (pre 528.5)

The hot end connector shield is a simple square shape. It uses 2 x M3x20mm cap head screws and 2 x M3 nuts.

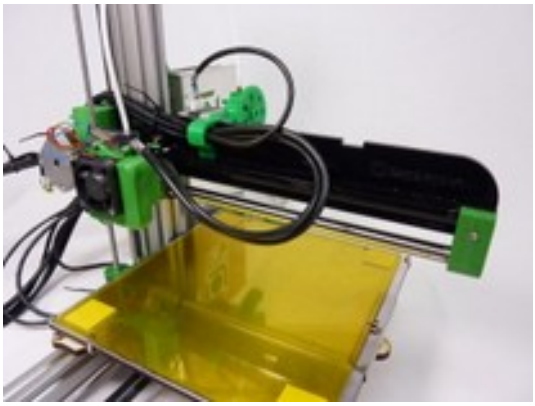
Fold it along the two scored lines, at 90 degrees.



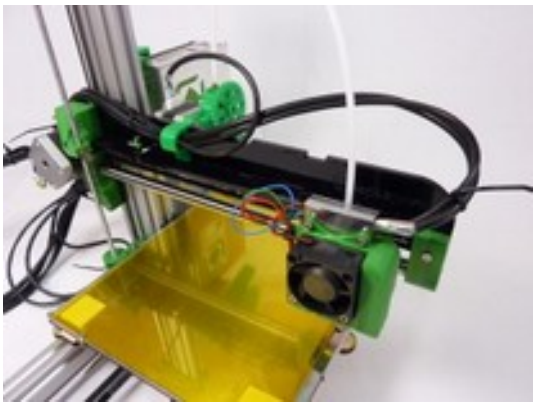
It fits over the hot end wiring connector, holding it tight. The wire shielding should touch it at one end.



Test the movement of the x-axis along the full range of motion. Check the wires do not kink, or droop down below the nozzle.

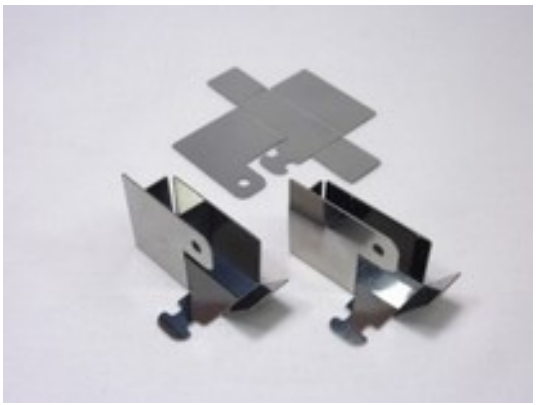


At the far end, check the wires don’t get caught around the end of the x-axis.

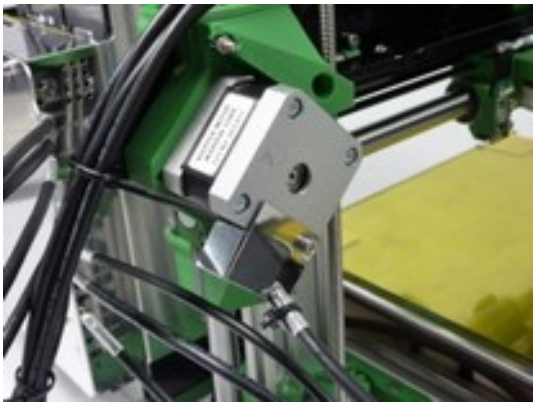


X motor shield (528.2 onwards)

Fold two of the motor shields as shown; one for the X motor, one for the Y motor.



Remove the crosshead screw from the corner of the motor. Fit the shield in place using an M3x30mm cap head screw. Secure the motor loom to the shield with a cable tie.

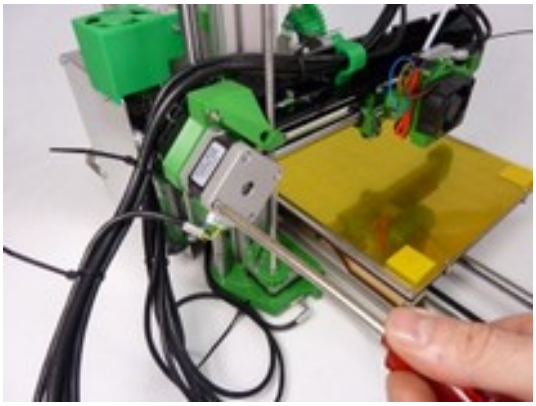


X motor shield (pre 528.2)

The x-motor and extruder motor shield fold the same way, so can be done together. They both use an M3x30mm cap head screw, an M3x10mm cap head screw, and an M3 nut.

Fold two motor shields as shown.

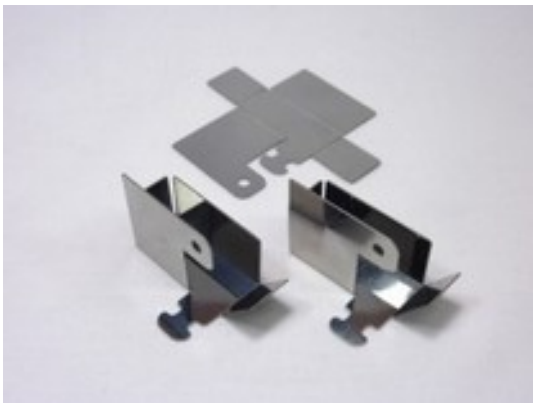
Remove the crosshead screw from the corner of the x-motor.



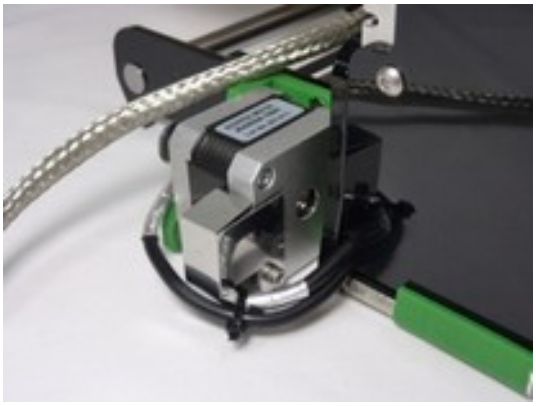
Fit the shield over the motor wiring connector as shown. The long M3 cap head screw holds the shield on the motor. Fold the cable clamp over the end of the wire, so it holds the exposed shielding of the cable, and secure with the M3x10mm cap head screw and M3 nut.

Y motor shield (528.2 onwards)

Use the second shield that you folded in the X motor shield step, for the Y motor.



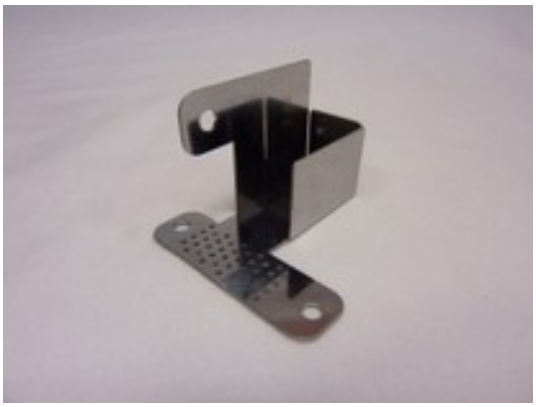
Remove the crosshead screw from the corner of the motor. Fit the shield in place using an M3x30mm cap head screw. Secure the motor loom to the shield with a cable tie, as shown. You can also secure the Y endstop loom.



Y motor shield (pre 528.2)

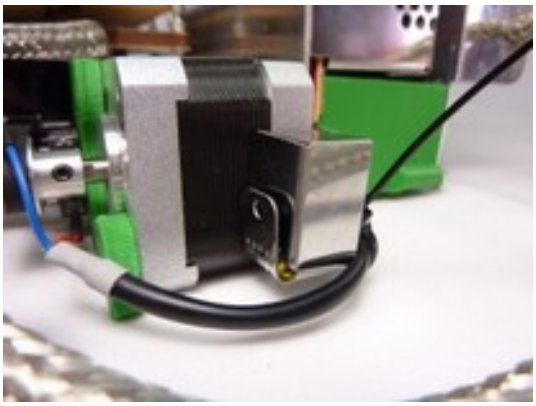
The y-motor shield uses just a single M3x30mm cap head screw.

It folds in the opposite direction from the x-motor and extruder-motor shield, as shown.



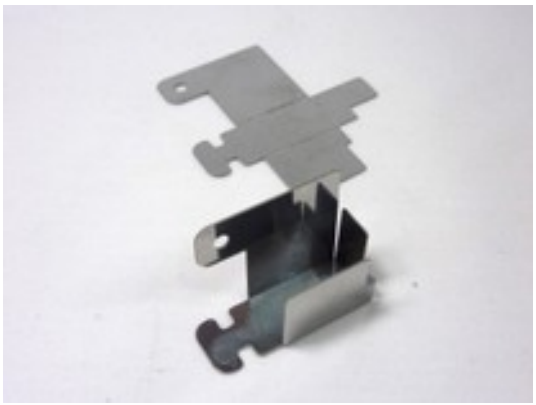
As with the other shields, remove the screw from the motor, and screw the shielding onto the back of the motor.

Fold the shield up and around, trapping the cable shielding.

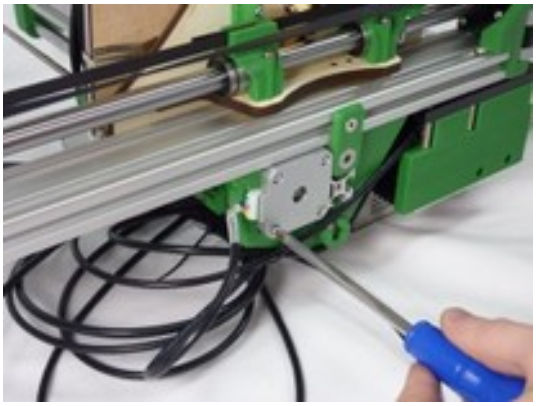


Z motor shield (528.2 onwards)

Fold the shield as shown. This shield is different from the other three; the wiring loom path is straight, and there is a notch in the shield to fit around the Z lower mount.



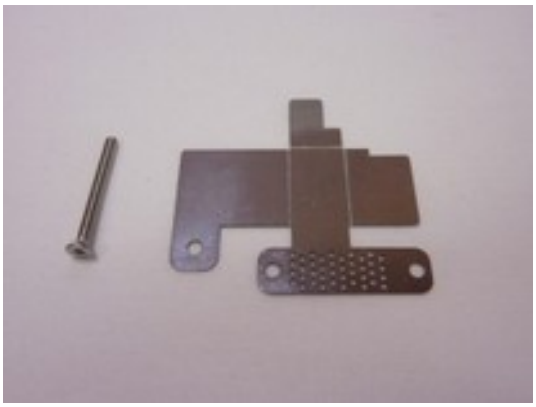
Remove the crosshead screw from the corner of the motor. Fit the shield in place using an M3x30mm countersunk screw.



Secure the motor loom to the shield with a cable tie, as shown. Make sure the shield does not stick out below the foot of the Z lower mount, or the printer will not sit flat.

Z motor shield (pre 528.2)

The z-motor-shield is different from the other motor shields; it has an extra notch in it. It uses an M3x30mm countersunk screw, a M3x10mm cap head screw (not shown), and an M3 nut (not shown).

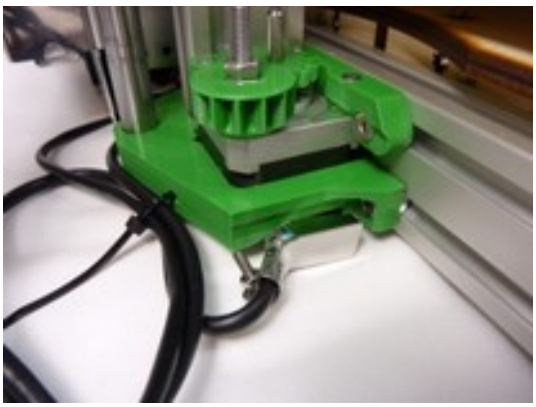


Fold the z-motor-shield as shown.

The z-motor-shield is quite tricky to fit, to make sure that the printer does not rest on it. Remove the motor screw, and attach the shield. It should slide in around the motor connector, between the printed part.

Another view of the connector.

Fold the cable clamp over the end of the wire, so it holds the exposed shielding of the cable, and secure with the M3x10mm cap head screw and M3 nut.



Extruder motor shield (528.2 onwards)

Fold the motor shields as shown. This is the same shield as fitted to the X and Y motors, but folds in the opposite direction from them.

Remove the crosshead screw from the corner of the motor. Fit the shield in place using an M3x30mm cap head screw. Secure the motor loom to the shield with a cable tie.

Extruder motor shield (pre 528.2)

The x-motor and extruder motor shield fold the same way, so can be done together. They both use an M3x30mm cap head screw, an M3x10mm cap head screw, and an M3 nut.

Fold two motor shields as shown.

Remove the crosshead screw from the corner of the motor. The extruder motor shield fits in a very similar way to the x-motor.