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**Version:** 1.1  
**www.factory3d.co.uk**
Kit Parts:
Forward

This manual is intended as a guide to your REPRAP Prusa I3 build, it would be impossible to cover everything involved in building and tuning a REPRAP Prusa I3 in a single 80 page guide, but it will greatly smooth the way to getting you up and running quickly. You are strongly encouraged to consult some on the many other I3 resources online especially the RAMPS 1.4 wiki (http://www.reprap.org/wiki/RAMPS_1.4) and other online Prusa I3 build manuals such as (http://reprap.org/wiki/Prusa_i3_Build_Manual). This is especially true when you come to tuning your printer during your first prints. Above all, you can build a REPRAP quickly but never build one rushed. Every nut and bolt that's perfectly tensioned, every rod that's perfectly aligned (especially the base), every bearing that's perfectly seated .. they will all translate to better print quality. The electronics are doubly important, check and triple check every connection is correct, tight and secure before powering up to avoid costly and time consuming mistakes!

Safety Notes:

**High Current** : Building and Operating a REPRAP involves high current, especially for the heated bed which can draw 10A on its own. All cables should be securely connected and checked. All high current connections should be well insulated to avoid contact and well secured to prevent movement at the points of connection.

**High Temp** : A REPRAP hot-end can reach well in excess of 200°C, caution is advised during operation.

**High Forces** : A REPRAP motor can exert considerable force, caution is advised putting your hands near any of the axis while in operation
1. Y-AXIS Frame

**Needed**

Grub + M3/M4 Allen Keys (1.5mm, 2.5mm, 3mm)

M3/M4 Spanners

2x 380mm M10 Threaded Rods

2x 350mm M8 Smooth Rods

12x M10 Nuts

8x M10 20mm Washers

2x M10 30mm Washers

4x 205mm M8 Threaded Rods

22x M8 Nuts & Washers

Y Idler (PLA - with belt pulley: 25mm M4 Bolt & Nut, 2x14mm M4 Washer, 2x9mm M4 Washer, 624zz bearing)

Y Motor Mount (PLA - with integrated endstop mount)

4x Y Corners (PLA)

3x LM8UU bearings

1x Wired Motor (round shaft)

1x 20 Tooth GT2 Timing Pulley (round shaft diam 5mm)

1x Mechanical Endstop

2x 16mm M3 bolts + nuts.

3x 16mm M3 bolts + washers
1.1 Y-AXIS Long Sections

First take the two 350mm M8 smooth rods and slot one LM8UU bearing onto one, and two LM8UU bearings onto the other. Next slot the four Y-Corners onto the ends of the 380mm M10 Threaded Rods, then slot the two 350mm M8 Smooth Rods (with bearings) into the Y-Corner top slots, finally screw on and loosely hand tighten the M10 nuts (and washers). The smooth rods need to be pushed well into the end corner slots .. but its not absolutely essential they are flush with the back of the slot, they aren't going to move around once its all assembled.
1.2 Y-Axis Rear Section (Motor)

Fig 1.2 Parts:

Firstly wire up a round shaft motor with about a 10cm extension length of wire & dupont connector. (see appendix A, motor wiring). Next slot the GT2 timing pulley onto the motor shaft with the teeth close to the motor and gently tighten the grub screws (see Fig 1.2a). Next mount the endstop into the endstop mount (it will only fit in one way round) and secure with 2 16mm M3 bolts+nuts (Fig 1.2a). Next mount the Motor onto the Y Endstop / Motor Mount using 3 x 16mm M3 bolts with M3 washers. Make sure the wires from the motor are orientated at the back of the motor mount and the motor is mounted on the right hand side of the mount (Fig 1.2a).

Fig 1.2a:
Next mount the motor assembly onto the two M8 threaded rods with the GT2 timing pulley teeth in the centre and the motor wires feeding out through the back of the two rods (Fig 1.2b). Just hand tighten the M8 nuts at this stage.

**Fig 1.2b:**
1.3 Y-Axis Front Section (Idler)

Secure the idler onto one of the M8 threaded rods, dead center (loosely hand tighten) see Fig 1.3a. If the idler pulley isn't pre assembled see appendix B (idler pulleys).

Fig 1.3a
1.4 Y-Axis Lower Frame Completed

To complete the lower frame slot the completed end sections into the Y-corners of the completed long side sections. Leave about 1 or 2 mm of M8 thread protruding and just loosely hand tighten the M8 nuts for now, they will be adjusted later when the build plate is mounted (section 3). With the idler at the front (top M8 threaded rod), motor at the back, single bearing on the left hand smooth rod and two bearings on the right hand smooth rod (Fig 1.4a). The 30mm centre ‘frame grip’ washer on the M10 threaded rod should be 10cm (with a MK8 extruder) or 11cm (with a J-Head/Gregs Wade Extruder) from the flat inner of the rear Y-corner (Fig 1.4b).

Figs 1.4a:

Fig 1.4b:
2. Z-AXIS Frame

**Needed:**

- M3 Allen Key (2.5mm)
- M3 Spanner
- 2 x M10 spanners (or adjustable)
- Completed Y-Axis Frame (see section 1)
- 6mm Thick Aluminium Waterjet-Cut Frame (pictures show polished aluminium)
- Z-Axis Top & Bottom PLA parts
- Z Endstop Holder (PLA)
- Mechanical Endstop
- 2 Motors (round shaft), with a 45cm extension for the right side motor and no extension for the left side.
- 4 x 10mm M3 Bolts + 6 x M3 washers (motor mounts)
- 2 x 16mm M3 Bolts + 2 x M3 nuts (endstop holder)
- 10 x 16mm M3 bolts + nuts + washers (Z-top/bottom secure to frame)

**Fig 2.0 parts:**

![Fig 2.0 parts](image_url)
2.1 Z-Axis Frame Mounting

Secure the Aluminium Waterjet Cut frame between the two large 30mm M10 washers (Fig 2.1a), then hand tighten on each side leaving approx 10cm between the flat rear of the Y-Corner and the rear of the frame (Fig 2.1b)

Fig 2.1a:

Fig 2.1b:
Once the lower frame is securely seated (press down) in the M10 notches of the Aluminium frame, and the measurement (about 10cm) is the same on each side and the 4 M10 bolts are hand tightened then flip the frame onto its side and firmly tighten using two M10 spanners (or adjustable spanners), Fig 2.1c. These nuts need to be tight as they prevent forward/backward wobble of the frame while printing.

**Fig 2.1c:**
2.2 Z-Axis Top/Bottom mounts (PLA)

Next bolt the Z-Top/Bottom PLA parts to the frame using 3 x M3 bolts/nuts/washers (Z-bottom Fig 2.2a) and 2 x M3 bolts/nuts/washers (z-top Fig 2.2b). M6 Rod holders (holes) on the outer edge, tighten M3 bolts/nuts firmly but not too firm, these parts tend to stay secure and its best not to stress the PLA by over tightening.

Fig 2.2a:

Fig 2.2b:
Same for both sides of the frame:
2.3 Z-Axis Motors & End-stop

Mount the two motors with wires facing the back. The right side motor needs a 45cm extension and the left side motor no extension (just the dupont 4 pin connector) .. see appendix A Motor Wiring. While mounting the left side motor include the end-stop mount using 2 x 20mm M3 bolts & washers and 1 x 10mm M3 bolt & washer (Fig 2.3a). Be careful mounting motors you really don't want to strip any of the motor threads! The M3 bolts should screw in smoothly and tighten after about 4-5 mm .. that's not a huge amount of thread but you can tighten them firmly (but carefully). Right side motor mount with 3 x 10mm M3 bolts & washers (Fig 2.3b).

Fig 2.3a:

Fig 2.3b:
3. **Build Plate & Heated Bed**

**Needed:**
M3 Allen Key (2.5mm)
M3 Spanner
6mm Waterjet Cut Aluminium Build Plate
Y-beltholder (PLA)
Aluminium Plate Composite MK2A Heated Bed
2 x Build Plate Springs + 2 x Nylon Build Plate Spacers
2 x M3 Red Fibre Washers
4 x M3 Washers (or 8 if your using 4 springs).
4 x M3 Nylock Nuts
3 x Strong 2.5mm Zip Ties
approx 61cm GT2 Timing Belt (enough to overlap slightly when passed over the GT2 pulley and Idler)

**Parts:**
3.1 Build Plate Mounting

Firstly attach the Y-beltholder to the underneath of the waterjetcut Aluminium build plate, open side facing towards the two bearing slots (Fig 3.1).

Fig 3.1a:

Next mount the build plate onto the 3 bearings of the Y axis smooth rods, using cable ties (Fig 3.2).

Fig 3.1b:
Now is the time to tighten up all the nuts on the Y-axis, while ensuring the build plate slides freely on the smooth rods and is aligned straight, adjusting the nut positions slightly if necessary. Also make sure the motor end-stop isn’t slanting forwards or backwards but sitting up straight so that the build plate will make square contact with it. Finally make sure all M8 and M10 nuts are firmly tightened (but not too firmly). It’s worth spending some time on this tightening stage to get it right before moving to the next steps.

### 3.2 Y-axis belt

Cut approx 61cm of GT2 Timing Belt and feed through the idler pulley and around the motor pulley, slotting both ends into the teeth of the Y-beltholder, then screw in the M3 belt clamp bolts and clamp down lightly (it does not need to be very tight and this part can break if too tight). Make sure the idler is pushed fully forward so that you can tighten the belt later and tilt the frame onto its side to get good access (Fig 3.2a)

**Fig 3.2a:**
Next tighten the belt by slacking/positioning/re-tightening the idler between the M8 nuts (Fig 3.2b). The belt should be tight enough so that you meet a bit of resistance when you push down on the belt, but not extremely tight as that can stress the motor.

**Fig 3.2b:**
3.3 Heated Bed Mounting

After all the nuts on the Y-axis are tightened, mount the Heated Bed onto the Aluminium Build Plate, using the 25mm M3 bolts & washers secured with the 4 M3 nylock nuts. We use a fixed mounted front on the heated bed as it greatly simplifies bed levelling as well as increasing stability and reliability, without compromising on accuracy. Also firmly cable tie the smooth rods into the Y-corners at this stage (not shown in the Figs).

Mount as follows:

Front: M3 Bolt head, 2 steel washers, heated bed, fibre washer, nylon spacer, steel washer, Aluminium build plate, M3 nylock nut.

Rear: M3 Bolt head, 2 steel washers, heated bed, steel washer, spring, steel washer, Aluminium build plate, M3 nylock nut.

Fig 3.3a:
4. Ramps Mounting

Now is a good time to mount the Ramps board while access to the frame is easy before the X-axis goes on. Unplug the power connector from the Ramps board (parts picture), it will be wired up later to the power supply & always on fans.

Needed:
M3 Allen Key (2.5mm)
M3 Spanner
Arduino / Ramps board
Ramps mount + fan mount crossbar
4 * M3 12mm bolts + 4 x washers + 4 x nuts
3 * M3 16mm bolts + 4 x washers + 3 x nuts
4 * M3 20mm bolts + 4 x nuts

Parts:
4.1 Ramps mount

Secure the Ramps mount to the rear left of the frame using the 4 M3 12mm bolts (nuts & washers on the front of the frame), Fig 4.1a

Fig 4.1a:

Next slide the Arduino/Ramps into to the Ramps mount from the top of the mount (Fig 4.1b), power connectors facing down. Secure in place using the ramps mount top clip.

Fig 4.1b:
4.2 Ramps Y & Z Wiring

Now is a good time to deal with the wiring for the Y and Z axis. Firstly secure the wiring out of the way of the build plate by cable tieing onto the M10 and M8 threaded rods (Fig 4.2b). Then connect the Z-axis motors to the top right twin 4pin connectors and the Y-axis motor to the middle right 4pin connector (red wire up). Finally Connect the Z-endstop and Y-endstop wires to the left two pins of the 18 pin bank of pins at the top left. The 18 pin bank of pins is in 6 rows of 3, if the bottom row is row 0 and the top row is row 6, connect the Y-axis to row 3 and the Z-axis to row 5 (X-axis goes on row 0), see Fig 4.2c. (Note: An older style ramps mount is shown here)

Note: If you connect your endstops to the incorrect pins you will destroy your electronics the moment an endstop is triggered (you will be able to smell your Mega 2560 burning). It will save time and money re-reading and triple checking your endstop connections before powering up, take as long as necessary until your 100% sure your connected correctly. Looking at the RAMPS from the rear of the machine, the 18 pin bank, 6 rows of 3 pins. Your endstops connect to the left hand two pins (see 4.2a and 4.2c showing the connectors attached to the left two pins). If your end-stop connector housings are 3 pin, the third pin will be disabled. See also the RAMPS wiring diagram in section 8, as well as the RAMPS 1.4 wiki online.

Fig 4.2a
Fig 4.2c:
5. **X-AXIS + Z-AXIS Rods**

Now to complete all the axis assembly we need to build the X-Axis assembly and fit onto the Z-Axis rods.

**Needed:**

- M3 + M4 Allen Keys (2.5mm & 3mm)
- 2 x M8 375mm X-Axis Smooth Rods
- 2 x M8 320mm Z-Axis Smooth Rods
- 2 x M5 300mm Z-Axis Threaded Rods
- 8 x LM8UU bearings
- 2 x Flexible CNC M5 couplings
- 2 x M5 Cage Nuts
- Motor (round shaft) + 4pin Connector (no wire extension needed) + 3 x M3 16mm bolts
- approx 79/80cm of GT2 belt + pulley
- Z-axis sprung adjustable endstop trigger (M3 16mm bolt + washers + spring + M3 square nut)
- X-Endstop holder with 2 x M3 20mm bolts + 2 x M3 nuts
- Mechanical Endstop
- X-Idler Pully (25mm M4 Bolt & Nut, 2x14mm M4 Washer, 2x9mm M4 Washer, 624zz bearing)
- Cable Ties
- X-Axis PLA Motor Mount, Idler and Carriage/Extruder Mount.

**Parts:**
5.1 X-Axis Assembly

Firstly assemble the basic X-Axis, take the X-Axis Idler and slot in one of the cage nuts to its housing (easiest done by compressing the sides of the cage nut with a pair of needle nose pliers). Ensure the the centre of the nut aligns with the hole for the M5 threaded rod (Fig 5.1a). Next put in the idler pulley (see appendix B) making sure the head of the M4 bolt is on the front face of the idler (so the M4 nut is next to where the M5 threaded rod will pass .. see Fig 5.1b). Lastly slot in two LM8UU bearings .. the should both be flush with the bottom and top edges of the idler (i.e. dont push the bearings together so they touch), then secure with cable ties (Fig 5.1b).

Note: an M5 cage nut is specifically used to allow some horizontal play in the nut, this keeps the Z movement smooth and prevents Z-wobble.

Fig 5.1a:
Now mount the second M5 cage nut and 2 LM8UU bearings in the same way for the X-axis motor and secure the cable ties, additionally slot 2 M3 nuts into the X-endstop mount nut-traps and mount the Z-axis sprung adjustable end-stop trigger (M3 16mm bolt + washers + spring + M3 square nut) making sure the square M3 nut is well seated in the square nut-trap, see Fig 5.1c.

Fig 5.1c:
Next bolt in place the X-Axis motor with 3 M3 16mm bolts, motor wire pointing down, and slot in place the GT2 belt pulley so that the teeth line up with the belt slot running through the centre of the assembly, then tighten the grub screws, the teeth of the pulley will be 2-3mm from the motor housing, see Fig 5.1d

Fig 5.1d:
Now for the X-Axis M8 375mm smooth rods, firstly place two LM8UU bearings on one of the rods and push into the top M8 hole of the X-Axis motor (motor on the left, idler on the right), secondly place another 2 LM8UU bearing onto the other M8 375mm smooth rod and push into the bottom hole of the X-Axis motor, then push the X-Axis idler onto the other end of the rods, see Fig 5.1e. Don't push together hard the precise adjustment will be when the X-Axis is mounted onto the Z-Axis rods.

Fig 5.1e
5.2 X-Axis Mounting

Now to mount the X-Axis assembly onto the Z-Axis smooth rods, firstly secure the 2 flexible CNC M5 couplings to the Z Motor shafts, don't push them far onto the shaft, just enough so that the grub screws tighten onto the motor shaft firmly (the further you push this coupling onto the shaft the less flexibility you get in the coupling .. and you want them to be flexible). See Fig 5.2a.

Fig 5.2a:

Next carefully slot the remaining 2 M8 smooth rods through the top Z-Axis mounts, push them about half way down, Fig 5.2b. Note: it helps to twist the rods as your pushing them in, don't force them and support the mount as your pushing down on it.
Fig 5.2b:
Next slot the M8 smooth rods through the LM8UU bearings of the assembled X-Axis (Fig 5.2c), adjust the ends of the X-Axis on the rods to line up with the smooth rods, then push the smooth rods down into the M8 holes on the top of the Z-motor mounts.

**Fig 5.2c:**
Next screw the two M5 threaded rods through the M5 cage nuts. They should thread through very smoothly, if not don't force it, check the alignment, clean and oil the threaded rod and try again. Also you can try screwing in the other end of the rod which may have a better start to the thread. Screw the threaded rods all the way down into the top M5 openings of the flexible CNC connectors to a depth of approx 8 mm, then tighten the grub screws gradually alternating between the two grub screws so as to keep the rod centred. Twist the connector and note the play at the top of M5 rod, it's ok if it has 'some' visible play on rotation.

Fig 5.2d:
Now turn both motors by twisting both flexible connectors simultaneously clockwise until the x-axis is raised about 35/40 cm further away from the build plate.

Next cable tie the X-Axis carriage/extruder mount onto the 4 LM8UU bearings (flat face of the mount front facing, belt toothed slot at the top with the teeth pointing upwards, also note the lower MK8 mounting tabs in Fig 5.2e .. one is positioned wide), make sure the bearings are pushed together and pressed well into the slots of the mount (they will click into place when pressed in). Not: It would be a good idea to practice pressing one bearing into place to hear what it sounds like when it snaps into place, its very important all 4 are seated correctly. Next thread through the cable ties and secure tightly.

Then thread the GT2 belt around the GT2 motor pulley and around the idler pulley (with the idler slackened) and push the belt well into the belt teeth of the extruder mount keeping the belt reasonably taught (tension can be increased next with the small clip on belt tensioner), trim to the correct length if necessary. (Fig 5.2e)

Fig 5.2e (rear view):
Next you can increase the belt tension by slotting the small belt tensioner onto the belt close to where the belt leaves the teeth of the x-carriage (see Fig 5.2f)

**Fig 5.2f:**

Finally plug the X-Axis motor into the lower right hand 4 pin motor header on the Ramps and the X-Endstop cable into the lower two pins of the bank of endstop pins (Fig 4.2b from the previous section).
6. Extruder & Hot-End

Now to mount the extruder and hot-end onto the X-Axis

**Needed:**
- M3 + M4 allen keys (2.5mm ,3mm)
- MK8 mounting bracket sections (left, right, rear + fanmounts)
- MK8 Hot-End & Extruder
  - 4 x M4 25mm rear bracket mounting bolts & 4 * M4 nuts & 8 * washers
  - 1 x M4 25mm X-endstop trigger bolt.
  - 2 x M3 35mm left/right side bolts & 2 * M3 nuts
  - 2 x M3 20mm fanmount bolts & 2 * M3 nuts & 2 * M3 washers
  - 8 x M3 16mm fan housing bolts.

**Parts:**

![Image of Extruder & Hot-End components]
6.1 Hot-end Mounting

Now you can mount the MK8 onto the x-axis. First check that the heater block / throat are firmly tightened, and the heater block approx 16/17mm distance from the base of the aluminium extruder housing. This will give the correct height from the build plate in relation to the build plate fans (PLA printing). Note: You will be sent the MK8 pre-tensioned and set at the correct length, it should be un-necessary to undo either of the throat nuts or nozzle. See Fig 6.1a

Fig 6.1a:
Now bolt the left and right MK8 mounting brackets together using the M3 35mm bolts and M3 nuts (slotted into the nut-traps on the right had bracket).

Then slot the MK8 into the bracket, fan to the left, motor to the right and hot-end power / thermistor wires running to the rear. Carefully note the alignment of the MK8 with the mounting bracket and make sure the fan wires are tucked into the notch at the top of the fan so that they aren't snagged by the mounting bracket, and can protrude out to the left hand side of the fan. See Fig 6.1 b (shown upside down).

Fig 6.1b:
Next slot the rear plate into place, endstop screwmount facing left (fan side) See Fig 6.1 c.

**Fig 6.1c:**

Next attach the build plate fans to the two fan brackets, the fans should be focused just underneath the brass hot-end nozzle. The mounting bolts shouldn't be overtightened See Fig 6.1d

**Fig 6.1d:**
Finally mount the whole assembly onto the x-carriage using 4 * 25mm M4 bolts, 8 M4 washers & 4 M4 nuts. Feed the hot-end and buildplate fan wires underneath the x-carriage, Hot-end fan wires over the top of the x-carriage. Tighten the M4 bolts firmly. See Fig 6.1 e & Fig 6.1f (rear)

**Fig 6.1e:**
Fig 6.1f (rear) :
7. X & Z-Endstop Triggers

Now to setup the X and Z endstop triggers.

7.1 X-Endstop Trigger

Screw in the M4 25mm X-Endstop trigger bolt on the left side of the MK8 mounting backplate and check that it lines up with the X-endstop. See Fig 7.1a.

Fig 7.1a:

You can also check and see where x=0 is going to be on the build plate when the endstop is triggered. See Fig 7.1b:

Fig 7.1b:
7.2 Z-Endstop Trigger

Check the Z-endstop trigger to make sure there is at least 7 mm of trigger protruding and that its lined up with the Z-endstop. This is important so that you don't crash the print head on your first auto-home test. See Fig 7.2a
8. Final RAMPS Wiring

Now to complete the RAMPS wiring including the hot-end, heated bed, fans and power supply (if you have not yet got a power supply ready to connect see Appendix C). For your reference here is a RAMPS 1.4 wiring diagram taken from RAMPS wiki:

![RAMPS 1.4 Wiring Diagram](image-url)
8.1 Heated Bed Connecting

Strip the ends of the heated bed positive and negative wires and connect to the D8 +/- on the RAMPS (at the bottom directly left of the power connector). Also connect the Heated Bed thermistor cable to the middle two thermistor pins on the vertical column of six pins to the left of the Z-Axis motor headers (it doesn't matter about +/- for thermistor pins). See Fig 8.1a for a picture of the pins. The Heated bed wiring should be firmly cable tied whilst allowing full backwards/forwards movement of the build plate.

8.2 Build Plate Fans Connecting

Connect the positive and negative wires for the pair of build plate fans to the D9 +/- on the RAMPS (to the left of where you connected the heated bed power)

8.3 Hot-End Connecting

For convenience of cleaning/maintaining the hot-end the power supply and thermistor cables are unplug-able. Connect the two red hot-end power cables with attached 2-pin socket and wire into D10 on the RAMPS (+/- doesn't matter). Also take the thermistor cable with the two pin DUPONT connector and plug onto the two pins underneath the heated bed thermistor as described above.
8.4 Power Supply / Hot-End Fan and RAMPS Fan Connecting

Now connect the 50mm RAMPS fan +/- and one of the power supply +/- to one side of the small green RAMPS power plug (note the +/- orientation: negative to the right with the plug screws facing up), also mount the fan onto one of the RAMPS mount crossbars using 2x16mm M3 bolts + washers + nuts. There are two fans which should wire direct to 12v which are the RAMPS fan and the MK8 fan, which can both be wired by whatever means you choose, but the easiest way is via the green RAMPS power plug. See Fig 8.4b for RAMPS power and fan wiring diagram.

Now do the same for the remaining power supply cable and the single front hot-end fan cable (which should be already cable tied with the rest of the hot-end cables). Then connect the power plug to the bottom socket of the RAMPS. Finally mount the crossbar+rampsfan to the RAMPS mount using two M3 + 10mm bolts.

Tidy up the cables connected to the RAMPS using cable ties (and spiral wrap if you have it) (Fig 8.4a). The cables going to the hot-end should be cable tied just underneath the frame and allow for full Z-axis/X-axis movement of the hotend.

Fig 8.4a:
To Power Supply 4 Connections - Yellow/Black - Yellow/Black (+/- +/-) using Spade/Crimp or connectors of your choice (must be rated at the very minimum 11A at 12v (pref 16A))
9. Spool Mount

Parts:
2x 18cm M8 Threaded Rods
1x 15cm M8 Smooth Rod
8x M8 Nuts
2x PLA Frame Mounts
2x PLA Spool Spindle Mounts

9.1 Spool Mount Assembly

The spool mount can be used to mount a 1Kg reel of filament directly above the hot-end, with the filament feeding over the top of the reel and giving a path of least resistance into the extruder. This arrangement minimises the drag on the extruder from the filament.

Mount the frame clips and the spindle holders on either end of the M8 18cm threaded rods, secured by the M8 nuts as shown in Fig 9.1a. Then slot the 15cm M8 smooth rod (spindle) into the grooves.
Fig 9.1a:
10. LCD / LCD Case & Mount

Parts:
LCD + 2x Ribbon Cables + Ramps Adapter
LCD Case PLA pieces
LCD Knob
Frame Mounting Clip
4x 20mm M3 bolts
2x 10mm M3 bolts + washers
2x 16mm M3 bolts + washers
10.1 LCD Case Assembly

Firstly slot the LCD top first into the case centre section, then bolt on (using the 4x 20mm M3 bolts) the bottom section ensuring the LCD circuit board is seated properly in the grooves. Next slot on the right hand cover over the LCD control knob shaft (Fig 10.1a) and bolt in place from the rear with the 2x 10mm M3 bolts+washers (Fig 10.1b).

Fig 10.1a

Fig 10.1b
10.2 LCD Wiring and Frame Mounting

Next mount the frame clip on the bottom of the LCD case using the 2x16mm M3 bolts (Fig 10.2a). Then plug in the two ribbon cables to the back of the LCD and into the adapter and clip the LCD case onto the top left of the frame with the ribbon cables running straight down the the ramps (Fig 10.2b). The adapter plugs into the top header of the RAMPS.

Fig 10.2a:  
Fig 10.2b:
11. First Power-on and Test

Before powering on the printer for the first time and testing, screw in the X-endstop trigger (M4 25mm bolt) to the side of the extruder... screw it well in until there is approx 10mm of thread showing (Fig 11.0a). Also make sure the Z-endstop is aligned with the trigger and the trigger bolt is protruding 7-8mm (Fig 11.0b).

Apply a small amount of oil to the X/Y and Z-axis smooth rods, also the Z-axis M5 threaded rods, and make sure the build platform and X-axis carriage assembly move through their range without snagging on anything.

Then connect the two 12v power supply cables to the ramps (11A to the left, nearest D8, 5A to the right).

Fig 11.0a:                                                                         Fig 11.0b:
11.1 First Power-on

With everything connected up and the end-stops checked, power-on the printer from the power supply. The LCD should light up after after 1-2 seconds and say Factory 3D Ready, with the temperatures of the hot-end and heated bed displayed (room temp). See Fig 11.1a. If the LCD doesn't light up but your RAMPS fan is running, power-off and check your cabling to the LCD. If the LCD says error:MINTEMP, power-off and check your two thermistor cables from the hot-end and from the heated-bed.

Never adjust a cable (or anything on the RAMPS) with the power-on, the only exception being adjusting the pots on the stepper motor drivers). See Troubleshooting Appendix Z also.

If your LCD is displaying ready .. then you can move to the Motor Tuning stage.

Fig 11.1a:
11.2 Motor Tuning (Optional for first test but necessary to achieve very good prints)

Before shipping your RAMPS has been tested, which involves setting the stepper driver pots to approximate power for the motors we ship, which will be good enough to get up and running for the first test. However some tuning will likely be necessary for optimum prints. Motors can be tuned from scratch using the long method described below however another method is just to start printing and touch temp test the motor housings .. they should be running warm but not hot. If they start to get hot after a few layers .. backoff (ant-clockwise) the stepper driver pot by a fraction (maybe 1/12 th of a turn – five mins on the clock). Repeat until the motors will do a print and stay warm but not hot. If they are running cool .. they could possibly require an extra 1/12th clockwise. This method of tuning is surprisingly accurate and if you don't mind wasting a few less than ideal prints its a painless way to tune your motors.

This next section describes fully tuning your motors from scratch:

Before starting these tests, familiarise yourself with the reset button on the side of the RAMPS .. press it to instantly stop the printer and reset it to the start screen.

Manually move the build platform and the X-Axis so that they touch the endstops then select from the LCD menu : Prepare → Move Axis → 1mm → X-Axis, then turn the knob clockwise which should move the x-axis to the right, probably quite jerkily .. or possibly it wont move at all. Locate and turn the adjuster 'pot' on the stepper motor driver for the X-Axis using the ceramic screwdriver, turn it anti-clockwise until the motor starts juddering then no longer moves (or clockwise until it starts to move). See Fig 11.2a. You will find that the motor will be perfectly tuned a small amount after the point it starts to move without juddering (maybe ¼ of a turn after) .. and it will move smoothly and not overheat during printing. If either your stepper motor driver or your stepper motor get too hot during printing it will ruin your print, and they will over-heat if the adjusters are set even fractionally too high (especially the extruder and z-axis). For your first couple of prints touch test the heat of the motors during the print.. they will get warm (in fact they should get a little warm, if they are staying cold they may not be getting enough power) but if they start to get hot you have adjusted too high. Once you get these tuned right .. don't be tempted to re-tune if you run into a print problem, once they are tuned they tend to stay tuned and not need to be changed.

Fig 11.2a
(Y-Axis stepper motor driver adjuster pot)
11.3 Filament Feeding

Mount the spool assembly directly above the extruder (with the extruder as centred as possible). Make sure the end 10cm or so of the filament is very straight so the it will feed easily down into the hot-end throat (Its can help also to cut the end of the filament at an approx 45 deg angle). See Fig 11.3a.

Note: To reduce the amount of dust and particles making their way into the hot-end its best to wrap a small piece of felt or sponge or similar material around the filament secured with some tape, so that it sits just above the extruder/idler opening. This will significantly reduce the incidence of nozzle blockages.

Fig 11.3a:
Press down on the quick release lever at the front of the MK8 to allow you to push the straight part of the filament down into the MK8 throat. This may take a few attempts until you get the hang of keeping the filament straight and judging how far to push it down (any distance into the throat is fine). See Fig 11.3b.

**Fig 11.3b:**

Next heat up your hot-end and go to the menu and as before using the Move Axis → 1mm → Extruder option, feed a few mm of filament through the nozzle to check all is ok.
11.4 Extruder Calibration (Optional)

This step is not really necessary because your extruder comes pre-calibrated for 1.75mm filament, however optionally you can also check your calibration by marking say 3cm on the filament above the idler (with a marker or a small piece of tape) and then feeding 30mm via the menu and checking if 3cm exactly is fed down to the idler. Note: Changes to the calibration of all the axis can be made from the LCD config menu, also they can be made in the Configuration.h file of the Marlin Arduino Code.

11.5 End-stop Test

Make sure your x-axis is absolutely level (i.e. the X-Axis motor and the X-Axis idler are exactly the same height from the table surface .. OR .. raise the X-axis up and line up the top smooth rod with the underneath of the frame. If it isn't level then level it by holding both Z-couplers and turning the left/or right M5 threaded rods until the axis is exactly level. Note: you can turn the Z-axis motors manually like this if the power is off OR you have just reset the RAMPS OR you have selected menu option 'Disable Steppers'.

IMPORTANT: do this slowly and carefully .. this is the stage you can destroy your hard work.

The end-stops are crucial .. if you auto-home and one of your end-stops is not triggering then the motor will crash the axis and keep going. This is especially bad for the Z-axis where you will likely damage your hot-end , your heated bed and probably one or more Z-axis structural parts.

Do this for each axis:

1. Reset the ramps using the side reset button.
2. Center the axis (e.g. move the X-Carriage to the middle)
3. Hold Axis (e.g. the x-axis) end-stop closed with your finger, and while holding it closed , from the LCD menu Move Axis, 1mm, X Axis (or Y or Z) .. and turn the knob right a fraction then back. The Axis should move right (or forward for Y or up for Z) but refuse to move when you turn the knob back -- this means your end-stop is working ok. Also if you go back to the LCD info front screen it will say end-stop triggered {axis}.

Finally check that the end-stop triggers (bolts for X and Z, rear of the build plate for Y) are lined up correctly. This is easy for the X and Y axis so check those first. For the Z-axis, carefully perform an auto-home from the LCD menu, with your finger on the ramps reset button ready to reset and stop the auto-home with the Z-axis approx 2cm away from triggering the end-stop.
11.6 Bed Levelling Preparation

If you have carefully performed all the steps from 11.5 you can confidently now perform a full auto-home, test that now and allow the Z-end-stop to trigger this time. Note the distance from the hot-end nozzle to the aluminium surface, it should be at least 8 or 9mm enough to comfortably fit the mirrored surface through, see Fig 11.6a (Note pictured is a J-Head hot-end but same procedure with the MK8)

Fig 11.6a:

Now select Prepare → Raise Print Head from the LCD menu and clip your mirrored surface onto the heated bed using the crocodile clips and tighten up your front two nylon spacers (unless your using 4 springs). Also tighten up the z-axis endstop trigger screw to increase the height slightly of the hot-end nozzle after auto-home.
11.7 Bed Levelling

With mirrored surface in place, first tighten up your two nylon spacers supporting the front of the heated bed (unless you using 4 springs). Then perform an auto-home. Check the distance of the nozzle from the mirrored surface, if it's close use a normal piece of paper (the type you would use to print on) and slide it between the nozzle and the surface. The perfect height is when the paper can be slid through the gap but only just so that it feels like its catching on the nozzle. See Fig 11.7a.

Fig 11.7a:

Loosen (or tighten if it's too close) the z-endstop trigger and re-auto-home until the distance is correct. But after each adjustment manually move the nozzle to the right hand side of the build plate and check the x-axis is level (i.e. the same height as the auto-home position). If it isn't then level it by holding both Z-couplers and turning the left/or right M5 threaded rods until the axis is exactly level. Once you have the correct distance on both front sides of the build plate, slide the build plate forwards adjusting the rear 'sprung' mounts until they are correct also. The first time you perform this levelling you will probably need to make 2 or 3 passes starting from the front left again, but after that levelling will just involve minor tweaks. In fact with solidly mounted end-stops, fixed front bed mounts and the nyloc nuts underneath, the reliability is such that you can typically print through an entire kg reel of filament without any bed levelling to do.
11.8 First Print

Once your bed is levelled, apply a thin layer of PLA glue solution to the mirrored surface with the small paintbrush. Don't worry if it looks uneven or too thick (as in Fig 11.8a), once the bed heats up the solution will dry to a near invisible smooth surface (Fig 11.8b)

Fig 11.8a (PLA glue applied):                                           Fig 11.8b (now dried):

Now save a 3D model gcode file to the SD card (e.g. for this example z_endstopmount.gcode) and insert the card to the slot on the left hand side of the LCD (SD contacts facing towards you), the RAMPS should detect the SD card. Now you can select the Print option from the LCD menu and it will list the 3D models you have saved on the card, select the z_endstopmount (for example). The first thing the printer will do is execute the start/gcode thats saved with your 3D print model (i.e. raise head, heatup bed, heatup hot-end etc), this gcode it editable either in the gcode file itself or in the software that wrote the gcode (Cura). When the correct temps are reached it will move the head into position and start printing .. its a good idea to be watching the printer at this point to remove any surplus filament that has extruded before the first layer goes down (with a pair of tweasers).
Fig 11.8c – First Print:
Appendix A – Motor Wiring

Needed:

Multipurpose Crimp Tool & Ideally a dupont crimper .. but you can use other crimpers or even pliers.
4 x Female Dupont Pin Connectors (2.54mm Pitch) + 1x 4pin Female Dupont Housing
4 x 1.5mm Bootlace Ferrules
4 x Heat shrink tubing pieces.

Extension Length of red,blue,green,black wire (7/0.2mm equipment wire).

There are 5 stepper motors: 1 Y-Axis (round shaft), 1 X-Axis (round shaft), 2 Z-Axis (round shaft) and 1 Extruder (flat shaft). All come with about 30cm of wire which needs to be extended and fitted with Female Dupont Pin Connectors (2.54mm Pitch) and housed in a 4 pin Dupont housing so that they can be plugged onto the 4 pin connectors on the RAMPS board. The motor wires are red,blue,green,black which are paired red+blue and green+black. You can test the pairing of any stepper motor by connecting together a pair (e.g. red + blue) and turning the motor shaft .. it will resist if you have connected a matched pair. We use motors from one manufacturer and the correct pin sequence from top to bottom with the ramps power connector facing down is red,blue,green,black. There is no colour standard between motor manufacturers so if you use different motors this can be different .. but its not hard to get right, so long as you position together your matched pairs .. if the motor spins the wrong way just reverse the connector and plug it back in.

First the wire extension, strip about 1cm from each end to connect and slip onto the motor wire section a length of heat shrink tubing then a bootlace ferrule (open end facing the wire join) and fold both wire ends to be joined into a hook and hook together (Fig A1)
Next press the wire join together and slide over the bootlace ferrule, then crimp the ferrule to seal the joint (Fig A2). Then slide over the heat shrink tubing and shrink it in place using a lighter or other heat source (Fig A3). Repeat this for all four wires.
Finally attach a female Dupont connector to the end of each wire (if you have never crimped Dupont connectors before there are some youtube videos which are easily searchable show exactly how). Strip about 1cm from the end of each wire and fold the bare wire in half so you have about 0.5 cm to push into the connector. Next slot the open end of the dupont connector into your crimpers (Fig A4), then gently push in your folded over wire, once you feel it is snugly into the dupont connector (Fig A5) .. crimp down firmly (but not too firmly so you disform the connector).

Fig A4 & A5:
Next slot the crimped connector into the housing (Fig A6).

Fig A6:
Then repeat for all 4 wires in the order red, blue, green, black:
Appendix B – Idler Pulleys

Needed:
M4 Allen Key (3mm)
M4 30mm bolt + nut
4 x M4 9mm washers
2 x M4 14mm washers
624zz bearing
PLA Y-axis idler or X-axis idler

The idler pulley assembly is identical for both Y and X axis, for this example we are using the Y-axis idler:

Fig B1 (parts)
First slot a 9mm M4 washer onto the M4 bolt and poke through the idler (Fig B2):

**Fig B2:**

Next slot a 14mm M4 washer onto the bolt on the inner side of the idler (Fig B3):

**Fig B3:**
Next slot a 9mm M4 washer onto the bolt then the 624zz bearing (Fig B4).

Fig B4:

followed by another 9mm washer and the last washer on the inner of the idler another 14mm washer, finished off with a 9mm washer and nut on the outside of the idler (Fig B5).

Fig B5:
Appendix C – Power Supply (ATX Modified)

Needed:
ATX Power Supply
approx 60cm of paired red/black 12V/20A cable (2x30cm)
10 Watt 10 Ohm Resistor (10R)
10 Watt 47 Ohm Resistor (47R)
2x Female Spade Connector Housings + 4x Female Spade Connectors
2x Male Spade Connector Housings + 4x Male Spade Connectors
Heat Shrink Tubing
Soldering Iron + Solder
Cable Ties

Parts:
This is the most common method for adding a power supply to a reprap, its a relatively easy and neat solution however it does invalidate the warranty of the power supply.

Note: Before you start ensure the power supply is unplugged from the mains (and has been for at least an hour, they retain power which can shock for a while after being unplugged).

Note: Power supply model may vary and look slightly different to the pictures but the wire colours remain the same.

Note: You will often see mentioned online 4R7 (4.7Ohm) resistors being used to convert an ATX power supply, this is to draw sufficient current to keep older style power supplies stable under load. The 47R (47 Ohm) resistor supplied here draws less current and stays cooler than the 4R7. The power supply shipped with this kit will remain stable under load despite the lower current as its a more modern specification designed to work with Haswell PC architecture.

To start, undo the 4 top retaining screws on the 4 outer corners of the casing (fan facing up) and unplug the fan power cable so that you can lift the case lid off (Fig C1)

Fig C1:
Next cut off (as close to the circuit board as is convenient) the following wires (Fig C2):

– The Grey
– The Blue
– The Purple
– All the Orange (Except One)
– All the Red (Except One)

Fig C2:
Now your going to connect orange+brown and green+black to the 47R resistor and red and black to the 10R resistor. So cut the wires for orange,brown,green,red and 2xblack so that you have got about 26cm of wire off the circuit board and strip the ends for soldering. Also cut off all the cable connectors and discard the wires cut off at the circuit board in step 1, leaving just 1 x orange,1 x brown,1 x green,1 x red and all the black and yellow (see Fig C3).

Fig C3:
Now you can choose to attach your resistors on the outside of the power supply (if so then you will need feed your 26cm wires through the back vent holes)... or attach the resistors on the inside of the power supply which is a lot neater. So slot on some heat shrink tubing and solder up the resistors. Orange+Brown and Green+Black to the 47R resistor. Red and Black to the 10R resistor. See Fig C4.

Fig C4:
Then cable tie the resistors to the back vent of the power supply low/central so that they will be out of the way of the fan housing and transformer when the case lid goes back on, see Fig C5.

**Fig C5:**
Next tuck all the cabling away using cable ties if necessary so that it can’t impede the fan, also secure the cables exiting the power supply case with a cable tie then replace the case lid, re-attaching the fan power supply cable as you do, and replace the four retaining screws.

Now wire 6 black and 3 yellow to each female spade connector.

Connect the remaining Male spade connectors to the 12V/20A red/black cabling to match the yellow/black Female connectors. See Fig C6.

Fig C6:
Appendix D – Firmware Update

Your electronics come pre-loaded with the correct firmware, however should the need arise through upgrade/tuning or some other reason, this section covers briefly the firmware upgrade procedure.

The Reprap RAMPS board is driven by an Arduino (Or Clone) Mega 2560 R3. The Mega 2560 is loaded with a firmware called Marlin (Factory 3D modified, source code included). This firmware can be loaded onto the Mega 2560 from a desktop PC (not a laptop which lacks sufficient USB power) via the USB port. The printer power supply should be switched OFF during this process, with the only source of power to the Ramps/Mega board being from your computers USB port. Ideally leave the LCD connected so you can see what the board is doing, however the process can be done with the LCD disconnected also.

Note: Be very careful not to allow anything metal to touch the board when its powered up, this includes resting the board on any metal object. Also be careful plugging the USB cable into the board. The Arduino/Mega 2560 is very easily damaged by any kind of metallic contact while powered up.

This is a well documented platform with lots of online reference material available, however the following is a simple (by no means exhaustive) guide to updating the firmware. Firstly download the Arduino development platform (IDE) from here: https://www.arduino.cc/en/Main/Software and install it.

Next create a directory for marlin on your C: drive called c:\marlin (or location of your choice on any local drive) and unzip the F3D marlin zip file from the directory on the cdrom (e.g.: {cdrom:}\marlin\marlin_f3d_i3_mk8_jul16.zip) inside c:\marlin (or the location you decided).

Now launch the Arduino IDE and from the Tools → board menu select the Arduino Mega 2560 board (also sometimes labelled Arduino Mega 2560 or Mega ADK). Then select File->Open and navigate into the c:\marlin\marlin_f3d directory then into f3d and double click the f3d project (a file called f3d.ino).

Now you should be able to just compile the project to check all is ok .. click the [tick] icon named 'Verify' which will actually compile the project for you. If all is ok you can connect your Ramps/Arduino (carefully) to the USB port, it will take a few seconds (maybe 10 or so) to power up. Next check the Arduino IDE has detected the board, go to the Tools → Port menu and you should see the board listed as COM1,COM2 or COM3 etc. Select the COM port the board is detected on.

Now you can click the icon named 'Upload' to upload it .. this will take approx 30-60 seconds. Once the upload has finished the board will reboot itself and the Arduino IDE will display 'upload finished'. The firmware update is now complete so you can unplug the USB and power up the board from the printer power supply as normal.
Appendix Z – Troubleshooting

Hot-end heating up too slowly or not reaching temp at all.
The front fan flow onto the hot-end is hitting too much of the nozzle section, fit the fan spoiler onto the fan (if it isn't already). Add kapton tape to the hot-end aluminium section.

Extruder stops extruding mid-print
Check the motor temperature with your finger … your stepper motor driver pot may be adjusted too high and overheating the motor and/or itself.

Check the hot-end temperature reading on the LCD .. if its below melt-temperature of the filament then the filament cannot feed causing the motor to stop, adjust the build plate fan positioning they may be blowing too much air on the hot-end.

If its non of the above you unfortunately probably have a filament blockage which can sometimes be cleared by:
1. Heating up hot-end beyond 200c for a while and trying again to extrude.
2. Heating up the hot-end and inserting a very thin piece of wire carefully into the nozzle (like the wire from a wire brush).
3. Failing this .. taking apart and carefully cleaning the hot-end will be necessary.

Printed part is mis-shapen or lopsided
Check the motor temps for overheating , they motors can get warm but if uncomfortably hot to touch they are overheating. Adjust the stepper motor driver pot down a tiny fraction.

Check the belt tensioning – belts should be moderately firm, not loose so that you can press down more than 8 or 9mm on the belt.

Check the motor cogs are tight and not slipping.

Printed part is warping up at the base
Try adding a brim to the print in Cura

Check that the heated-bed is reaching temperature.

Wash the mirrored surface thoroughly and allow to dry then re-apply PLA glue

Check bed levelling