Folger Technologies LLC
www.folgertech.com

Kossel Rev B 3D Printer

Owner's Manual

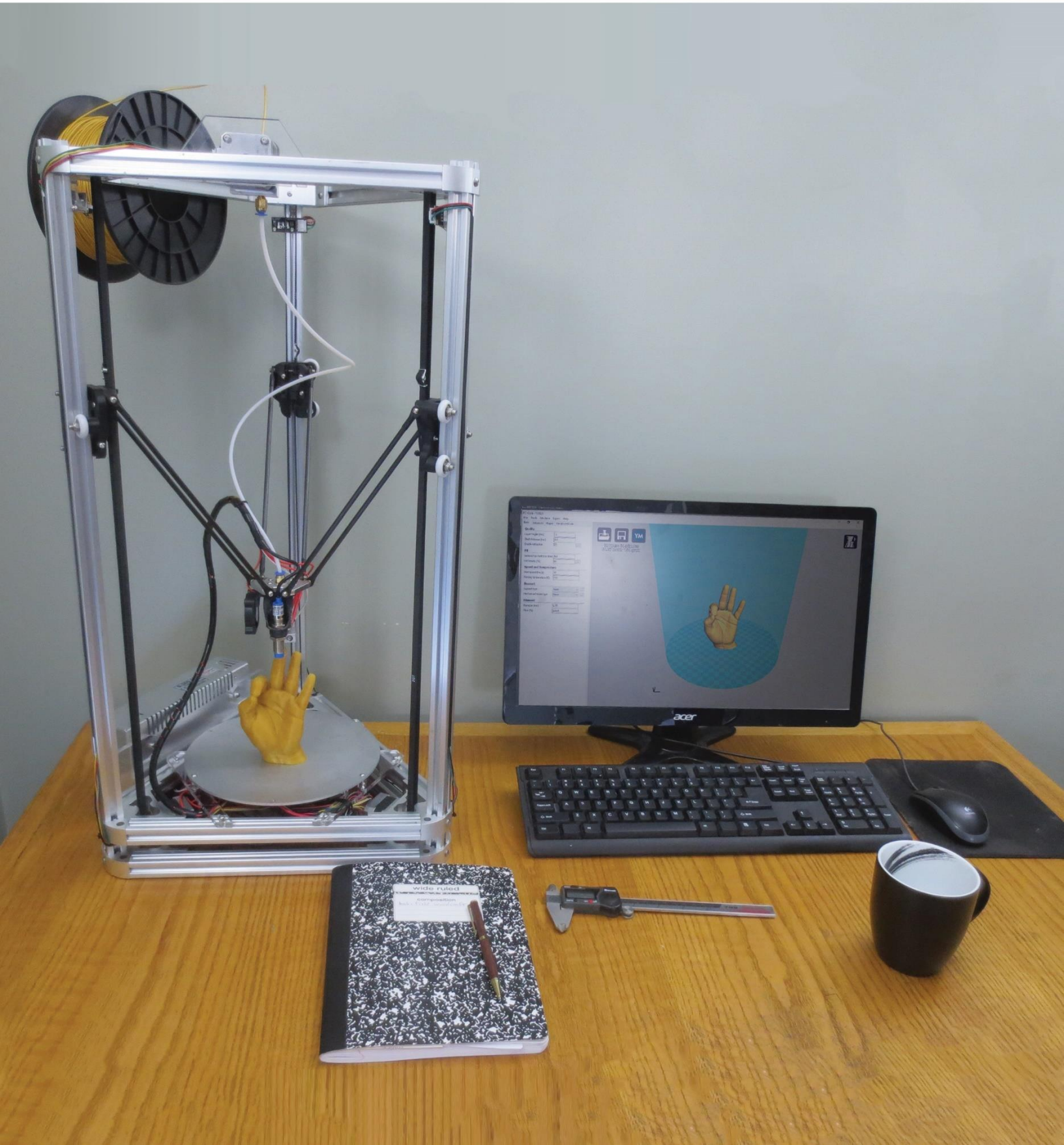


Table of Contents

CONTENTS

INTRODUCTION

Congratulations! If you are looking over this manual it means that you are the proud owner of a Folger Tech Kossel 3D Printer, which is a powerful tool that can help you unleash your creative spirit.

Our goal as a company is to provide affordable 3D printers to consumers worldwide. On top of this we want everyone's first printing experience to be a great one. So this User Manual was assembled to provide guidance in assembling and understanding common procedures while using our 3D printer. It covers everything from assembly to the maintenance required to keep your printer performing like new.

We look forward to helping you succeed in the exciting world of 3D printing and giving you everything you need to unlock your innovation.

CONTACT FOLGER TECH

We understand that manual only covers the basics of your Folger Tech printer, so if at any time you need more assistance, visit our support page at Folger Tech Support to send us a **message** and we will be happy to address your question or concern.

DISCLAIMER OF LIABILITY: FOLGER TECHNOLOGIES LLC specifically DISCLAIMS LIABILITY FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES and assumes no responsibility or liability for any loss or damage suffered by any person as a result of the use or misuse of any of the information or product. FOLGER TECHNOLOGIES LLC assumes or undertakes NO LIABILITY for any loss or damage suffered as a result of the use, misuse or reliance on the information and or product. USE AT YOUR OWN RISK: Never leave your printer unattended. This kit involves working with 110v/220v and should only be done if you are qualified, if you are not, speak to a qualified electrician.

INVENTORY OF PARTS

This section lists the individual parts included in the Folger Tech Kossel 3D Printer Kit. Each item is given a number or letter identification, which may be referenced later in the manual. Parts are itemized by number and hardware is itemized by letter. It may be helpful to use these tables as a guide to help you navigate this manual. **If you received a different part then what is in this table, check the Appendix at the end of this manual. That will cover any older bill of materials.**

FOLGER TECH KOSSEL PARTS

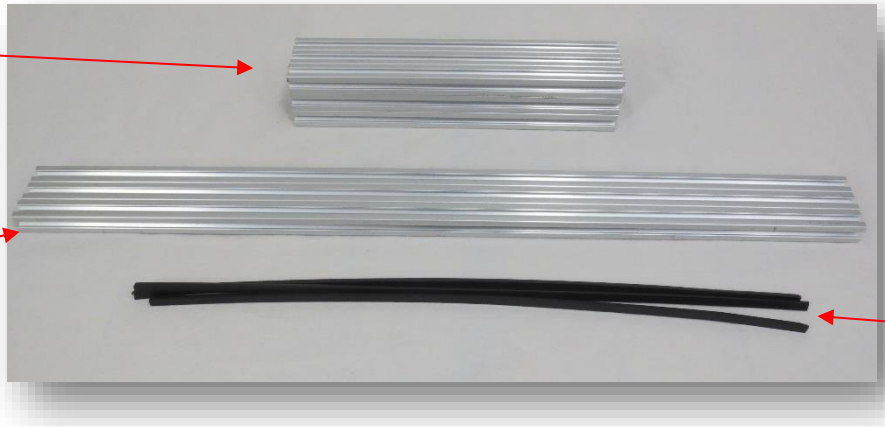
Item ID	Quantity	Description	Item ID	Quantity	Description
1	*6*	AL Bottom Corner	24	*3*	GT2 20tooth Pulley
2	*3*	AL Top Corner	25	*1*	Inductive Probe
3	*9*	300mm 2020 Beam	26	*1*	10K Resistor
4	*3*	700mm 2020 Beam	27	*1*	15K Resistor
5	*3*	2600 Stepper Motor	28	*6*	Bed Mount Spacer
6	*3*	5800 Stepper Motor	29	*1*	Spool Mount
7	*6*	Carbon Fiber Arm	30	*1*	Electronic Mount
8	*1*	1.75 Teflon Tube (Bowden)	31	*1*	Extruder Mount
9	*1*	Upper Block	32	*2*	Power Supply Mount
10	*1*	1.75 All Metal Hot End	33	*3*	End Stop Mount
11	*1*	2mm Push Fit	34	*1*	Drive Gear
12	*1*	Round Heat Bed	35	*1*	40mm Fan
13	*1*	100K NTC Thermistor	36	*1*	AC Cord
14	*1*	MKS Base Board	37	*3*	2020 Insert
15	*5*	Stepper Driver	38	*1*	Filament Sample
16	*3*	Endstop (Limit Switch)	39	*4'*	Red 14 AWG Wire
17	*1*	USB Cable	40	*4'*	Black 14 AWG Wire
18	*1*	360W Power Supply	41	*3'*	Red 22 AWG Wire
19	*3*	Belt Holder	42	*3'*	Black 22 AWG Wire
20	*3*	Roller Carriages	43	*1*	Long Motor Wire
21	*1*	Effector	44	*3*	Short Motor Wire
22	*1*	Sensor Mount	45	*1*	3 pin connector pigtail
23	*1*	GT2 Belt	46	*1*	Kapton Tape
			47	*1*	Injection Molded Block

FOLGER TECH KOSSEL HARDWARE

Item ID	Total Supplied	Description	Item ID	Total Supplied	Description
A	*3*	M3 Nut	L	*4*	M4 Large Washer
B	*40*	M3 Nylock Nut	M	*46*	M4 T-nut
C	*16*	M3 T-nut	N	13	M4x8 Screw
D	*4*	M3 Flat Washer	O	40	M4x10 Screw
E	*30*	M3x8 Screw	P	10	M5 Nylock Nut
F	*18*	M3x12 Screw	Q	10	M5x25 Screw
G	*24*	M3x16 Screw	R	6	F623zz Bearing
H	*10*	M3x20 Screw	S	*4*	Belt Tensioner
I	*30*	M3x25 Screw	T	*18*	Black Zip Tie
J	*6*	M3x30 Screw	U	*10*	Nylon Roller
K	*3*	M3x45 Screw	V	*1*	Wire Wrap

3. 300mm 2020 Beam

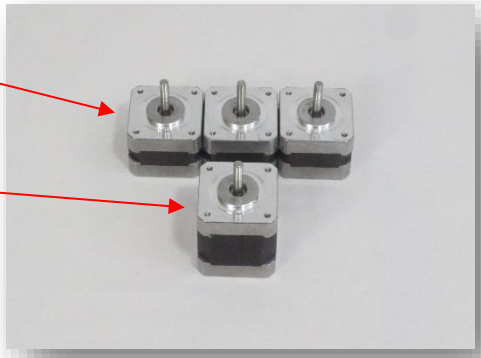
4. 700mm 2020 Beam



37. 2020 Insert

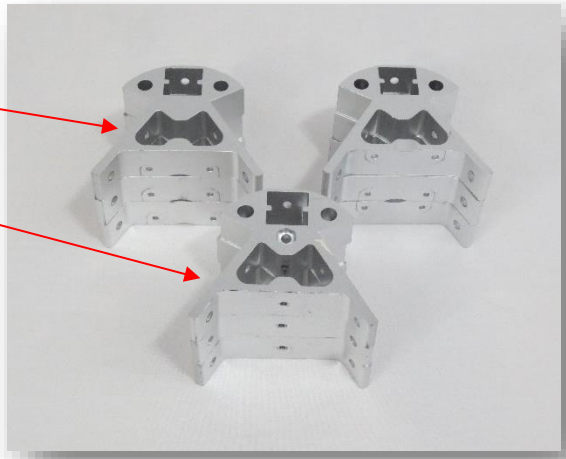
5. 2600 Stepper Motor

6. 5800 Stepper Motor



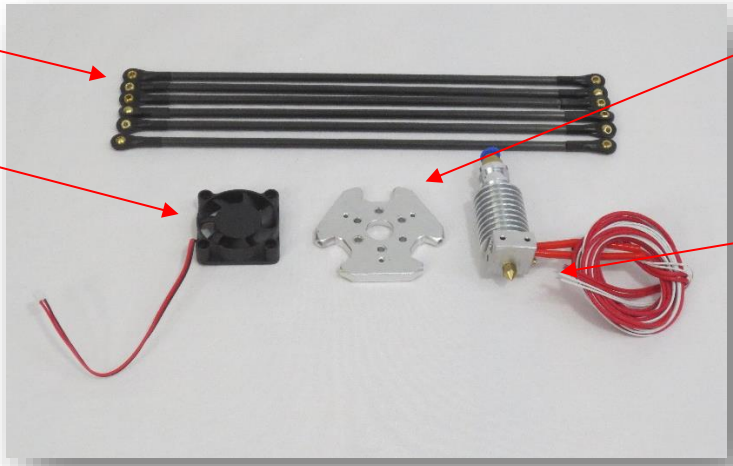
1. AL Bottom Corner

2. AL Top Corner



7. Carbon Fiber Arm

35. 40mm Fan



21. AL Effector

(optional add-on feature not included with stock kit)

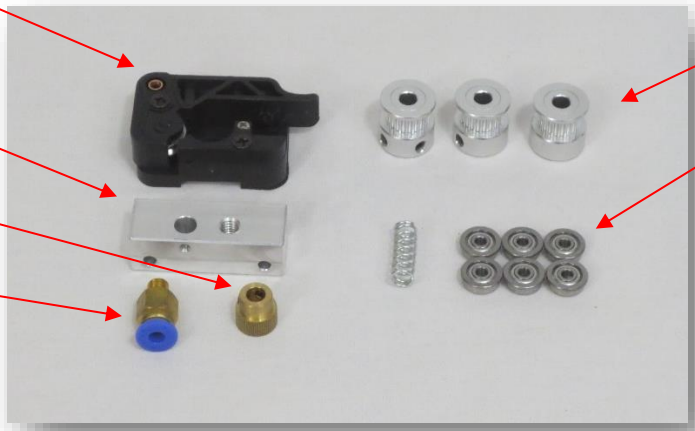
10. All Metal Hot end

47. Injection Mold Block

9. Upper Block

34. Drive Gear

11. 2mm Push Fit



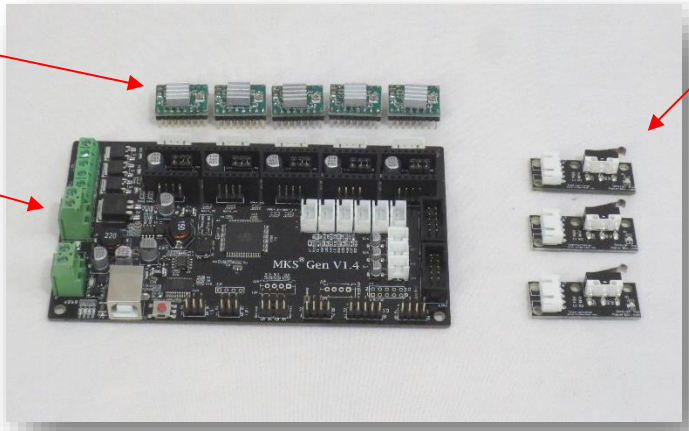
24. GT2 20Tooth Pulley

Q. F623zz Bearing

15. Stepper Driver

14. MKS Base Board

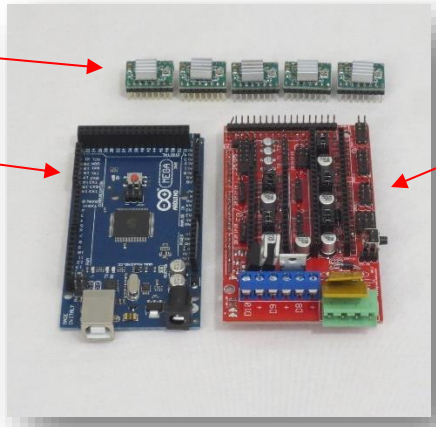
(MKS board is an add-on feature not included in stock kit)



16. Endstop

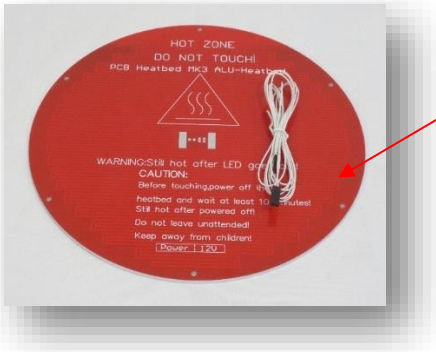
Stepper Motor

Arduino Mega



Ramps 1.4 Board

12. Round Hot Bed



13. 100k NTC Thermisor

22. Sensor Mount

19. Belt Holder

20. Roller Carriages

Printed Effector

18. 360W Power Supply

36. AC Cord

V. Wire Wrap

23. GT2 Belt

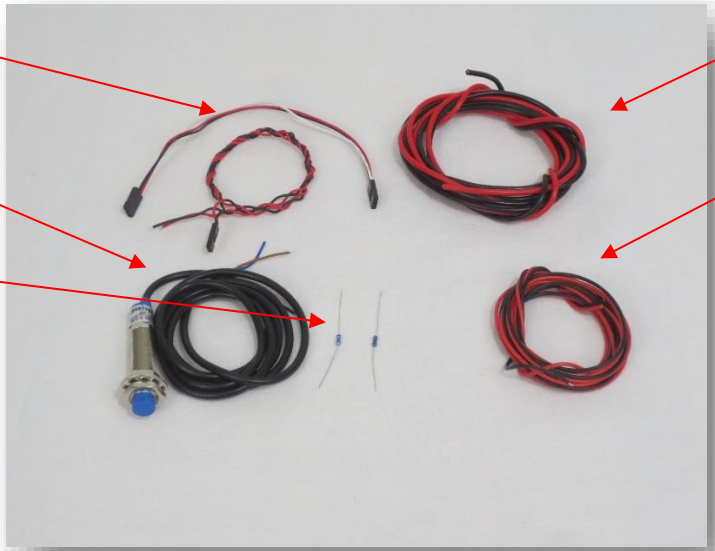
45. 3 Pin Connector

25. Inductance Probe

26-27. Resistors

39-40. 14 AWG Wire

41-42. 22 AWG Wire



Hardware Kit

8. 1.75 Teflon Tube

46. Kapton Tape

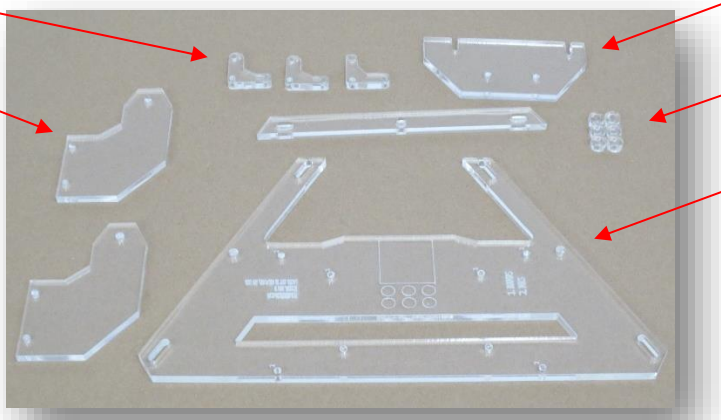
33. Endstop Mount

32 Power Supply Mount

31. Extruder Mount

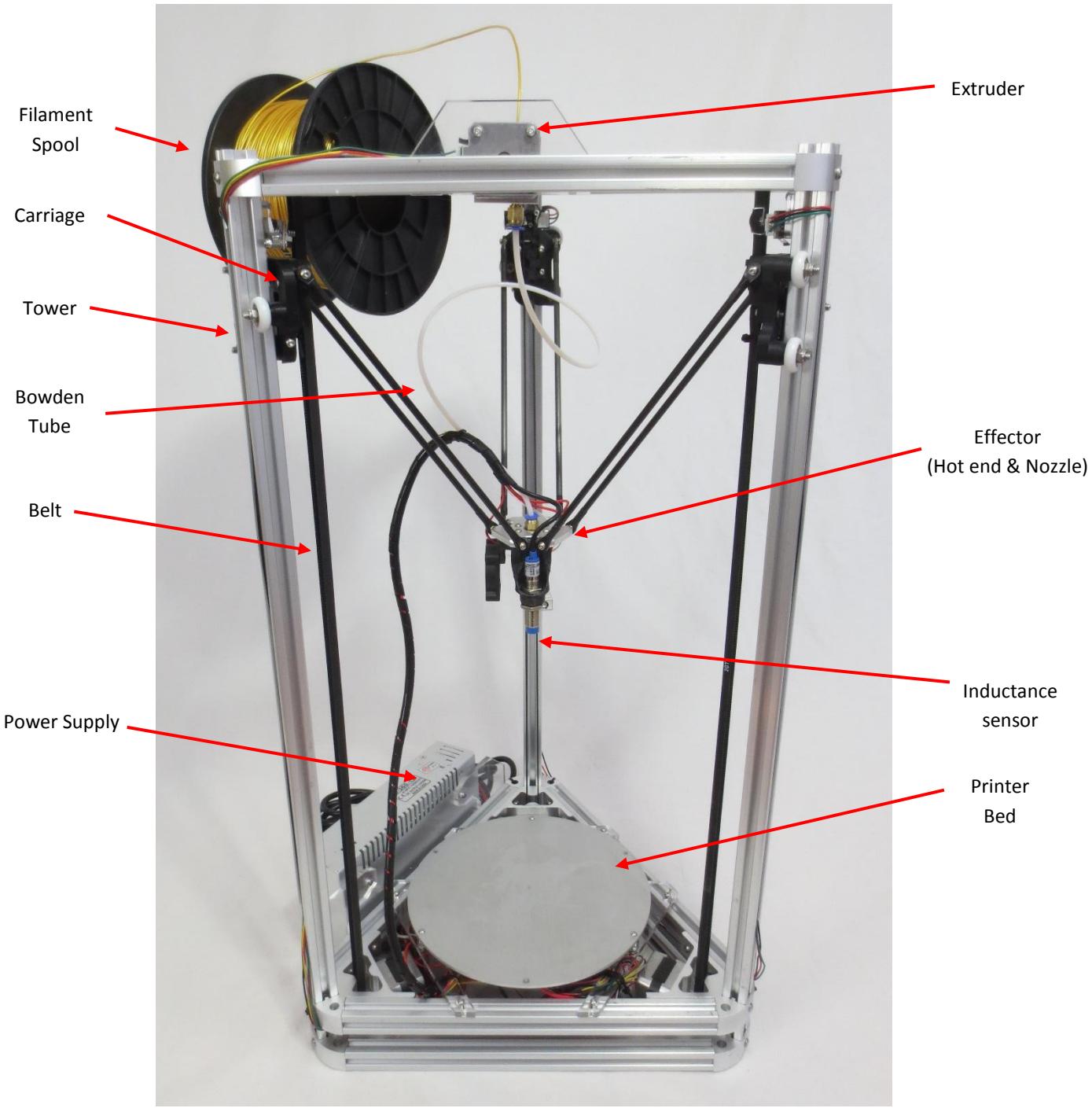
28. Bed Mount Spacer

30. Electronic Mount



PRINTER FEATURES & DEFINITIONS

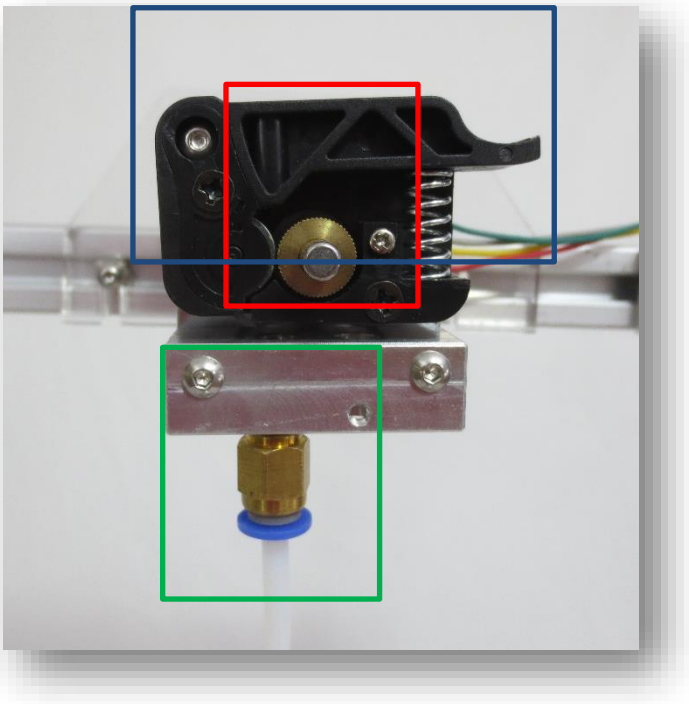
The figure below shows the features of the Folger Tech Kossel 3D printer. You can reference this graphic for clarification of printer parts mentioned in this manual.



Extruder

The extruder pushes the filament from the spool into the hot end of the effector. Components of the extruder:

- Drive Gear (Red), feeds the filament to the hot end
- Extruder Lever (Blue), applies force so the drive gear can grip the filament
- Bowden Tube push fitting (Green), attaches the Teflon bowden tube to the extruder.



Bowden Tube (Teflon Tube)

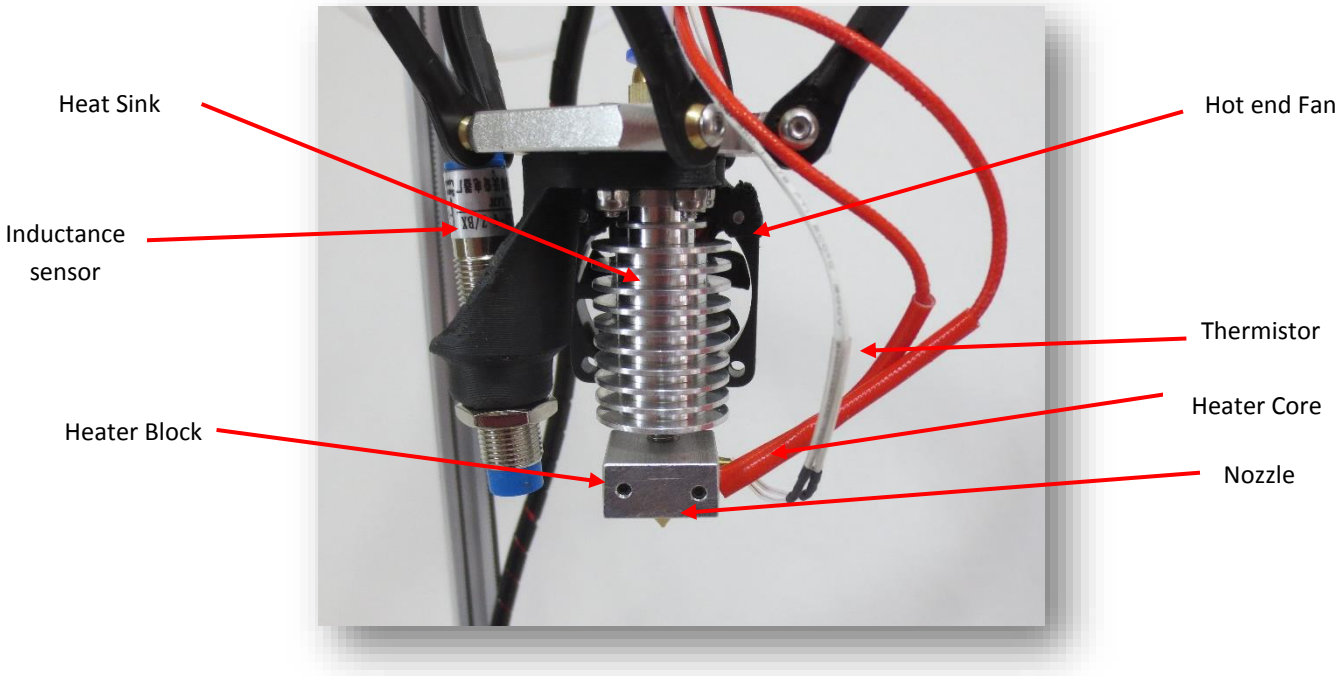
The Bowden Tube is the small tube that runs from the extruder to the hot end.

Nozzle

The nozzle is the brass fitting below the heater block that the plastic extrudes from.

Hot end

The hot end melts the filament as it gets pushed through the Bowden Tube by the Extruder. It is comprised of the following parts:



X, Y, Z Towers

Looking at the front of the printer (facing the back of the extruder), the left tower is the X, the right tower is the Y, and the back tower is the Z. These designations are used when leveling the bed and during troubleshooting procedures.

Carriage

Attached to each rail is a carriage, each carriage connects to the effector using two support arms. The position of the three carriages together controls the absolute position of the effector.

Effector

The effector holds the hot end and moves about the printing area. It is connected to the three carriages by the support arms.

Power Supply

The power supply is what takes the 120 AC from the wall and converts it into 12v DC.

PRINTER ASSEMBLY

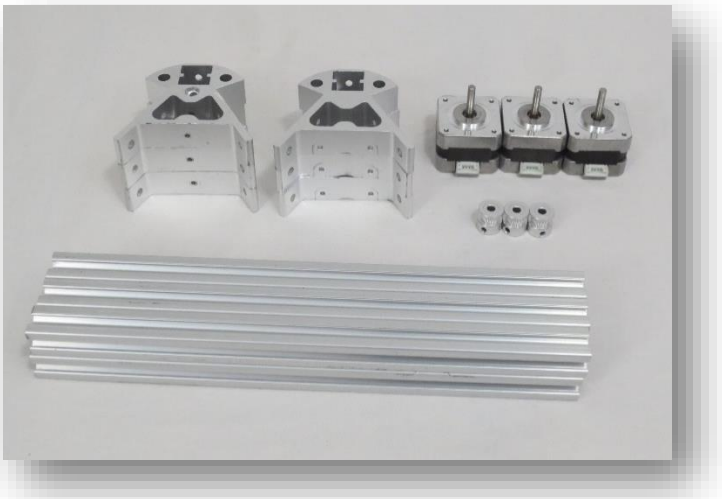
Construction of a Folger Tech Kossel 3D Printer is broken into 15 individual phases and sub-assemblies. The table below shows the different phases required to complete your 3D printer.

1) ASSEMBLE THE BASE

In this section you will be building the base frame of the Kossel 3D Printer.

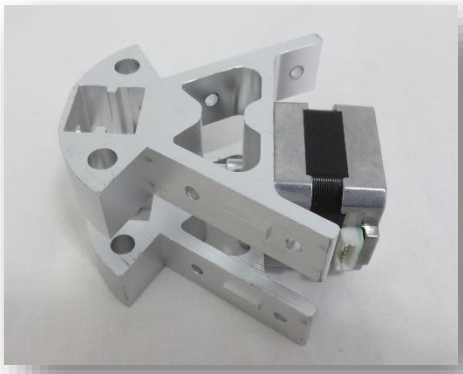
You will need:

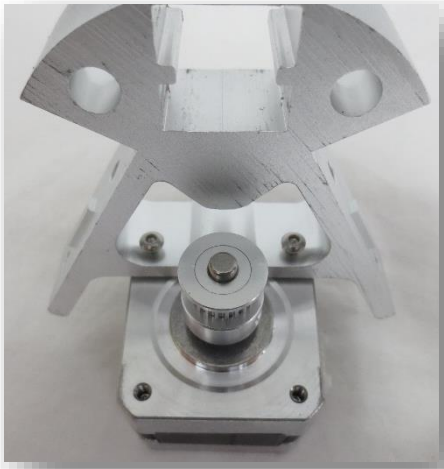
Item ID	Quantity	Description
1	*3*	A Bottom Corner
3	*3*	300mm 2020 beams
5	*6*	2600 Stepper Motor
24	*3*	GT2 20tooth Pulley
E	*12*	M3x8mm Screw
O	*24*	M4x10mm Screw
M	*24*	M4 T-nut



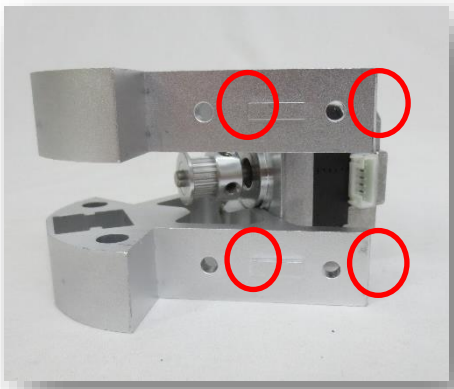
1. Insert the GT2 pulley onto the stepper motor (you may need to loosen the set screw on the pulley). There should be a 2mm gap between the tip of the motor shaft and the end of the pulley. Once the pulley is positioned correctly, tighten both set screws.

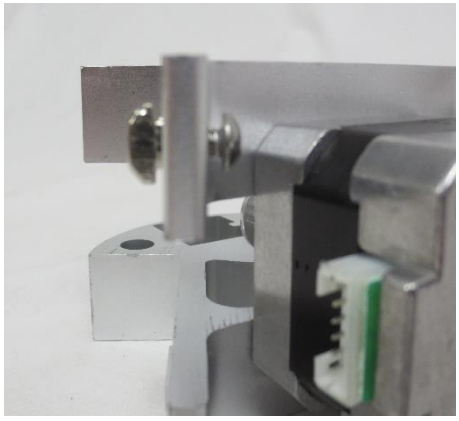
2. Position the Aluminum corner so the two screw holes line up with the stepper mounting holes (see picture). Use two M3x8mm screws to secure the corner to the motor. Repeat this for the second aluminum corner that mounts to the same stepper motor. **Note: The connector for the stepper should be pointing towards the left or the right. This will make wiring easier later on.**





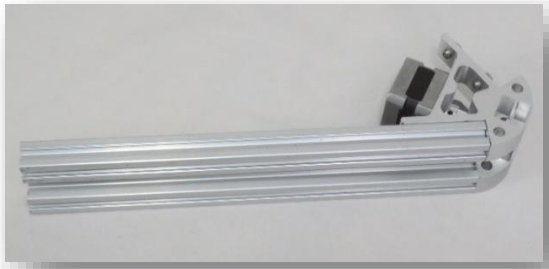
3. Take an M4x10mm screw and a M4 T-nut, insert the screw into one of the holes on the side of the aluminum corner. Attach the T-nut to the other side. Do not tighten the T-nut down, these will be inserted into the 2020 beams at a later step. Repeat this process for the other 7 holes (see picture for locations). Make sure the taped edged side of the T-nut faces away from the corner.

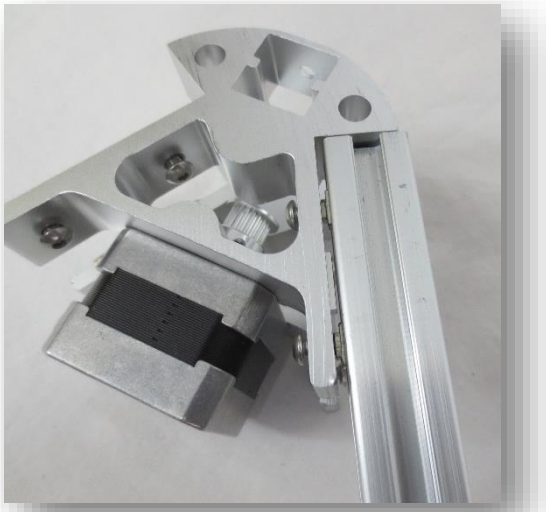




4. Repeat steps 1- 3 for the other two corners.

5. Take one of the 300mm 2020 beams and place it over two of the T-nuts to the side of the motor. Then tighten the two screws and the T-nuts will lock into the 2020 beam. Make sure the beam is tight into the corner (see picture). Repeat this step for the other 2020 beam on that side.





6. Repeat step 5 for the other two corners. Make sure the 2020 Beams are located on the same side of the corner.

7. Line up the three corner pieces so they form a triangle. Slide each corner towards each other until all the 2020 beams are tight into the other corners. Make sure the T-nuts are slotted into their respective beam. Tighten the screws and lock the T-nuts into place.

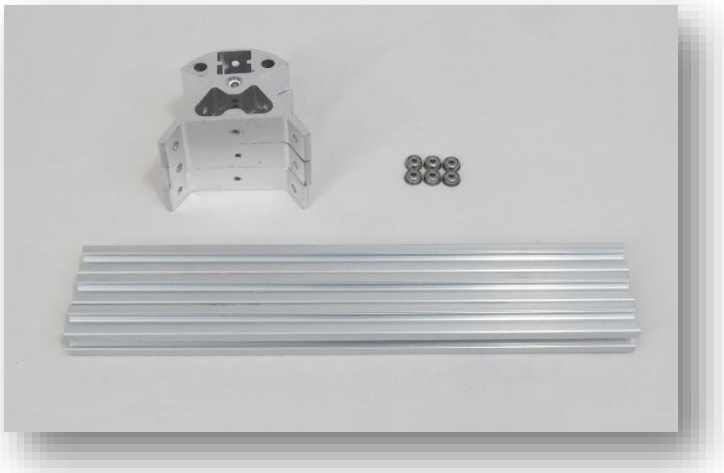
8. Double check all of the screws to make sure they are tight and that the base is locked tightly together.

2) ASSEMBLE THE TOP

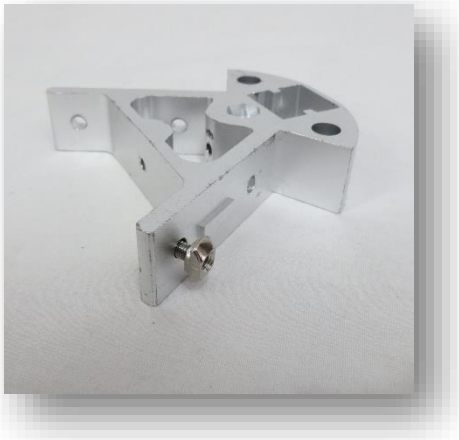
In this section, the top of the printer will be assembled.

You will need:

Item ID	Quantity	Description
2	*3*	Al Top Corner
3	*3*	300mm 2020 beams
R	*6*	F623zz Bearing
B	*3*	M3 Nylock
I	*3*	M3x25mm Screw
O	*12*	M4x10mm Screw
N	*3*	M4x8mm Screw
M	*15*	M4 T-nut



1. Insert a M4x10mm screw into one of the side holes on the aluminum corner and screw a M4 T-nut onto the other end. Repeat this for the three holes on the corner piece.



2. Take a M3x25mm screw and insert it into the hole on the inside of the corner, opposite of the square hole (see picture). Using a pair of pliers, thread the M3 nylock nut onto the screw just enough so the screw is just protruding past the nylock.

3. Sandwich the two F623zz bearings so the wider diameter flange is on the outside. Line the bearings up with the M3x25mm screw and continue tightening down the screw until the bearings are secure. Make sure the bearings can still rotate freely afterwards.

4. Take a 300mm 2020 beam and place it over two of the T-nuts (left of the hex hole on one of the sides or the corner). Tighten the screw to lock in the 2020 beam.

5. Repeat steps 1-4 on the other two corners.

6. Line up the three corners so that they form a triangle. Bring each corner in towards each other until the 2020 beams are tight against the adjacent corner. Tighten the M4x10mm screws to lock the 2020 beams into place.

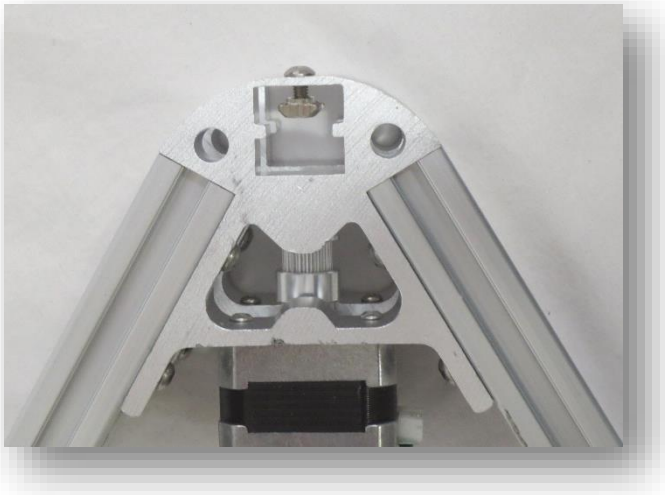
7. At each corner, insert a M4x8mm screw through the corner and thread a M4 T-nut onto the end. The T-nut should be loose and be able to rotate freely.

3) VERTICAL RAIL INSTALLATION

In this section, the vertical rails will be installed on the base (built in step 1).

You will need:

Item ID	Quantity	Description
	1	Base (Step 1)
4	*3*	700mm 2020 beam
N	*6*	M4x8mm screw
M	*6*	M4 T-nut



1. Take a M4x8mm and insert it into the hole on the outside of the corner on the base. Put a M4 T-nut on the M4 screw (the T-nut will be inside the square hole on the corner). Repeat this for the remaining five corners on the base.

2. With the base laying on the table, line all the T-nuts so that they perpendicular to the table (pointing up). Take a 700mm 2020 beam and insert it into the one of the corners. The end of the 2020 beam should touch the table. Tighten the M4 screws so that the 2020 beam is locked into place.

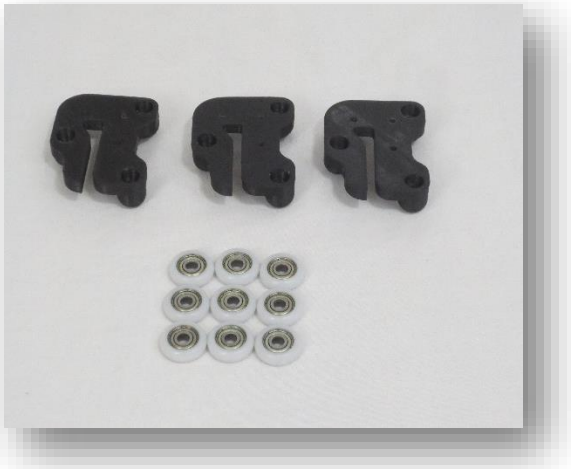
3. Repeat step 2 for the remaining two corners.

4) ASSEMBLE THE CARRIAGES

In this section, the Carriages will be assembled.

You will need:

Item ID	Quantity	Description
20	*3*	Roller Carriages
U	*9*	Nylon Roller
Q	*9*	M5x25mm Countersunk screws
P	*9*	M5 Nylock Nut
H	*3*	M3x20mm Screw
C	*3*	M3 Nut



1. Take the 3D printed carriage and insert the M5x25mm screws into the face of the carriage (the screw should not protrude out the face).

2. With the face of the carriage laying on the table, take three roller wheels and insert them onto the three screws. Use a M5 nylock to finish off each screw. The roller should turn freely at the end.

3. Insert a M3x20mm screw into the hole highlighted in the picture. Insert a M3 nut into the slotted hole that is in line with the M3 screw. Thread the screw into the nut. This will act as the tensioner when the slide is located on the 2020 beam.

4. Repeat steps 1-3 for the remaining two carriages.

5) MOUNTING THE CARRIAGES

In this section, the carriages will be mounted to the carriages.

You will need:

Item ID	Quantity	Description
	3	Carriage Assembly (step 4)
19	*3*	Belt Holder
H	*6*	M3x20mm screw
G	*3*	M3x16mm screw
B	*9*	M3 Nylock Nut

1. With the carriage laying on the table (face down), Insert thee M3 Nylock nuts into the three hex holes.

2. Flip the carriage over and line the top two holes on the belt holder with the top two holes on the carriage (the tensioner on the carriage is located on the bottom). Insert two M3x20mm screws into the top two holes of the belt holder and one M3x16mm screw into the bottom left hole. Finally, tighten the three screws.

3. Repeat steps 1-2 for the remaining two carriages.

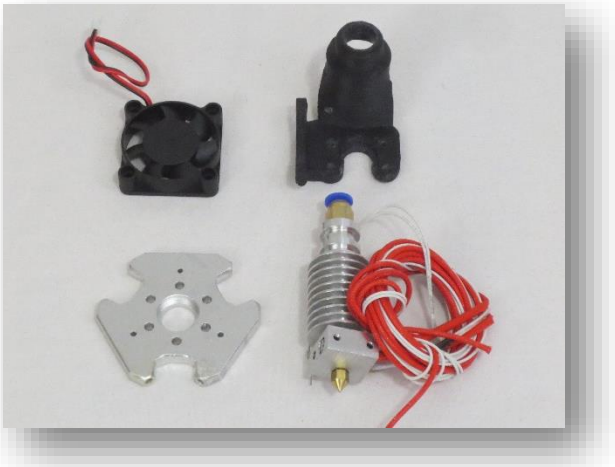
6) ASSEMBLY THE EFFECTOR

In this section the effector will be assembled. The hot end will be mounted to the effector.

Note: The pictured aluminum effector is an add-on feature, please refer to page 96 for assembly instructions on the plastic effector included with your kit.

You will need:

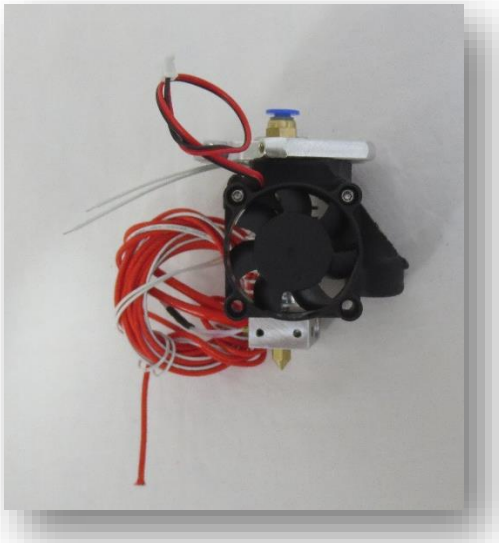
Item ID	Quantity	Description
13	*1*	Hot End/Sensor Mount
G	*4*	M3x16mm Screw
F	*2*	M3x12mm Screw
B	*4*	M3 Nylock
21	*1*	AL Effector
10	*1*	1.75mm All Metal Hot end
5	*1*	40mm Fan
46	*1*	Roll Kapton Tape



1. Take the hot end mount and dry fit it onto the All metal hot end. It should be a tight fit and you may need to sand it to get it to fit onto the collar.

2. With the hot end mount on the collar of the all metal hot end, mount it to the effector and line up the four holes of the hot end mount and the effector. Insert four M3x16mm screws through the effector and the hot end mount. Secure this with 4 M3 Nylock nuts.

3. Mount the 40mm fan using two M3x12mm screws. The wires of the fan should be located at the top of the effector.

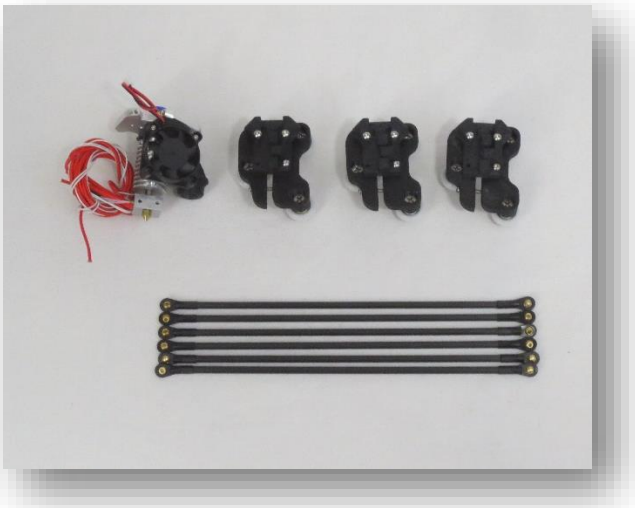


7) ATTACH THE CARBON FIBER ARMS

In this section, the carbon fiber rods will be attached to the effector. **If you did not receive fully assembled carbon fiber rods, see the appendix for instructions on how to build them.**

You will need:

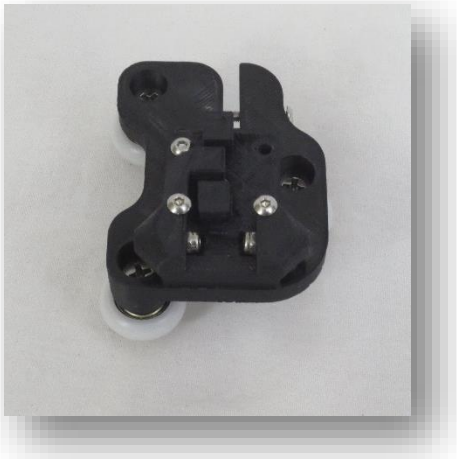
Item ID	Quantity	Description
7	*3*	Carbon Fiber Arms
	3	Carriages (Assembled in step 5)
E	*6*	M3x8mm Screw
I	*6*	M3x25mm Screws
B	*6*	M3 Nylock
	1	Effector (Step 6)

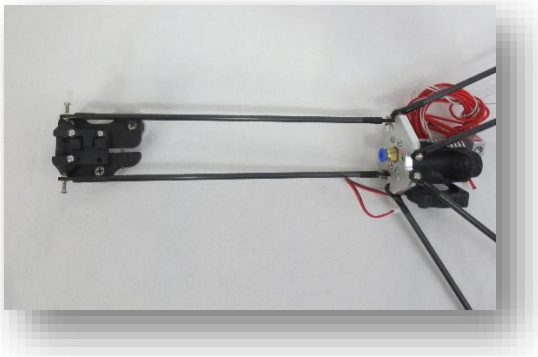


1. Insert a M3x8mm screw through the ball joint on a carbon fiber rod, then thread onto the hole on the effector. The screw should be tight enough that there is no movement on the carbon fiber arm.

2. Repeat step 1 on the remaining 5 mounting locations on the effector.

3. Take one of the carriages and insert two nylock nuts into the hex holes located at the top of the carriage. They should slide into a hex hole and lock in place. Insert a M3x25mm screw through the ball joint and the carriage. Tighten this down on the nylock nut. Repeat this for the other carbon fiber arms that mounts to the carriage.





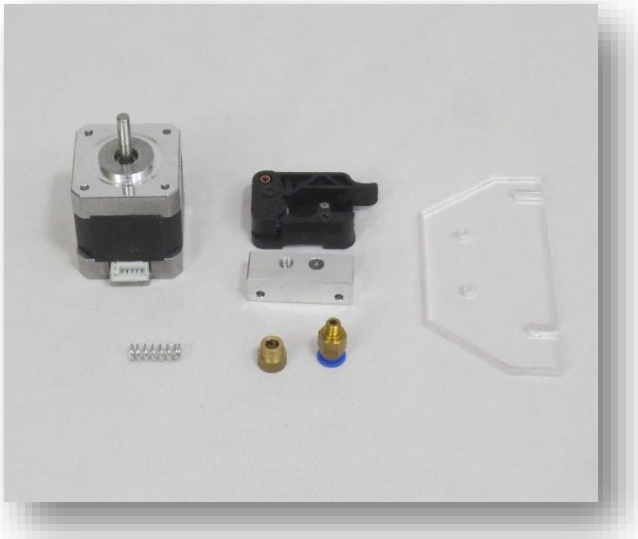
4. Repeat step 3 on the other two carriages.

8) ASSEMBLE THE EXTRUDER

In this section, the extruder will be assembled.

You will need:

Item ID	Quantity	Description
6	*1*	5800 Stepper Motor
47	*1*	Injection Molded Block (MK9)
9	*1*	Upper Block
11	*1*	2mm Push Fit
31	*1*	Laser Cut Extruder Mount
K	*2*	M3x45mm screw
H	*2*	M3x20mm Screw
E	*1*	M3x8mm Screw
G	*1*	M3x16mm Screw



1. With the motor flat on the table and the stepper motor wire connector facing you. Install the brass drive gear on the shaft of the motor. Secure it in place using the setscrew located on the drive gear. The drive gear should be just above the face of the stepper motor.

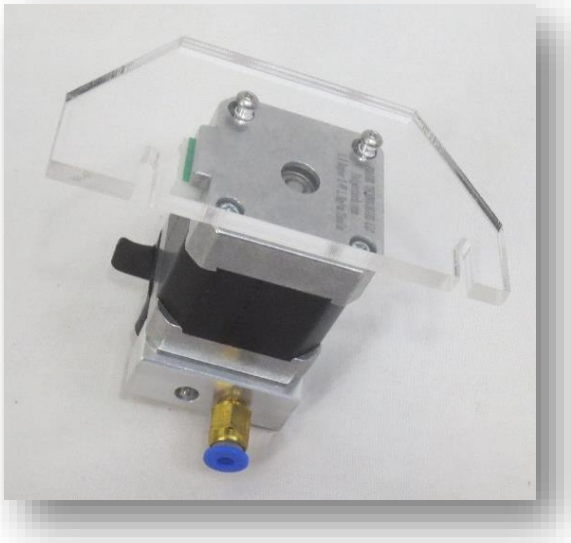
2. Install the upper aluminum extruder block on the left of the stepper motor. Secure it in place using two M3x20mm screws. Install the bottom of the injection molded MK9 on the other half of the stepper motor. Secure it in place with a M3x8mm screw.

3. Install the arm of the MK9 and secure it down with a M3x16mm screw. The spring should be put in place while tightening it down the screw.

4. Thread the 2mm Push Fitting on the threaded hole of the upper aluminum extruder block.

5. Flipping the stepper motor over, removing the two Philips head screws on the back of the motor opposite of the AL upper block.

6. Mount the stepper motor to the laser cut extruder mount using two M3x45mm screws. The slots of the mounting plate should be on the same side as the quick disconnect fitting.



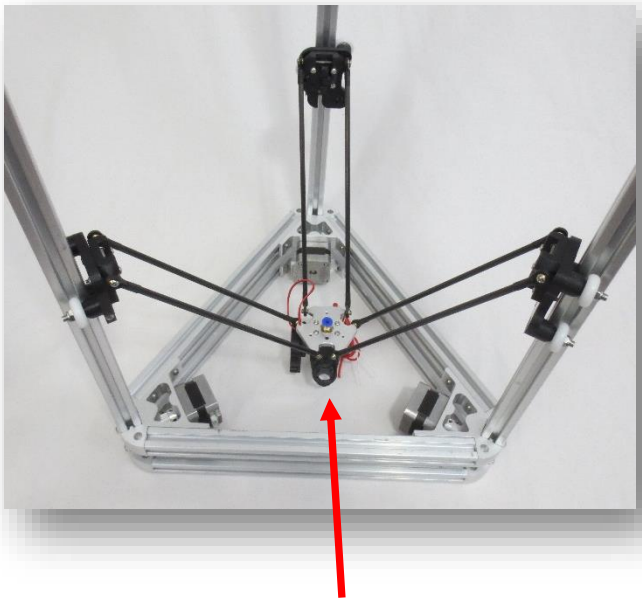
9) MOUNTING THE EFFECTOR, ENDSTOPS, AND TOP

In this section, the remaining mechanical components will be mounted to the printer.

You will need:

Item ID	Quantity	Description
	1	Effector Assembly (Step 6)
	1	Top (Step 2)
	1	Extruder Assembly (Step 8)
16	*3*	Endstop
33	*3*	Laser Cut End Stop Mounts
E	*2*	M3x8mm Screw
F	*9*	M3x12mm Screw
C	*8*	M3 T-nut
B	*3*	M3 Nylock

1. With the frame of the printer (what was assembled in step 3) set flat on a table (base down), feed the three carriages (assembled in step 6) down the three 2020 beams. The direction the sensor mount is facing, is now the front of the machine.
2. Tighten the tensioning screws on the carriages. This will lock them onto the 2020 beams.

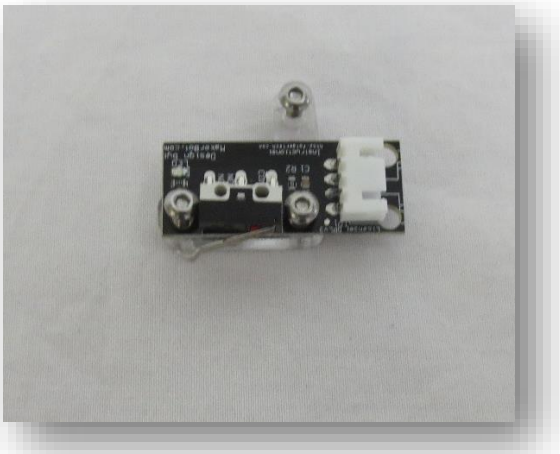


3. Slide the top (assembled in step 2) down the 2020 beams. Make sure the T-nuts in the corners are lined up properly. Tighten the M4 screws on each corner to lock the top into place.

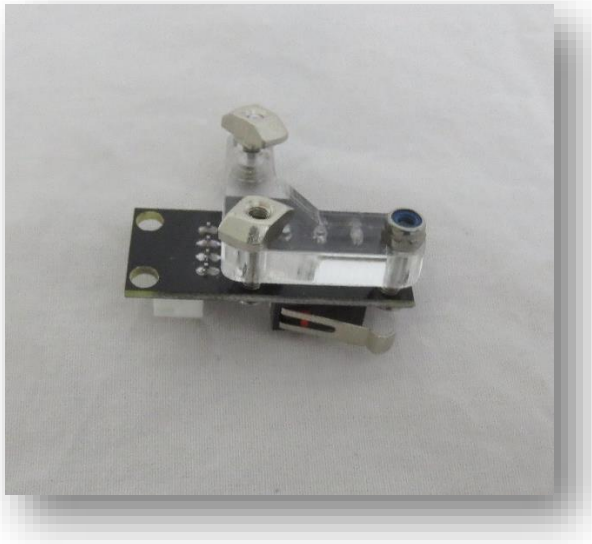
Note: It may help to leave a few mm protruding out of the top during the belt tension step in a later section.

4. Position the extruder on the front member of a 2020 beam on the top. Use two M3x8mm screws and two M3 T-nuts to attach the extruder to the 2020 beam. The quick disconnect should be pointing down.

5. Place an endstop on top of a laser cut endstop mount. Line up the two holes on the endstop with two of the holes on the end stop mount. Insert three M3x12mm screws through the three holes.



6. Thread on two M3 T-nuts on the two screws on the left side of the endstop, they should be one over the other. Tighten down the last screw with a M3 nylock nut.



7. Repeat steps 1-2 for the remaining two endstops.

8. Position an endstops on one of the vertical 2020 beams above the carriage. It should be touching the top. Tighten the two remaining M3 screws and lock in the T-nuts to the 2020 beam.

9. Repeat step 7 on the remaining two endstops. Try to keep them equal distance from the base, this will be important when calibrating the printer. As this determines the level of the bed and Z height.

10) MOUNTING BELTS

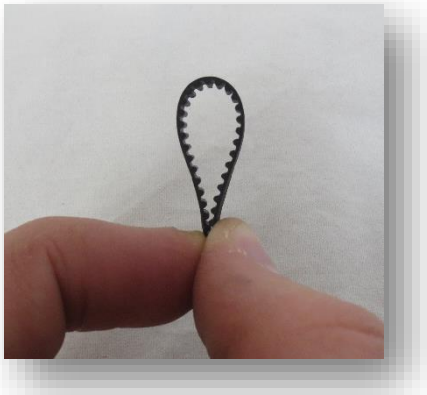
In this section, the GT2 belts will be added.

You will need:

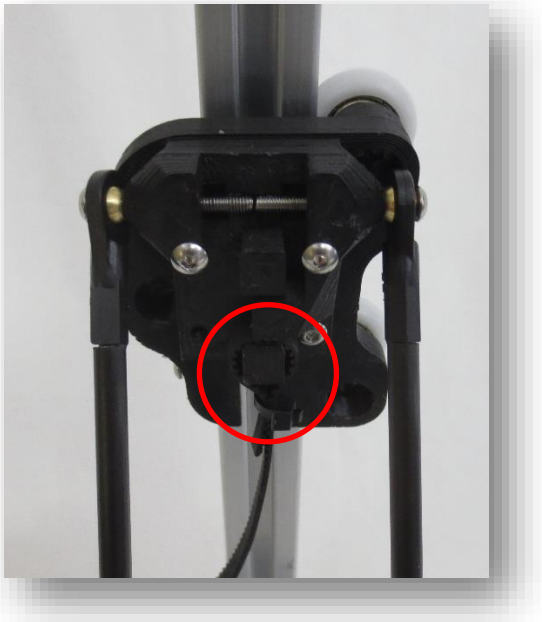
Item ID	Quantity	Description
23	*5 meters*	GT2 Belt
T	*6*	Zip Ties
S	*3*	Belt Tensioners

1. Cut the GT2 belt into three equal lengths, approximately 1.6m.

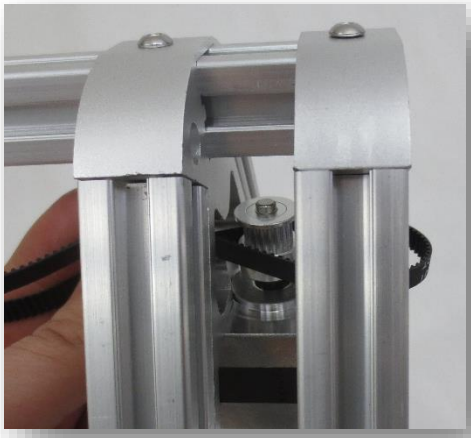
2. Form a half inch diameter loop in the belt using approximately 2 inches of the belt end. Use a zip tie to secure the loop and cut away excess zip tie material. The teeth of the belt should be inward.



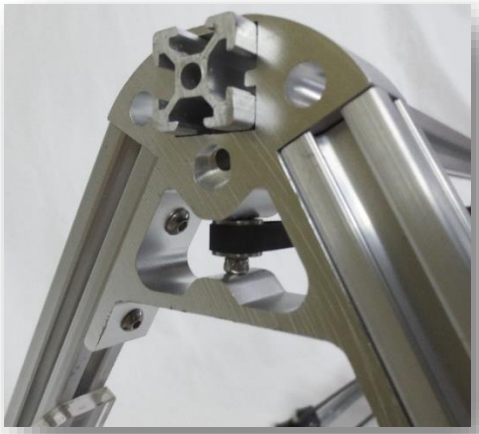
3. Place the loop around the bottom square mounting stub of the plastic belt holder.



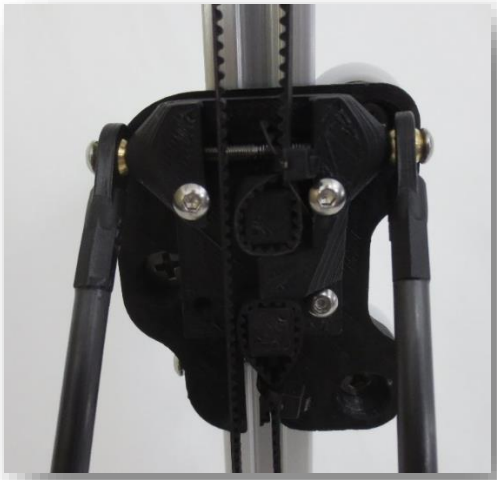
4. Feed the other end of the GT2 belt down and around the pulley that is mounted to the stepper motor.



5. Then feed the end up around the idler on the top corner. Make sure the belt is not twisted and the timing belt teeth are facing inwards. Then pull the free end of the belt until it is tight against both the timing belt pulley and the idler pulley. Note that as you pull the belt tight it may click as it skips over the timing belt pulley; that is normal.



6. Once the belt is free of any slack, loop the free end of the belt around the upper square mounting stub in the plastic belt holder, making sure it remains tight throughout the process. Secure the free end by using a zip tie to form a loop in the belt and cut away any excess, leaving about ¼ inch of the end past the zip tie. Ensure that the end of the zip tie is facing away from the other belt as shown in the image.



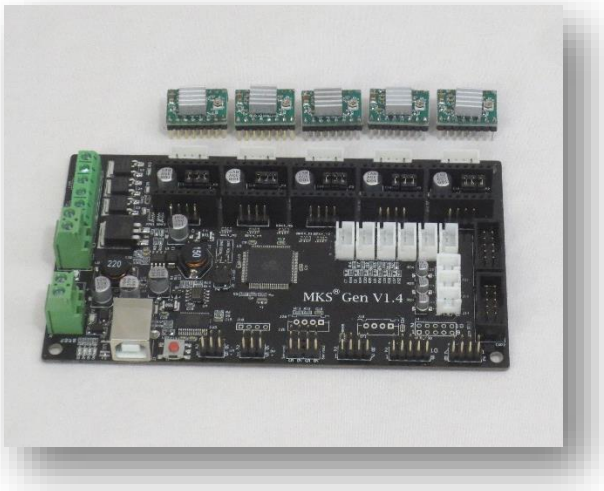
7. Install a belt tensioner above the last loop. This will ensure the belt is always tight.

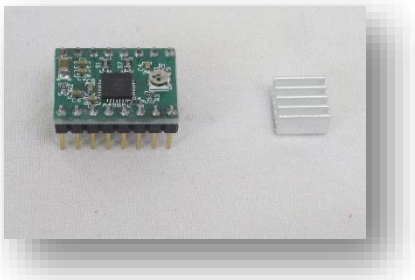
11) ASSEMBLE AND MOUNT THE ELECTRONICS

In this section, the MKS Base Baord will be assembled and mounted to the frame. The power supply will be mounted to the frame.
Note: The pictured MKS board is an add-on, please refer to page 99 for RAMPS board assembly instructions.

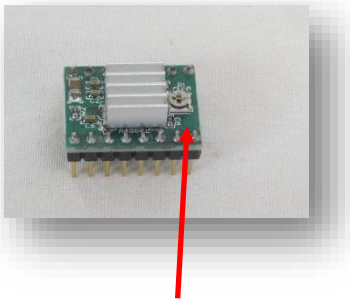
You will need:

Item ID	Quantity	Description
30	*1*	Laser Cut Electronics Mount
14	*1*	MKS Board
15	*5*	Stepper Driver
18	*1*	360W Power Supply
G	*4*	M3x16mm Screw
F	*10*	M3x12mm Screw
B	*4*	M3 Nylock
C	*10*	M3 T-nut
O	*2*	M4x10mm Screw



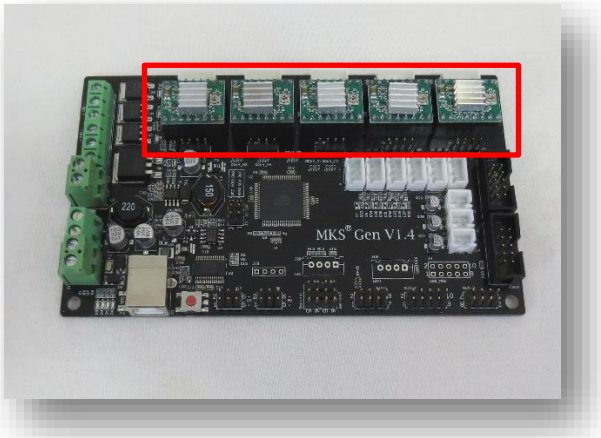


1. Remove a stepper driver from its packaging and stick the aluminum heatsink on top of the chip on the stepper driver.

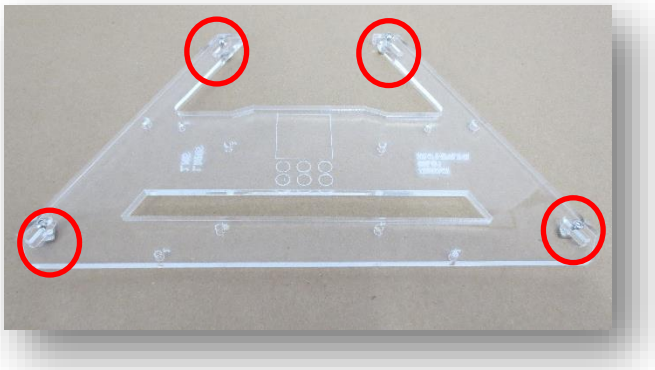


Trim Pot

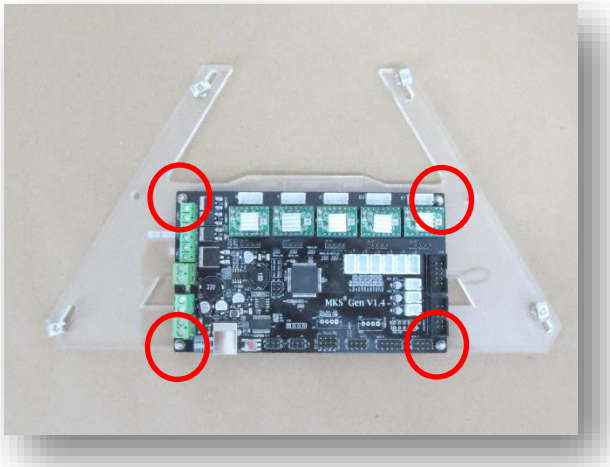
2. Lay the MKS board down on the table and insert a stepper driver into the first five stepper driver slots. The trim point should be pointing to the right. If they are backwards, the driver will be burned out and potentially destroy the MKS board.



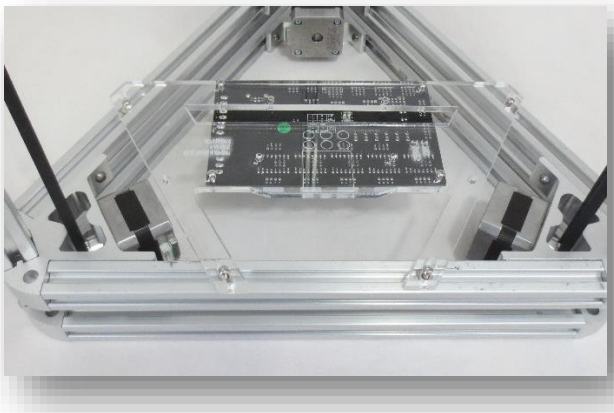
3. Take the laser cut controller board mount and insert four M3x12mm screws on the outer most holes. Thread on four M3 T-nuts on the end of the screws.



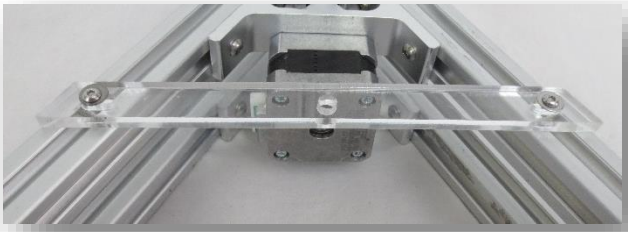
4. Flip the electronics mount over and Mount the MKS board using four M3x16mm screws and four M3 nylocks. The t-nuts and the board should be on the same side of the controller mount.



5. Attach the controller mount to the base. It should straddle two of the cross members of the base. The MKS board should be parallel to the front of the machine. Lock it in place by tightening the M3 screws attached to the T-nuts.



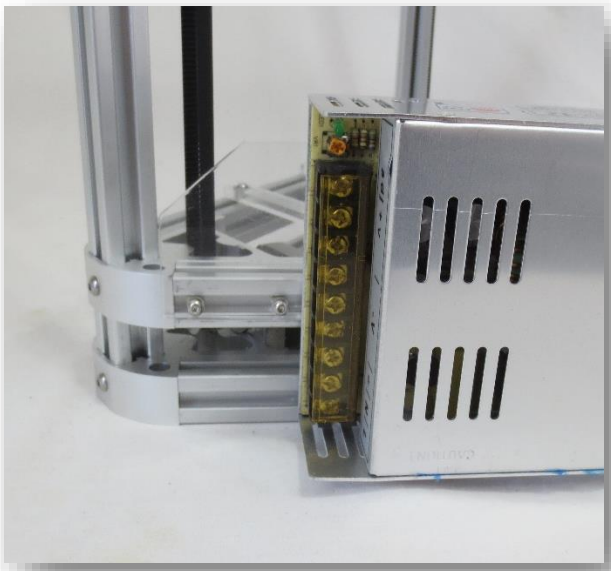
6. Take the laser cut bed mount and insert two M3x12mm screws through the outer most holes. Thread on two M3 T-nuts onto the ends of the screws. It should mount opposite the electronics mount at the Z Tower.



7. Place the power supply face down on the table (round fan cutout facing down). Take the two power supply mounts and attach them to the power supply using two M4x10mm screws.

8. On the remaining four holes on the power supply mounts, insert a M3x12mm screw into each hole and thread on a M3 T-nut. The T-nut should be on the same side as the back of the power supply.

9. Line the power supply so the fan hole is facing away from the frame. Slide the T-nuts into the top 2020 beam on the X-Z side and lock it into place by tightening the M3 screws.

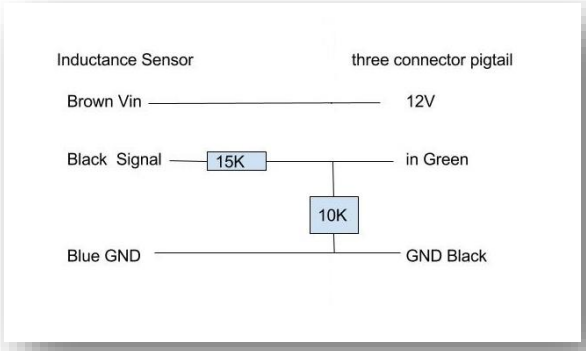


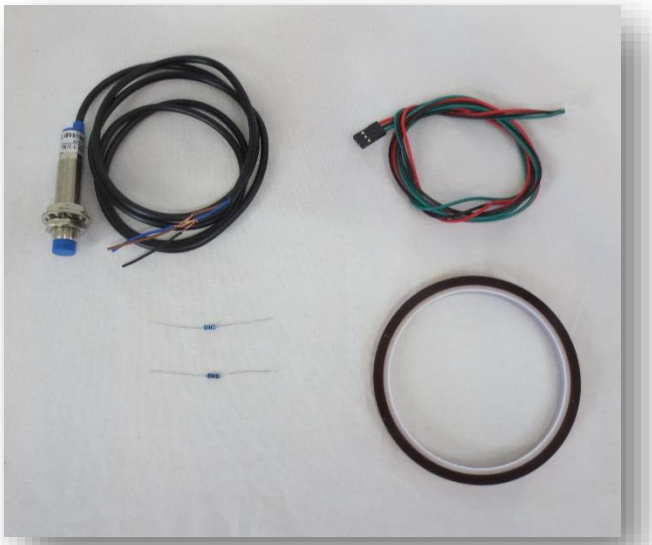
12) WIRING THE INDUCTANCE SENSOR

In this section, the inductance sensor will be wired up. The inductance sensor runs off 12v but the MKS base runs off 5v. So a voltage divider will be used to bring the 12v signal from the sensor down below 5v.

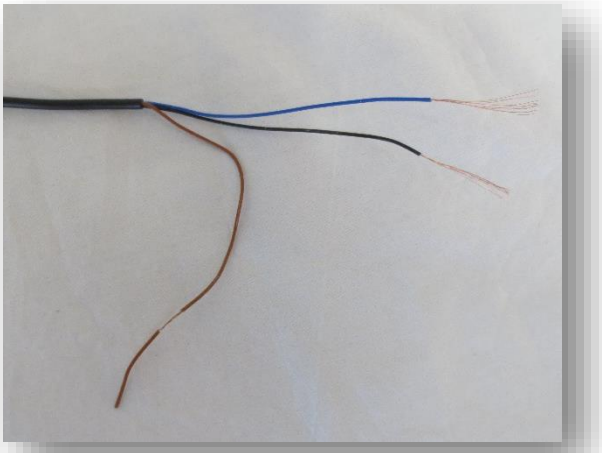
You will need:

Item ID	Quantity	Description
25	*1*	Inductance Probe
26	*1*	10k Resistor
27	*1*	15K Resistor
46	*1*	Kapton Tape
45	*1*	Three Pin Connector

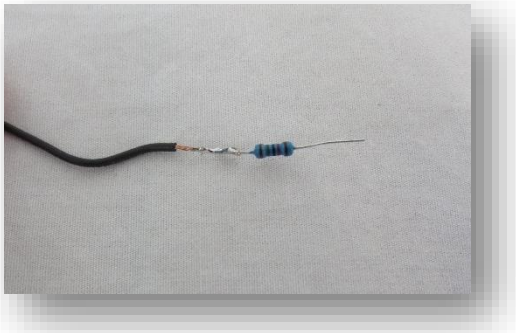




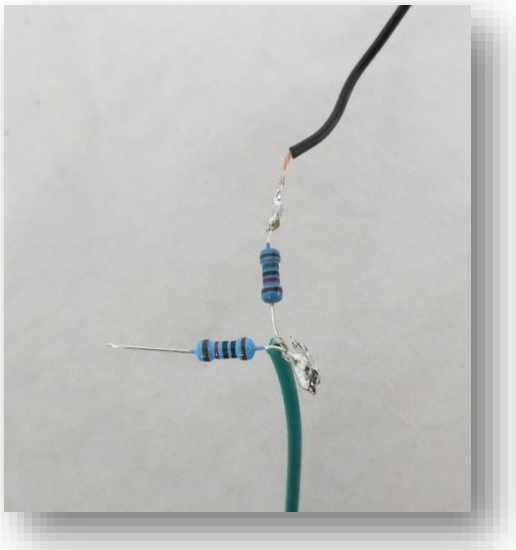
1. Take the inductance sensor and remove 4 inches of the black shielding. Take the brown wire and curl it back. This is the 12v supply line and nothing has to happen to it.



2. Solder the 15k resistor onto the end of the black wire of the inductance sensor.



3. Solder one end of the 10k resistor, the other end of the 15k resistor, and the green pigtail end of the three wire connector



4. Solder the other end of the 10k resistor to the blue wire from the inductance sensor and the black wire from the pigtail end of the three wire connector.

5. Wrap everything in kapton or electrical tape to prevent any damage to the sensor and the MKS board. Make sure all of the exposed wires are wrapped and there is no interference between lines.

13) WIRING THE HEATED BED

In this section, the heated bed will be wired up.

You will need:

Item ID	Quantity	Description
12	*1*	Round Heat Bed
14	*1*	100k NTC Thermistor
46	*1*	Kapton Tape
39	*1'*	Red 14AWG Wire
40	*1'*	Black 14AWG Wire

1. Cut a 12-inch and 2-inch length of black wire and 12-inch length of red 14 AWG wire. Strip ¼ from one of the ends on each wire. With the hotbed lying top down on the table (red up), solder the red (1) and black (3) wire onto the back of the hot bed. Use the 2-inch black wire as a jumper between 3 and 2.

2. Place the tip of the thermistor on the center of the hot bed. Using Kapton tape, tape the thermistor and the 14 AWG wires down to the hotbed.

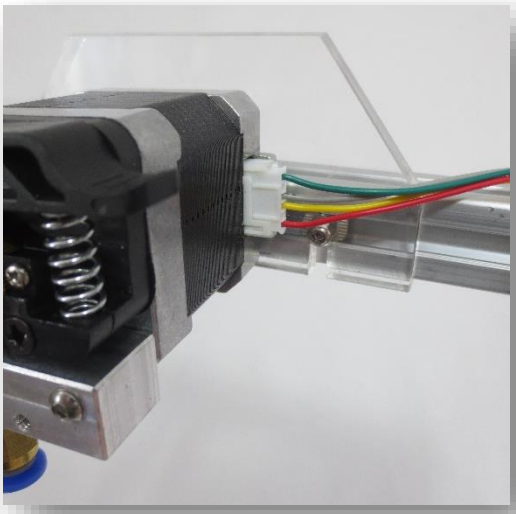
14) WIRING THE PRINTER

In this section, the printer will be wired up.

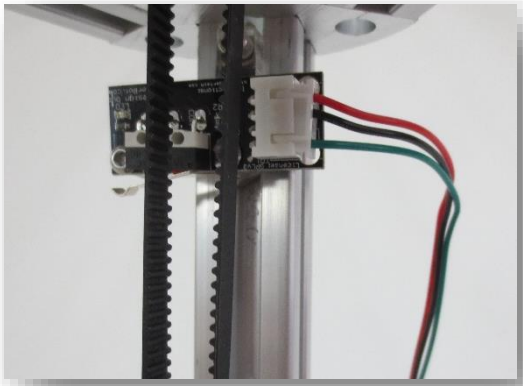
You will need:

Item ID	Quantity	Description
	1	Heater Bed Assembly (Step 13)
	1	Inductance Assembly (Step 12)
39	*3'*	14 AWG Red Wire
40	*3'*	14 AWG Black Wire
43	*1*	Long Motor Wire
44	*3*	Short Motor Wire
	3	Endstop Cable (In Endstop Package)
37	*3*	2020 insert

1. Take the long stepper motor cable, plug the motor end (6 pin connector) into the extruder motor. Run the cable across the top to the tower the connector on the motor is pointing towards. The cable should run down the outside of the machine and down into the base.

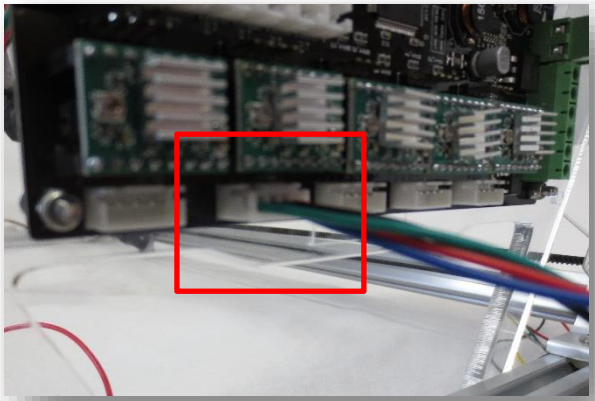


2. Plug one of the endstop cables into the endstop that the extruder cable just traveled down. Run the endstop cable along the outside and down into the base. Take a 2020 insert and insert it into the groove of the 2020 beam. It should cover and hold in the wires on that beam.

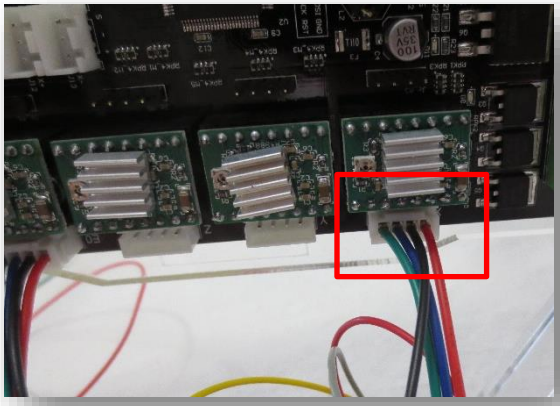


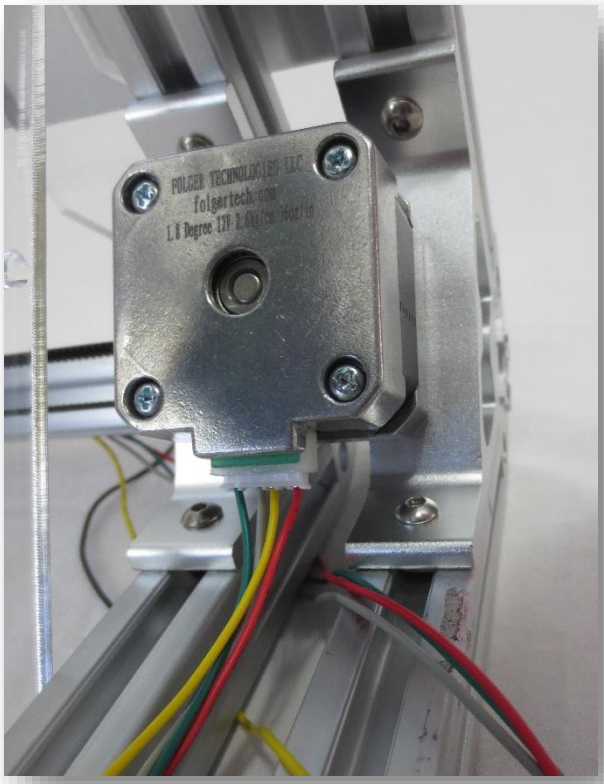
3. Repeat step 2 for the remaining two endstop.

4. With the 3D printer on its side, plug the board side of the extruder motor cable into the fourth stepper driver plug on the MKS board.

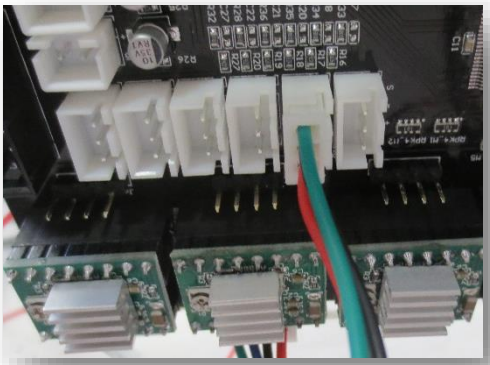


5. Take one of the short stepper motor cables and plug the motor end of the cable into the stepper motor to the left of the extruder motor (looking at the back of the extruder). This is now the X tower. Plug the board end of the cable into the first stepper plug.

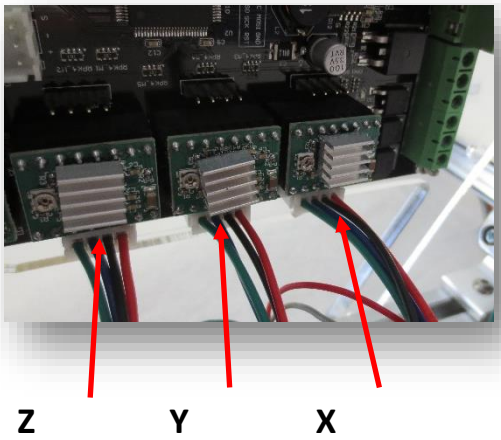


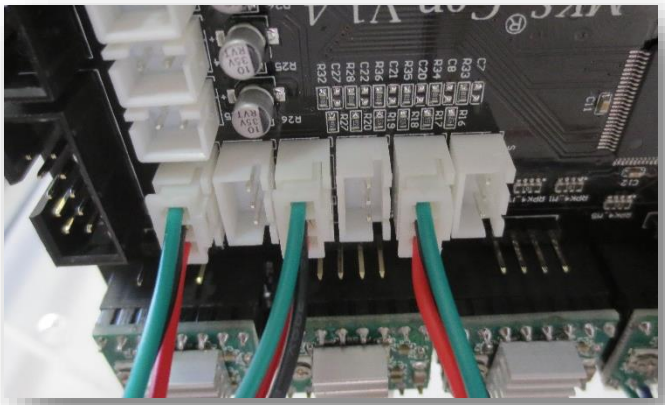


6. Take the endstop cable that is located at the same beam as the stepper motor from the previous step. Plug the board end into the X-Max plug.

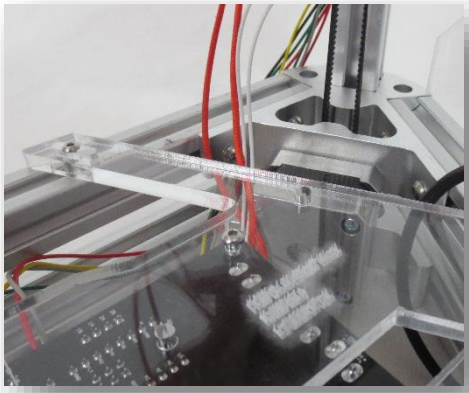


7. Repeat steps 5 and 6 for the remaining two towers. The tower to the right of the extruder is the Y tower and the Tower in back is the Z tower.

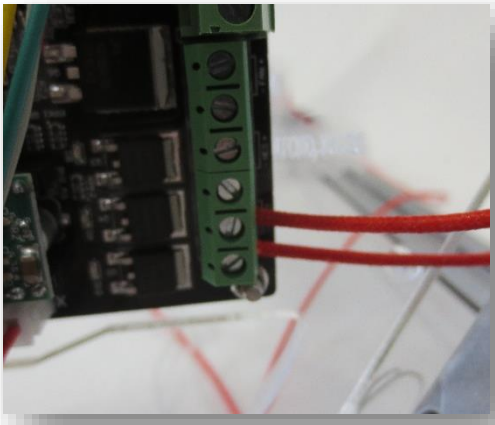




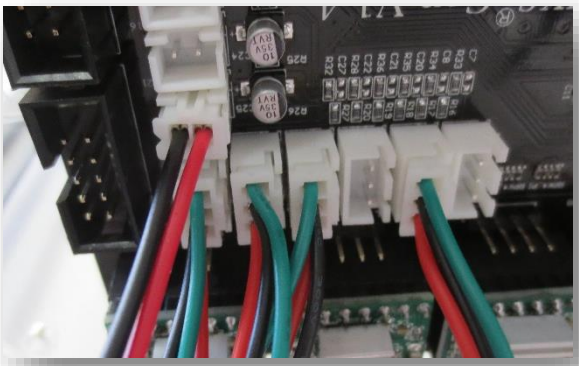
8. Uncoil the heater core wire (red) and the thermistor wire (white) from the all metal hot end. Strip ¼ inch from the ends of both heater cable (red). Run all the wires down into the base by the Z tower.



9. Using a small screw driver, loosen the two set screws on the top green connector. Insert the red wires into the connector and tighten the set screws back down.

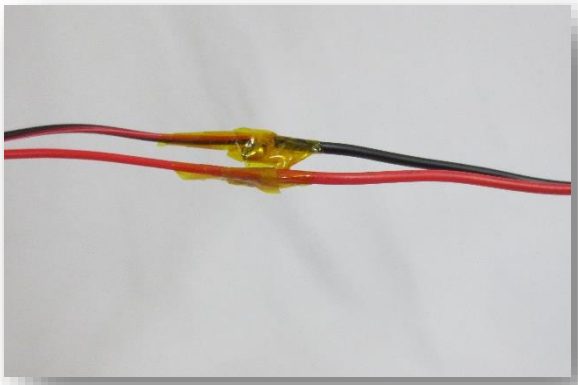


10. Plug the board end of the thermistor wire into the MKS Board.

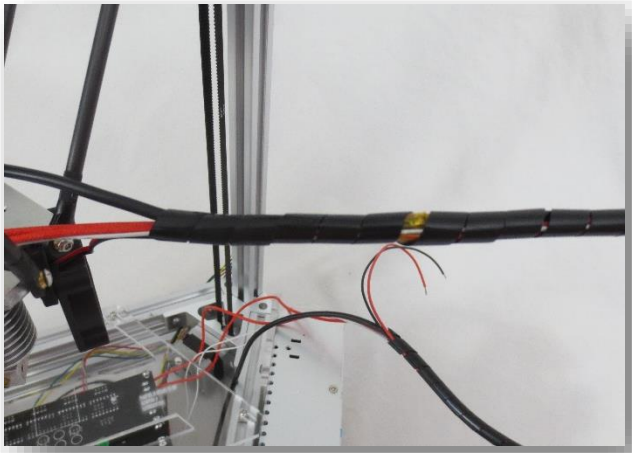


11. Plug the three wire connector of the inductance sensor into the Z-min on the MKS Board. The brown wire will be fed into the 12v feed later. Run the Inductance sensor along the same route as the heater core wire and thermistor wire. Take off one of the nuts and both of the washers. Insert the inductance sensor into the sensor mount of the effector (you may need to undo one of the carbon fiber arm). Thread the nut back on so that the sensor does not move. This will be calibrated later.

12. Cut and strip a ½ off the two wires from the hot end fan. Cut the 22 AWG wire in half, and strip both end ½ inch. Twist and solder them together and seal them using kapton tape.



13. Take the wire wrap and start wrapping all the wires running to the hot end into one bundle.



15) ODDS AND ENDS

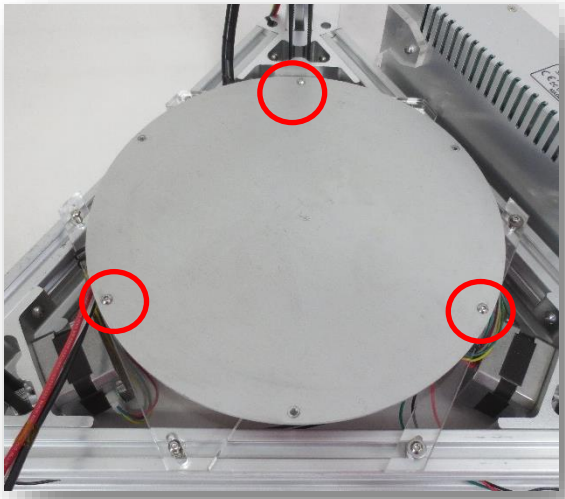
The Goal of this section is to install the heated bed, wire up the power supply, and install the Bowden tube. **Warning: When wiring the power supply, it is important that the power plug be unplugged from the wall at all times. Do not plug in your printer until you have gone through the pre-startup checklist.**

You will need:

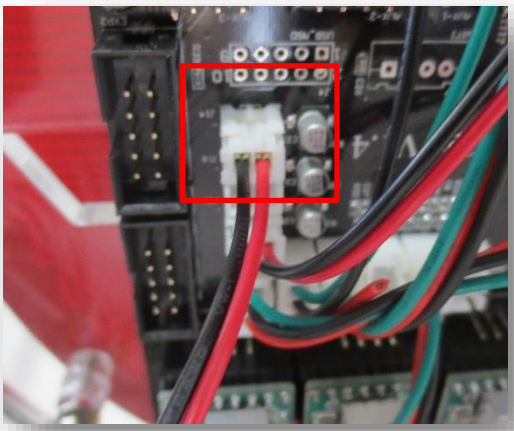
Item ID	Quantity	Description
	1	Heated bed (step 13)
8	*1*	Teflon Bowden Tube
39	*3'*	Red 14 AWG Wire
40	*3'*	Black 14 AWG Wire
36	*1*	AC Cord
28	*6*	Hotbed Spacer
I	*3*	M3x25mm Screw
B	*3*	M3 Nylock
T	*3*	Zip Tie

1. With the printer laying on its side, insert a M3x25mm screw through a hole on the aluminum side of the hotbed. Through two hotbed spacer and into one of the holes on the electronic mount. Finish the screw off with a washer and a M3 nylock nut.

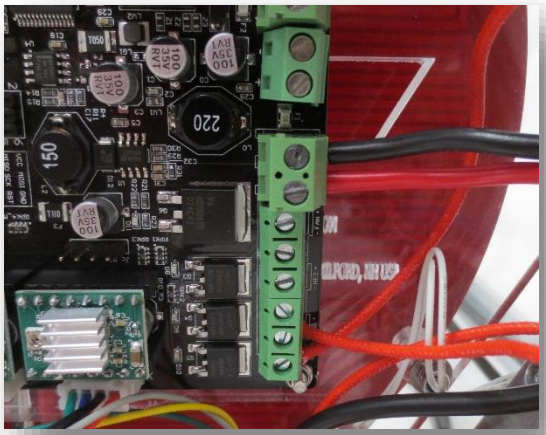
2. Repeat step one for the other two holes. Each hole is positioned at a tower.



3. Plug in the thermistor wire into the MKS Board.

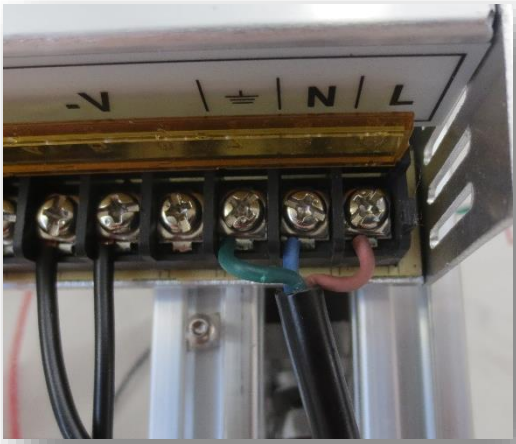


4. Using a small screw driver, loosen the two set screws on the heated bed power plug on the MKS board. Insert the 14 AWG wires from the hot bed into the power plug (black over Red).

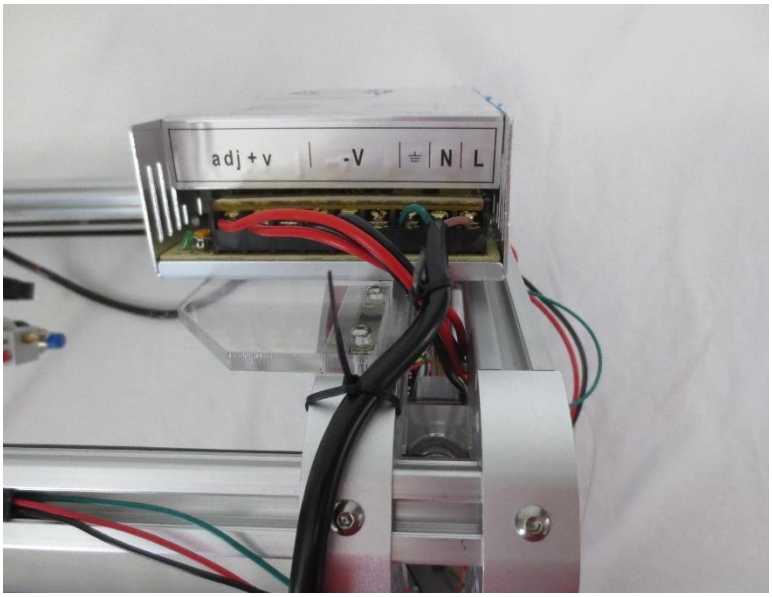


5. Flip the yellow cover on the power supply and loosen the (from left to right) 1,2, 4, 5, 7, 8, and 9 screws. The remaining 14 AWG wire and cut it in half. Strip a ¼ inch of shielding off of each side. Insert a red wire into the set screw slot (under the plate washer). Insert it to the left of the screw, that way when the screw is tightened, it pulls the wire in. Tighten the set screw. Repeat this for the other red and two black wires. See picture for locations.

6. Strip a ¼ of each wire from the power cable. Following the same procedure from the previous step, insert the green wire into the 7th screw (from the left). Tighten the screw down. Repeat this from the blue (8th screw) and tan (9th screw) wire, reference the picture for wire location.

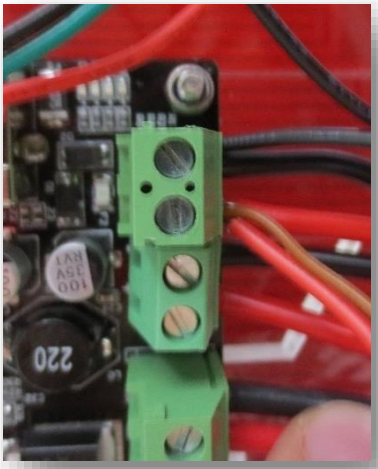


7. Take a zip two zip ties and zip tie all of the wires together. Then zip tie the power cable to the frame. This will relieve any stress on the wires from normal use.

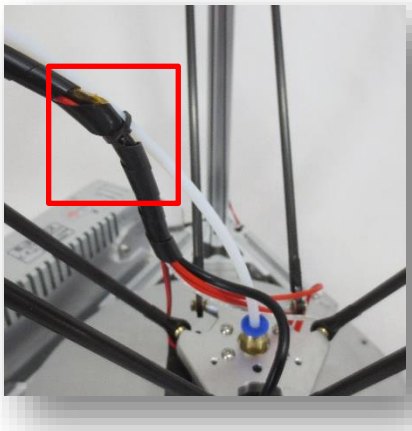


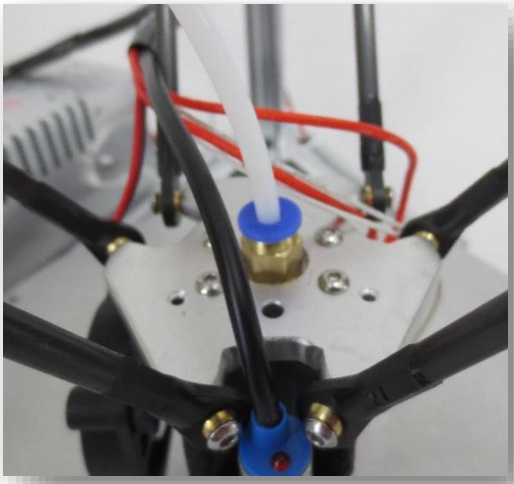
8. Loosen the set screws on the two power input plugs on the MKS Board. Insert the wires black over red, reference the picture for orientation. This is critical because connecting it backwards will damage the board. Tighten down the two screws on the bottom connector.

9. Take the black wire from the hot end fan and insert it into the top slot with the other black wire. Tighten down the screw. Twist the brown wire from the inductance sensor and the red wire from the hot end fan. Insert this into the slot with the red wire form the power supply.

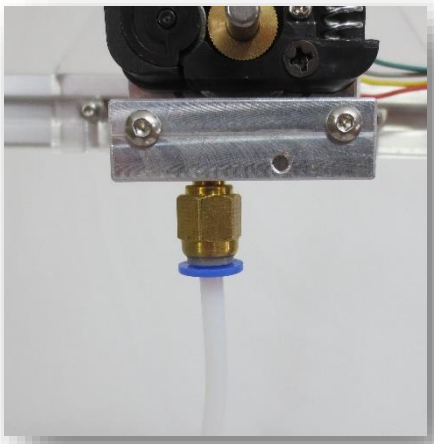


10. Take the Bowden tube and cut it in half. Plug in one end of it into the quick disconnect fitting on the hot end. Using a zip tie, connect the hot end bundle to the Bowden tube.





11. Plug the other end of the Bowden tube into the quick disconnect fitting on the extruder.



TESTING AND CALIBRATION

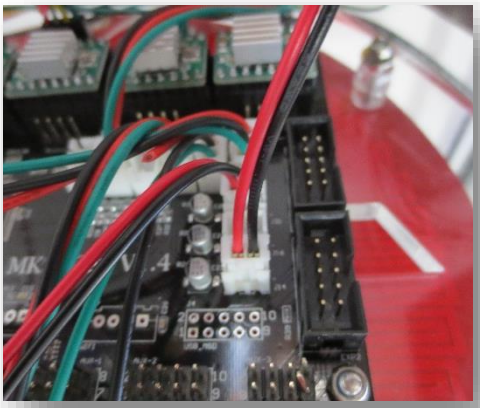
Congratulations on successfully assembling your Folger Tech Kossel 3D Printer Kit! Now that it is built, it's time to verify that all the components are working properly. This will require a computer and the USB cable that came with the printer.

ELECTRONICS CHECK LIST

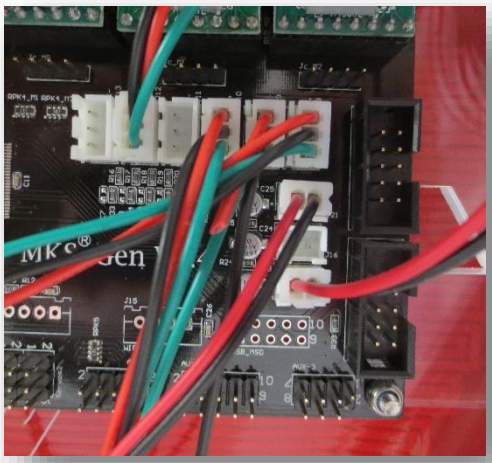
The goal of this section is to make sure all of the electronics are plugged in correctly. It is important that you follow these steps and do not power up the printer before it says so.

1. The power coming into the board should be black on the bottom and red on top (moving away from the USB connector) for both power connectors.

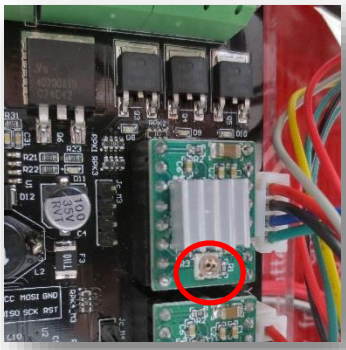
2. The thermistor wires should be plugged into the 1st and 3rd connector. The top one should be the hot end and the bottom should be the heated bed.



3. The endstops connectors should be in the following order:
None, X-Max, None, Y-Max, Z-Min, Z-Max.
The Z-Min is the inductance sensor.



4. All of the stepper drivers should be pointing to the left (trim pot facing away from the power input plugs).



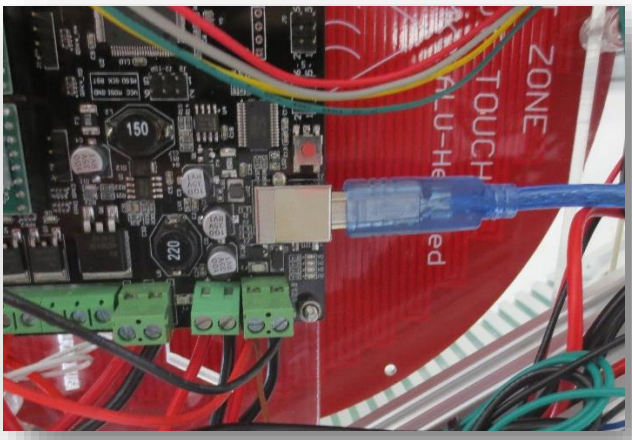
SOFTWARE

The following software is used to test and run a Folger Tech Kossel 3D Printer.

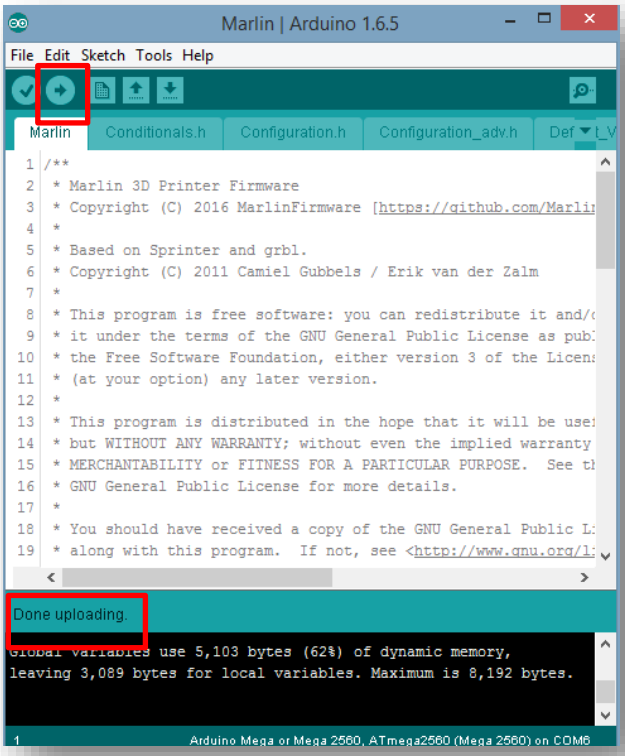
- **Arduino** - Arduino is an open source hardware package that is attached to the underside of the base and is used to control the printer. The firmware running on Arduino is written in the Arduino programming language. This firmware is already loaded onto the printer and ready to go. http://www.arduino.cc/en/main/software
- **Pronterface** - Pronterface is used to test the components of the printer and run basic functions. It has a graphical user interface (gui) that controls the printer and allows the user to send individual g-code files to the printer. http://www.pronterface.com/
- **Cura** - Cura is the slicing software that turns the digital object, which is the stl file 3D model, into the g-code the printer can understand. https://ultimaker.com/en/products/cura-software

CONNECT TO THE PRINTER & LOADING FIRMWARE

Rotate the printer on its side, so that it is resting on the X and Z towers, and plug the USB cable into Arduino, which is the control board shown in the image below.



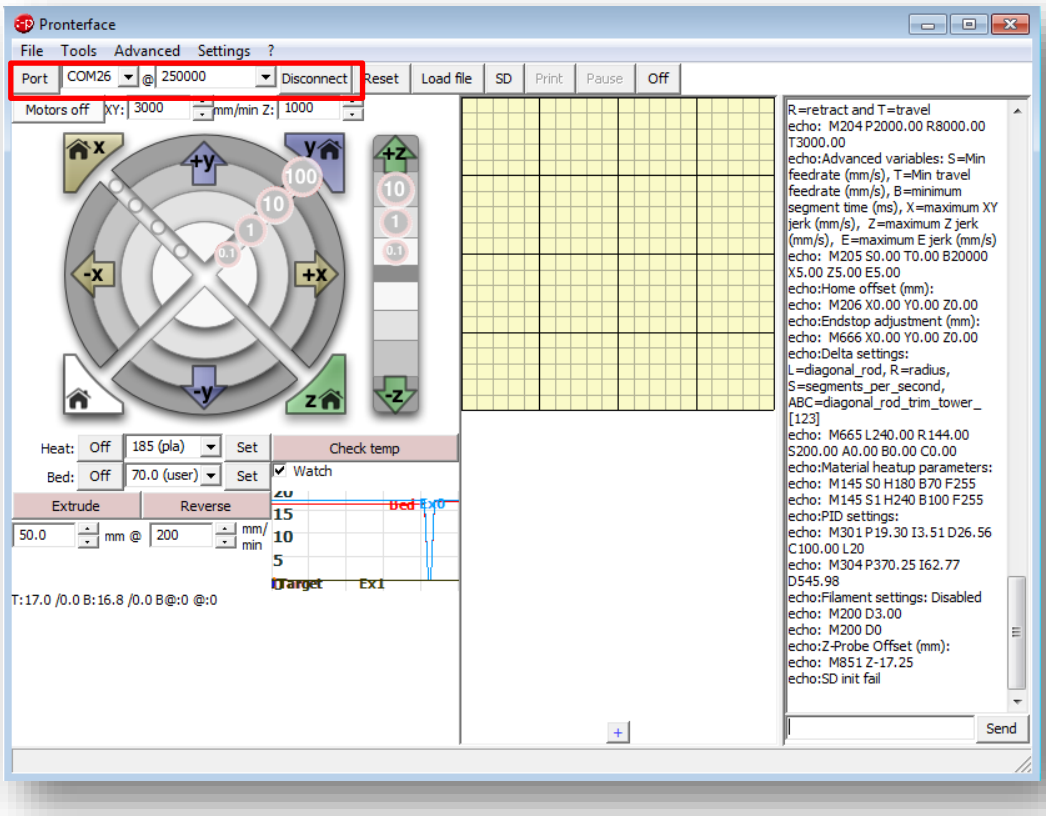
Open the Marlin.ino firmware using the Arduino IDE. Press the compile and load button and wait for it to say done uploading. Leave this open because we will be coming back to calibrate the printer.



VERIFY THE ENDSTOPS

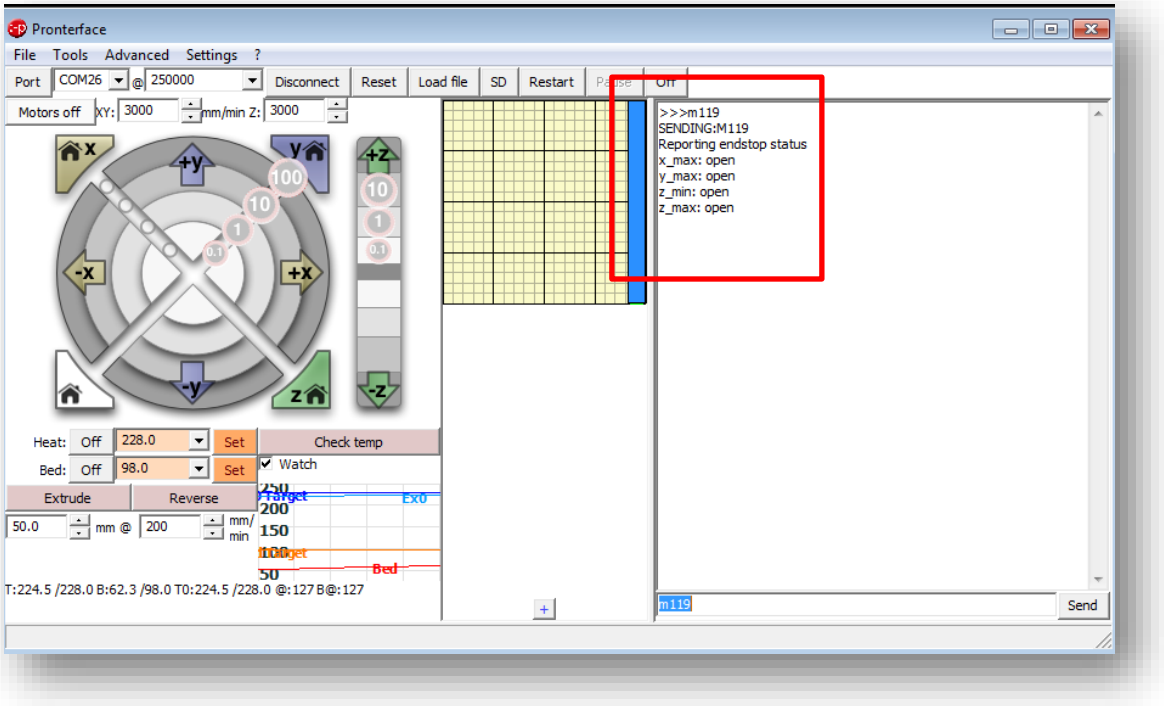
Now that the printer is connected to the computer and it has recognized Arduino it's time to open the Pronterface software. Open the Pronterface folder on the SD card, and select the Pronterface icon shown in the image below. We suggest copying the entire Pronterface folder onto your computer for later use.

Select the "COM" port that is associated with the printer (this will depend on which one your computer assigns). Then click the "Connect" button to the right of the port pulldown. If the computer is connected to the printer correctly, then you should see "the printer is now online" on the right.

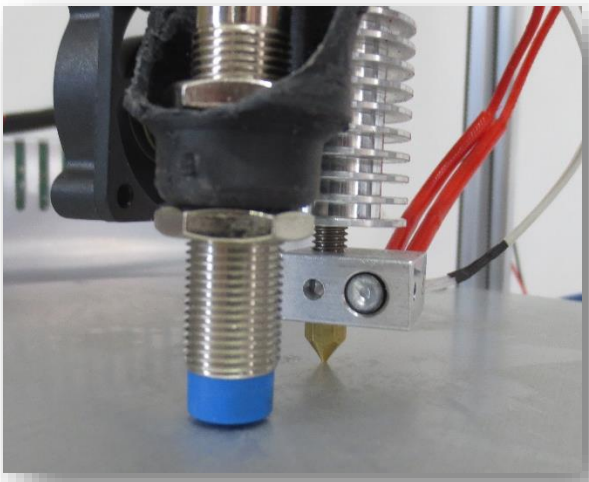


Manually move the carriages down with your hands so that they are not touching the endstops. In the bottom right of the screen in Pronterface, type in “m119” and click send. This code will tell the printer to send back the status of the end stops.

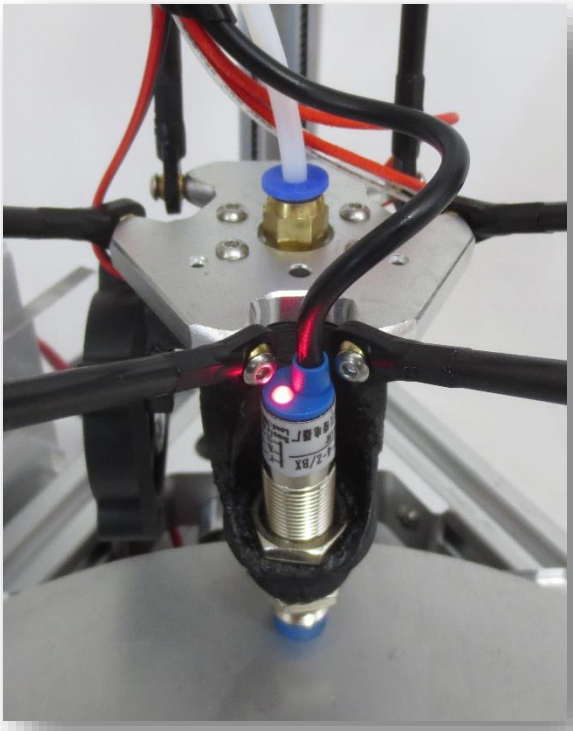
Each tower endstop status should return as “open,” which will appear in the text column on the right side of the screen. Now, manually move the carriages up the tower until all endstops make a click noise and the led on the endstops turns red. Once all three endstops are triggered, send “m119” again in the bottom right corner. All three Max end stops should return as “triggered” in the text column on the right.



Lower the hotend down to the printer bed so the nozzle is touching the center of the bed. Adjust the inductance sensor by loosening the top nut. Lower the inductance sensor until it is just above the bed and the led on top has gone off.

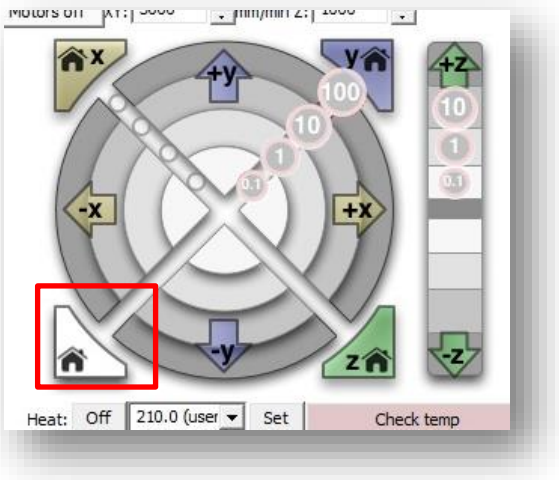


Lift the hot end away form the printer bed. Type in the “m119” command, the z-min should read OPEN. Move the hotend back down to the printer bed so that the inductance sensor trips (red led comes on). Type in the “m119” command and the Z-min should read TRIGGERED.



VERIFY MOTOR DIRECTION AND HOMING

To verify that the motors are wired correctly, click on the home button on Pronterface. This will tell all the carriages to move upwards twards the endstops**. Note that at any time durring this step be ready to turn off the printer in case the carriages are moving downwards during the homing process.**



ADJUSTING Z HEIGHT

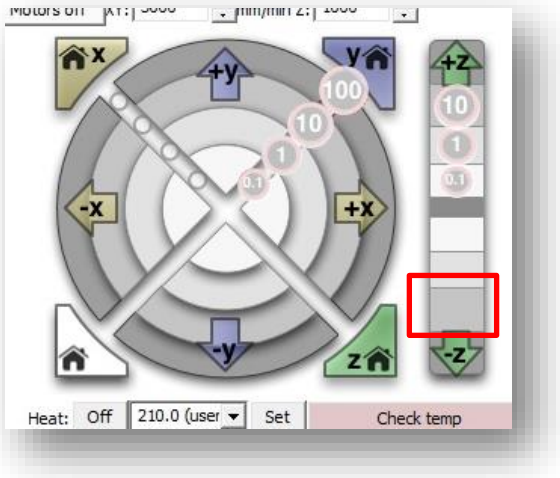
The Marlin Firmware come with a z height that may apply to most machines but because each one is built slightly differently, it is important to double check.

Open Marlin.ino and click on the Configuration.h tab.

Scroll down until you find the MANUAL_Z_HOME_POS variable. This is the value that will be adjusted to make each printer.

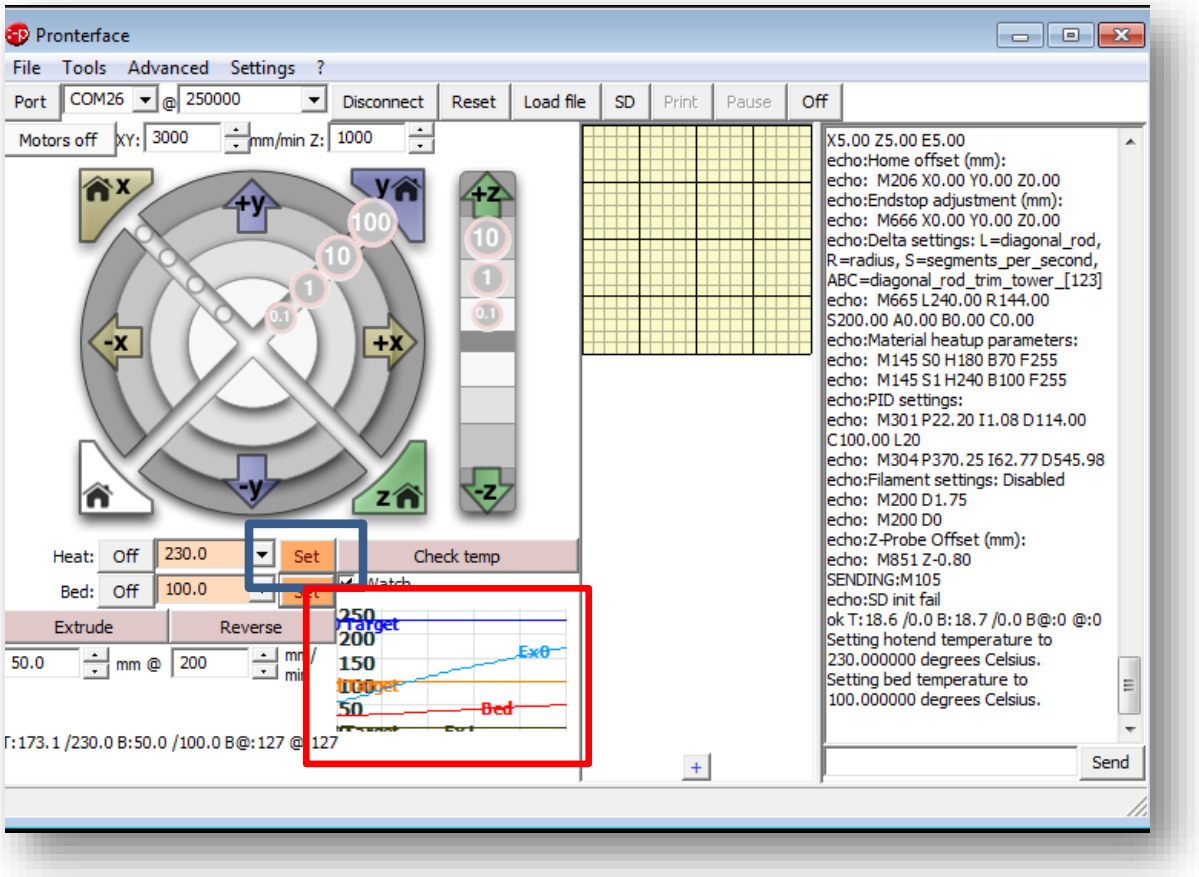
```
342 //Manual homing switch locations:
343 // For deltabots this means top and center of the cartesian print
344 #define MANUAL_X_HOME_POS 0
345 #define MANUAL_Y_HOME_POS 0
346 #define MANUAL_Z_HOME_POS 276  // For delta: Distance between noz
```

Using Pronterface, home the printer. Then click on 10mm down button and keep count how many times you have clicked it. Once you get close to the bed, go down to the 1mm down button. Keep track of how many times the bottom is pressed until you hear the nozzle bump the bed. This number is your Z height. This number is just a general value, when printing the z-probe will accurately capture the z-height.



VERIFY THE HOT END TEMPERATURE

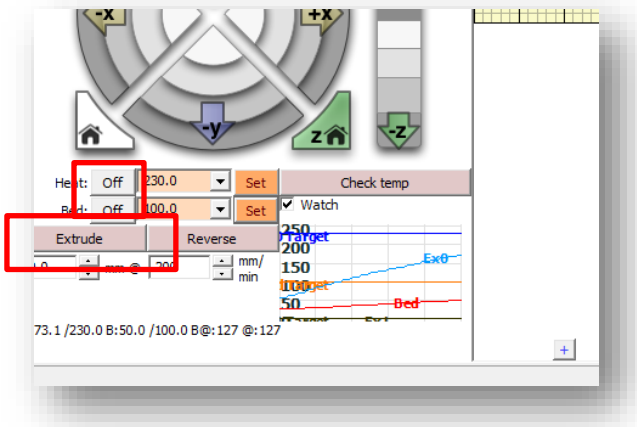
Use Pronterface to verify that the hot end is working properly. Set the “heat” temperature to 230°C and click the set button. Watch the graph to make sure the temperature of the hot end is heating up and holds steady around 230°C. If the bed temp is rising, then they are plugged in backwards. Set the bed temp to 100 and click the set button.

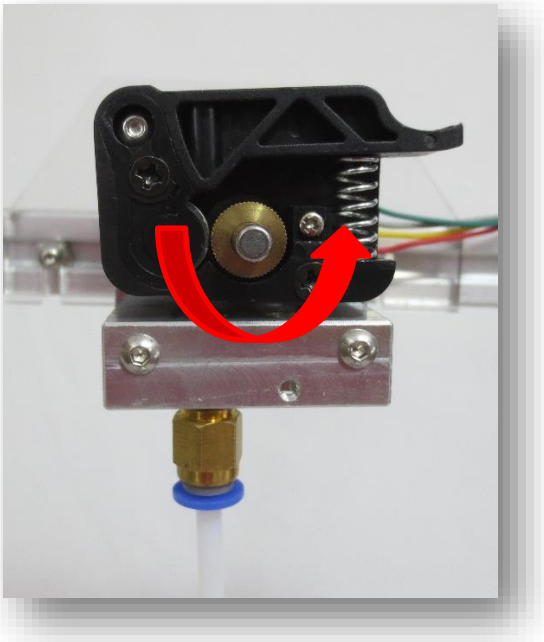


Once the printer bed has reached temp and maintained it for a few minutes, press the off button. **Before turning off the hot end, proceed to the next step “Verify the Extruder”.**

VERIFY THE EXTRUDER

With the hot end at 230°C, click on the “Extrude” button on Pronterface. The extruder will not run if the hot end is under 170°C. Now the drive gear should turn in a counter-clockwise direction. Turn off the hot end by clicking the “Off” button next to “Heat” on Pronterface.





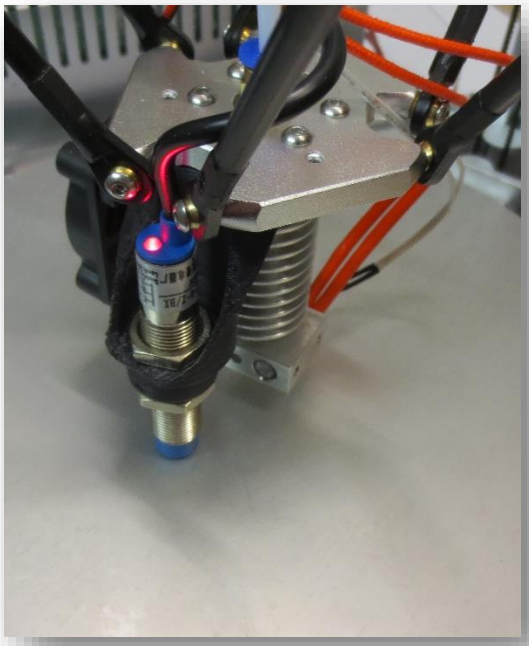
CALIBRATE INDUCTANCE PROBE

The Inductance probe location must be calibrated in the firmware. This will be important to leveling the bed.

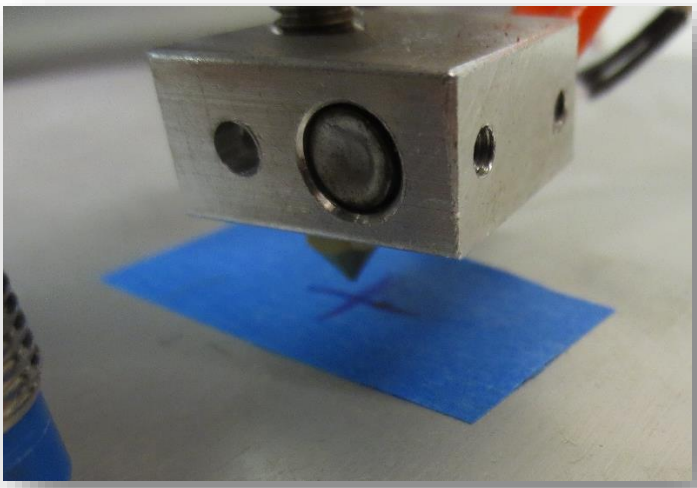
1. Start out by homing the printer and entering the gcode command “G1 Z2” in pronterface. This will bring the effector down to the bed. **Note the “M114” command will return the printers current position.**
2. Click the .1mm down button until the red light on the inductance sensor goes off. Once the light has gone off, click the .1mm down button until the nozzle touches the bed. This value is the Z_Probe_Offset. In marlin.ino under the Configuration.h tab, change the Z_PROBE_OFFSET_FROM_EXTRUDER value. This value can be adjusting later to get the first layer just right. Lower will increase the first layer height, Higher will decrease first layer height.

Z_PROBE_OFFSET (X, Y, Z, E)

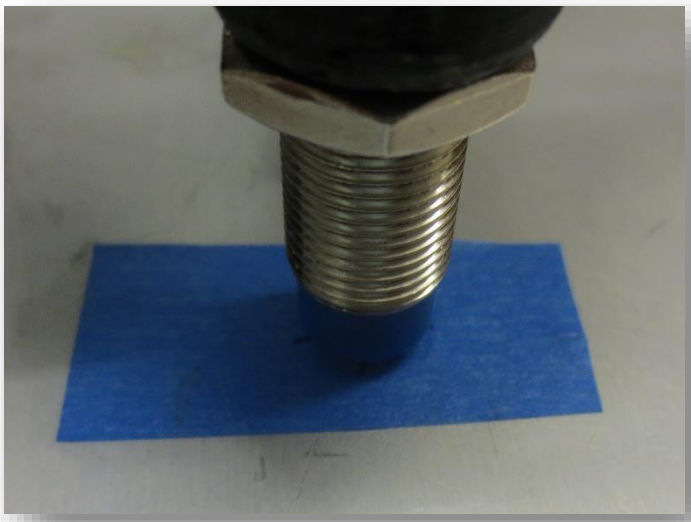
```
353
354 #define Z_PROBE_OFFSET {0, -30, -.3, 0}
355
```



3. Take a piece of tape and draw a cross hair on it.



4. Place the crosshair right under the nozzle. Move the effector in the positive Y direct until the inductance probe is centered on the crosshair. This value is the Y_PROBE_OFFSET_FROM_EXTRUDER value (when entering it into the firmware, make this value a negative number.



5. If the machine was assembled right, the inductance probe should line up with the nozzle along the X axis. If not, move both the Y and the X using pronterface until the inductance probe is under the crosshair.

SOFTWARE PARAMETER SETUP

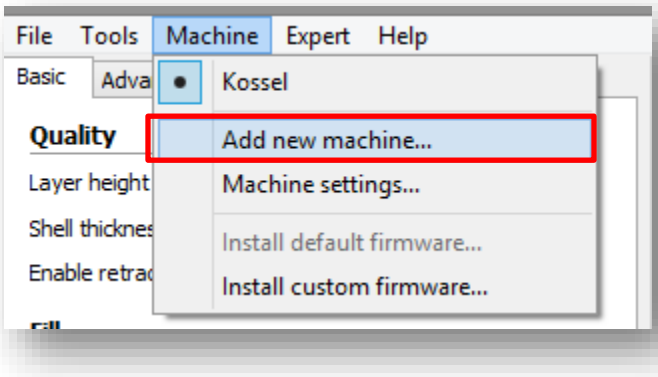
Folger Tech recommends using Cura Software as the G-code generation software. G-code is a commonly used numerical control programing language used to control the position, speed, and path of the 3D printer.

Note: *While Folger Tech recommends using Cura for slicing and G-code generation, other slicing software can be used. The printer parameters detailed below are a recommended for optimum performance of a Folger Tech printer, which can be used for other software.*

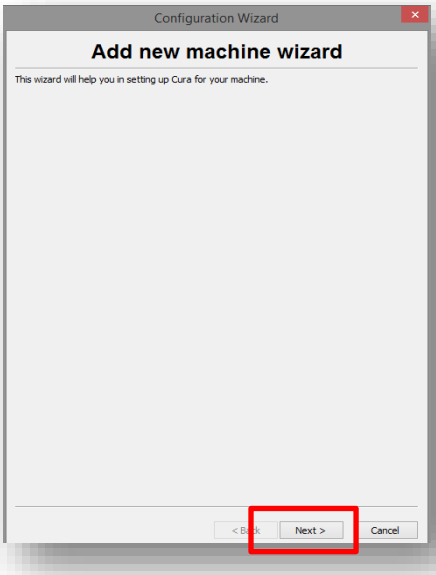
The printer setup for Cura will only need to be completed once.

SETTING UP A PRINTER PROFILE IN CURA

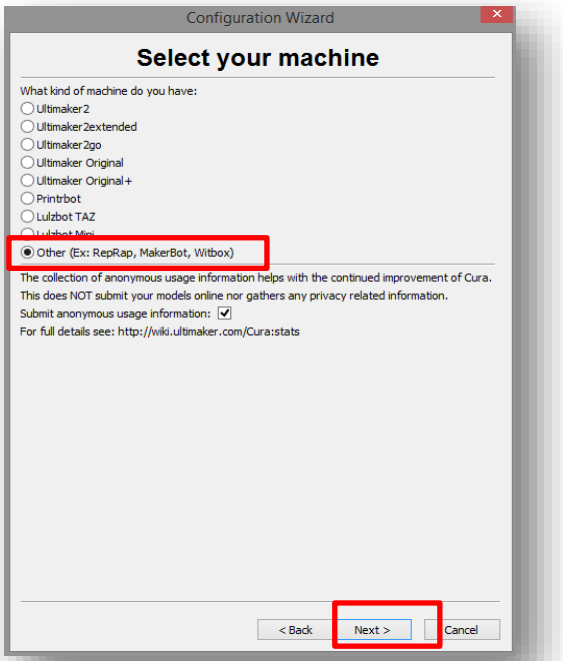
1. Download and install Cura at https://software.ultimaker.com/
2. Launch the Cura program from your computer's start menu or desktop icon
3. To setup your printer, select **Machine > Add new Machine**



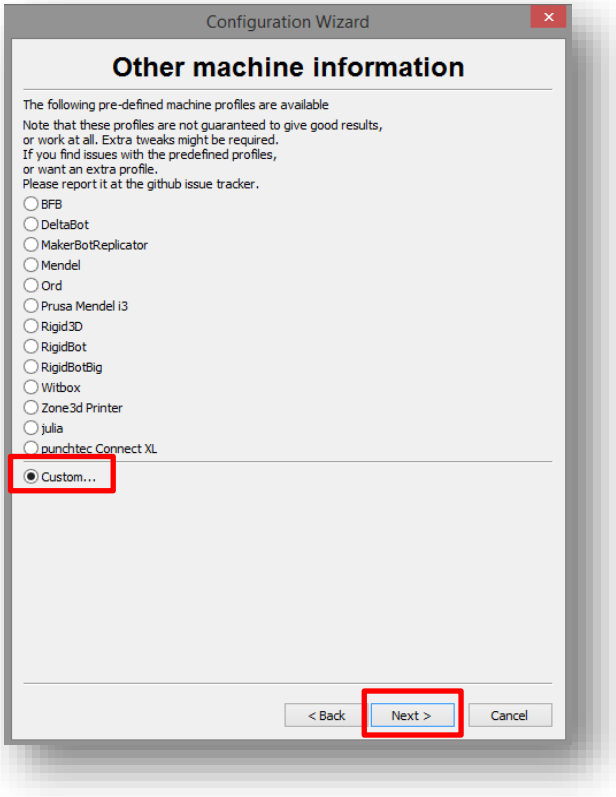
4. Click **Next** on the Configuration Wizard.



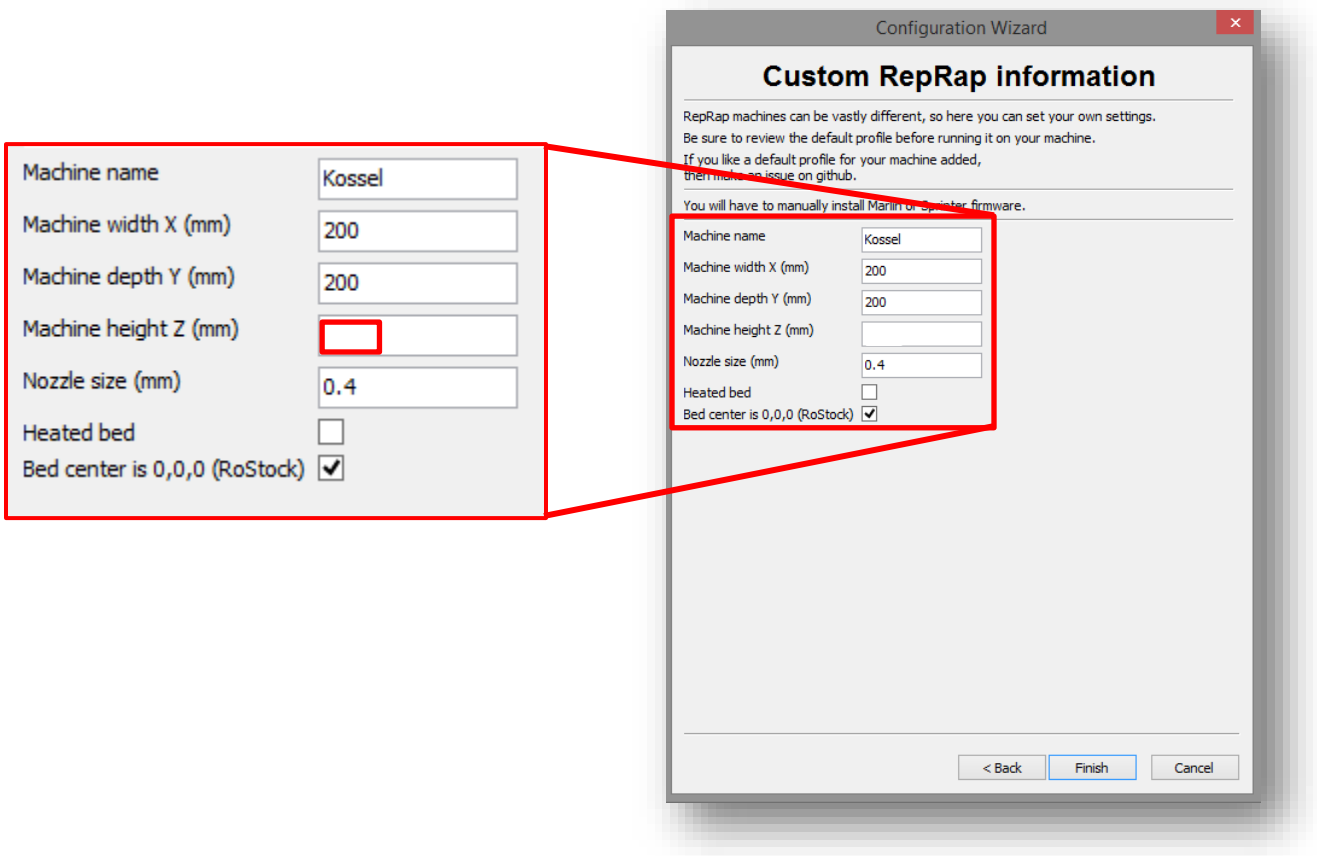
5. Under “Select your machine,” choose **Other (Ex: RepRap, MakerBot, Witbox)**. Then click **Next.**



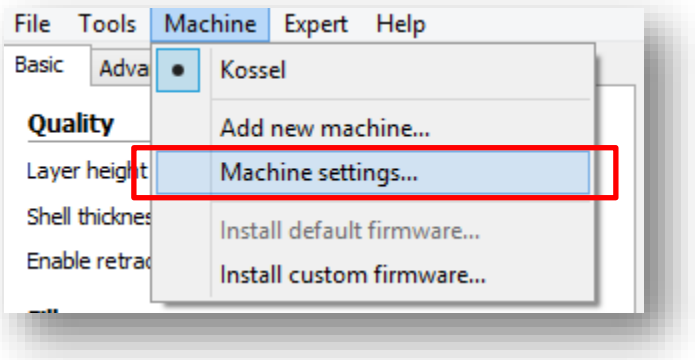
6. Under “Other machine information,” select **Custom** and click **Next.**



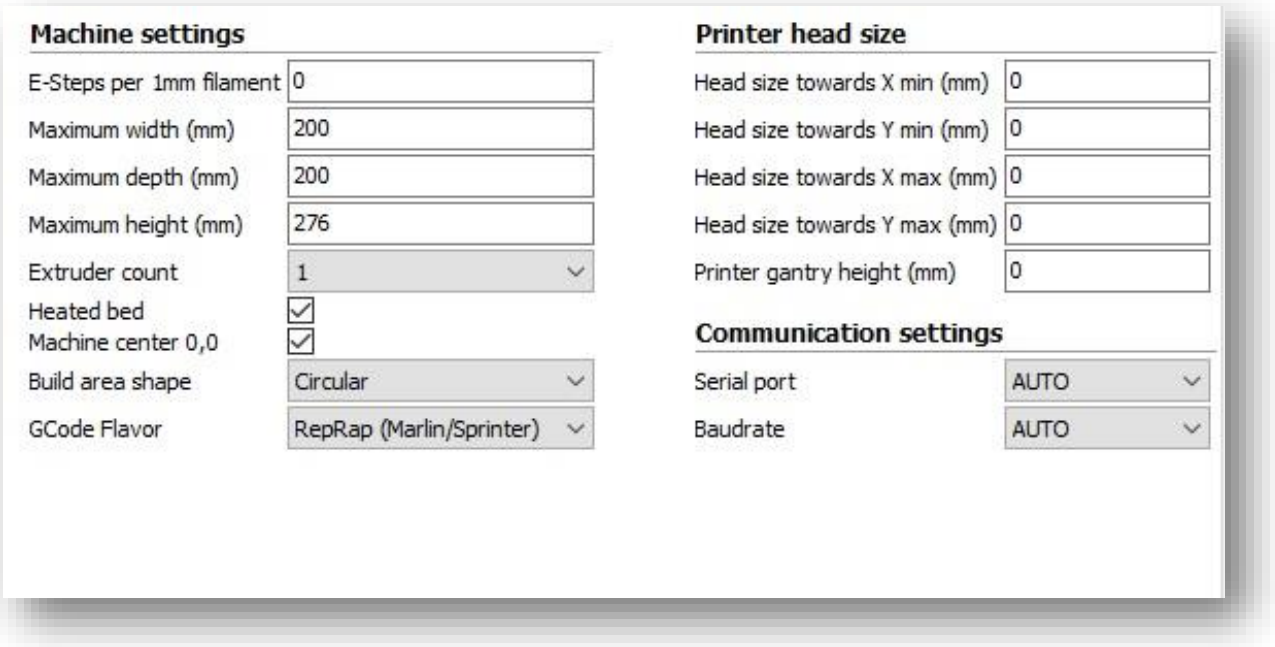
Input the following values into the RepRap custom settings. Machine height was calculated in a previous section.



7. Go to **Machine > Machine Setting**



8. Verify the following values in the table under Machine settings and click **Ok**.



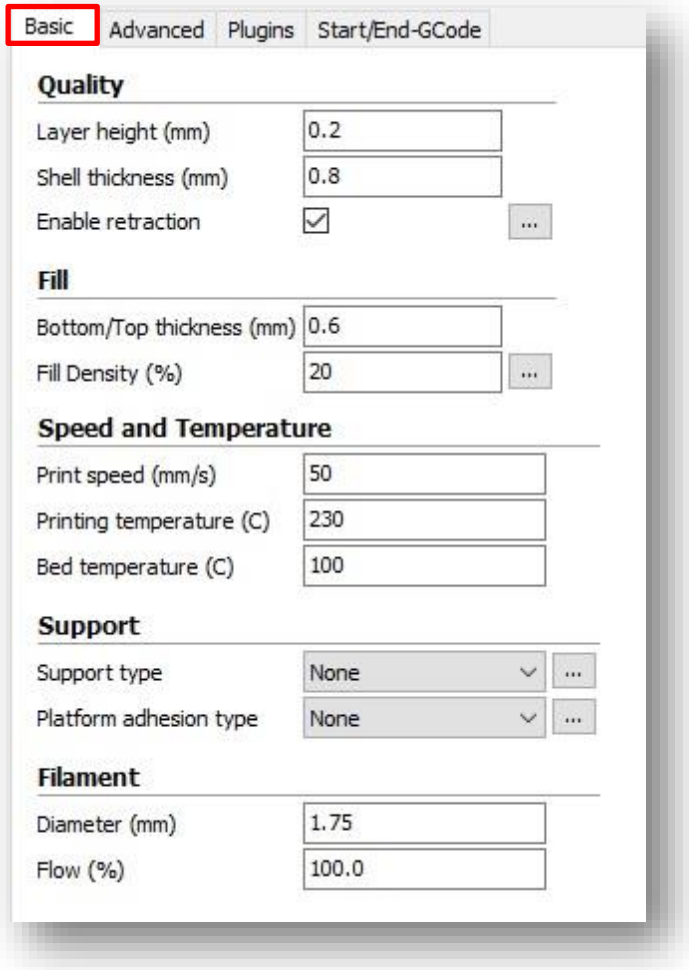
PRINTING SETTINGS

Printing settings determine the characteristics for an individual print. These settings include: print speed, fill density, shell thickness, layer height, and other advanced settings. This section should be used as a guide to the different settings that may need to be changed, and which settings should remain constant depending on your desired results.

PRINTING SETTING DEFINITIONS

Basic Settings

The parameters that are frequently adjusted to obtain the desire results for an individual part are found under the Basic Setting tab in Cura. The figure below shows the typical Basic tab settings for most prints. A detailed explanation of each parameter can be found below in the figure.

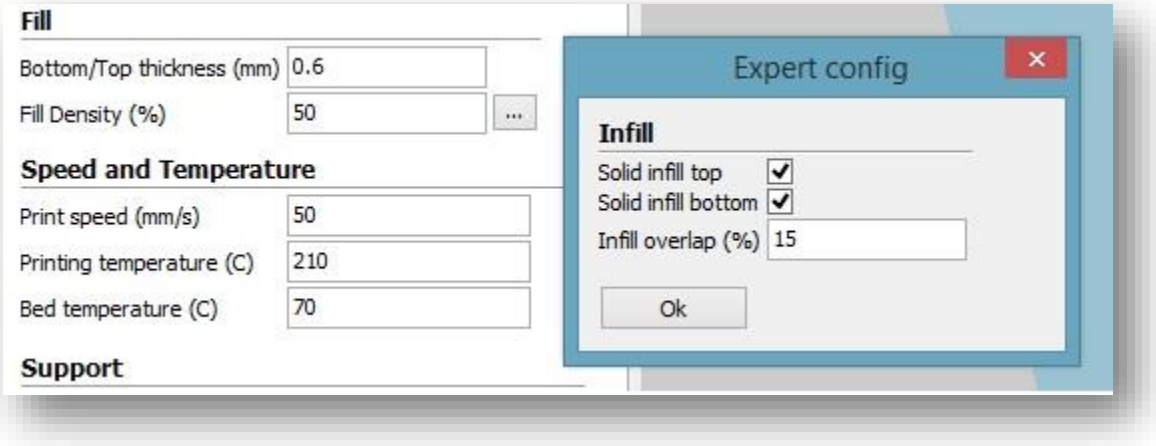


Quality

- **Layer Height (mm):** This describes the Z distance between each layer. For a 0.4 mm nozzle, the average quality can be achieved with a layer height of 0.2 mm. Average quality is sufficient for most prints except for items with fine details. If a higher resolution is desired, the layer height setting can be changed to 0.15 mm or 0.1 mm.
- **Shell Thickness (mm):** This describes the thickness of the outer shell of a printed part. This value must be a multiple of the nozzle size. For example, when using a 0.4 mm nozzle a 0.8 mm shell thickness is two nozzle widths.
- **Enable Retraction:** This setting allows the extruder to retract the filament when it is traveling between points during a print. Retracting the filament will prevent the nozzle from leaving a residue as it travels.

Fill

- **Bottom/Top Thickness (mm):** This describes the thickness of the solid bottom and top layers of a part. This value must be a multiple of the layer height. For example, a part with a layer height of 0.2 mm will have 3 solid bottom and top layers when the input is 0.6 mm for this parameter.
- **Fill Density (%):** This describes the amount of infill that will be printed in a part. Typically, an infill of 20% is sufficient internal support to make a strong part. Increasing the infill to 70% will make an almost solid part. Click on the "…" button to show the Expert config window. In this window, the top and bottom layers can be turned off. For example, a vase can be made by turning the solid infill top to off and setting the fill density to 0%.

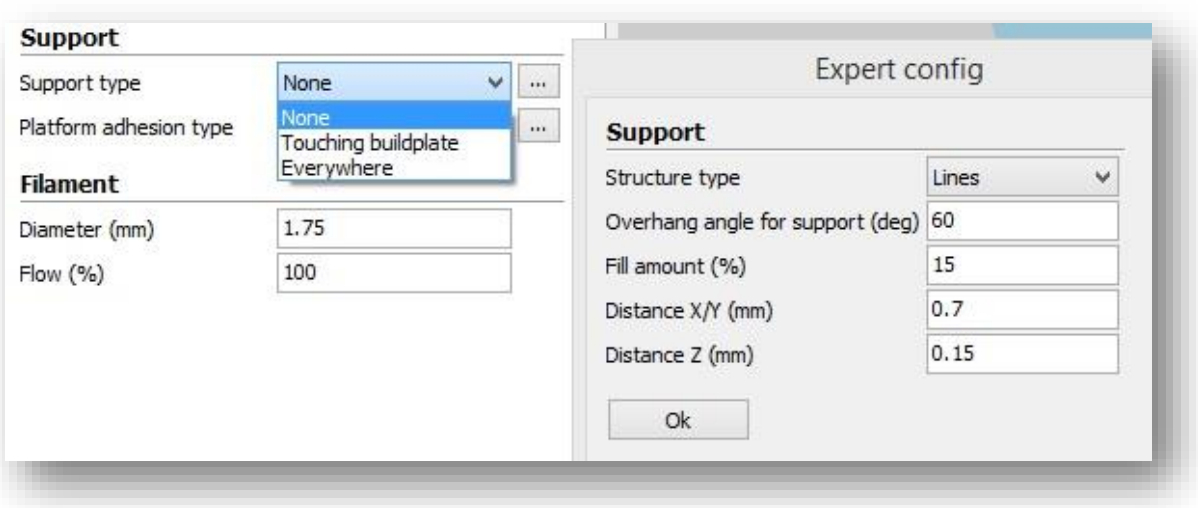


Speed and Temperature

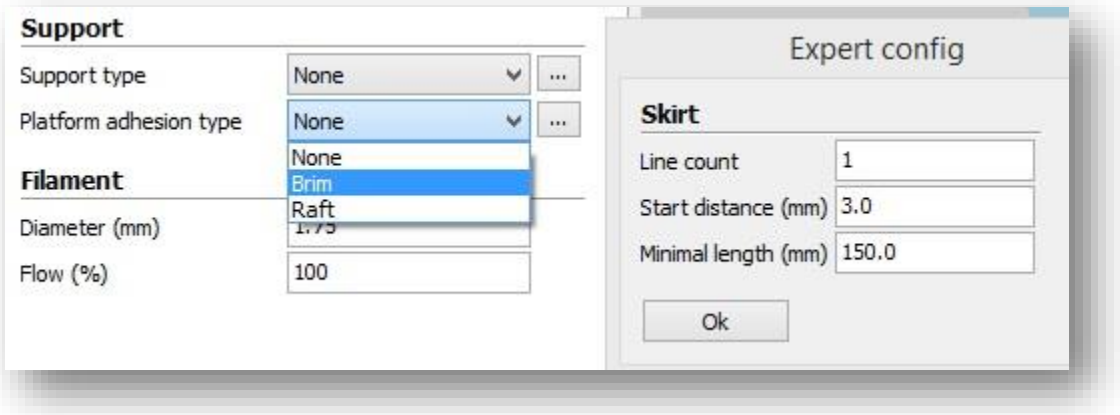
- **Printing speed (mm/s):** This describes the nozzle speed while printing.
- **Printing temperature (°C):** This describes the temperature of the hotend while printing. This value can be adjusted depending on the material being used. PLA should be set between 200 °C - 210 °C.
- **Bed Temperature (°C):** This is the temperature of the heated bed. ABS should be set too 100 °C and PLA should be set to 70 °C. Although PLA can be printed without the heated bed turned on.

Support

- **Support type:** Support material is used when a model's geometry exceeds 60 degrees from the vertical for a part feature. There are three support type options: 1) None, which should be used when there are no features that exceed 60 degrees.
- **Touching buildplate,** which will add support material everywhere that a feature exceeds the 60-degree requirement as long as the structure overhangs the printer bed and not another section of the part, and 3) Everywhere, which will add support material to all features that exceed the 60-degree requirement, including overhangs that are over another section of the part. Clicking on the "…" button will bring up the Expert config window where additional features can be edited.



- **Platform adhesion type:** The platform adhesion setting is used to prevent the part from warping or peeling off the printer bed. If the printer bed is properly prepared using blue painters tape, the platform adhesion parameter should not be needed using PLA filament. There are two types of platform adhesion: 1) Brim, which is a flat single layer that extends past the footprint of the part to extend the adhesion area, and 2) Raft, which is a support structure under a print that helps secure it to the bed. A skirt is the initial pass that outlines a part to prepare the hot end for printing.

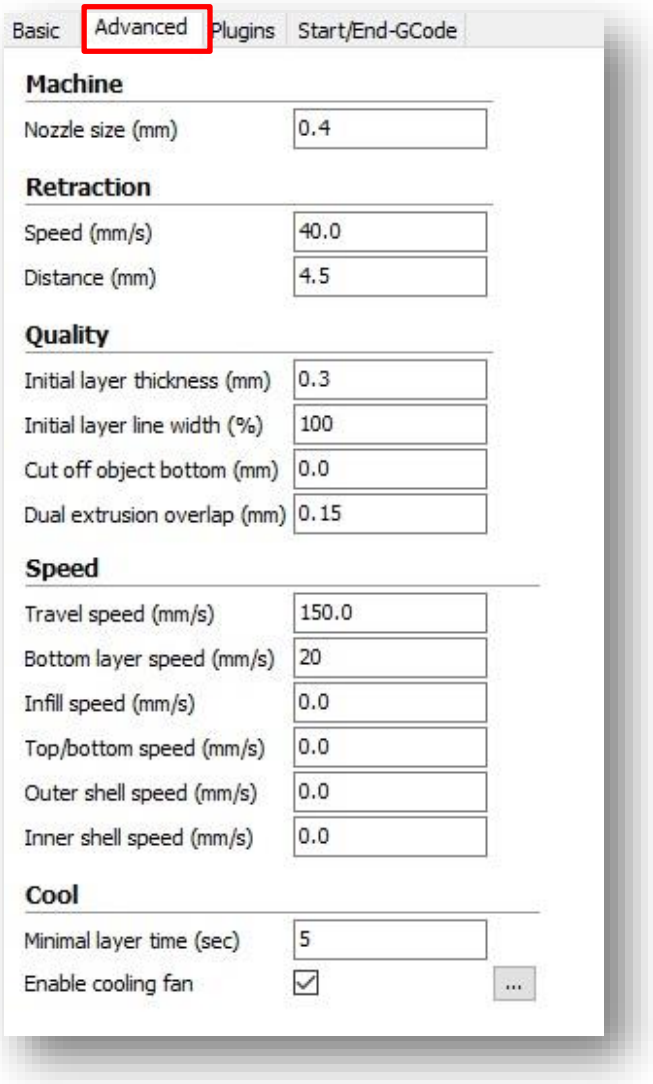


Filament

- **Diameter (mm):** This describes the diameter of the filament being used. This value should be adjusted to the standard Folger Tech filament of 1.75 mm.
- **Flow (%):** This describes the amount of filament being pushed through the nozzle. This value can be adjusted to optimize the quality of the print. A typical value is between 90-100 % for your Kossel printer. If excessive plastic is being extruded, reduce this value by 5%.

Advanced Settings Defined

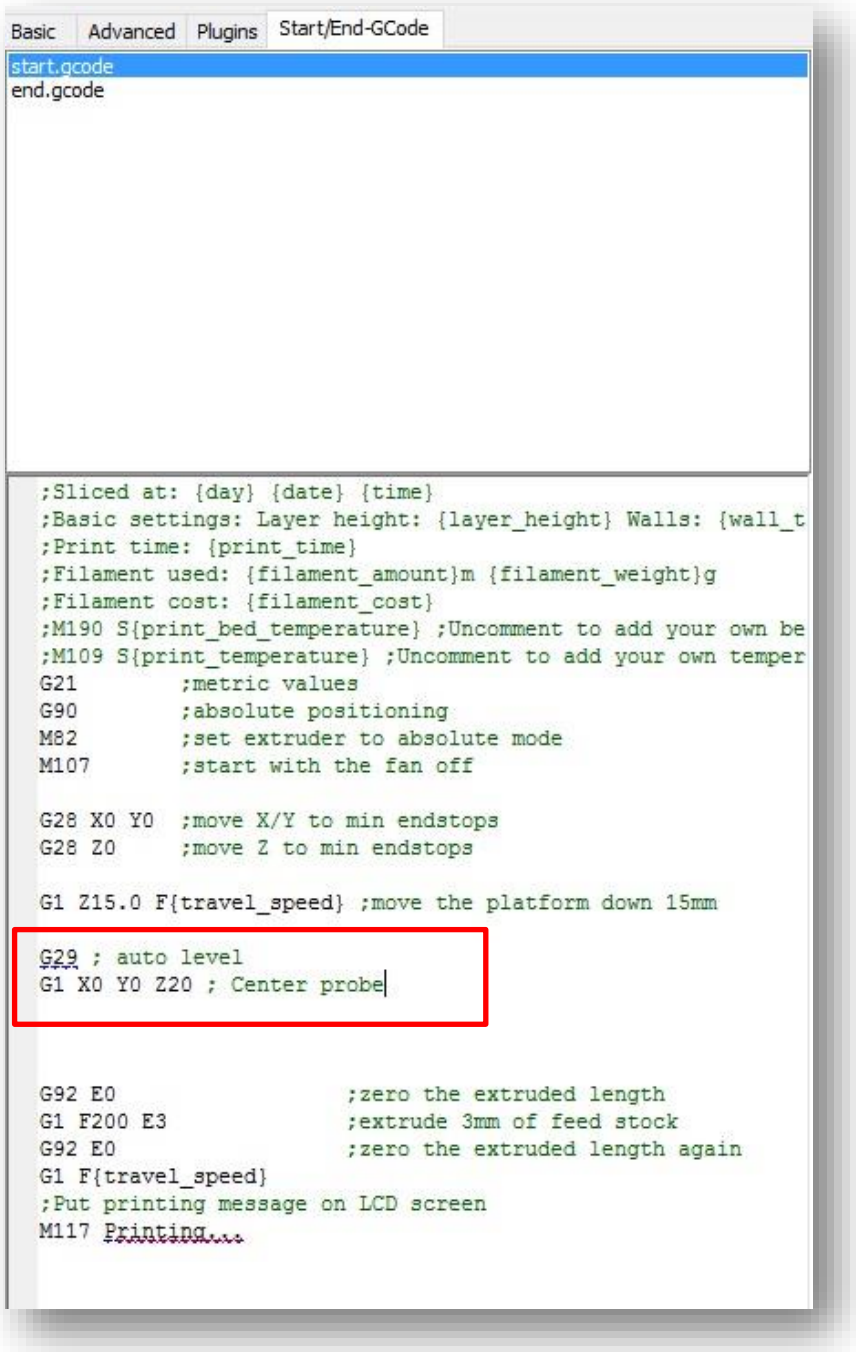
The Advanced tab parameters are printer specific and most will only need to be adjusted once. The figure below shows the typical advanced tab settings for your Kossel printer. A detailed explanation of each parameter can be found below in the figure.



Starting Gcode

To enact auto leveling, the proper gcode has to be added to the starting gcode.

Add “G29” and “G1 X0 Y0 Z10” to the starting gcode. This will execute the auto leveling command before each print.



Machine

- **Nozzle size:** The size of the nozzle being used.

Retraction

- **Speed (mm/s):** The speed at which the filament is retracted.
- **Distance (mm):** The distance the filament is retracted. This value can be raised if there is excessive residue during printing.

Quality (Only applicable parameters discussed)

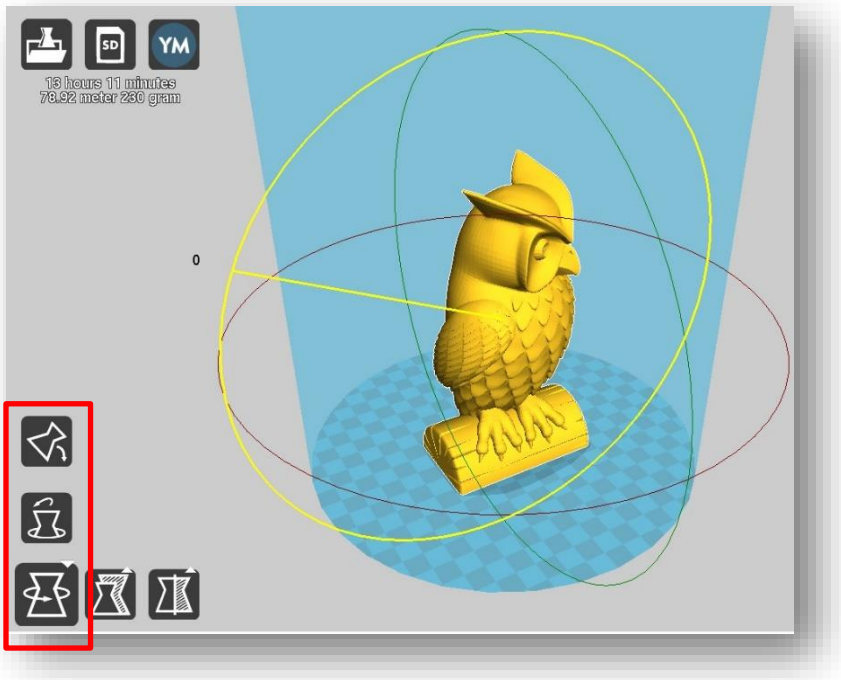
- **Initial layer thickness (mm):** The distance between the printer bed and the nozzle for the initial printed layer.

Speed (Only applicable parameters discussed)

- **Travel speed (mm/s):** The speed at which the hot end moves when it's not extruding filament.
- **Bottom layer speed (mm/s):** The speed at which the hot end moves when printing the first layer. This value is typically set lower than the normal print speed to ensure adhesion of the first layer.

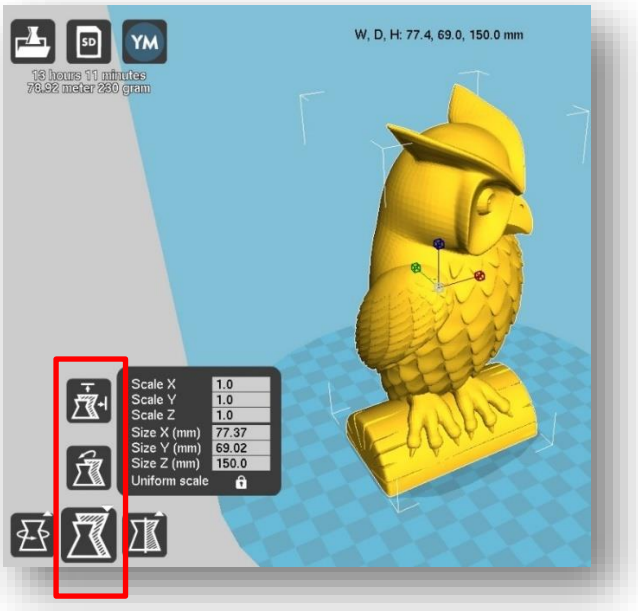
Individual Part Settings (located at the lower right of the printer window)

- **Rotate -** This function allows the part to be rotated inside the printer's workable volume. To rotate a model, click on the rotate function in the lower left corner. Select the axis of rotation by selecting and holding the desired circle around the part. Drag the circle to change the orientation of the part.

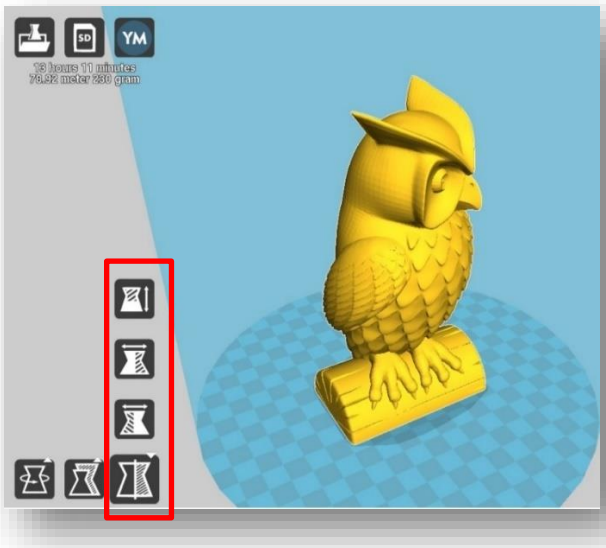


Scale – The scale function adjusts the dimensions of the part. Click on the scale icon in the lower left corner. The scale can be adjusted by a percentage or a dimension.

> **Note:** Cura interprets all dimensions in millimeters. If the model was made using inches it will appear very small in the Cura window. Simply select the part and uniformly scale it by 25.4 to restore the part to its correct size.



- **Mirror –** This function allows you to mirror the part about an axis. Click on the mirror icon in the lower left corner to activate this function. Select the desired axis to mirror part about.

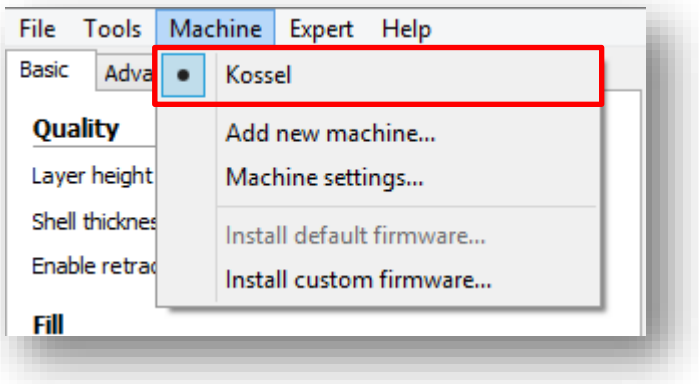


GENERATING G-CODE USING CURA

This section details the baseline parameters to use for generating G-code in the Cura software. G-code is the machine language that the control the printer motors and heater. Individual objects may require changing some of the parameters discussed in the previous sections to obtain the desired quality and speed.

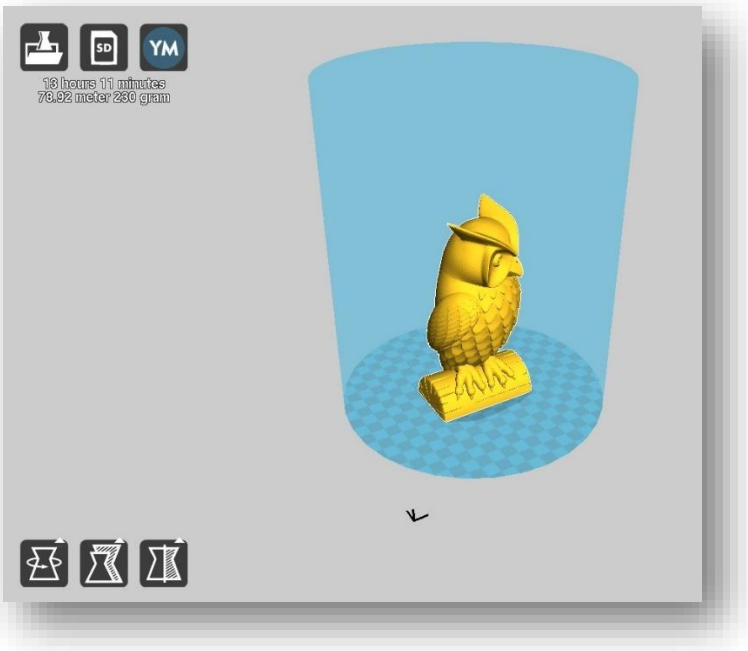
STEP-BY-STEP PROCESS

1. Verify that Kossel is selected under the Machine tab.



2. Load the desired model file (typically STL but CURA does accept other formats) by clicking on the Load icon in the top left of the print window.

3. Once the model has loaded, reposition the part to the desired location and orientation on the printer bed. To reposition the model, click, hold, and drag it to the desired location in the printer's volume, identified by the shaded blue area.



Note: the orientation will determine if support structure is required. Reference the Printing Settings Definitions section for help manipulating the part.

4. Verify and adjust any of the Basic and Advanced printing settings. See the Printer Settings Definitions section for more detailed information on these settings.

Note: Hovering the mouse over a setting will bring up a description of how the setting will affect the print.

5. Plug the printer into the computer into your computer. Click the print icon in the top left of the print window to connect Cura to your printer.

PRINTER OPERATION

This section details several processes that periodically will need to be performed to keep your printer running like new.

CHANGING FILAMENT

This section will guide you through the process of changing filament to allow you to replace fully consumed filament spools or change colors between prints. To change the filament, you must first completely remove the current filament and then install the next filament spool.

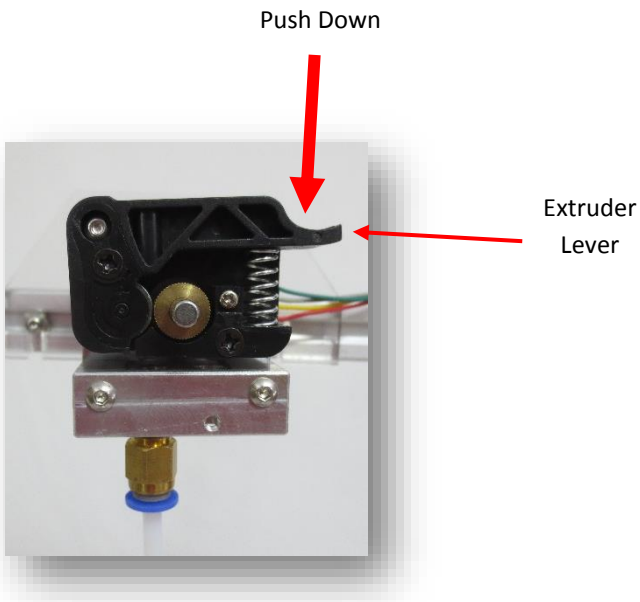
CAUTION: The hot end will be heated to operating temperatures and can cause injury.

Removal

1. Turn on the printer and preheat the hot end to the operating temperature (210 °C for PLA).
2. Push up on the extruder lever and slightly push in on the filament until it comes out of the tip of the nozzle. The figure below shows the extruder lever and direction to push.
3. Gently pull the filament completely out of the Bowden Tube while continuing to push up on the extruder lever.

Installation

1. Prep the end of the new filament by clipping it at a 45-degree angle, and straighten 2 to 4 inches of the clipped end, which will be inserted into the extruder.
2. Push up on the extruder lever and insert the filament into the extruder.
3. Continue to feed the filament through the extruder and the Bowden Tube until it flushes out the old filament from the nozzle.
4. Release the extruder lever and you are now ready to get back to printing!



BED PREPARATION

The bed preparation process ensures that the filament will stick to the printer bed. This process requires 3M Scotch Blue Painters Tape and a razor blade (optional).

1. Remove any old tape that needs to be replaced.
2. Apply the new Scotch Blue painters tape to the bed to replace the tape that was removed.
3. Gently press down on the new tape to smooth out the edges. Ensure there are no bubbles in the tape. Use a razor blade to trim the edges of the tape to the dimensions of the bed (optional).
4. If printing with ABS, apply a layer of glue (normal glue stick) over the area to be printed on. Allow this layer to dry before printing.

MAINTENANCE

Regular maintenance is important for accurate worry free printing. Perform these simple steps to optimize your printing experience.

CHECK BELT TENSION

Every few weeks it is important to make sure the belts are the correct tension, as they may stretch out during use. Follow the instructions in the Belt Tension section if you suspect a belt need to be tighten. The belts should be checked every few weeks for casual use and every week if the printer is used daily. Checking the belt tension regularly will help prevent print failures and/or damage to the printer.

CHECK FOR LOOSE SCREWS

As you print, you may find that some screws will start to come loose. Go around the machine and make sure all of the screws are tight. Check to make sure the set screw for the hot end thermistor is tight, if the thermistor comes loose and falls out, the hot end will heat uncontrollably.

TROUBLESHOOTING

The table below shows some of the most common problems experienced with 3D printer use and solutions to resolve them. For more troubleshooting help, visit our FAQ page **http://folgertech.com/pages/kossel-faq%20**.

Symptom	Solution
Layers are shifting towards a tower	Check and tighten the belt on the tower that the layers are shifting towards. Also check for a loose belt pulley on the stepper motor on that tower.
Belt skipped	Check the belts for tension.
Nozzle too close to bed on first layer.	Adjust the Z_PROBE_OFFSET value in the firmware higher to bring the nozzle away from the bed during the first layer.
Initial Layer is not sticking	First try replacing the Scotch Blue Painter's Tape. Next, check the bed level. Finally, a thin layer of Elmer's glue (glue stick only) can be applied for maximum adhesion.
Plastic is not extruding from the nozzle.	Ensure the filament is feeding correctly and being pushed into the nozzle from the extruder. Next, verify the nozzle temperature is correctly set between 210 °C for PLA and 230 C for ABS.

APPENDIX

1) DIAGNAL ROD ASSEMBLY

The goal of this section is to build the carbon fiber arms. This section should only be used if the kit did not come with assembled rods.

You will need:

Item ID	Quantity	Description
	4	Carbon Fiber Rods
	1	M3 Threaded Rod
	12	Tie Rod Ends
	1	Hacksaw blade
	1	Super Glue
2	*1*	300mm 2020 Beam
N	*1*	M4x8mm Screw
M	*1*	M4 T-nut

1. Take the M3 Threaded rod and cut it into 12x 30mm sections (use the hacksaw blade for this step).

2. Screw one M3x30mm (made in the previous step) into each of the tie rod ends. There should be 15mm of the thread showing.

3. The target length of the whole assembly is 240mm. To determine how long to cut each carbon fiber rod, use the following equation.

Tie rod length x2 – 240mm = carbon fiber rod length

Tie rod length = the distance between the end of the tie rod to the center of the ball joint (see picture). Units are mm.

4. Using a piece of extruded aluminum as a guide, measure the carbon fiber rod length from the end. Lock in the M3-T nut at the end, this will act as a stop for the carbon fiber rod.

5. Use the hacksaw blade to cute the carbon fiber rod into 6 equal pieces. **Take your time with this step, it is important that these are equal length. If they are not, this will negatively impact print quality.**

6. Insert a tie rod end into each end of carbon fiber rods. Using what is left of the M3 threaded rod (or a long M3 screw), insert it into six of the tie rod ends. Repeat this for the other side.

7. Ensure all of the tie rod ends are aligned properly (the faces should be parallel to each other). Use what is left of the M3 threaded rod as a guide.

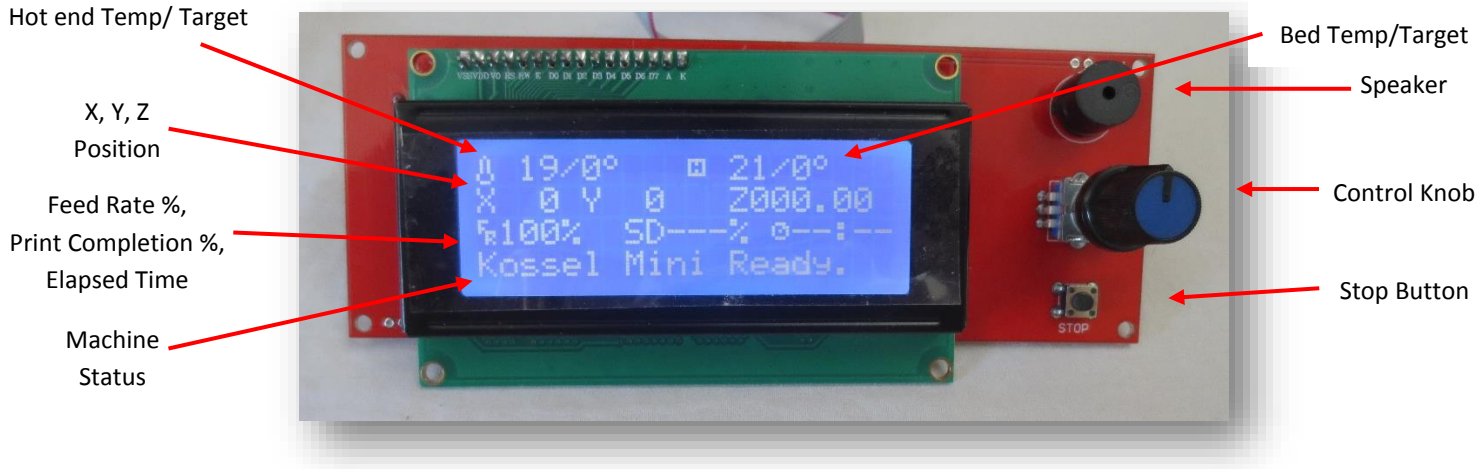
8. Back the tie rod ends away from the carbon fiber rods. Use the supplied glue and apply it to the M3 insert of each tie rod. Repeat this for the other side.

9. It is important these dry properly, so set these aside and let them dry.

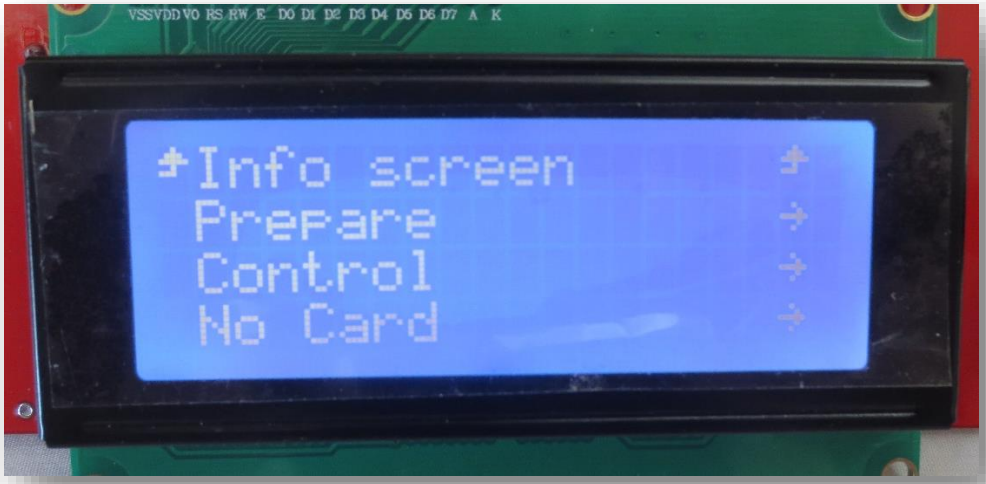
LCD Screen

The LCD screen is the user interface that controls the printer. To the right of the LCD screen is a speaker (top), control knob (center), and emergency stop button (bottom). Press in the control knob to select a function or rotate it to scroll through the menu options. If the stop button is pressed the machine must be power cycled for functionality to return.

- **Info Screen**: The info screen is the home screen display for the LCD screen.



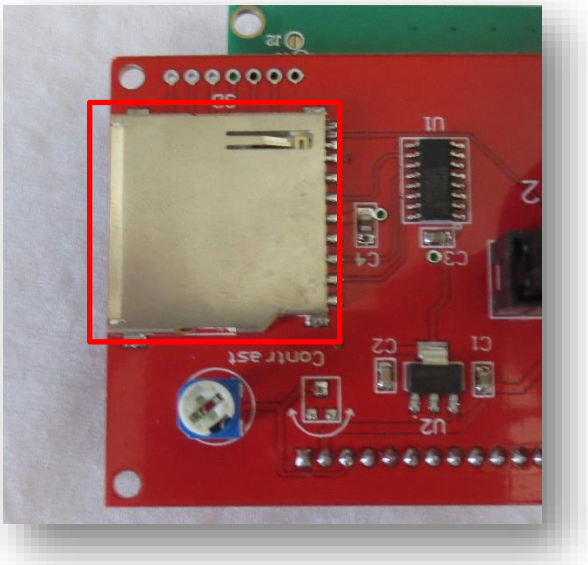
- **Main Menu**: Press in on the control knob from the info screen to navigate to the Main Menu.
  Info Screen – Returns to the home screen
  Prepare – Option to setup a print (preheat hot end, auto home, cool down, etc)
  Control – Change printer firmware settings (temperature, motion, and restore failsafe)
  Print From SD – Select a file to be printed



- **Prepare**: You can reach this from the Main Menu. The two common features that will be used on this screen are:
  Auto Home – Zeros the machine and returns the effector to the home position
  Preheat PLA – Sets the hot end temperature to 200 °C

SD Card Slot

The SD card slot at the front of the printer allows you to insert an SD card to run the machine code and print without connecting to a computer.



3) PRINTING FROM AN SD CARD

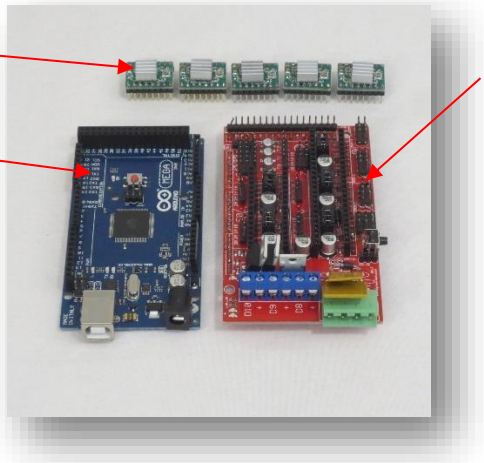
The LCD screen allows the Kossel 3D Printer to read the G-code for your print file directly from an SD card. This allows the machine to run without being connected to a computer.

STEP-BY-STEP PROCESS

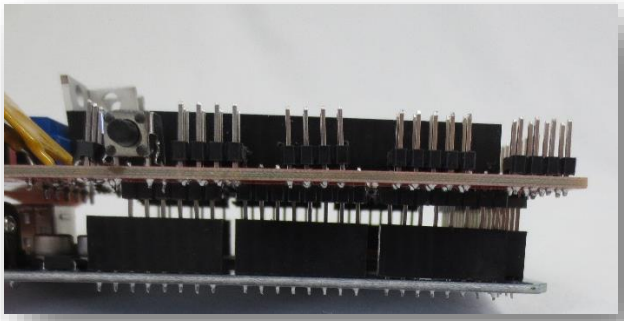
1. Insert the SD card into the printer. The SD card slot is located next to the print bed, and to the right of the LCD screen.
2. Turn on the printer or restart if required. When an SD card is installed the machine must be restarted to recognize the card.
3. Press the control knob once to reach the Main Menu.
4. Scroll down to “Print from SD” and press the control knob again to select this function.
5. Use the control knob to scroll to the desired print file. Newly added files will usually appear at the bottom of the file list.
6. Press the control knob to select the file you want to print. The printer will heat the hot end to operating temperature and auto home the effector.
7. Watch the first layer being printed to ensure that the bed is at the correct height and properly leveled. If the bed appears to be at the wrong level stop the printing process and relevel the bed. Once printing is completed the effector will return to the home position.
8. Allow the hot end to reach room temperature. Then remove your finished masterpiece.

4) RAMPS 1.4

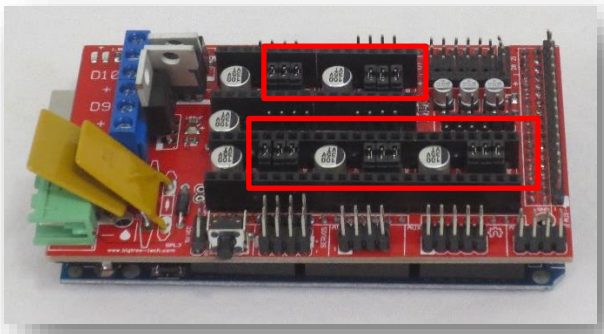
The goal of this section is to show how the Ramps 1.4 kit is assembled, installed, and wired into the Kossel 3D printer. This section will just call attention to the differences.



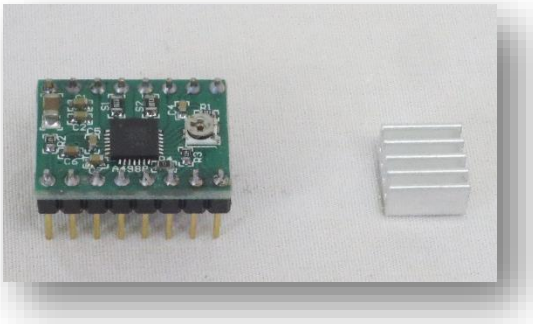
1. Plug in the ramps 1.4 board into the Arduino Mega. Make sure all the pins line up nicely, then push the two together.

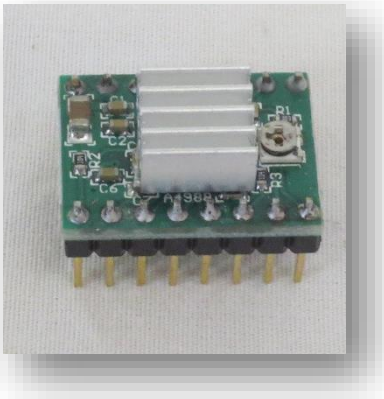


2. Insert three jumpers per stepper motor plug. This tells the board that 1/16 micro steps will be used.

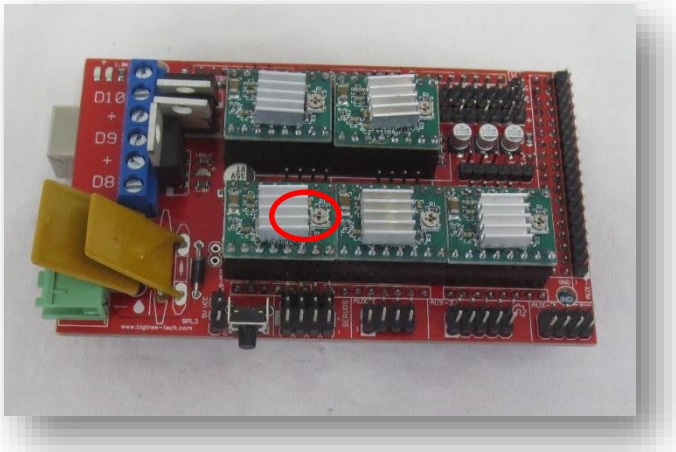


3. Take the stepper motor out of the packaging and stick the heat sink onto the black chip.

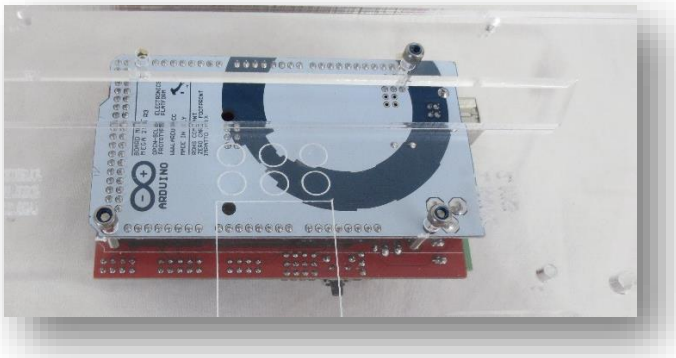




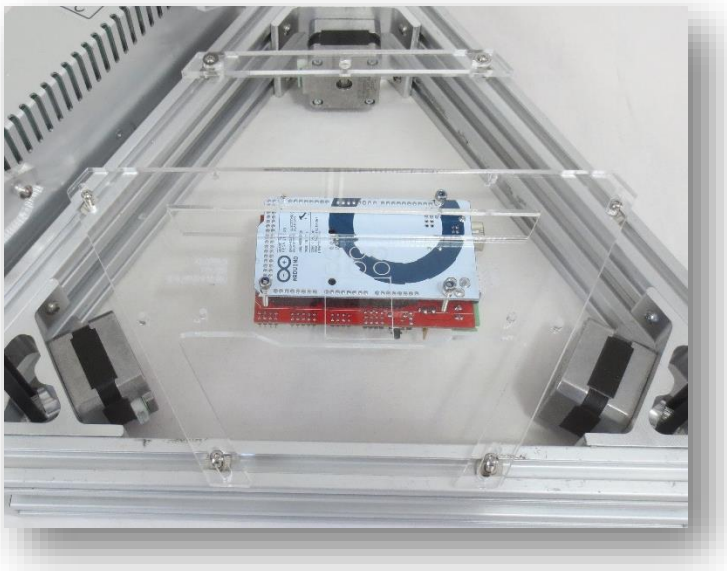
4. Plug in the five stepper motors into the ramps 1.4 board. The trim pot should be away from the power supply plug.



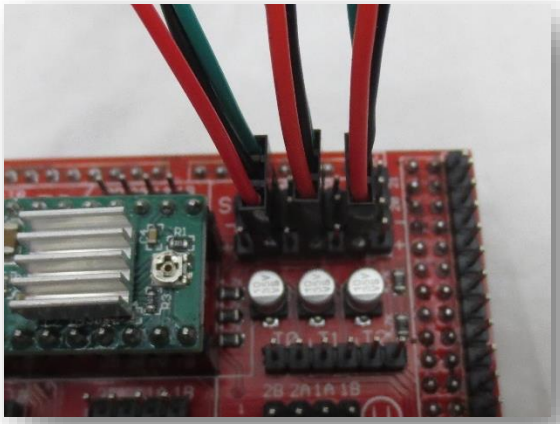
5. Secure the ramps assembly to the electronics mount using three M3x25mm screws and two M3 nylock nuts.



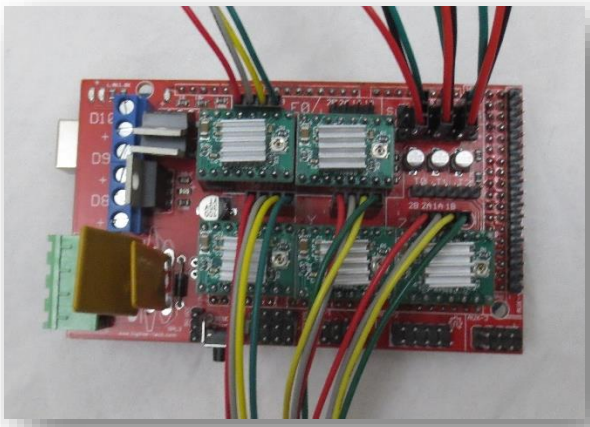
6. Mount the electronics mount by locking in the four T-nuts.



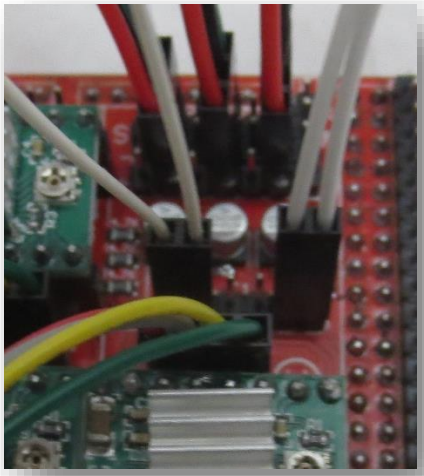
7. Plug in the three Endstops.
In order pictured:
X-Max, Y-Max, Z-Max



8. Plug in the four stepper motors. Make sure the red wire is on the right side. Extruder motor (top left), X tower (bottom left), Y tower (bottom middle), and Z-tower (bottom right).

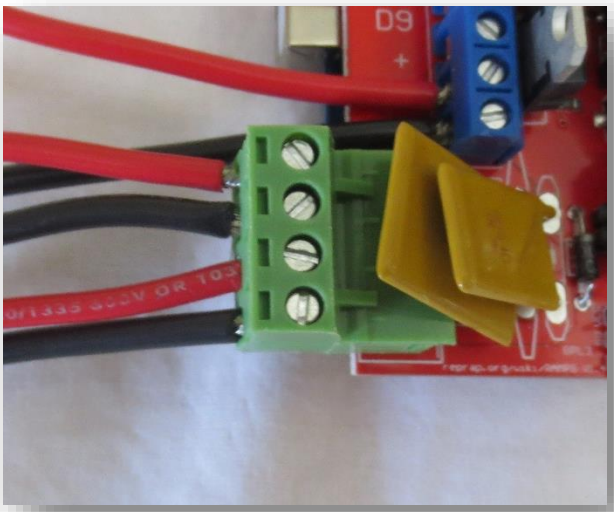


9. Plug in the hot end thermistor wire (right) and the heated bed thermistor wire (left).



10. Wire in the hot end heater wire into the top two connectors on the blue plug. Then wire in the hotbed wire into the bottom two connectors.

11. Wire in the four wires from the power supply. Make sure the order is black-red-black-red, as seen in the picture.



4) ASSEMBLY THE EFFECTOR WITH PLASTIC EFFECTOR

In this section the effector will be assembled. The hot end will be mounted to the effector.

You will need:

Item ID	Quantity	Description
13	*1*	Hot End/Sensor Mount
G	*4*	M3x16mm Screw
F	*2*	M3x12mm Screw
B	*4*	M3 Nylock
21	*1*	3D Printed Effector
10	*1*	1.75mm All Metal Hot end
5	*1*	40mm Fan
46	*1*	Roll Kapton Tape

4. Take the hot end mount and dry fit it onto the All metal hot end. It should be a tight fit and you may need to sand it to get it to fit onto the collar.

5. With the hot end mount on the collar of the all metal hot end, mount it to the effector and line up the four holes of the hot end mount and the effector. Insert four M3x16mm screws through the effector and the hot end mount. Secure this with 4 M3 Nylock nuts.

6. Mount the 40mm fan using two M3x12mm screws. The wires of the fan should be located at the top of the effector.

7. Insert a M3 nylock nut into the hex hole located on the 3D printed effector.

8. Insert a M3x25mm screw through the ball joint of the tie rod end, through the 3D printed effector and thread it into the Nylock nut.

9. Repeat this step for the remaining five carbon fiber arms.

13) WIRING THE 12V HEATED BED

In this section, the heated bed will be wired up.

You will need:

Item ID	Quantity	Description
12	*1*	Round Heat Bed
14	*1*	100k NTC Thermistor
46	*1*	Kapton Tape
39	*1'*	Red 14AWG Wire
40	*1'*	Black 14AWG Wire

3. Cut a 12-inch length of black and red 14 AWG wire. Strip ¼ from one of the ends on each wire. With the hotbed lying top down on the table (red up), solder the red and black wire onto the back of the hot bed.

4. Place the tip of the thermistor on the center of the hot bed. Using Kapton tape, tape the thermistor and the 14 AWG wires down to the hotbed.