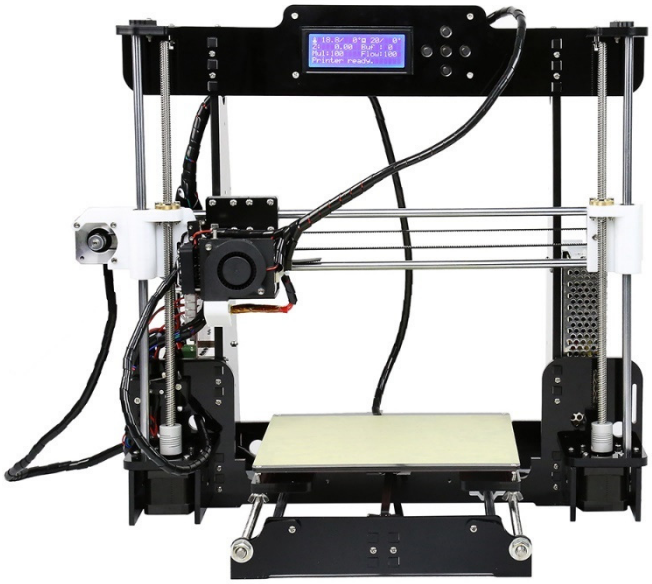
The BIG Troubleshooting Guide v2

by Jan Hedström 30.01.2017

For Anet A2, Anet A6 and Anet A8 3D Printers



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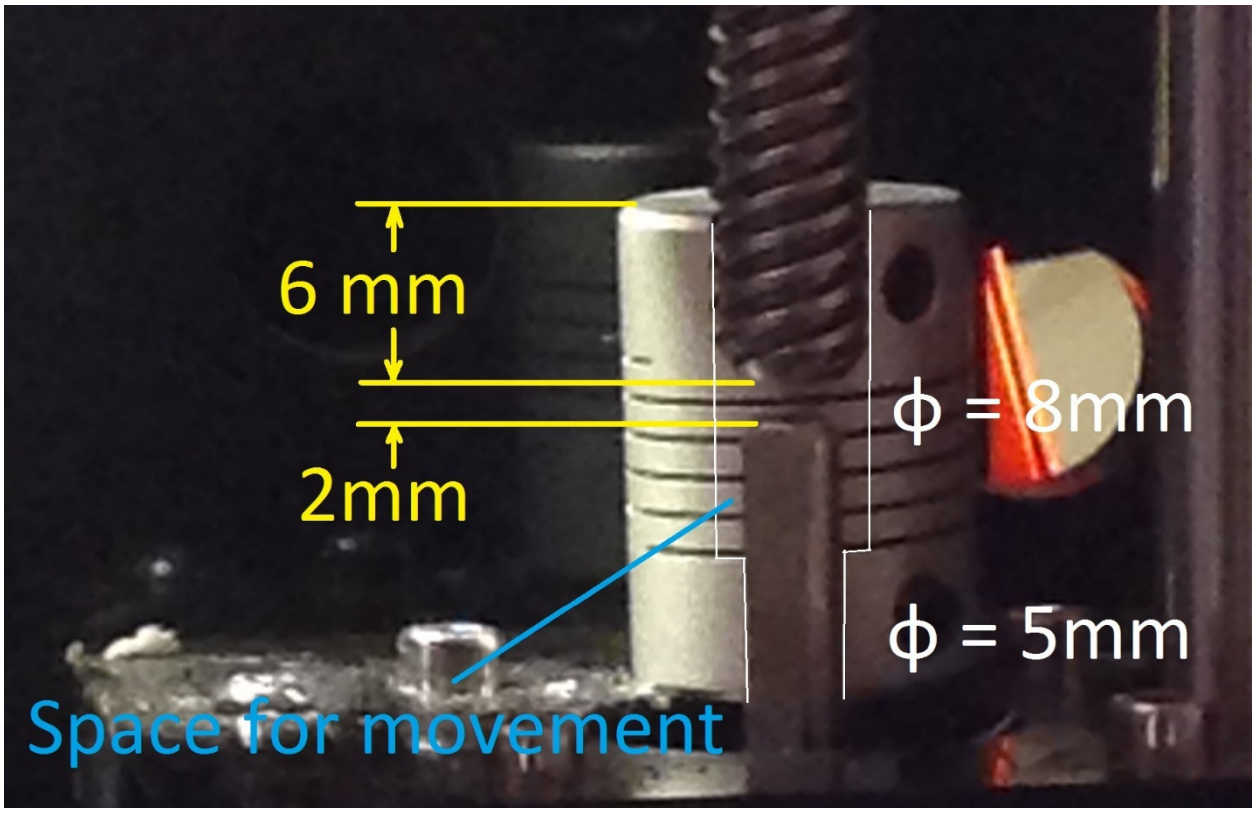
Chapter 1. Z-Axis problems

1. If motors move sometimes, or just twitches, check the z-motor plugs and jacks for proper connection, bad crimps or pushback contacts.

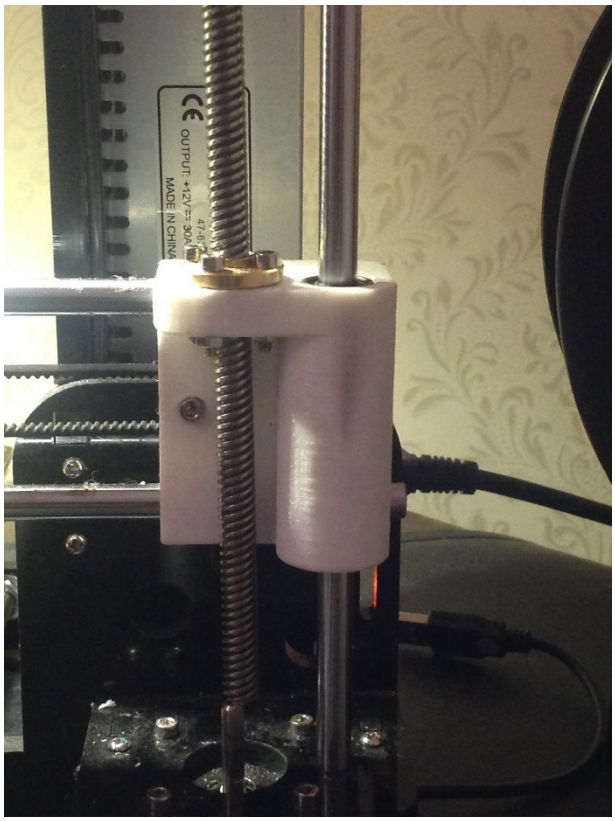
2. If Z-axis one or both sides are binding and stalls, check that the “Helical drive couplers” are installed right, the thread bar can't be inserted more than 6mm in the coupler, and make sure there is a gap between motor shaft and thread bar to prevent locking of the coupler.

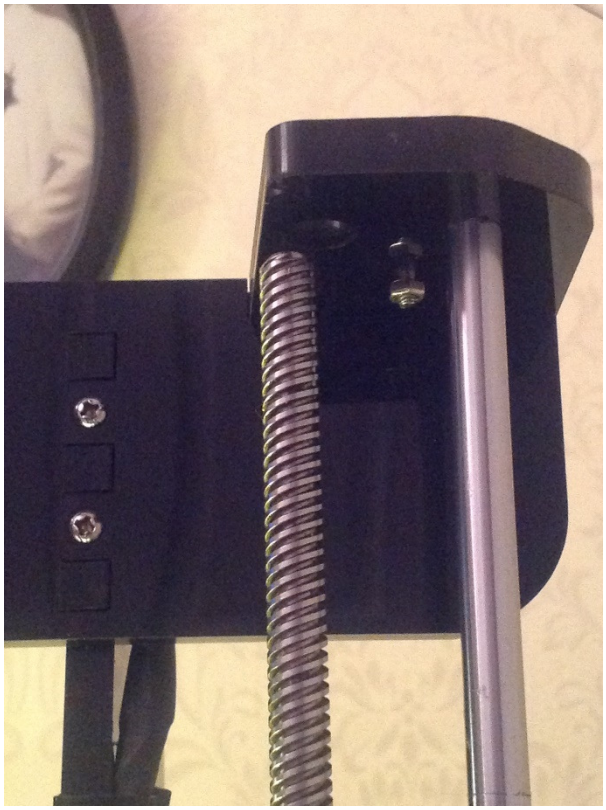


1. On some printers the Brass nut is not straight, causing the thread bar jamming. It can easily be detected as this, Remove the Drive coupling, is the thread bar straight and aligned with the motor shaft and top hole in the frame?

If not loosen the brass nut and either shim it straight with some thin washers, file/grind the top surface of the white block straight or print a wedged washer from PLA or ABS.

How you ever do the important thing is to get the thread bar parallel with the guide bar.



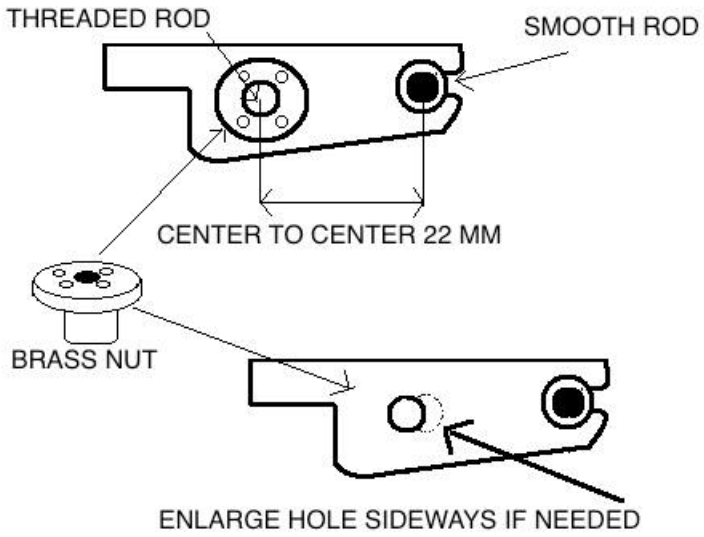


Example of skewed thread bar

2. Another cause of jamming is bad alignment of the brass thread nut.

Check that the distance between center of brass tread nut and center of guide bar bearing is exact 22.0 mm, just a little bit off and the thread bar is not parallel with the guide bar when driving down.

If not exact 22.0 mm take out the brass nut and enlarge the hole sideways, put the nut back in correct position and drill new holes for the mounting screws.



3. If all of the above corrections was made, but the drive current simply is not enough, Increase the z-axis drive current, turn this pot ¼ of a turn clockwise.

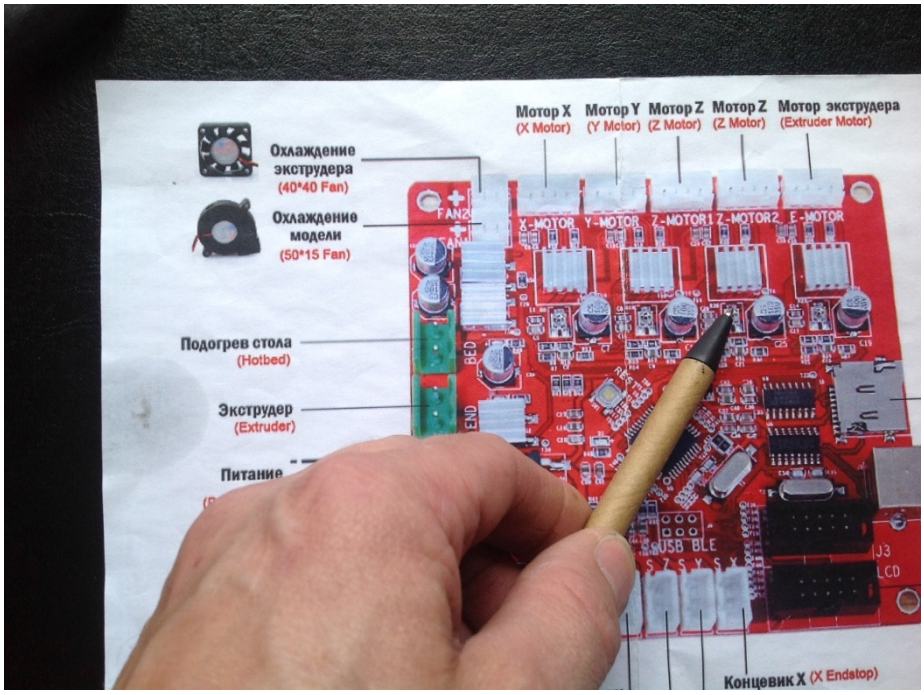
There is for now 3 versions of the board.

On the oldest board was 4 pots, one for each axis. (before May 2015)

On the second board there was no adjustment pots. (May 2015- October 2015)

On the current board is one pot for z-axis only. (October 2015 and forward)

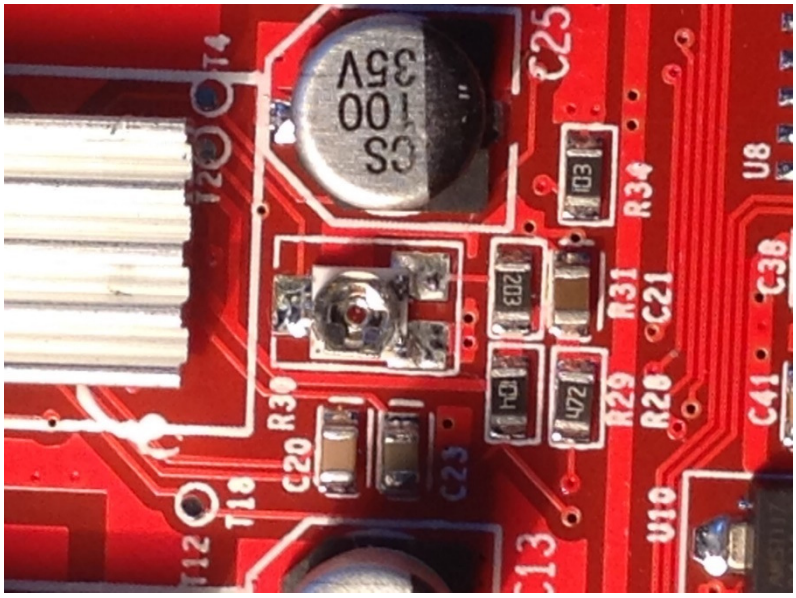
The pot is still located in the same position for old and new controller boards.



4. Correct position is when the potentiometer flat spot is pointing away from the nearest big capacitor.

That gives about 75 % of max drive current.

And that should be enough



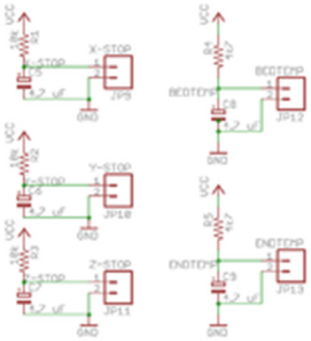
5. If binding occurs a couple of centimeters above Z-Home position:

Check that X-Axis belt is not overtightened

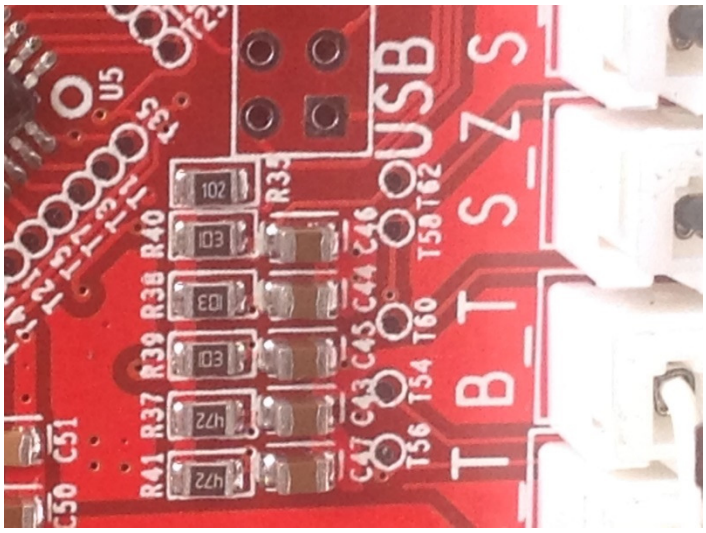
In chapter 6 is a guide how to tighten the belts

6. Switch is not sensed and axis only moves up, disconnection of switch does not change anything.

It could be bad soldering on the controller board, possibly around the pullup resistor or the 4,7Uf capacitor that is connecter across the plug pins

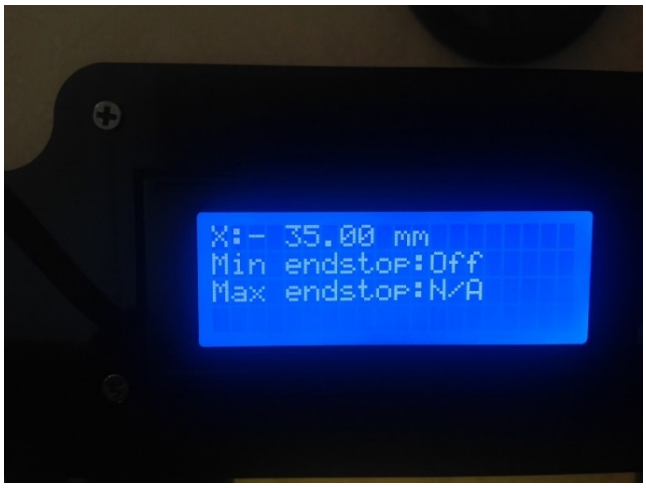


Visually check or just re solder both the black resistor and the brown capacitor. The bottom resistor R39 and cap C45 goes to the Z-axis switch.



How to test the switch w/o multimeter

- Go to printer “Position” menu
- Chose “Z Pos. FAST”, if the switch is not pressed it should read “OFF”.



- When switch is pressed it should read “ON”

Chapter 2. Temperature reading problems

If you are reading DEF on the printer screen, and you have open circuit, it does not go away even when the connection is restored, it is a latching fault. You need to turn the power off and back on to see the changes.

These sensors are simply a resistor whose resistance value changes with heat. If you have access to a test meter, at 25C the value will be 100kohms.

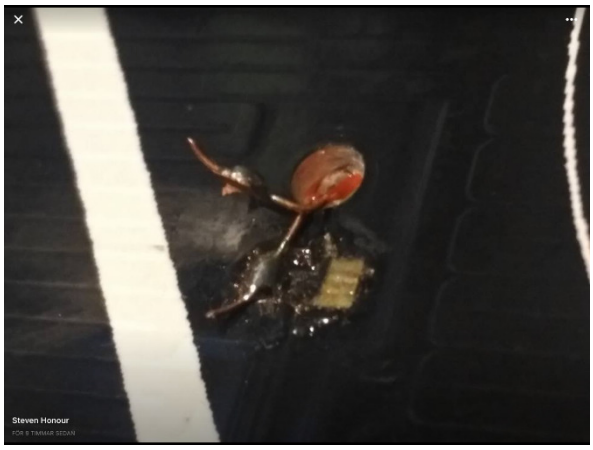
However, there is an easy way to check without a meter. If only one temp is showing DEF then switch off the machine, swap the bed and hot end sensor around and switch back on. If the letters DEF have now swapped places, the faulty sensor is open circuit, the usual problem is bad soldered joints at the sensor end, or a bad crimp connection at the plug end.

If the display shows something like 295C and then changes to DEF, then you have a short circuit, if it shows something like -55C and then changes to DEF you have open circuit.

The attached data sheet shows the resistance value for many temperatures, using a test meter you can accurately read the resistance value and cross check it to the nearest temperature.

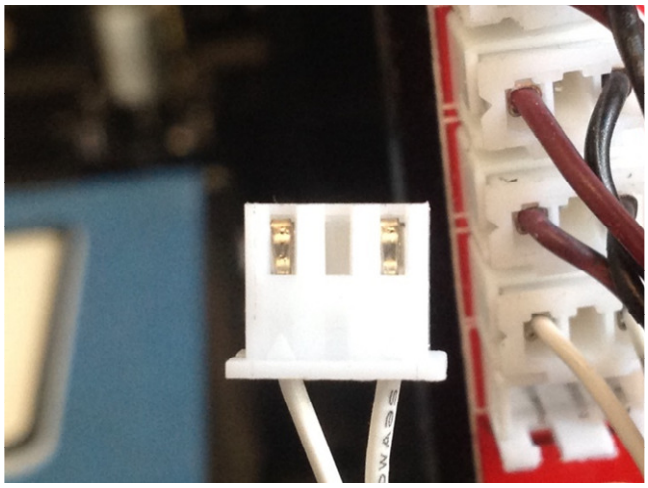
Short Circuit, Poor insulation, broken sensor

- Most common reason is poor or damaged insulation to the sensor, visually inspect the cables all the way from plug to sensor.
- Damaged temp sensor, check the sensor tip, it is made of glass and can crack. If the sensor is taped on with heat resistant kapton tape, remove it carefully so it can be reused I you don't have a roll at hand.
- On the new MK3 beds with white plug on the back, is also the thermistor soldered to the underside of the bed, that is very easy to damage. Here is an example of thermistor ripped loose on one side.

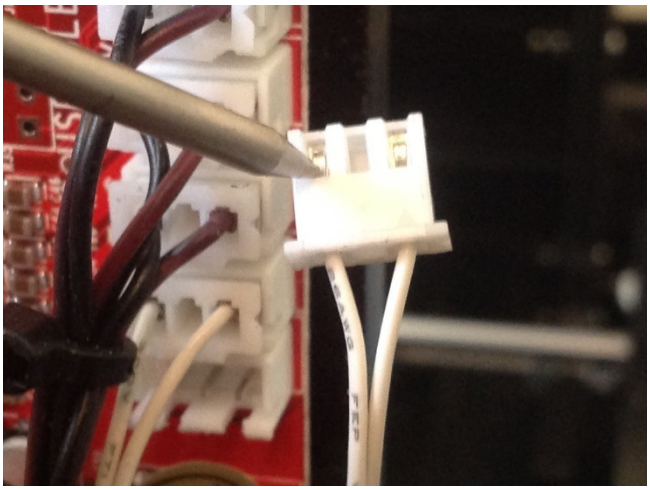


Open Circuit, how to fix badly crimped temperature sensor plugs

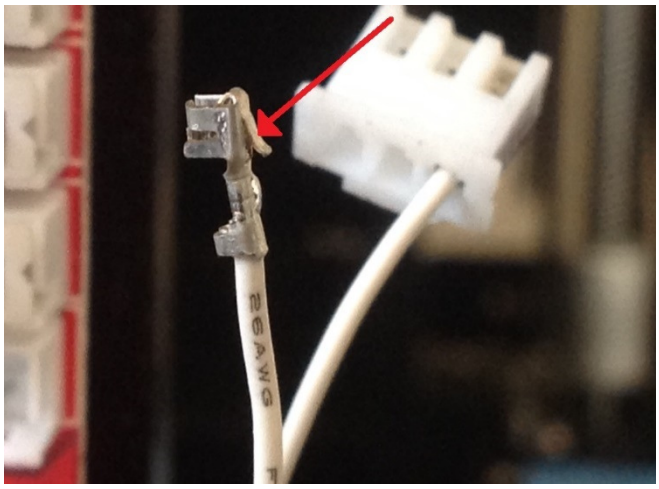
- Take out the plug from the controller PCB and turn it so you can see the slots on the side.



- To remove the pin from the body, press gently on the metal tongue and pull the cable and pin out from the housing.

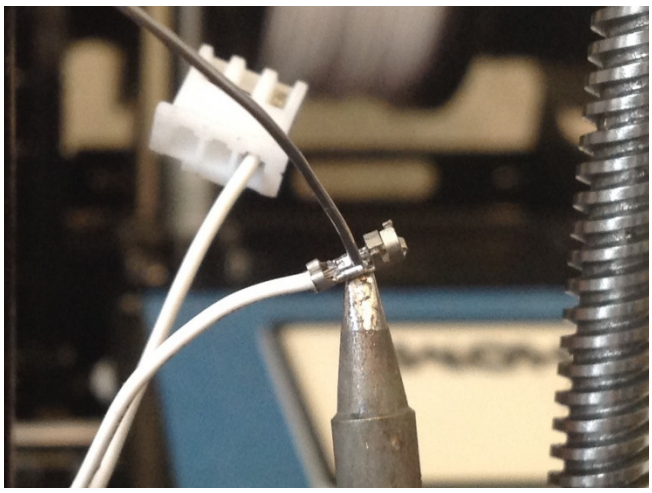


- This is the tongue to be pressed

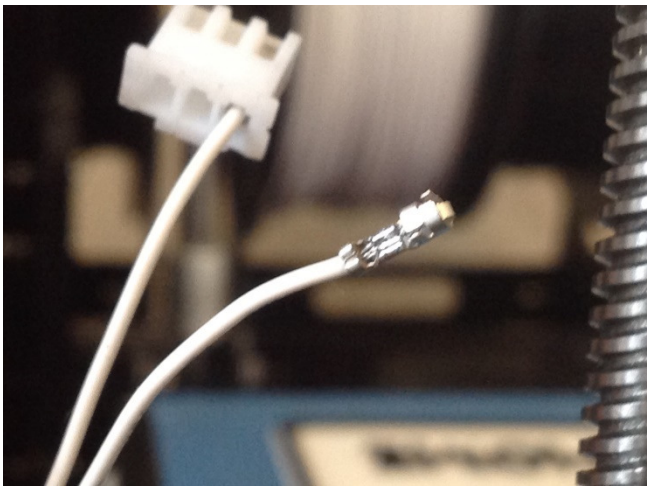


- To solder it, put the soldering iron from the same side where the tongue is, right under the crimp.

  Allow to heat up for about 3-4 sec. then apply just a little bit of solder, you see when it floats out on the crimp, then it is enough, don't put too much solder on, it won't fit in the plug if it is overdone.



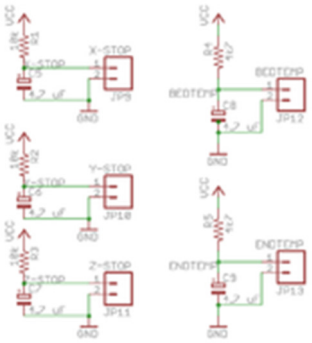
- This is what it should look like when done.
- Repeat the process for all four pins just to be sure that I do not come back in the middle of a print.



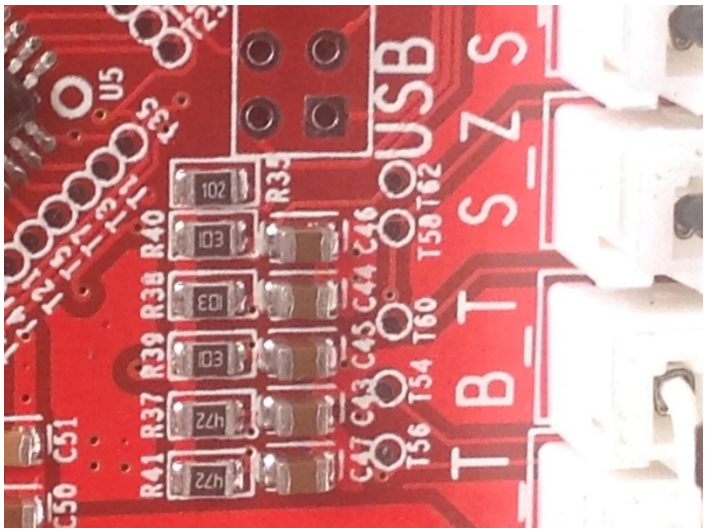
- Reconnect the plugs and power on the printer, you should now have valid temperature readings.

Bad or wrong temperature reading

- Poor connection is one cause, and it need to be cured as above.
- Second thing, measure the sensor for right size, @25 degrees it should be 100kohm, there has been some cases when the sensor shipped was wrong…
- Third thing, bad soldering on the controller board, possibly around the pullup resistor or the 4,7Uf capacitor that is connecter across the plug pins



- Visually check for short or bad soldering. Or just re-solder both the black resistor and the brown capacitor. The bottom resistor R41 and cap C47 goes to the nozzle, and the second resistor R37 and cap C43 from the bottom goes to the bed.



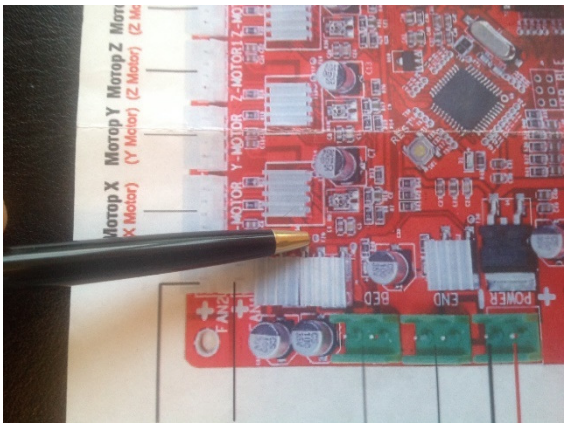
Chapter 3. Heating problem

There can be a number of different heating problems

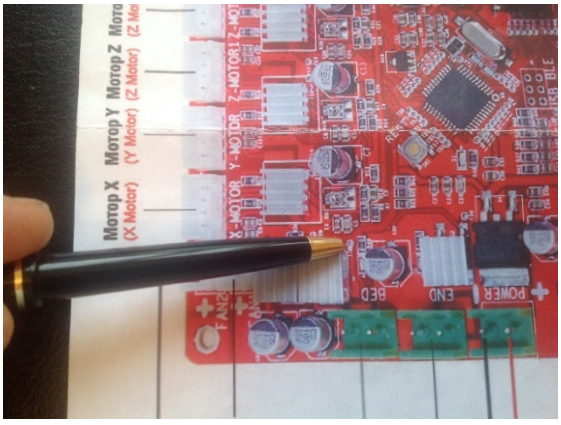
1. Not heating at all
    - Check the cabling to the heaters
    - Check the resistance to on the heaters, the bed heater should have a resistance of about 1,2 ohms, the nozzle heater should have a resistance of 3,6 ohms.
    - Check when turning on the bed or heater manually from printer “Quick Settings” preheat menu or Extruder menu. That you have 12V on the heater plug on the controller.
    - If the led for bed heater or led for nozzle heater comes on but you don’t get 12V over the heater connector on your controller, the board is bad and you need a replacement.

2. Runaway temperature
    - The heater wires to nozzle and bed might be swopped.
    - The thermistors to nozzle and bed might be swopped.
    - If you have 12V on the heater connectors on the controller, even when no heating is turned on, the board is bad and you need a replacement.

3. Insufficient temperature
    - If the bed resistance is more than 1,2 ohm and nozzle heater resistance is more than 3,6 ohms. 12V from the power supply might not be enough. In that case, turn up the voltage on the power supply, the potentiometer is to the right of the terminal screws. You can adjust the voltage between 10,5 – 14,5 V. if you need to go over 13V I recommend you to put a cooling fan on the controller and power supply to prevent overheating.



Bed heater led



Nozzle heater led

Chapter 4. X, Y or Z-axis switches not sensed

1. Double check the wiring, so that right switch is connected to right axis.

2. Switch trouble shooting, Disconnect the switch plug, measure with multimeter between the pins in the plug, does the resistance changes when switch is activated? if not the switch might be bad or the cable crimp might be bad, else replace the switch.

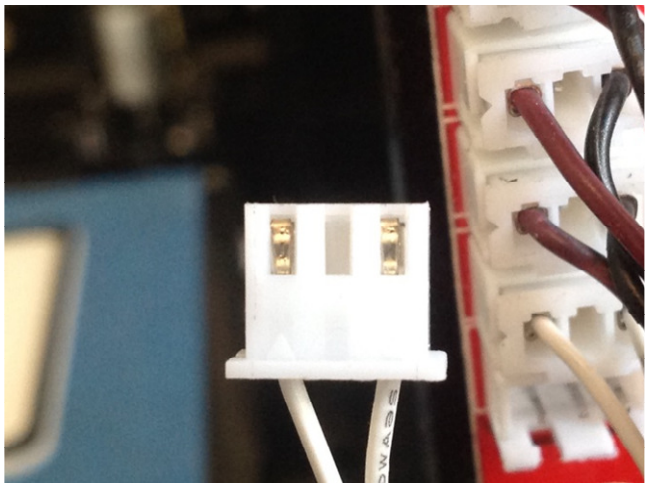
How to test the switch w/o multimeter

- Go to printer “Position” menu
- Chose X, Y or Z “Pos. FAST”, if the switch is not pressed it should read “OFF”.

- When switch is pressed it should read “ON”

How to solder the connector pins

- Take out the plug from the controller PCB and turn it so you can see the slots on the side.



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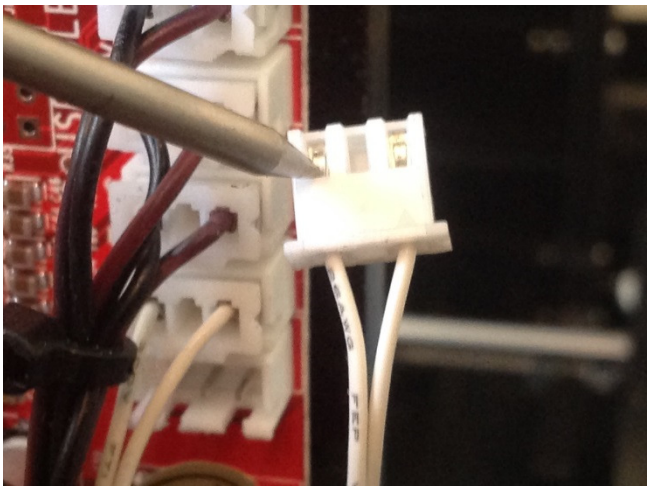
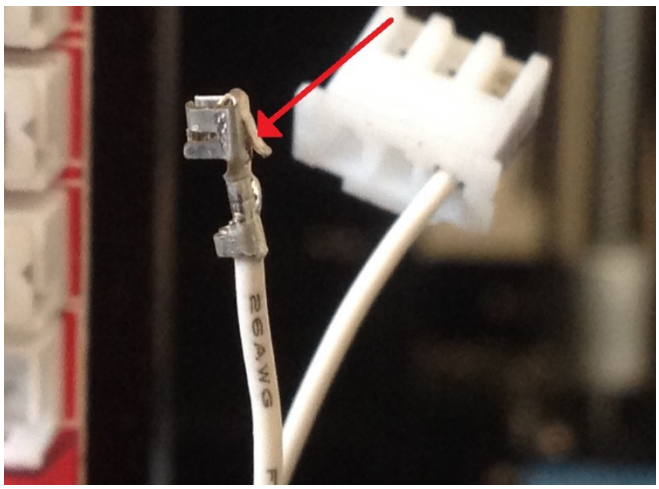
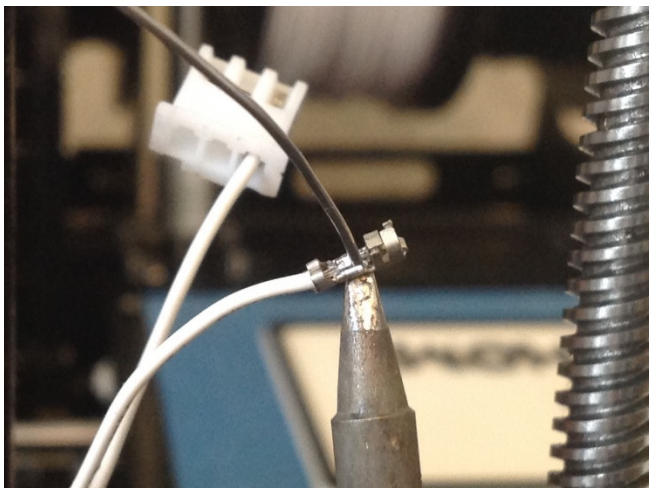


- This is the tongue to be pressed

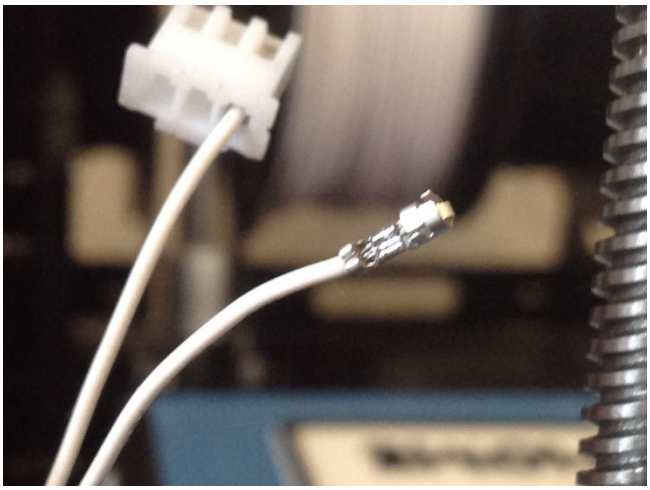


- To solder it, put the soldering iron from the same side where the tongue is, right under the crimp.

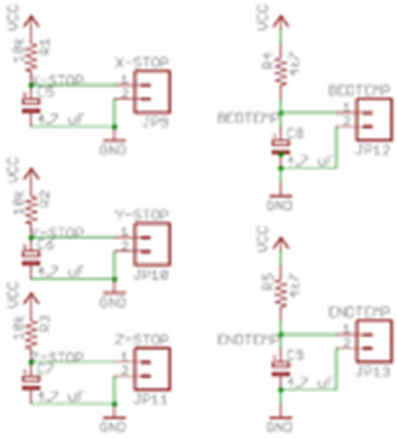
  Allow to heat up for about 3-4 sec. then apply just a little bit of solder, you see when it floats out on the crimp, then it is enough, don't put too much solder on, it won't fit in the plug if it is overdone.



- This is what it should look like when done.



3. If the switch and connector is ok, but still active all the time it might be bad soldered components or short circuit on the board, possibly around the pullup resistor or the 4,7Uf capacitor that is connecter across the plug pins

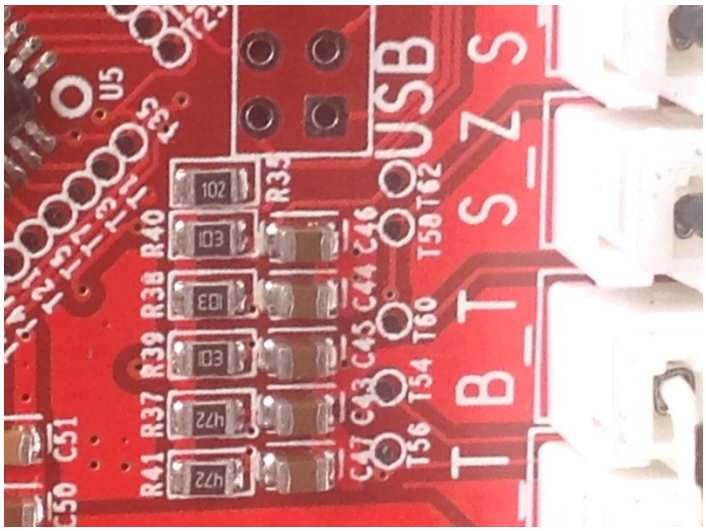


- Visually check for short or bad soldering.
- Sometimes it is enough to re solder both the black resistor and the brown capacitor.
- Sometimes there is solder bridges under the components and they need to be removed and cleaned before re soldered.

  X-axis, Resistor R40 and cap C46.

  Y-axis, Resistor R38 and cap C44

  Z-axis, Resistor R39 and cap C45



Chapter 5. Leaking nozzle or throat tube

1. Remember to turn on the heat before trying to unscrew the nozzle or throat tube, old filament work as glue and you will most likely break off the throat tube or nozzle.

2. The right way of fixing the leak on top of the heater block is to unscrew the nozzle

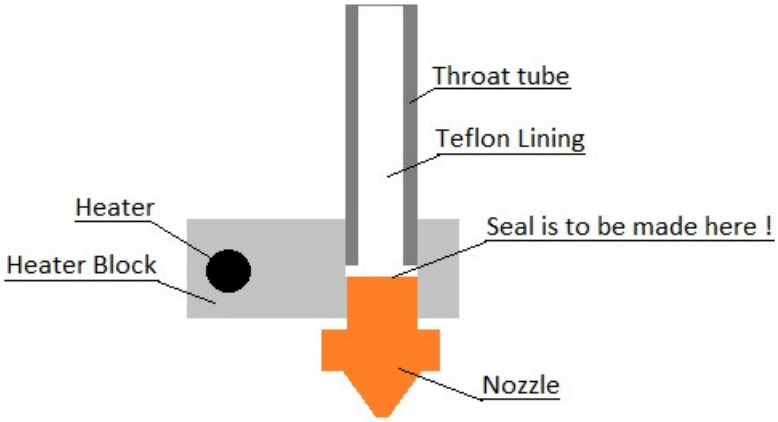
   1-2mm

   screw in the throat tube so that it touches the nozzle, make sure that the end of the nozzle is flat and the throat tube lining is intact.

   tighten the nozzle again so it makes a good seal against the throat tube inside the heater block.

4. If for some reason the seal is not holding, you can always use plumbers Teflon thread seal tape around the tip of the throat tube.

5. When fixing the throat tube to the extruder, do not overtighten the nut, the material is very thin and will snap if overtightened.



Chapter 6. X- and Y-axis Belt Tension

It is quite important to have right tension on the belts, too lose you will see "ringing" artefacts on the side of your prints, or you can see that the layers are not printed exactly on top of each other and the sides looks "wrinkled"

If the belts are too tight you will get stiff axes with too much motion resistance, in worst case the motors start to skip steps. Or the frame of the printer becomes bent.

The easy way of getting the right belt tension

The rule of “thump”

- Slide the bed or extruder carriage all the way to one end.
- Tap the belt.
- If the belt is silent it is too loose.
- If the belt sound a short “thump” it is correct.
- If the belt give a low tone it is too thght.

The accurate way

The most accurate way of telling the tension on a drive belt is to measure the resonance frequency of the belt. Just tap the belt and you hear a tone. that tone can be measured.

Belt manufacturer recommend static tension of 20-27 N for G2T belt (Reinforced Neoprene) in these applications.
I will show the calculation based on the lower number.

f= frequency in HZ
M= belt mass constant for G2T belt 4.1 g/m
W= belt with 5 mm
S= belt span, x-axis 425mm, y-axis 320mm
T= desired belt tension 20N

Formula:

f=sqrt(T/(4*M*W*S^2*10^-9))

That gives for x-axis 11.6 Hz
And for y-axis 15Hz

If you can't measure that low frequency, measure a shorter distance.

Adjust the bed or extruder to any position and take the "S" measurement between the belt attachment and support roll where the belt touch (or motor drive wheel).

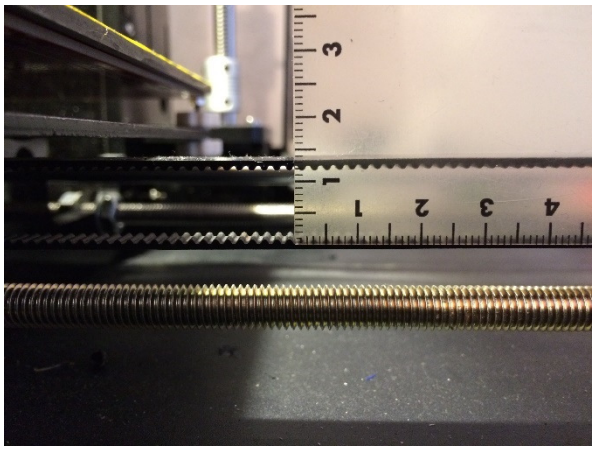
If you don't have a belt tension meter as Gates 508c you can do as follows…

The fiddeling way…

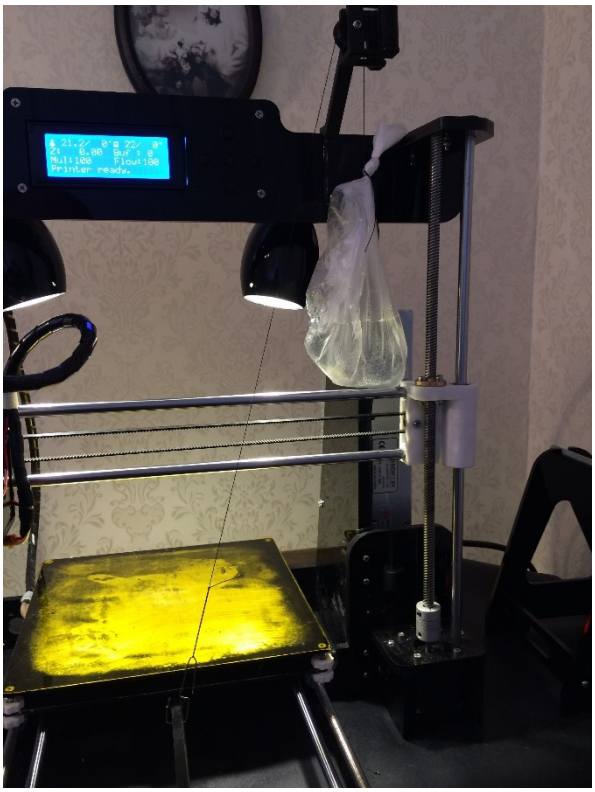
Fill a plastic bag with 1dl of water and tie it off to get a 100g load. Or use a 100g load of your choice.

For Y-axis belt tension:

Measure the distance between the belts, in my case 11mm

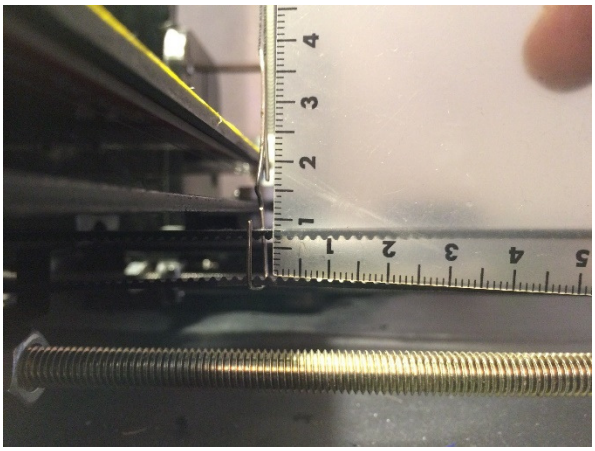


Then make a hook, I used a paperclip, and hook it around the lower belt. Suspend the weight in a string over something, I used my filament guide roll, the string is not 100% straight but it is close enough.



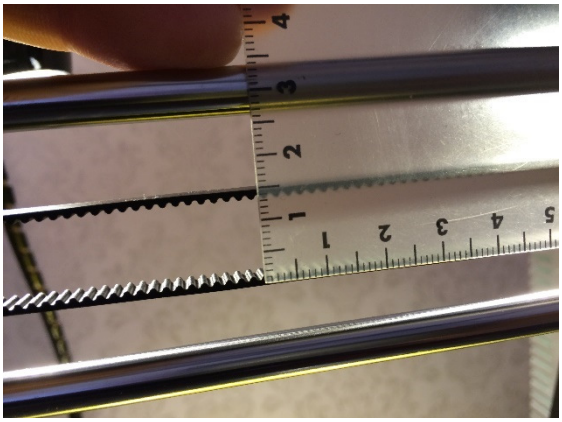
Measure again, I got 7mm, calculate the difference 11 - 7 = 4mm

4mm equals ~20N, if you don't get 4mm deflection adjust your belt tension and measure again.



For X-axis belt tension:

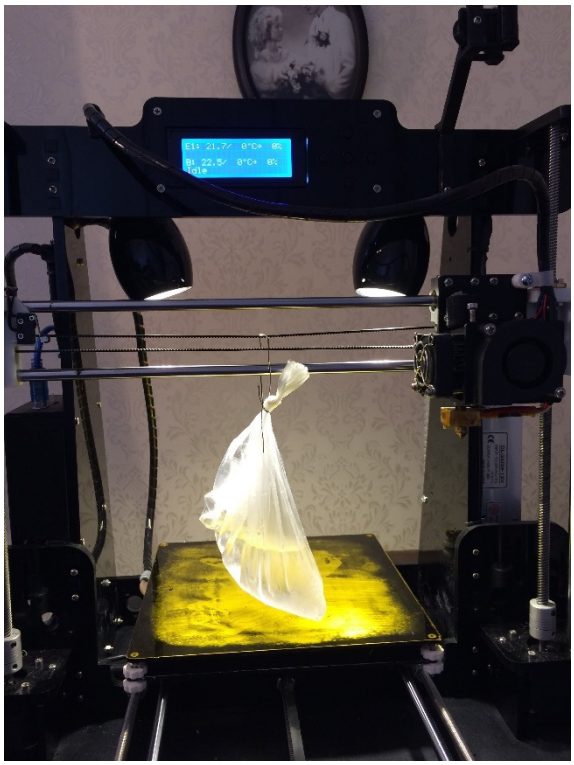
Measure the distance between the belts in my case 12mm



Rise the z-axis so your weight can hang from the belt w/o touching the bed.

Slide the extruder fully to the right.

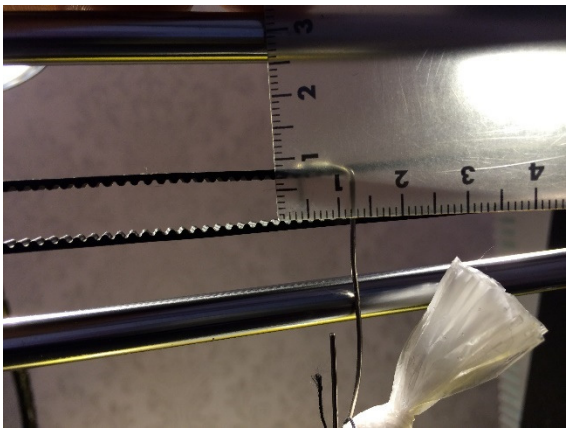
Hook the weight on the upper belt.



Measure again, I got 7mm, calculate the difference 12 – 7 = 5mm

5mm equals ~20N, if you don't get 5mm deflection adjust your belt tension and measure again.

Notice, the belt span on X-axis is longer (425mm) than Y-axis (320mm) that is why belt deflection is bigger on X-axis for the same tension.



Chapter 7. Z-axis fine adjustment and bed leveling

1. Clean nozzle from any remains of filament.

2. Make sure that Left and Right side is at the same height, measure between horizontal guide bar and z-motor mount. A credit card works as well, put it between the horizontal guide bar and motor mount and turn motor shafts by hand until the guide bar touch the card.

3. Power on the printer, from Position menu, Home z-axis, the nozzle should now be in the same height as bed +/- 1mm, if not realign z-axis micro switch.

4. From Extruder menu, heat the bed to 70 degrees. (Or the bed temp you are going to use)

5. If you plan to print on masking tape, put it on now.

6. When bed reach 70 degrees turn printer off to be able to move the bed and extruder manually.

7. Adjust bed screws so a double folded piece of paper, or a 0.1mm feeler gauge, can slide with some resistance between nozzle and bed with some resistance in all 4 corners.

Chapter 8. Printer USB connection (windows)

How to setup printer communication over USB

1. Download and install “CH340G.zip”, on your computer.
   The files “the BIG troubleshooting file bundle” can be downloaded from “file section” on the “Official Anet 3D Printer” Facebook group.

2. Connect USB cable between printer and computer and turn on the printer.

3. On your computer, go to: Computer Management, Device manager, Ports (Com&Lpt) Look for “USB to serial device” Note the com port number.

4. Go to your software of use (Cura 15.04, Repetier Host, etc.) In the communication settings set the comport number you detected in device manager. Set the Baud rate to 115200

5. In the printer Configuration menu, check that the baud rate is set to the same as in your software. The communication should work now.

Troubleshooting

1. If the communication is still not working, try to lower the baud rate in the software and printer a couple of steps, make sure it is set to the same speed on both places.

2. If you still not have communication, try to replace the USB cable.

3. If it still not works, try to use a USB1 or USB2 port.

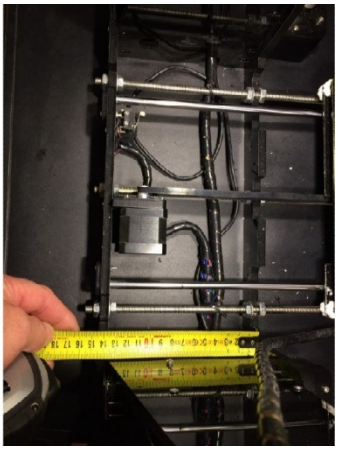
4. If it still not works, try to use another computer with Win7.

5. If it still doesn’t work, you might have a faulty controller board, contact the seller for replacement.

Chapter 9. Making the printer square

1. Measure left and right front to midsection, if the numbers are different loosen the nuts and make them exactly the same.

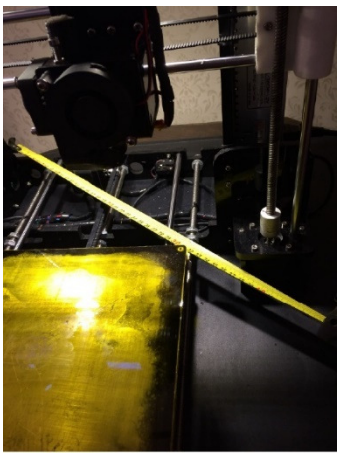

2. Measure left and right back to midsection, if the numbers are different loosen the nuts and make them exactly the same.

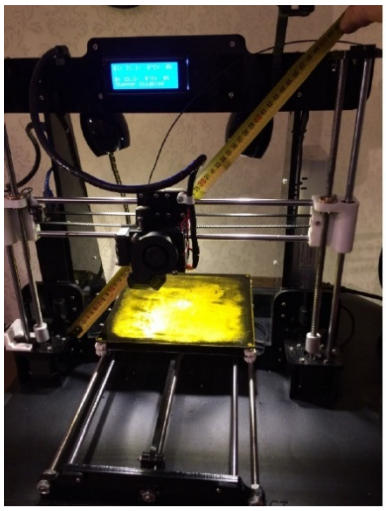
3. Cross measure right back to left front.
   Measure from the frame back corner to corner of motor mount and note the number.

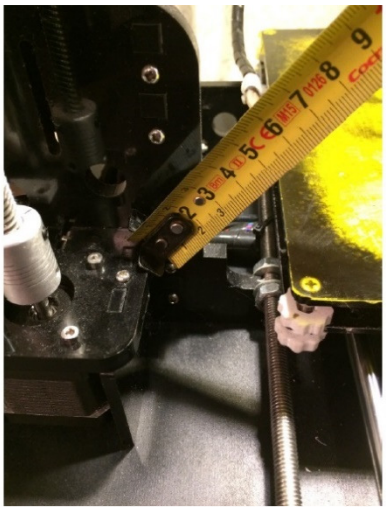


4. Cross measure from left back frame corner to right front motor mount, compare the number with measurement in point 3.
   If there are different numbers, loosen the nuts so you can force the frame straight and then tighten the nuts.

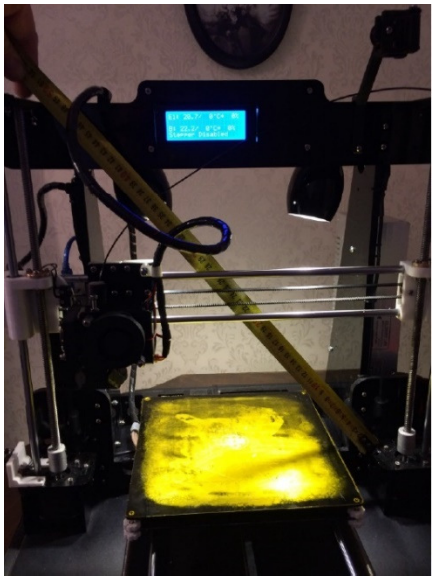


5. Cross measure also from left bottom to right top
   Measure from motor mount corner to top frame corner and note the number.

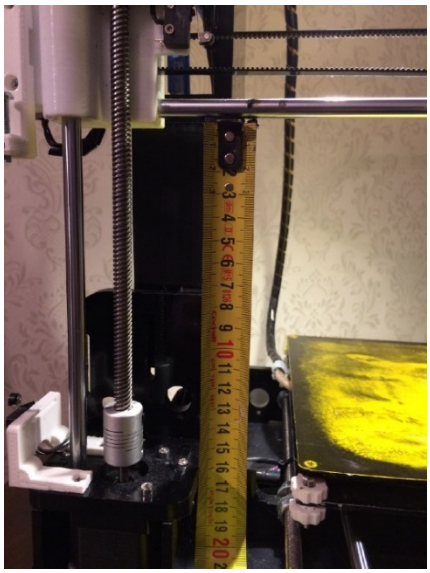




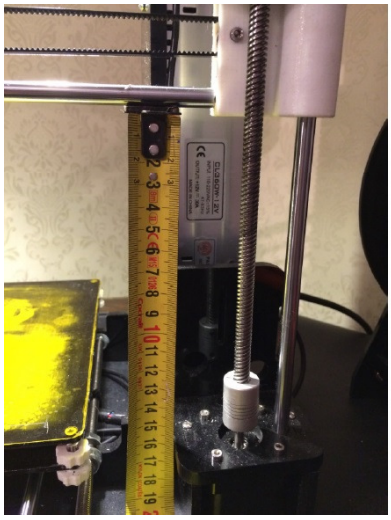
6. Cross measure from right motor mount to left top frame corner, compare the number with measurement in point 5.
If there are different numbers, loosen the 3mm frame screws so you can force the frame straight and then tighten the screws.

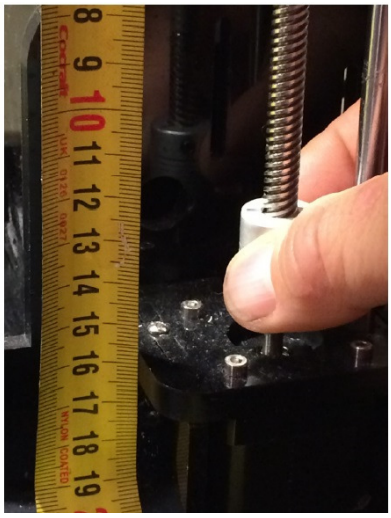


7. To make sure that x-axis guide bars are leveled to the frame (do not use water level)
Measure from left motor mount to the guide bar, note the measurement.



8. Measure from right motor mount to the guide bar, compare the numbers with measurement in point 7. If they differ just turn the thread bar until the distance is the same on both sides.

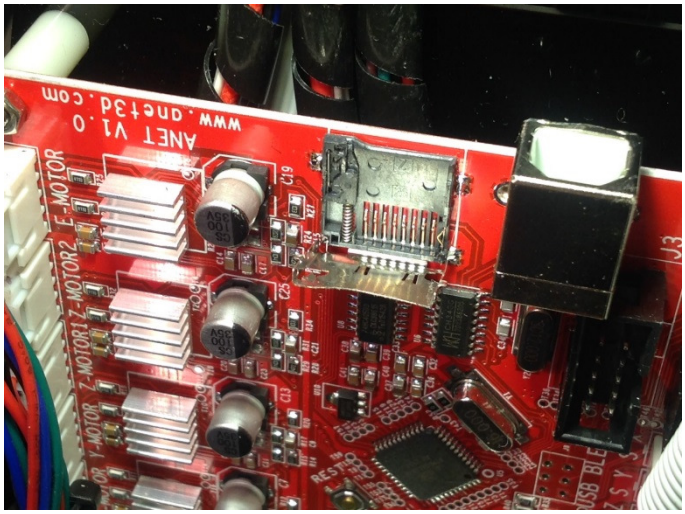




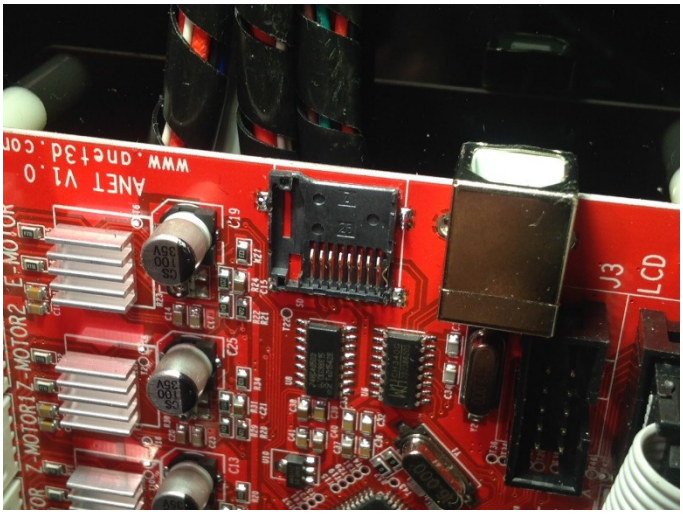
9. After these adjustments, follow “Chapter 6. z-axis fine adjust and bed leveling” and you are back on track!

Chapter 10. Self-ejecting card reader

- Unsolder the metal cover and open the card reader

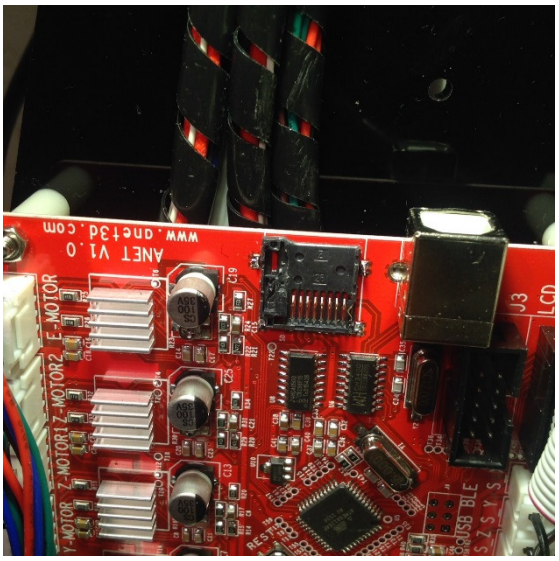


- The ejecting mechanism removed from the left upper corner of the reader.

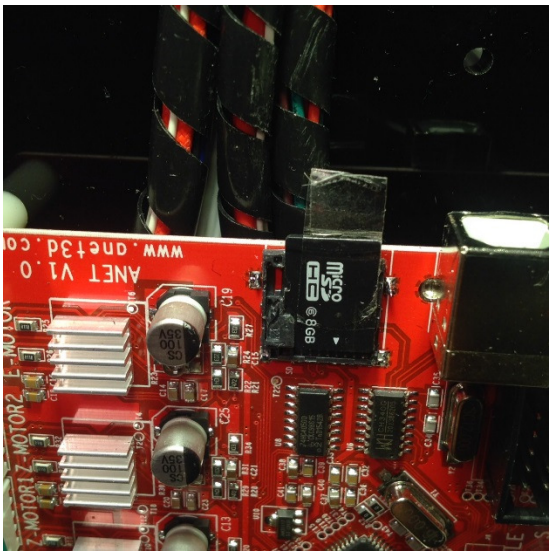


- The removed parts, if it is only the thin wire that got bent out of shape, try to straighten it and put it back together.
  If the narrow slot in the plastic is damaged follow this guide.

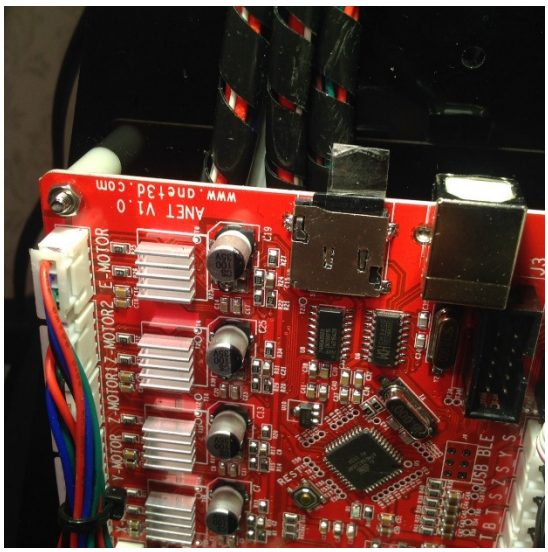
- Glue the plastic guide to the card reader lower left corner, I used hot glue. Don’t put the spring and thin wire in.



- Test that the card aligns properly in the reader



- Resolder the reader metal cover, I also put a piece of tape on the card to get a better grip when pulling it out.

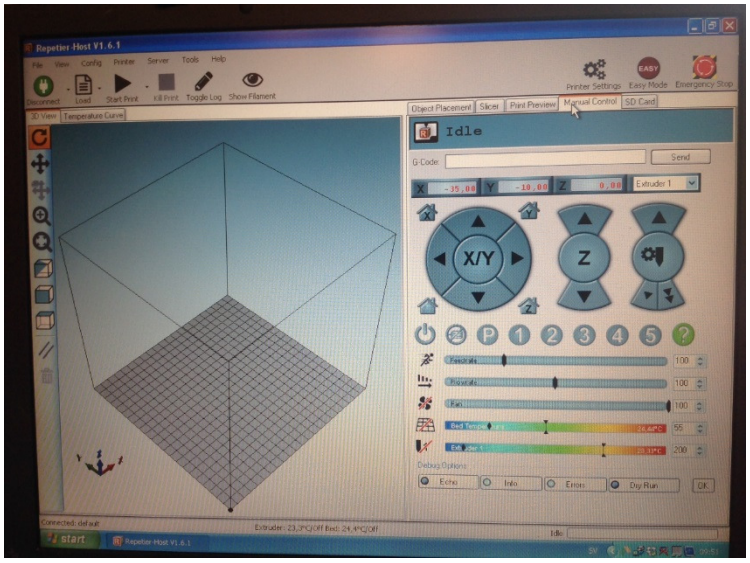


Chapter 11. Print area adjustment using Repetier Host v1.6.2

Unfortunately, this works only on the older versions of original firmware from before June 2016

- Download and install Repetier Host on your computer, make sure you can connect and communicate with your printer. (It is important to use the right version of Repetier Host, since different versions show different set of EEprom data)

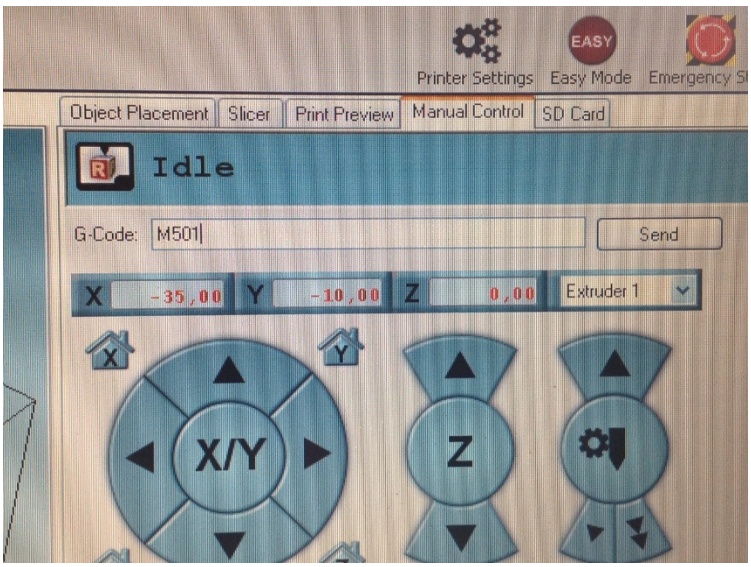
  Repetier Host v1.6.2 you can find in “the BIG troubleshooting file bundle” it can be downloaded from “file section” on the “Official Anet 3D Printer” Facebook group.



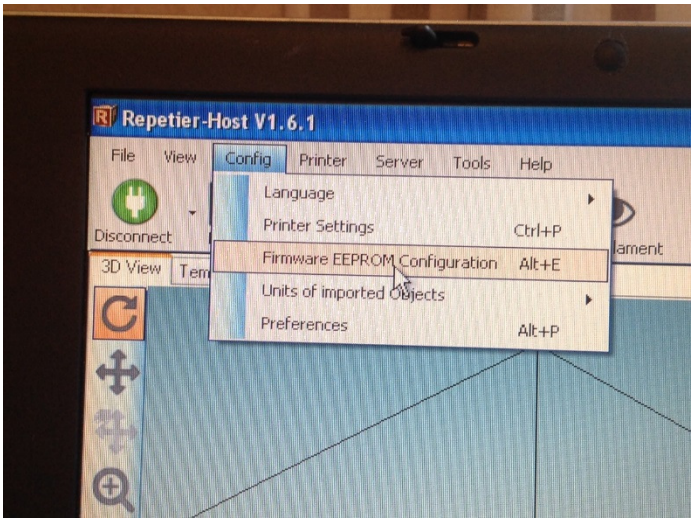
- Pre adjustments on printer. Home X and Y axis from printer menu, go to Position menu and drive with “Fast” commands X and Y axis to 0.0 position. If the nozzle is not right at the edge of hotbed, move X and Y micro switches (drill new holes for the screws) and home again until X and Y 0.0 position is right on the edge of the hotbed.

- Press Connect in Repetier SW to connect to the printer

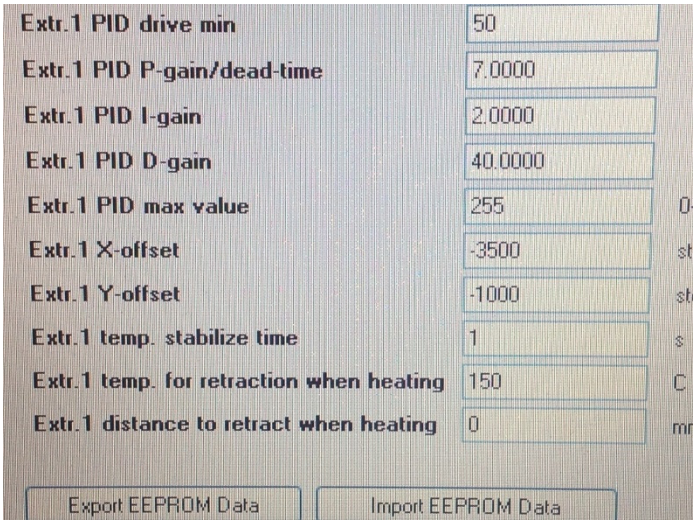
- Go to Manual Control tab, and write “M501” in G-code window, press Send to load Printer EEPROM settings to Repetier Host.



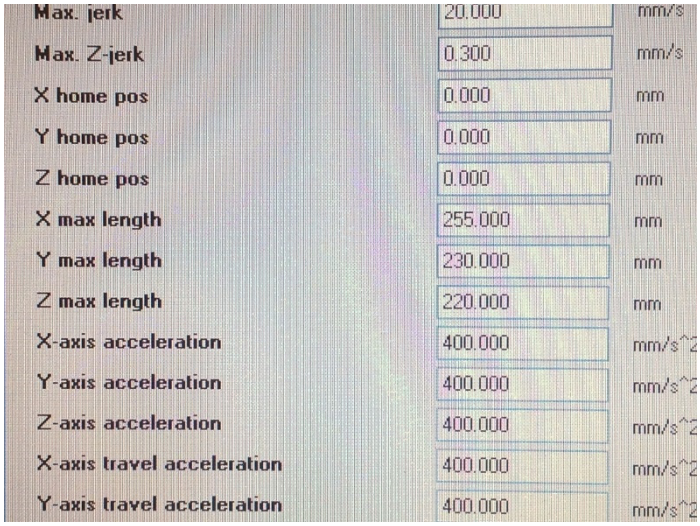
- Under Config, Choose “firmware EEPROM Configuration”



- Check settings for “Extr.1 X Offset” and “Extr.1 X Offset” for x -3500 means 0.0 position is 35mm from home switch and for y -1000 means 0.0 position is 10mm from home switch.

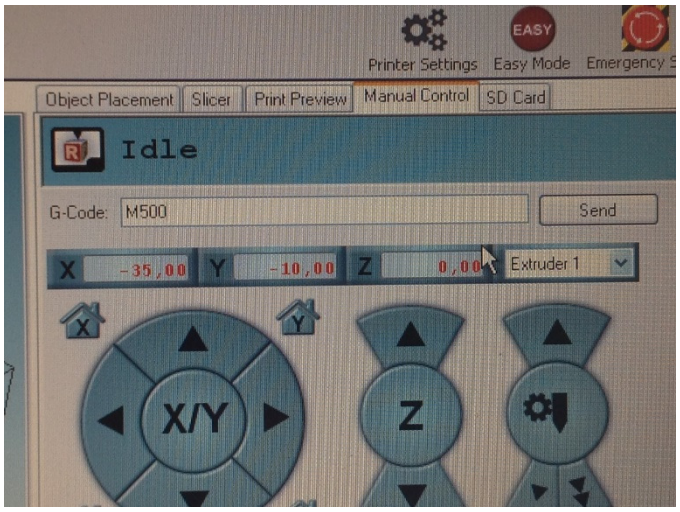


- Set print size by entering new values.
  If the x offset was 35mm you need to calculate (for bed size 220mm) 35+220 = 255.
  And enter in “X max length” 255.
  If the y offset was 10mm you need to calculate (for bed size 220mm) 10+220 = 230.
  And enter in “Y max length” 255.
  For “Z max length” 220 if that is your travel range.



- In “Firmware EEprom settings” window you can Export EEPROM data to a file for future use or reconfiguration.

- In Manual Control Tab Write “M500” in G-Code window and press “Send” to upload you new settings to printer EEPROM.



- On Printer go to Configuration Menu, chose “Load f. EEPROM” to activate you new settings.

Now you should be able to use and print on your whole hotbed print area.

Capter12. Settings for Cura 14.07 and 15.04

You will find Cura 15.04.06 in “the BIG troubleshooting file bundle”, it can be downloaded from “file section” on the official Anet 3D Printer” Facebook group.

In that file you also find the Cura profile files

In Cura, go to "File"

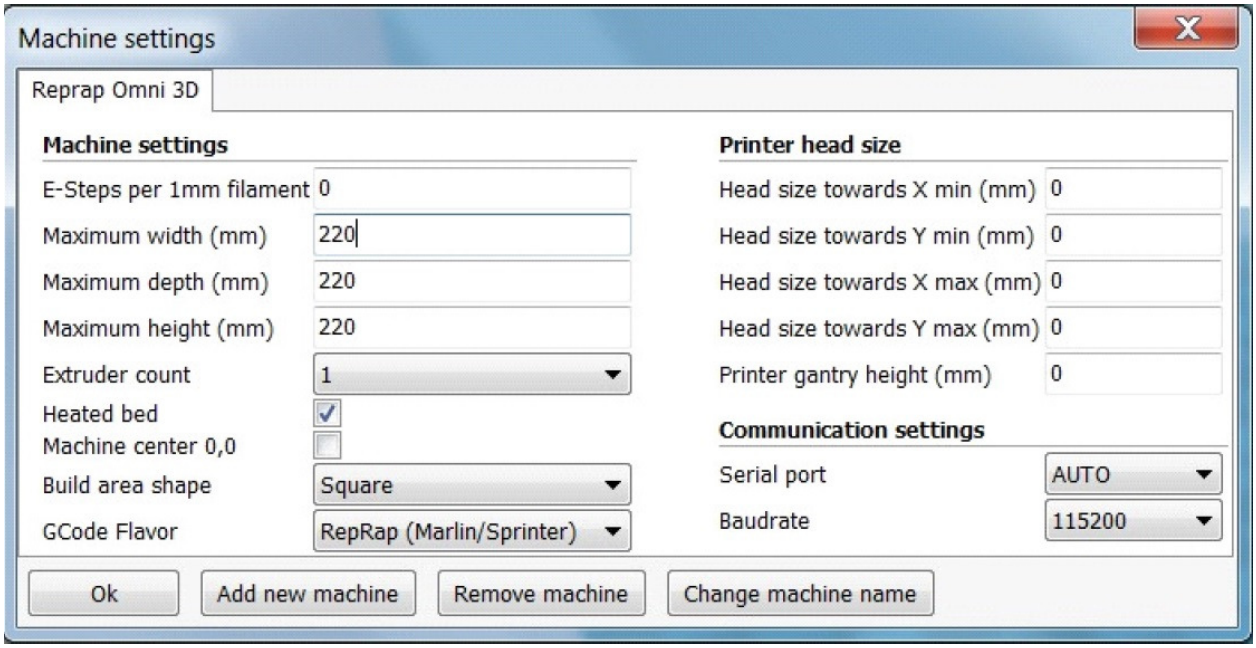
Select "Open Profile..."

browse to where the ini file is located, chose either the PLA or ABS file you downloaded from the bundle file.

The "machine settings" only needs to be set once

In Cura go to "Machine"

choose "machine settings" and put these values in manually.

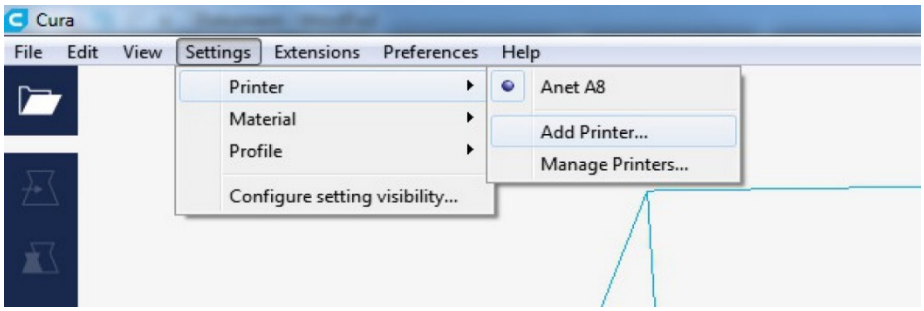


Chapter 13. Settings for Cura 2.3.1

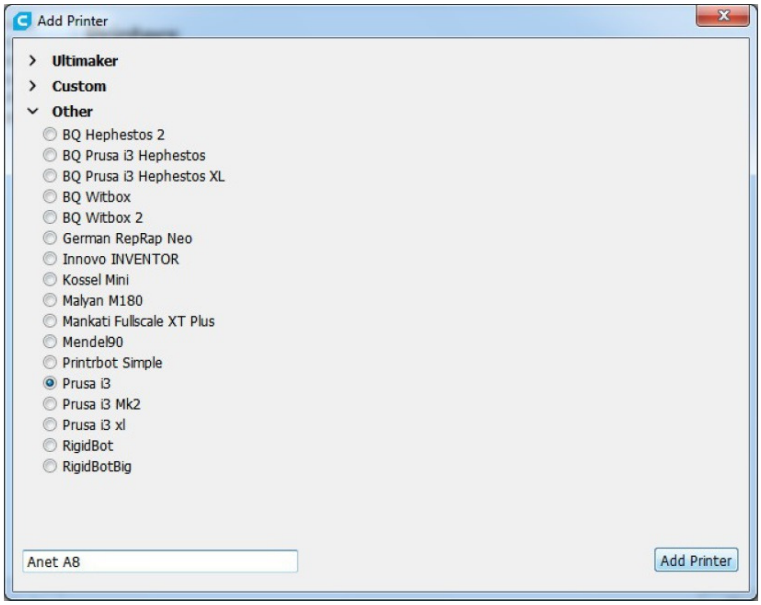
You will find Cura 2.3.1 in “the BIG troubleshooting file bundle”, it can be downloaded from “file section” on the official Anet 3D Printer” Facebook group.

In that file you also find the Cura 2.3.1 profile files.

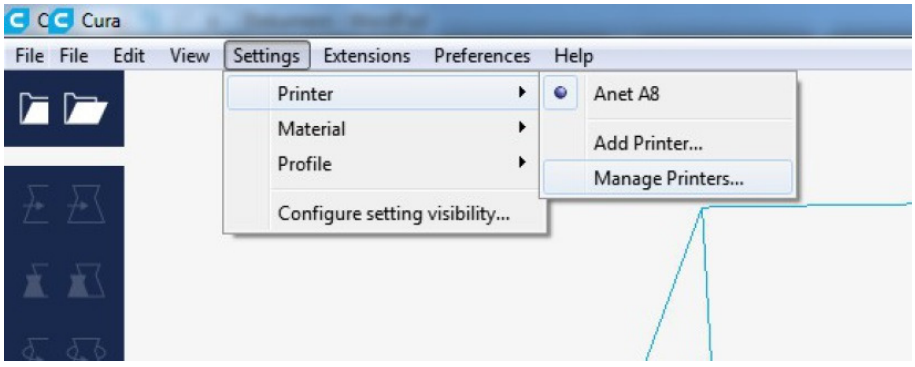
Go to settings
Choose "Printer"
Choose "Add Printer"



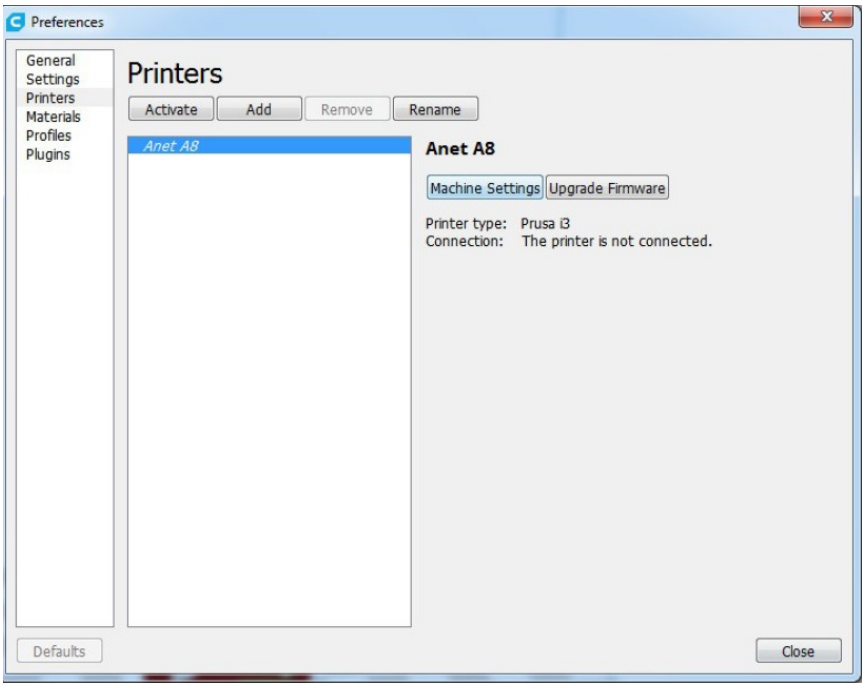
Go to "Other"
Choose "Prusa i3"
Name the printer
Click on "Add the printer"



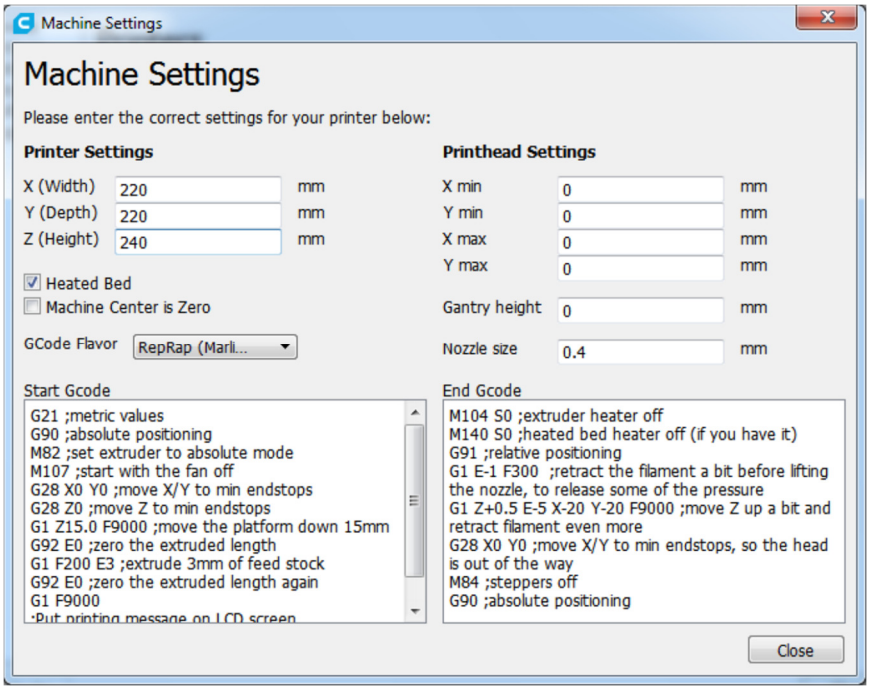
Go to settings
Choose "Printer"
Choose "Manage Printers"



Select the printer you just created and press on "Activate"
Click on Machine settings

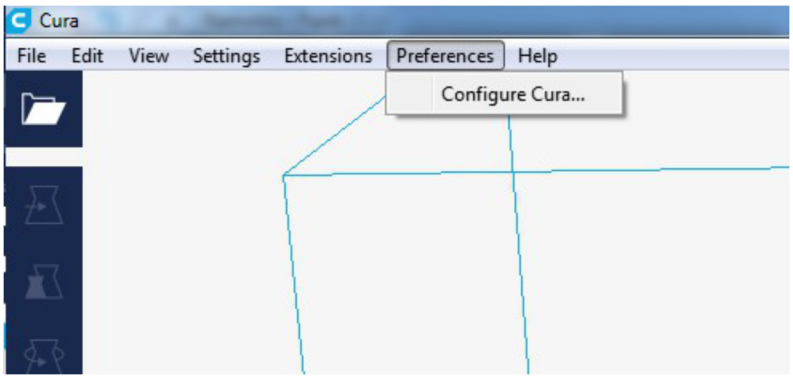


Set the numbers and checkboxes according to the picture above
when done press on "Close"

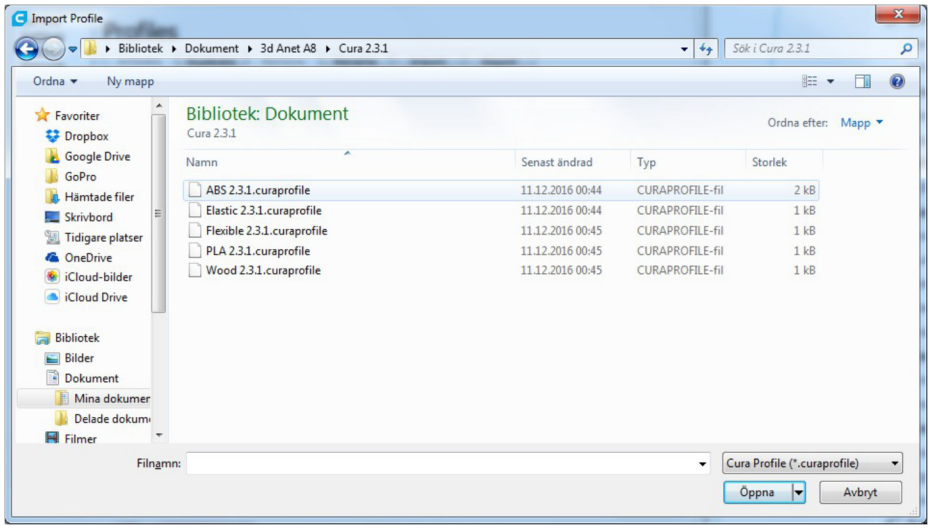


How import Cura Profile files to Cura 2.3.1

Choose "Preferences"
Select "Configure Cura"

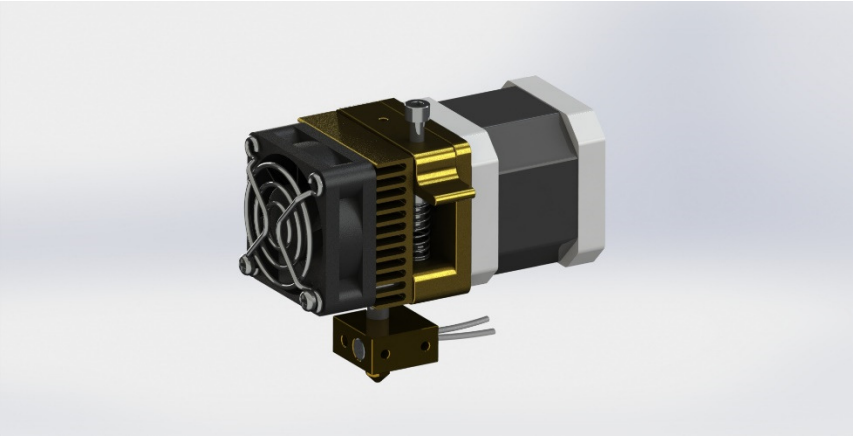


Select "Profiles"
Chose "Import"
Select the Cura 2.3.1 profile files that you just downloaded

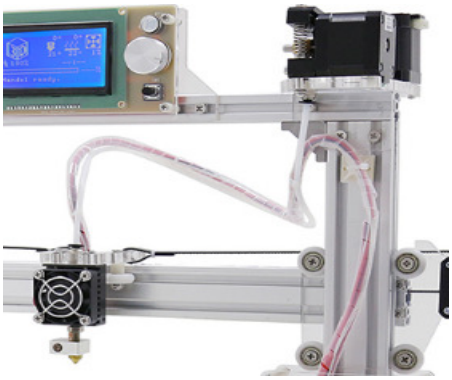


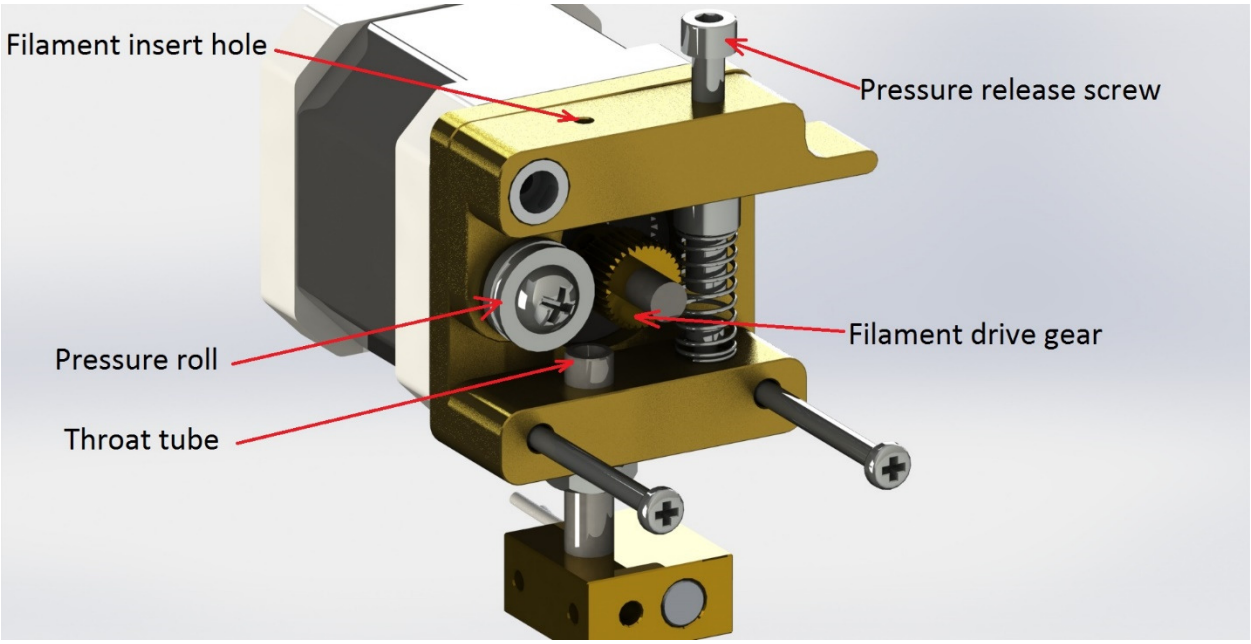
Chapter 14. How to load filament

Anet A6 and A8 is using MK8 direct extruders



Anet A2 is using the same extruder but with Bowden setup.





How to remove old filament

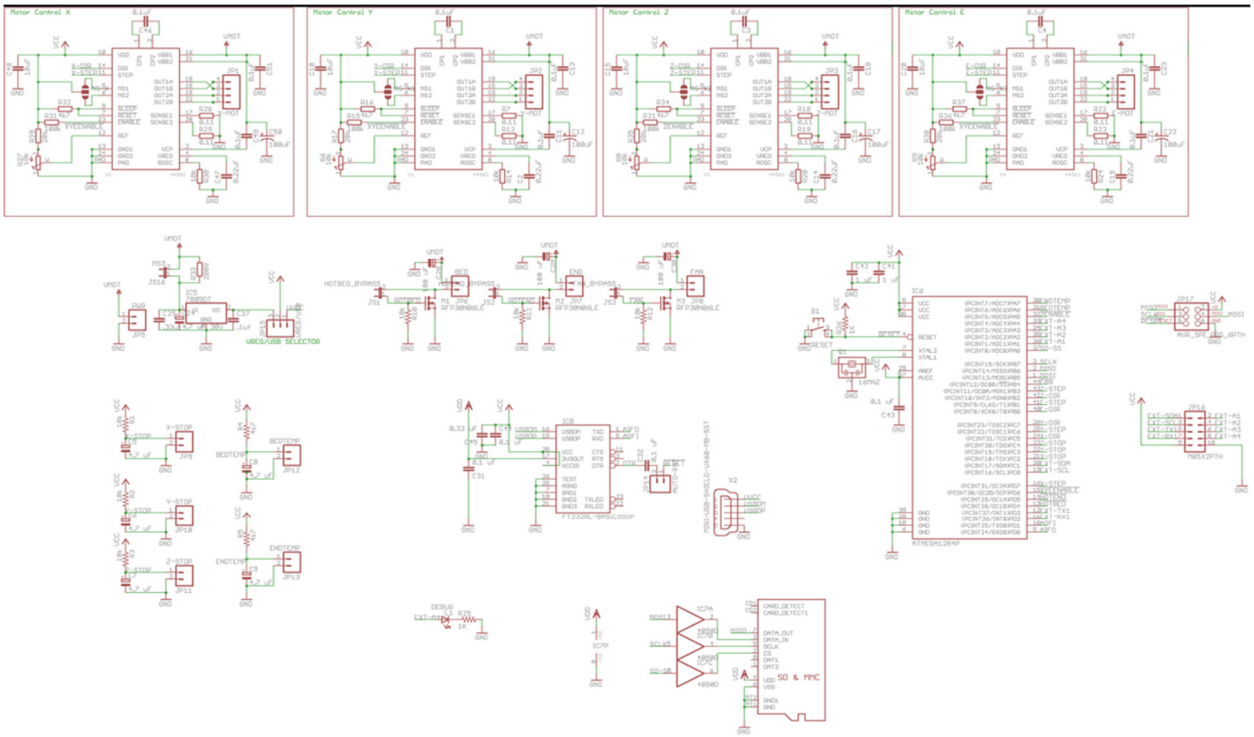
When removing old filament always heat the nozzle, if heating it to about 2/3 of normal temperature for that filament it usually pulls out all old melted filament with it, else if changing color, the new color will be contaminated with old color until everything is out.

1. Heat the nozzle to 2/3 of temperature for the filament from extruder menu on the printer.
2. Support the extruder carriage with 2 fingers from beneath, press and hold the pressure release screw with your thumb to release the pressure roll.
3. Pull out the old filament and secure it on the filament roll so it doesn't tangle.

How to insert new filament

1. Prepare the new filament.
   Straighten at least 5cm of the filament.
   Cut off melted "blobs" from the end.
   If cutting it in 45 degrees angle it is easier to insert.
2. Heat the nozzle to right temperature for the filament
3. Support the extruder carriage with 2 fingers from beneath, press and hold the pressure release screw with your thumb to release the pressure roll.
4. Insert the filament trough the top, it should go in easy 25mm, then it most likely hit the throat tube.
5. Wiggle the filament a bit so it finds the throat tube, then it should go in another 20mm.
6. Continue to feed the filament until melted filament is coming oit trough the nozzle.
7. Release the Pressure release screw and turn off the nozzle heat

Appendix 1 Controller schematics



OBS! Component numbering might be wrong, but connection is the same.

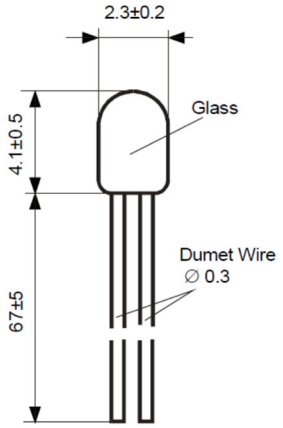
Appendix 2 Thermistor data sheet

EPCOS

Electronic Parts and Components

DATA SHEET NTC G560/100k/+

Application
Temperature measurement
for high temperature and
short response times.



Dimensions in [mm]

Version
NTC-thermistor sealed in glass body.

Dumet wires:	∅ 0.3 mm
lead length:	67 ± 5 mm
headdiameter:	2.3 ± 0.2 mm
headlength:	4.1 ± 0.5 mm

Data

Climatic Category (IEC 60068-1)		:	**55/300/56**
Lower category temperature		[°C] :	**-55**
Upper category temperature		[°C] :	**300**
Rated resistance R_N // Tolerance $\Delta R/R$	R_N	[Ω // %] :	**100 000 // ± 1)**
Rated temperature	T_N	[°C] :	**25**
B-value : $B_{(0/100)}$ // Tolerance $\Delta B/B$	B_N	[K//%]:	**4036 // ± 1**
R_{25}		[Ω]:	**100 000**
Dissipation factor (air)	δ_{th}	[mW/K] :	**approx. 1.3**
Thermal time constant (air)	τ_C	[s] :	**approx. 15**
Heat capacity	C_{th}	[mJ/K] :	**approx. 20**

Ordering code : **B57560G104+**

Remarks

1) +: F for $\Delta R/R_N$ = ±1%; standard dumet wires
H for $\Delta R/R_N$ = ±3%; standard dumet wires
F2 for $\Delta R/R_N$ = ±1%; dumet wires, Ni-plated
H2 for $\Delta R/R_N$ = ±3%; dumet wires, Ni-plated

				DATENBLATT / DATA SHEET	
				HEISSLEITER / NTC	
a		25.09.01		B57560G104+	Bl./Page 2
Ausg. Issue	Mitteilung Info No.	Datum Date	Name Sign		

Resistance Temperature Characteristics

R at 25°C 100000 [Ω]
B(0/100) 4036 [K] ± 1 [%]
RN at 25 °C 100000 [Ω] ± 1 [%]

T [°C]	R_nom [Ω]	R_min [Ω]	R_max [Ω]	$\Delta R/R_N$ [±%]	ΔT [±°C]	α [%/K]
-55	10723236	10101868	11381685	6,1	0,8	7,7
-50	7366689	6968648	7786687	5,7	0,8	7,4
-45	5132757	4874705	5403929	5,3	0,7	7,1
-40	3624165	3455040	3801187	4,9	0,7	6,9
-35	2591304	2479373	2708016	4,5	0,7	6,6
-30	1874913	1800190	1952543	4,1	0,6	6,4
-25	1371886	1321623	1423918	3,8	0,6	6,2
-20	1014545	980519	1049646	3,5	0,6	5,9
-15	757881	734728	781685	3,1	0,5	5,8
-10	571590	555777	587794	2,8	0,5	5,6
-5	435026	424202	446081	2,5	0,5	5,4
0	333964	326553	341508	2,3	0,4	5,2
5	258497	253434	263636	2,0	0,4	5,1
10	201659	198216	205142	1,7	0,4	4,9
15	158499	156178	160838	1,5	0,3	4,8
20	125468	123927	127016	1,2	0,3	4,6
25	**100000**	**99000**	**101000**	**1,0**	**0,2**	**4,5**
30	80223	79243	81206	1,2	0,3	4,4
35	64759	63830	65695	1,4	0,3	4,2
40	52589	51727	53460	1,7	0,4	4,1
45	42951	42161	43751	1,9	0,5	4,0
50	35272	34556	36000	2,1	0,5	3,9
55	29119	28473	29776	2,3	0,6	3,8
60	24161	23581	24752	2,4	0,7	3,7
65	20144	19626	20674	2,6	0,7	3,6
70	16874	16411	17348	2,8	0,8	3,5
75	14198	13786	14622	3,0	0,9	3,4
80	11998	11631	12376	3,2	0,9	3,3
85	10181	9854	10519	3,3	1,0	3,2
90	8674	8382	8976	3,5	1,1	3,2
95	7419	7158	7688	3,6	1,2	3,1
100	6369	6136	6610	3,8	1,3	3,0
105	5487	5279	5703	3,9	1,3	2,9
110	4744	4557	4937	4,1	1,4	2,9
115	4115	3948	4288	4,2	1,5	2,8
120	3581	3431	3737	4,4	1,6	2,8
125	3126	2991	3266	4,5	1,7	2,7

Resistance Temperature Characteristics

R at 25°C 100000 [Ω]
B(0/100) 4036 [K] ± 1 [%]
RN at 25 °C 100000 [Ω] ± 1 [%]

T [°C]	R_nom [Ω]	R_min [Ω]	R_max [Ω]	$\Delta R/R_N$ [±%]	ΔT [±°C]	α [%/K]
130	2737	2616	2864	4,6	1,8	2,6
135	2404	2294	2518	4,8	1,8	2,6
140	2117	2018	2220	4,9	1,9	2,5
145	1869	1780	1963	5,0	2,0	2,5
150	1655	1574	1740	5,1	2,1	2,4
155	1469	1396	1546	5,2	2,2	2,4
160	1307	1241	1377	5,4	2,3	2,3
165	1166	1106	1230	5,5	2,4	2,3
170	1043	987,6	1101	5,6	2,5	2,2
175	934,5	884,1	987,5	5,7	2,6	2,2
180	839,3	793,3	887,8	5,8	2,7	2,1
185	755,4	713,3	799,9	5,9	2,8	2,1
190	681,3	642,8	722,2	6,0	2,9	2,0
195	615,8	580,4	653,3	6,1	3,0	2,0
200	557,6	525,1	592,1	6,2	3,1	2,0
205	505,9	476,0	537,7	6,3	3,3	1,9
210	459,9	432,3	489,2	6,4	3,4	1,9
215	418,8	393,3	445,8	6,5	3,5	1,9
220	382,0	358,5	407,0	6,6	3,6	1,8
225	349,1	327,3	372,2	6,6	3,7	1,8
230	319,5	299,3	341,0	6,7	3,8	1,8
235	292,9	274,2	312,9	6,8	4,0	1,7
240	269,0	251,6	287,5	6,9	4,1	1,7
245	247,3	231,2	264,6	7,0	4,2	1,7
250	227,8	212,8	243,9	7,1	4,3	1,6
255	210,1	196,1	225,1	7,1	4,5	1,6
260	194,1	181,0	208,1	7,2	4,6	1,6
265	179,5	167,3	192,6	7,3	4,7	1,5
270	166,3	154,9	178,5	7,4	4,8	1,5
275	154,2	143,5	165,7	7,4	5,0	1,5
280	143,2	133,2	154,0	7,5	5,1	1,5
285	133,2	123,8	143,2	7,6	5,2	1,4
290	124,0	115,2	133,4	7,6	5,4	1,4
295	115,5	107,3	124,5	7,7	5,5	1,4
300	107,8	100,0	116,2	7,8	5,7	1,4

Resistance Temperature Characteristics

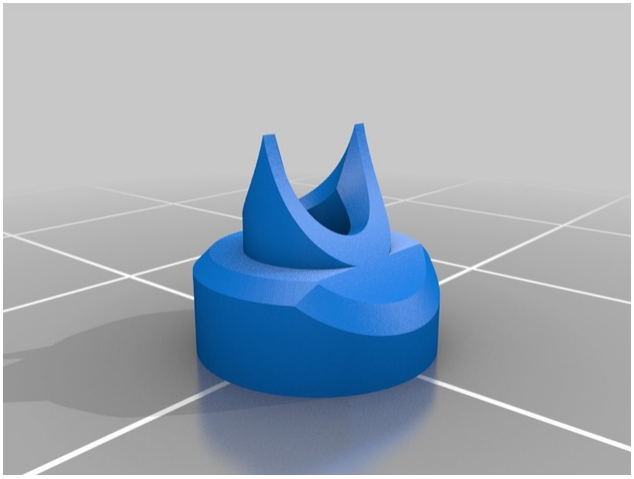
R at 25°C 100000 [Ω]
B(0/100) 4036 [K] ± 1 [%]
RN at 25 °C 100000 [Ω] ± 3 [%]

T [°C]	R_nom [Ω]	R_min [Ω]	R_max [Ω]	$\Delta R/R_N$ [±%]	ΔT [±°C]	α [%/K]
-55	10723236	9897790	11607065	8,2	1,1	7,7
-50	7366689	6827867	7940878	7,8	1,1	7,4
-45	5132757	4776226	5510938	7,4	1,0	7,1
-40	3624165	3385242	3876459	7,0	1,0	6,9
-35	2591304	2429285	2761640	6,6	1,0	6,6
-30	1874913	1763822	1991207	6,2	1,0	6,4
-25	1371886	1294924	1452115	5,8	0,9	6,2
-20	1014545	960710	1070431	5,5	0,9	5,9
-15	757881	719885	797164	5,2	0,9	5,8
-10	571590	544549	599434	4,9	0,9	5,6
-5	435026	415633	454914	4,6	0,8	5,4
0	333964	319956	348271	4,3	0,8	5,2
5	258497	248314	268857	4,0	0,8	5,1
10	201659	194212	209204	3,7	0,8	4,9
15	158499	153023	164023	3,5	0,7	4,8
20	125468	121423	129531	3,2	0,7	4,6
25	**100000**	**97000**	**103000**	**3,0**	**0,7**	**4,5**
30	80223	77642	82814	3,2	0,7	4,4
35	64759	62541	66995	3,5	0,8	4,2
40	52589	50682	54519	3,7	0,9	4,1
45	42951	41310	44618	3,9	1,0	4,0
50	35272	33858	36713	4,1	1,0	3,9
55	29119	27898	30366	4,3	1,1	3,8
60	24161	23105	25242	4,5	1,2	3,7
65	20144	19230	21084	4,7	1,3	3,6
70	16874	16080	17692	4,8	1,4	3,5
75	14198	13507	14911	5,0	1,5	3,4
80	11998	11396	12622	5,2	1,6	3,3
85	10181	9655	10727	5,4	1,7	3,2
90	8674	8213	9154	5,5	1,7	3,2
95	7419	7013	7841	5,7	1,8	3,1
100	6369	6012	6741	5,8	1,9	3,0
105	5487	5172	5816	6,0	2,0	2,9
110	4744	4465	5035	6,1	2,1	2,9
115	4115	3868	4373	6,3	2,2	2,8
120	3581	3362	3811	6,4	2,3	2,8
125	3126	2931	3331	6,6	2,4	2,7

Appendix 3. Upgrade parts on Thingiverse.com

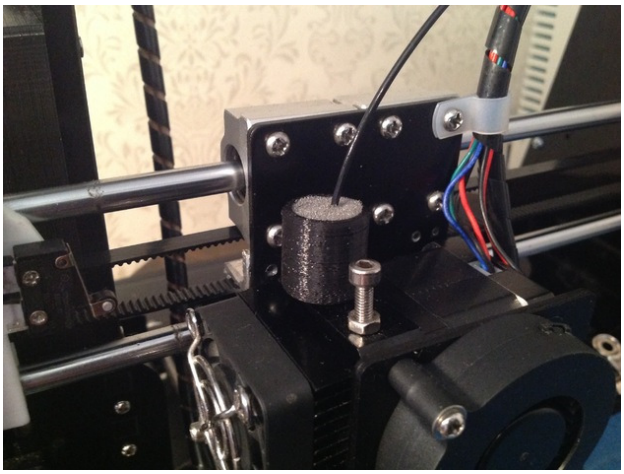
Filament guide for soft filaments

http://www.thingiverse.com/thing:1978036



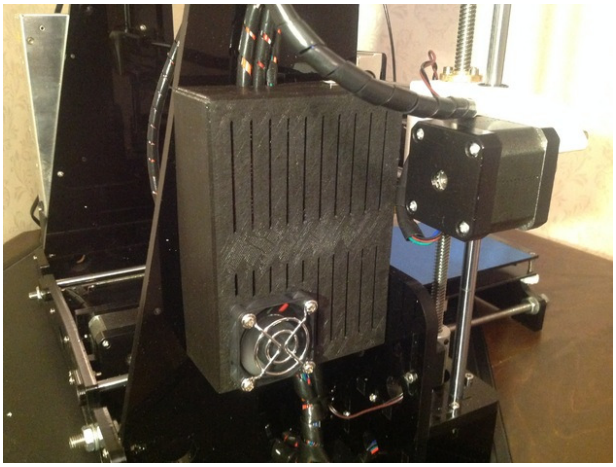
Filament dust remover

http://www.thingiverse.com/thing:1646890



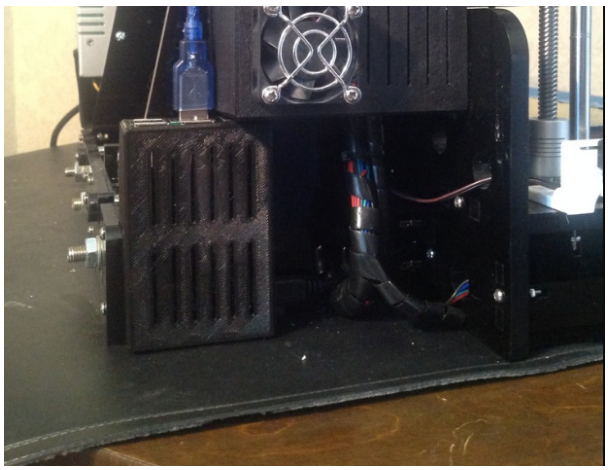
Controller cover

http://www.thingiverse.com/thing:1492839



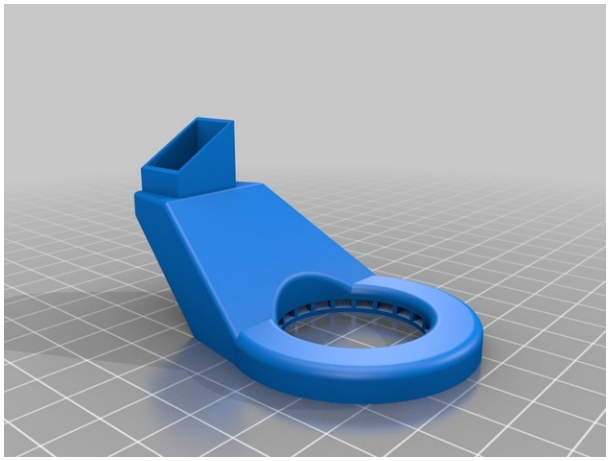
Raspberry Pi 3 Cover

http://www.thingiverse.com/thing:1726961



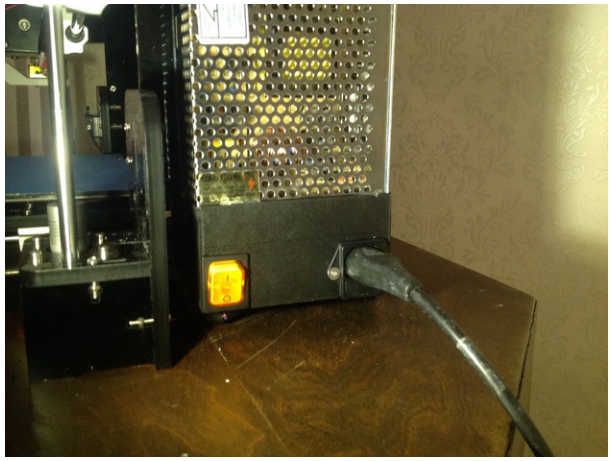
Circular cooling duct

http://www.thingiverse.com/thing:1487275



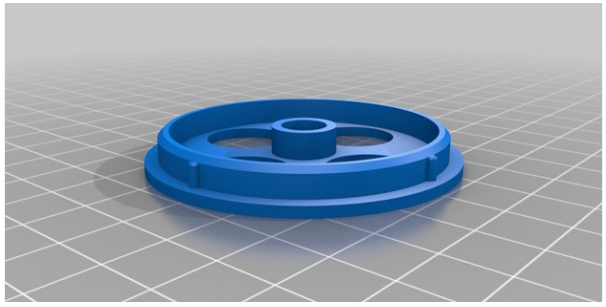
Power supply cover

http://www.thingiverse.com/thing:1482846



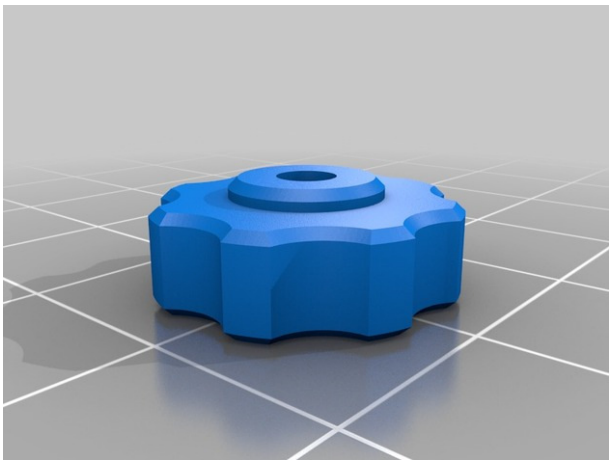
Filament roll hub

http://www.thingiverse.com/thing:1479733



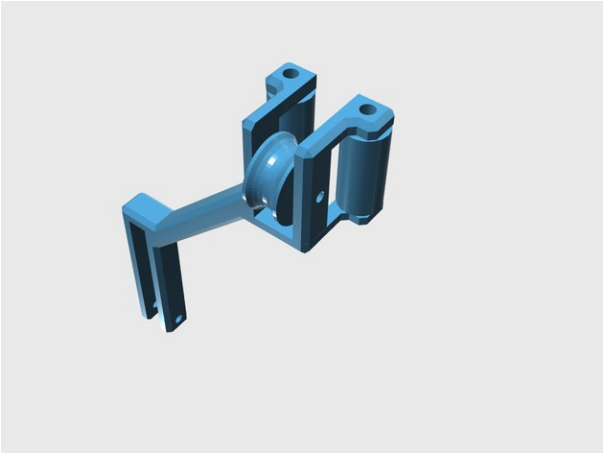
Bed leveling thumb nuts 16mm

http://www.thingiverse.com/thing:1484261



Filament guide

http://www.thingiverse.com/thing:1517738

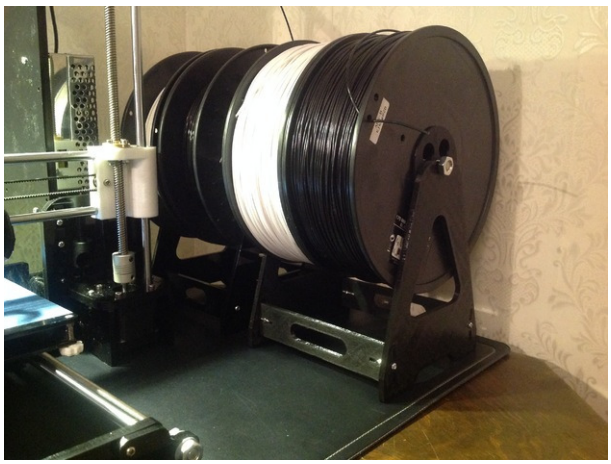


Sturdy and simple frame brace

http://www.thingiverse.com/thing:1517525

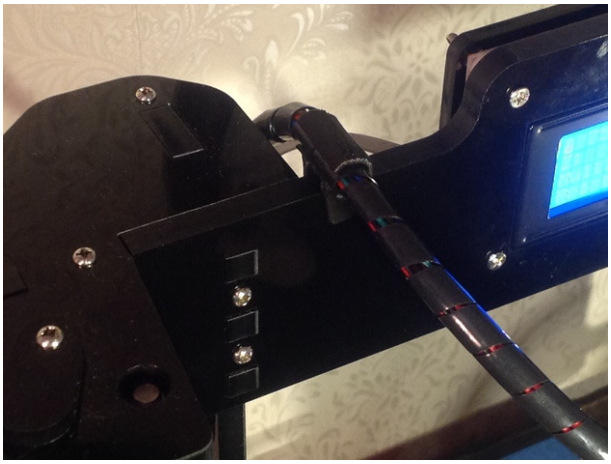
Filament roll stand

http://www.thingiverse.com/thing:1512184



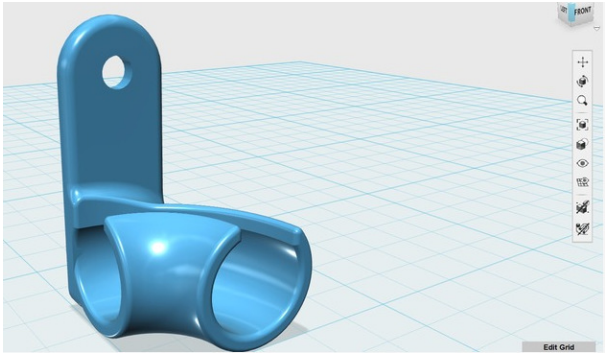
Extruder cable frame mount

http://www.thingiverse.com/thing:1497484



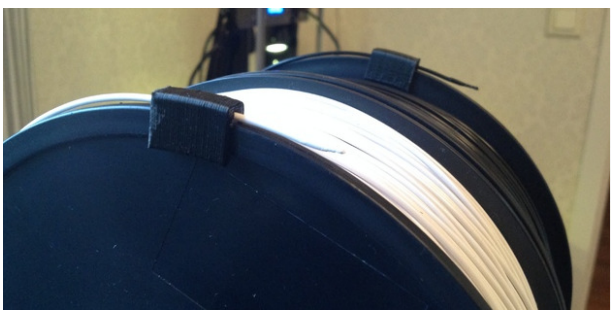
X-Axis cable frame mount

http://www.thingiverse.com/thing:1497259



Filament holder for filament roll

http://www.thingiverse.com/thing:1563190



Appendix 4. Electrical wire color by country

Standard wire colours for flexible cable (eg Extention cords, power [line] and lamp cords)			
Region or Country	Phases	Neutral	Protective earth/ground
European Union (EU), Austrailia, South Africa (IEC 60446)	Brown	Blue	Green/Yellow
Australia, New Zealand (AS/NZS 3000:2007 3.8.3	Brown, Red	Blue, Black	Green/Yellow
Brazil	Yellow, Red	Blue	Green
United States, Canada	Black (Brass)	White (Silver)	Green, Green/Yellow
Standard wire colours for fixed cable (eg: In, on or behind-the-wall)			
Argentina	Brown, Black, Grey	Blue	Green/Yellow
European Union (EU), Austrailia, South Africa (IEC 60446)	Brown, Black, Grey	Blue	Green/Yellow
UK prior to 31 March 2004 (BS 7671)	Red, Yellow, Blue	Black	Green/Yellow, Green, Bare
Austraila, New Zealand (AS/NZS 3000:2007 clause 3.8.1, table 3.4)	Any colors other than Green, Yellow, Green/Yellow, Black or Blue. Recommended for single phase: Red, Brown. Recommended for multiphase: Red, White, Blue	Black, Blue	Green/Yellow, Green, Bare
Brazil	Yellow, Red, Black, White	Blue	Green
South Africa	Red,White or Yellow, Blue	Black	Green/Yellow, Bare
India, Pakistan	Red, Yellow, Blue	Black	Green
United States	Black, Red, Blue	White, Grey	Green/Yellow, Green, Bare
Canada	Red, Black, Blue	White	Green, Bare

(Diagram made by Dudeness Dave)

Appendix 5. Anet A8/A6/A2 comparison sheet

Model	A8	A6	A2
View			
LCD	2004	12864	12864
Screen	5 Keys	Knob	Knob
Reset Key	On The Mainboard	On The Screen & Mainboard	On The Screen & Mainboard
Mainboard	Anet v1.0	Anet v2.0	Anet v2.0
Exruder	Vertical	Parallel	Bowden
Hotbed	MK2B	3mm Aluminum PCB	3mm Aluminum PCB
Structure	Prusa i3	Combine i3 with Industrial	Aluminium profiles
Print Size	220*220*240mm	220*220*250mm	220*220/270*220mm
TF Card	8GB	16GB	16GB
Auto leveling	Optional	Optional	Optional