Quick guide - Rabbit Proto Extruder

V1.0 Sept 2014

Please email questions or corrections to info@rabbitproto.com

1. Material required

Hardware

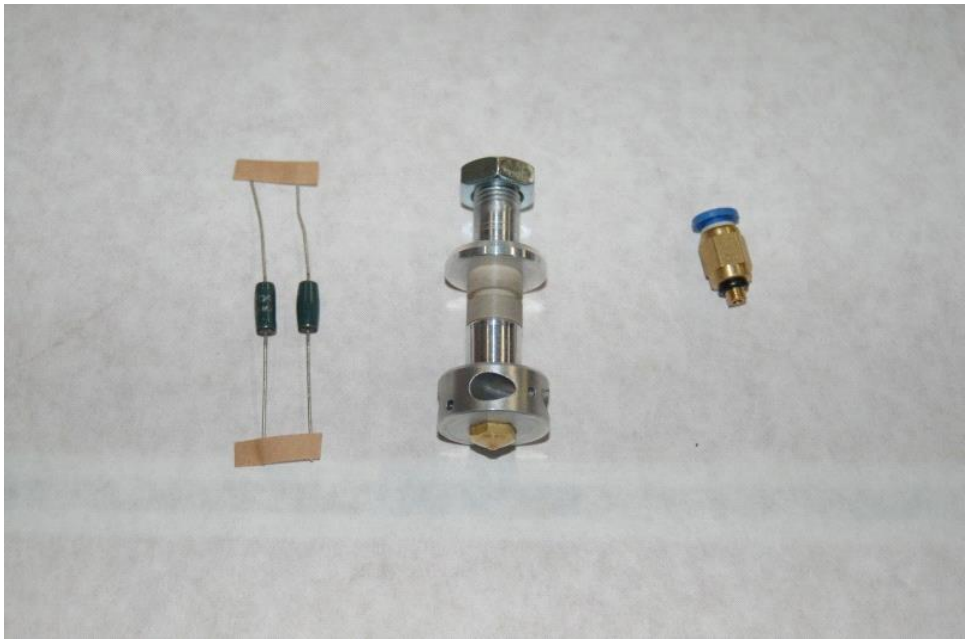
- Rep Rap 3D printer
- Rabbit Proto – Supper Rabbit PrintHead
- Copper filled silicone RTV (http://www.amazon.com/Permatex-81878-Maximum-Temperature-Silicone/dp/B0002UEOPA)
- Kapton tape
- Allen Wrench (Metric)

Software

- Repetier Host + Slic3r
- Arduino Software

2. Finalize the plastic extruder assembly

From the Rostock Max Assembly guide by SeeMeCNC



Hot end components.

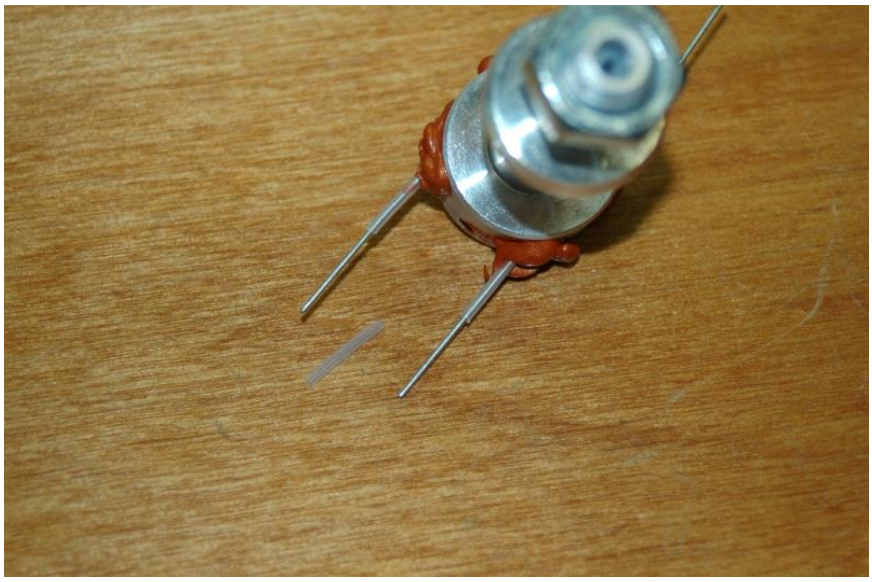
The only tasks you need to complete involve installing the heating resistors, the thermistor and the push-fit connector.

The resistors included with the hot end (the green objects in Fig. 15-1) are too small to fit snugly into the bore holes to either side of the hot end. In order to make them bigger, you'll need to cut a strip of aluminum foil and wrap the resistor. You want the width of the foil strip to be about 1/16" shorter than the length of the resistor body so that it can't come into contact with the leads on either end of the resistor.

Note that in order to shield the resistor leads from accidental shorts, you should wrap the leads in Kapton tape.

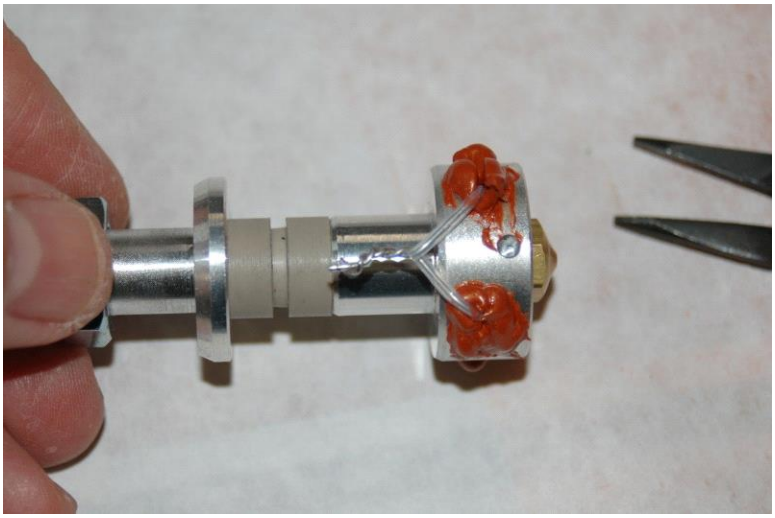
Once you've got the resistors installed in the hot end with a snug fit, cover each end with RTV to glue them into place. We use RTV here because if you have a resistor failure, it can be removed easily, but is very resistant to high temperatures.

Before the RTV cures, install a 3/4" length of PTFE tubing on each of the resistor leads as shown below.



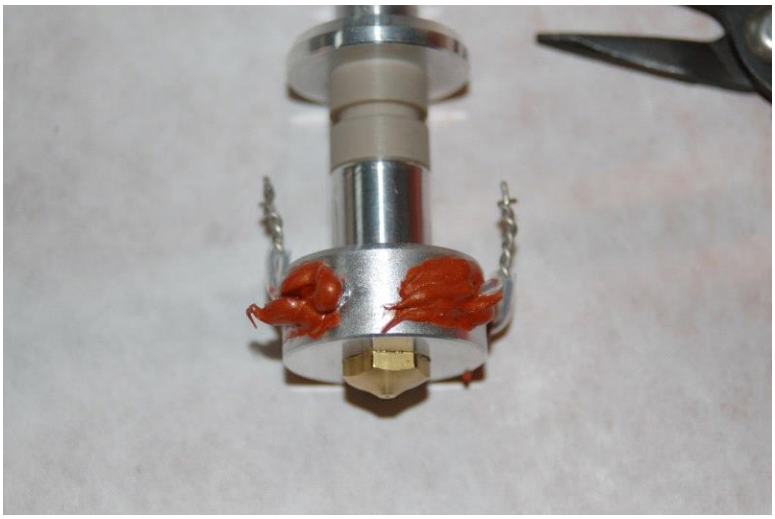
Insulating the hot end resistor leads.

Once the RTV cures, carefully twist the resistor leads together as shown below. Use a pair of needle nose pliers to help you get a good, tight twist.



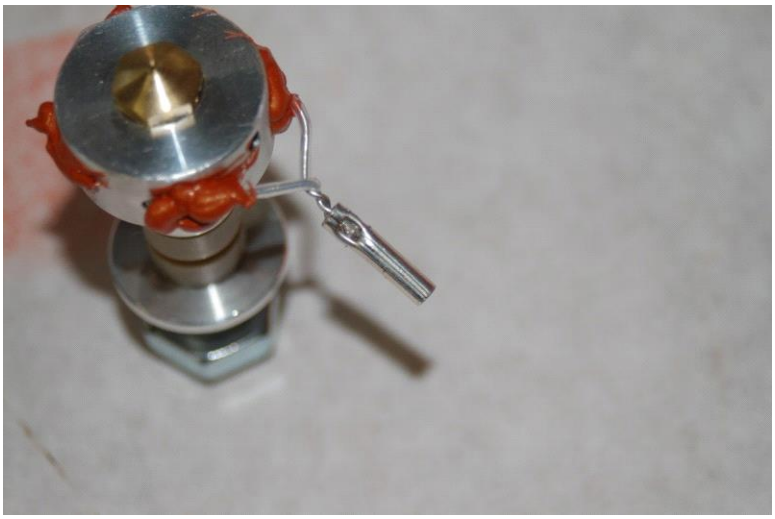
Resistor leads twisted together

When you're done twisting the leads together, clip about 1/16” to 1/8” off each end to clean up the ends a bit. A crimp connector will go on them and you want the best fit you can get.



Resistor leads ready to crimp.

Because of the temperatures reached by the hot end, we can't use solder to attach the power wires to the resistors. Use crimps marked “22-16”. Crimp one connector to each twisted pair of resistor leads as shown below.



Crimp on connector in place.

Note that you only want to crimp it in one place.

The lower portion of the hot end is threaded on to a PEEK barrel that acts like a thermal break. In order to keep repeated heating and cooling cycles from loosening the hot end from the PEEK, wrap the seam with a short length of Kapton tape as shown below.

Kapton wrap on the PEEK barrel.

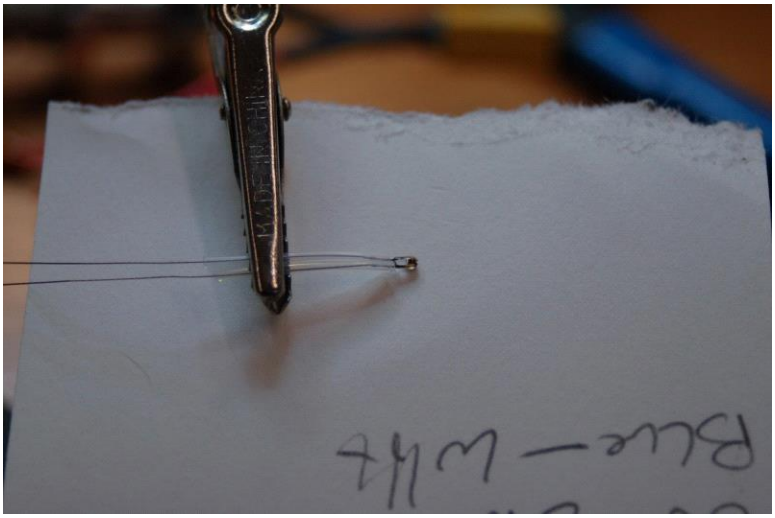
I prefer to use a quick disconnect connector on my hot-end and I strongly suggest you do the same. In Section 1 I list two different types – the Deans and XT-60 connectors. My preference is the XT-60, but if you've got Deans on hand, they're well suited to the task. I won't show how to attach them – it should be pretty obvious and if not, there's always Google. :) I'm going with the assumption that you like to be able to change out hot-ends and have installed the connectors of your choice.

Attach a 3” or so length of 16ga wire (one black, one red) to the crimped connectors, and wrap them in Kapton tape to insulate them.

Attaching the power leads to the hot end.

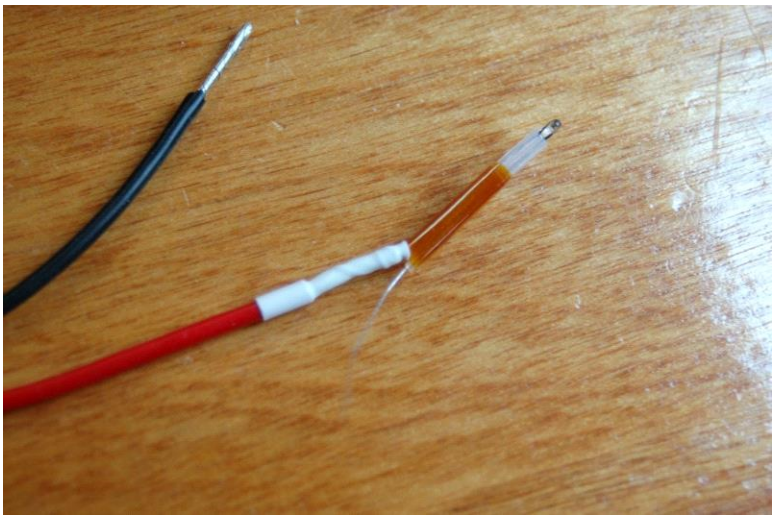
Now you need to install the thermistor into the hot end. A thermistor is a tiny temperature sensing device that changes resistance as the temperature around it changes. I cannot stress this enough *it's a very delicate component!* Please handle it very carefully! The glass bead is fragile and the wire can be brittle if soldered and moved too much.

First, cut two 1" lengths of the included PTFE tubing and slide them over the thermistor leads as shown:



Insulating the thermistor leads.

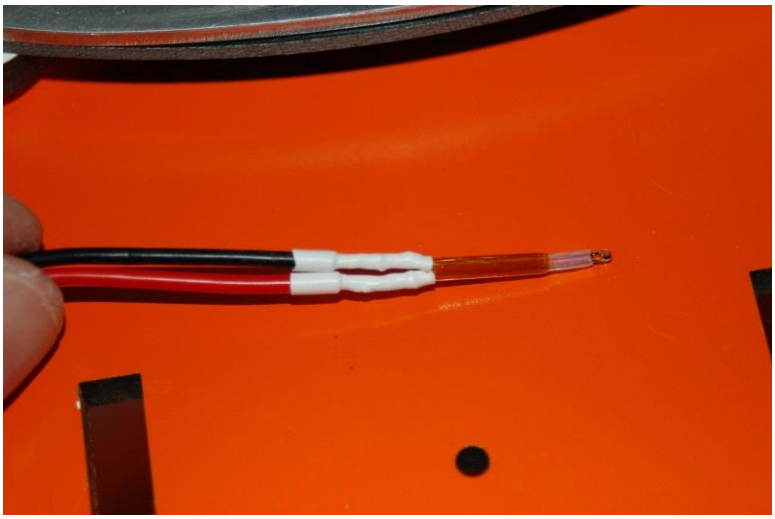
Just like the resistor wiring, I recommend you use a quick disconnect connector. For the thermistor, I recommend using a JST connector. You can cut a 2" long section from the wiring supplied for doing the stepper motor extension for this purpose. Thermistors have no polarity, so it doesn't matter how you attach the JST connectors.



Attaching leads to the thermistor.

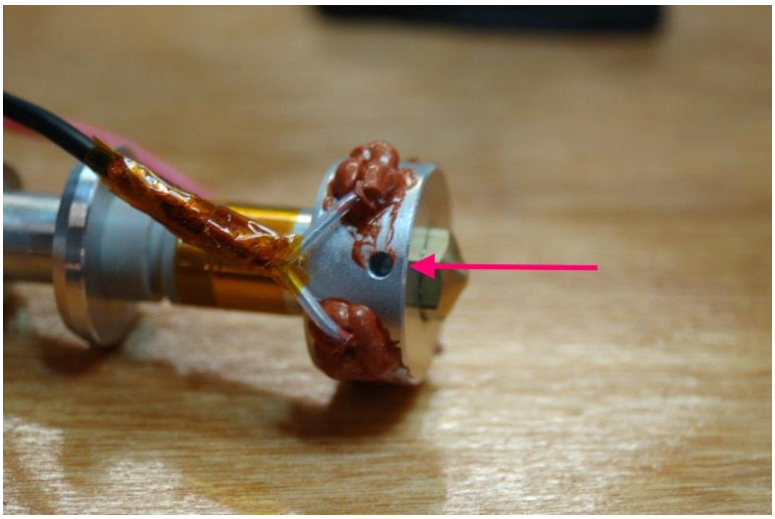
Now you can solder your leads to the thermistor. I recommend covering the solder joint with heat shrink tubing. The thermistor wires won't get hot enough to affect it. You'll also see that I taped the leads together with Kapton tape. This is done to give it a bit more protection.

Be careful when you're soldering this up. The thermistor leads are very brittle and can break easily once soldered.



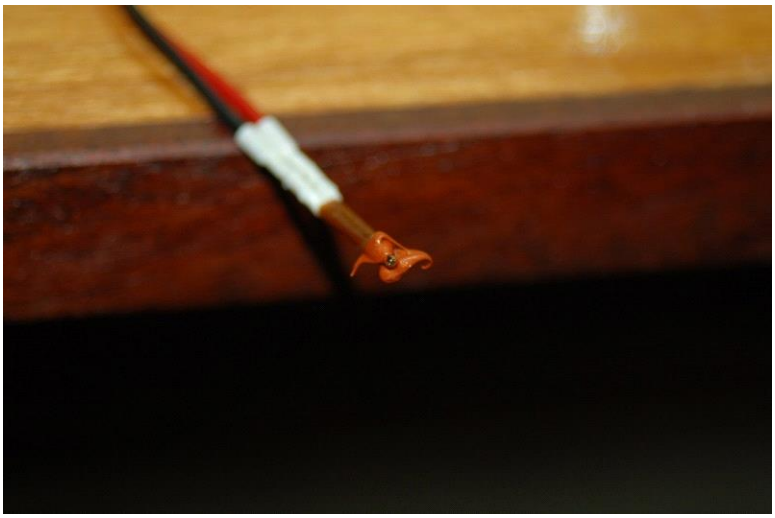
Thermistor ready to install.

Once you've got the leads added, I strongly suggest that you use Kapton tape or more heat shrink to bind the two leads together at the joint – this will help prevent flex that could cause the thermistor lead solder joint to fail. The thermistor is installed in the hot end at the location shown in Fig. 15-11.



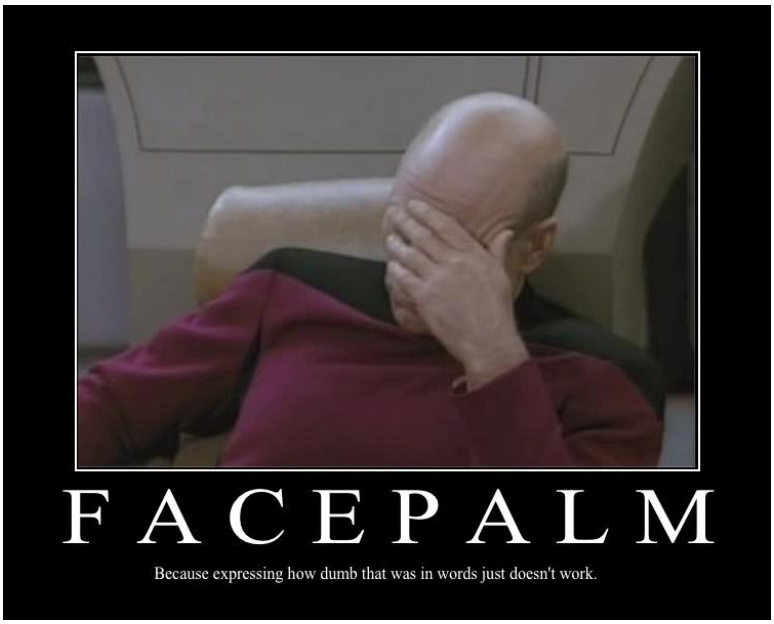
Thermistor installation location.

In order to “glue” the thermistor into place, you'll need to coat the *sides* of the thermistor bead with a small amount of RTV as shown in Fig. 15-12.



RTV applied to the thermistor sides.

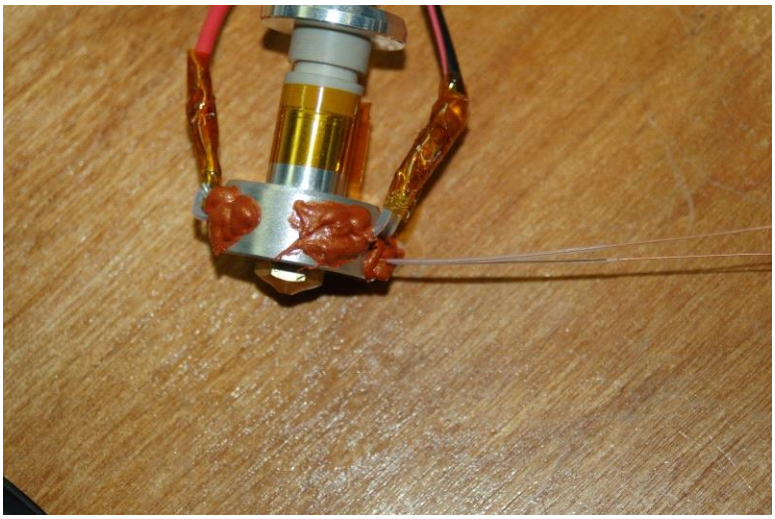
The idea here is to leave the tip of the glass bead exposed. This will allow it to come into unobstructed contact with the thermistor port on the hot end.



D'OH!

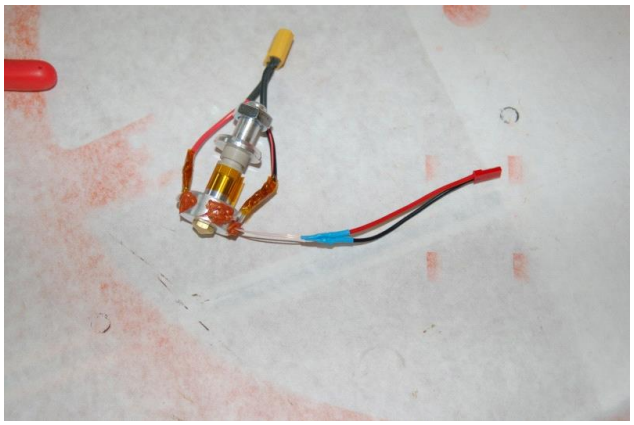
Wait, you just broke the wires on your thermistor, didn't you? Oh. You didn't? Well ***I*** just did.

So instead of doing the technical writing equivalent of sweeping the bits of broken ceramic under the couch with your foot while smiling and telling your mother you have *no idea* where her prize vase is, I'm going to show you photos of the thermistor as I *actually* installed it.

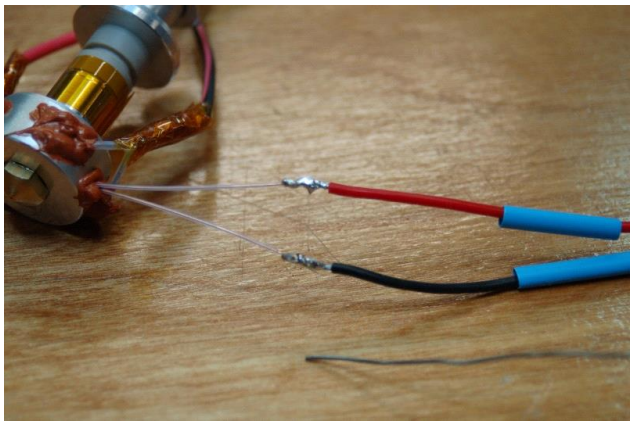


Magically repaired (and slightly different) thermistor installed in the hot end.

Please give the RTV time to fully cure before you move on to the next steps.



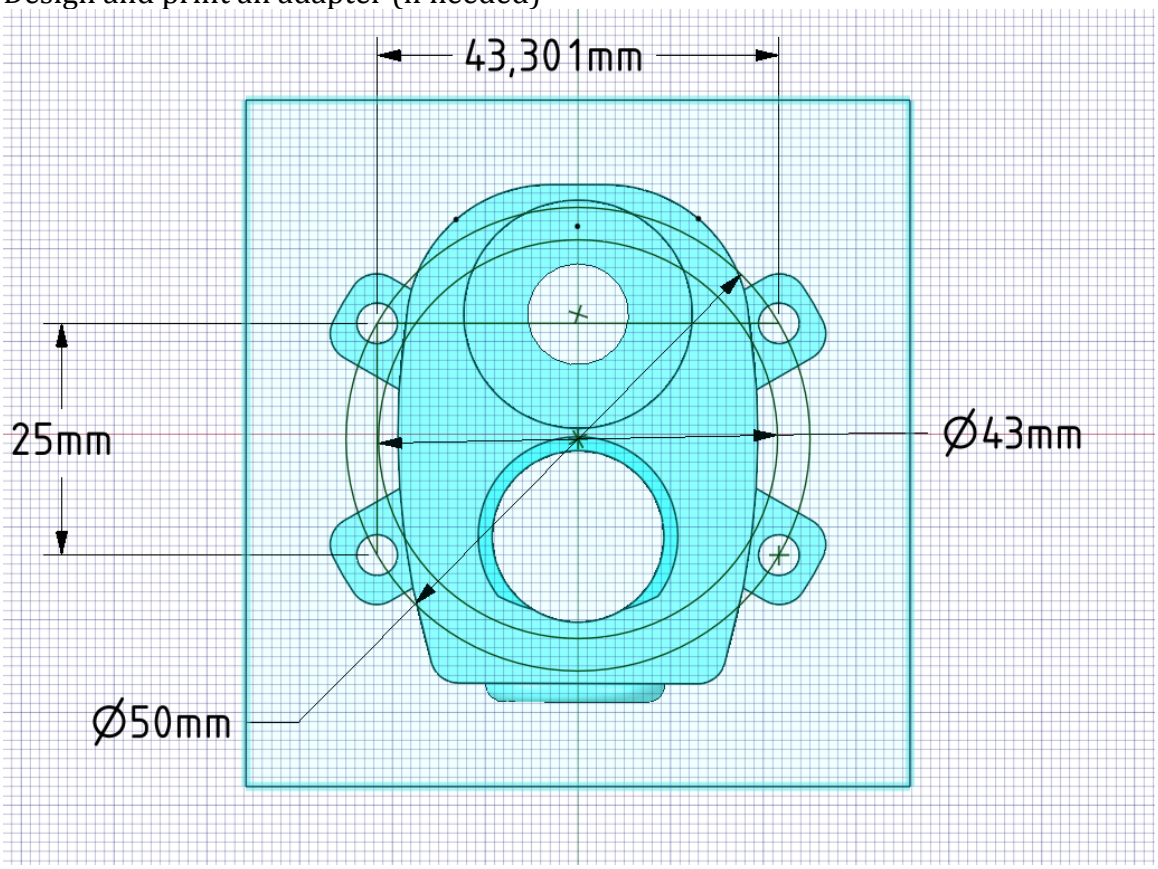
Magic thermistor with JST connector in place.



Magic thermistor getting JST connector.

3. Attach the extruder to your 3D printer

a. Design and print an adapter (if needed)



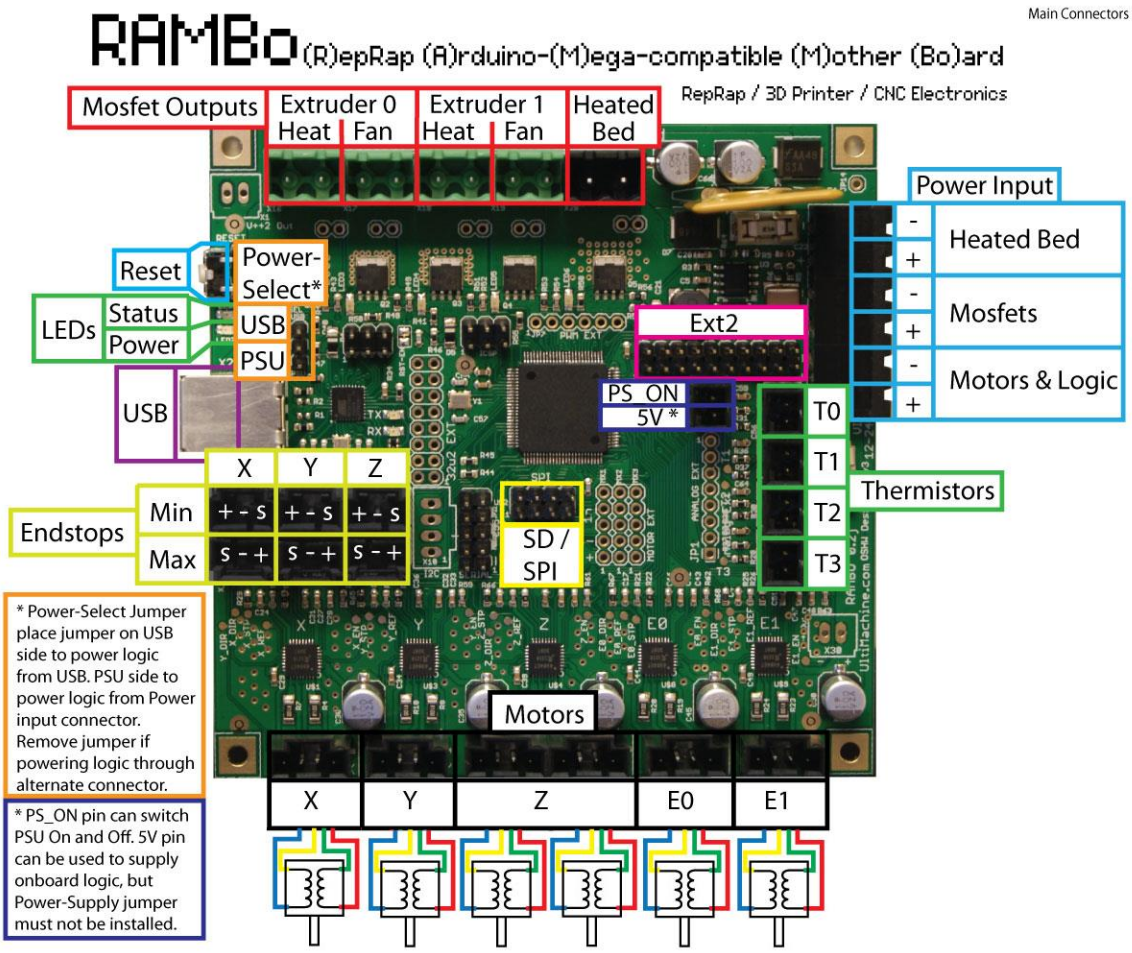
Rabbit Proto's footprint.

If you own a Mendel Prusa or a Rostock, there is a high chance you will be able to attach the RP extruder directly to your machine. Otherwise you should be able to print a carriage adapter that can hold the extruder.

b. Optional – Bowden extruder assembly
If you don't have a Bowden-compatible extrusion system, we have included an Ezstruder system from SeeMeCnc (http://seemecnc.com/products/ezstruder-cold-end-kit). Assembly should be straightforward but you'll find documentation on their website (or look at this video and ignore the hot-end assembly part). https://www.youtube.com/watch?v=2bmbvPiY7qM#t=191

c. Attach to the printer or your homemade adapter using screw and self-locking nuts preferably

d. Connect the second extruder stepper motor on your board. If your printer is compatible with dual extrusion, you should have an available port for the conductive paste extruder stepper motor.



On the Rambo Board use the port noted E1.

4. Modify your printer's firmware

In order to be able to use your second extruder, you need to modify the configuration file of the firmware of your machine. The amount of modification is in general extremely small especially if the settings of your printer can be modified with the EEPROM. You can find a copy of a modified Repetier Firmware for Rostock Max on our github at https://github.com/rabbitproto/glowing-carrot/. The three most important steps to take:

- Set up two extruders
- Allow cold extrusion (so that your second extruder can work even without any thermistor checking the temperature).
- Tune up the number of steps per mm for the second extruder (1100 steps/mm).
- If you end-up using the Ez-struder, you will also need to change the number of steps per mm.

5. Configuration in Repetier Host/Slic3r

Tuned Slic3r parameters:

Parameters	**Values**
Layer Height	0.2mm
First Layer Height	0.35mm
Minimum Perimeters	2
Fill Density	1
Fill Pattern	Rectilinear
Top/Bottom Fill Pattern	Rectilinear
Infill Every # Layers	1
Solid Infill Every # Layers	1
Fill Angle	0
Perimeter Speed	60mm/s
Small Perimeter Speed	10mm/s
External Perimeter Speed	70%
Infill Speed	60mm/s
Solid Infill Speed	60mm/s
Top Solid Infill Speed	60mm/s
Support Material Speed	60mm/s
Bridges Speed	60mm/s
Gap Speed	60mm/s
Non Printing Speed	130mm/s
First Layer Speed	30%
Skirt Loops	2
Skirt Distance from Objects	6mm
Skirt Height	1 Layer Height
Support Material Pattern	Rectilinear
Support Material Pattern Spacing	2.5mm
Support Material Pattern Angle	0
Default Extrusion Width	0.4mm
First Layer Extrusion Width	300%
Plastic Filament Diameter	1.75 mm (please check for your own filament)
Plastic Extrusion Multiplier	1
Plastic Extrusion Nozzle Temperature	230°C
Plastic Extrusion Print-bed Temperature	55
Syringe Filament Diameter	7.358491
Syringe Extrusion Multiplier	4
Syringe Extrusion Nozzle Temperature	0
Syringe Extrusion Print-bed Temperature	0
Print-bed Size	Depending on your printer
Printer Center	Depending on your printer
Number of Extruders	2

Z-offset	0
Plastic Extruder Retraction Length	0.5mm
Plastic Extruder Retraction Speed	6mm/s
Tool Change Retraction Length for Plastics	0.5mm
Syringe Extruder X-offset	1.1mm
Syringe Extruder Y-offset	-24.6mm
Syringe Extruder Retraction Length	0.001mm
Syringe Extruder Retraction Speed	1mm/s
Extra Extrusion on Restart for Syringe	0.01mm
Tool Change Retraction Length for Syringe	0

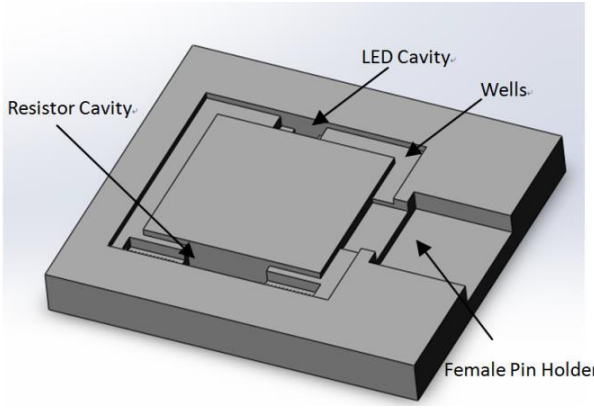
Please fine tune the offsets and the extrusion multipliers as there could be some fine modifications needed after a few prints.

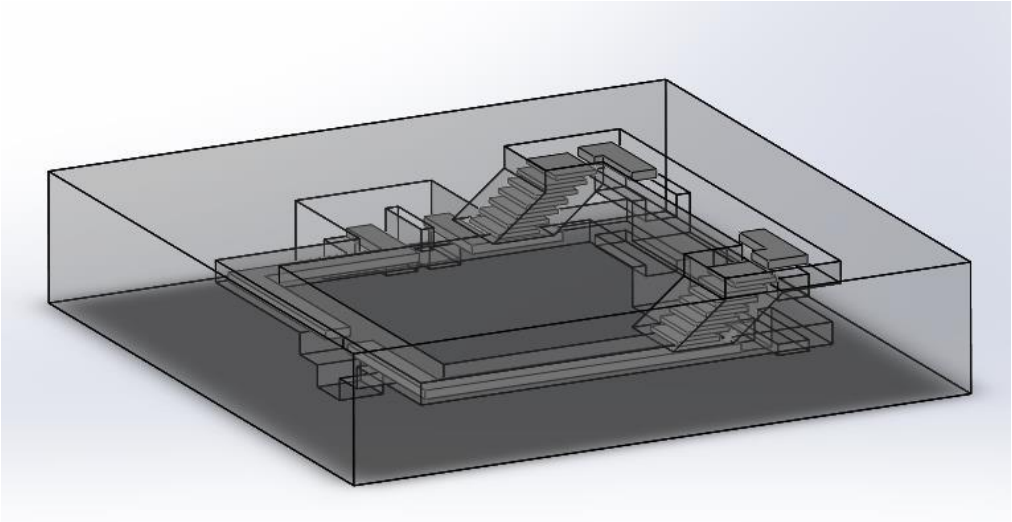
6. Generating a CAD file

In order to generate a proper CAD file for printing with the Rabbit Extruder, you can use any standard CAD solution as long as you are able to generate multiple components that will be outputted as STL files. One will contain the plastic, the other one the conductive traces. You will want to have wells pre-formed into your plastic parts to hold the conductive traces. You can also add cavities for holding electronic components that you can pick and place during or after the print:

General requirements for design:

Features	**Dimensions**
Conductive traces	for cross-section 1.20x0.4mm
Plastic wells to contain conductive traces	for cross-section 2.0x0.6mm
Cavities to hold SMT LEDs	4.3x1.2x1.2mm
Cavities to hold regular resistors	7.6x2.8x3.5mm
Cavities to hold 3 parallel male pin headers	9.5x3.5x3mm
Cavities to hold 3 parallel female pin headers	9.2x3.2x8.9mm
Cavities to hold 2025 button batteries	Dia: 21mm thickness 5.8mm





7. Printing using Repetier Host

Slic3r can output gcode for a multi-material printer, which can then be read inside repetier host. You can find more details on how to generate proper gcode at http://manual.slic3r.org/expert-mode/multiple-extruders.

8. Uploading your designs

Please share your designs with the Rabbit Proto community! A current repository of designs is available on our github, at https://github.com/rabbitproto/glowing-carrot/tree/master/demo_applications, and our twitter handle is @rabbitproto.

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