Cupcake CNC Batch 10+ & Starter Kit Build Instructions

Ordinarily, it will take a couple of people a weekend or so to put a Cupcake CNC together. Here's how!
Before you begin you might want to check out this collection of videos tutorial detailing every step of the build process (deluxe kit). Please note these videos are done with a PRE BATCH 10 deluxe kit. The optical end stops are no longer included. There may also be some other differences.

Additionally, for those who are assembling an Ultimate kit or are otherwise creating several of our new upgrade kits at once: we strongly recommend that you step through them one at a time. Build your Plastruder MK5 and print on the acrylic build platform before building your Automated Build Platform or Heated Build Platform. Your understanding of how the interconnected elements of your bot function will increase and your build will proceed more smoothly.

Prep Work

1. Cupcake Parts List
2. Before you begin
3. About bolts and nuts
4. About timing belts
5. Some mistakes to avoid

Build It

1. Cupcake Y Stage Assembly
2. Cupcake X Stage Assembly
3. Cupcake Body Assembly
4. Cupcake Z Stage Assembly
5. Cupcake XY Stage Installation
6. Cupcake Z Stage Installation

Finish It Up

1. Plastruder MK4 Build Instructions
2. Cupcake Electronics Installation
3. Cupcake Calibration
4. Optional step: Cupcake Endstop Installation

Updating Your Firmware

1. Cupcake Motherboard Firmware Update
2. Plastruder Firmware Update

Experimental

Heated build platforms

Troubleshooting

1. When things go wrong!
2. Think you are missing parts?

CupCake CNC

http://www.thingiverse.com/thing:457

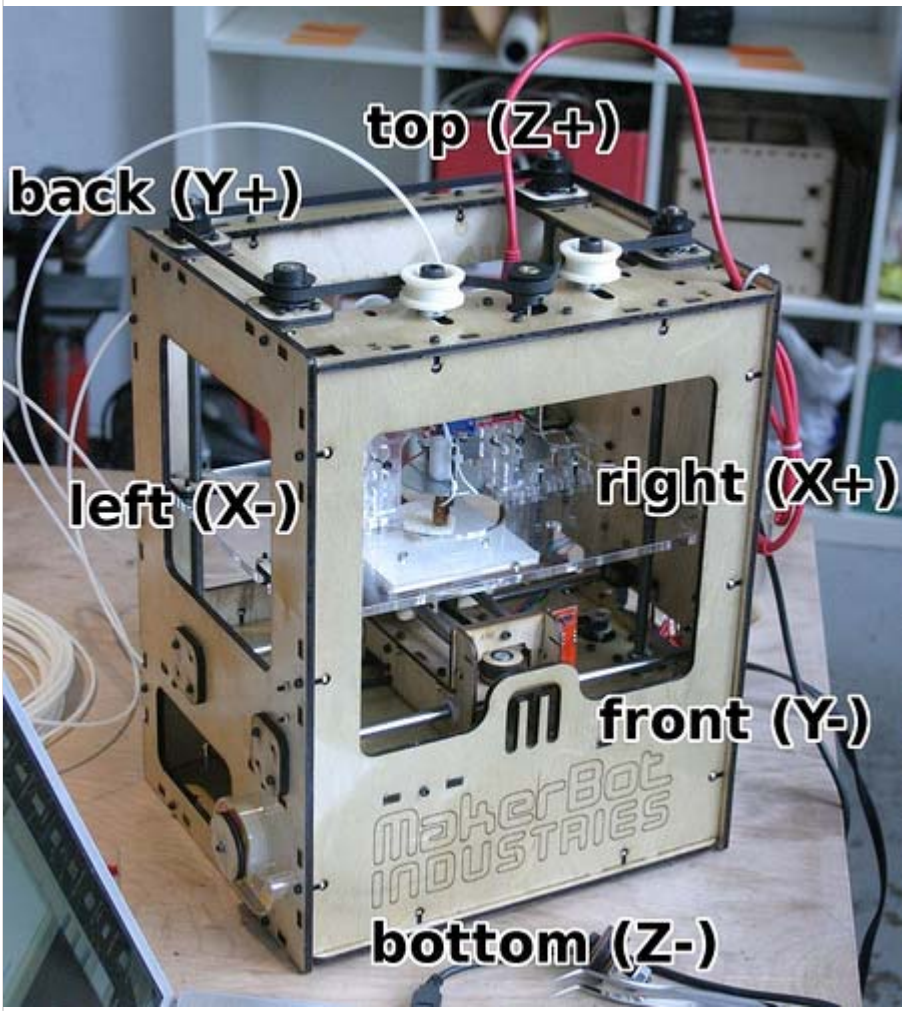
Part List: tree | flat | csv

Part	Qty
Cupcake CNC Lasercut Parts Kit	1
Drive Rod Kit	1
X Rods	2
Y Rods	2
Z Rods	4
Stepper Motor NEMA17 200	3
Hardware Burrito	1
Hardware Burrito - M8 Hardware	1
M8 x 50mm socket cap bolt	3
M8 nut	30
M8 washer	15
Hardware Burrito - M5 Hardware	1
M5 x 45mm socket cap bolt	1
M5 nut	3
M5 washer	4
Hardware Burrito - M3 Hardware	1
M3 x 8mm socket cap bolt	16
M3 x 16mm socket cap bolt	200
M3 nut	200
Hardware Burrito - Misc Hardware	1
6-32 x 3/8" screws	4
M3 Spacer - 1/4" Length	25
3mm Cube Magnet	10
Hardware Burrito - Hex Keys	1
1.3mm hex key	1
1.5mm hex key	1
2.0mm hex key	1
2.5mm hex key	1
4.0mm hex key	1
6.0mm hex key	1
Belt & Pulleys Kit	1
Large Idler Pulley	3
X Belt	1
Y Belt	1
Z Belt	1
XY Motor Pulley	2
Z Rod Pulley	4
Z Motor Pulley	1
XY Linear Bearings	8

Supplemental Bearing and Pulley Kit	1
608 Bearing	8
Small Idler Pulley	1
Modified lasercut X front	1
Modified lasercut X end cap	1
Generation 3 Electronics	1
Stepper Motor Driver v2.3 Fully Assembled	3
RepRap Motherboard v1.2 Fully Assembled	1
Extruder Controller v2.2 Fully Assembled	1
ABS Natural - 1lb coil	1
Plastruder MK4	1
Deluxe Add-ons Kit	1
Build Surface Kit	1
Acrylic Build Surface	1
Wooden Build Platform	1
3mm Cube Magnet	5
M3 x 10mm socket cap bolt	6
M3 nut	6
Tools Kit	1
13mm Wrench	2
1GB SD Card	1
Cables Kit	1
USB to TTL Cable	1
Power Cable - 6ft	1
Cat5e Cable - 2ft	1
ATX Power Supply	1
ABS Black - 5lb coil	1

Cupcake CNC notation

The diagram below describes what we mean when we refer to, for example, the "left" or "bottom" of the machine:

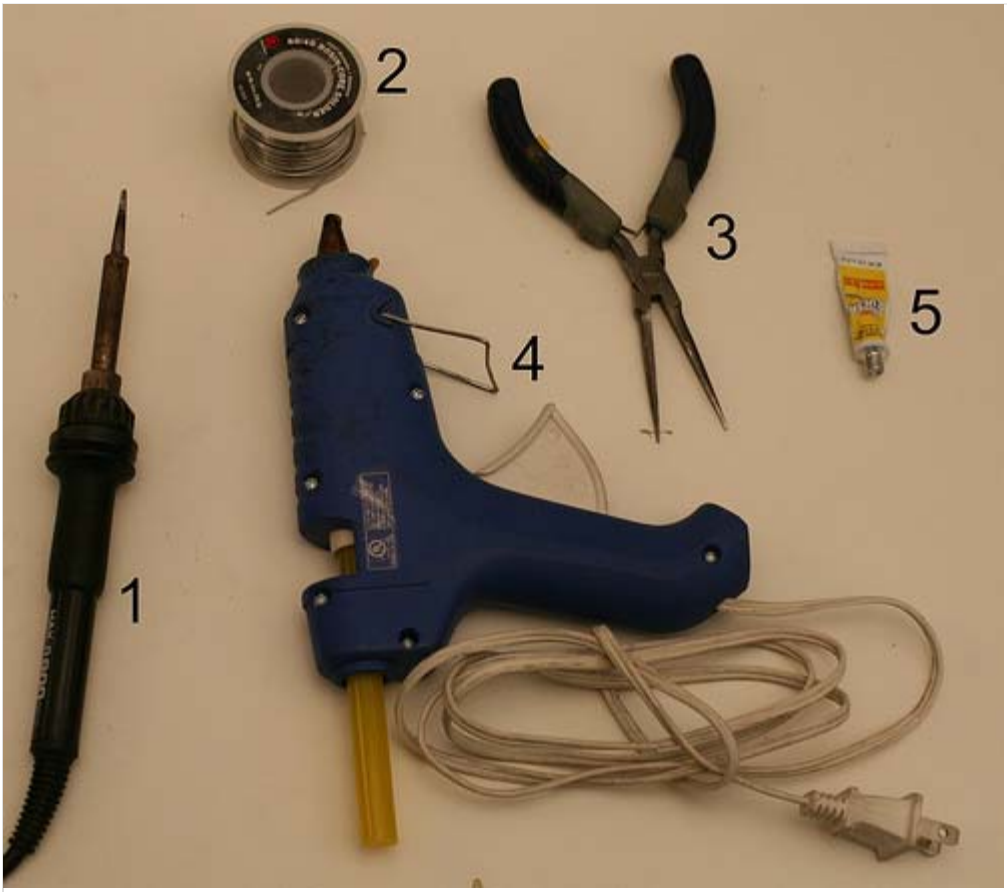


The Cupcake CNC moves pieces and tools along three axis: the X axis, the Y axis, and the Z axis. The X axis is the one that runs from left to right; the Y axis is the one that runs towards and away from you. (Think of these as being like the X and Y axis of a graph, seen from above.) The Z axis goes up and down.

Spend a moment to study this illustration carefully— it seems simple, but it will save you a lot of time and frustration later!

Tools you'll need

There are some common tools and supplies that are required to build the Cupcake CNC but don't ship with the deluxe kit:



1. Soldering iron
    - You'll need to make four easy solder connections to hook up the Plastruder Mk4
2. Electronics solder
3. Pliers, preferably needle-nosed
    - These will help you tighten down nuts
4. Hot glue gun
    - A dab of hot glue will help keep the bearings from coming loose
5. Super glue, or white glue
    - A bit of glue can be used to make sure the magnets don't come loose from their press-fit bearings

You may also want these additional items, which are suggested in the Z Stage Assembly instructions:

1. Loctite thread locking compound
2. Bikechain lubricant or some other such compound

About Bolts And Nuts

Cupcake CNC uses metric hardware for all its fasteners. Metric bolts are described in terms of the diameter of their shafts. For instance, an "M3" bolt is one with a shaft that is 3mm in diameter. Likewise, an M8 bolt has an 8mm shaft diameter. M3 nuts are nuts that fit M3 bolts.

The Cupcake CNC uses bolts of several lengths. They're described by the length of the bolt *excluding* the head. For example, a 16mm bolt is 16mm from the tip of the screw to the underside of the head. Sometimes you'll see a bolt described, for example, as M3x16. That means an M3 bolt with a length of 16mm, excluding the head.

Almost every one of the nuts and bolts you'll use will be M3x16 - the Cupcake comes with 180 M3x16 nuts and bolts, but you'll end up with quite a few left over.

Bolt Together Action: The Nuts and Bolts

Nuts and bolts hold the MakerBot together. You put the nut in the t-slot, put the bolt in the hole and twist it with your fingers. Once you've got it hand tight, give it a small twist with the allen key to make sure it stays tight.

The Cupcake CNC uses two lengths of M3 bolt. The 16mm bolts are used to hold the wooden parts together; the 10mm M3 bolts are used to fasten the NEMA 17 stepper motors to the bot. Be sure not to use the 16mm bolts to attach the motors— they can enter the motor housings and cause them to jam!

M3 nuts are not manufactured to very tight specs, so some may be slightly smaller or larger than others. Additionally, wood always has a little variability. If you're having trouble fitting a nut into a t-slot, try rotating the nut a sixth of a turn, or inserting the nut from the other side of the t-slot and see if you have an easier time of it. If you're really stuck, try lightly sanding or filing the slot.

Sometimes the t-slot is actually a touch too wide, and won't hold the bolt in place until you're ready to screw in the bolt. In these cases, you can add a dot of white glue or super glue to keep it from falling out until you're ready to screw in the corresponding bolt.

Maintenance

MakerBots vibrate, so you're going to want to occasionally check the nuts and bolts and tighten them down if they loosen up. Most bolts, like those in the outer frame, may never need tightening; others, like those that hold the build platform down, may need to be checked every few months or so.

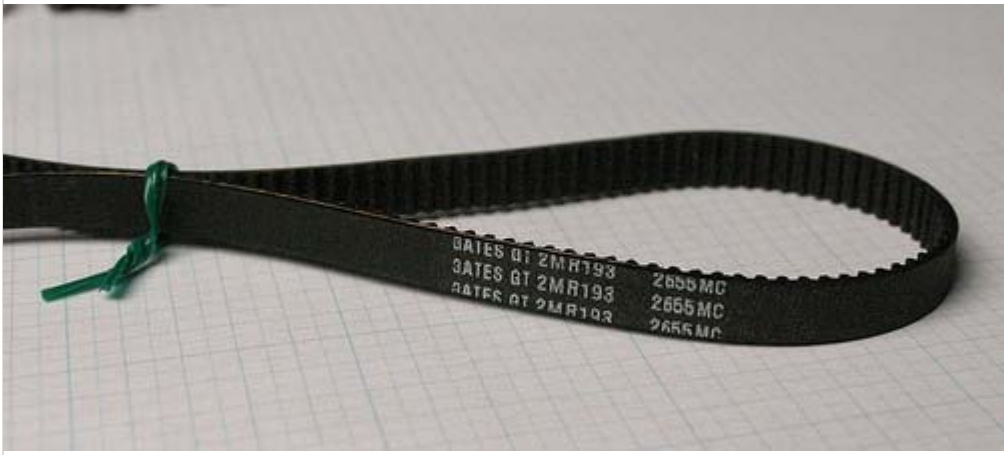
Slots and tabs

The slots and tabs in the frame should match up well. If you've screwed a couple of parts together, and are having trouble fitting the tabs on a third part that connects to both, try loosening the bolts first.

About Timing Belts

Cupcake CNC uses *timing belts* to move its various parts. Timing belts are belts made of reinforced rubber with little teeth molded onto the inside, which mesh with slots in pulleys. Cupcake CNC uses continuous belts 6mm in width, with 2mm between teeth (the GT2 drive system).

The belts we use have silkscreened part numbers which include the number of teeth on the belt. For example, this belt has the code: GATES GT 2MR193 2655MC



The number after the "R" indicates the number of teeth on the belt. In this example, for instance, the belt has 193 teeth.

Fitting belts

We mount our idler pulleys in slots to allow you to tension the belt properly, but even when the pulleys are at their loosest, it can be tough to get the belt around them. Often, it is simplest to run the belt around all the pulleys except for the small metal drive pulley first. Then get the belt partway around the drive pulley, and then rotate the pulley to pull the belt onto it.

Tensioning belts

In general, belts should be tight enough to minimize slack, but not so tight that they start placing a lot of stress on the motor shaft or pulleys. Once a belt is on, turn the motor pulley with your fingers to gauge if there's too much resistance. In general the belts should not be tight enough to make a distinct note when plucked with your finger. Also, if your motor makes a humming or buzzing noise when operating, loosen the belts, operation should be nearly silent.

The three belts need to be tensioned in slightly different ways:

- Y belt: the Y belt needs to be relatively tight to make sure that the idler pulley bolt doesn't collide with the X rods. See the [cupcake-cnc-10:cupcake-x-stage-assembly X stage assembly instructions] for details.
- X belt: the X belt should be reasonably tight, without being so tight that it offers a lot of resistance.

- Z belt: the Z belt should be relatively slack; it doesn't need to be as tight as the other two belts, and overtightening can cause the Z stage to sometimes miss steps.

Before you get started, you may want to review Don't Do That!

Don't Do That!

OH NO CUPCAKES!

Several MakerBot builders have shared their mistakes and missteps in the hopes that others will not follow in their footsteps! Everyone makes some mistakes putting their machines together, and yet they all eventually work. Hopefully this section will both provide useful information and make you feel better when you make your own errors. The names have been removed to protect the embarrassed!. We will add to this list based on what comes through the MakerBot Operators group, but feel free to add your own experiences by editing the page.

Be sure and also check out the "When things go wrong" page at: When things go wrong!

Be careful when you cut down your threaded rods!

> Heh- just a warning for those of you working on your Makerbots- be very careful if/when you cut down the M8 threaded rod of the Z-stage. I inadvertently cut it too short, and had to reorder another set of rods from McMaster-Carr. My suggestion is to get the whole thing

> working, and then cut them down at that point. I thought I was being clever by doing it at the beginning, but I made an error of measurement rather than working from an assembled Makerbot. Lesson learned, but hopefully nobody else is this dumb… :-)

> I would like to add, if you are cutting your own M8 rods with a dremel or > other cutting device, not to grab the end you cut with bare fingers just > after cutting, i now have a nice M8 thread branded into my fingers for the > next week or so… From Roboteernat.

Double-check that the sides are on the right ways!

> HA HA HA! At least you didnt assemble your whole makerbot to figure out that your sides were backwards

If you always remember that the labels face _outward_ and watch the illustrations on the build instructions carefully, you should be okay.

Switch your power supply to the right voltage!

> I almost plugged in my MakerBot without switching the power supply from 110V to 230V! Luckily I *accidently* glanced the 110/230V switch next to the main power switch when pluging in the power cable.
> That was really close, I can tell you…
>
> So I'd like to extend your warning for all new MakerBot operators in Europe: Remember to switch the power supply to your actual current! :)

Make sure your idler wheel is well attached

> Heh. Never use superglue to attach the idler wheel, mine fell off.
> Used Epoxy instead. Mucho strengtho!

If you must use superglue, get the good stuff, a reputable hobby shop will usually have glue of the right strength and viscosity.

Be very careful with the small SMD parts!

> Apart from loosing an SMD Capacitor and a resistor mine went quite smooth… .

Don't forget to tighten the bolts on the plastruder motor!

> how about disassembling your plastruder then reassembling then disassembling because you forgot to tighten the bolts on the motor?

Make sure your laser cutter is in alignment!

If you laser cut your own panels, make sure that the cutter is aligned before you start- the parts need a significant amount of precision to assemble and run properly.

> At least you didn't assemble your makerbot z-body and then spend 30 minutes figuring out that it didn't sit level because your laser cutter was out of alignment….

Be careful where you plug in your cables!

> I had a long close look at the "not ethernet" ports on the MoBo, before I figured that the end stops probably do not plug into there.. ha ha.. not sure what would have happened, but I know they feed power for the extruder sooo.

Don't unplug a stepper motor while its stepped board is powered!

> I lost a stepper board this way trying to move the cable around. There's a warning on the cupcake-calibration page but I saw it too late.

Make sure you turn your motherboard on before you try to upload!

> When you start the upload, you have to hit the reset button on the motherboard to get it to upload correctly. Yes, your motherboard should have lights on it. If it does not, check the power switch. There should be a green power light at the very minimum near the top right under where you plug the TTL cable in. the LED underneath this should flash red while you are uploading.

Make sure your reset button is in alignment!

When soldering in your reset button(s), make sure pin one on the switch lines up with pin one on the board. If you put in sideways, the board is always resetting, meaning it'll never take firmware.

> Those four-pin reset switches? Directional. Don't just solder them in any-which-way; turn them over and look for the logo. The terminal to the right-side of the logo is generally pin 1. There's a notation on the

> silkscreen for a reason

Make sure you thread the right end of the heater barrel into the insulator

Thread the dressed/tapered end into the teflon or the gap will cause a dam to form that will force the head apart.

Don't over-tighten the idler wheel!

If you bought the MK4 UPGRADE kit for your MK3 be sure not to over-tighten the idler wheel it puts a ton of stress on the wheel and can fracture and/or break it!

> "This is to all of you that bought the mk4 upgrade kit! dont tighten the idler wheel down onto the metal rod that came with the kit! this puts excess stress on the wheel and can cause it to crack and break…"

Don't over-tighten… period!!

Be careful not to over-tighten the ubiquitous M3 16mm bolts. You can crack the pieces, especially the acrylic Plastruder pieces. Doh!

Don't lose the thermistor!

It would be a good idea to make sure you never drop the thermistor, if you do it will most likely vanish into thin air. Finding a needle in a haystack is trivial compared to finding a thermistor the size of a hair in carpet. Just don't do it. Attaching a piece of tape to it until the wires are soldered on would be a great idea too.

The 100k glass bead thermistors stick to magnets - so attaching it to a magnet is a good way not to lose it! If you do drop it, a magnet can help you find it…

Don't get too carried away trying to unblock your extruder!

That last bit of resistance I felt apparently wasn't solidified ABS residue after all…

Don't get too close while watching the print!

I did and got my hair caught in the z-pulley and belt. Ouch!

If you change filament on the fly, make sure BOTH ends are nice & square

If you're printing along and are thinking about swapping the filament - maybe you want to change colors or are running out of filament - without stopping the print, make sure that both ends have nice, straight cuts to the end.

If you don't do this and one/both ends are wedge-shaped, the two filaments may try to work themselves around each other. This is bad and can rapidly lead to you needing to rebuild the hot end. Straight, square cuts only!

Don't break your thermistor!!!

Ever since I first built extruders, I have broken the thermistor that came with the extruder. For my first 2 extruders, I had to order new thermistors. My MK5 is the only extruder I have not broken the thermistor for.

Never overtighten anything!

My first Cupcake has way overtightened bolts everywhere. Only tighten the T-slot connectors

to where the nut becomes snug but doesn't start digging into any wood. In the tough-to-reach places, you can make it dig a little so you don't have to go in and tighten them, but otherwise don't overtighten.

Especially on the pulleys! DO NOT TIGHTEN DOWN THE PULLEY BOLTS UNTIL YOU HAVE USED YOUR MACHINE QUITE A BIT AND KNOW THE OPTIMAL TENSION. I accidentally smooshed the wood and now I am stuck with certain belt tensions. Fortunately they are okay :)

Cupcake Y Stage Assembly

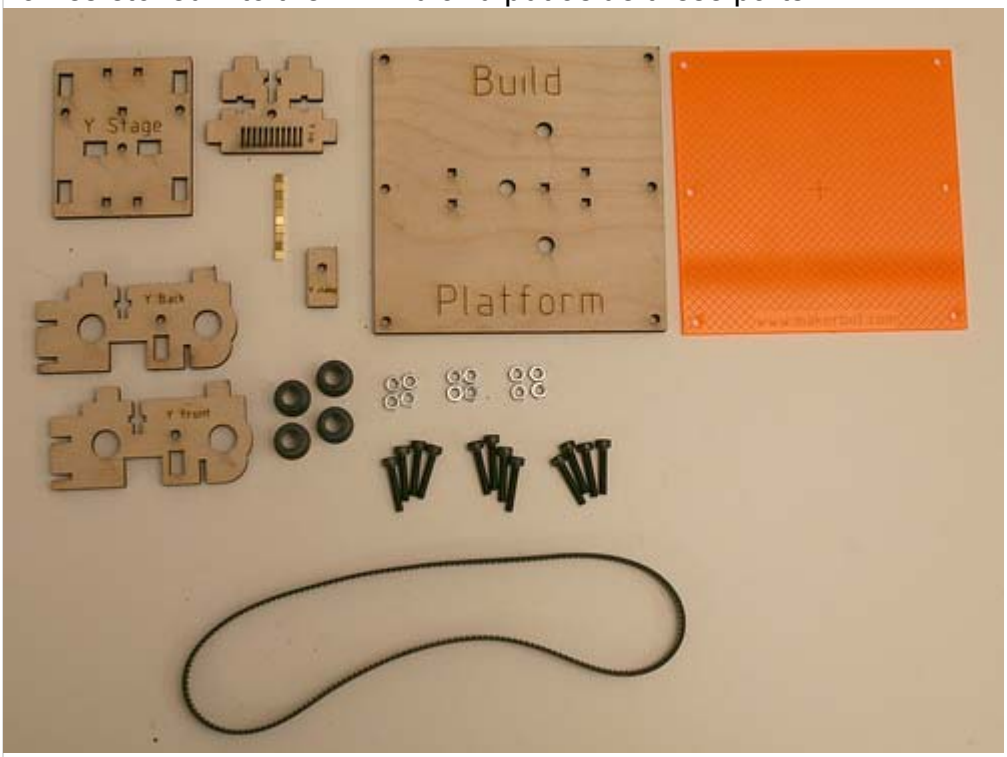
Table of Contents

Summary

Building the Y stage should take you about thirty minutes.

Parts list

These are the parts you'll need to assemble the Y stage. All laser-cut parts should have their names etched into them. Find and put aside these parts:



- Laser-cut stage parts
  - Build platform

    - Y stage
    - Y front
    - Y back
    - Y rib
    - Y clamp
    - Acrylic build surface
- 12 M3x16 bolts
- 12 M3 nuts
- 10 3mmx3mmx3mm gold magnets
- 4 flanged slide bearings
- 196 tooth continuous timing belt

You'll find the bolts in the bag labeled **Hardware burrito**.
The lasercut parts are in the **Cupcake CNC Lasercut Parts** box.
The belts and flanged bearings are in the **Belt, Bearing and Pulley** bag.

You'll also want to have on hand:

- 2 smooth Y rods (the shorter pair of rods)
- superglue
- hot glue gun or regular wood glue

If you have a deluxe kit, you'll probably also have a spare build surface kit, with an extra build platform and magnets. You can use these to build a spare platform, in case the one that comes in the laser-cut kit gets misplaced or damaged. Just make sure that you get the magnets the right way around when you do!

Assembly

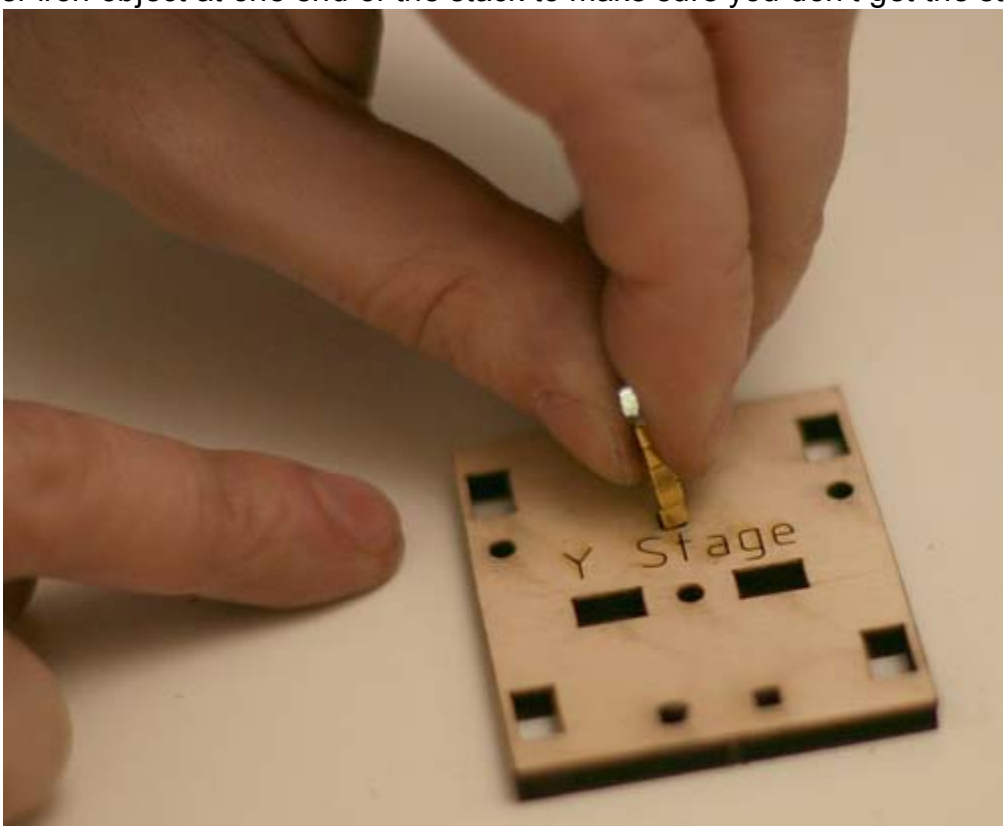
Insert magnets

The small square magnets keep the build platform firmly in place on the Y stage when the Cupcake CNC is in motion. The magnets are press-fit into the square holes on the build platform.

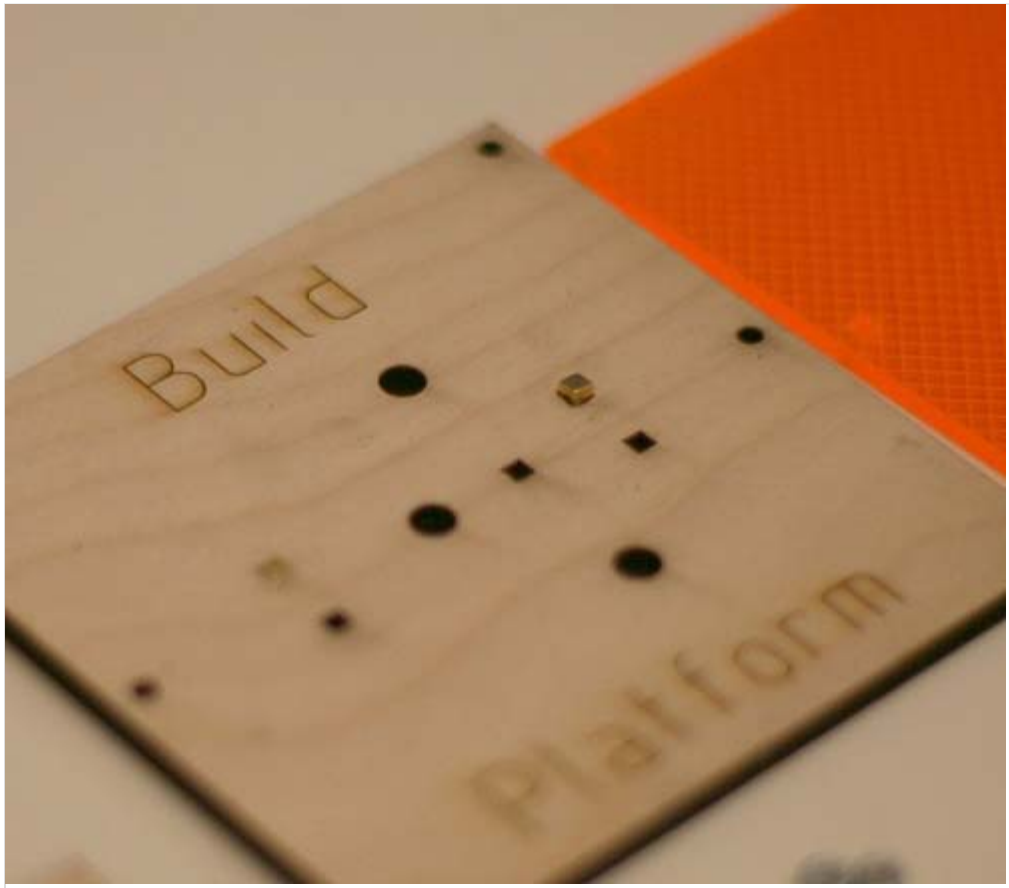
How to install a magnet

All the magnets must be aligned in the same direction. The easiest way to make sure you don't get a magnet backward is to stack them all so that they stick together.

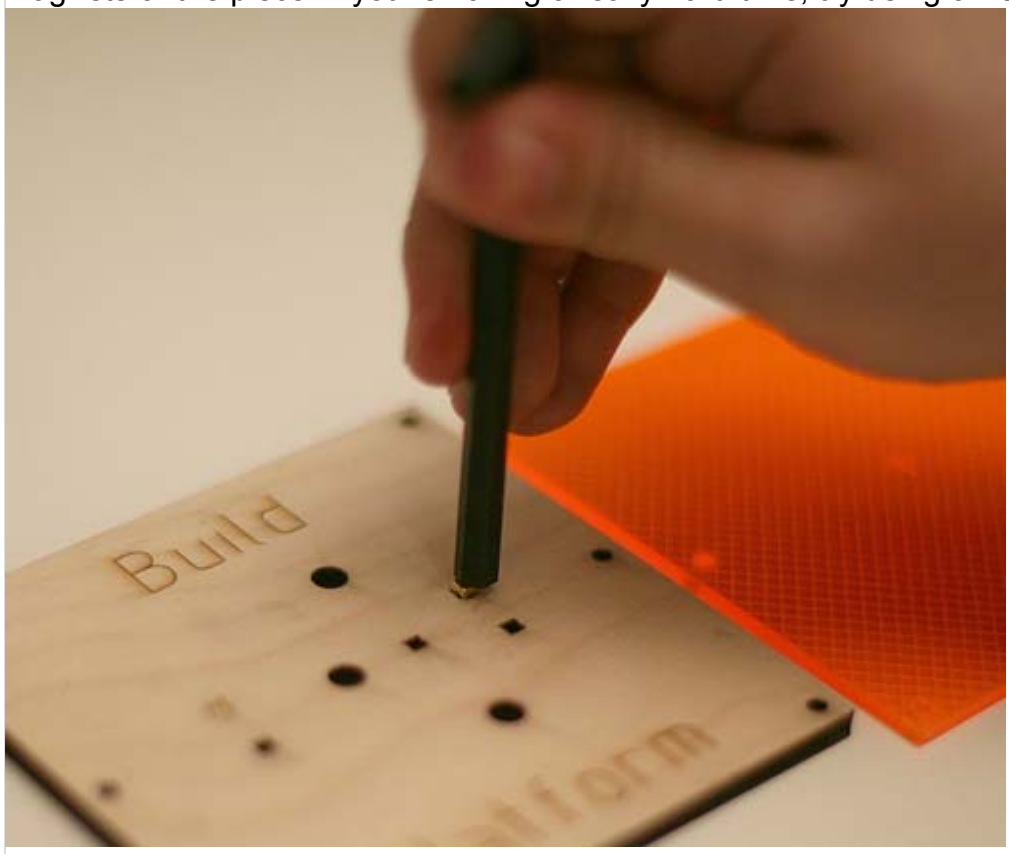
Put a nut or other iron object at one end of the stack to make sure you don't get the stack flipped around.



Push the end of the stack without the nut into the hole until the magnet at the end of the stack is partway into the hole. If you're having trouble getting the magnet into the hole, try reaming out the edge of the hole slightly with a small tool, like a hex key. Once the magnet is in the hole should then be able to remove the rest of the stack.



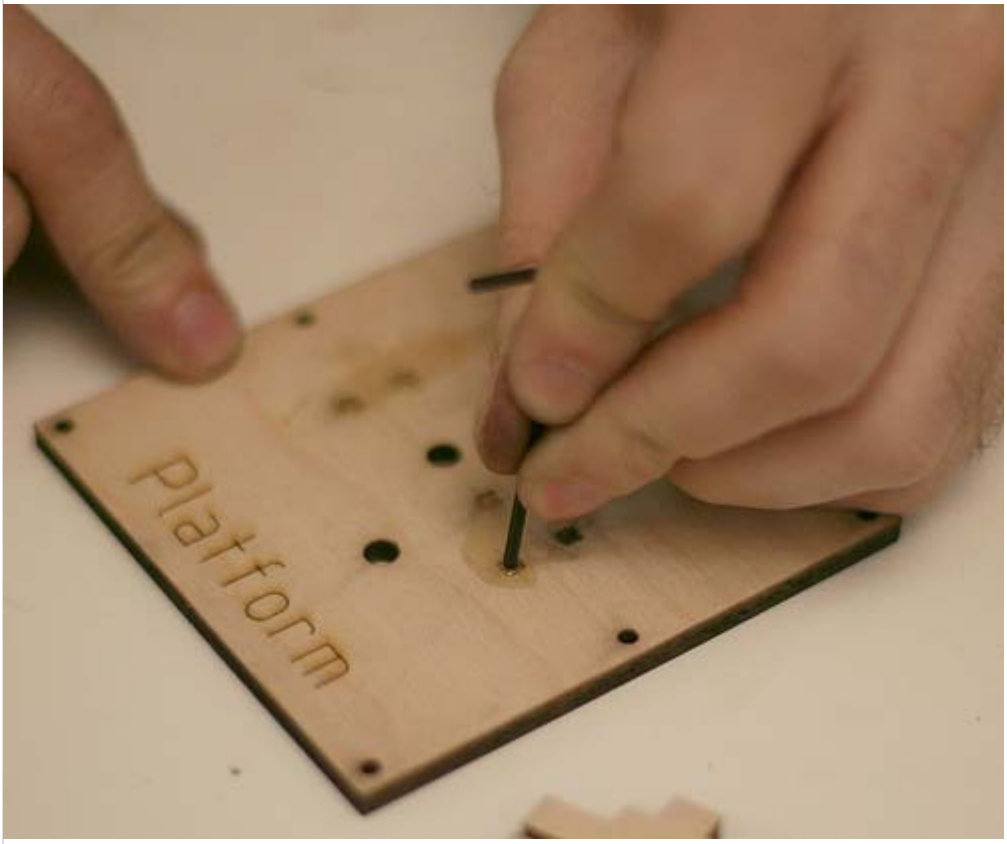
Use a some sort of blunt tool to press the magnet the rest of the way into the hole. We like to use a large hex key for this. *Don't hammer the magnets into the holes*— you may shatter the magnets or the piece. If you're having a really hard time, try using a vise or clamp.



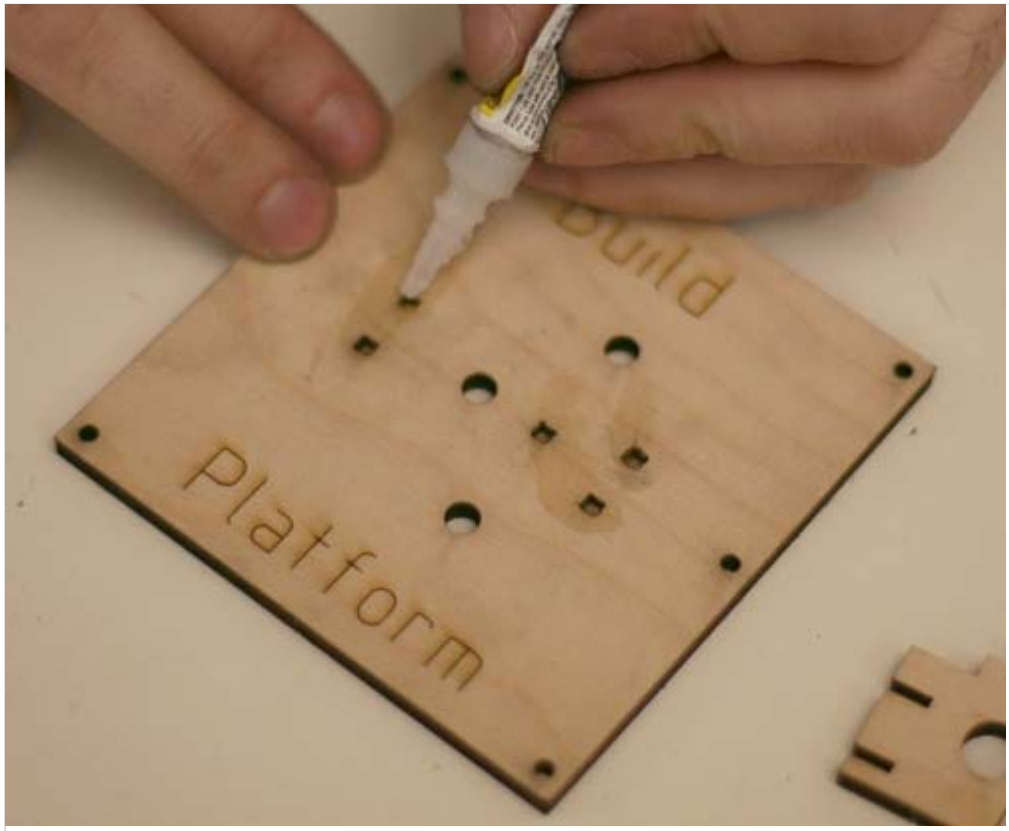
- Place the Build platform and Y stage pieces on a flat work surface so that the text on

each piece is facing upwards.

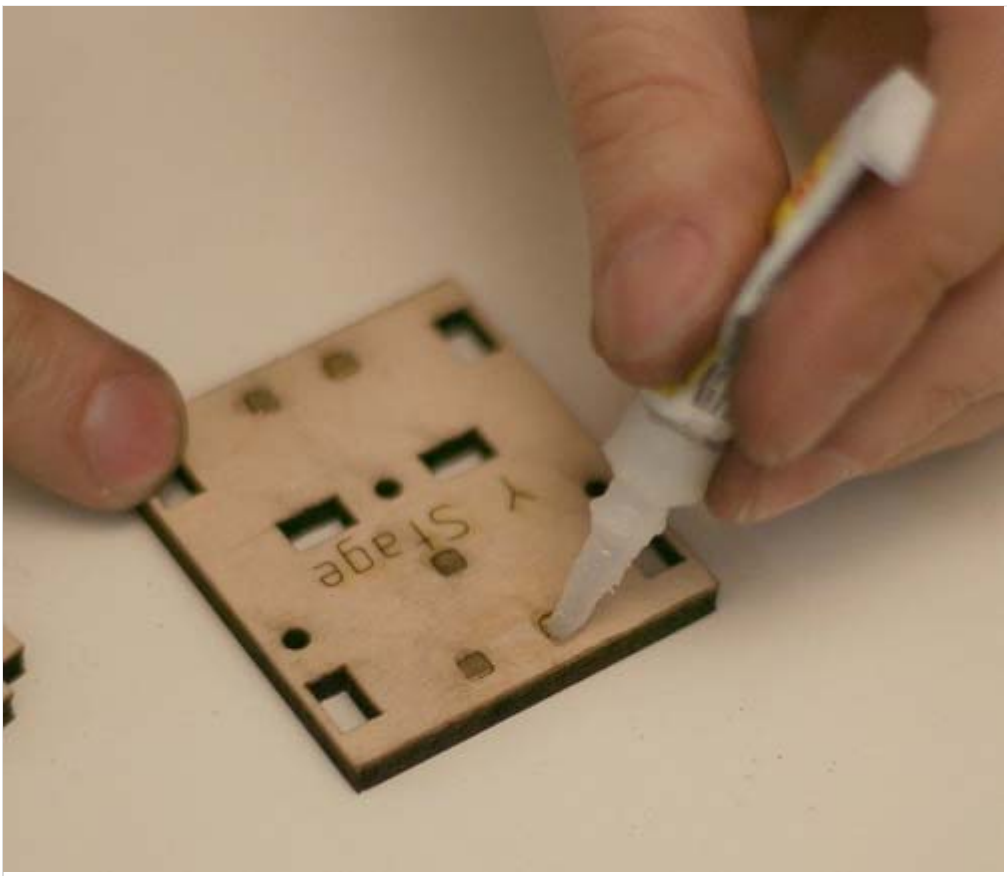
- Press five magnets into each of the square holes on the Build platform.



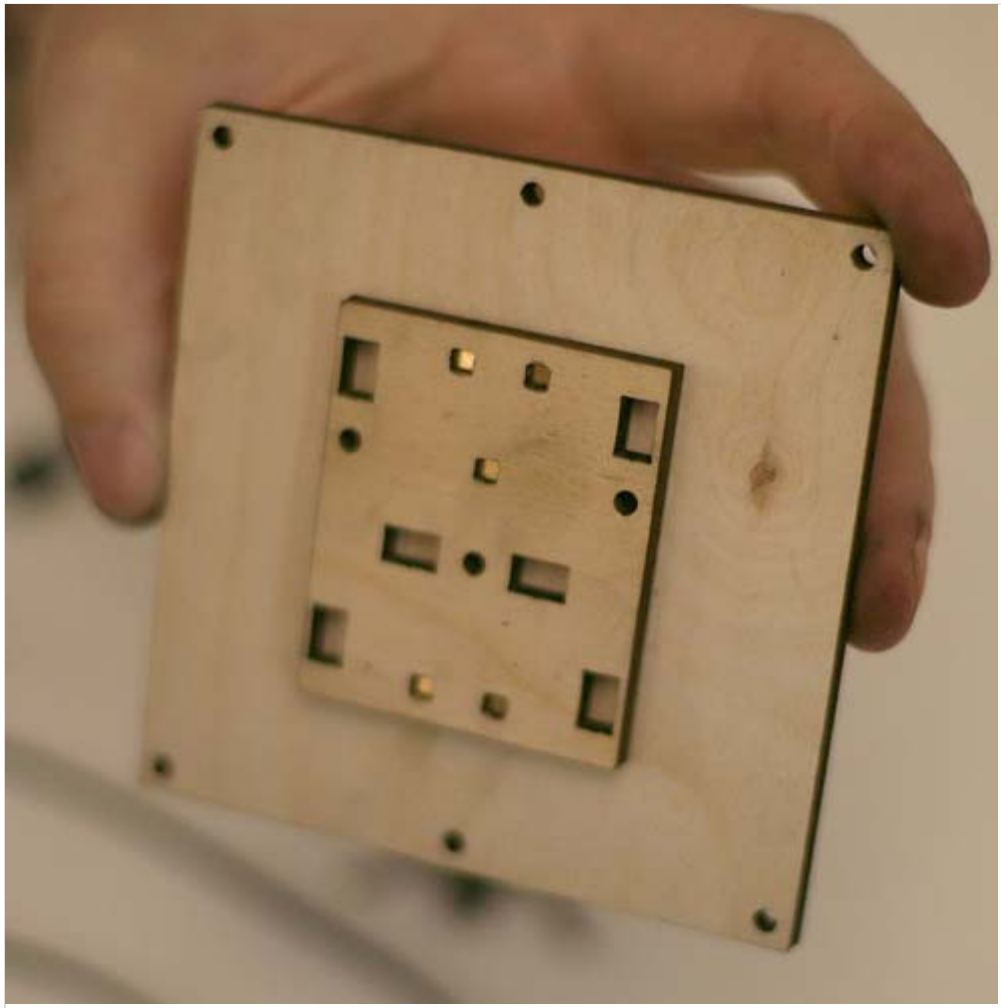
- Use a small tool to push the magnets all the way to bottom of their holes. These magnets should be flush with the *bottom* of the Build platform. If they stick out from the bottom, push them back up a bit. Make sure they're not protruding— you need the bottom of the Build platform to be flat against the top of the Y stage.



- Add a dot of superglue to each hole to help lock each magnet in place. (You may want to glue in the holes on the back side. This will still hold the magnets in place and you will be able to keep the front side with the flush magnets nice and smooth.)
- Press five magnets into each of the square holes on the Y stage.
- Make sure the magnets on the Y stage are flush with the *top* of the Y stage. If they stick up at all, push them down a little.

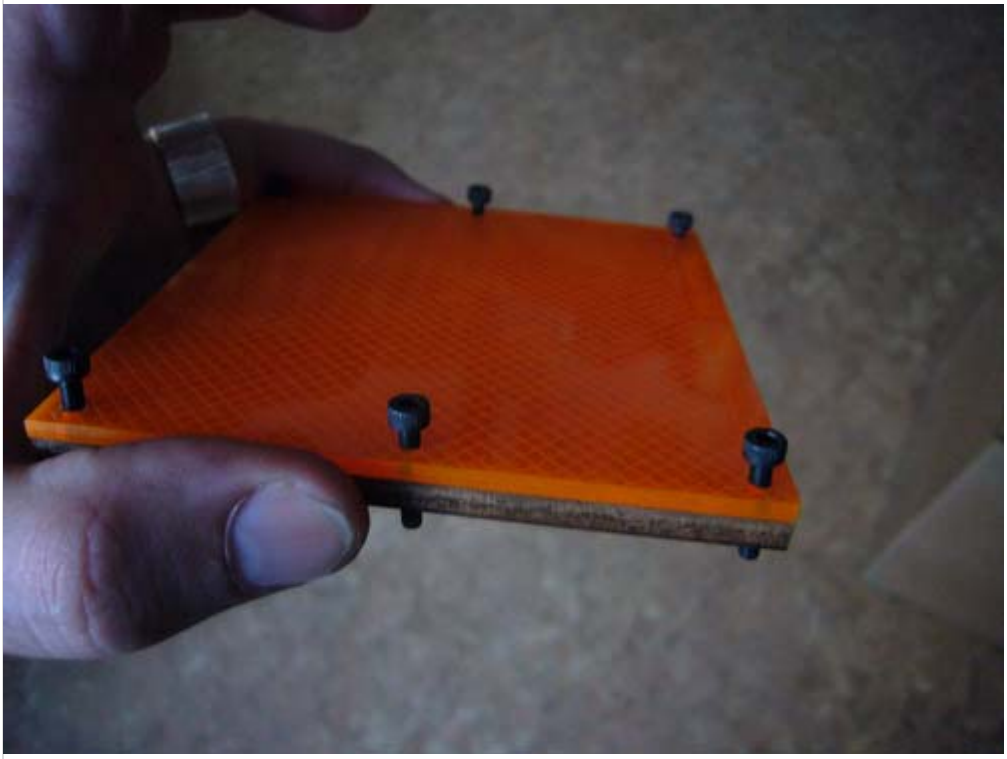


- Add a dot of superglue to each hole to help lock each magnet in place.



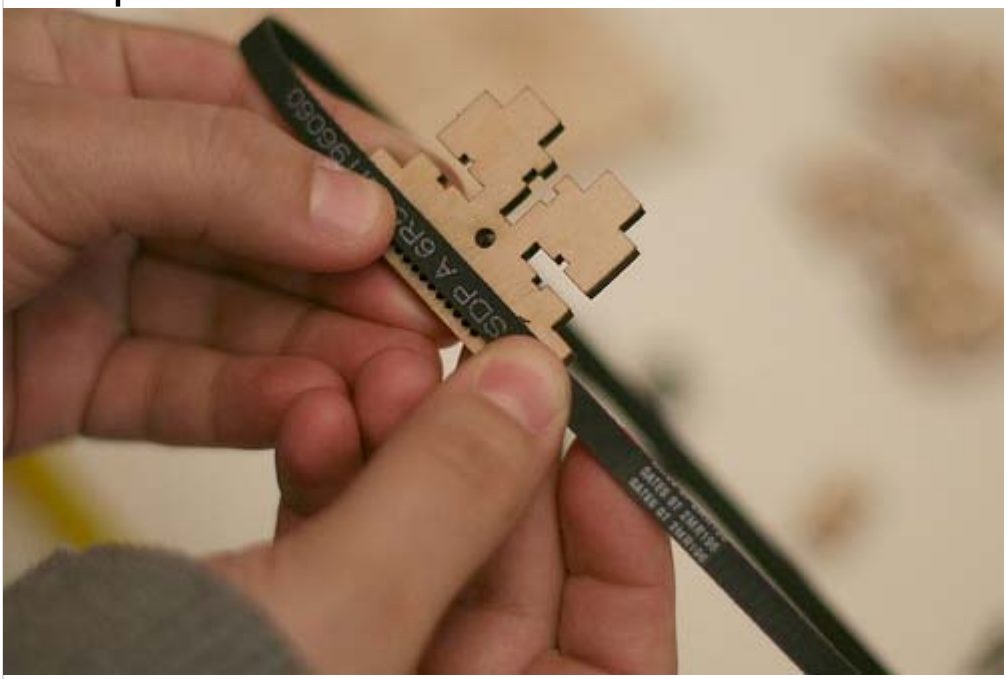
- Place the Build platform on top of the Y stage so that the round holes line up. The magnets should each attract the corresponding magnet below it. If there are magnets that repel one another, you have a magnet in backwards— carefully push it out and insert it the other way.
- Make sure the build surface and Y stage are flat against each other— if a magnet is sticking up, it can be a pain to adjust for later.

Attach the acrylic stage to the Build Platform

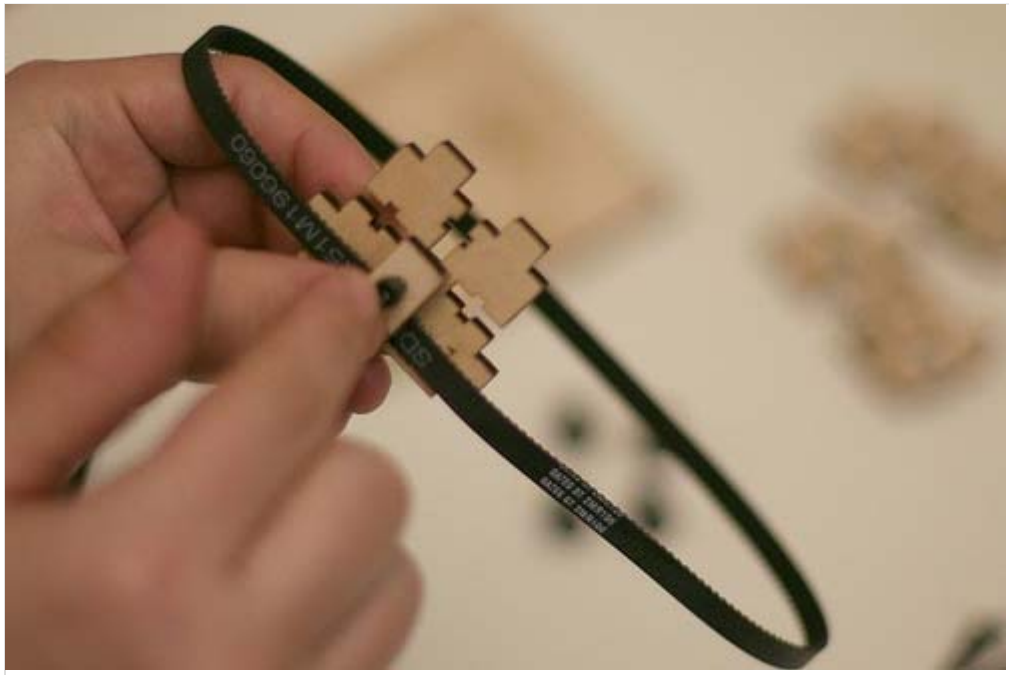


Use 6 M3x16 bolts and 6 M3 nuts to attach the acrylic stage to the top of the Build Platform.

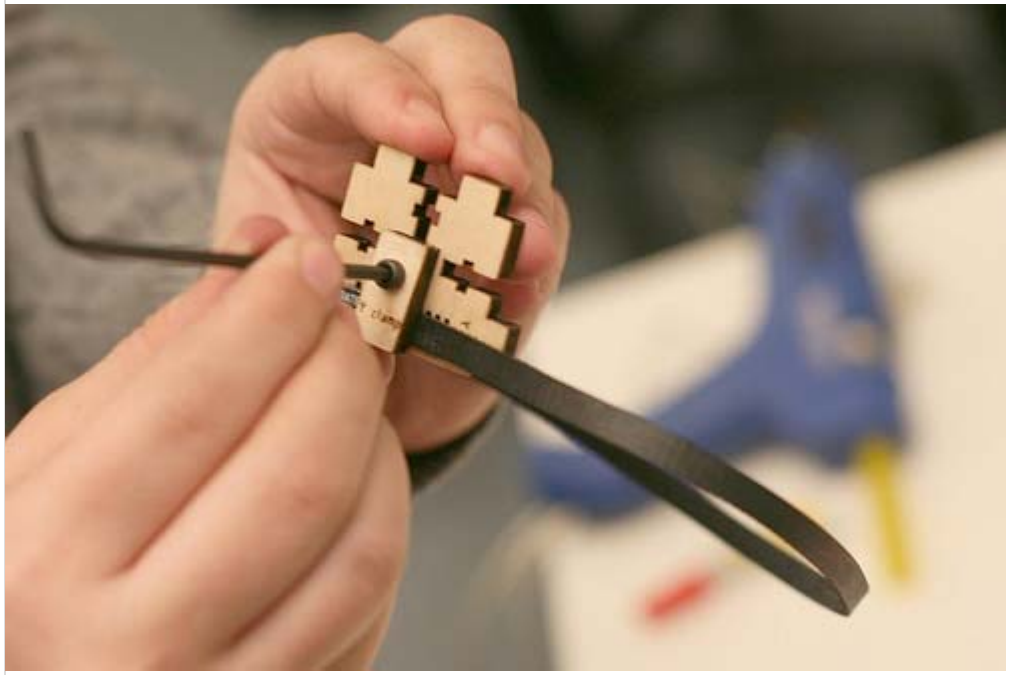
Clamp the Y belt to the Y rib



- Put the Y belt (the small, 196 tooth one) on the Y rib so that the teeth of the belt mesh with the slots in the rib.

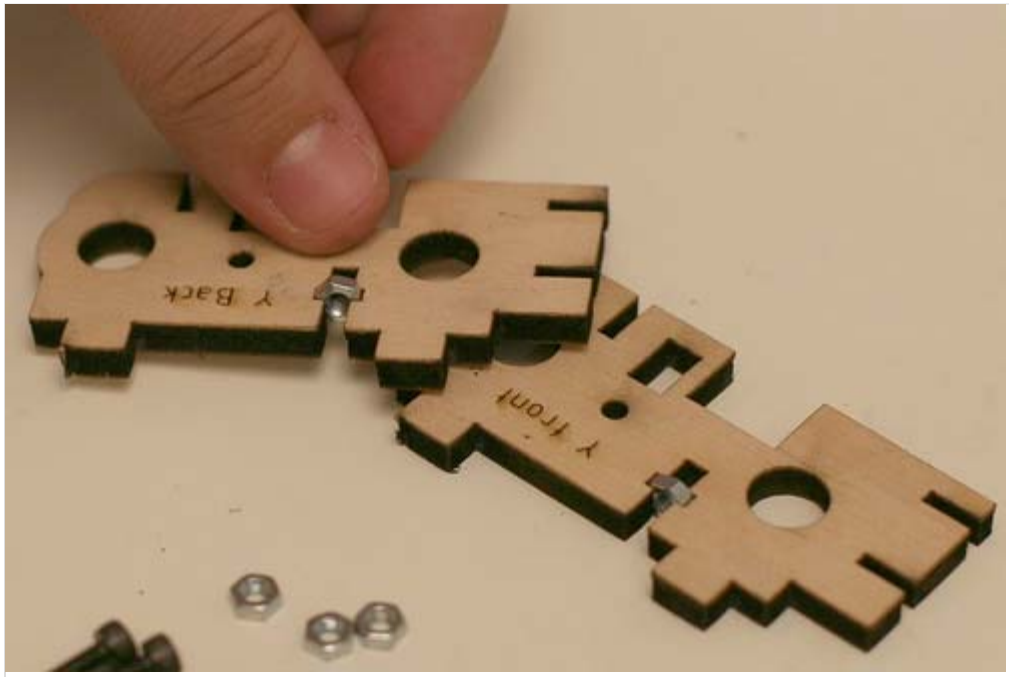


- Use an M3x16 bolt and an M3 nut to attach the Y clamp to the Y rib.

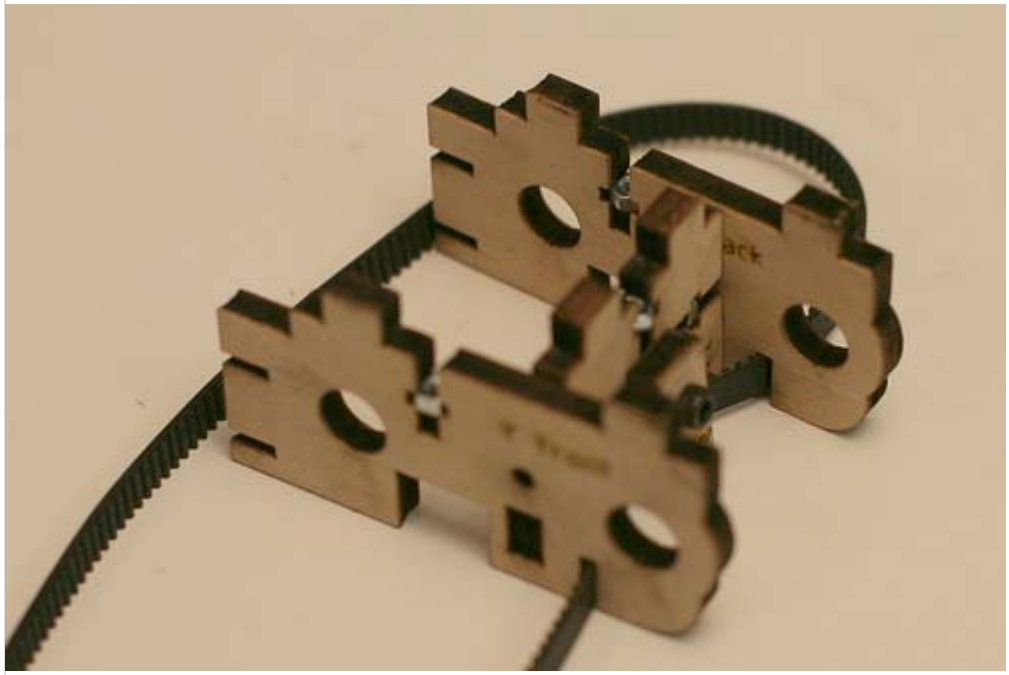


- Tighten the bolt with a hex key to firmly clamp the belt into place.

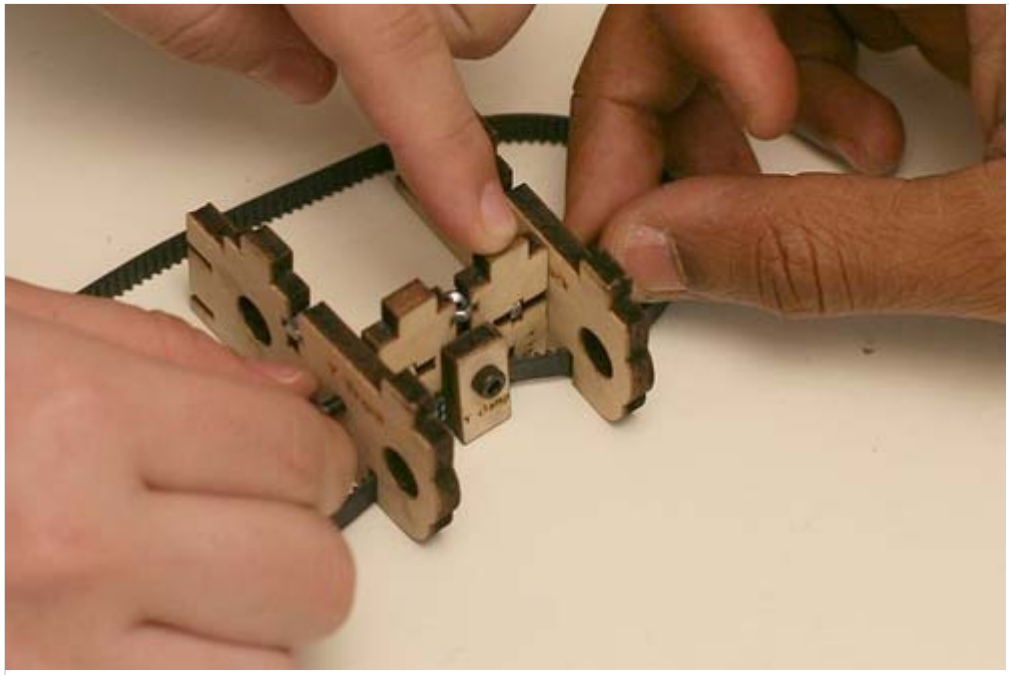
Assemble the carriage



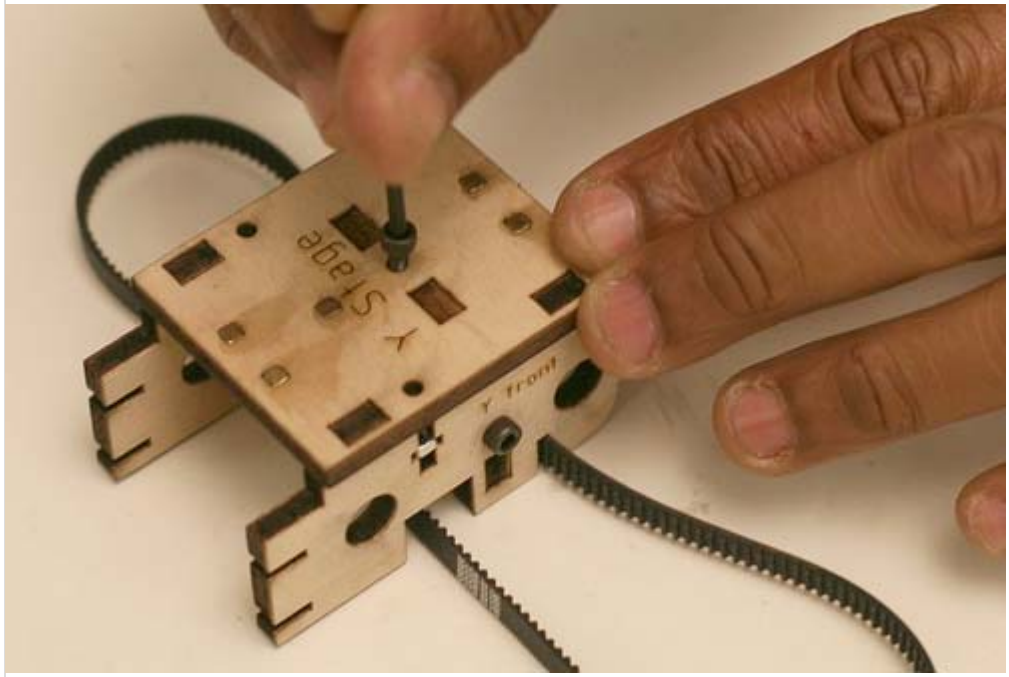
- Insert M3 nuts into the captive nut slots on the Y rib, Y front and Y back pieces.



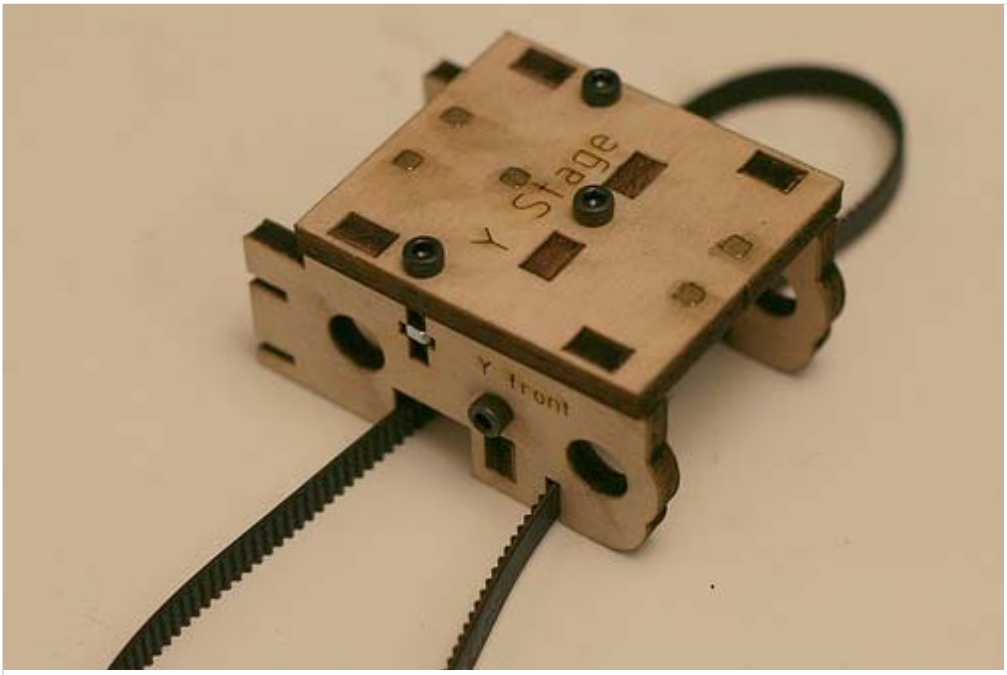
- Assemble the Y rib, Y front and Y back pieces. Make sure the Y rib is facing towards the small slots in the Y front and Y back, and that the Y belt is threaded through these slots as shown above.



- Bolt the front and back on to the rib by hand. Don't tighten these bolts yet.

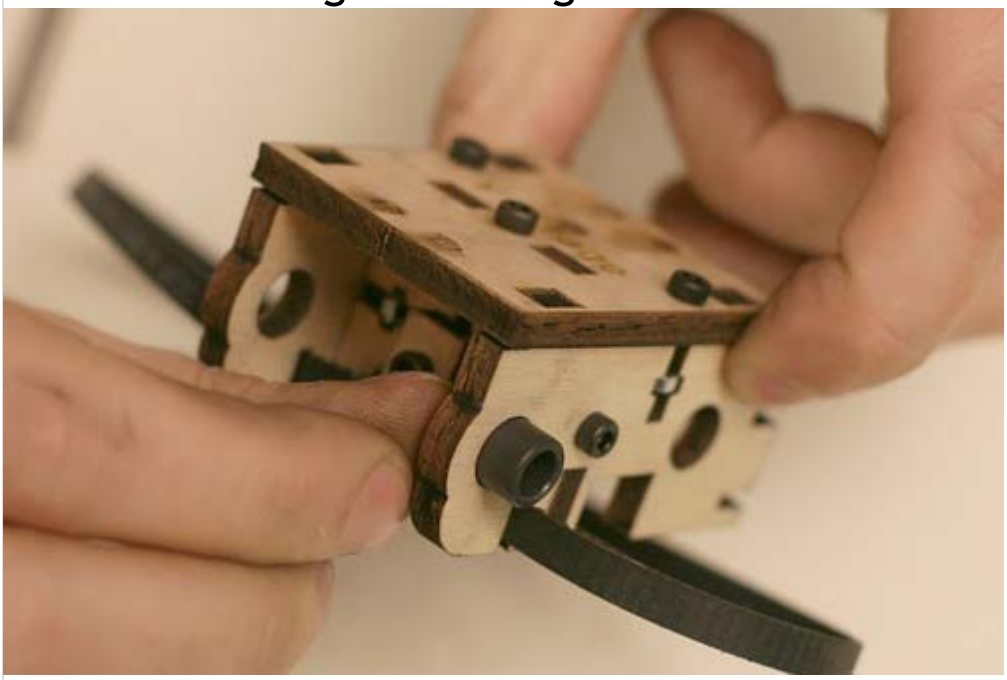


- Slot the Y stage on to the rest of the assembly, and bolt it on with three screws.

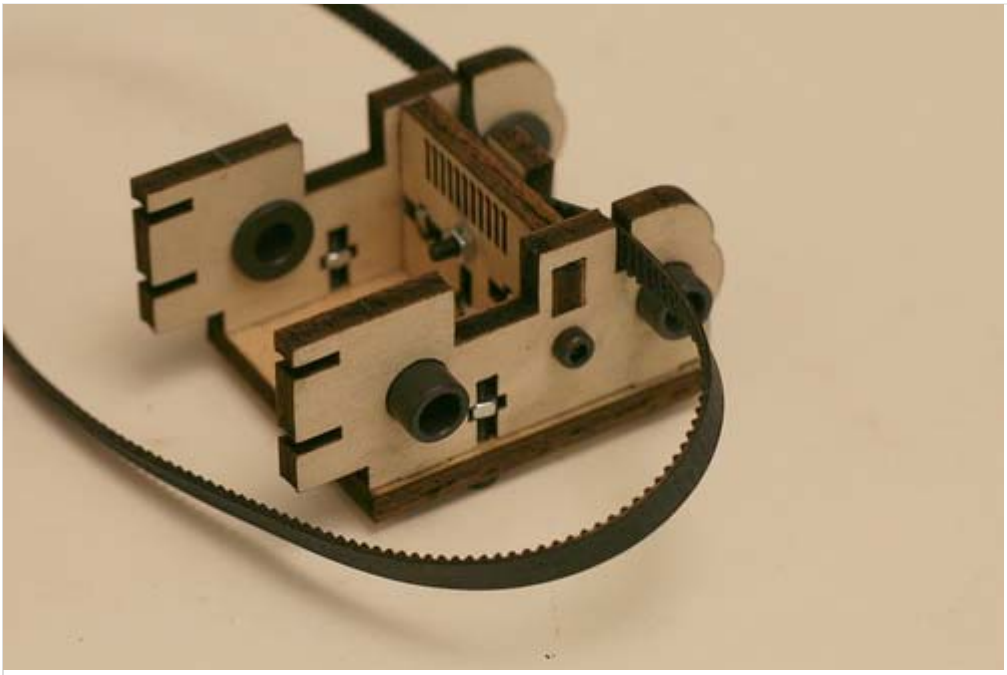


- Once the assembly is complete, tighten all the bolts.

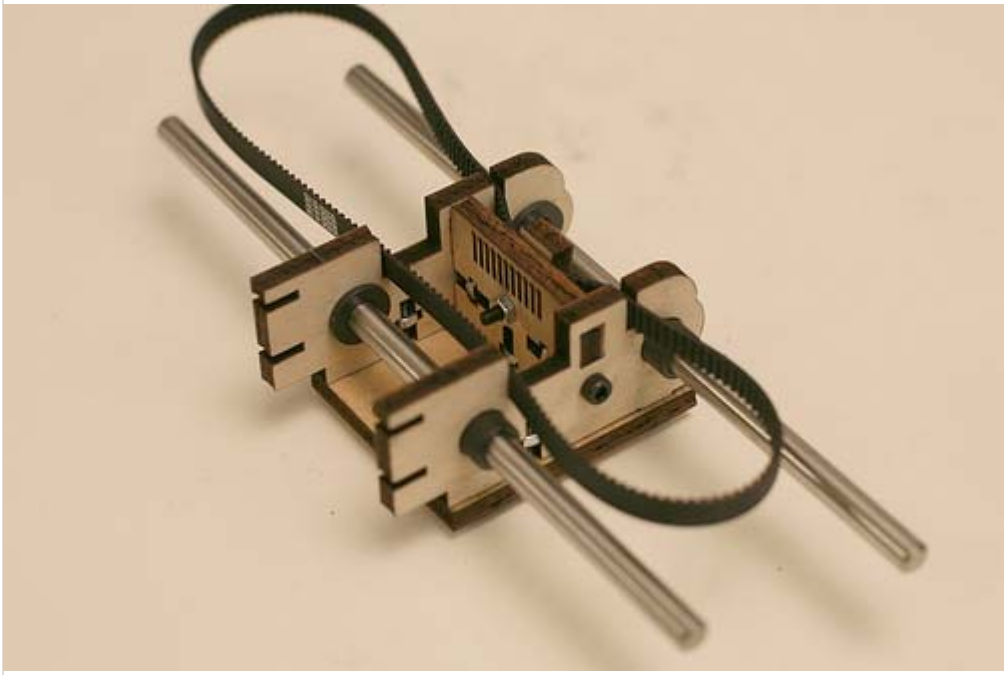
Install the flanged bearings



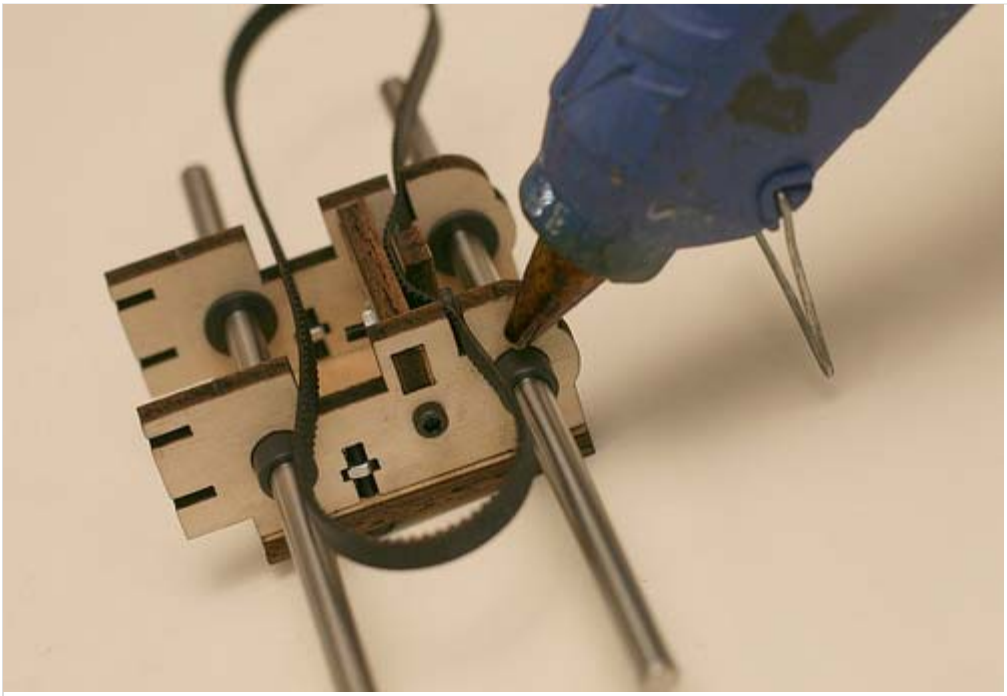
- Insert the flanged bearings into the round holes in the Y front and Y back pieces. Turn the bearings so the flange is on the inside.



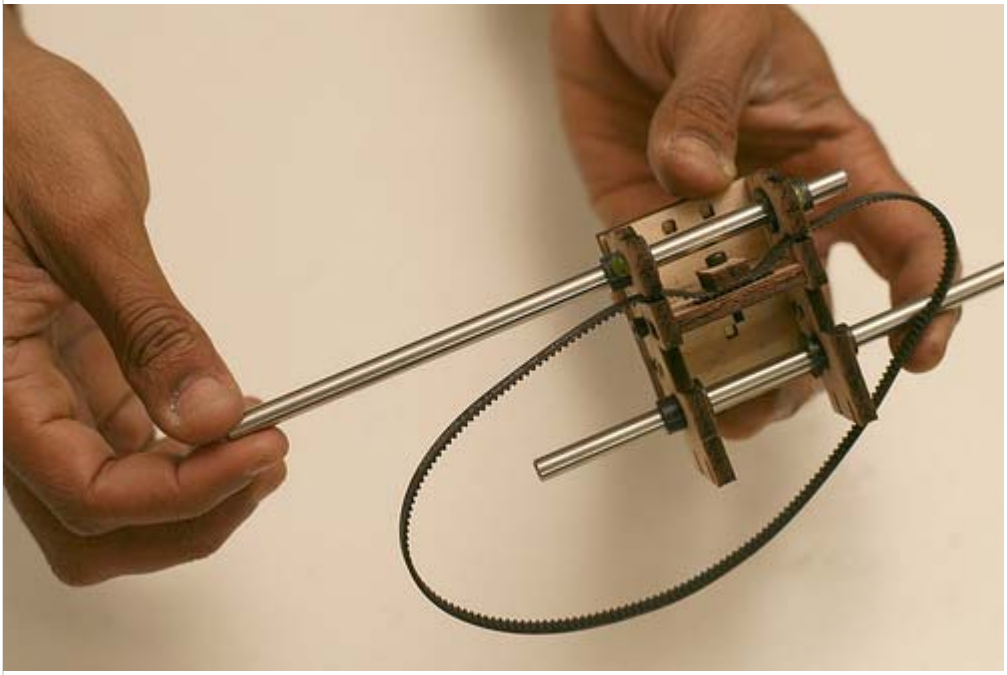
- When all four flanged bearings are all inserted, turn the stage on its back.



- Insert the Y rods into the bearings. (These are the shorter of the two sets of smooth rods.)



- Use a touch of hot glue or white glue to secure the bearings in place. Be careful not to get any glue on the rods. If you do, wait until it dries and then peel it off.



- Once you've confirmed that the rods slide smoothly on the bearings, remove the rods.

Congratulations! Your Y stage is now complete.

Cupcake X Stage Assembly

Summary

Building the X stage will take you about one and a half hours. You will need your previously assembled Y stage.

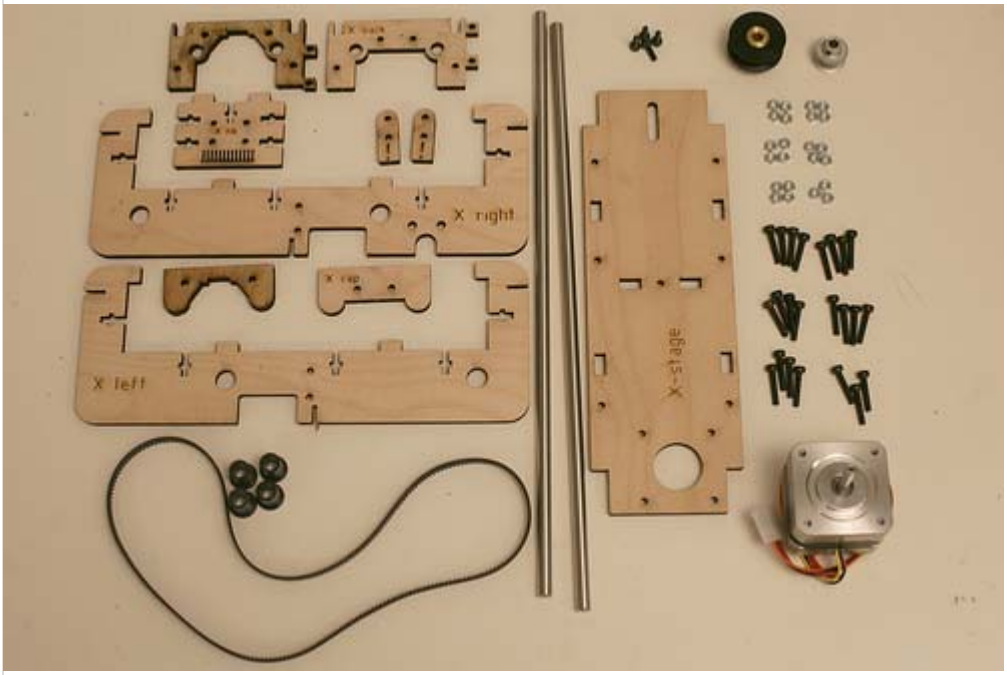
Before You Begin

- **Take Note:** the X front and front cap parts have changed as of the Batch 10 version of the kit! In your box, you may find two X front and X cap parts. They should be inside the bag marked "Supplemental Bearing and Pulley Kit". Use the new ones indicated in the picture above! You can keep the old ones as souvenirs.
- **Take Note 2:** There is a minor defect in CupCakes with a Serial Number of 982 and above. This includes part of Batch #13 and all of Batch #14. Batch #15 should be unaffected. Check the M3 bolt holes on the **X back** part relative to an **X cap** part and decide how you wish to proceed.
- **Take Note 3:** The narrow slots that allow the timing belt to run through on **X left** and **X right** are misaligned in batch 16. You will need to widen these slots slightly.

PICTURE NEEDED

- Identify the small idler pulley to distinguish it from the Z stepper pulley. You'll find the small idler pulley in the Supplemental Bearing and Pulley Kit.

Parts list

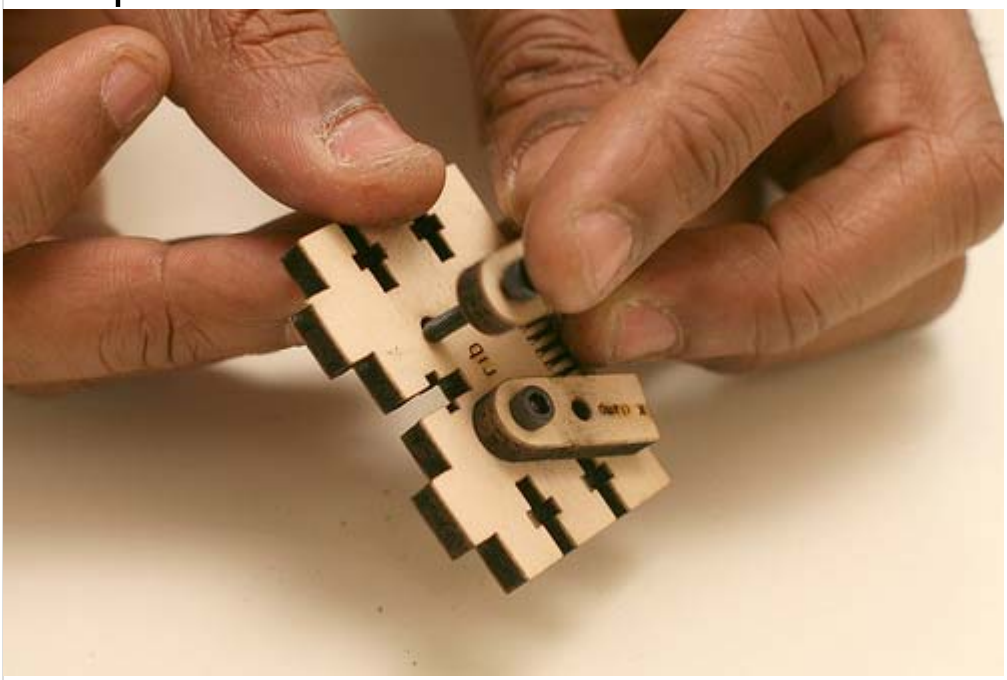


- Laser-cut stage parts
  - X stage
  - X left
  - X right
  - X front
  - X back
  - X rib
  - X back cap
  - X front cap
  - 2 X clamps
- NEMA 17 stepper motor
- 17-tooth aluminum drive pulley
- Small idler pulley (see above)
- 1 M5 45mm bolt (not shown above)
- 2 M5 nuts (not shown above)
- 1 M5 washer (not shown above)
- 4 flanged slide bearings
- 23 M3 16mm bolts
- 23 M3 nuts
- 4 M3 10mm bolts
- 2 smooth supporting X rods
- 2 smooth supporting Y rods (not shown above)
- 264 tooth continuous timing belt (the second-shortest one)

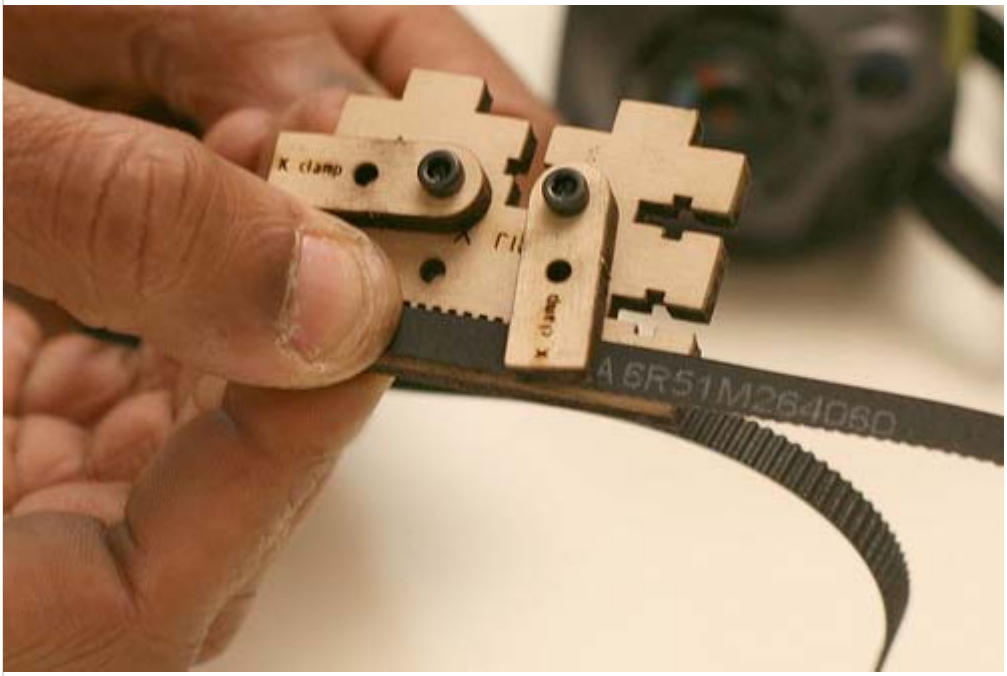
The lasercut parts are in the **Cupcake CNC Lasercut Parts** box.
The M3 & M5 bolts, washers and nuts are in the **Hardware burrito** bag.
The pulleys, belts, and flanged bearings are in the **Belt, Bearing and Pulley** bag.
The rods are bagged in the **Drive Rod Kit**.
The NEMA 17 motor is bubble-wrapped with the other NEMA 17 motors.

Assembly

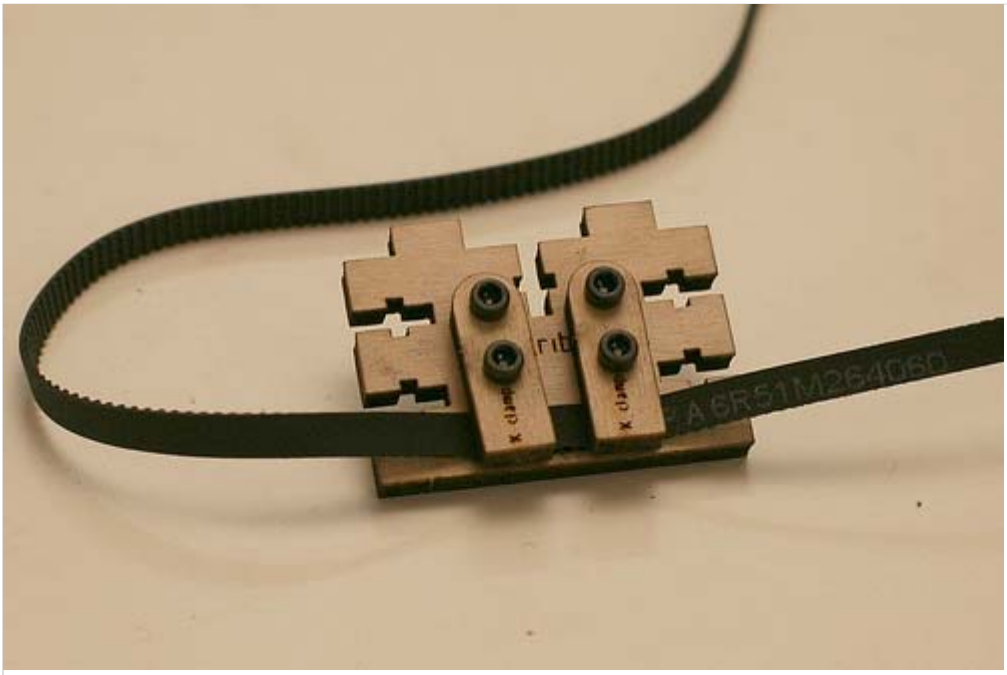
Clamp the X belt to the X rib



- Attach each X clamp to the front of the X rib through the uppermost holes with a 16mm M3. Loosely thread a nut onto each bolt, but do not tighten. Rotate the two clamps so they do not cover the slots in the rib.

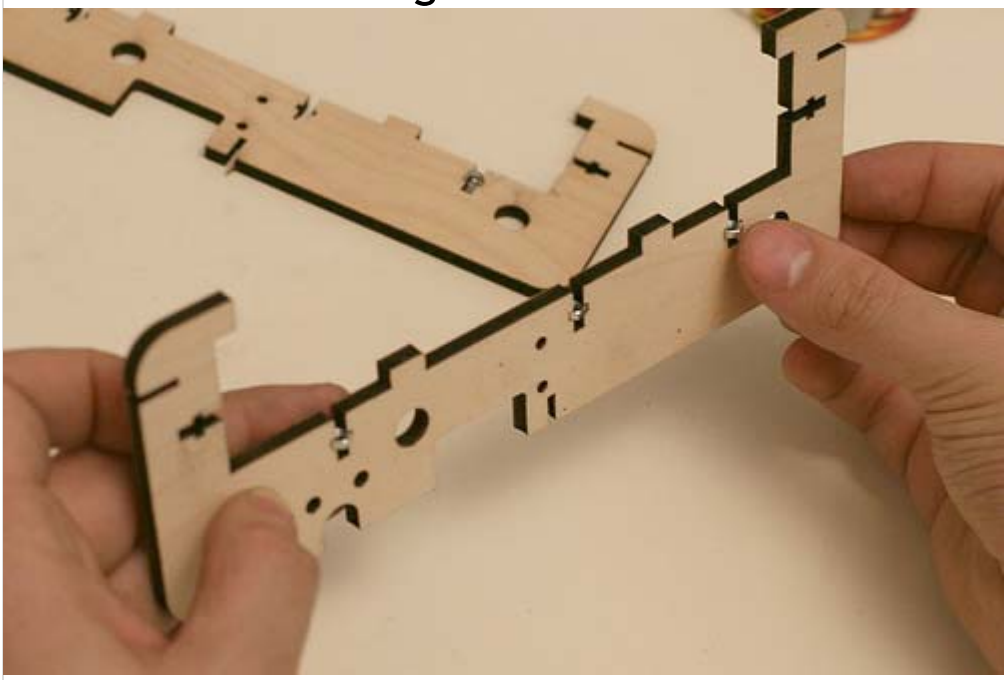


- Place the belt against the front of the rib so that the teeth of the rib engage the slots in the rib. Swing the clamps over the belt.

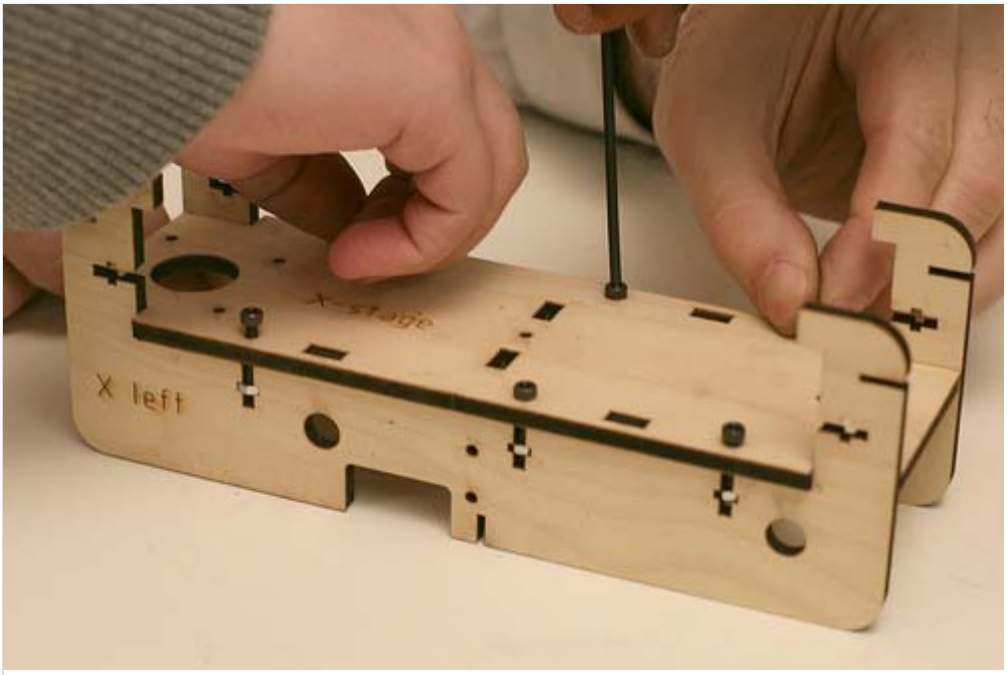


- Insert bolts in the lower set of holes and tighten all the nuts until the belt is firmly clamped to the X rib.

Assemble the X stage

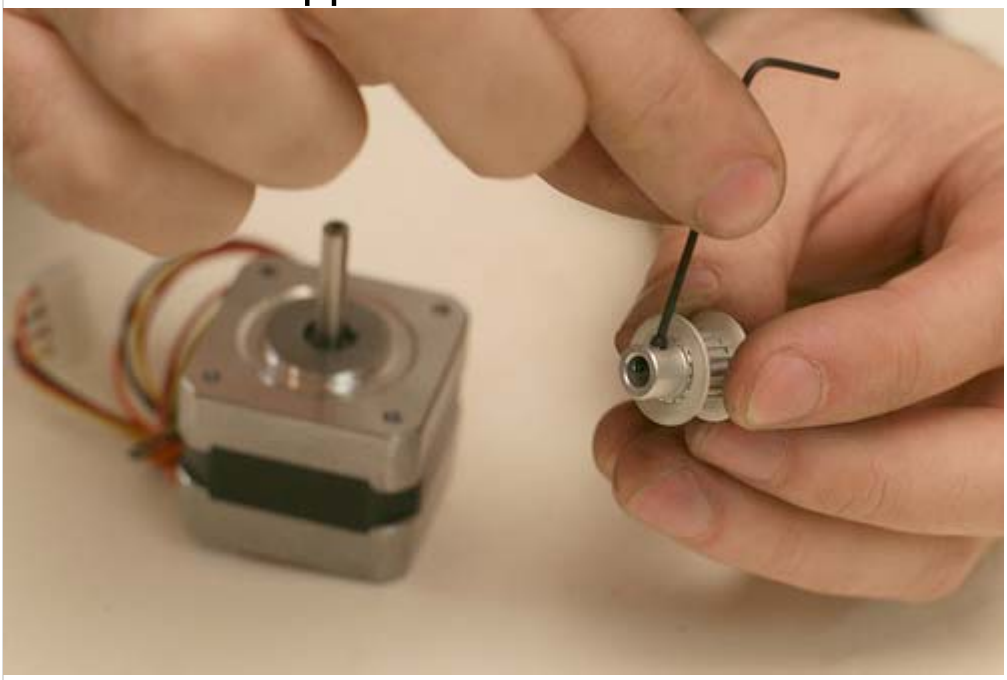


- Place 3 M3 nuts in the lower three T-slots on the X right and X left pieces. (You can leave the two t-slots at the ends empty for now.)

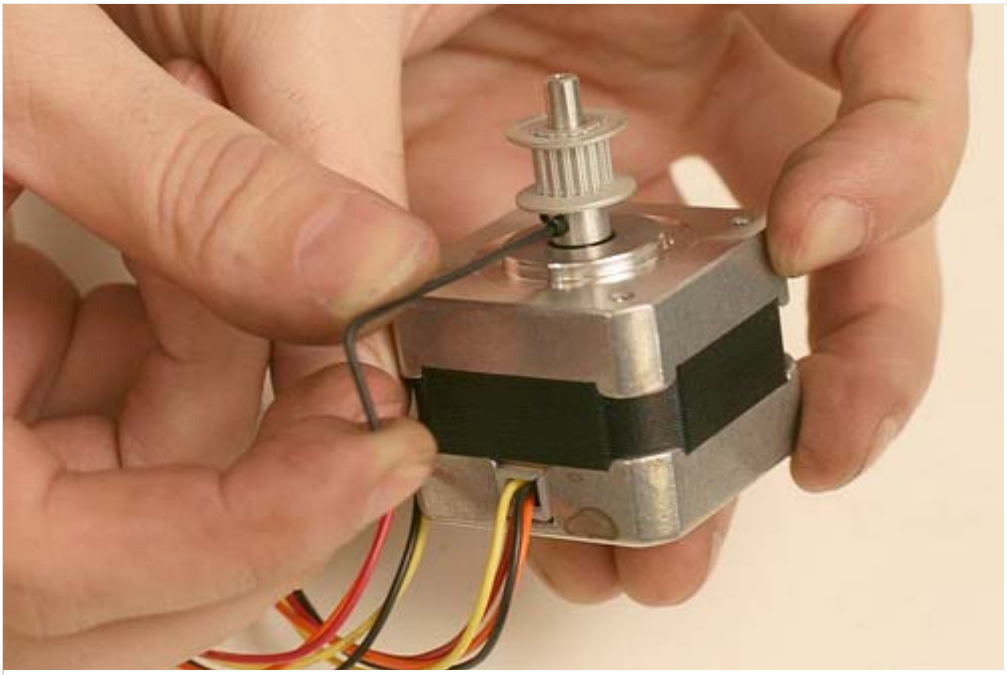


- Slot the X left and X right pieces into the X stage. The text on all three pieces should face outwards. Use six M3 bolts to tighten the sides to the stage.

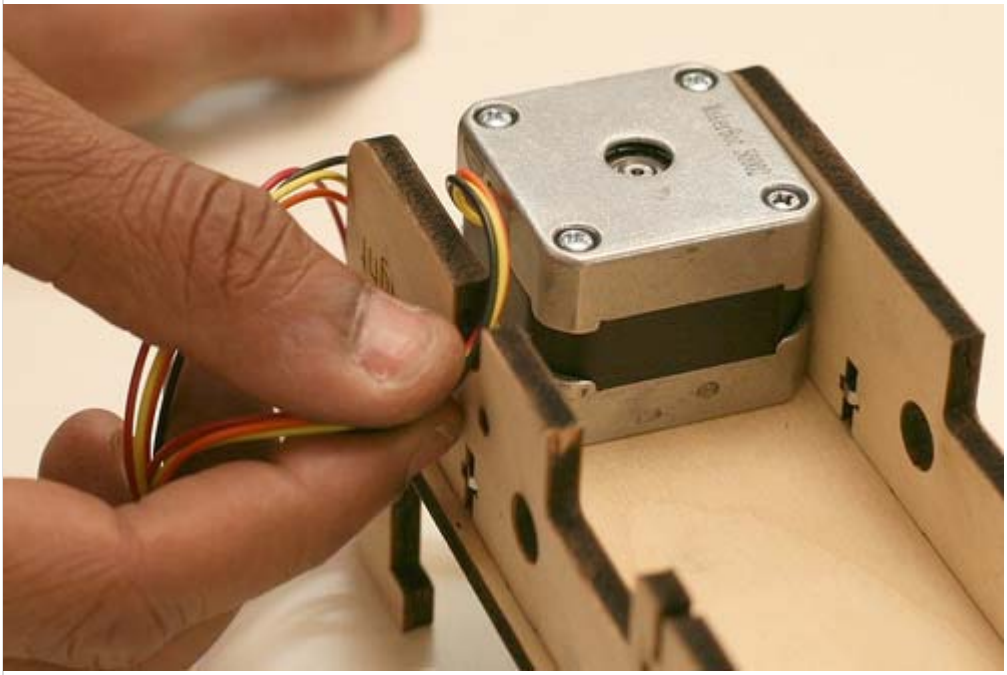
Mount the stepper motor



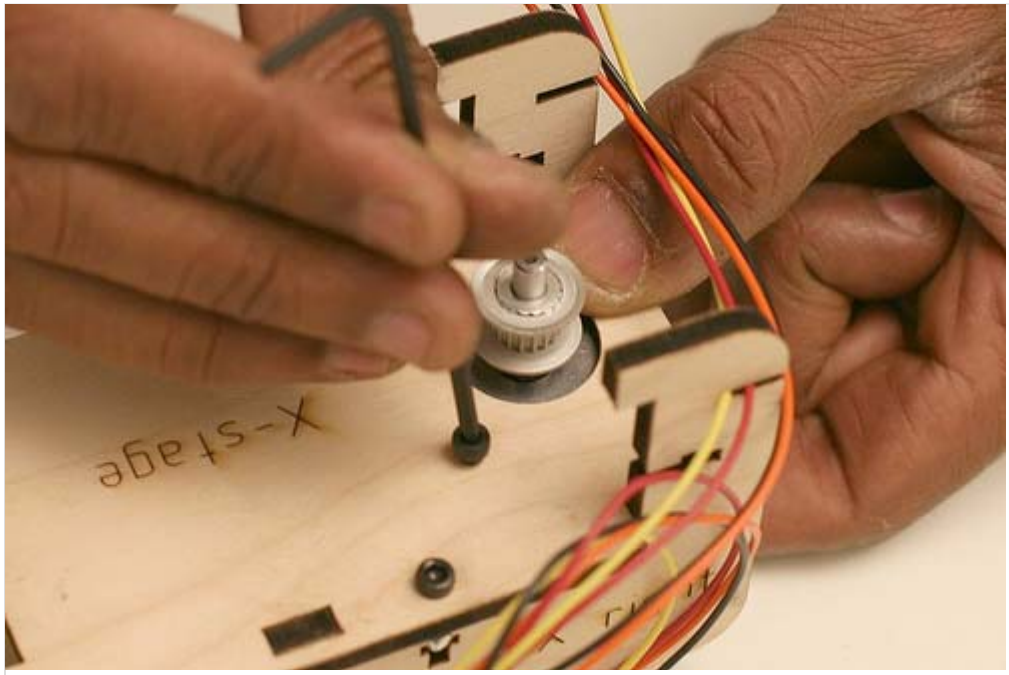
- Using the small hex key, loosen the set screws on the small aluminum pulley. Look down the bore to make sure the set screws are completely out of the way.
- Push the pulley onto the motor shaft, set-screw end first. The fit is very tight; if you're having a lot of trouble, try lightly sanding the inside of the pulley slightly. Adjust height of pulley depending on the height of the small idler pulley. This height should be around 3 millimeters.



- Tighten both set screws with the hex key. Make sure they're nice and tight.

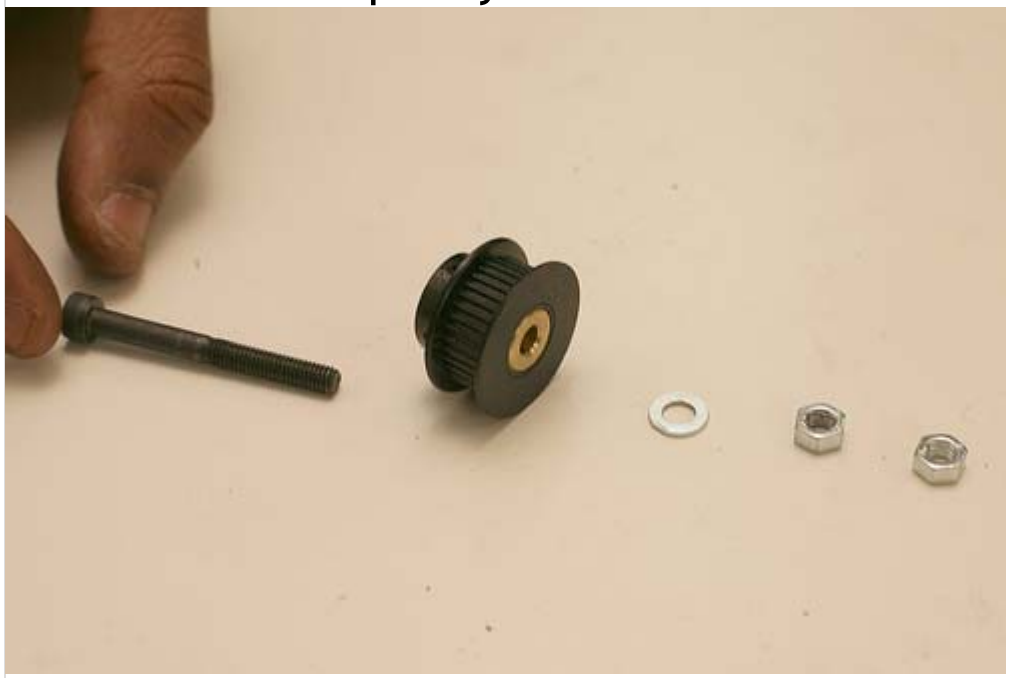


- Place the motor inside the stage, with the wires facing inside (towards the right) of the stage. Run the wires through the notch in the side. If you like, you can run a zip tie through the holes above the notch to hold the wires in place.



- Use the four 10mm (shorter) M3 screws to secure the motor to the X stage. *Do not use the longer 16mm screws to hold in the motor! They can potentially jam the motor and keep it from moving.*

Mount the small pulley



- Set aside the small idler pulley, the long M5 bolt, two M5 nuts, and an M5 washer.

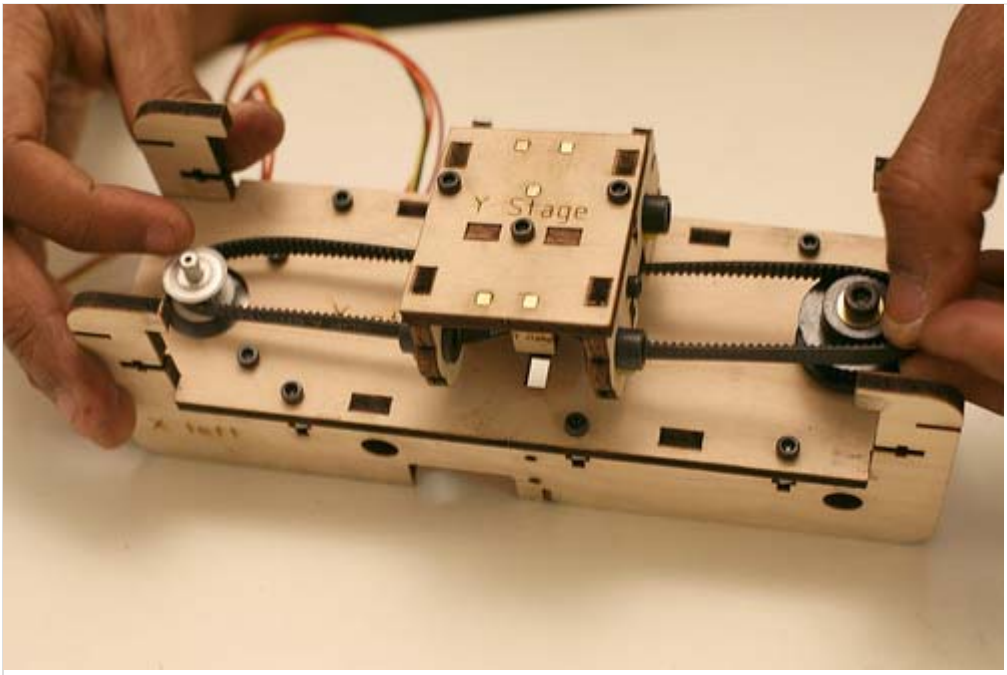
- Put the pulley on the bolt, with the side with the set screws towards the head of the bolt. Add a washer and then screw on an M5 nut as far as it can go and tighten it.
- Make sure the set screw on the idler pulley is not pressing on the bolt! You can even take it out altogether, if you like.
- Insert the rod of the pulley into the oblong slot on the right side of the X stage.
- Hand-tighten the the second M5 nut onto the bolt from the underside of the X stage. (Don't tighten it too much, because you will be adjusting it very soon.)

M5 Bolt Clearance Cutting

Starting around Batch 11 or 12, a number of people reported insufficient clearance between the M5 bolt-mounted small pulley (next step) and the X axis guide rods. One solution is to cut the 45mm long M5 bolt down to 40mm:

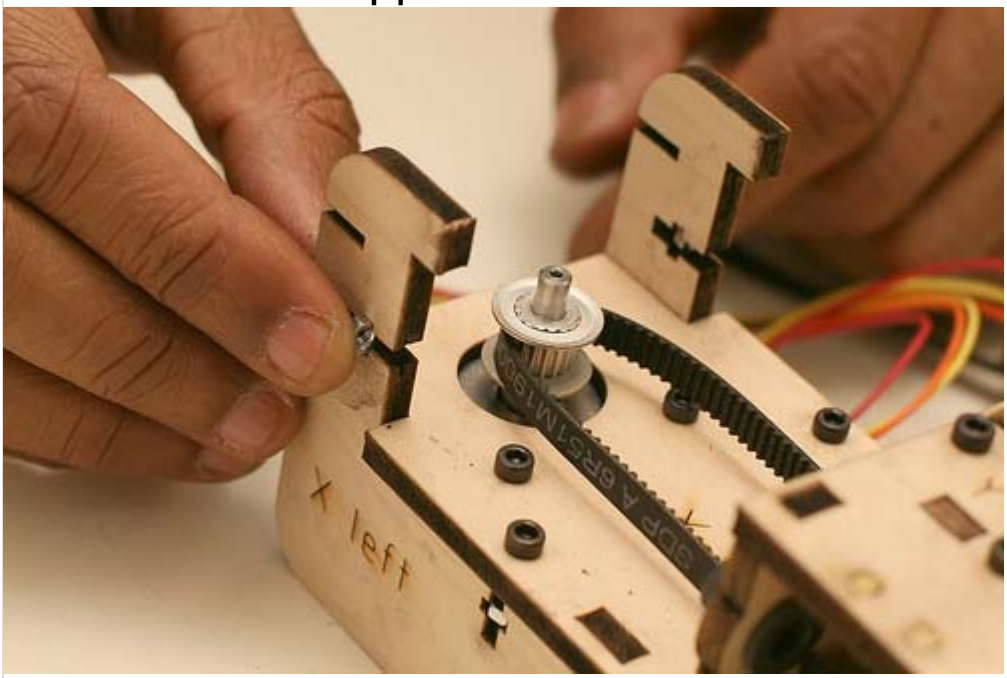
1. Run a nut all the way down to the head of the bolt **before** you start cutting.
2. Measure off **40mm** of bolt length, not including the head, and notch the position with a file.
3. Clamp the bolt head in a vice and with a Dremel ceramic cutting disc or hand-saw, cut off the remaining 5mm of bolt.
    - Take care not to spray sparks on your flammables.
    - You may want to use a grinder or buffer to remove any burrs or rough edges from the cut end of the bolt.
4. Remove the nut you added previously, using a wrench if necessary.
    - This may take a little muscle depending on how clean the cut is. You will need to be careful not to damage the threads, but as a result you will "repair" the cut threads of the bolt so the nut can be removed and replaced later.

Place the Y stage on the X stage

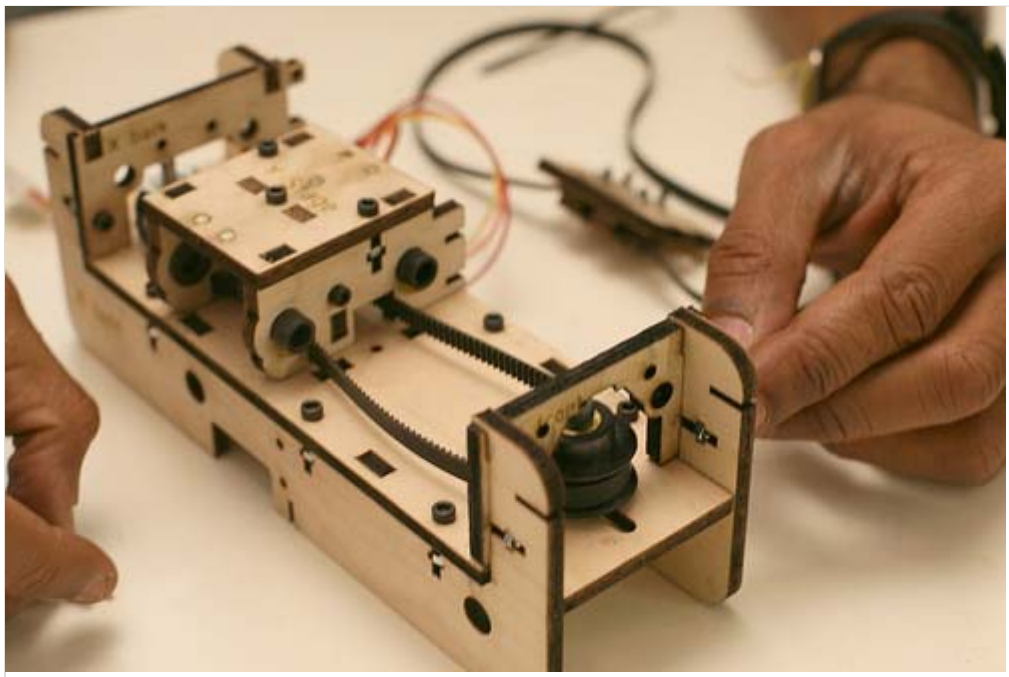


- Place the Y stage on the X stage. The side labelled "Y front" should face the front of the X stage (towards the motor). The slots in the side of the stage should point in the same direction as the motor wires. Loop the Y belt around the two pulleys.

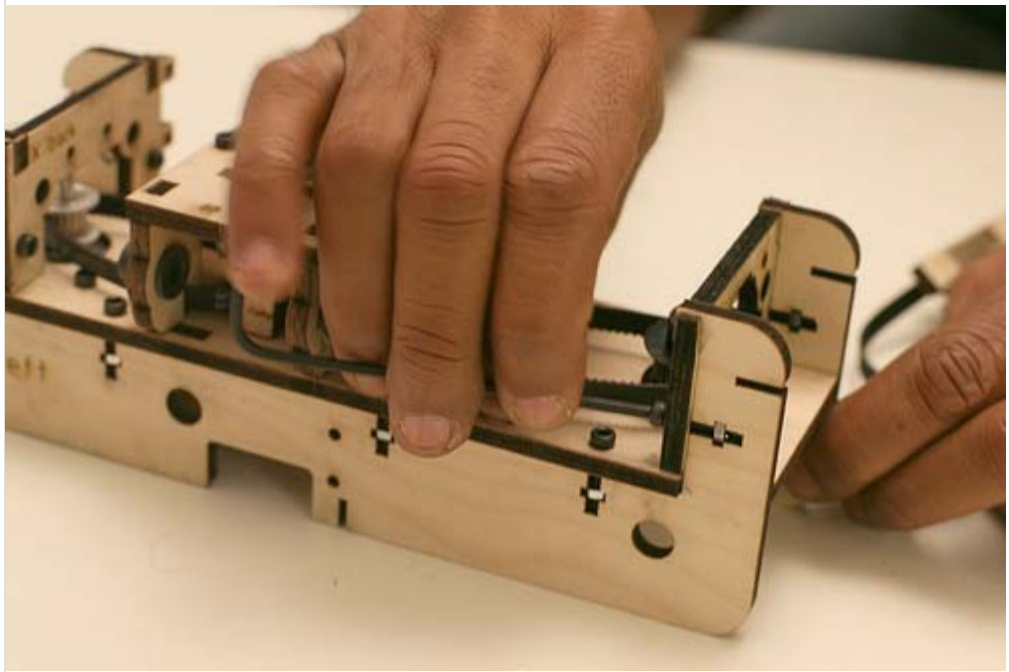
Mount the rod supports



- Put M3 nuts into the slots at the ends of the X left and X right pieces.

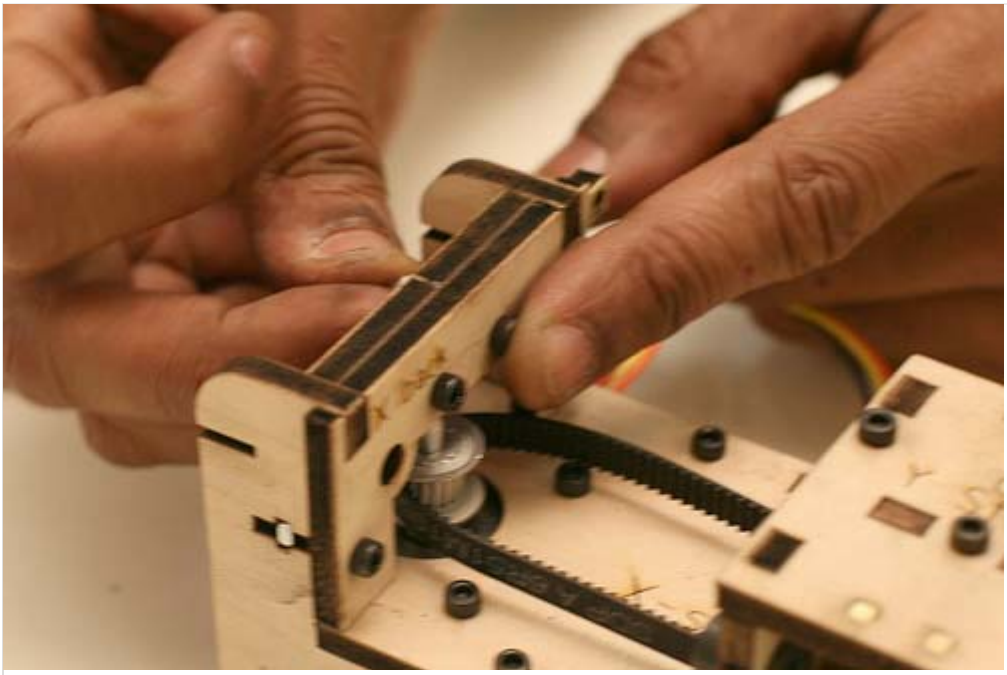


- Attach the X front and X back pieces to the frame as shown. The "front" of the stage is the end with the idler pulley; the "back" is the end with the motor. The text on both pieces should face the "front" of the stage.

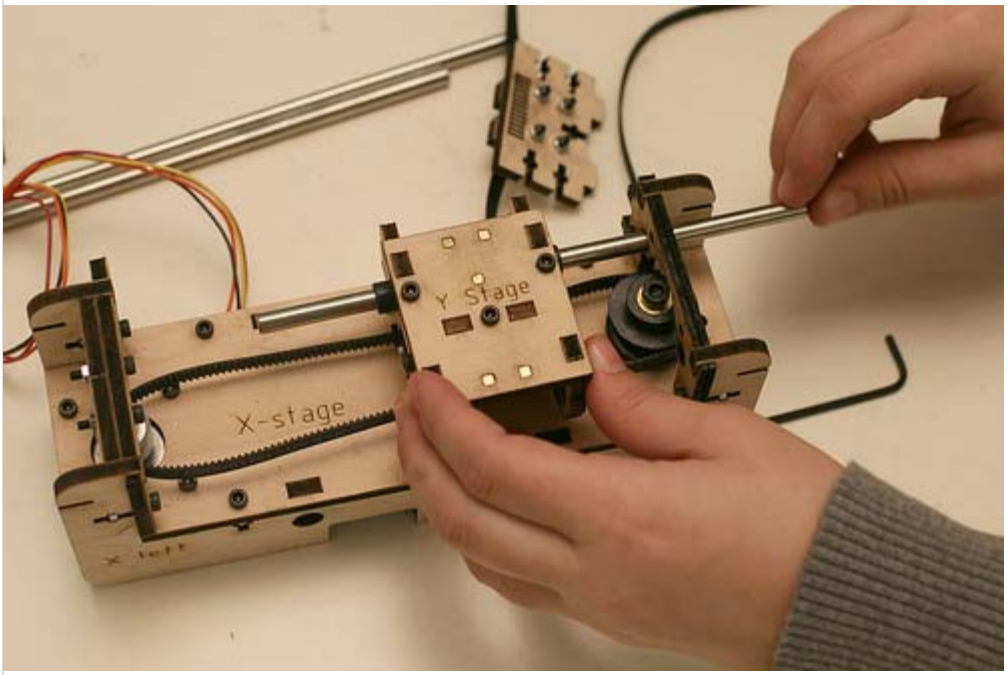


- Secure the front and back pieces in place with 16mm M3 bolts.

Mount the Y stage rods



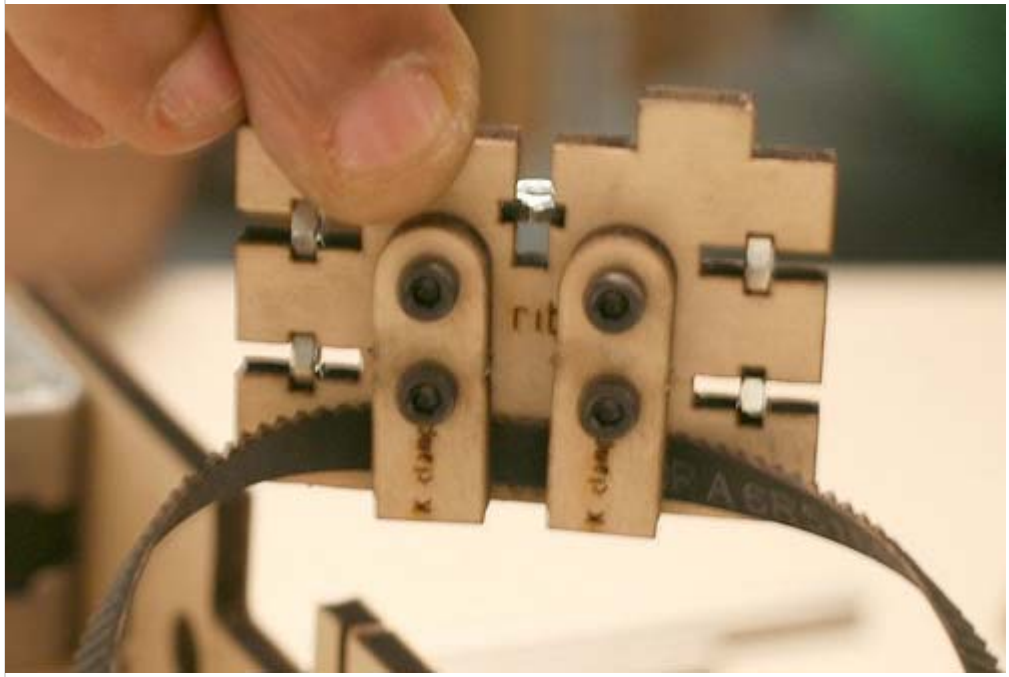
- Using an two M3 bolts and nuts, affix the X cap to the back of the X back piece. (Use the X cap piece that matches the X back.) This will hold one end of the Y rods in. Make sure the heads of the bolts are facing the front of the X stage.



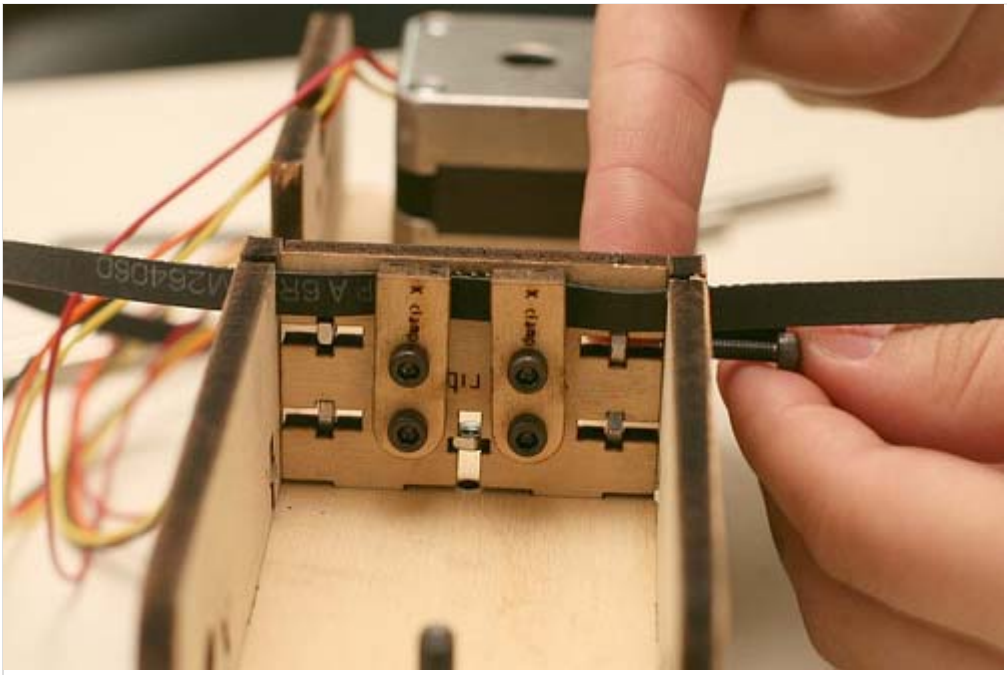
- Slide the Y rods (those are the shorter ones!) through the holes in the X front, the slide bearings in the Y stage, and into the holes in the X back.
- It's likely that the rods will extend very slightly from the holes. That's fine; we're going to clamp them in place with the other X cap.

- Using two 16mm M3 bolts and nuts, attach the other X cap to the front of the X front, clamping the rods in place. Make sure the heads of the bolts are facing the back of the machine.

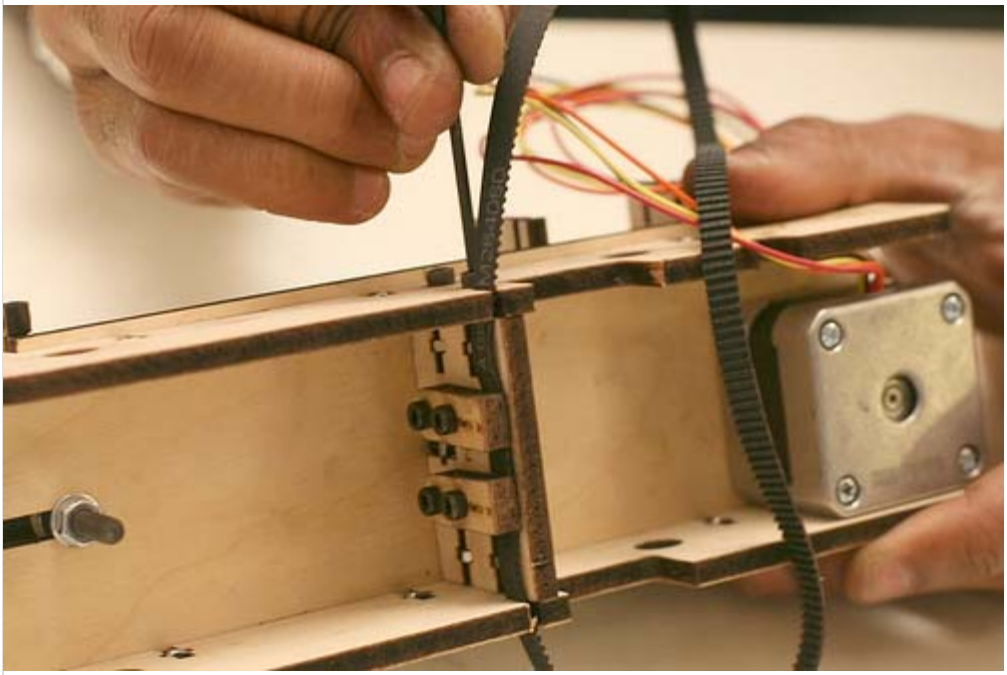
Install the rib and belt



- Insert five M3 nuts into the slots in the X rib.

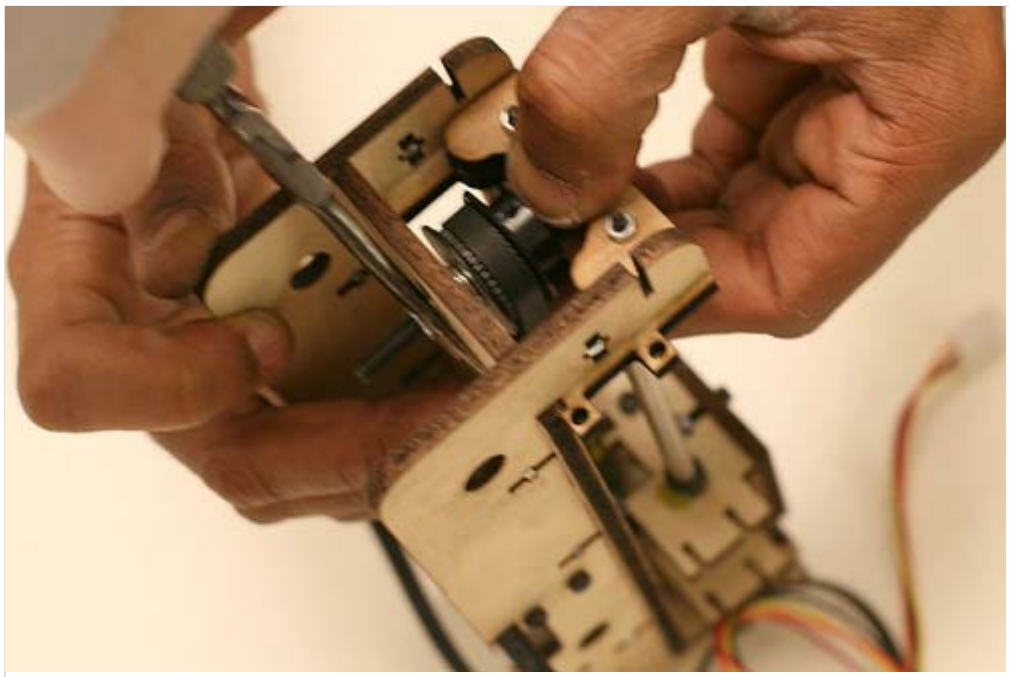


- Insert the rib into the underside of the X stage so that the belt runs through the two narrow slots. (The text on the piece should face away from the motor, towards the front of the X stage.)



- Screw the rib into place with five 16mm M3 bolts.

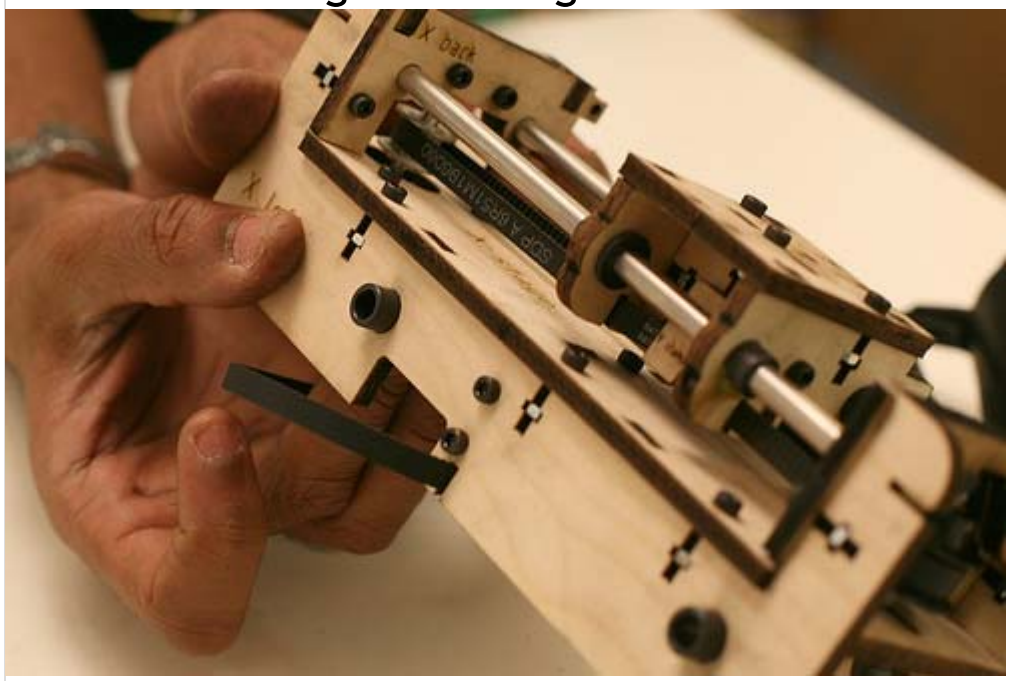
Tighten the Y belt



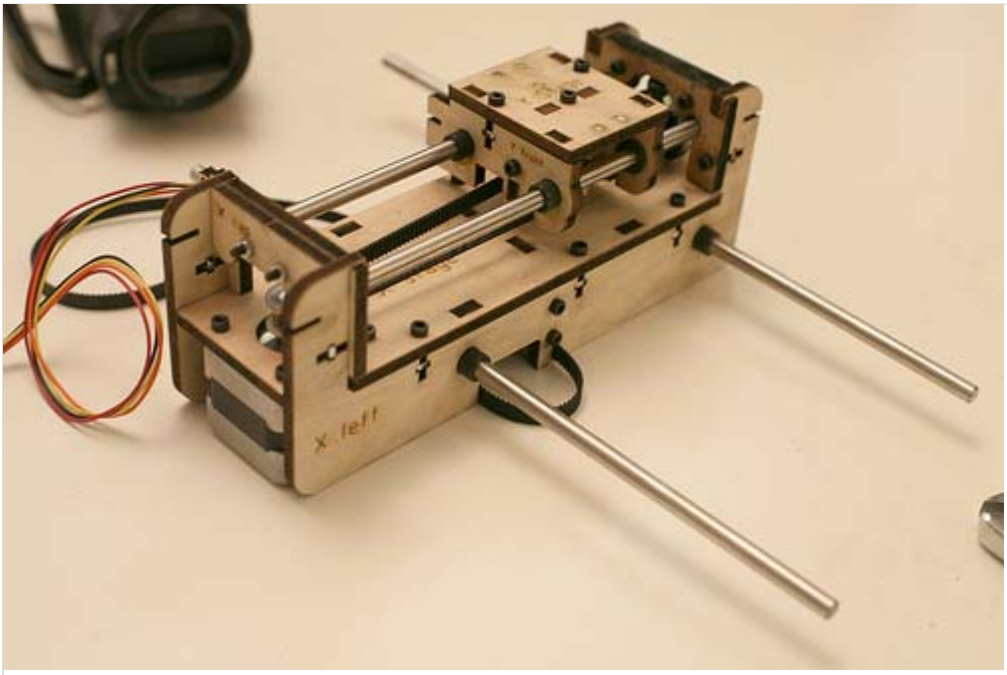
- Pull the idler pulley as far forward as it can go, and then tighten the nut beneath it with pliers. It is important that:
  - The pulley be as far forward as it can be, and
  - That the M5 nut under the pulley be well-tightened.

If the pulley is not moved forward far enough, the bolt will collide with the X rod.

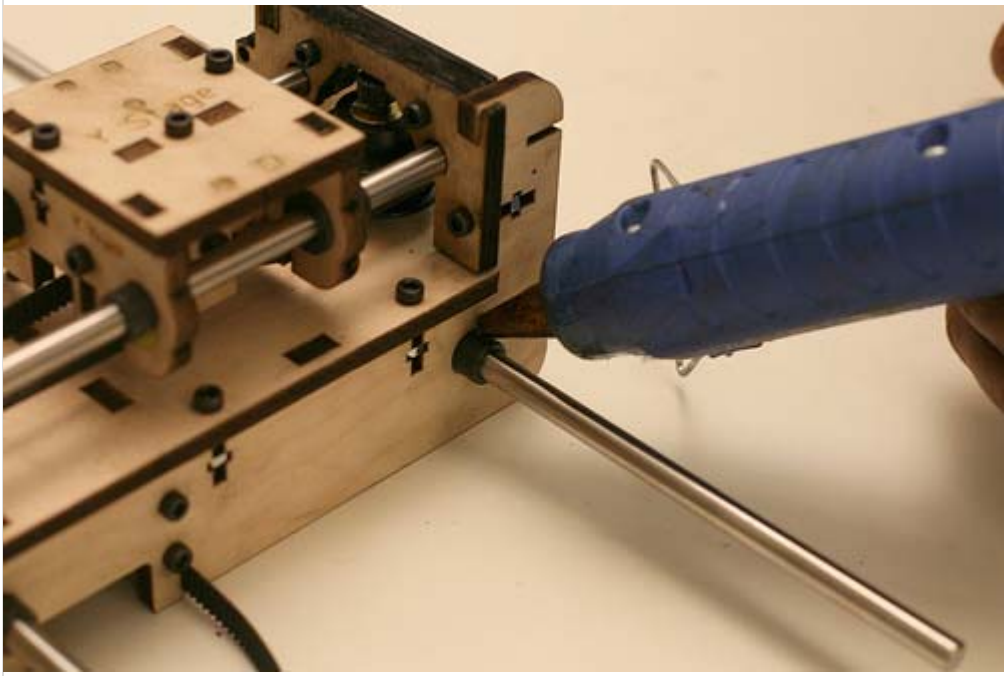
Install the flanged bearings



- Install the four linear bearings in the large holes in the X stage in the same way that you installed the other bearings in the Y stage.



- Slide the X rods through the bearings and make sure they slide easily. In particular, check that the front rod isn't hitting the idler pulley bolt.



- Once you're happy with the X rod's movement, add a touch of hot glue to each bearing to keep them in place.

That's it! Your X-Y mechanism is complete!

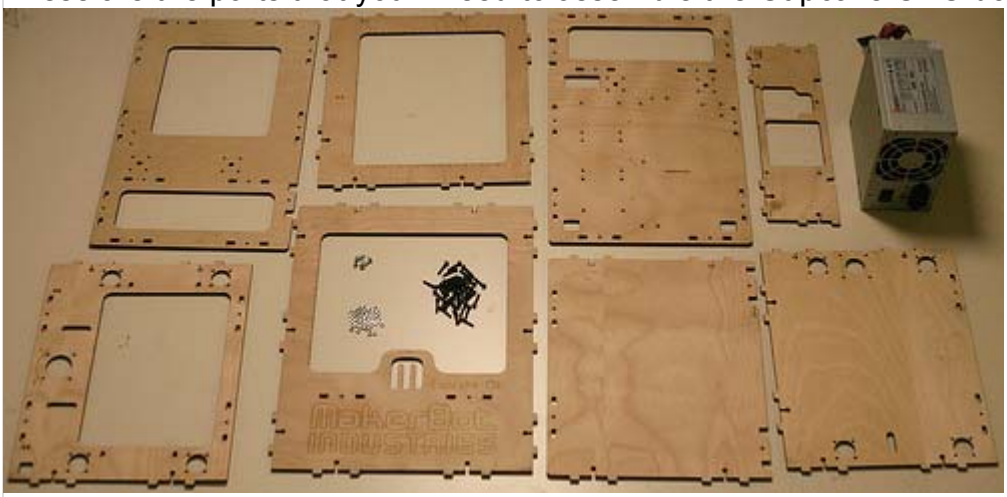
Cupcake Body Assembly

Summary

In this step, we'll be building the outer frame of the Cupcake CNC. It should take about 2 hours.

Parts list

These are the parts that you'll need to assemble the Cupcake CNC body. Find and set aside:



- Lasercut parts (each will have its name etched on the part)
  - Front panel
  - Back panel
  - Left panel
  - Right panel
  - Top panel
  - Bottom panel
  - Power panel
  - Middle panel
  - 4 bearing brackets (labeled 'bb'; not shown)
- ATX power supply
- 67 16mm M3 bolts
- 67 16mm M3 nuts
- 4 small phillips-head screws (for the power supply)
- 15 small plastic spacers (not shown)
- Motherboard (not shown)
- 3 stepper drivers (not shown)
- Extruder controller (not shown, Ultimate only)

The lasercut parts are in the **Cupcake CNC Lasercut Parts** box.
The M3 bolts & nuts are in the **Hardware Burrito** bag.
The ATX power supply is by itself.

The motherboard, stepper drivers & extruder board are in the **Generation 3 electronics** bag.

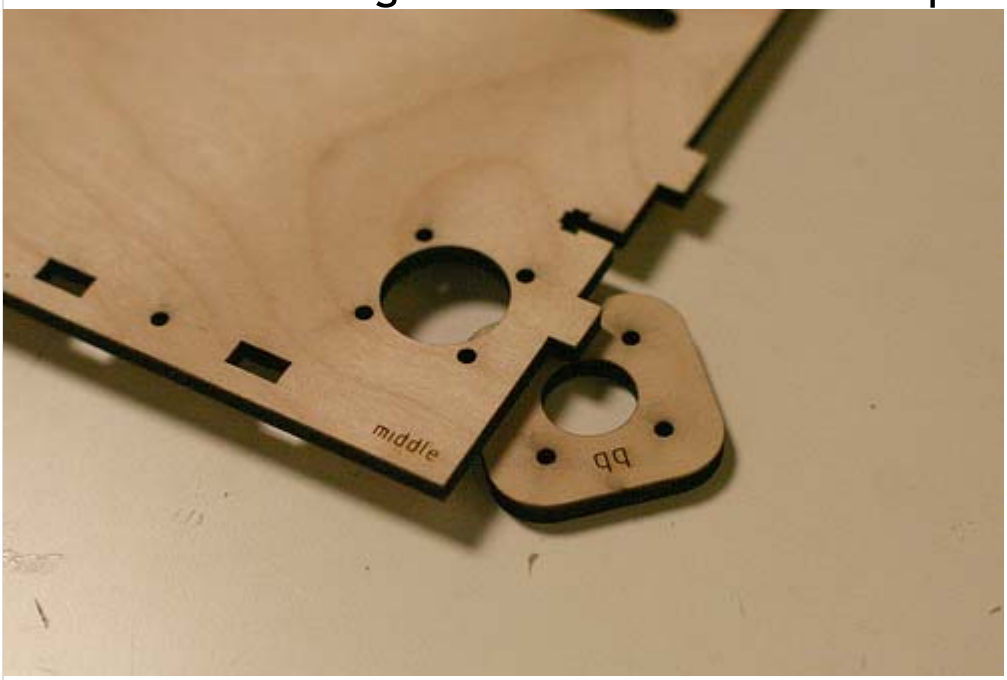
The panels ordinarily have text etched one side. This is the "face" of the panel. Horizontal panels are oriented facing up, and side panels are oriented so they face away from the center of the bot.

Before you begin

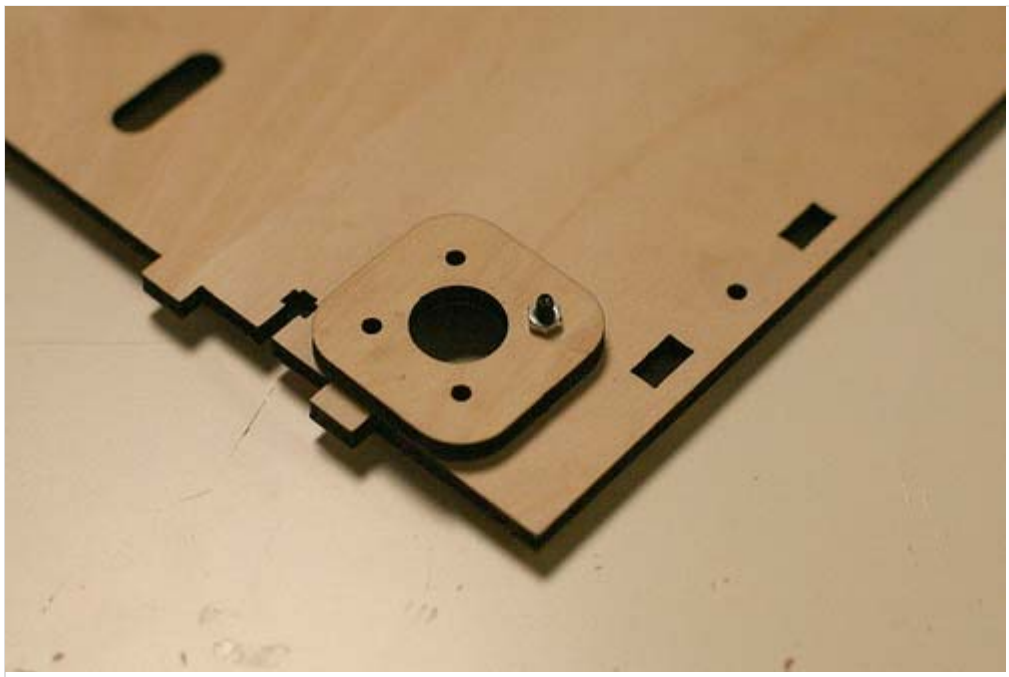
If you'd like to sand, paint, stain, or decorate your bot, now's the time. Make sure the pieces are completely dry before you begin assembly. If the additional paint makes it hard for the tabs to fit in the slots, lightly sand the tabs with the included square of sandpaper.

Assembly

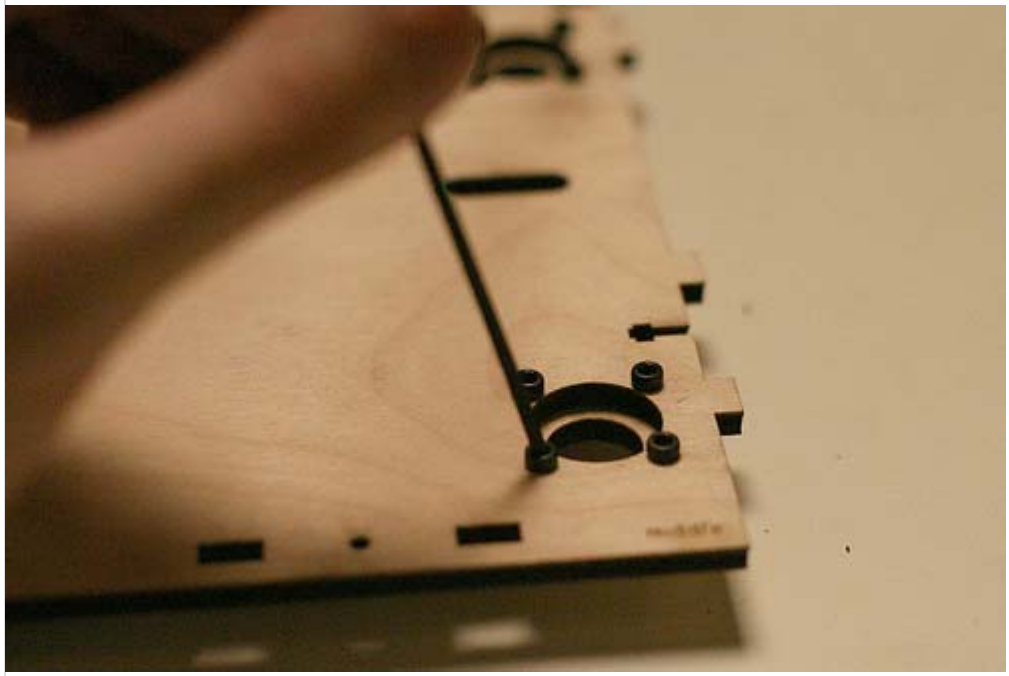
Mount the bearing brackets on the middle panel



- Take the middle panel and turn it face-up. Place a bearing bracket *below* the one of the corner holes.



- Insert a bolt through one of the mounting holes and fasten it with a nut. Make sure the head of the bolt is facing the top of the panel.

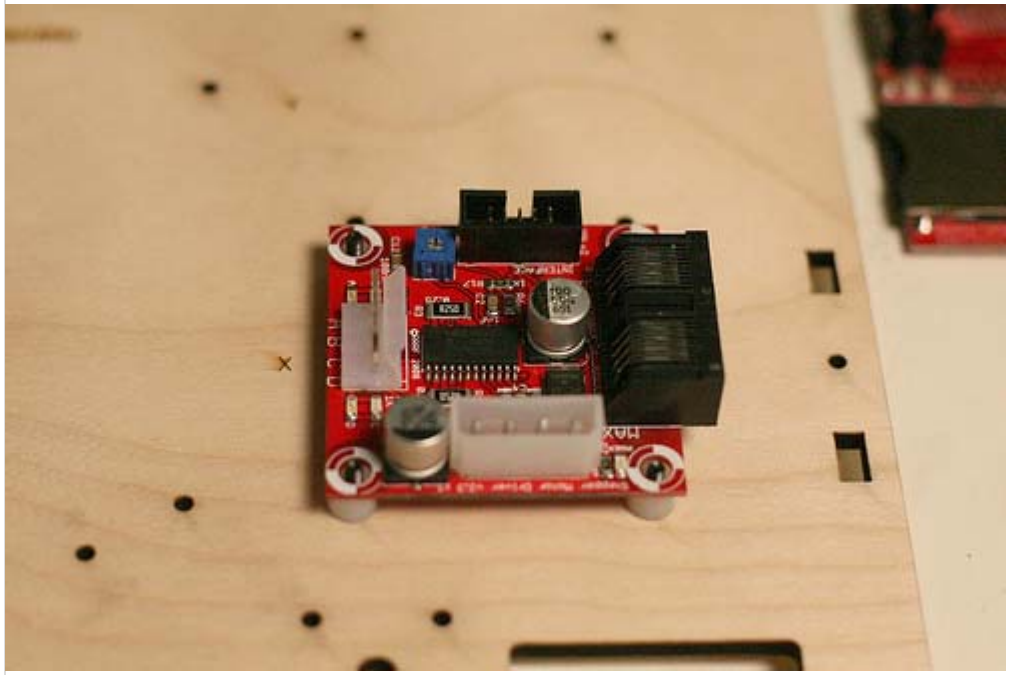


- Put bolts and nuts through the remaining three mounting holes, and tighten.

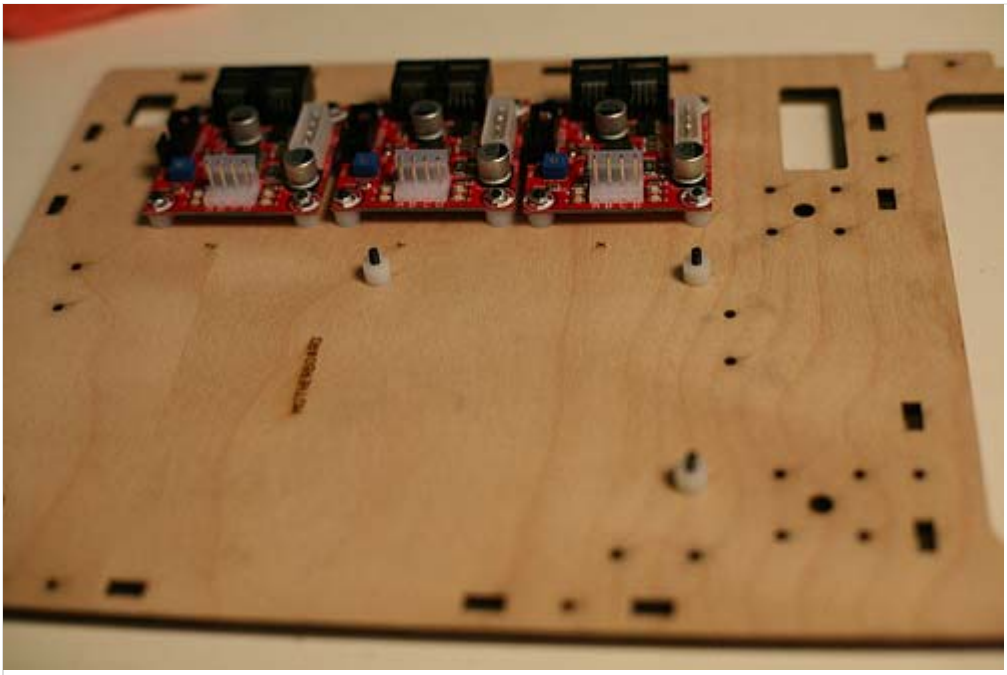
- Add bearing brackets to the other three corners of the middle panel.

Mount the boards on the right panel

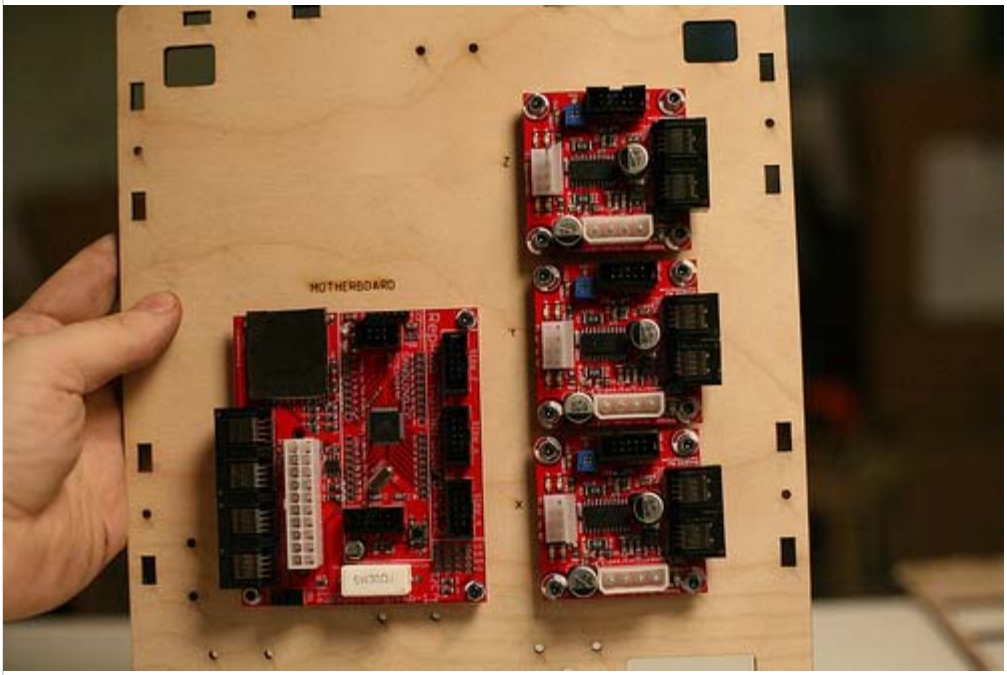
Set aside the right panel, the spacers, your motherboard and the three stepper motor drivers. If you're building an Ultimate, you might also want to grab your extruder controller board and a drill.
Check out this page for a bit more info.



- Use four bolts and spacers to bolt the X stepper driver to the *outside* of the right panel (the side with the etching). Orient the board so that the two RJ45 jacks face what will be the back of the machine.
- Mount the other two stepper drivers.



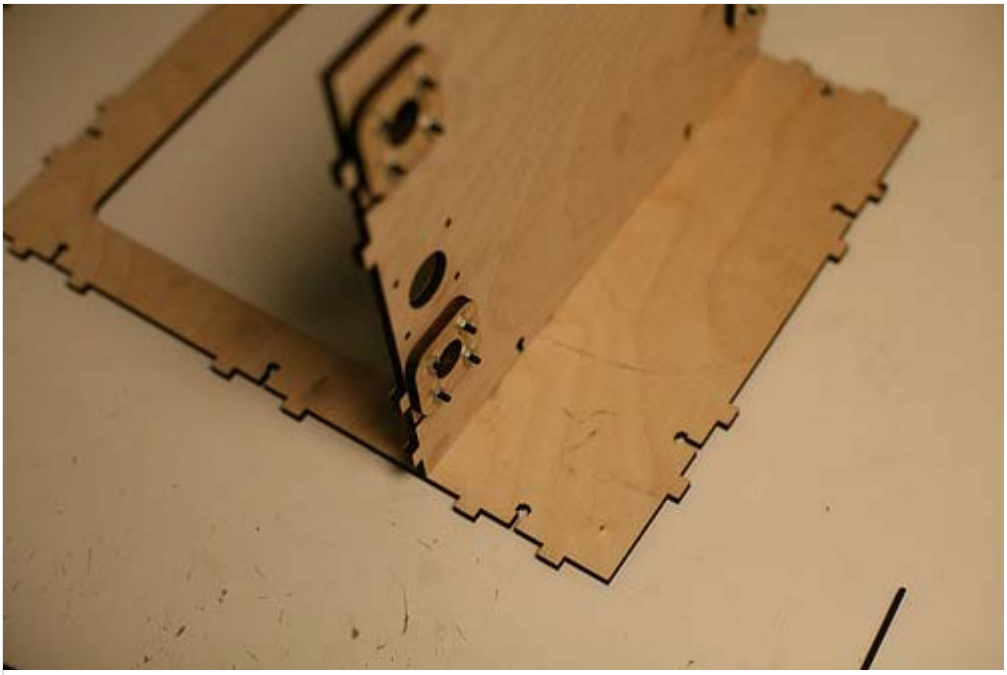
- Bolt the motherboard to the outside of the right panel using three bolts and spacers. There's only one way to bolt this board on…UNLESS you're building an Ultimate! In that case you might want to flip it upside down and drill another hole on the upper left.



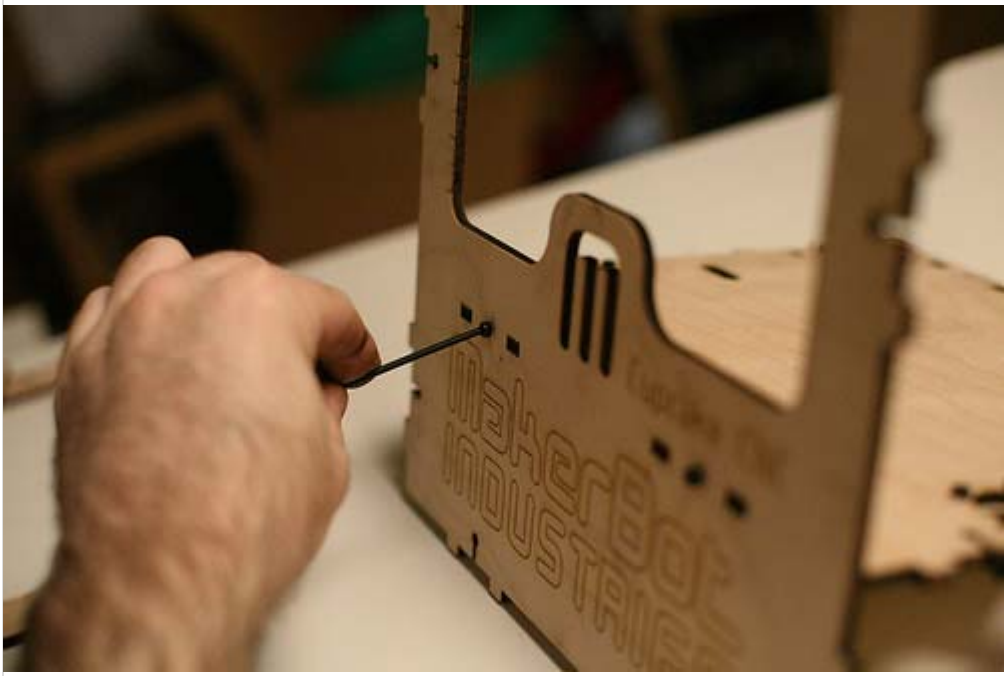
- The electronics are now mounted! We'll hook them up later.

Assemble the body

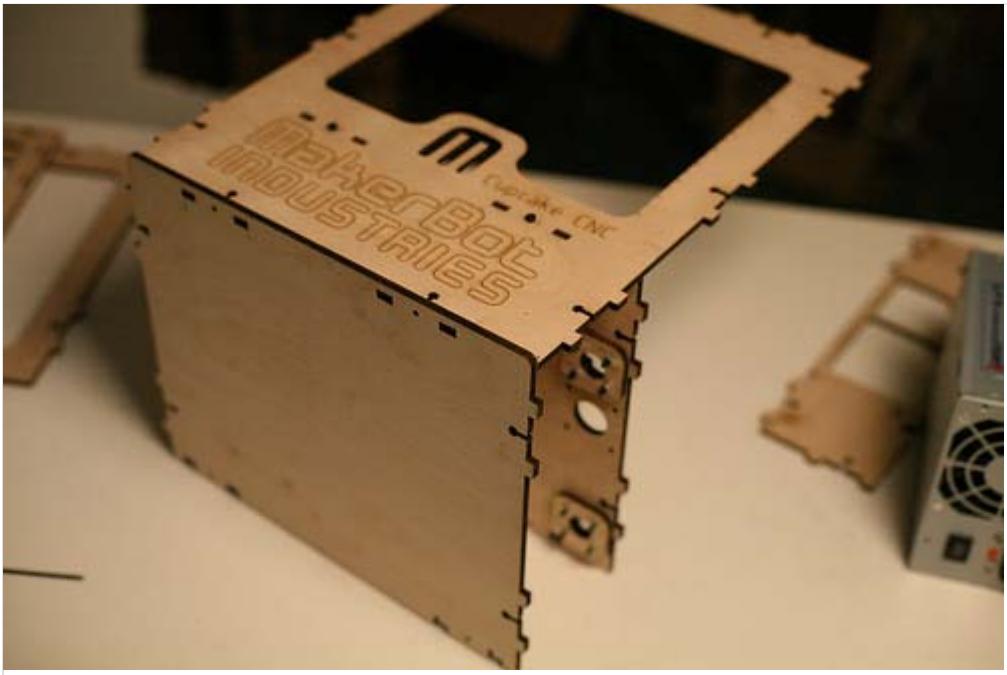
- While assembling the body, don't make the bolts more than finger-tight. You'll go back and tighten them down when you're done with primary assembly.



- Take the front and middle panels. Slot the middle panel into the backside of the front, so that the etched text faces towards the top of the bot.

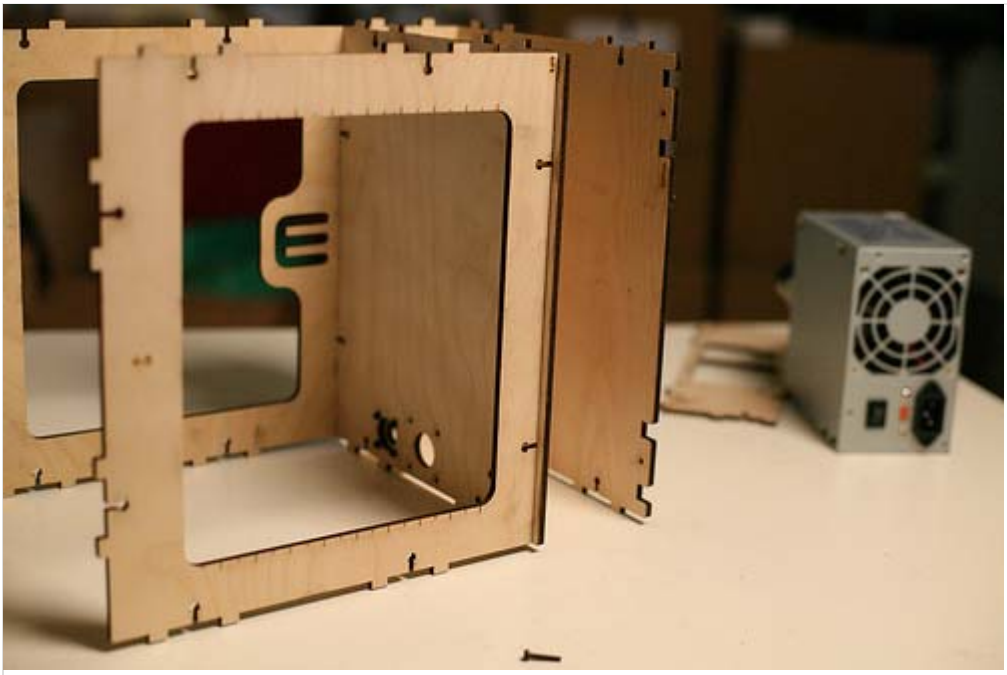


- Fasten the parts together with two bolts and nuts.

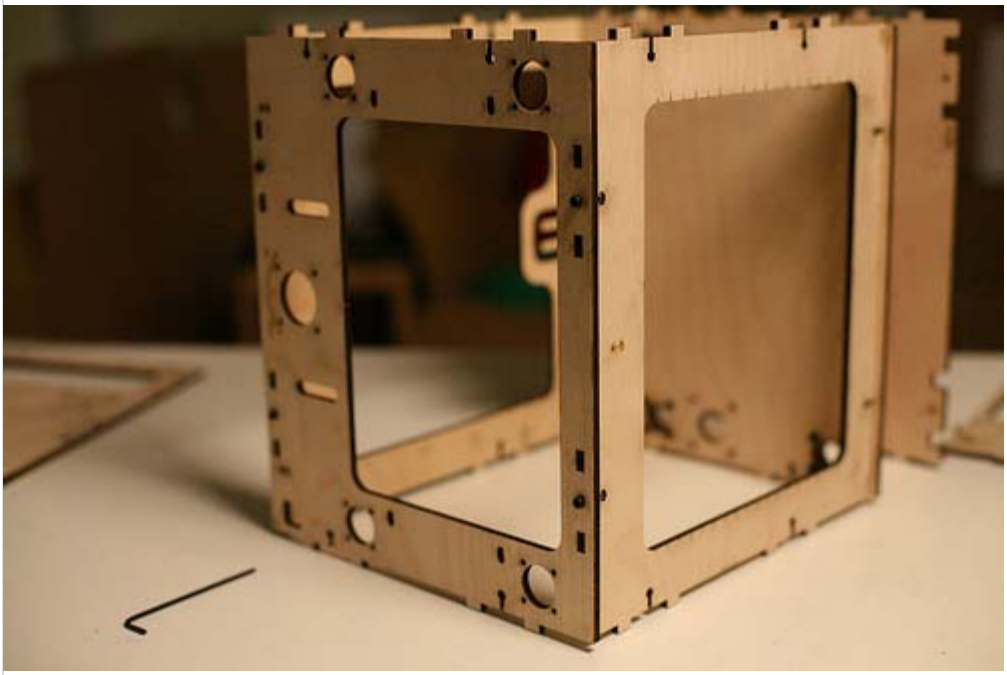


- Slot the front panel in to the bottom panel.

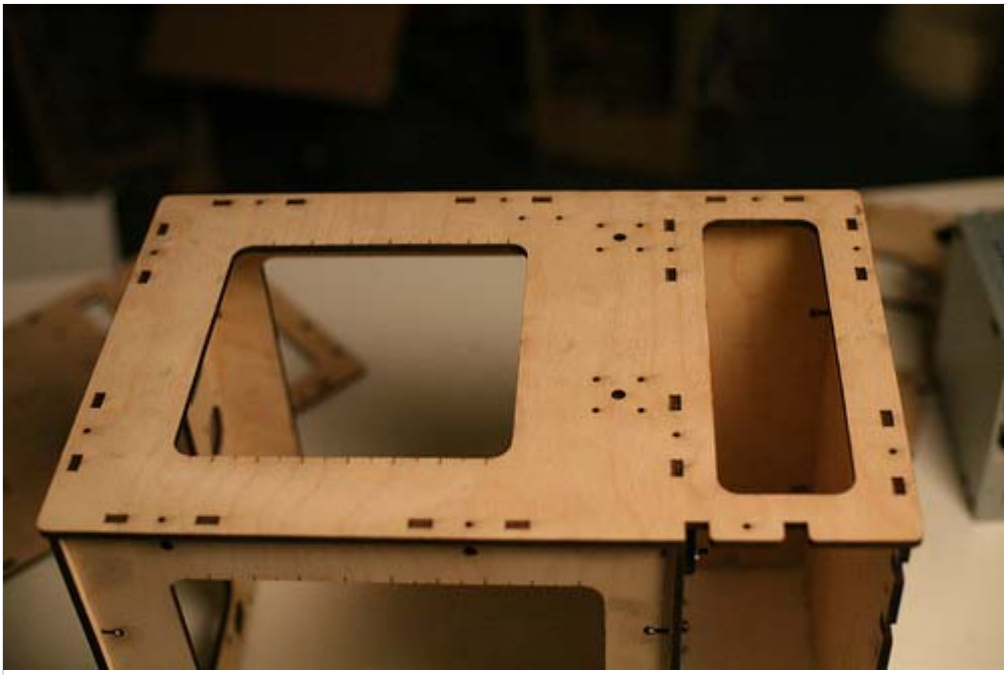
- Fasten the bottom to the front with two bolts and nuts.



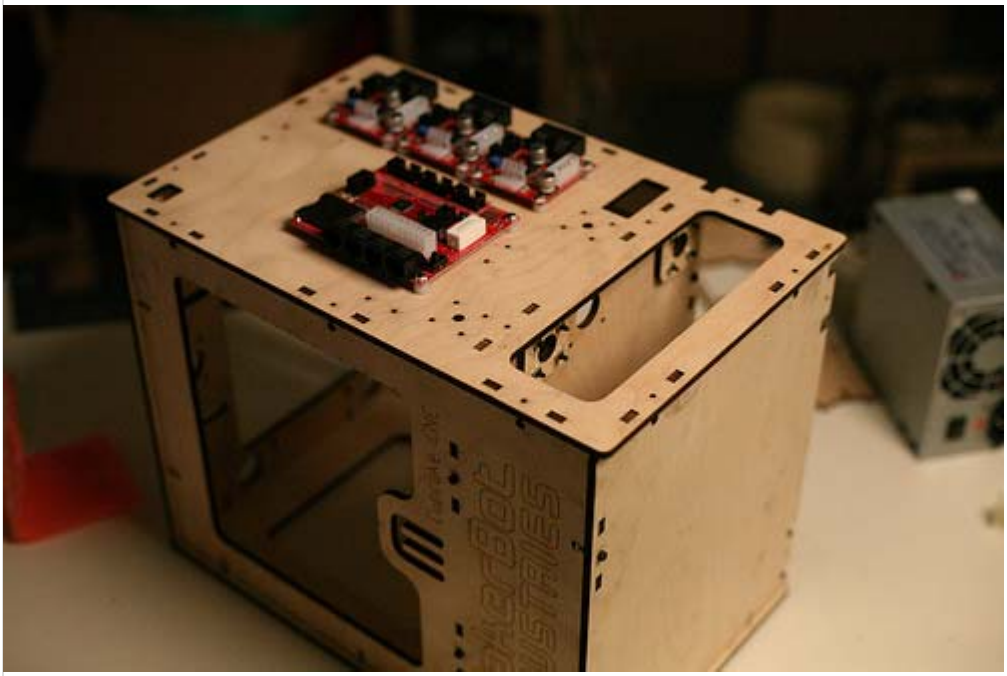
- Slot the back panel into the middle panel and bolt it on. Note the "up" marking on the back panel, which will help you to orient it. The text on the back panel should face the back of the bot.



- Slot the top panel onto the front and back panels and bolt. Notice that the fifth hole and two slots are facing the front of the machine.

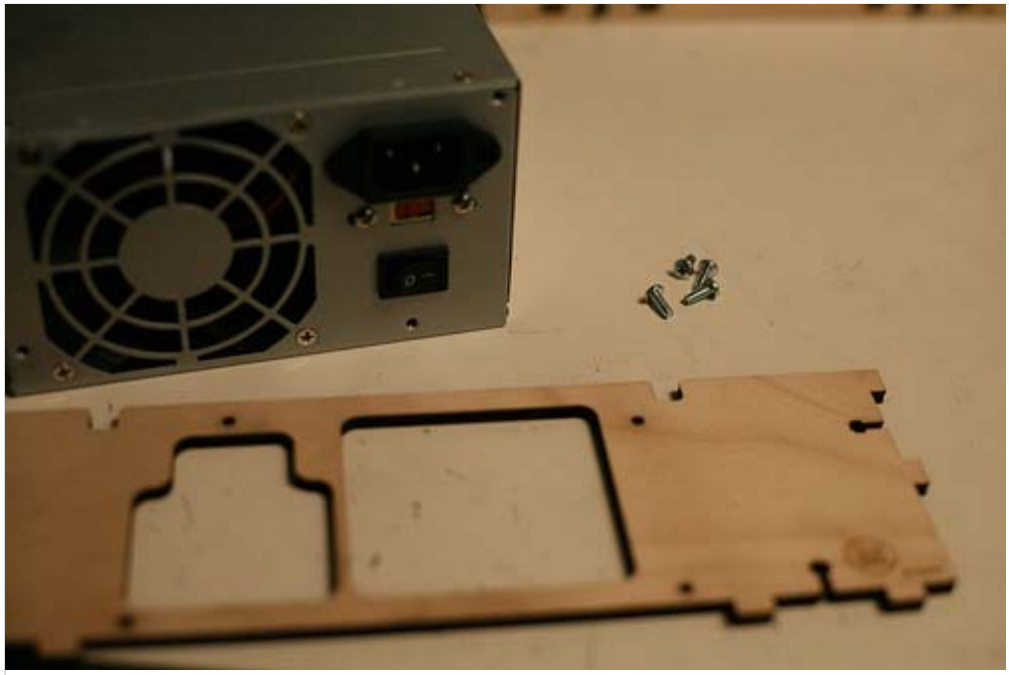


- Attach the left panel. There are many tabs which slot into this panel, so be patient. Once the tabs are all in their slots, bolt it together.



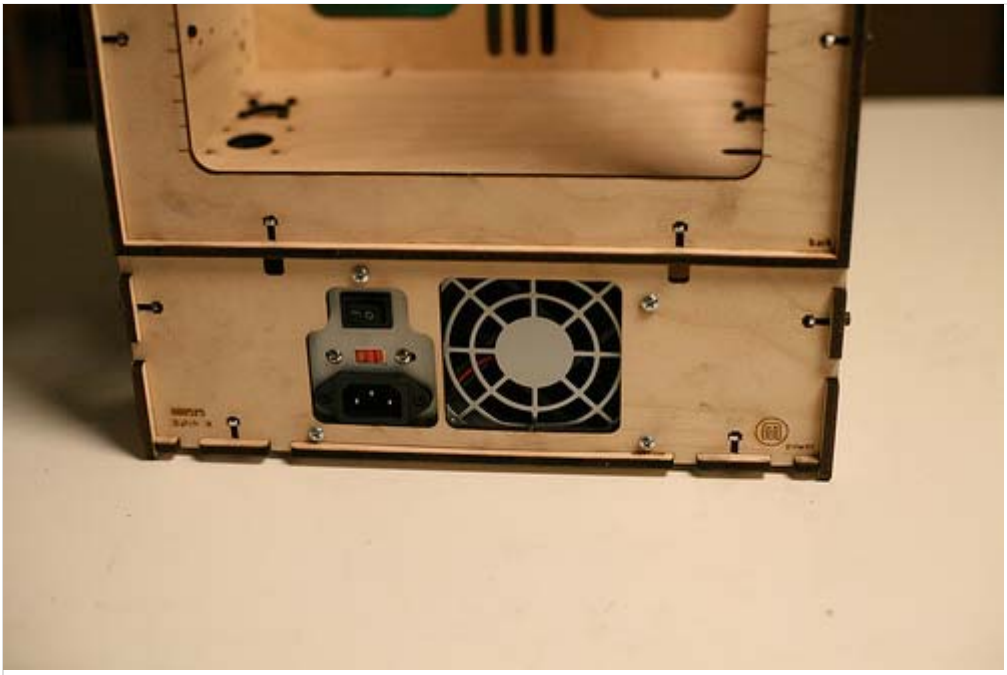
- Attach the right panel, with the electronics.
- You can now go back and tighten all the bolts with a hex key. This will keep the bot from rattling and make sure all the parts are squared up.

Add the power panel

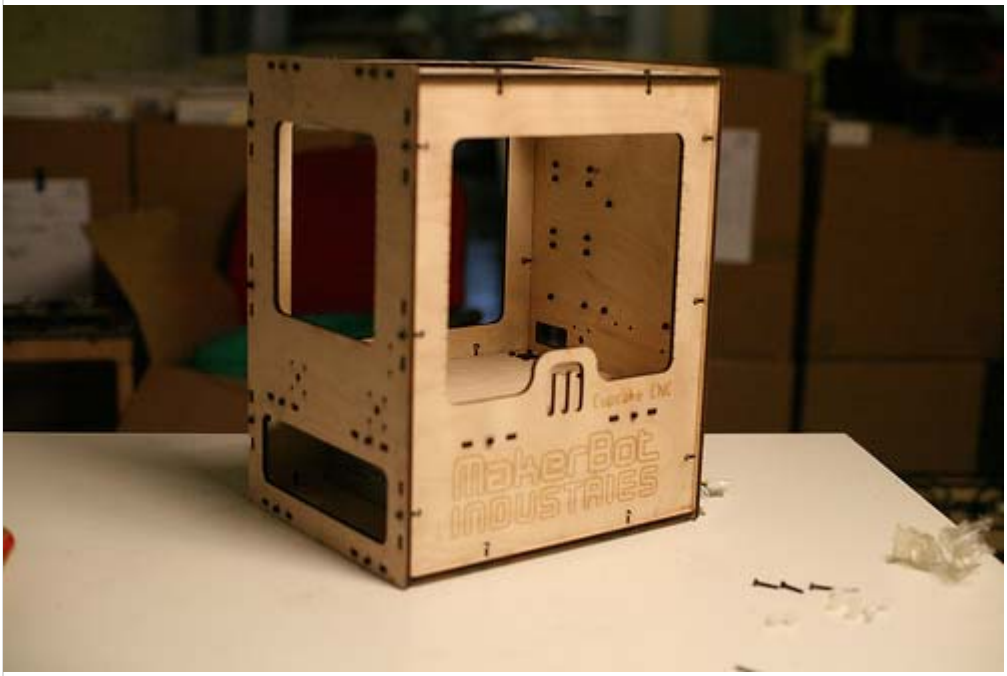


- The last step is to add the power supply and power plate.

- Use the four phillips-head screws to attach the power plate to the power supply. Do not use M3 bolts! They won't fit properly, and too-long bolts could potentially enter the power supply body and damage the PSU.
    - *Note:* if you're not using one of the power supplies shipped with the deluxe kit, it may not precisely match the power panel. Cut or modify the panel as you see fit.



- The power supply and power panel can now slot neatly into the niche in the rear of the bot. Use four nuts and bolts to secure it in place.



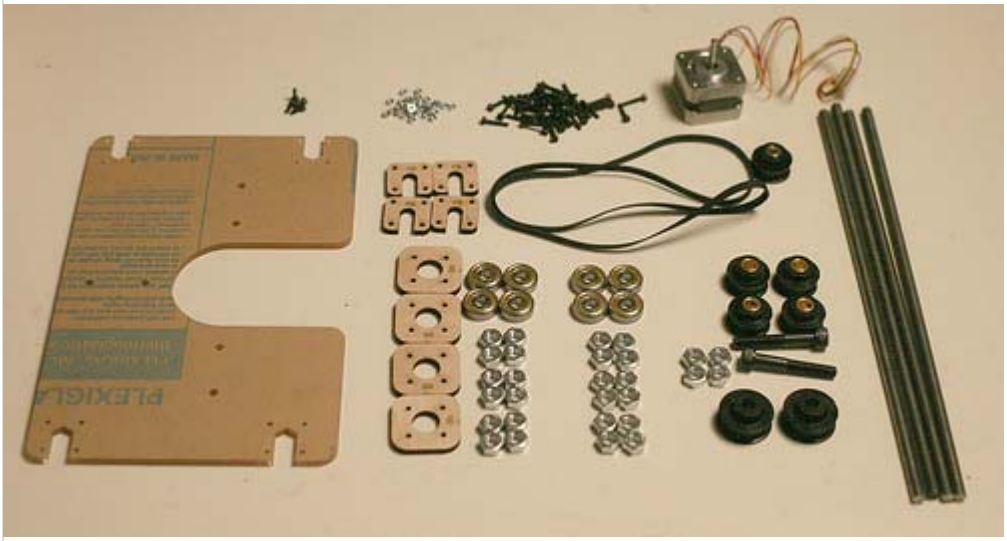
That's it! You've completed the body of your Cupcake CNC.

Cupcake Z Stage Assembly

Summary

Assembling the Z stage mechanisms will take you about two hours.

Parts list



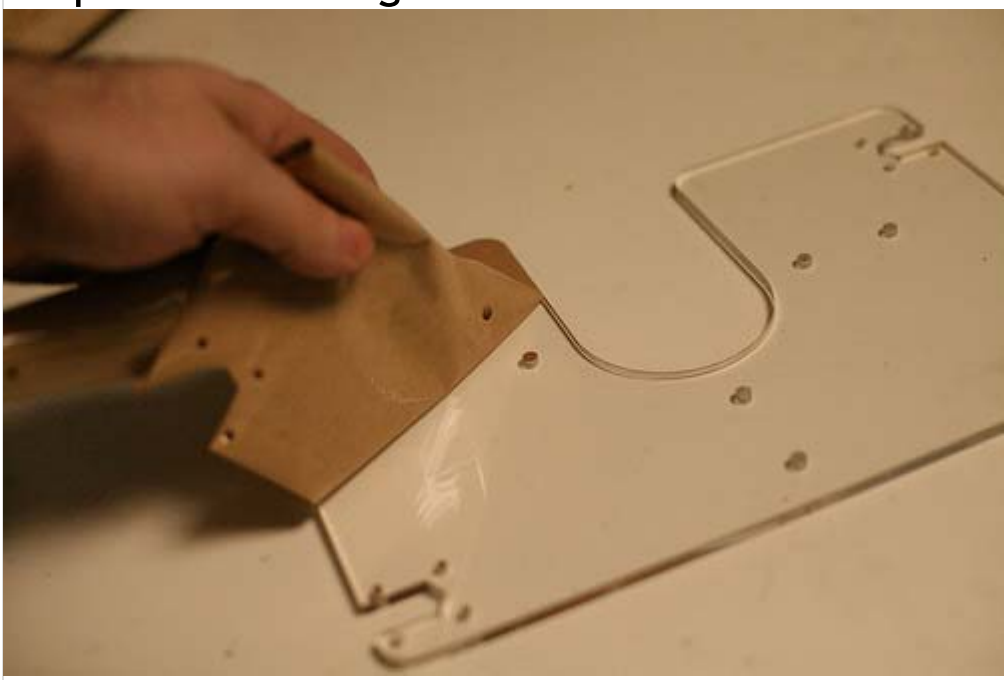
Set aside the following parts:

- Lasercut parts
  - Z stage
  - 4 bearing brackets (labeled 'bb')
  - 4 Z guides (labeled 'zg')
- 8 608 skate bearings
- 22 M8 nuts
- Z belt (the longest of the three toothed belts)
- Z Small Idler/Drive pulley (the one with the smaller bore)
- 4 Z rod stepper pulleys
- 2 Z idler pulleys (the ones with no metal insert in the bore)
- 2 M8x50 bolts
- 4 1' M8 threaded rods
- NEMA17 stepper motor
- 4 M3x10 bolts
- 32 M3x16 bolts
- 32 M3 nuts

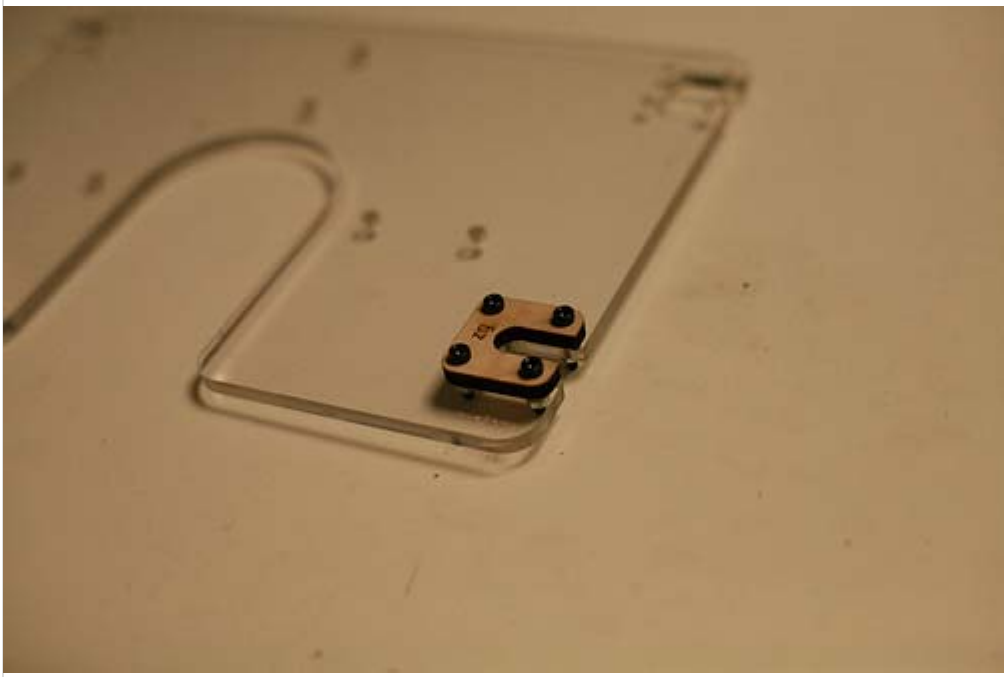
The lasercut parts are in the **Cupcake CNC Lasercut Parts** box.
The skate bearings, pulleys and belt are in the **Belt, Bearing and Pulley** bag.
The M8 and M3 bolts and nuts are in the **Hardware Burrito** bag.
The threaded rods are in the **Drive Rod Kit**.
The NEMA17 motor is bubble-wrapped with the other NEMA17 motors.

Assembly

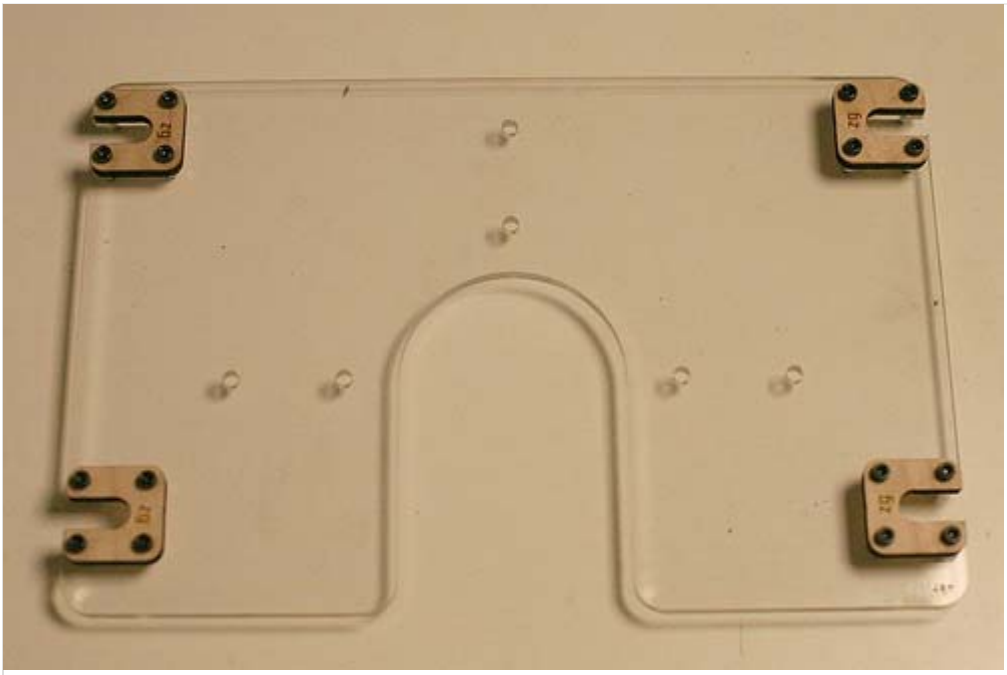
Prepare the Z stage



- Remove the protective paper from both sides of the acrylic Z platform.



- Use 4 M3x16 bolts to bolt a Z guide to one corner of the platform. Make sure that the Z guide is bolted to the top face of the platform (the side with *z-stage* printed on it), and that the slot is facing towards the side of the platform, in the same direction as the slot cut in to the platform.



- Add Z guides to the remaining 3 corners in the same manner.
- Put the Z stage aside. You'll install in the machine later in the build process.

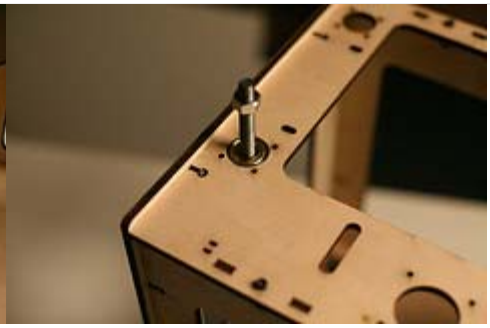
Assemble the Z rods

- Before Assembly you should Clean the threaded rods

- Take one of the Z rods. Thread an M8 nut on to one end. Then add a bearing and another nut. Keep all three close to the end.

- Using two wrenches, tighten the bolts against each other until they do not move and the bearing is locked in place, but still spinning freely. You may want to put some Loctite or other thread locking compound on the nut closest to the end as it can loosen due to vibration and cause the rods to become misaligned, especially if your rods are not perfectly straight.

- On the other end of the rod, thread one nut about halfway down the rod. Then thread another nut, another bearing, and one more nut. Do not tighten any of these. Make sure you have *two* nuts threaded on below the bearing! One will be used to hold the bearing in place; the other will move the Z platform up and down. Now would be a good time to spray the rods with bikechain lubricant or some other such compound just to ensure smooth operation. coat the central area of the rods not the ends.

- Insert the rod into the body so that the tightened bearing fits in the socket at the bottom, and the top of the rod protrudes from the matching hole at the top. Note that the amount of protrusion is determined by the mounting of the belt mechanism shown in later instructions, below. Adjust the nut below the top bearing so that it holds the top bearing flush with the top of the top panel of the body. Once the bearing is properly positioned, screw down the top nut and tighten the nuts to hold the bearing in place.
- When you're done, the rod should rotate freely around its axis, and you should have one free nut that slides up and down the rod.

- Take one of the bearing brackets and mount it over the top bearing. Use four bolts and nuts to secure it.

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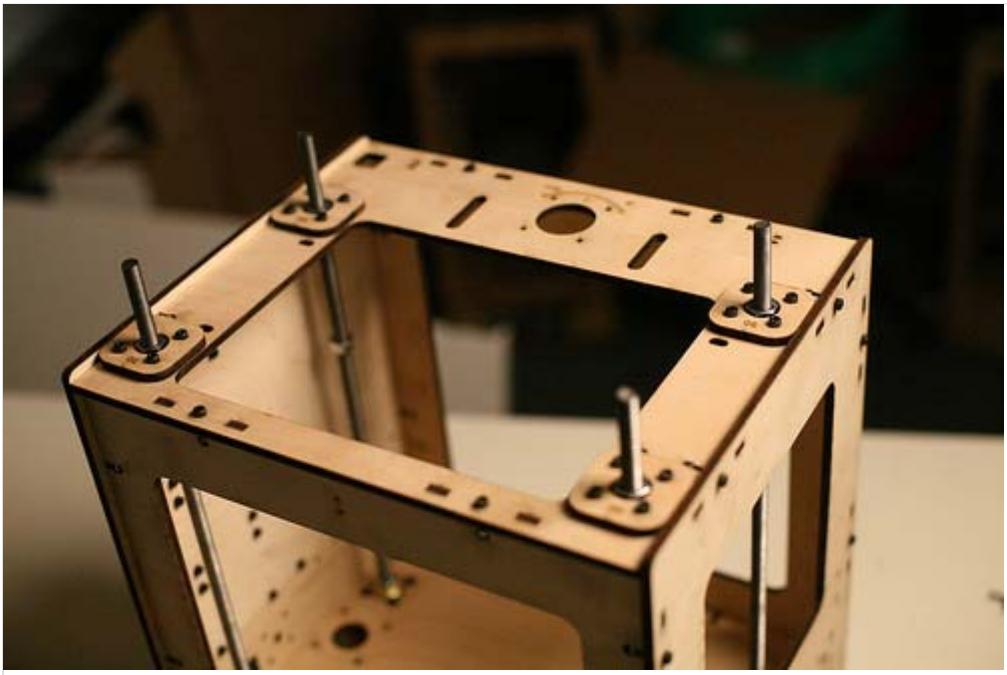
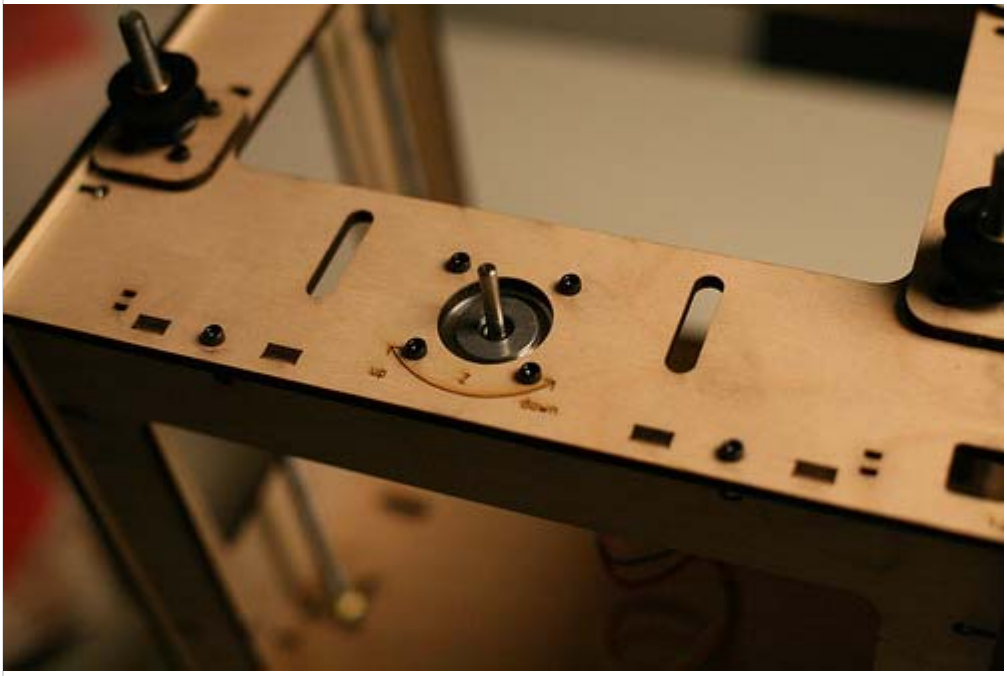
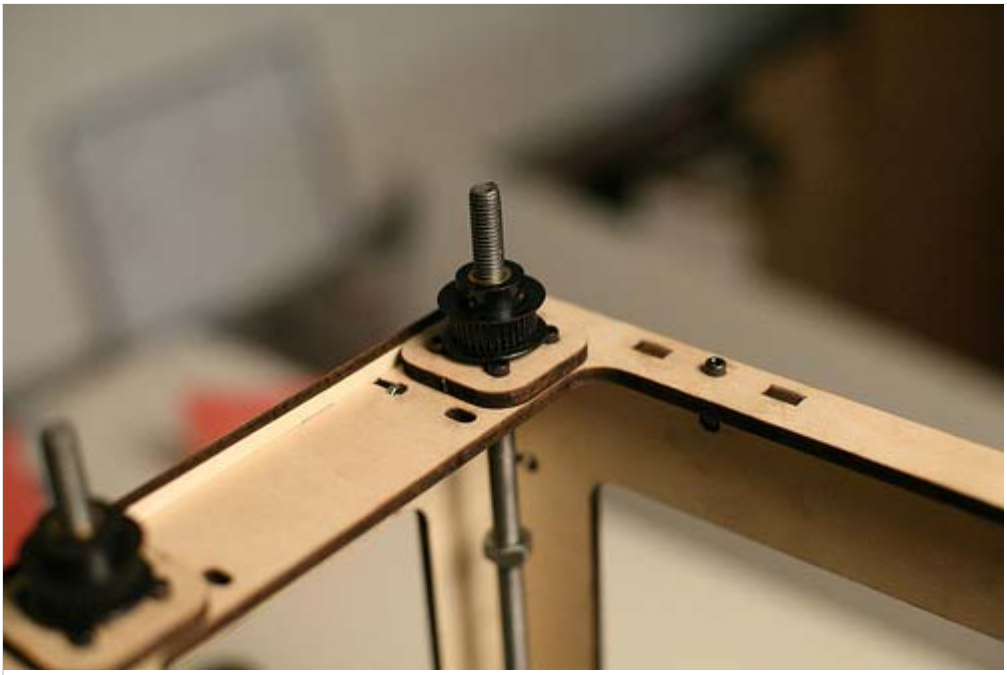


- Prepare and mount the remaining three rods.

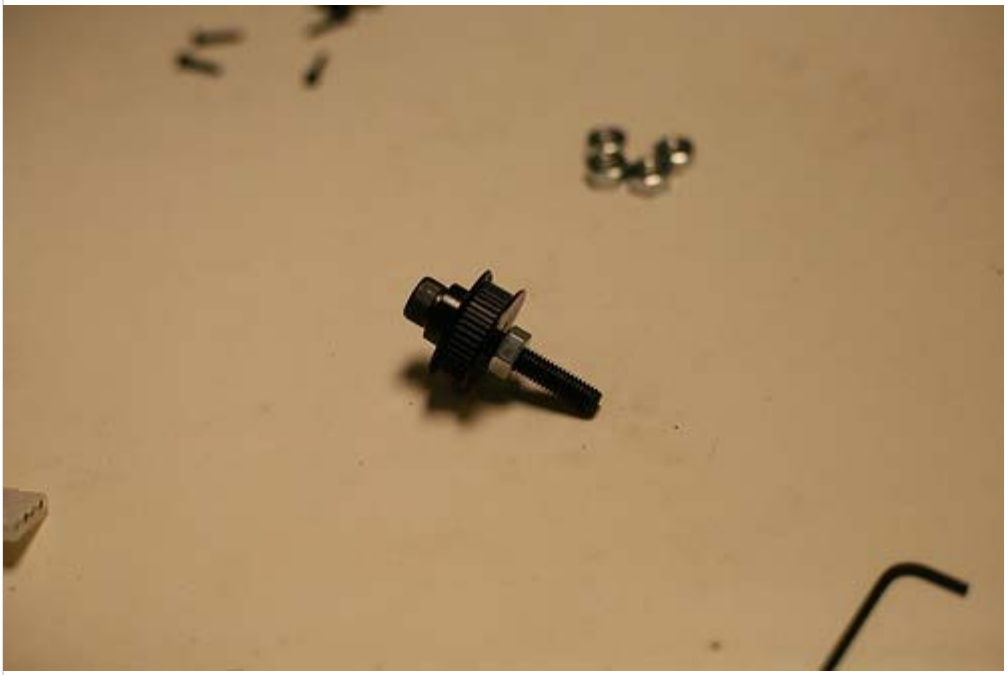
Assemble the belt mechanism



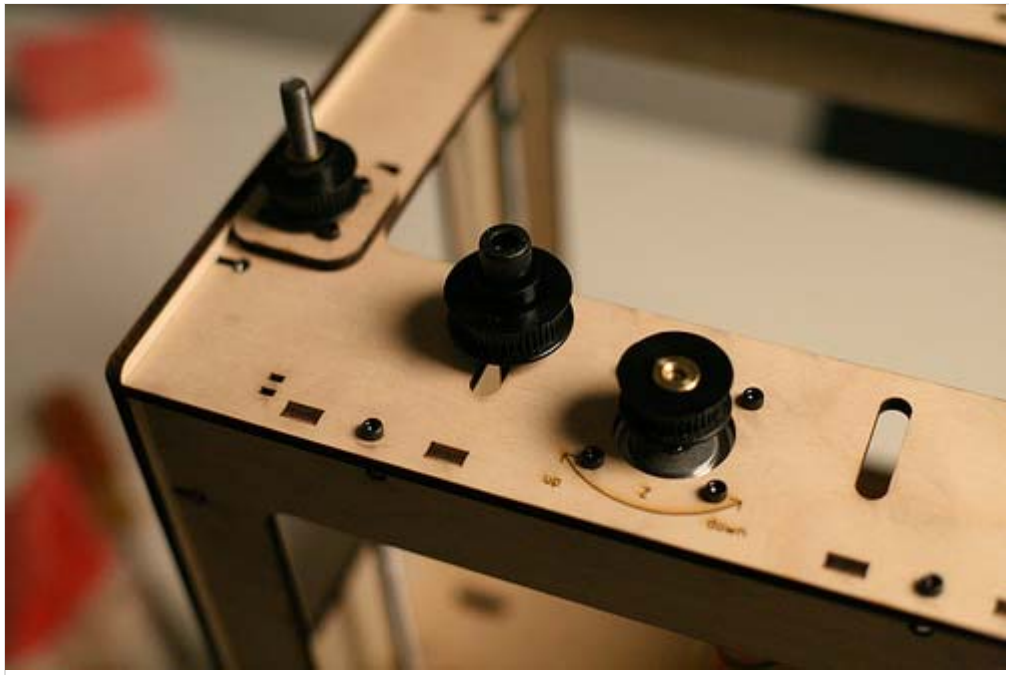
- Mount the motor on the underside of top plate with the shaft facing upward. *Be sure to use 10mm long bolts, not 16mm long bolts!* Using the wrong bolts can jam or damage your motor. Orient the motor so that the cables face the right side of the machine.



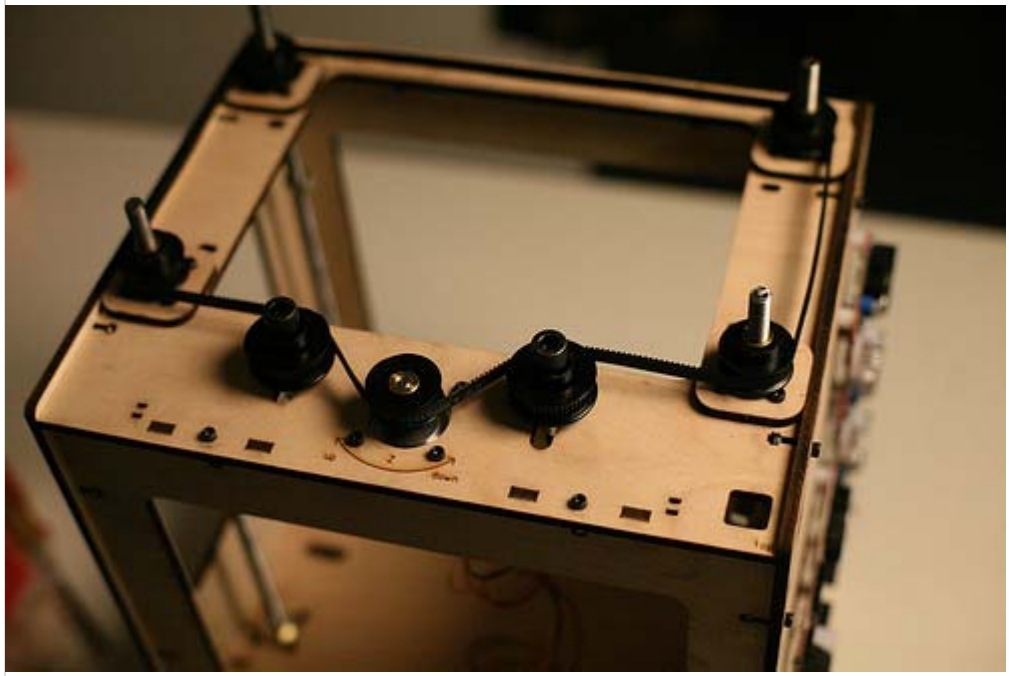
- Place the four Z rod pulleys on the tops of the Z rods, with the end containing the set screw facing upwards. Do not tighten the set screws yet! Leave the pulleys freely sliding on the rods.



- Prepare the two idler pulleys by sliding the large idler pulleys on to the M8 bolt. Point the collar of the pulley towards the head of the bolt. After the pulley is on, thread an M8 nut on to the bolt as far as it will go and tighten it. The pulley should still slide freely.

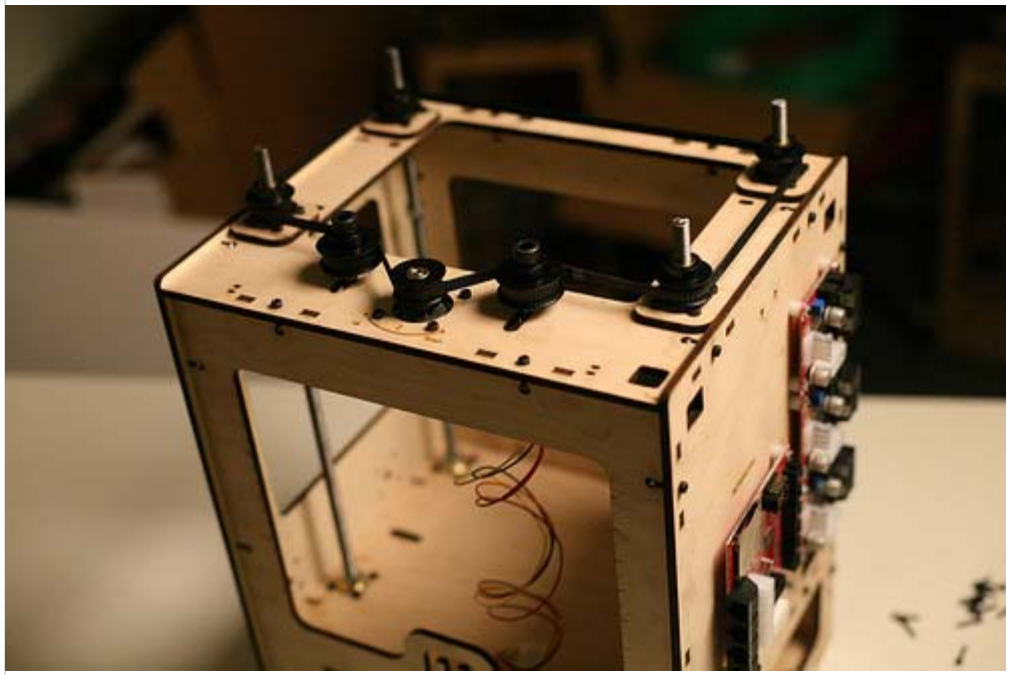


- Place the idler pulleys into the slots on the top panel. Use an M8 nut to loosely secure the pulley to the bot.
- Loosen the set screw in the Z drive pulley(Small Idler) and place it on the motor shaft. The set screw and collar should point *down*.



- Wrap the Z belt around all the Z rods and the drive pulley. Thread it so that the idler pulleys meet the back of the belt, pulling it to the interior of the bot.

- Adjust the height of the rod pulleys and the drive pulley so that they are all level. Make sure the rod pulleys are high enough that they do not scrape the bolts that hold on the bearing brackets. Once you've got them to the right height, tighten the set screws.



- Slide the idler pulleys forward in their slots until the belt is snug, but not too tight. Turn the motor pulley by hand to make sure that the belt is still loose enough to let the belt turn smoothly. Once you've tensioned it, tighten the nuts beneath.

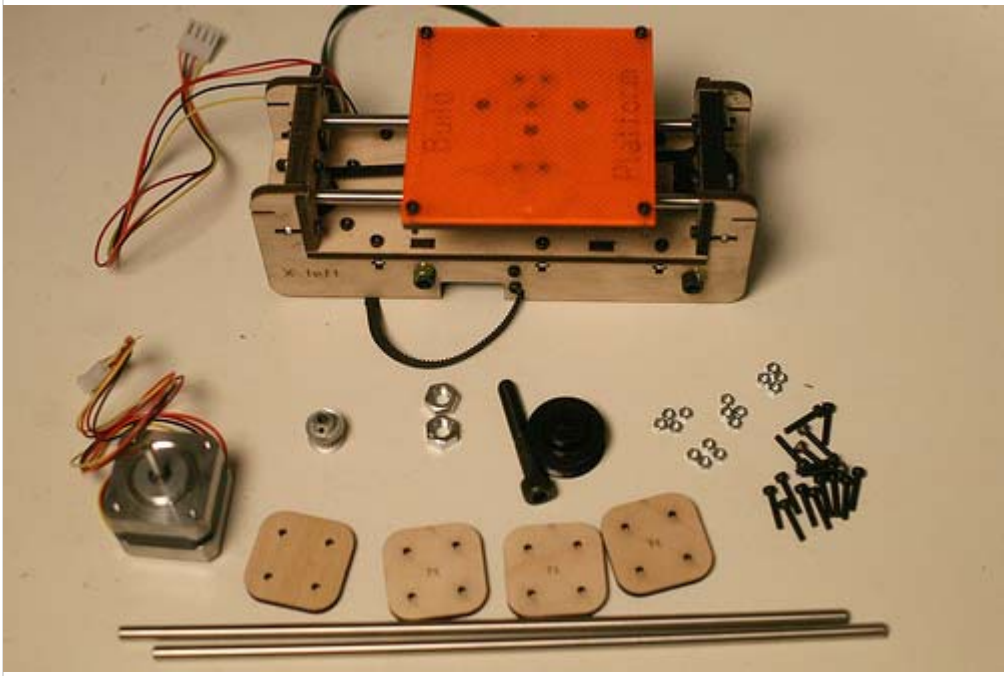
That's it! You've got the Z stage assembly ready to go.

Cupcake XY Stage Installation

Summary

Installing the XY stage should take under thirty minutes.

Parts List

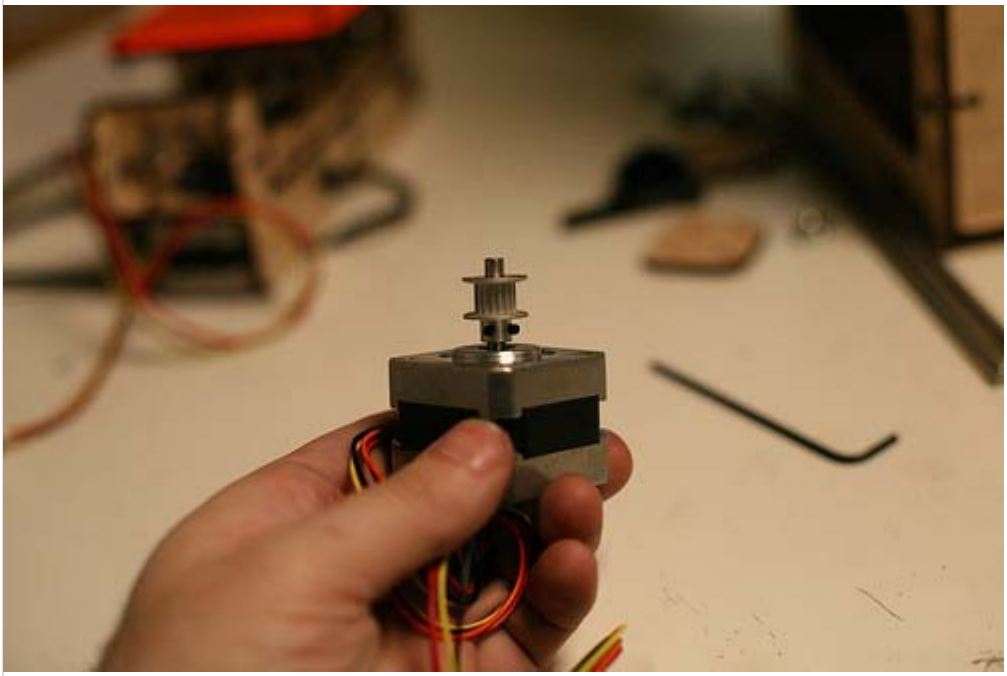


- XY Stage (assembled earlier)
- 4 laser-cut rod covers (marked 'rc')
- 2 smooth X rods
- NEMA17 stepper motor
- small aluminum pulley
- 4 M3 10mm bolts
- 16 M3 16mm bolts
- 16 M3 nuts
- M8 50mm bolt
- 2 M8 nuts
- Idler pulley

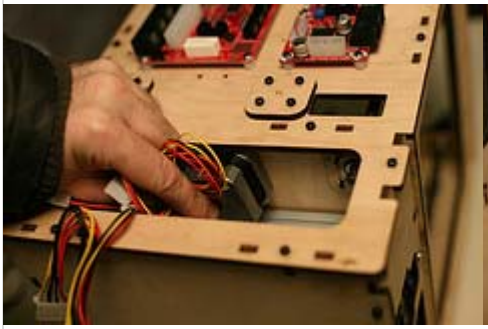
The lasercut rod covers are in the **Cupcake CNC Lasercut Parts** box.
The rods are in the **Drive Rod Kit**.
The NEMA17 motor was bubble-wrapped with the other motors.
The pulleys are in the **Belt, Bearing and Pulley** bag.
The remaining bolts & nuts are in the **Hardware Burrito** bag.

Assembly

Install motor



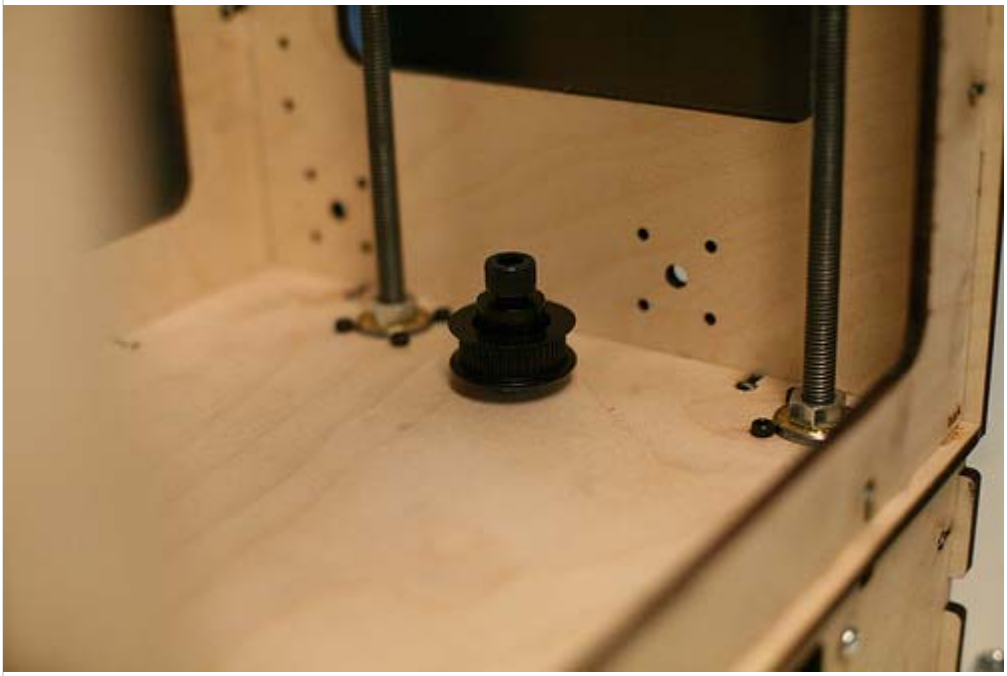
- Mount the small aluminum pulley on the motor shaft. The fit will be very tight, so be patient; you may need to sand the inside of the pulley or the shaft slightly. Mount it with the set screw side facing the motor body, with about 3-4mm between the pulley and the motor. Tighten the set screws once the pulley is position.



- Install the motor in the underside of the middle plate. Place the motor so that its wires are facing towards the outside of the bot. As always, *be sure to use 10mm long bolts, not 16mm long bolts!* Using the wrong bolts can jam or damage your motor.

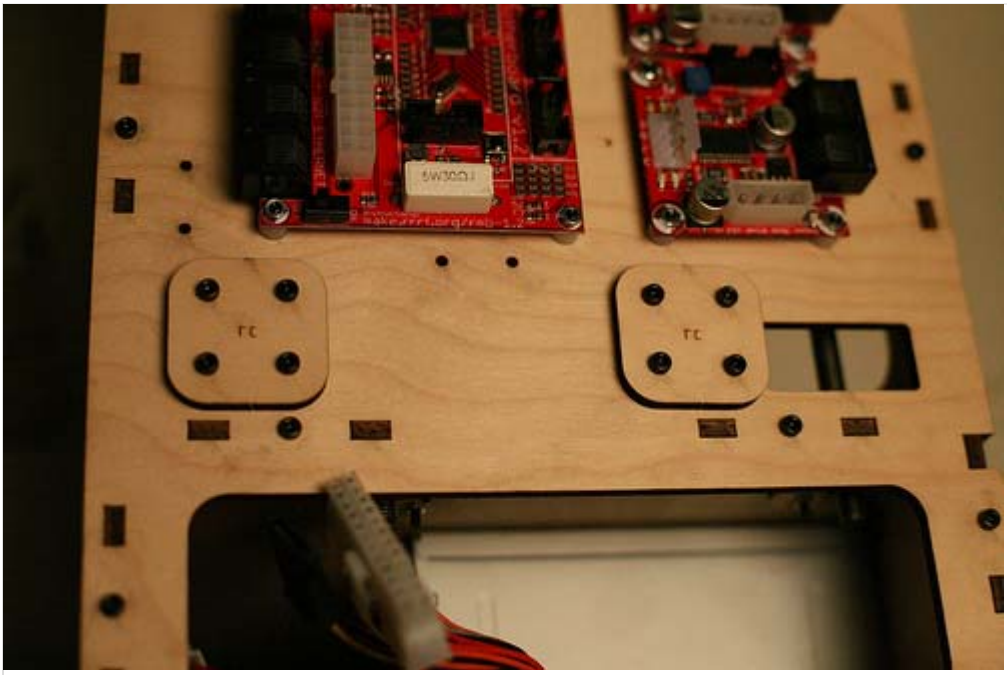
Install idler

- Put the idler pulley on the 50mm M8 bolt with the collar facing the head of the bolt. Thread an M8 nut on the bolt and tighten it as far as it will go.

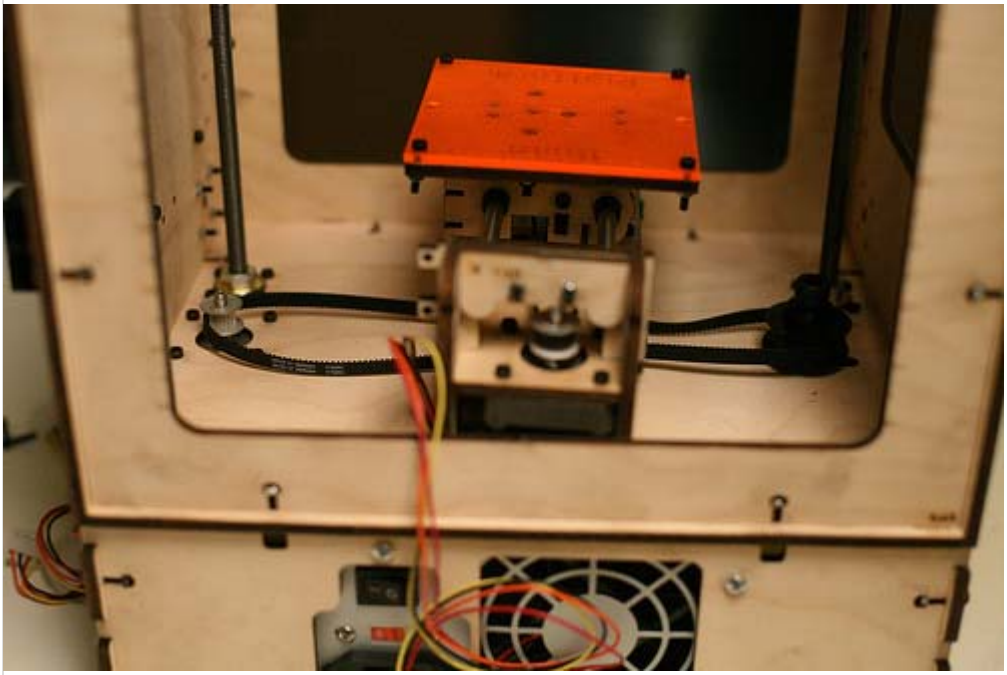


- Insert the idler pulley bolt in the slot in the left side of the middle plate of the bot. Use an M8 nut to loosely attach it, but do not tighten it.

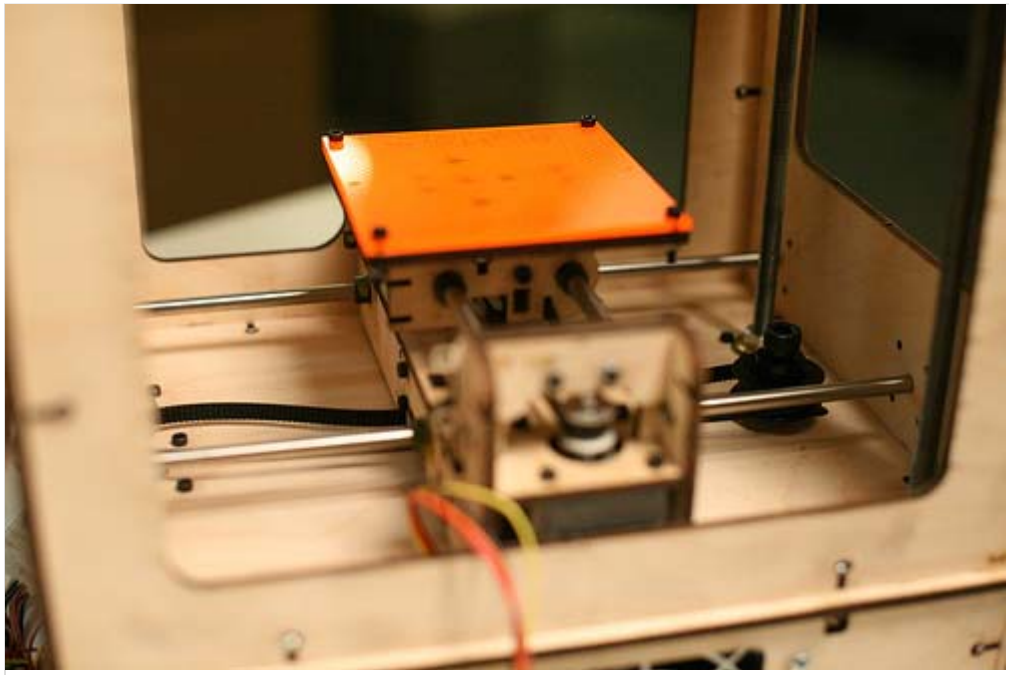
Install XY assembly



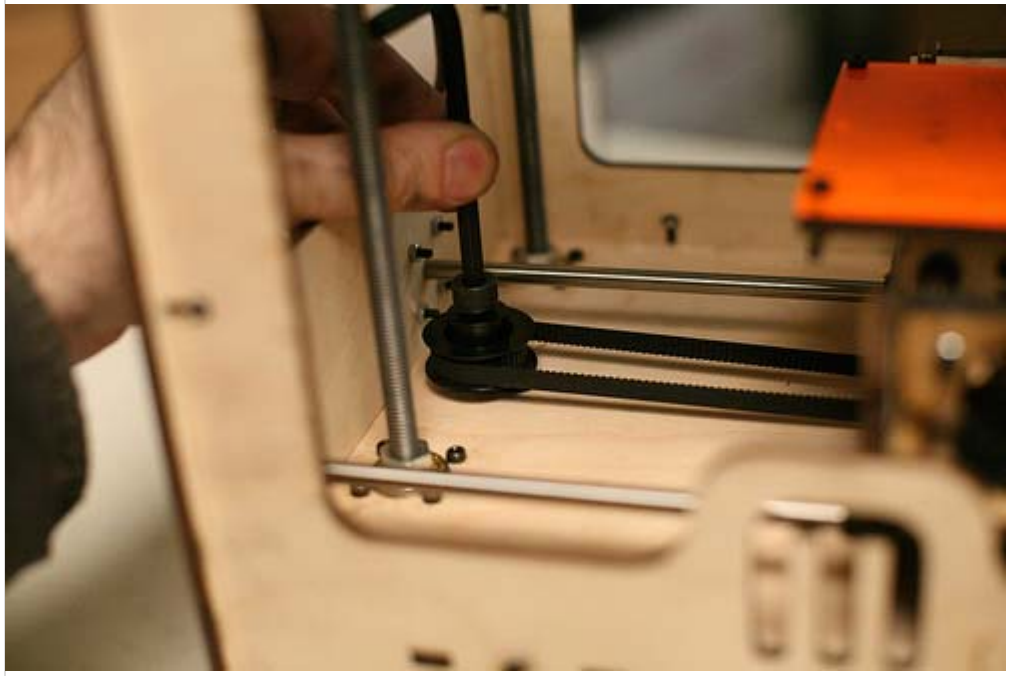
- Install two rod covers, labeled 'rc', on the right side of the bot using four bolts each.



- Place the XY stage in the bot. The idler pulley on the XY stage should face the front of the bot. Loop the belt around the motor and idler pulleys on the bot. Position the belt so that it runs through the wide slot in the bottom of the XY stage, and make sure the stepper wires go through the provided niche.



- Insert the smooth X rods into the bot by sliding them through the holes in the left side of the machine, through the bearing holes in the X stage, and into the covered holes at the right of the machine. The rods should support the X stage slightly above the middle plate.



- Pull the idler pulley back until the belt is fairly taut. Make sure that it's not so tight that it prevents the motor from turning and moving the platform readily. When you've got the tension about right, tighten the bolt and nut well with a hex key and a wrench.

Install the second set of X rod end caps.

TIP If the rods are too short they will move back and forth causing loss of resolution and additional noise. If this is the case for you, just insert something between the end cap and the rod to help compress it. One reader had success with a dab of glue from the glue gun.

That's it— the XY stage is installed!

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Cupcake Z Stage Installation

Summary

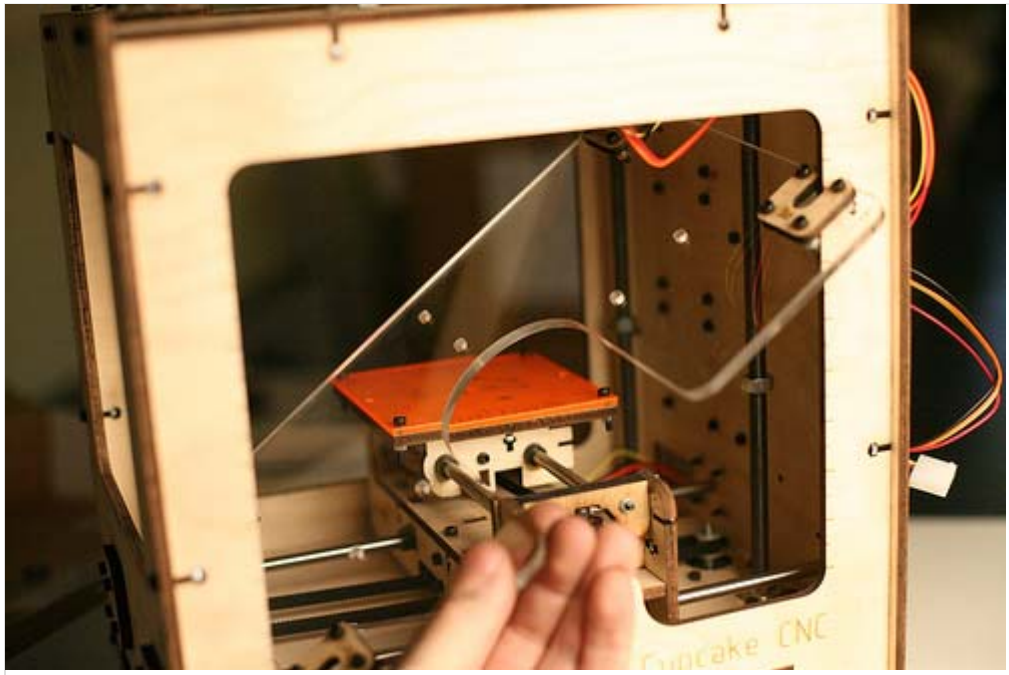
Installing the Z stage should take less than ten minutes.

Parts List

You'll just need the Z stage you assembled earlier.

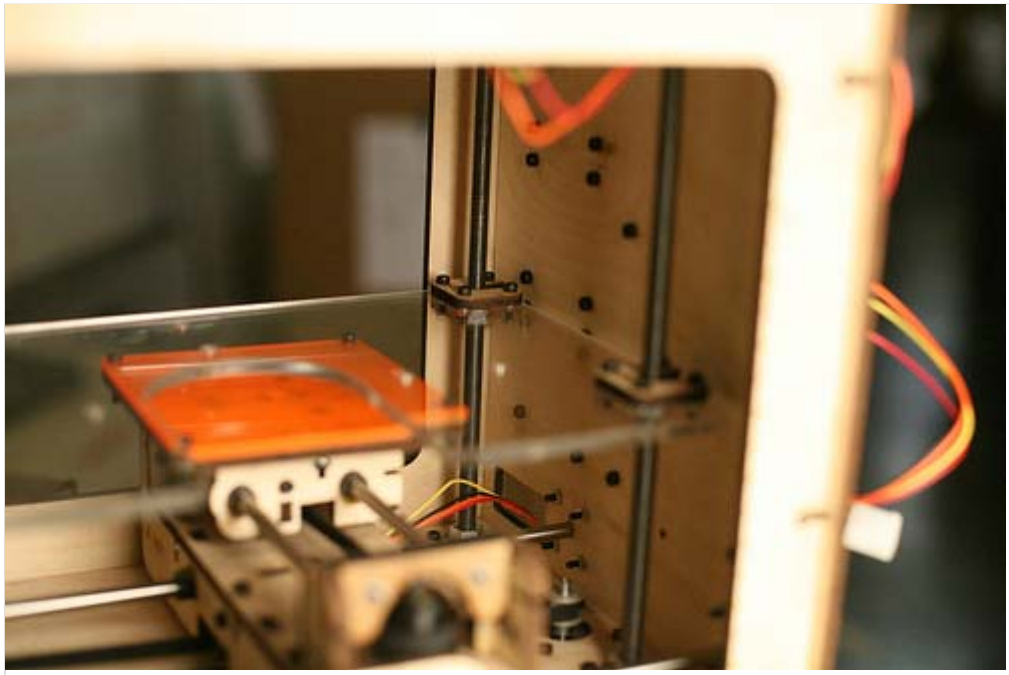
Assembly

- Rotate the four free nuts on the Z rods until they are about two-thirds of the way towards the bottom of the rods.

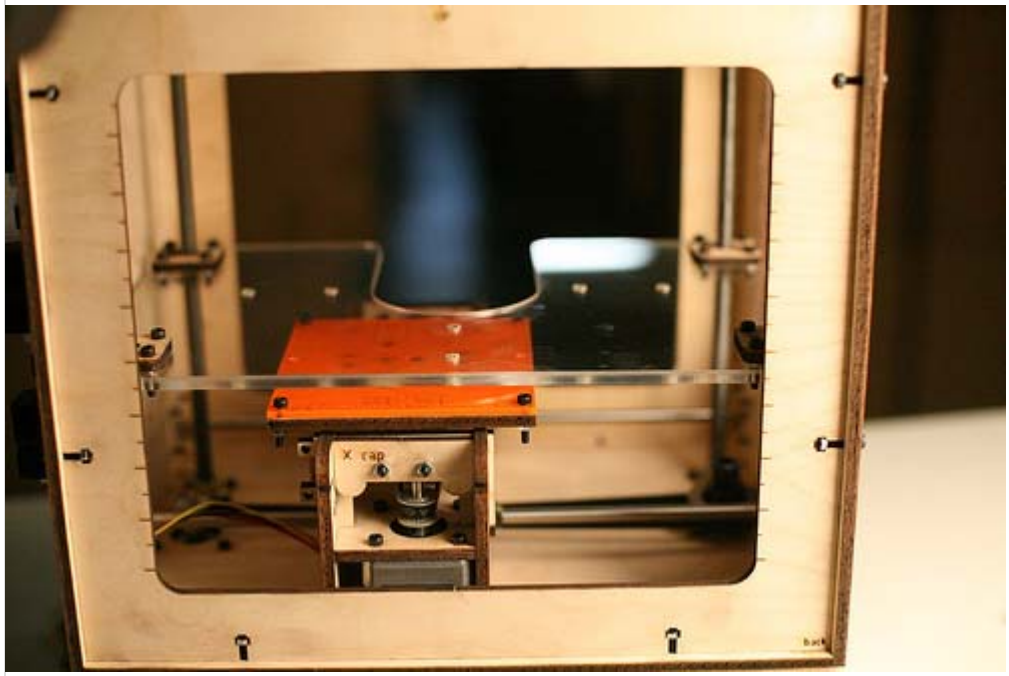


- Tilt the Z stage at a 45 degree angle and insert it into the bot, with the U-shaped opening facing the front of the bot.

- Move the Z stage so that two rods slide into the Z guides on the lower side of the stage.



- Lower the other side of the stage so that the rods on the other end also enter the Z guides.



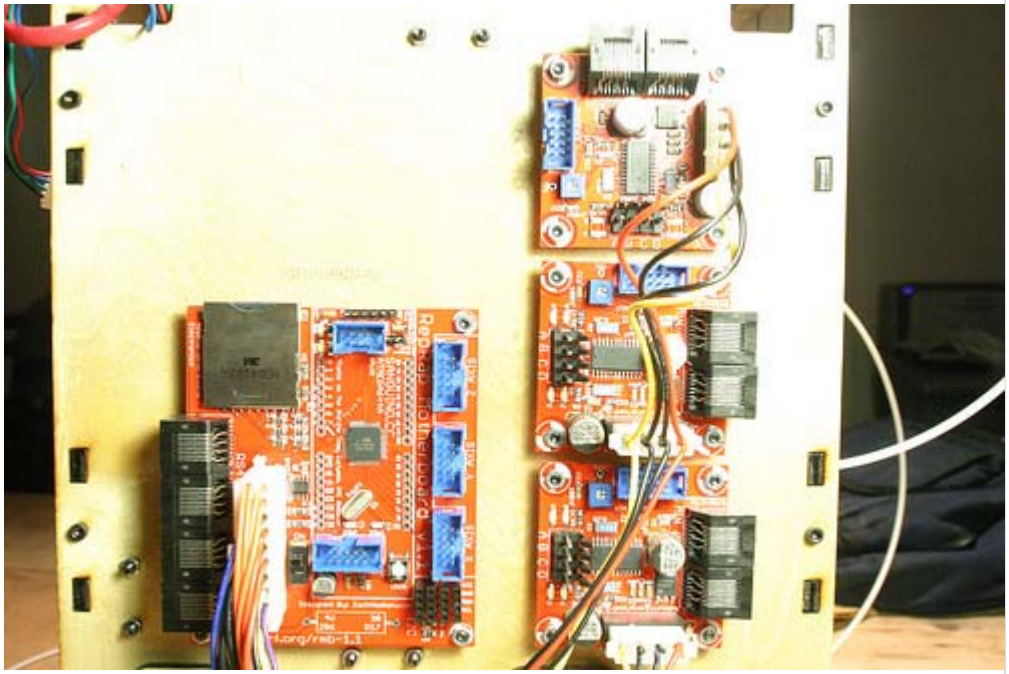
- Now rotate the nuts so that the stage rises above the build platform. Level the platform by raising the nuts to the same height. The nuts should sit inside the hexagonal slot in the Z platform, so that the Z guide rests on top of the nut directly. It's important to get all four nuts to the same height, so play around a bit to make sure the Z platform is completely level. Turn the Z belt by hand a bit to make sure the platform smoothly rises and falls.

Your Cupcake CNC is mechanically complete! Now you'll just need to hook up the electronics and install a Plastruder or other toolhead to get started!

Cupcake Electronics Installation

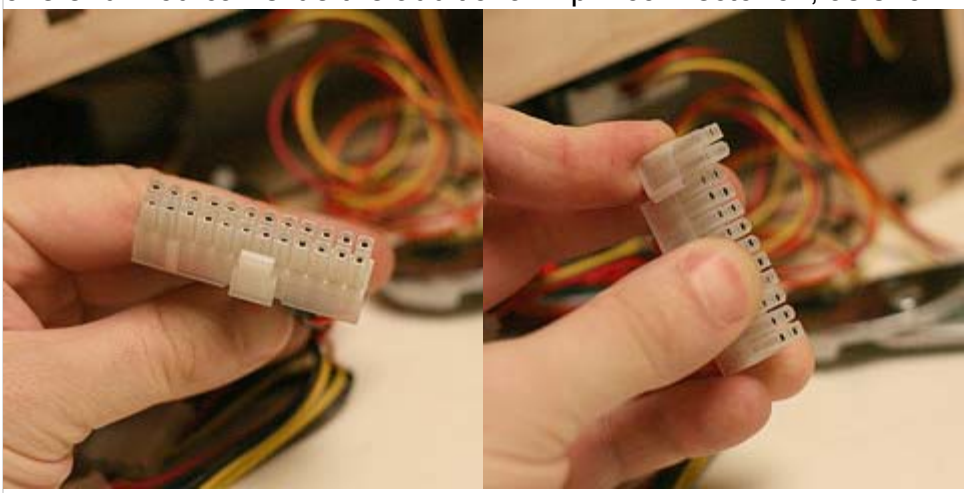
STOP! Check that the 110V/220V switch on your power supply is set correctly.

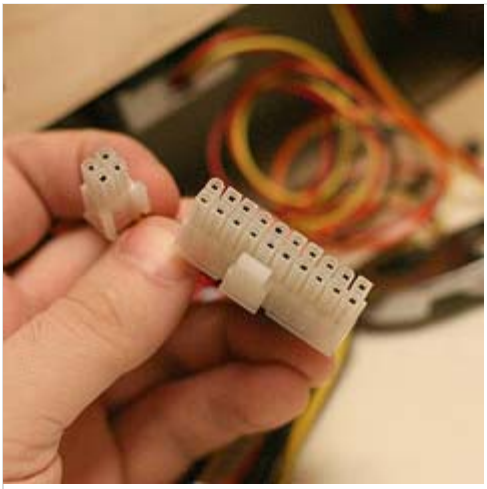
Connect the power supply



Connect the four-pin molex connectors from your ATX power supply to each of the stepper boards. Connect the 20-pin connector to the motherboard. All the sockets are keyed, so it should be clear which way around each connector goes.

Your power supply may have what appears to be a 24-pin connector. Don't panic! It's actually a 20 pin connector with an extra 4-pin connector attached on one end. You can slide the additional 4-pin connector off, as shown below.





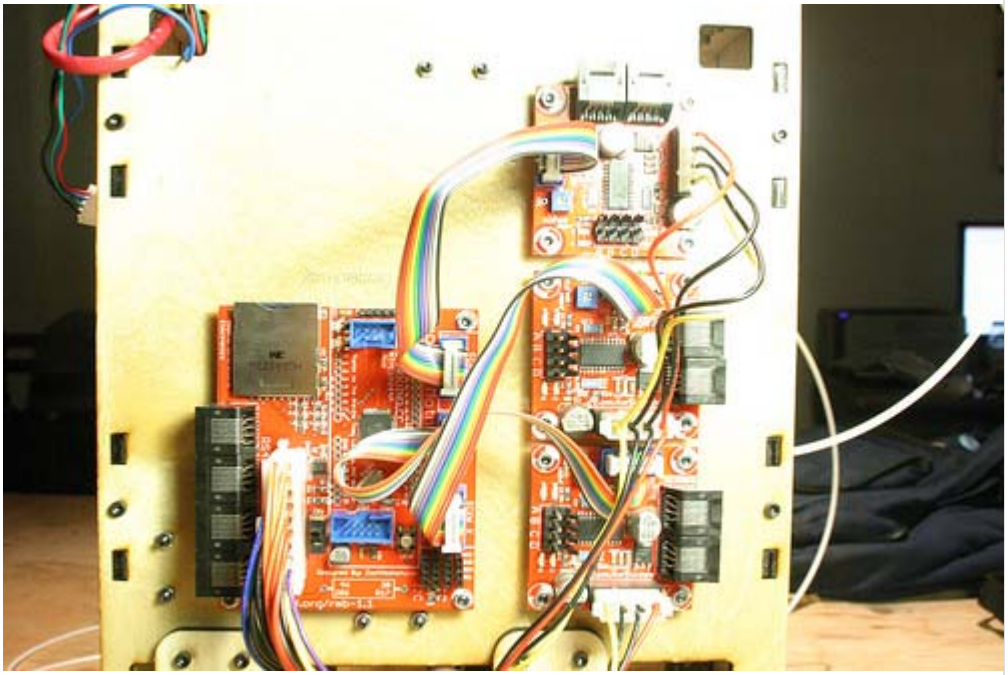
After that, find the molex connectors among the power supply wiring. The molex connector is a chunky 4-pin connector with a trapezoidal tip. It's the kind of power connector that plugs into an internal cd-rom drive in a computer, if that helps. Hook one 4-pin molex power connector up to each of the 3 stepper motor drivers. If you have a relay board, that also gets a molex. Be mindful that it is inadvisable to chain y-splitters — if you have multiple y-splitters, then connect each one to a separate molex plug off of the power supply. We advise that the Relay Board kit be served directly by the power supply when possible.

Assemble your ribbon cables

If you haven't done so already, assemble the ribbon cables that came with your stepper drivers. the directions on the RepRap wiki for details. Make sure that both ends of the cable are hooked up in the same way— the engraved arrow on the IDC connector should line up with the same colors on both ends.

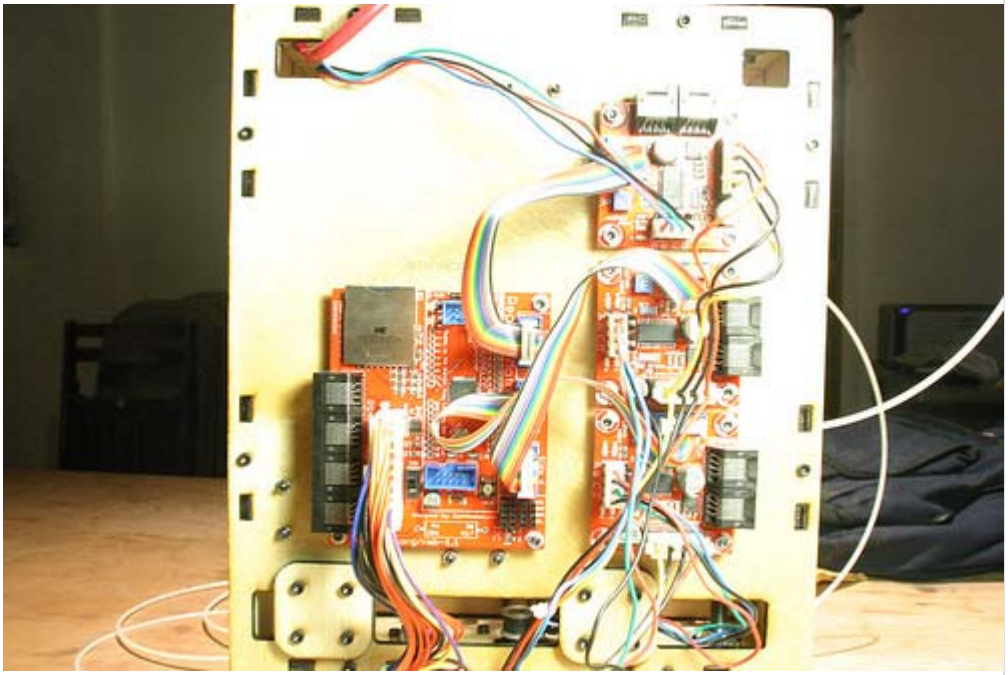
Wire up the stepper boards

NOTICE: DO NOT hook the Stepper Motor Drivers up to the Motherboard with the Cat5(ethernet)patch cables. This causes your Stepper Drivers to become damaged. Bad news!
Use the ribbon cables with the IDC sockets to connect the stepper driver boards to the labeled X, Y, and Z connections on the motherboard.



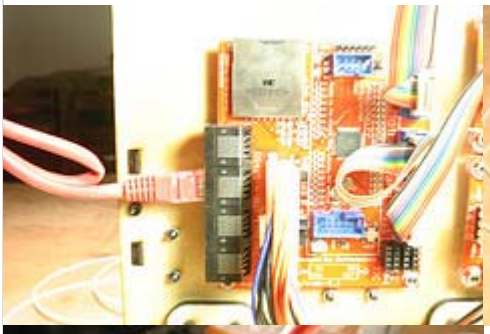
Hook up the steppers

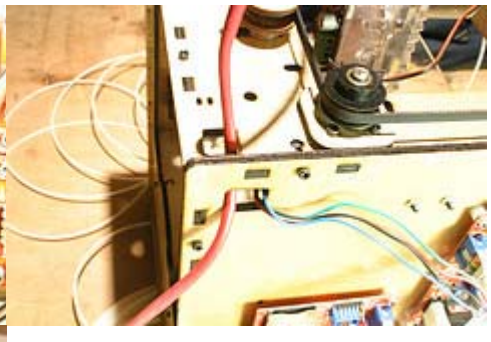
Attach the stepper connectors on the motherboard to the corresponding driver boards for each of the X, Y, and Z axis. One side of each connector should have a couple of small triangular ramps on it; these should meet the corresponding protrusions on the board when the connector is the right way around.



Connect the extruder

If you haven't assembled your plastruder yet, go here.





Plug one end of a patch cable into any of the RJ45 jacks on the motherboard, run it through the holes in the corner of the machine as shown, and plug the far end into the extruder.

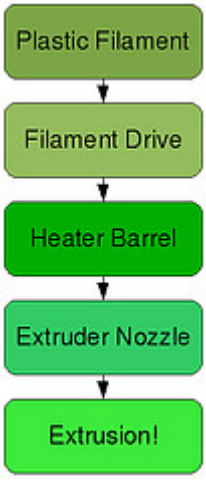
Plastruder MK4

Good to Know

The Extruder contains certain parts that could be dangerous if used in an improper manner. The extruder tip can become extremely hot. (>250 celsius) There is also an extremely powerful motor that can pinch fingers. Make sure you always run the extruder fully assembled and that you never touch the hot metal tip. Always keep the extruder away from flammable objects and never leave it hot unless you are actively printing.

Overview

The Plastruder is the 'print head' for your MakerBot. You can think of it as a souped-up, robotic hot glue gun. Its main purpose in life is to heat up the plastic you feed it, and then extrude it out in a fine stream that you can build with. It has two main parts: the filament drive mechanism, and the heater barrel assembly. The filament drive mechanism is the part that grips the plastic and pushes it into the heater for extrusion. The heater barrel assembly is the hot part of the extruder that melts the filament. It also has a small diameter nozzle where the hot plastic is forced out.



Specifications:

- Accepts 3mm plastic filament
- Maximum extrusion rate: 16mm/second
- Maximum temperature: 260C

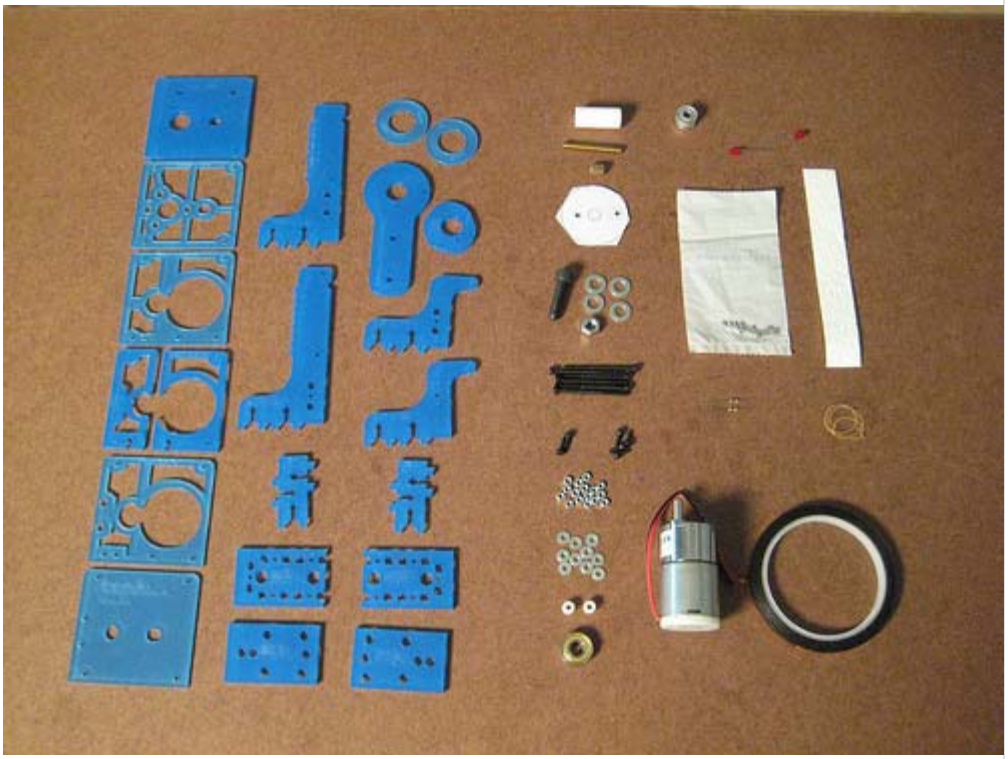
Usable Plastics

- ABS - recommended polymer. cheap, ubiquitous, low shrinkage, strong objects. ABS == Acrylonitrile butadiene styrene.
- PLA - excellent polymer. made from corn, transparent, eco-friendly, biocompatible and biodegradable in the body. PLA == Polylactic acid.
- HDPE - cheap polymer. very smooth, relatively high shrinkage factor. HDPE == High density polyethylene.
- CAPA - fairly expensive polymer. very low melting point. low friction. CAPA, aka PCL == Polycaprolactone.

Get one!

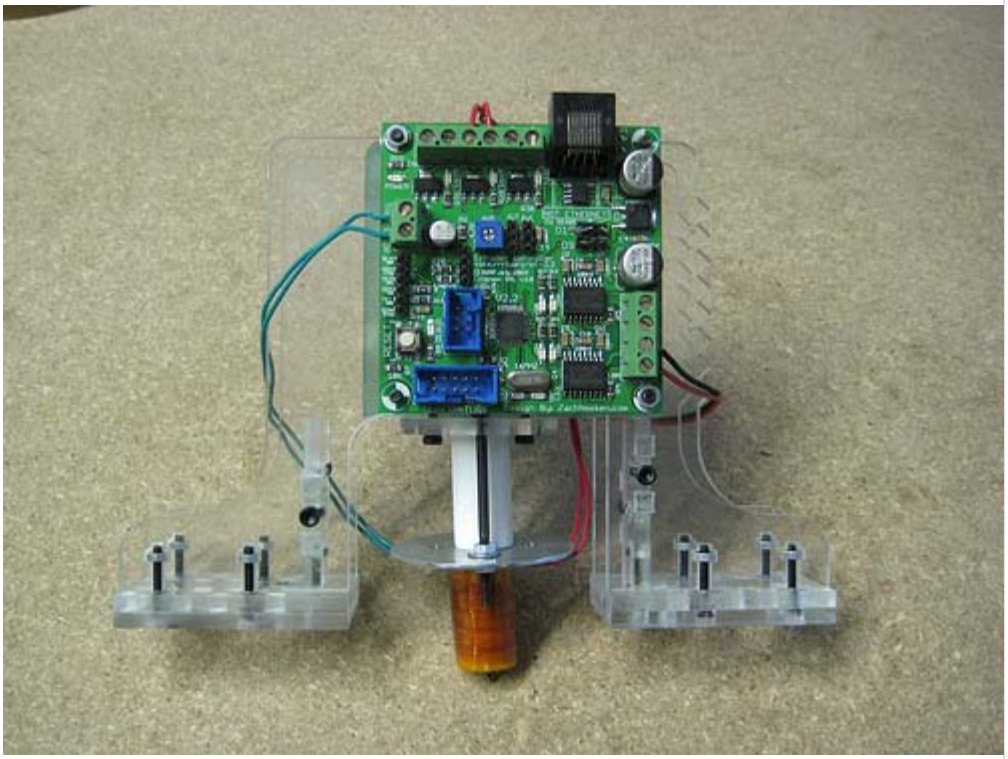
Gathering all the parts for building one of these can be pretty time-consuming. Also, you have to buy a large amount of something (like Nichrome) when all you need is small amount. Not only that, but buying a kit from the creators supports us so we can make it better. That's why we offer a kit that contains everything you need to build one yourself.

You may buy a Plastruder MK4 kit from the MakerBot Store.



Assembly

Building the extruder takes about 2 hours from start to finish. It's a pretty straight-forward process where you bolt together parts, use tape, cut and solder wires, and other fairly simple tasks. We've simplified the extruder design so that it only requires simple, common tools to assemble. If you have a partner or friend to help you out, it will be much more fun.



View the assembly instructions here.

Usage

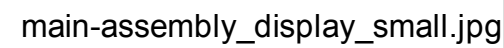
Your finished extruder is a robust, solid device for extrusion. If you treat it properly, it will extrude for a long time. There are certain things you should know about your extruder in order

to avoid damaging it.

1. Never run the motor without extruder being hot.
2. Never feed in a second strand of filament.
3. Always turn off extruder when you are done printing.
4. Double check the target temperature before extruding.
5. Never let your filament run all the way into the extruder.

View the usage instructions here.

Source Code


main-assembly_display_small.jpg

The design of this extruder is 100% open source. What this means is that we've released all the CAD files used for parts and the documentation under free licenses. The majority of the files are DXF files created by QCad. There are a few different ways you can access the files:

- Thingiverse - download the source, talk about it, etc.
- Google Code - download the release.
- Subversion - direct link to the MK4 release tag.

Tuning and troubleshooting.

There are a number of things that can be adjusted and tuned to get a plastruder to work just right.

Top of the plastruder!

- Filing the hole - Early machines didn't let you tighten the wheel close enough for the filament to get a strong grip. The fix is to file the hole for the M8 bolt that holds the retainer wheel.
- Tensioning - Check the pressure on the filament with the 2mm measuring stick. If you don't have one, you can try the flat sides of a hex key for an m3 nut (about 2.5mm)
- Floss the teeth - Plastic can build up between the teeth on the plastruder drive pulley which results in an innefective grip on the filament. Take the motor out and use a needle to scrape the plastic out.

Bottom of the plastruder

- Small thermistor- (A "small" thermistor is 1mm (1/25") or smaller in diameter; a "large" thermistor is around 3mm (1/10"). The small thermistor is different and requires that you either raise the temps to from 220 to 235 in the raft section of skeinforge, or update your extruder board firmware after changing the values in ArduinoSlaveExtruder/ThermistorTable.cpp accordingly. (see this thread for more info.) **New** — you can now upload the v1.8 extruder firmware and adjust the thermistor settings directly from ReplicatorG. See our page on adjusting the thermistor settings.
- Check the resistance of the nichrome wire. It should be 6 ohms. You'll need a multimeter for this. A lot of people skip this step when building their machine and regret it later.
- Check placement of the thermistor, it should be very close to the tip of the nozzle.
- Continuity check. Check the nichrome wire and see if it's burned through it's protective

sleeve and is grounding out.
- Make sure your using some heavy duty wire for the connection from the nichrome wire to the board, otherwise it will heat up too and cause problems! One pair of twisted pair ethernet seems to work nicely.

Plastruder MK4 Assembly

Assembly

Estimated build time: 2 hours.

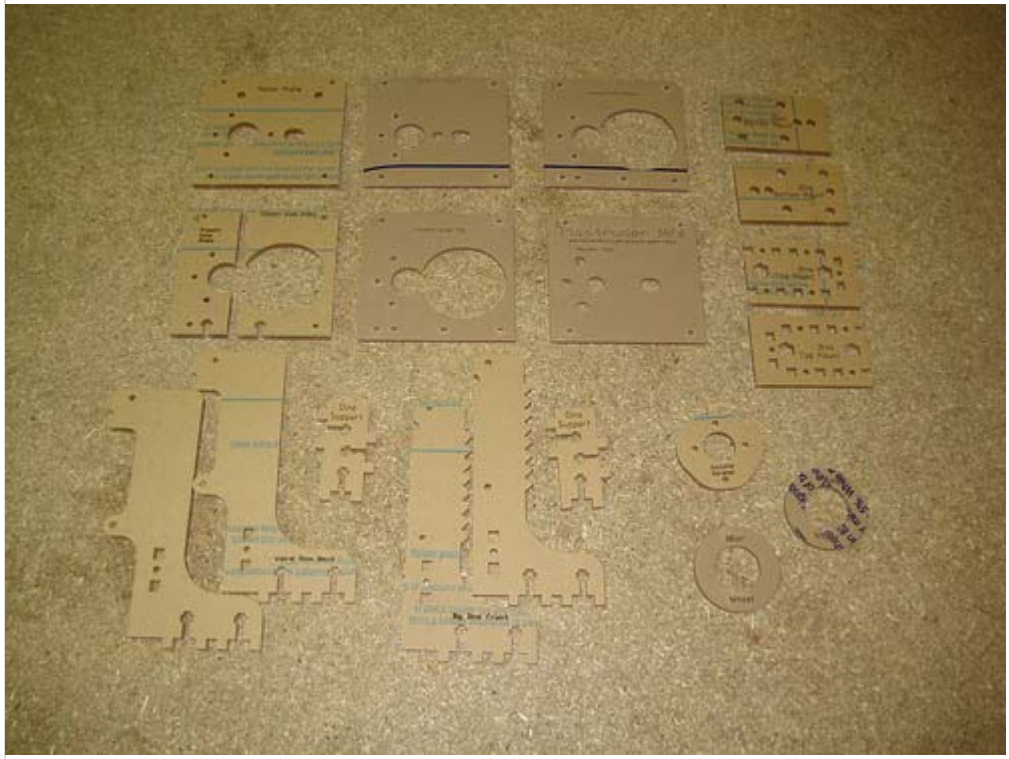
Tools You'll Need:

- Wire cutters
- Wire strippers
- Soldering iron
- Scissors
- Needle nose pliers
- M3 and M8 hex keys
- M3 and M8 wrenches or an adjustable wrench
- Super glue
- Acrylic glue if you have it
- A knife

Parts You'll Need

Nuts and Bolts

Lasercut Parts



Custom Bits + Motor

Partlist

Plastruder MK4

http://www.thingiverse.com/thing:964

Part List: tree | flat | csv

Part		Qty
Plastruder MK4 Hardware Kit		1
M8 x 35mm socket cap bolt	1	
M8 nut	1	
M8 washer	2	
M6 Nut - Thin	1	
M5 x 14mm socket cap bolt	4	
M5 nut	4	
M3 x 50mm socket cap bolt	6	
M3 x 20mm socket cap bolt	3	
M3 x 16mm socket cap bolt	14	
M3 x 8mm socket cap bolt	1	
M3 Spacer - 1/2" Length	4	
M3 nut	30	
M3 washer	10	

Parts You *Won't* Need

The plastruder kit contains a few more pieces than most users will actually need. In particular, your kit may contain:

- An additional idler wheel. Overtensioning your idler wheel can cause it to crack or break;

we include a spare so you can replace it if it gets damaged. You can also use it to build a double-idler wheel (see below for more info).
- A RepRap Insulator Retainer plate. These are special plates for mounting the Plastruder Mk3 on a RepRap machine. If you're building a Cupcake CNC, you won't need this piece. (Likewise, if you only intend to mount your plastruder on a RepRap, you won't need the big and little dino assemblies!)
- Extra 5mm LEDs and through-hole resistors. These are included for experimenters who want to add more blinking lights to their extruders; they're completely optional.

Prep Work

The build process is much easier if you build all the sub-components first, and then assemble them all into a nice, working extruder in one shot. Things like the Dino's are easiest to make beforehand, and other things like the Idler Pulley need time for the glue to dry.

Peel off Plastic

We ship the acrylic pieces with their protective plastic intact. This prevents them from getting scratched or scuffed during shipping. Use your fingernail, a small flat-head screwdriver, and/or your teeth to catch and edge and pull the blue film off. The parts are actually clear acrylic. Both sides have the film on them.

The film often gets stuck in loop letter parts (o, p, e, etc.); you can scrape it out for a perfectly clear look or leave it in to remind yourself of high school notebook doodles during boring classes.

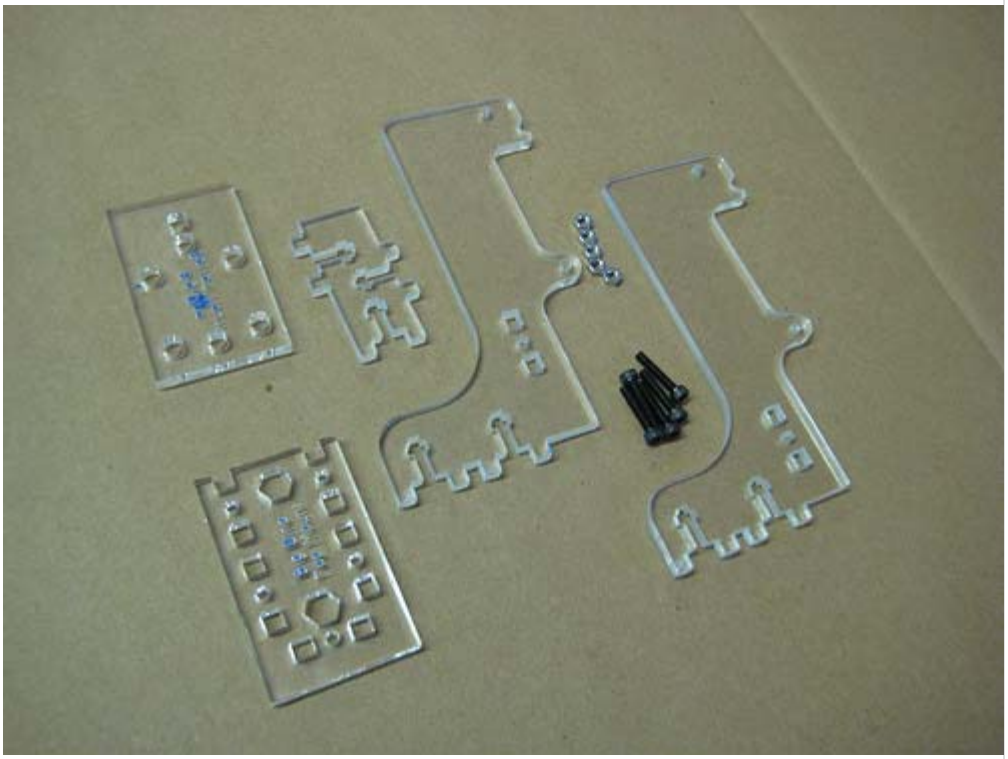
Weird Dinosaur

Parts You'll Need

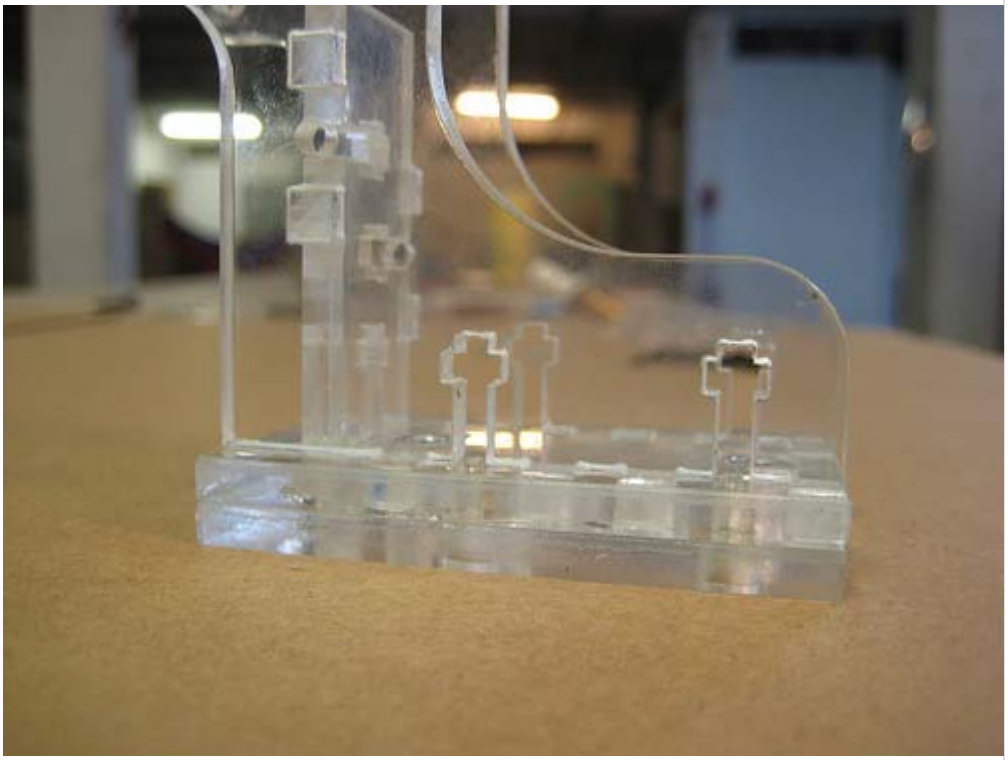
NOTE: in later batches Weird Dino Left and Weird Dino Right are called Weird Dino Front and Weird Dino Back.

- Weird Dino Left
- Weird Dino Right

- Dino Support
- Dino Bottom Mount
- Dino Top Mount
- 7 x M3 Nuts (only 5 in kit you may be 2 short)
- 7 x M3 x 16mm Bolts (only 5 in kit you may be 2 short)
- 2 x M5 Nuts



Assemble the Parts



The dino brackets lift the extruder housing up so that you get the maximum build height possible. They are very simple t-slot assemblies. It's easiest if you slot everything together, and then insert the nuts/bolts.

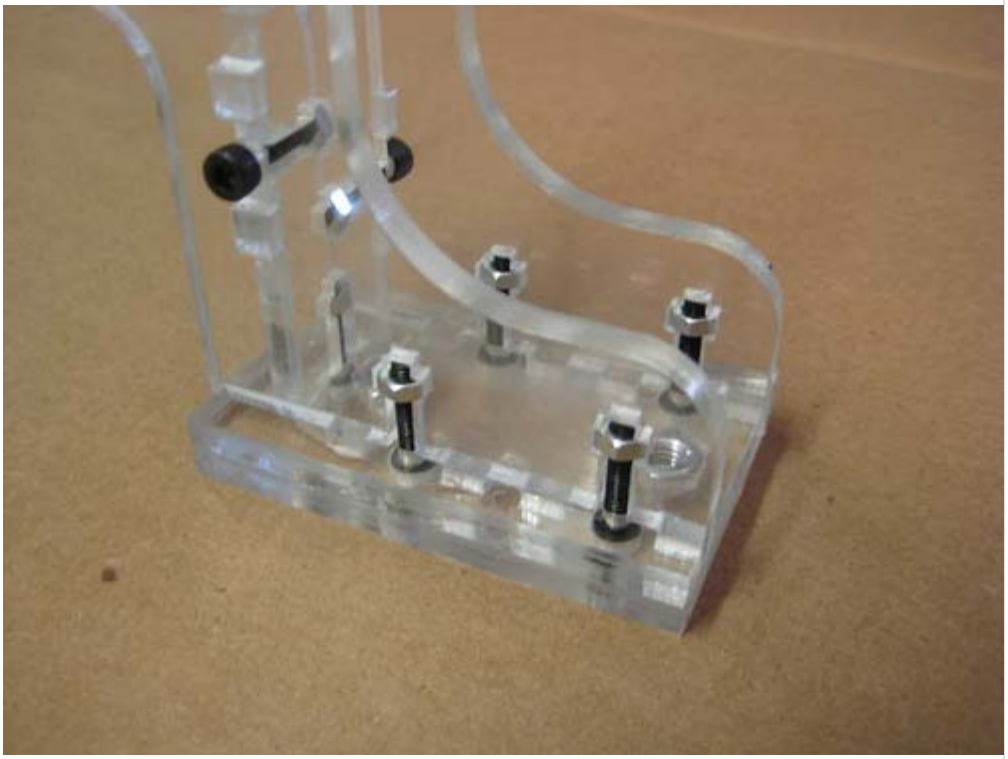
First, assemble the neck of the dino. Put the left and right sides together over the Dino Support piece.

Next, plug that assembly into the Build Base. The text should be facing towards the bottom.

Assemble T-slots

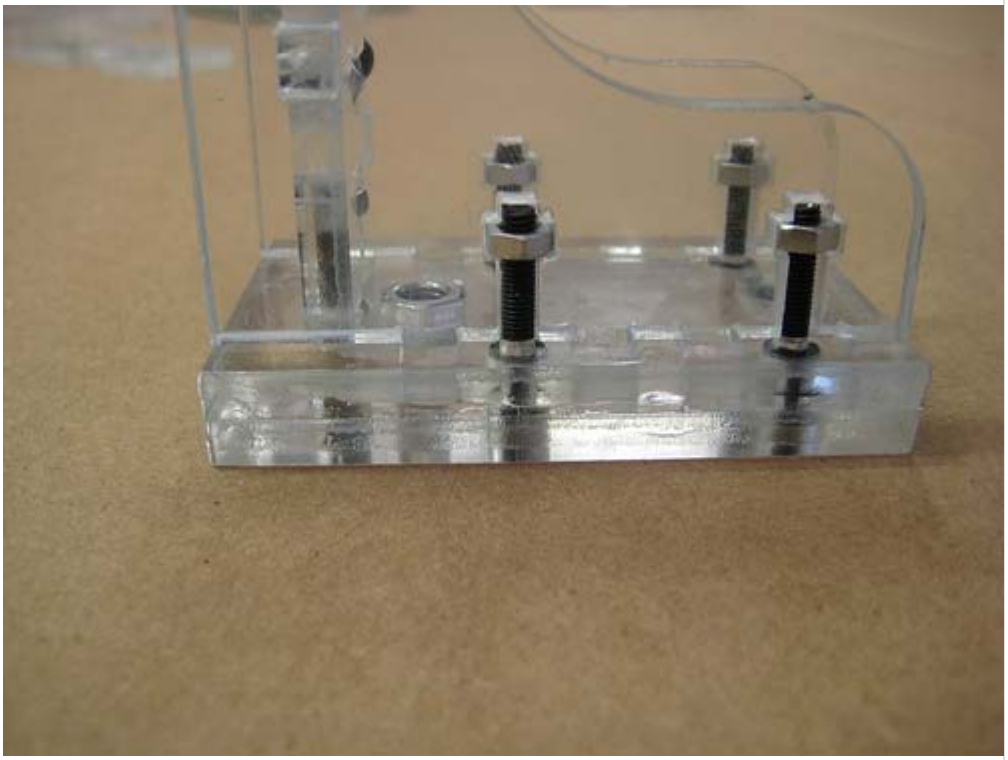
Now, insert bolts into each of the t-slots. You'll also want to screw in M3 x 16mm bolts as well.

Don't tighten things down yet, the dino's need to be a bit loose to fit over the extruder housing later.



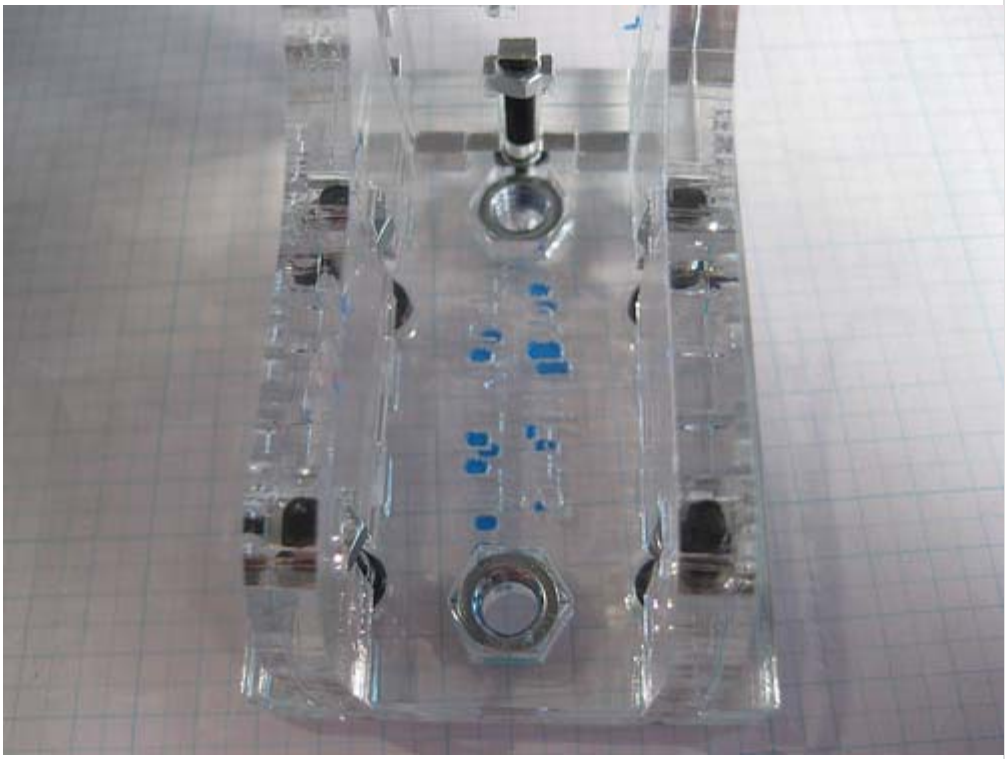
Attach Bottom Mount

Now is a good time to attach the bottom mount. Use Acrylic glue here instead of super glue if you have it - you'll get a much better joint. Put a dab of superglue in the middle of the plate and snap it on over the bolt heads that are sticking out. Let it sit for a few minutes and they'll be permanently connected.



Insert Captive Nuts

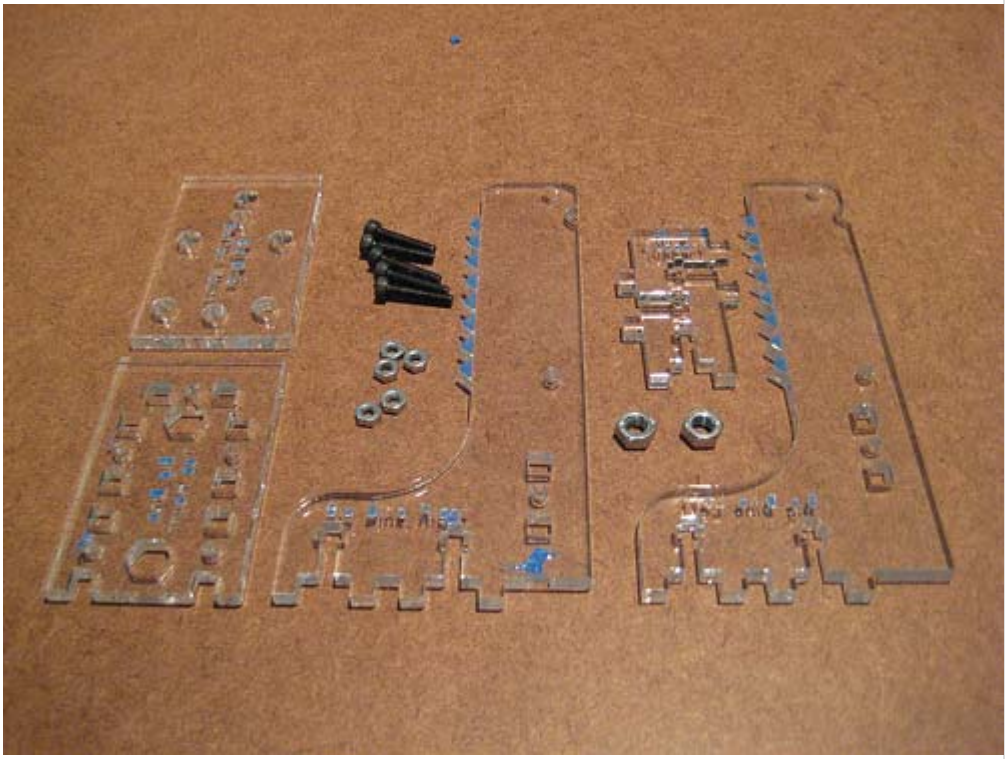
The dino brackets use captive nuts to make attaching them to the base easier. Take two M5 nuts and drop them into their respective places. They may fall out, so feel free to hold off on this step until you're ready to attach the extruder to the build base.



Big Dinosaur

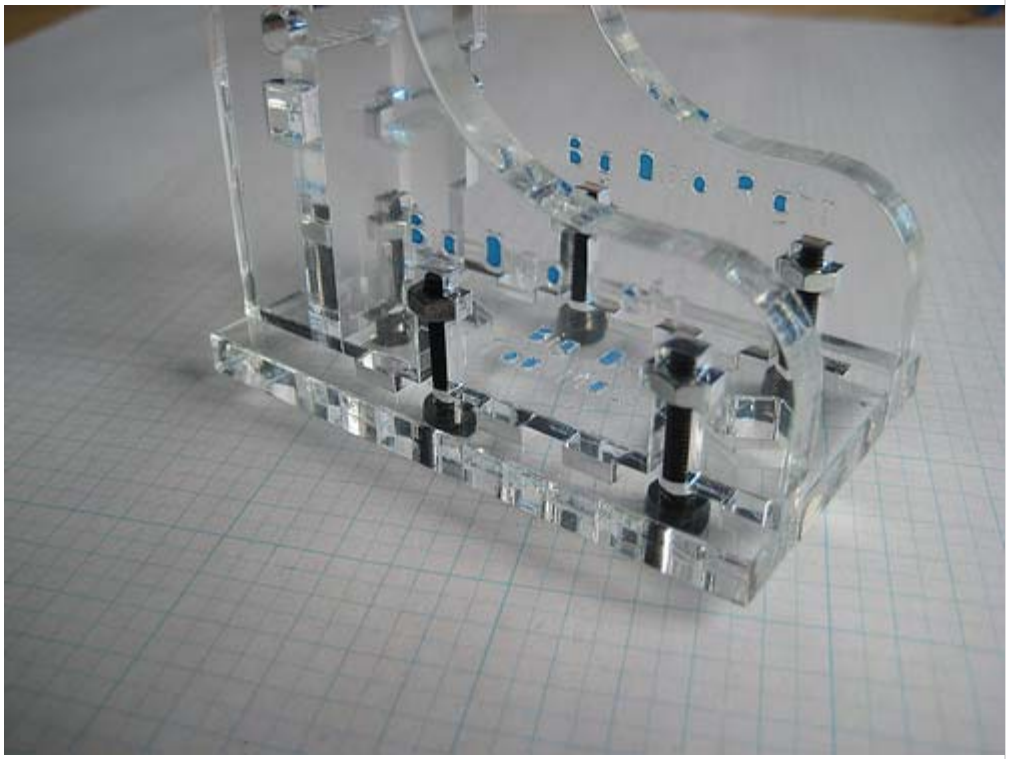
Parts You'll Need

- Big Dino Left
- Big Dino Right
- Dino Support
- Big Dino Bottom Mount
- Big Dino Top Mount
- 7 x M3 Nuts (only 5 in kit you may be 2 short)
- 7 x M3 x 16mm Bolts (only 5 in kit you may be 2 short)



Assemble It!

The big dino is just like the weird dino but with a different neck. Follow the directions above to build it.



Idler Pulley

The idler wheel is the part that rotates along with the filament and keeps things moving.

You'll need:

- The Idler Wheel
- A 608 skate wheel bearing
- 2 x M8 washers
- Superglue

NOTE: You may also want to consider the "Double Idler Wheel" technique. See here: DoubleIdlerWheel-WhenThingsGoWrong and here:

DoubleIdlerWheelDiscussion

The assembly instruction are very very clear that the smooth end goes into the nozzle? If that's wrong then the assembly page needs to be corrected. Mine is constructed this way and before the retaining ring broke was extruding very nicely. I'll update the list shortly now I have

replacements and will be back up this weekend.

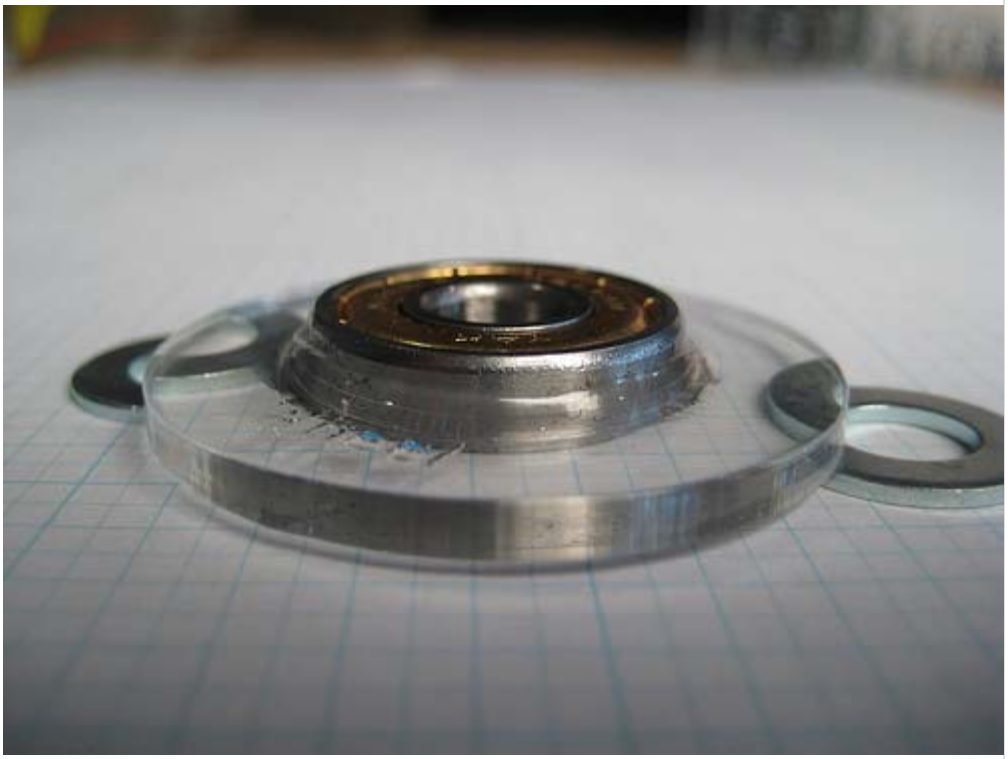
Position Idler Wheel

The first step is to position the idler wheel on the bearing in the exact right position. This is easiest to accomplish if you use two M8 washers to space the wheel off the table a bit. Position the idler wheel over the 608 bearing and push it down until it hits the washers.(Don't force it if the bearing does not want to go into the idler wheel, just enlarge the hole with some sandpaper. Forcing the bearing into the idler wheel will cause the wheel to break). Use a permanent marker to write radial lines all around the idler wheel. This will help when testing the idler wheel (below) and also in case you get extrusion slow downs later.

A bearing press (or vice with flat surfaces) allows you to put the bearing in to a much tighter fitting idler wheel without breaking it. Remember to press slowly.

Glue Idler Wheel Down

Once you have it properly in place, it needs to be glued down. Apply some superglue around the inner edge of the idler wheel to glue it to the 608 bearing. Be very careful not to get any on the inside of the bearing. You only want to glue it to the outer ring of the bearing. Let it sit for about a half hour or so.



Heater Barrel Assembly

Step 1: Gather Parts

In order to assemble the heater barrel, you'll need these parts:

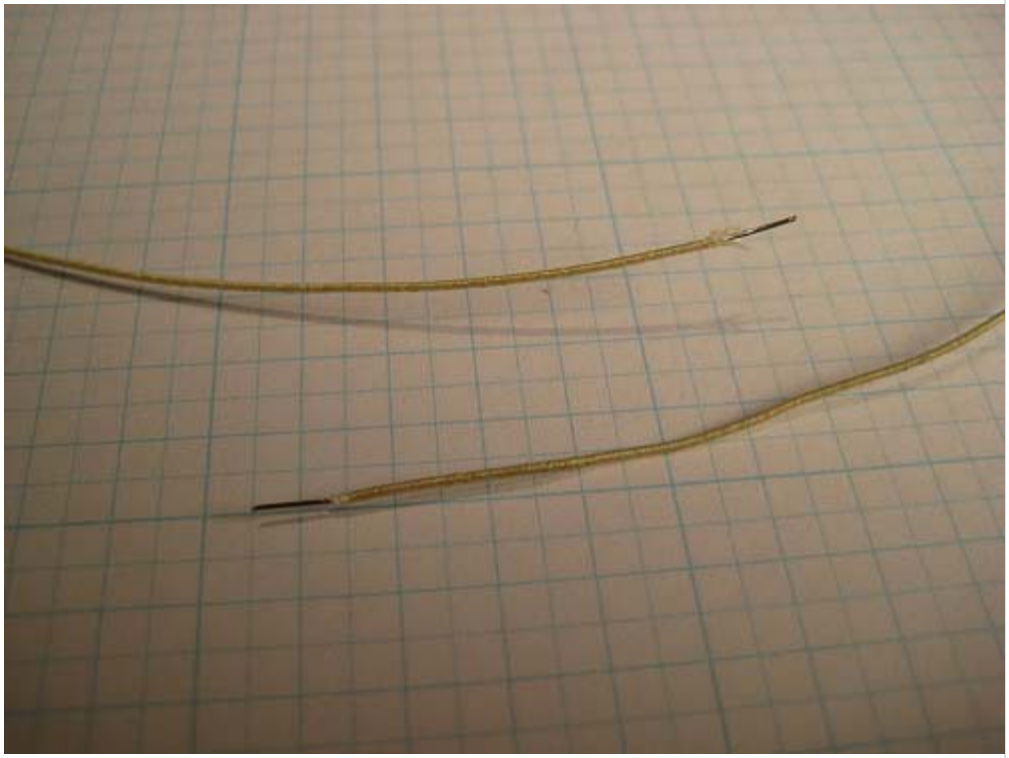
- 1 x Brass Heater Barrel
- 1 x PTFE Thermal Barrier
- 1 x Brass Nozzle
- 300mm nichrome wire
- Kapton tape
- 150mm ceramic tape
- 1 x 100K ohm thermistor
- two different color wires (2 x 300mm pieces of each color — 4 pieces total). 24-26 gauge is a good size. I like using red for hot, and blue for temperature. NOTE: these are NOT

included in the Plastruder kit; you must supply your own.
- some solder
- 2 x crimp-on ferrules for wire
- a multimeter
- Thin M6 nut (optional)

Step 2: Prepare the Wires

First up, you'll want to prepare the nichrome wire. Nichrome is nickel/chromium alloy with a set resistance. What that means is when you pump electricity through a length of it, it heats up. If you use the right length, and the right voltage you get simple, cheap heater. Thats what we're going to build now.

Trim and Strip the Nichrome



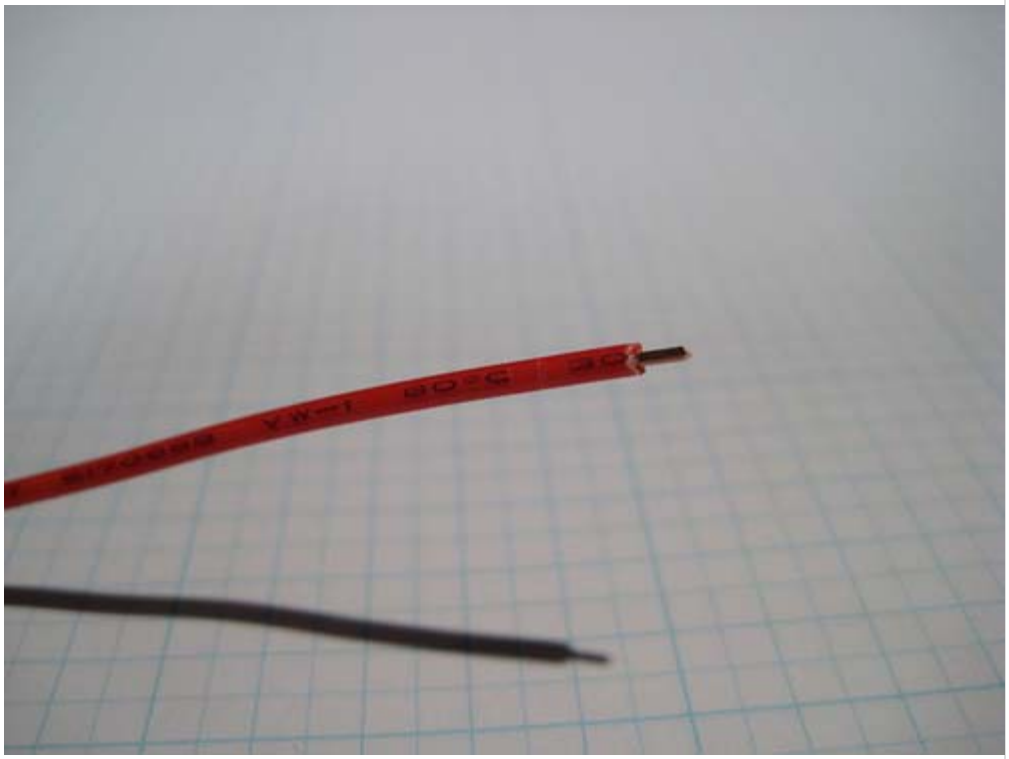
The nichrome wire should have a resistance of approximately 6 Ohm. Usually this amounts to about 300 mm of wire, but use a multimeter to be on the safe side.
Cut the nichrome wire to a length which amounts to about 6 Ohm of resistance (+/- 1 Ohm).
NOTE: It's difficult to measure the resistance of the nichrome until you strip the ends, so cut it long, then trim it down until you reach 6 Ohms.
NOTE: Make the wire too long, and your heater takes longer to heat up. Make it too short, and you burn out the MOSFET on the extruder board.

Take your length of nichrome and strip the insulation. The easiest way to do that is to use the edge of a knife and drag it along the insulation. Don't try to cut the insulation, but instead scrape it off. Scrape both sides of the nichrome wire and the insulation will easily fall away. Do this on both sides of the nichrome so that around 3mm of wire is exposed.

Strip the Heater Wires

Next, strip about 3mm from the ends of the wires you will use for the nichrome. Make sure you have a decent gauge wire as this will be carrying 2-3 amps for the heater. Its easiest if you crimp the ferrules onto this wire first. It is important you trim the exposed end of the wire to

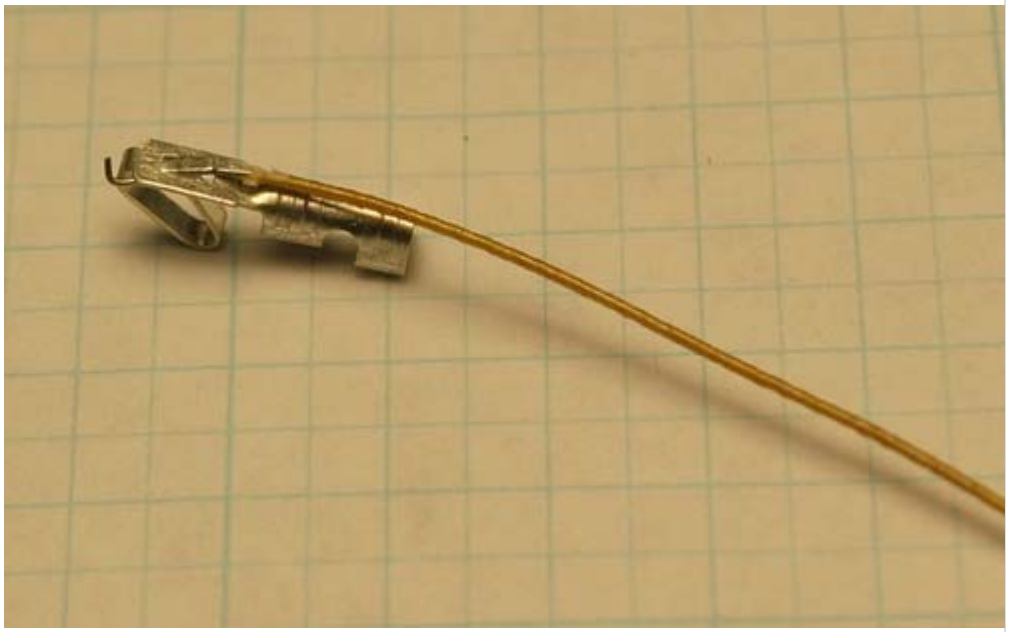
3mm. That way it won't take up all the space in the ferrule. If you mess up, its okay. You only need 2 ferrules and we provide 10 in a kit.



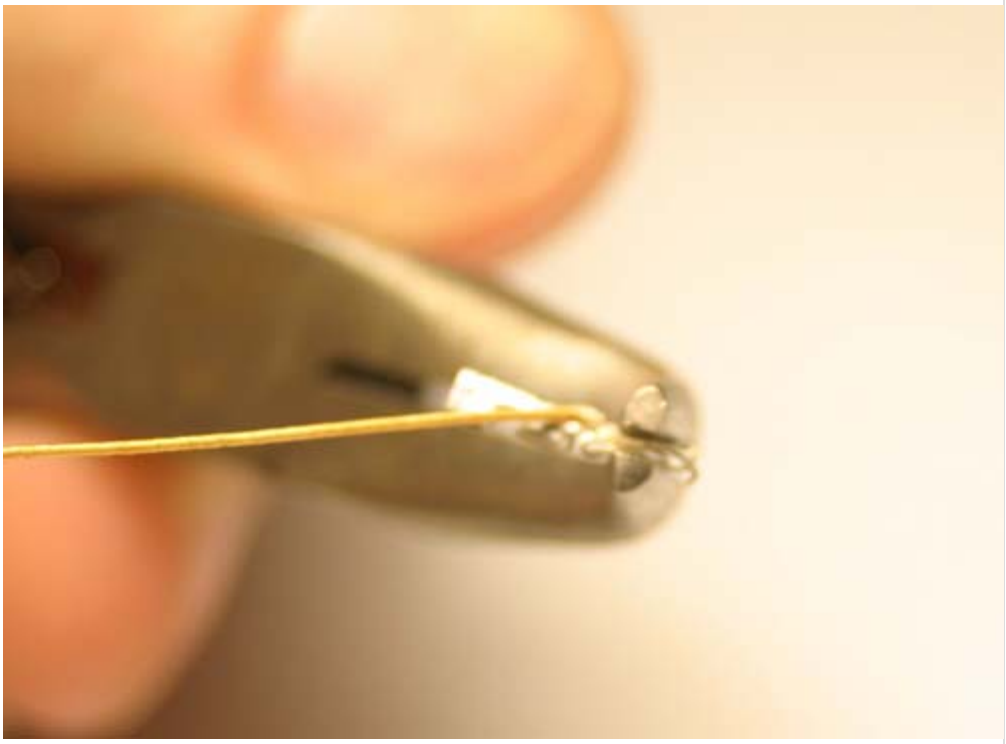
The next step will depend on which crimp connector came with your kit. Some kits will contain cylindrical ferrules, and others will contain terminal crimp pins (which have a springy metal curl at one end). Follow the directions below which are appropriate for your connector.

Crimp the nichrome wire to the connector

Insert the stripped tip of the nichrome wire into the small hole in the back of the terminal connector as shown. A little bit will stick out at the top; bend it back over the connector.

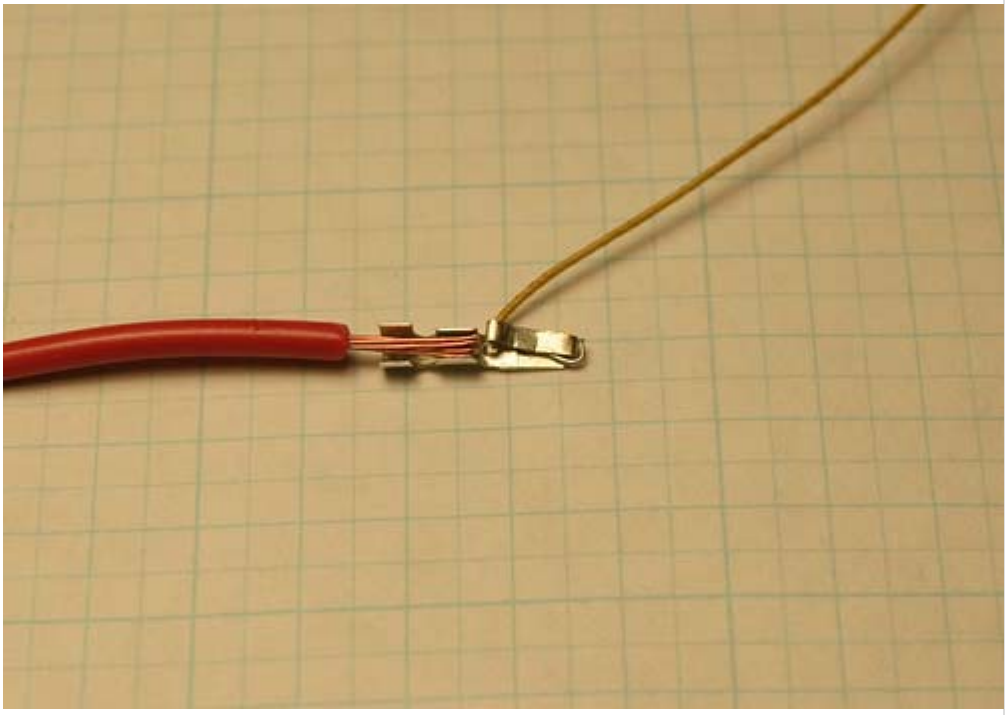


Now crimp the connection by squeezing the curled end of the connector flat with a pair of needle-nosed pliers.

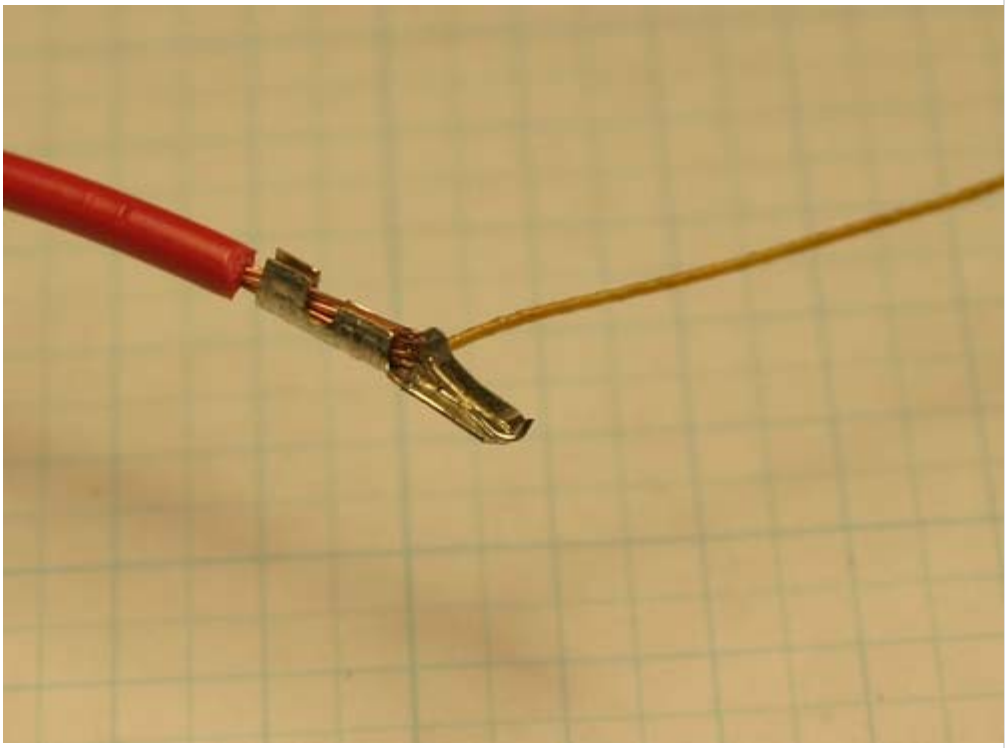


Crimp the copper wire to the connector

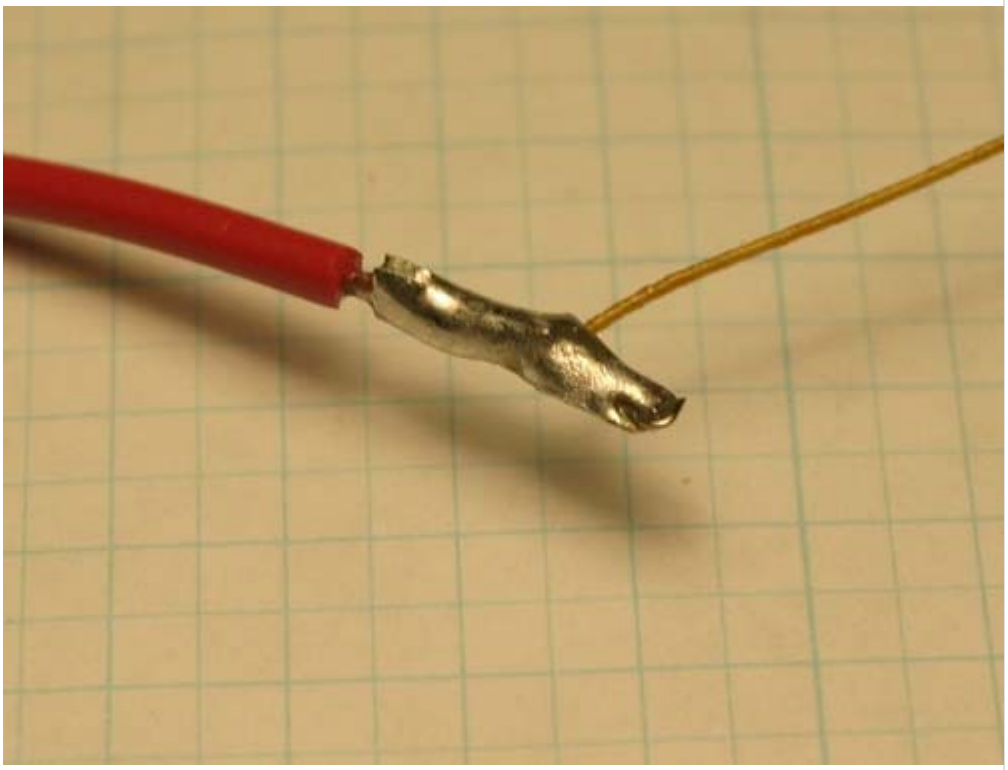
Insert the copper wire into the other end of the connector, as shown.



Use pliers to crimp the connector to the wire.



Solder the Connection



Because I don't trust mechanical connections, I like to solder the whole thing in place. Nichrome metal is pretty much impossible to solder, but the ferrule and copper wire are easy. The solder will provide a bit more stability and make the connection nice and strong.

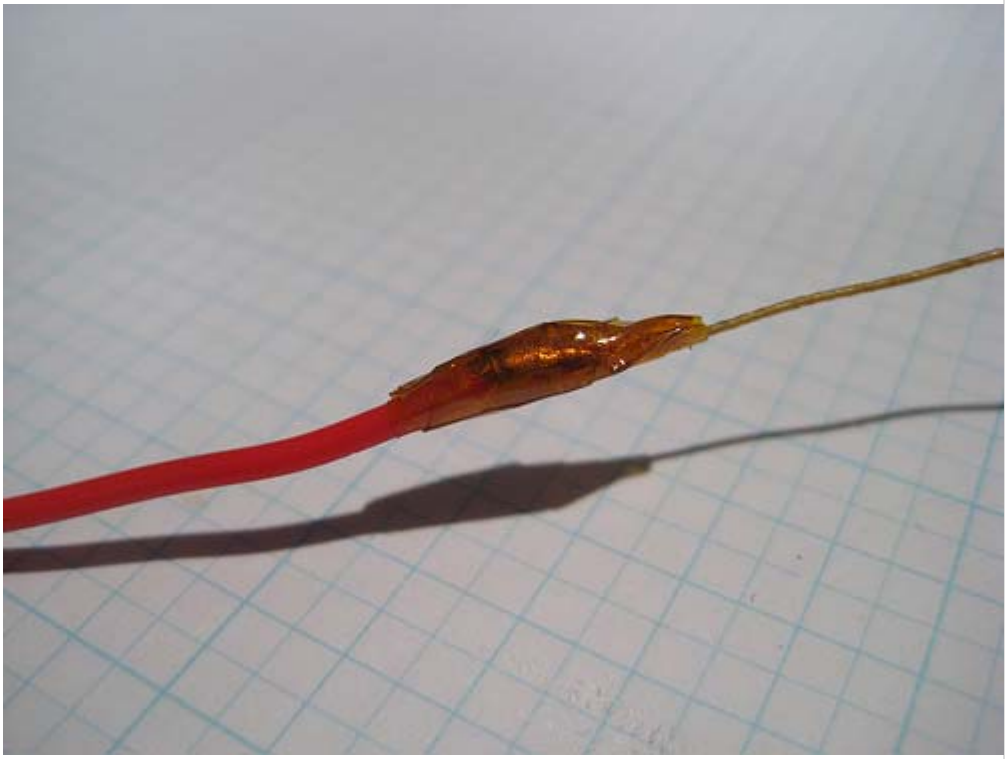
NOTE: I had no problems soldering this. Perhaps I found it trivial to solder as I tend to use lead-free solder which behaves a little differently than the typical lead-endowed junk. That said, it's not like it hurts anything to go solder crazy on a connection like this.

If the crimp connector doesn't work for you, try this Alternate Nichrome Soldering Technique.

Insulate the Connection

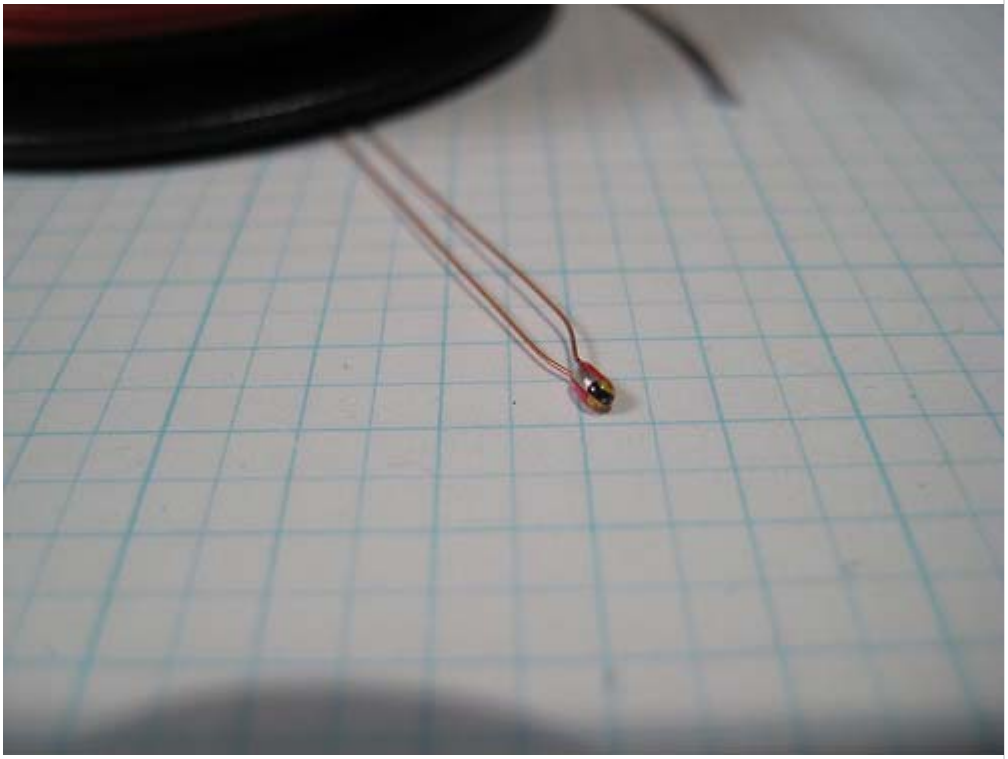
You'll want to do this so that you have a wire-nichrome-wire assembly. Once you have that, then wrap a tiny bit of Kapton tape around the joint to insulate it. Your heater wire is now ready to be attached. Win!

Repeat the same process with the other end of the nichrome wire and the other piece of the same color of wire.

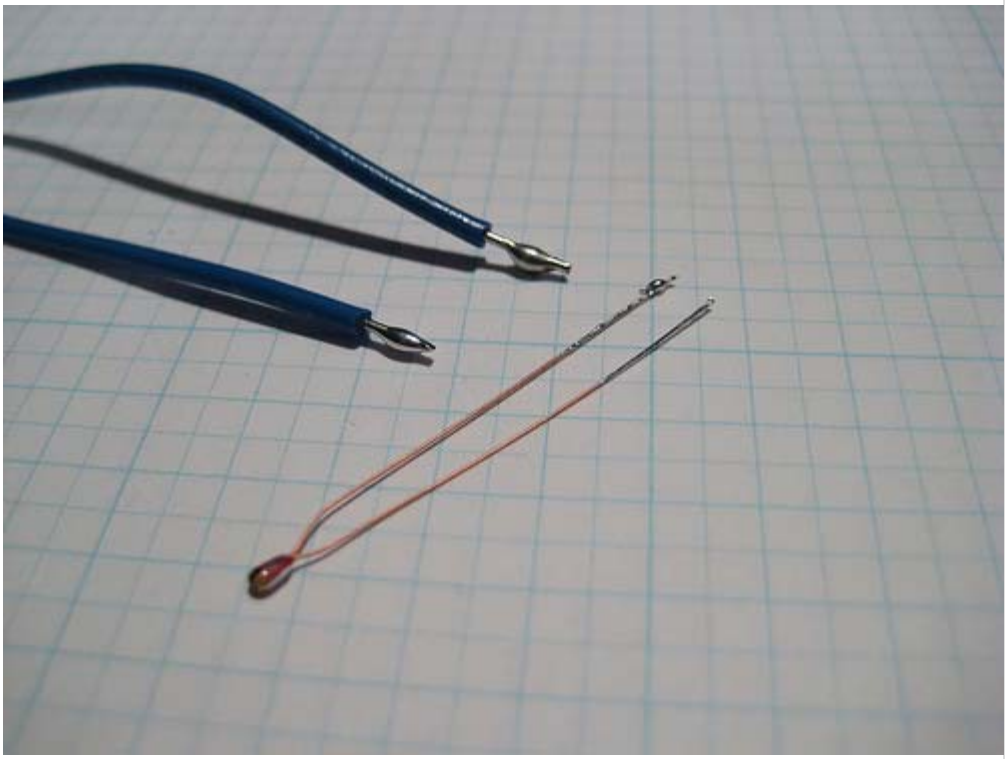


Separate Thermistor Leads

Next up: thermistor wire assembly. This is much easier. First, grab out the thermistor. The wires are un-insulated, so our first goal is to separate them to prevent shorts. Pull them apart so they are not touching and are separated by about 3mm. Don't pull too hard you pull it in half. The keyword here is 'gentle'.



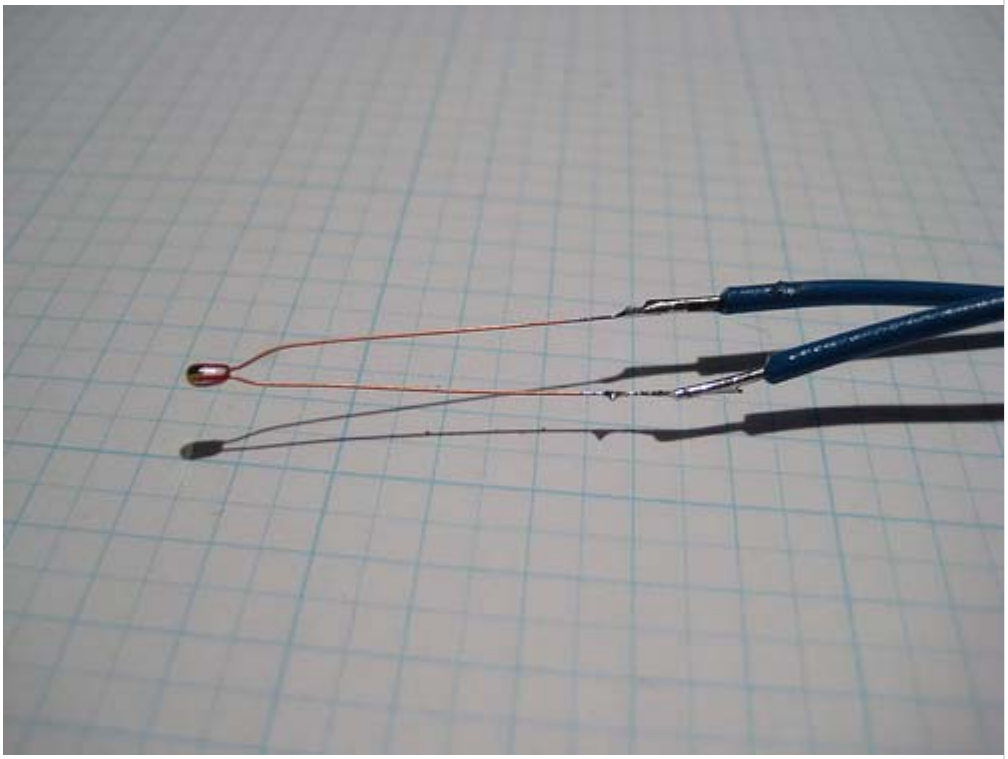
Trim and Tin



Once they are separated, you'll want to trim the leads to a length of 25mm. Take your soldering iron and apply a bit of solder to each end of the lead. This is called 'tinning' the leads. We'll do the same thing to the wires we'd like to connect and then we'll melt them both together at the same time to make a solid connection.

In order to do that, you'll want to strip the ends off the other set of wires you have. Make sure you're using different colors than the wires for the heater! Tin the end of these wires with some solder as well.

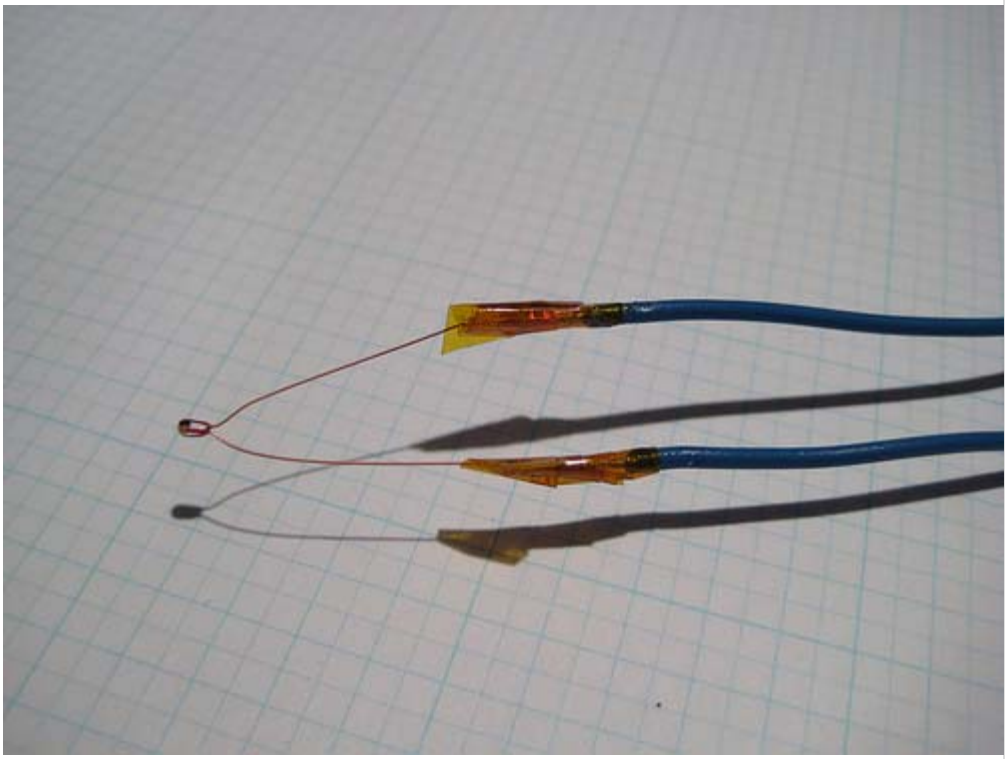
Solder Them Together



Once both the wires and the thermistor leads are tinned, you're going to want to connect one wire to each thermistor lead. This can be a bit fidgety, so if you can weight them down with your pliers or something, it will be much easier. Place them together and heat up the solder on both of them. You may want to apply a bit more solder as you do this. When it melts, remove the heat and both wires should be soldered together.

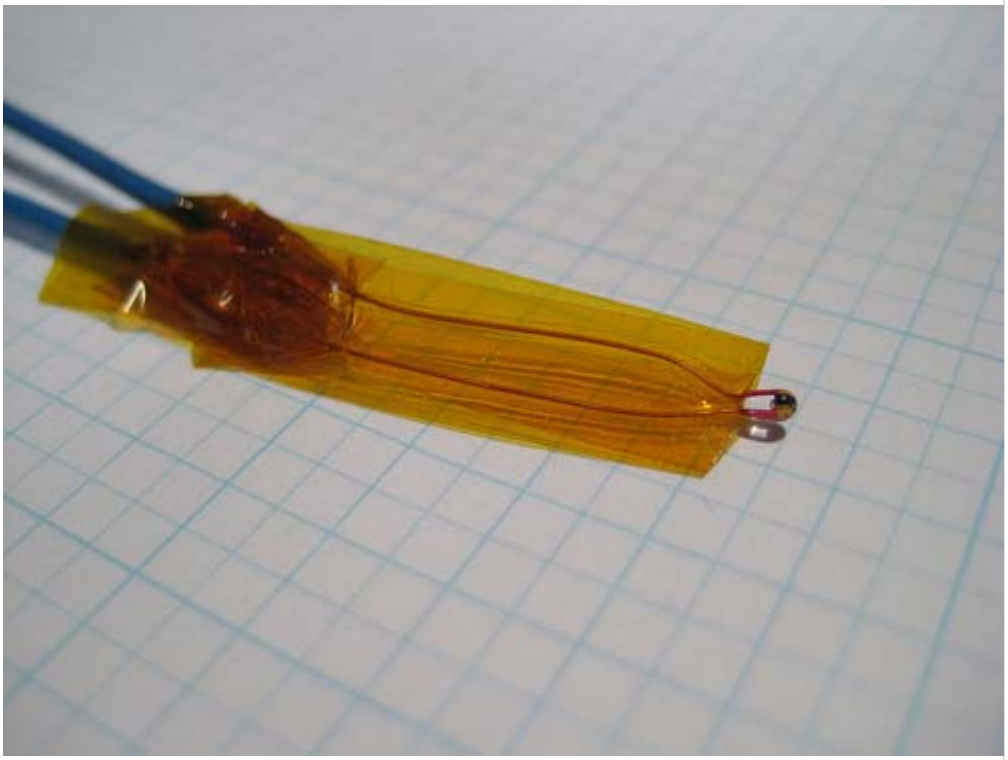
Insulate the Joints

After that is complete, wrap a tiny bit of Kapton around the solder joints. This will keep them from shorting out and may add a bit of mechanical stability.



Isolate the Leads

Take two more short pieces of Kapton Tape and tape from the glass bead to the solder joints. The point of this is to keep the thermistor leads apart so they don't short (and give you bad temperature readings). Put tape on both sides so its completely insulated and safe, and then your thermistor is ready for action.



Step 3: Prepare Heater Barrel

Thoroughly Clean Parts

Sometimes the heater barrel / thermal barrier / nozzle will have debris from the machining process on them. You'll want to wash all of these parts in water and/or rubbing alcohol. The heater barrel especially will need cleaning. Once you've washed them, I also like to clean the barrel out with a Qtip or other long stick thing that you can jam down it to push out any debris (like metal shavings.)

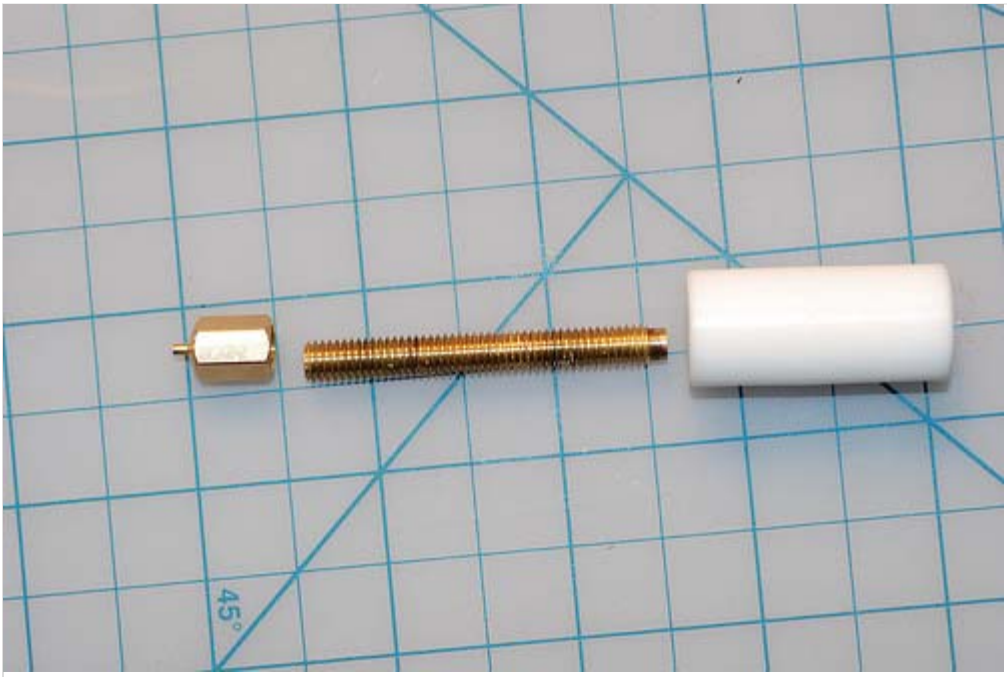
Assemble Machined Components

We don't want any shorts on the metal heater barrel in case the Kapton we used to insulate the solder joints falls off. The easiest way to do this is to assemble the Thermal Barrier, Heater Barrel, and Nozzle.
NOTE: Your barrel may have one end that is dressed/tapered, and one end that is simply sawcut. The "pretty" end is the one that goes into the PTFE barrier - the joint between the barrel and the barrier has to be clean and tight. As part of that, make sure that the barrel is screwed in tight, not just snug - need to make sure there isn't a gap at the top.

***NOTE: Newer barrels have one end with a smooth shoulder that is turned down to about 4.5mm for about 2mm. There has been a lot of debate about which orientation is better. Bre suggests that the end that is smooth for about 2mm goes into the PTFE, not the nozzle.

New style barrels go like this:

This is the correct way.



**Make sure you tighten the heater barrel all the way into the thermal barrier (but do not overtighten, see below). Failure to do so may cause extrusion failure due to plastic filling the gap between the heater barrel and thermal barrier.

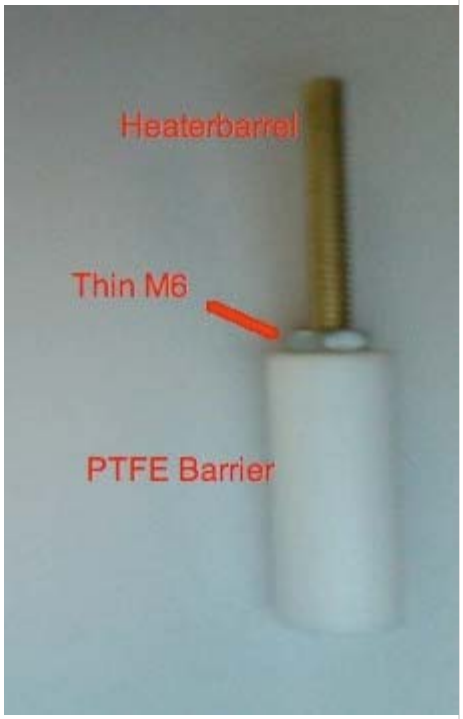
Don't go all crazy and use a vise to screw them together either. The goal here is to make sure there's no gap inside, but not to cut into the PTFE so deeply it deforms it. If you want to be really sure, check the drawings in thingiverse and look at how they are suppose to mate inside the PTFE, and check the length of the barrel that should be sticking out. It may help to put a piece of raw filament all the way through the insulator and into the barrel while you are tightening them together. This may help you from over tightening the barrel and deforming the edge of the hole causing the opening to narrow.

Go ahead and add the supplied M6 nut onto the heater barrel before you thread on the PTFE thermal barrier. Later, when the heater is fully put together, you will unthread the thermal barrier and the nut to add the big washer to end up with a stackup in this order: nozzle, heater, big washer, M6 nut, and finally PTFE thermal barrier. Having the nut there is crucial because it takes the load off the thermal barrier while the extruder is at temp and running. Without the nut, the threads on the PTFE thermal barrier will eventually fail because the hot heater barrel warms the plastic to the point that the force of the extruder motor will push the heater barrel out of the PTFE thermal barrier. Please note that after you are done assembling the heater in the steps below and are directed to add the big washer, don't screw the nut tight against the PTFE thermal barrier, as it will still be putting some stress on the PTFE threads. Tighten it only to the point that it just touches the PTFE thermal barrier, or even leave a small gap.

Note that if you partially disassemble this later and reassemble it in a different order, make sure the PTFE barrel top is flush with the top of the insulator retainer before you screw the assembly back onto the plastruder body. Otherwise you will crack the insulator retainer as you tighten it to the plastruder body.

Because the M6 nut modification transfers more sress from the PTFE to the insulator retainer, every builder should print a few spare insulator retainers just in case. The digital files to print are found here: http://www.thingiverse.com/thing:1004
Note: the printed ABS insulator retainer seems to be less brittle than the original acrylic one

anyway.

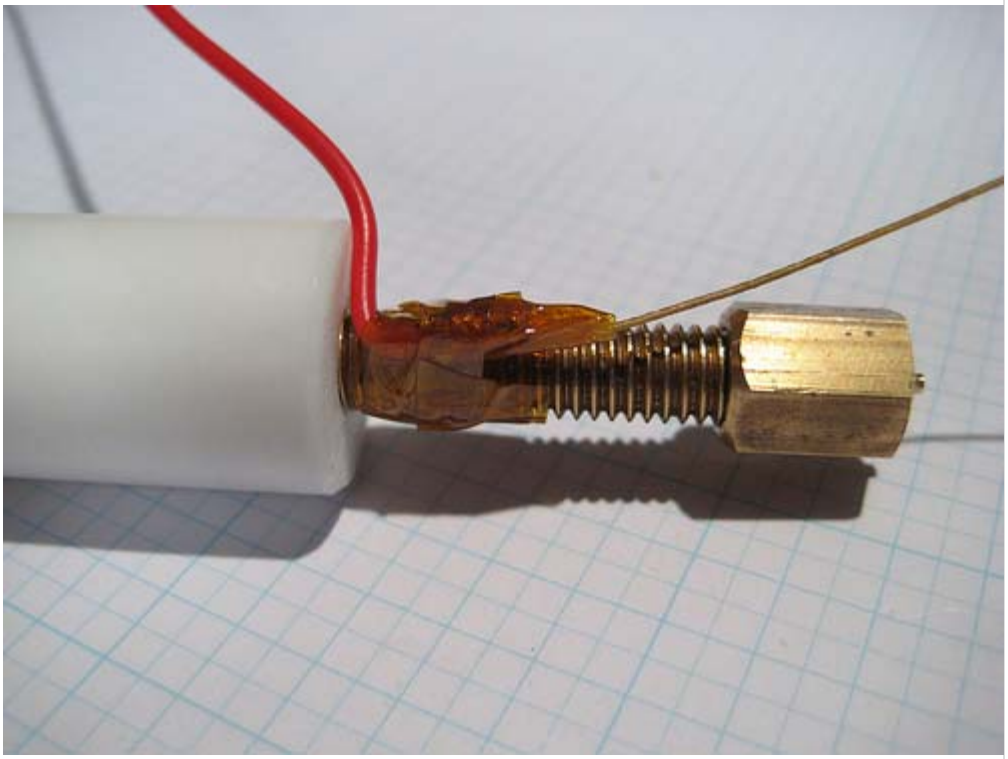


Insulate Heater Barrel

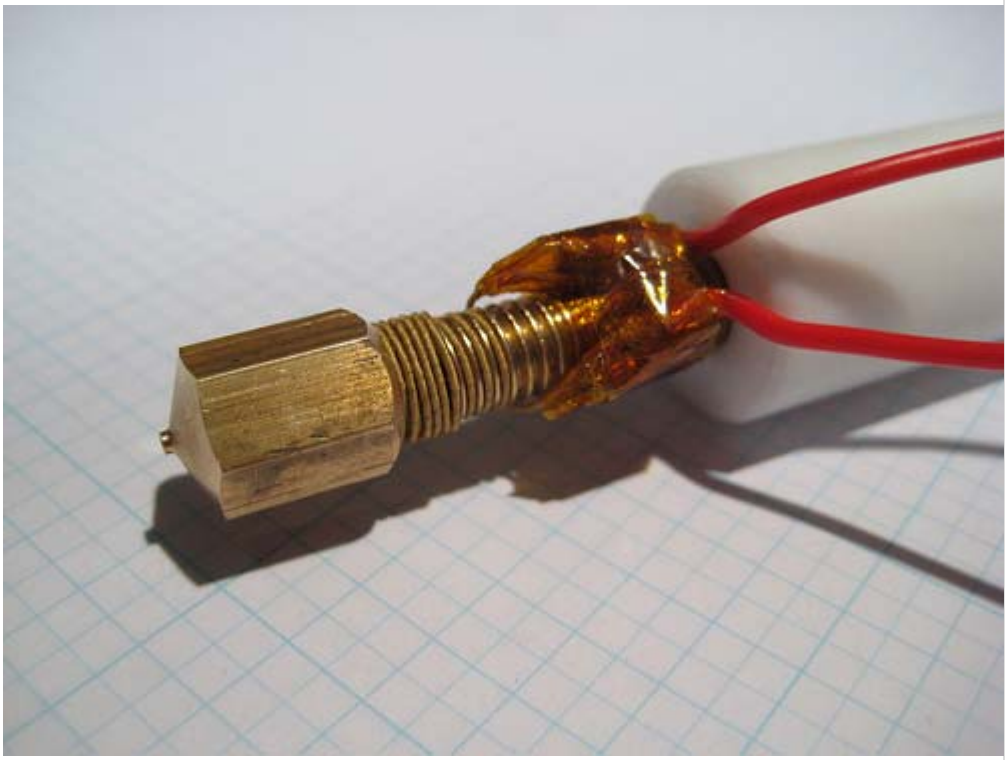
Once you do that, put one layer of Kapton tape just below the PTFE barrier, or the M6 nut if you used one. This is where there would be a potential short, so that's where we're protecting.

Attach One End of Heater

Now we're going to attach the nichrome heater to the heater barrel, and we're going to do that using Kapton tape. First, bend a right angle into the wire connecting to the nichrome just above the joint. Then, tape that end down to the heater barrel just below the PTFE where we just insulated the heater barrel.



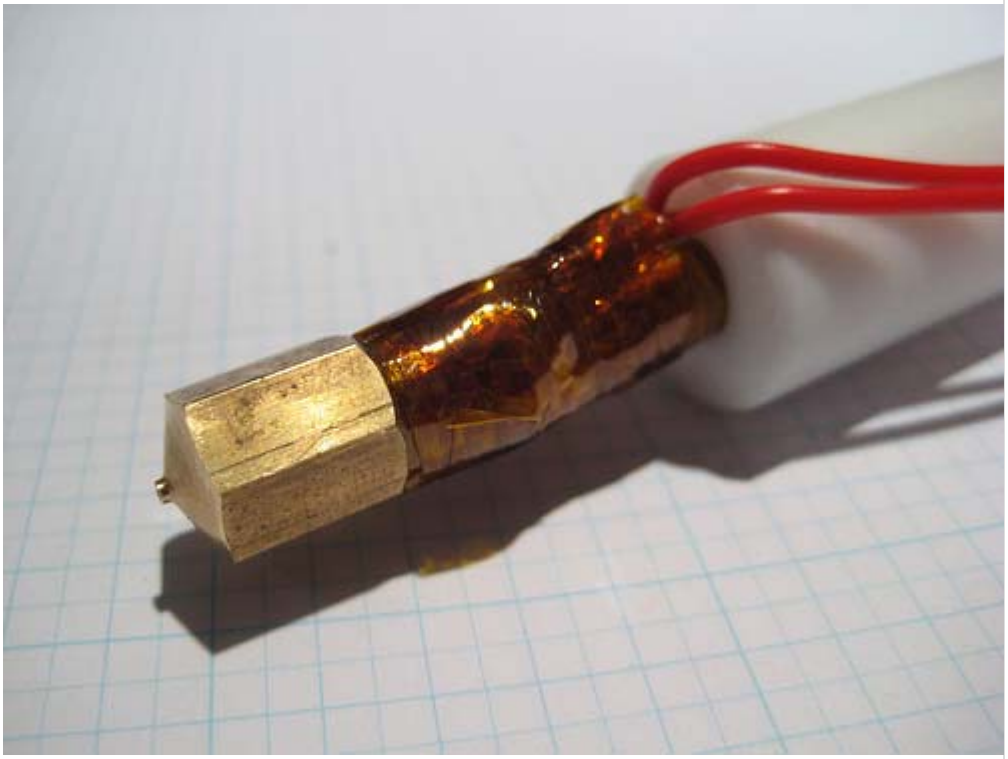
Wind Nichrome Around Heater Barrel



Next, you'll want to wind the nichrome wire around the heater barrel. The closer you get it to the nozzle, the better. Check the picture for a good indication of how far down the barrel to start. Make sure you wind it so the nichrome fits into the threads of the barrel. You may want to use some thermal paste here, but its certainly not necessary. I don't like it because its messy.

Note: There is some dispute as to whether you should layer the nichrome or not. Some people suggest wrapping one layer of nichrome wire. Others suggest overlapping the nichrome wire when you get close to the nozzle. ABS (the plastic you get with your kit) will work fine with either way, but PLA seems to work better with the nichrome wrapped in one layer.

Finish Attaching Heater



Once you've wrapped the nichrome around the heater barrel, carefully bring the other end back up next to the start of the wire and secure it into place with more Kapton tape.

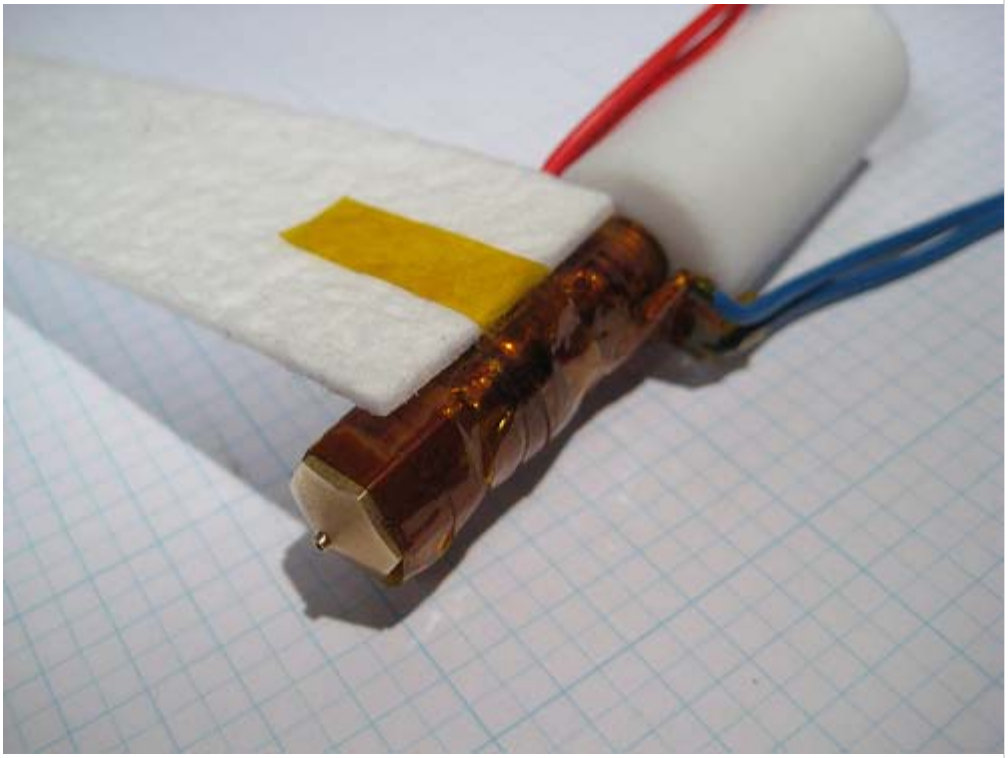
This is a good point to check for shorts across the heating wire to the nozzle using your multimeter's resistance setting. Probe one end of the nichrome wire and touch the other probe to the brass heater barrel. It should read a very high resistance (from your body's own conductivity) or as an open circuit. If you read a low resistance you **must** unwrap the nichrome, locate the break in the covering and insulate it with some Kapton tape. Failing to do so could release the magic smoke from your extruder electronics.

Now you'll want to secure the whole thing to the heater barrel using a decent amount of the tape. A good rule of thumb is to use enough tape so that the heater barrel + tape is even with the nozzle.

Attach Thermistor

Now that you have the heater attached, you'll want to attach the thermistor. This is what measures the temperature, so you'll want to attach it directly to the nozzle. If you want to go super-custom, drill a tiny indentation into the side of the nozzle. If you're like me and want to keep things simple, just tape it directly into the side of the nozzle. Use one or two layers of tape, and also tape all the way up so that the leads/wires are attached to the heater barrel. It is a good idea to attach it on the opposite side of the barrel for ease of wiring.

Step 4: Insulate the Heater



This step is not strictly necessary, but it does make things look tidy, keeps your heater warmer, and gives better startup times. I'd definitely recommend insulating the heater barrel.

Trim Ceramic Tape

The first step is to trim the width of the ceramic tape if necessary. You want it to insulate most of the heater barrel, and only go down about halfway on the nozzle. You can go further down, but it is possible it will interfere with extrusion and printing techniques like towering.

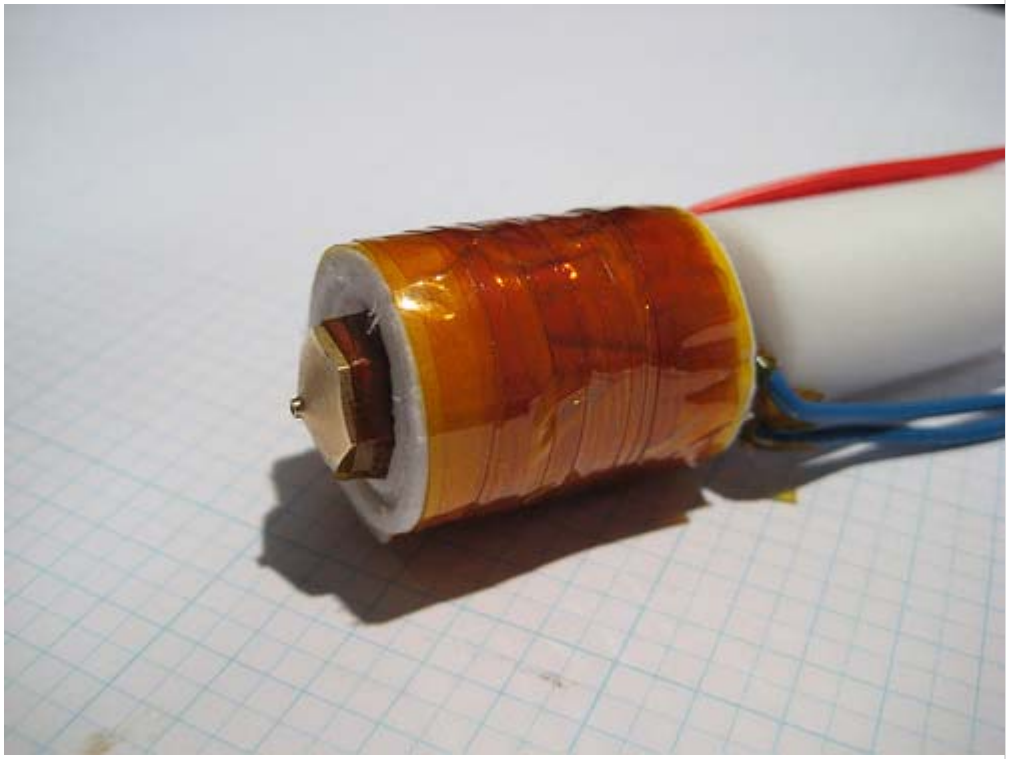
Attach Tape To Barrel

Once your ceramic tape is ready to go, take a short length of the Kapton tape and use it to attach one end of the ceramic tape to the heater barrel. Wrap it around the barrel and then use 2-3 layers of kapton tape to make sure it stays connected.

When wrapping the ceramic tape around the nozzle, don't pull on it too hard as it will tear…

Finish it Up

Can you tell we love Kapton tape? It's only the raddest space-age material for building robots EVER! No big deal.

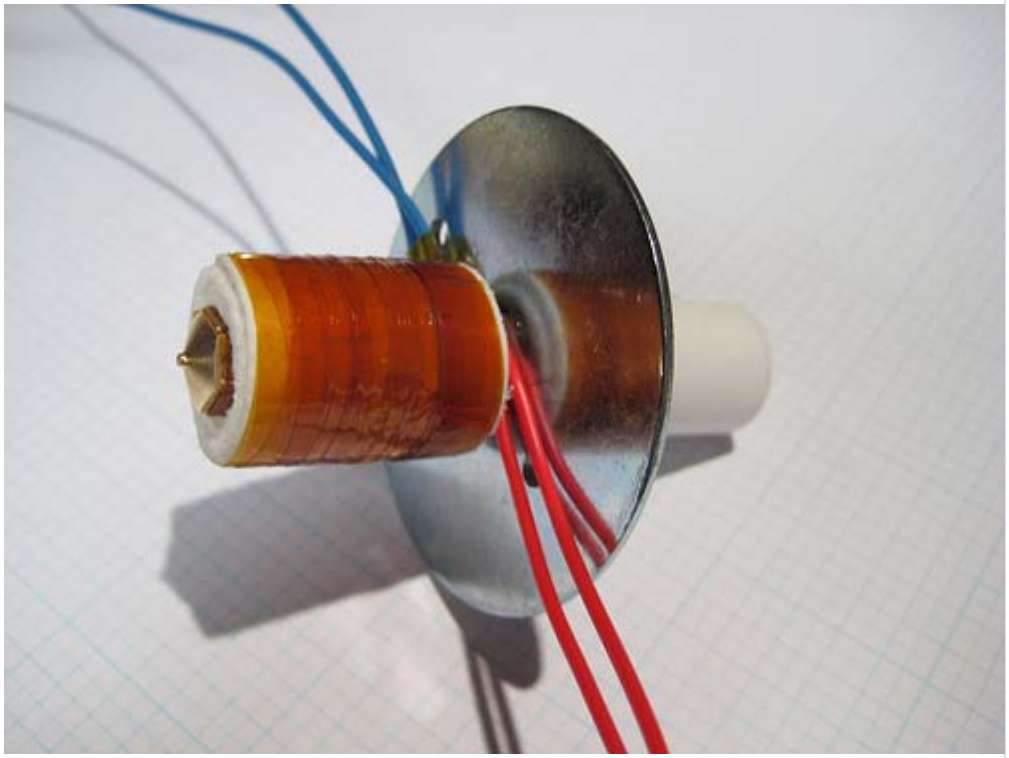


Add Retainer Washer

TIP: Before adding the retainer washer, insulate the center hole with 8-10 short strips of kapton tape. This prevents the sharp edges of the washer from cutting through the insulation on your heater and thermistor wires causing shorts, erratic extrusion, and days of frustration.

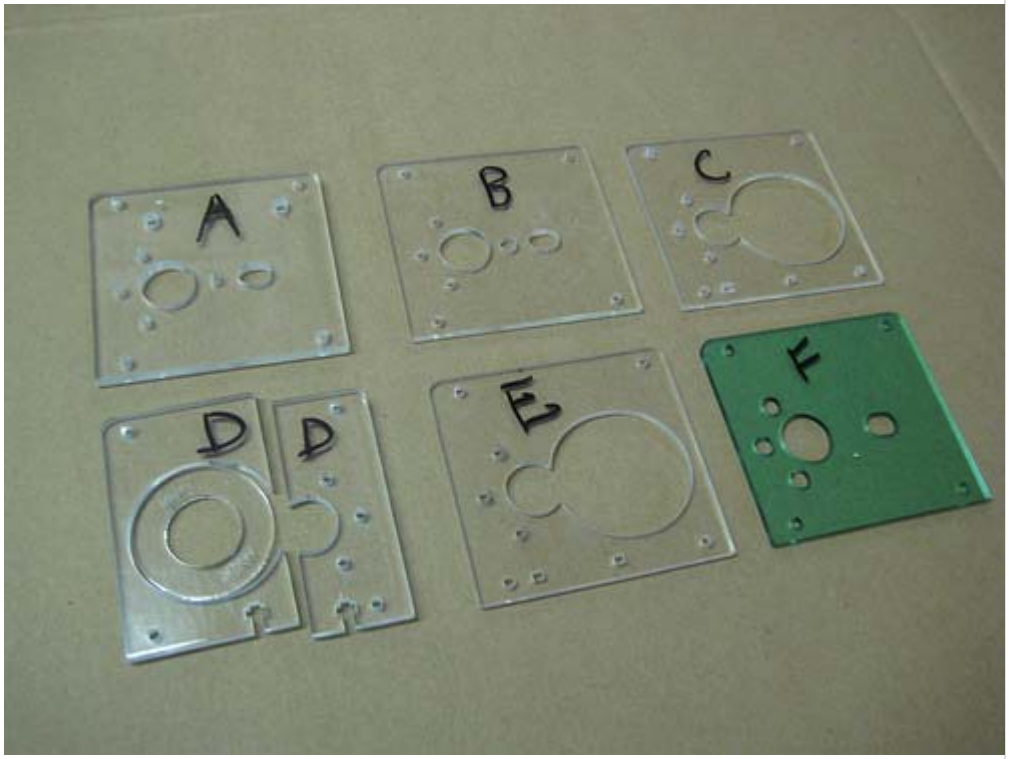
I like to save the retainer washer for last, because it makes it really difficult to do all the wrapping and rotating that needs to be done. To put it on, simply unscrew the PTFE Thermal Barrier and the M6 nut, slide on the washer, thread the M6 nut snug against the washer and then screw the PTFE Thermal Barrier Back on. Make sure you screw the PTFE Thermal Barrier all the way back on. You may have to bend the wires down a bit to make it fit, but thats okay. NOTE: Be extremely careful to make sure you are unscrewing the PTFE barrel and not the nozzle, or else you will wreck the whole assembly and need to start again. If you are worried, you can always put the washer on first. Once the PTFE Thermal Barrier has been threaded on, unthread the M6 nut a bit to back it off of the big washer and snug it gently against the PTFE Thermal Barrier.


kapton
Instructions: wiki.make



Filament Drive Mechanism

The filament drive mechanism is a stacked assembly made up of 6 plates. These plates are laser-etched with a number in the upper left corner. They are numbered in sequence. The bottom plate is #1 and the top plate is #6. I have labeled them A-F in the pictures to make them easy to see.



Stuff You'll Need

- motor
- 1.5mm hex key
- 2.5mm hex key
- 1 M3 x 8mm bolt
- 3 M3 x 20mm bolts
- 1 M8 x 35 mm bolt
- 1 M8 nut
- 2 M3 nuts
- 2 M8 washers
- the aluminum pulley
- the 606 bearing
- assembled idler wheel
- assembled dinos
- heater barrel assembly

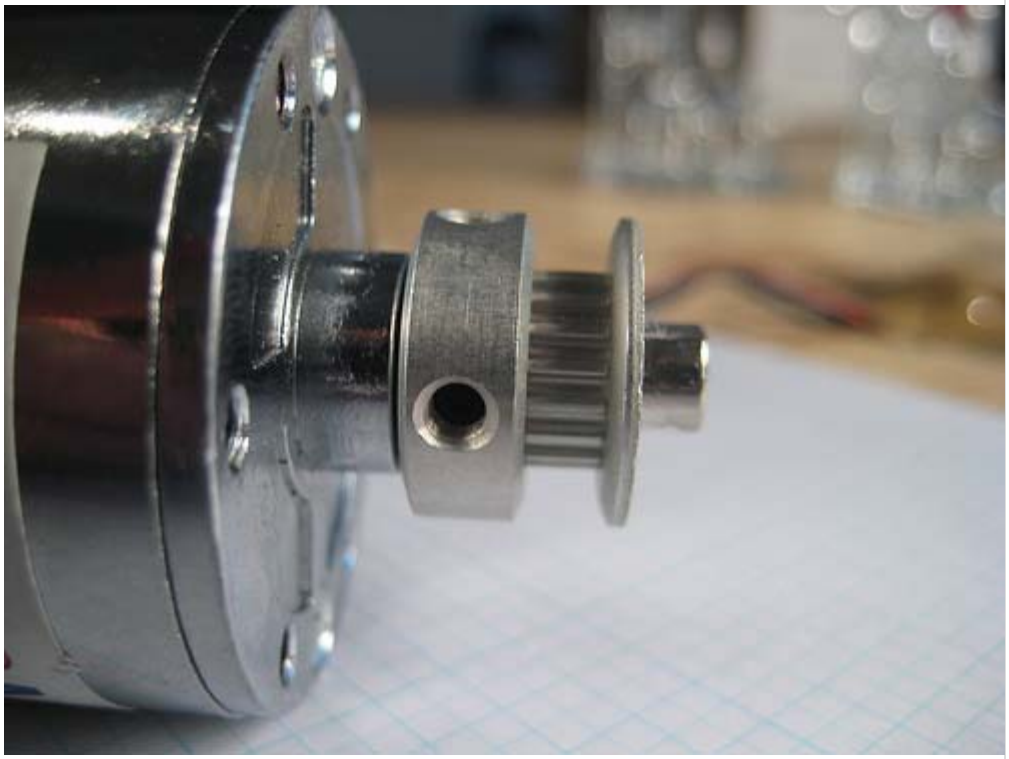
Step 1: Attach Pulley to Motor

The pulley is the part that 'bites' into the filament and physically pushes it into the heater barrel. Its very important that the pulley is very firmly attached to the motor shaft.

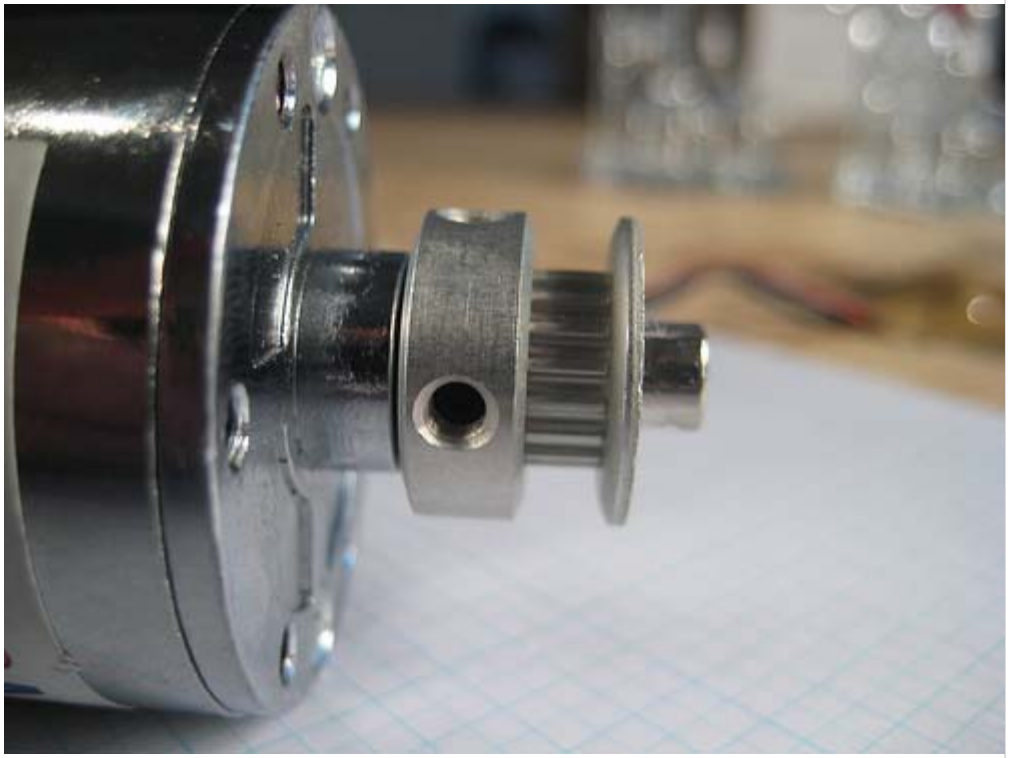
This is fairly easy to accomplish with the pulley that we use. It has two set screws that lock the pulley onto the shaft. First you should position the pulley onto the shaft properly. The set screws should be on the bottom towards the motor. The pulley itself should be close to the bottom of the shaft, and one of the set screws should be directly above the flat side of the

shaft.

Screw both of the set screws down and then tighten the proverbial daylight out of them.



Step 2: Attach 606 bearing to Motor

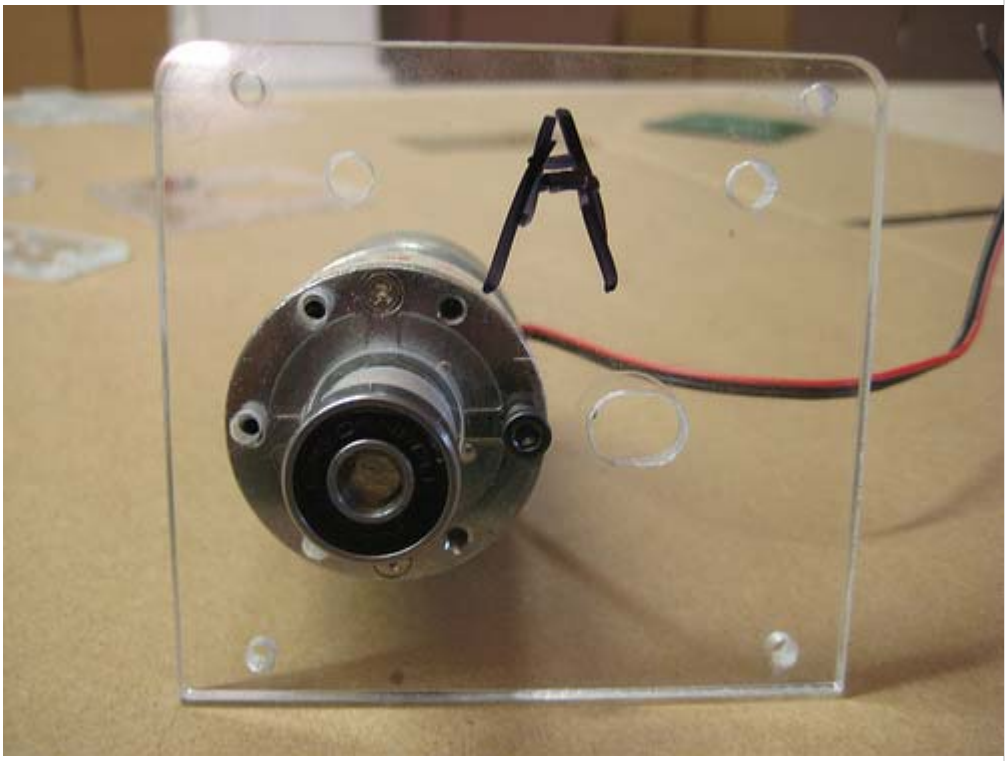


The 606 bearing is the smaller of the 2 bearings in the kit and has a 6mm inner diameter to match the motor shaft. This bearing will take the brunt of the force from the compression of the filament during normal operation. This is one of the major improvements to the MK4 design and will lead to longer motor life and better overall performance.

Simply push the bearing on over the motor until it is up next to the pulley. If it is a tight fit (though nothing like the tight fit of the motors you encountered while building the Cupcake), you may need to gently tap it into place.

The bearing will only be partway on the motor shaft when finished, but this is fine.

Step 3: Attach Motor to Motor Mount Plate (#1)



Grab out your trusty M3 hex key and one M3 x 8mm hex bolt. You'll also need the motor and the motor mount acrylic piece. Although there are four holes, you only want to put one bolt through the rightmost hole. Line up all the holes with the motor holes and tighten it down. More bolts will go in the other holes later.

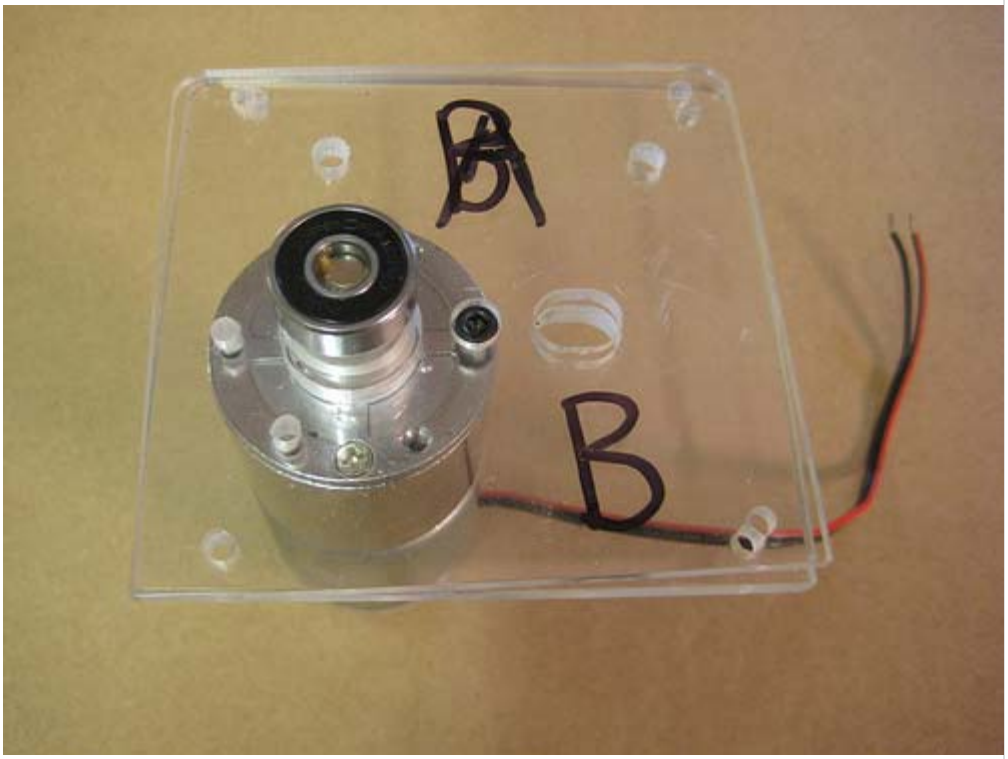
Make sure to have the wires from the motor coming off to the right towards the rest of the extruder housing as shown in the picture.

Note: Newer batches may not have this screw hole. They just rely on the 3 screws used in step 12. Just continue without screwing in this screw if there is no hole for it. Older batches may also benefit from leaving this screw out as it allows fast removal of the motor to clean chipped plastic out of the gear teeth.

Step 4: Add Spacer Plate (#2)

The spacer plate adds space to the body. It only fits on one way, so just stack it on.

Note: Newer batches may not have the hole depicted for the motor screw.

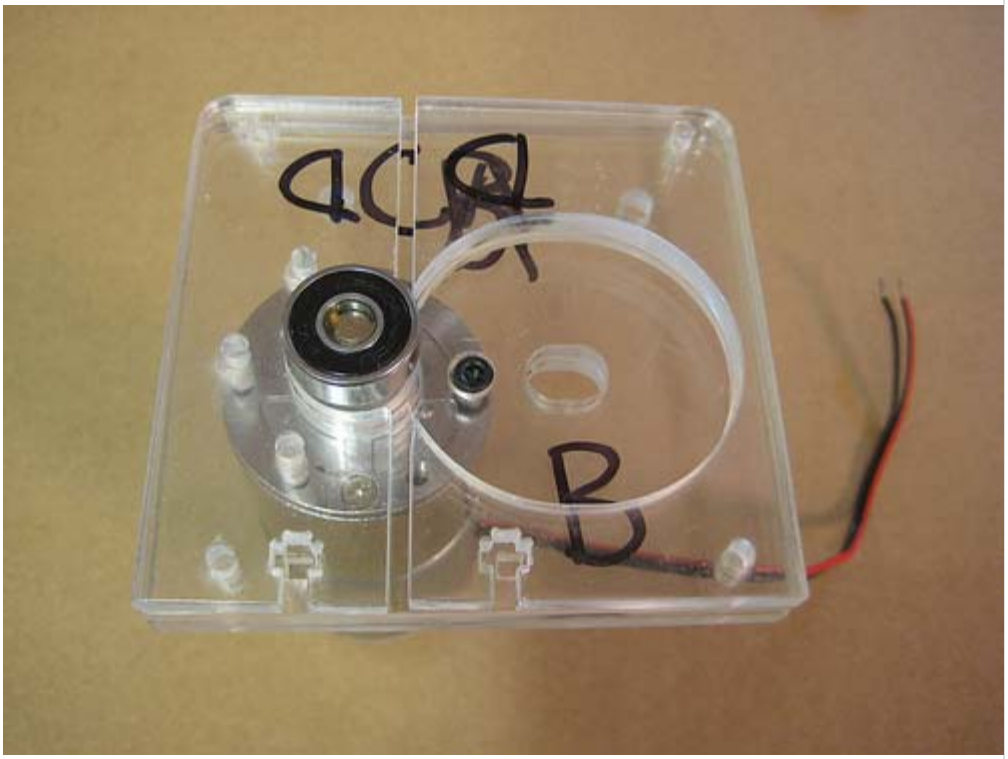


Step 5: Add Filament Guide Bottom Plate (#3)

This plate also just stacks up on top of the others. The text should be towards the top and legible from your point of view.

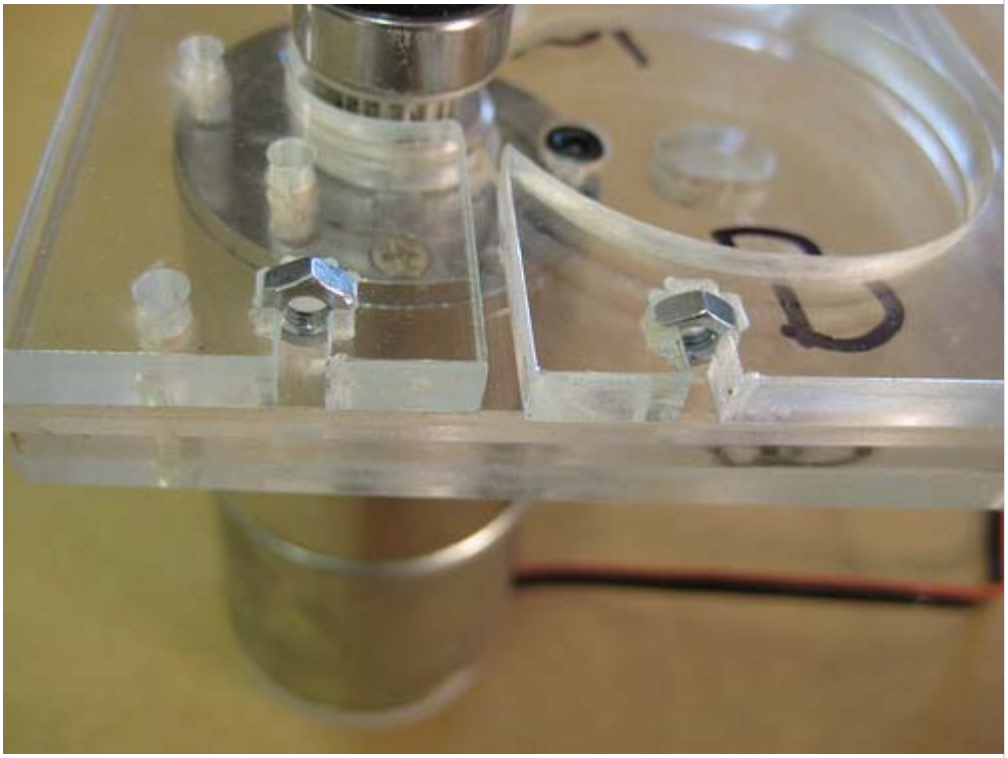
Step 6: Add Filament Guide Middle Plates (#4)

This is a two-part plate. There is a left side piece and a right side piece. The left side piece goes over the motor/pulley, and the right side goes over the big open space. The text should be towards the top as usual.



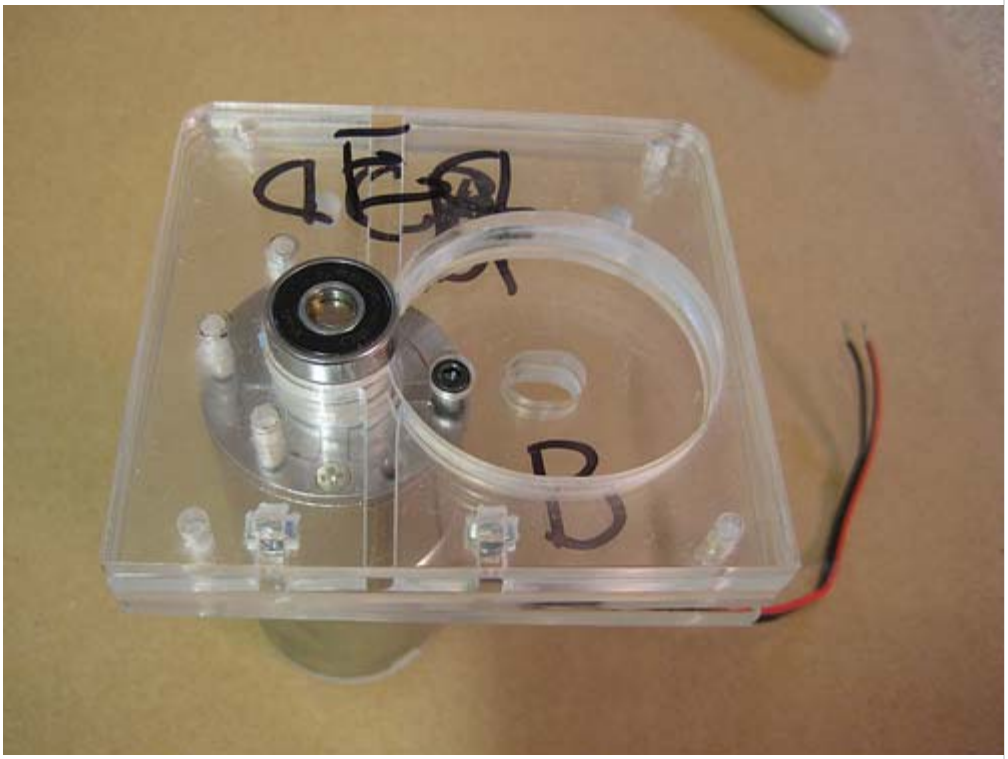
Step 7: Insert Captive Nuts

These nuts are very crucial for attaching the heater barrel assembly. There are two little rectangle slots towards the bottom of each fo the filament guides. Simply place one nut in each and you're done!

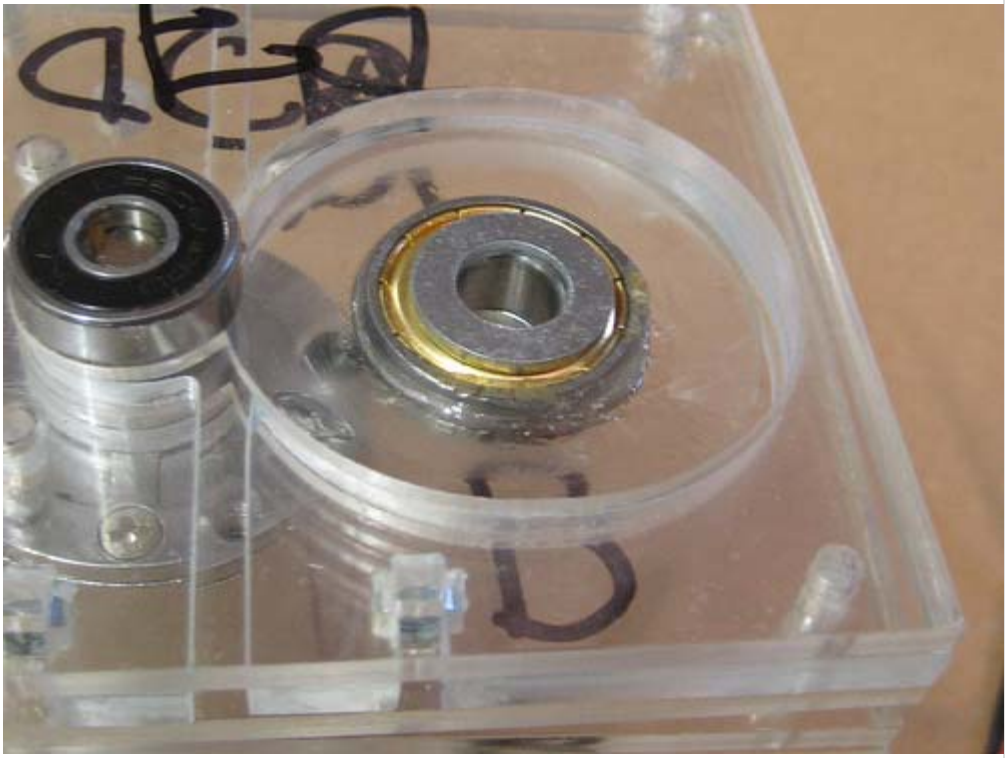


Step 8: Filament Plate Top (#5)

This plate fits on over the other plates. Lay it on top and you're done!



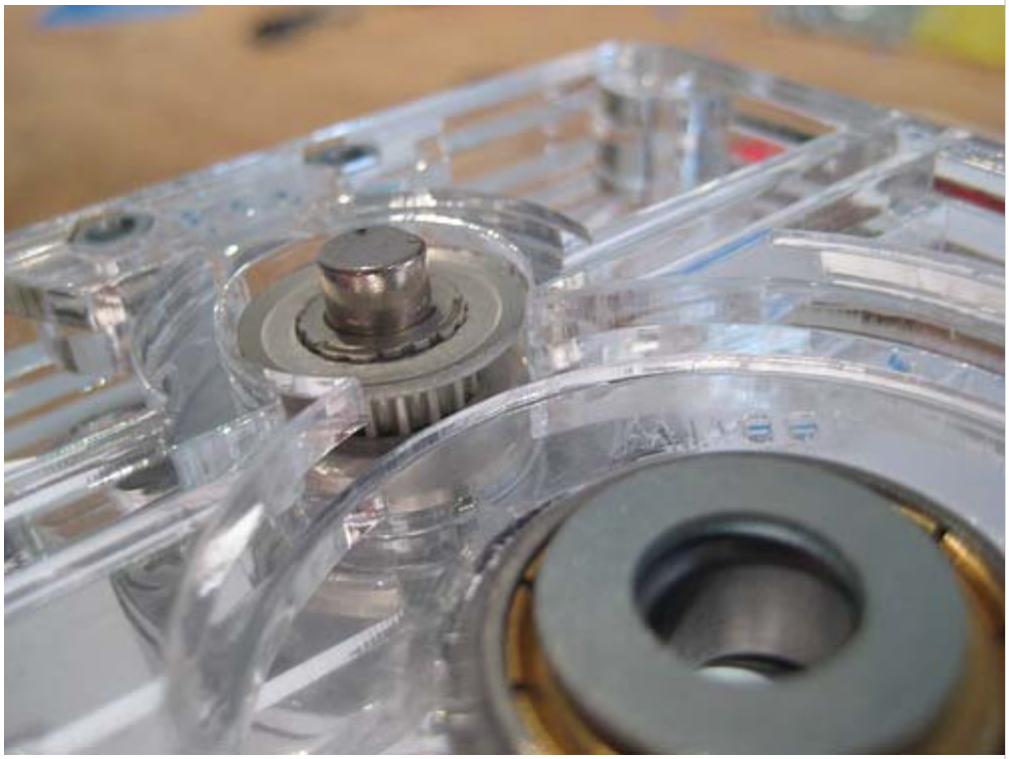
Step 9: Insert Idler Pulley



Take the assembled Idler Pulley that you made in a previous step. Put one M8 washer down on the inner area over the 8mm slot. Then place the idler pulley, and then place another washer over that. You'll want to do a quick sanity-check to make sure that the idler pulley can easily slide between the flanges on the pulley. If it does, you inserted it correctly. If not, try flipping the idler pulley over. If that still doesn't work, try juggling the washers around until you have it at just the right level.

Check the Pulley Alignment!

Once you do, make sure all the washers/pulleys line up over the 8mm slot. You'll be putting a bolt through there very shortly to keep everything in place, but until then it will be a bit wobbly.



Step 10: Attach Retainer Plate (#6)

The retainer plate is the top layer of the sandwich. Place it on the top of the stack with the text facing out and on the top. Be very careful not to disturb the idler bearing. If you manage to move them out of place, take the plate off and put them back in place.

The retainer plate is the final plate and should snap over the 606 bearing and lock it into place.

Step 11: Insert M8 Nut

Now, you'll want to put the M8 hex cap bolt through the back of the Motor Mount and then put a nut on it. You don't need to tighten it down yet, so just hand-tighten it so that nothing falls out. We'll be putting more M3 bolts on in a second, and those will align everything.

Step 12: Final Motor Bolts

Grab the M3 x 20mm bolts (there should be 3 of them). Insert them through the three holes around the 606 bearing so that they go through all of the plates to meet the motor. Use your M3 hex key to tighten them down and bolt the whole assembly to the motor. **Do not skip this step.**

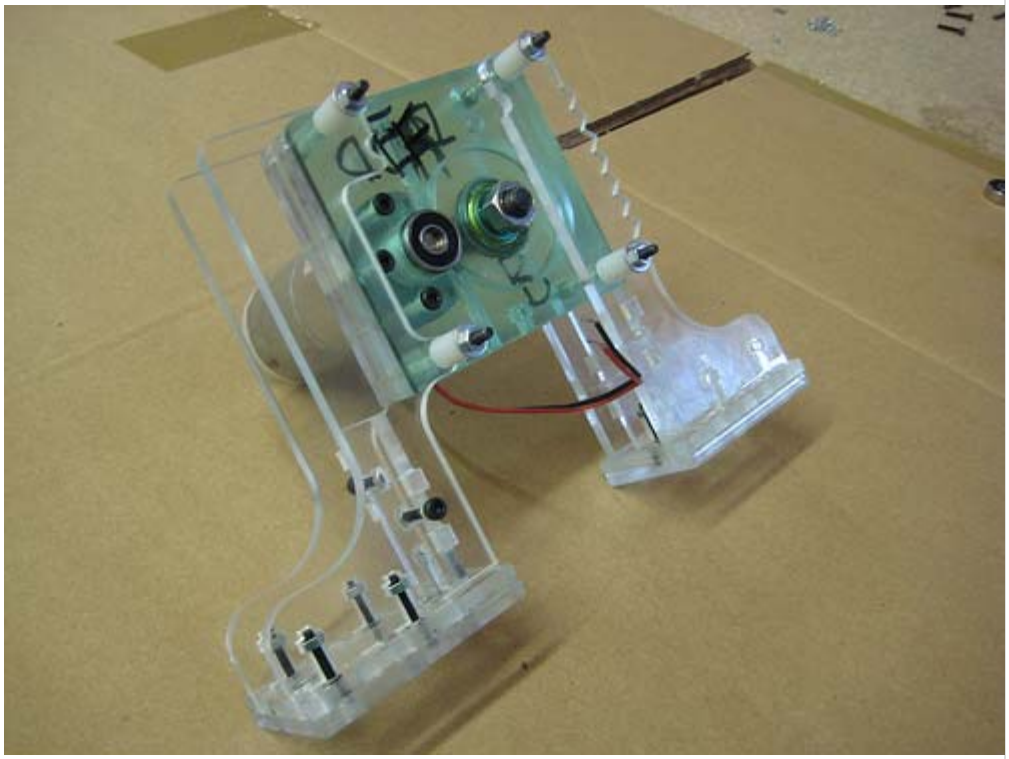
Step 13: Attach the Dinosaurs

You'll need:

4 x M3 x 50mm bolts

4 x M3 nuts

4 x M3 washers
4 x M3 x 1/2" spacers



The dinosaurs are the parts that elevate the extruder to give you more build area. The weird dino attaches to the left of the extruder, and the big dino attaches to the right of the extruder. Make sure the dinos are loose before you attempt to attach them, otherwise you may break them accidentally.

Put the M3 bolt through the back of the dino, then thread it through the entire housing, and finally out the front of the dino. Put a 1/2" spacer over the exposed bolt, followed by a washer, and finally a nut. Repeat this for the remaining three corner holes and you'll have a mostly assembled plastruder.

Once you have everything assembled, you can tighten everything down a bit, except for the M8 bolt.

Step 14: Adjust Pinch Wheel Distance

This is one of the other major innovations in the MK4 plastruder. We tested dozens of pulley to idler distances and found that 2.0mm is the ideal distance for optimum grip strength.

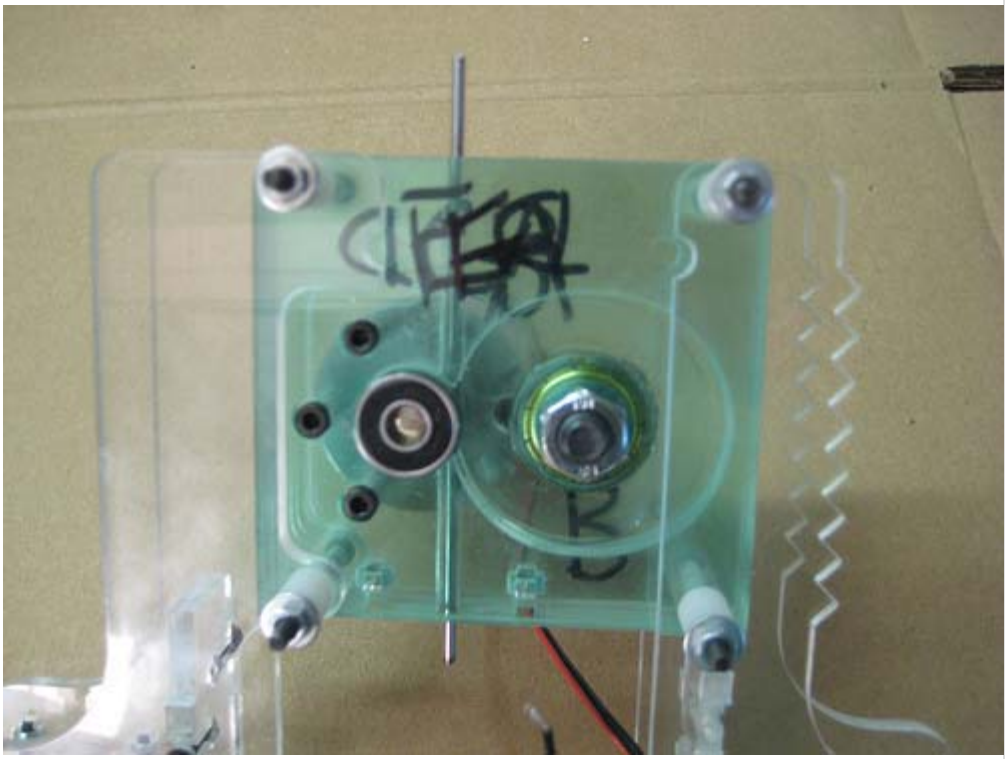
Simply insert the included length of steel rod into the gap between the idler wheel and the motor pulley. With your fingers, push the pulley up next to the idler wheel and then carefully tighten down the M8 bolt while making sure that the idler pulley does not slide out of position. If you made sure to sandwich the idler wheel between two M8 washers, then you will be able to really tighten down the idler wheel without breaking anything.

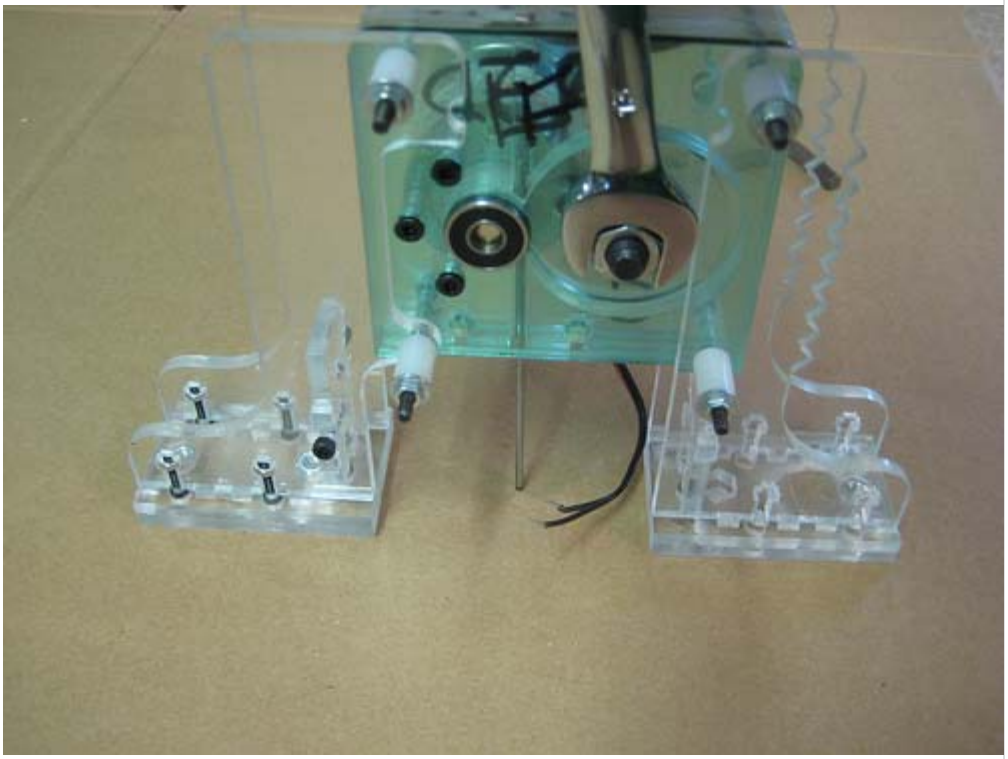
Once you have the idler wheel locked into place, pull out the steel measuring stick and put it somewhere safe. If you have it the right distance, you'll feel it slide against the idler wheel and pulley as you pull it out. If there is no resistance, or if there is quite a bit of resistance, then you either have it too loose or too tight. Loosen the M8 and give it another try.

Pro tip: If you position your M8 wrench as shown in the picture, you can lightly push up against the dino in order to keep the idler wheel snug up against the pulley while you tighten down the M8 bolt with your hex key.

NOTE: This is good time to measure the small hole at the top of the PTFE barrier with calipers. If you make the idler wheel too tight, it can deform the filament stock too much and cause it to

be wider than the hole in the PTFE, which can lead to extruder jams. When you start using new filament stock, it might be a good idea to put a inch or two through the pinch wheel then back it out and measure it to ensure the squished filament is not too wide to fit into the PTFE thermal barrier.





Step 15: Attach Extruder Controller Board

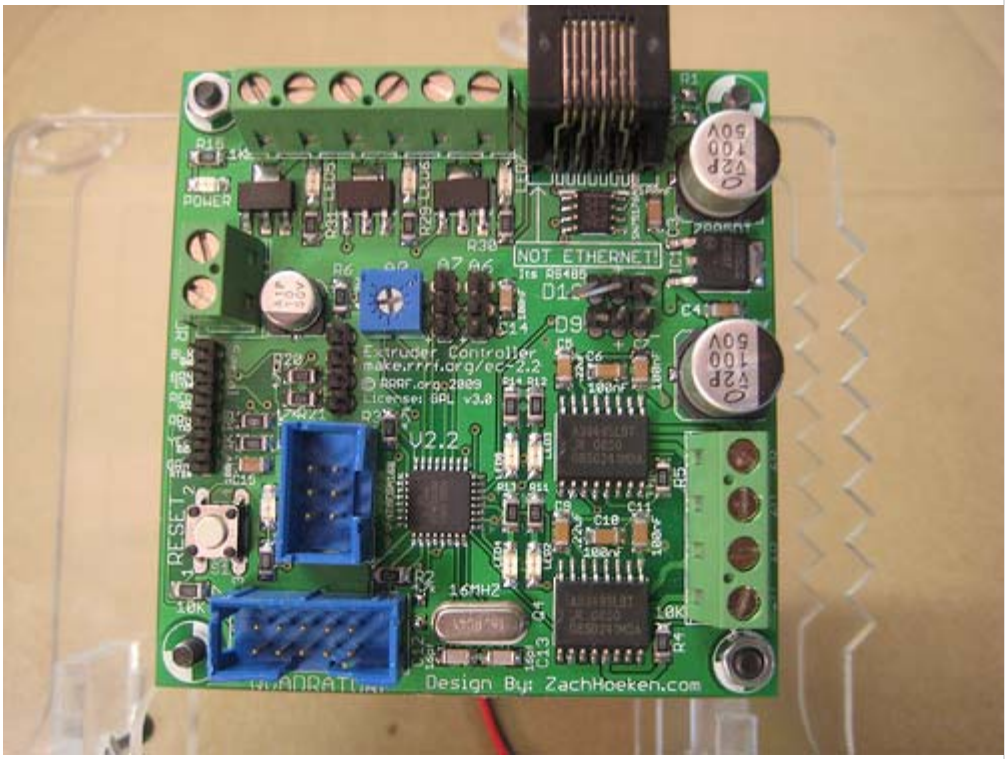
The extruder controller board should fit onto the ends of the 50mm bolts. Depending on how confident you are with your assembly skills, you will want to bolt it on with 0-4 nuts. If you feel like you're a rockstar and built it perfectly, use 4 nuts. If you feel like you may be taking it apart again soon, use 1-2 nuts. It will actually stay in place pretty well with zero nuts, but its not a

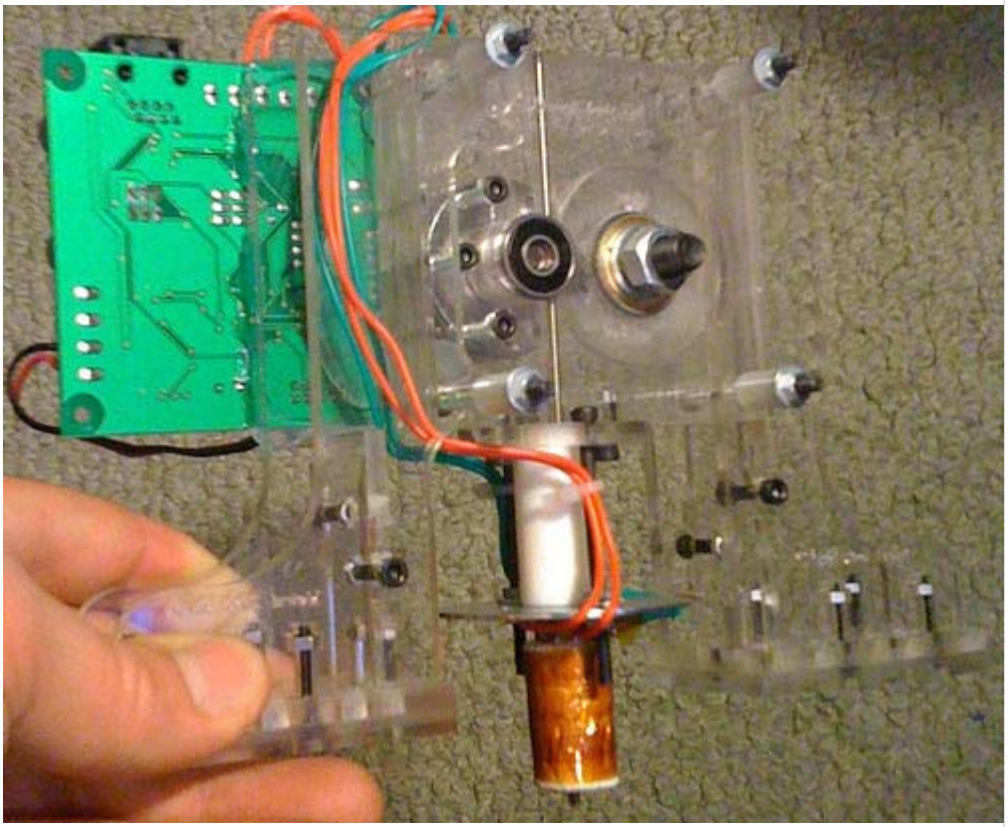
good idea to run it like that.

Alternative Arrangement: Some MakerBot Operators will prefer to mount the controller board somewhere else. This can provide a clear line of sight with plastic as it is pulled through the Plastruder.

Some of you may not need this line of sight, but it can be extremely helpful for debugging. As you can see from the image, one option is to mount it with a bunch of hot glue (or whatever else you think is safe).

If you go with another location, just BE SURE that you're not going to have the controller crashing in to your MakerBot casing.





Attach Heater Barrel

You'll need:

- 2 * M3 x 50mm bolts
- 2 * M3 x 16mm bolts
- 1 x Insulator Retainer
- 1 x Heater Barrel Assembly
- 1 x Retaining Washer
- 6 x M3 washer
- 6 x M3 nuts
- 2 x zipties

Step 1: Fit Bolts

Take 2 M3 x 16mm bolts, and 2 M3 x 50mm bolts and put them through the Insulator Retainer piece. The 50mm bolts should go **backwards** through the Retainer holes near the text and the one directly opposite it (top and bottom if you are reading the text).

The 16mm bolts should go through the holes on the left and right if reading the text, but the M3 16mm bolts are too long to fit into the casing and secure the Retainer tightly. **Before inserting the 16mm bolts, screw on a M3 nut all the way to the head, then, add a M3 washer**. This will allow correct tightening of the retainer assembly. Be careful not to tighten these bolts too much, or you can break layer #4.

Finally, put the M3 16mm bolt through the Retainer. The additional washer and nut should enable you to tighten the Retainer properly. Also, you may want to put some M3 nuts on the end of the long bolts to keep them from falling out.

Step 2: Attach Insulator Retainer

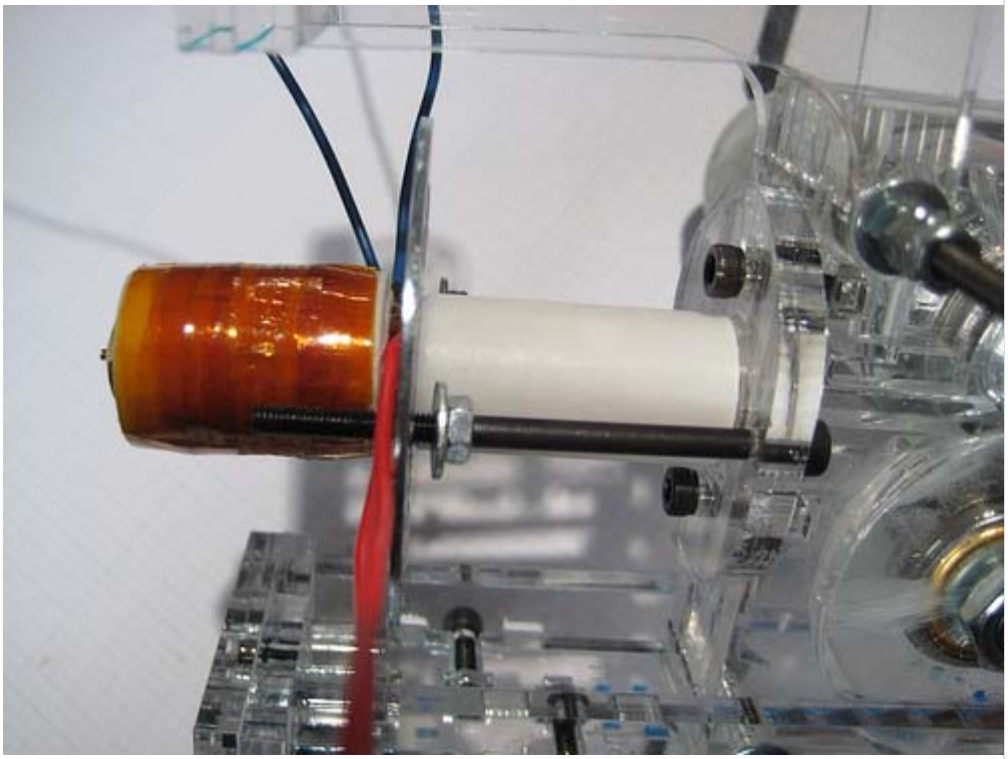
The Insulator retainer bolts into the captive nuts in the extruder housing. Tighten them down with your fingers and then give them a quarter-turn with the allen key. Keep in mind that there is a proper orientation so that the heads of the long bolts do not cause problems with the housing and/or electronics. The short side goes towards the front.

Step 3: Attach Heater Assembly

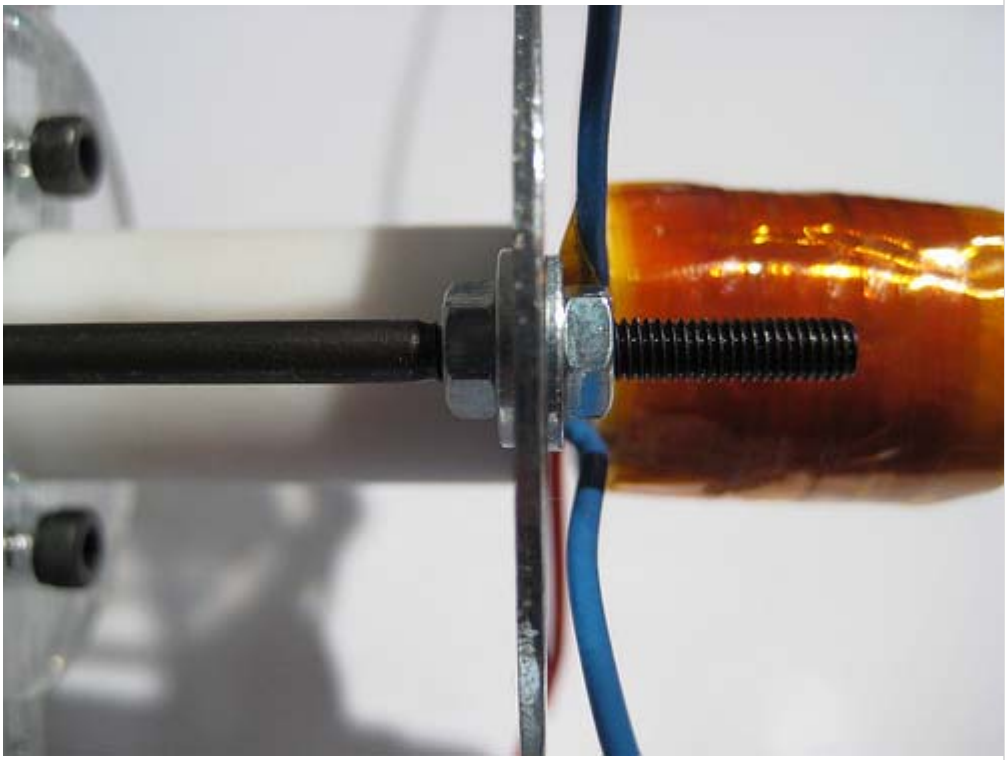
First, thread a single nut all the way up onto each of the two M3 x 50mm bolts.

Now, Grab your finished heater assembly. We're now going to bolt it into place, so make sure there is a drilled washer between the barrel and the PTFE insulator.

The washer has holes that are not symmetrical. These line up with the bolts coming down from the insulator retainer. Slide a washer on each of the M3 bolts, then slide the heater assembly, PTFE barrier first up into place. Fit the M3 bolts through the washer and then put a washer and nut on the end of each.



Tighten it down



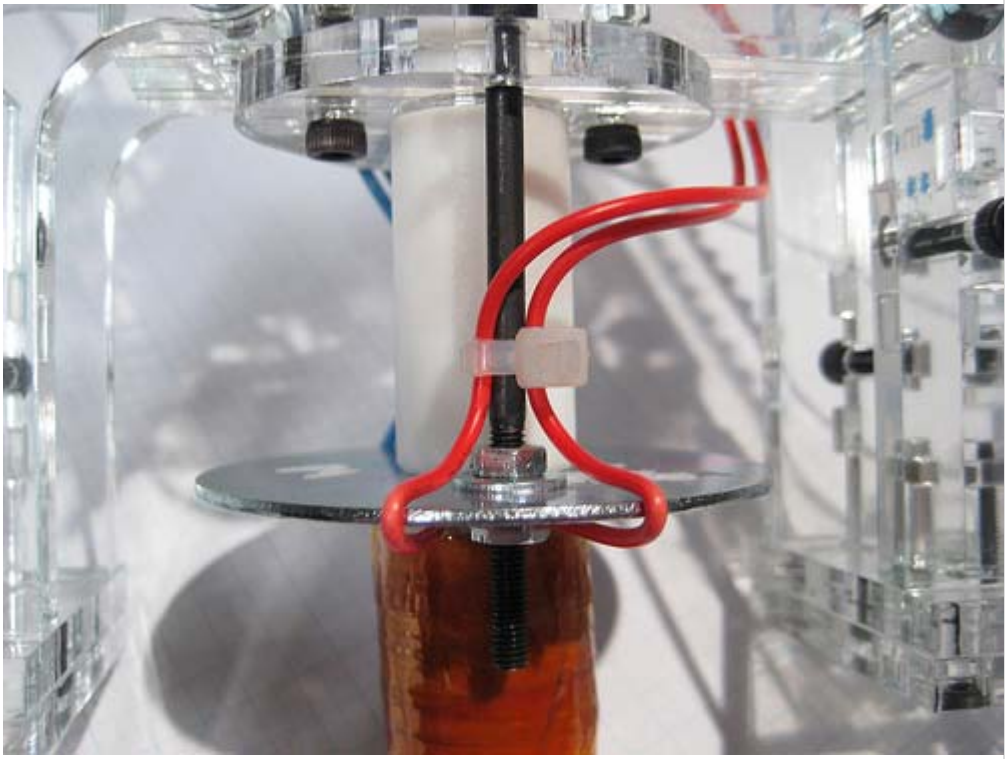
Rotate the nuts until they are holding the large washer snugly in place. Make sure there is no wiggle room between the extruder housing and the thermal barrier. Now rotate the nuts down from the top of the M3 bolts and tighten them all together. This will hold the whole assembly in place.

Take extra care here. If everything has gone well you should have very good alignment between the channel running down the acrylic plastruder, the PTFE thermal barrier, the brass heater barrel, and the brass nozzle. In fact, if you hold the whole assembly up to a light you should be able to see light coming through the nozzle, exactly centered in the channel. Checking this will ensure that your plastic filament has a very easy

time finding the path all the way down to the heater barrel and nozzle and that your extrusion will be very uniform. If you cannot see light coming through the nozzle then you should loosen the nuts, adjust, and retighten.

Step 4: Zip-tie the Wires

This is a tidying step. Bend the wires out and around the large washer. Then zip-tie each set to one of the bolts. You can also use twisty-ties, or even a short length of solid-core wire if you do not have zip-ties handy.



Electronics: Wire it all up!

Step 1: Cut wires to length

The first step is to cut the heater / thermistor wires to length. If you forgot which wires are which, you'll want to grab out your trusty multi-meter to measure the resistance of the wires. The thermistor should read somewhere >50Kohms, and the nichrome wire should read somewhere between 5 and 10 ohms.

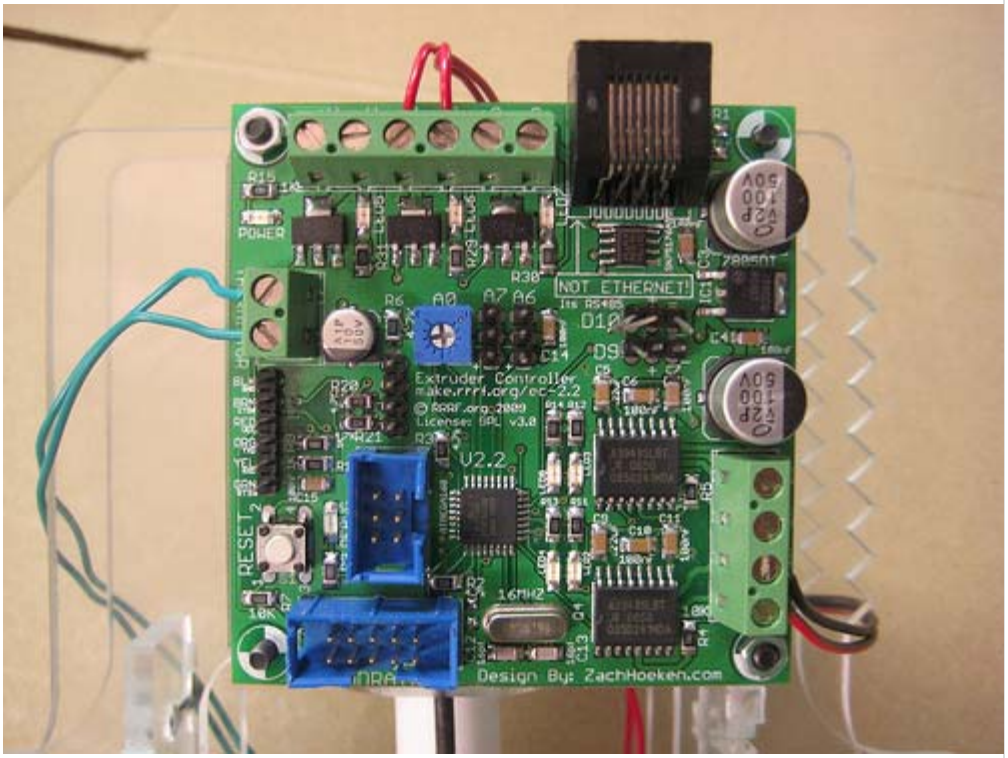
Run them closely along a path up to their appropriate screw terminals. Add a little bit of length to them, so that they hang over the back of the screw terminals, and then cut them to length. Now strip the ends of each of them and you're good.

Remember to twist the thermistor sensor wires around each other over the length of their path from the plastruder to their final destination. With four motors going in close proximity there will be plenty of opportunity for EMF-induced noise. Twist the heater wires together to keep things tidy.

Step 2: Insert and Secure Wires

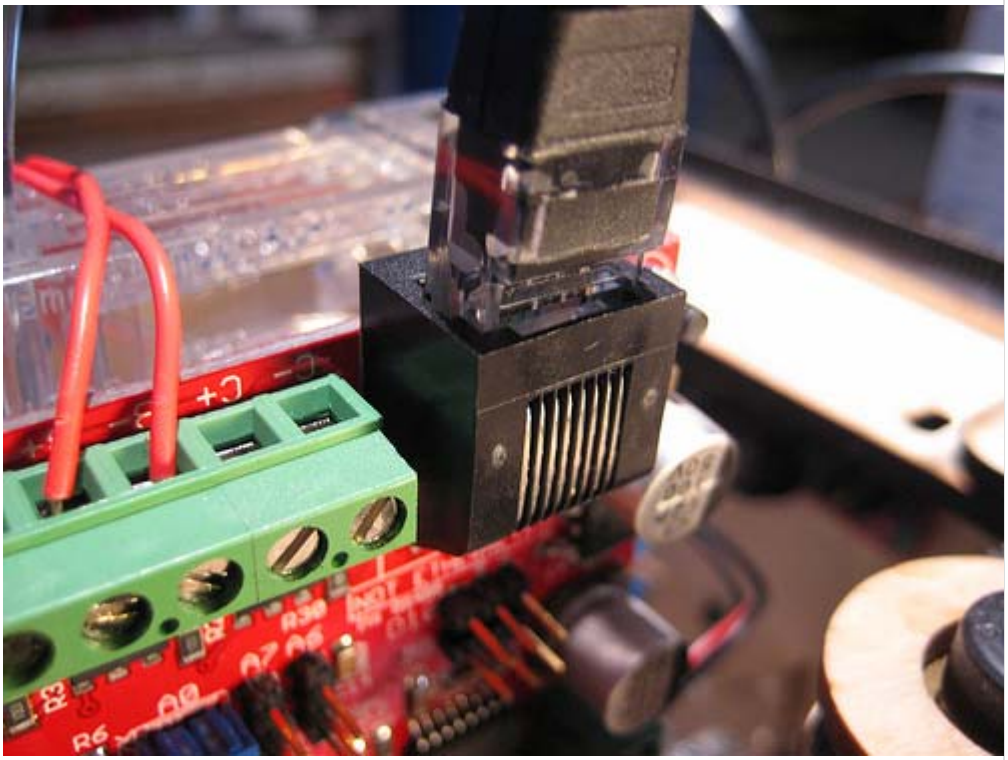
The wires for the heater are non-polar (can be inserted in any direction) as are the wires for the thermistor. Put them in their respective holes and tighten them down. The thermistor wires should go into the block labeled 'Thermistor', and the heater wires should go into the block

labeled 'B+/B-'. The motor wires are actually polar, so insert the red wire into 1A and the black one into 1B.



Plug in Extruder Controller

Finally, you'll want to plug the Extruder Controller into your RepRap Motherboard. Grab an ethernet patch cable, and you're good to go. Please note: this is not ethernet. We use these common cables to cut costs and provide a robust connection that can provide both power and communications over a single wire.



note : you may want to solder on the 180 ohm (R1) resistor near the serial jack to properly terminate the RS485 connection, see here for details. If you're careful, a through-hole resistor from RadioShack will do.

Test Your Plastruder

Before mounting your plastruder in your MakerBot, it is recommended that you "bench test" the Plastruder and make any necessary fine adjustments. Spend some time fine-tuning the position of the idler wheel in your plastruder.

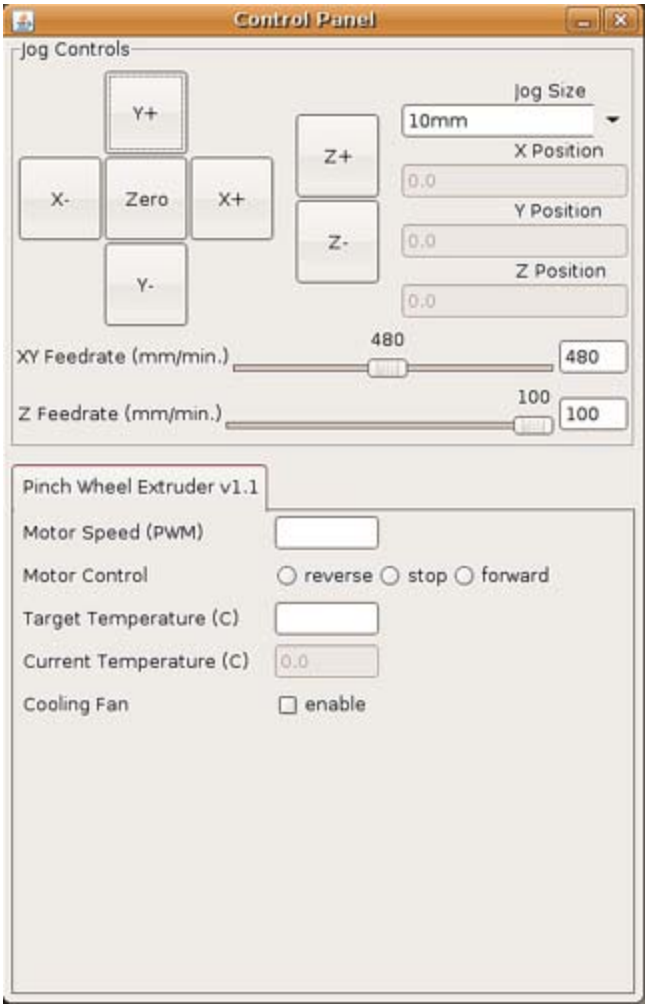
Note: Thermistors are an analog component and can vary significantly between batches, particularly when operating at extrusion temperature. Some kits have shipped with a 1mm diameter thermistor while others have a visibly different 3mm diameter thermistor, all under one manufacturer's product code. These will likely require different calibration settings; running the plastruder without proper calibration can damage it.

For example, if your extruder is too cold the filament will not pass through the extruder and the motor will repeatedly strip filament. If the heater is running too hot, the nozzle may become clogged with oxidized ABS, or more likely your thermal insulator will melt and begin to leak plastic.

Review Adjusting the Thermistor Settings for instructions on how to calibrate the extruder settings to match your specific thermistor.

Test procedure

1. Set up the Plastruder above a surface that you don't mind covering with hot melted plastic.
2. Hook everything up, but don't bother to mount the Plastruder in your MakerBot body yet. This means: connect the heater, thermistor, and motor to the Plastruder controller, connect the Plastruder controller to the motherboard, and connect your PC or laptop to the motherboard with the included USB cable. (All boards should have had firmware loaded on them in previous steps.)
3. Turn on the MakerBot!
4. Fire up the ReplicatorG software!
5. Select the Machine->Driver menu, and ensure that "Cupcake" is selected.
6. Select the Machine->Control Panel menu item to open the Control Panel. You should see a pop-up window that looks like this:



7. Set the target temperature to 220 degrees C, hot enough to melt ABS plastic. The heating element should switch on, and you should see the temperature shown in the Control Panel begin to rise.
8. Wait until the nozzle temperature reaches 220 degrees.
9. Set the motor PWM to 255 ("full on.")
10. Feed a strand of ABS plastic filament into the plastruder.
11. Click the "forward" button.
12. The ABS plastic should now begin to feed slowly into the plastruder. Feel free to make marks on the ABS plastic with a sharpie to make the movement easier to perceive. Look at your previously done radial marks on the idler wheel. Look to see if the filament is moving down the barrel at a good rate and also how large the indentations are in the filament (see video).
13. After a while, the Plastruder should begin to extrude a thin host plastic filament.
14. Continue to extrude plastic for three or four minutes.
15. When done, click the "Stop" button in the Control Panel. Use a hobby knife to trim the plastic filament from the nozzle of the extruder.
16. Set the temperature back to 20 degrees, and wait for the Plastruder to cool down before switching everything off.

If everything works perfectly, congratulations! Go ahead and attach your Plastruder to your MakerBot.

Fine Tuning

Problems to watch out for:

- Ensure that the nozzle heats up.
- Ensure that you get a continuous, fast flow of plastic filament out of the extrusion nozzle.
- Ensure that the ABS plastic filament feed works reliably. If the feeding motor slips or jams, you may need to adjust the Idler Wheel.
- If the ABS filament slips to the side of the Idler wheel, you may need to disassemble your Plastruder to adjust the position of the Idler Wheel and the position of the Motor Pulley.

Attaching to Your MakerBot

Now that your extruder is complete, you'll want to attach it to your MakerBot. This should take place after you have completed assembly of the MakerBot, so do that if you haven't already.

Grab four M5 x 15 bolts. You should have captive nuts in each of the dinosaur brackets. Replace them if they are missing. Place your extruder on the Z stage with the Extruder Controller facing the front of the machine.

Thread each bolt from the bottom up through the Z stage into the captive nuts. Tighten them down and your extruder is now attached. If you need to remove it, simply unbolt them and take the entire extruder out.

Revisit Adjusting the Thermistor Settings again with your extruder mounted in position.

Updating Your Firmware

Should you need to update the extruder firmware, instructions can be found at page:

Adjusting The Thermistor Settings

The new extruder controller firmware (v1.8) stores its thermistor settings in the on-chip EEPROM. That means you can use ReplicatorG to update and tweak the parameters for the thermistor and tune it to your specific extruder.

Since the settings are resident on the extruder controller, and are not retained in ReplicatorG, you can now tweak extruders on a per-bot basis.

This page explains how to get up and running with the new firmware, and set the parameters to useful values.

Step 0: Install ReplicatorG 0012 or later

ReplicatorG 0012 includes the software support for updating the thermistor tables, so make sure you've got it installed before you begin.

Step 1: Install the v1.8 firmware or later

If you haven't already, you should upgrade the firmware on your extruder controller to v1.8 or later. You only need to perform this step once.

1. fire up ReplicatorG 0012 or later.
2. plug your USB2TTL cable into the extruder controller's 6-pin header. Pay attention to the markings on the board and be careful not to plug the cable in backwards!
3. Select "Upload new firmware..." from the "Machine" menu in ReplicatorG.
4. Select the Extruder Controller, the version to install (v1.8 or later), and the name of the USB port your cable is using.
5. Press the small reset button on the extruder board at the same time as you click the "Upload" button in the uploading dialog. It will take a few moments to upload the firmware, so be patient.
6. If you see an error message, try again; sometimes it's hard to get the timing right.
7. Disconnect the USB2TTL cable from the extruder board.
8. When you're done, close ReplicatorG.

Step 2: Adjust the thermistor settings.

1. Start ReplicatorG.
2. Wait for ReplicatorG to connect to the makerbot. You won't be able to access the thermistor settings until after ReplicatorG has connected to the machine.
3. From the "Machine" menu, select "Onboard Preferences".
4. Click the "Set Extruder Parameters" buttons in the Onboard Preferences dialog.
5. You'll now see the thermistor options. Enter the beta, r0, and t0 settings appropriate to your thermistor. For a full explanation of what these parameters mean, see Nophead's excellent explanation on his blog. (The r2 is internally pegged at 4.7Kohms, the value of the resistor on the board, and r1 is infinite.) Here are a few useful settings:

Thermistor type	beta	r0	t0
Default "large" thermistor	4066	100000	25
Nick's "large" thermistor Settings	4198	100000	25
Zach's 1mm settings	4198	100000	25
J.E.T.'s 1mm thermistor settings	4881	93700	24
Keith's CupCake thermistor settings	3736	268000	0

1. Click on "commit changes".
2. Reset the extruder board. There are a few ways to do this. Try one of the following:
    1. Press the reset button on the extruder board itself.
    2. Turn the machine's power off and then on.
    3. Unplug the extruder, and then plug it back in again.

Once the extruder board has been reset, it will be using the new thermistor settings from the EEPROM.

If you find better settings than the ones you see here, be sure to share them!

Calculating New Beta Values Using Wolfram|Alpha

The following inputs can be used as starting points to calculating new values of *beta* using Wolfram|Alpha. Modify the T0, R0, R and T pairs of values as per your own measurements.

- T0=25.0, R0=100000, R=6450.0, T=100.0, beta=ln(R/R0)/((1/(T+273.15))-(1/(T0+273.15))) (read **LINK CAUTION**)
- T0=25.0, R0=100000, R=5901, T=100.0, beta=ln(R/R0)/((1/(T+273.15))-(1/(T0+273.15))) (read **LINK CAUTION**)

LINK CAUTION If you choose to follow the links instead of using the Wolfram|Alpha Widgets, double-check the resulting equations. Some browsers interpret the "+" symbols as space delimiters. For example, "T+273.15" may be converted to "T 273.15" which in turn is interpreted as "T*273.15". If you are getting beta values in the ~40 000 range (instead of ~4 000), try using a spreadsheet application (MS Excel, Open Office, etc) to perform the calculations.

Two-Pass Calibration Method With Thermocouple

Thermometer and Digital Multimeter

The following calibration method was used to measure and calculate a reasonably accurate R0, T0, beta triple to use in the extruder firmware for Cupcake 1068 using firmware v2.1/v2.3.

Connected Thermistor Resistance

IC Voltage 5.0

Thermistor Voltage

Submit

1. Set PID to the default P=7.0, I=0.35, D=36.0 settings
2. Apply settings and reset extruder to engage.
3. Tape the thermocouple probe to the extruder nozzle with Kapton tape right next to the thermistor.
4. Record the room temperature (all temperatures are in degrees Celsius)
   - **T0=26.1C**
5. With power applied to the motherboard and extruder, measure the voltage across the thermistor terminals (**V0**).
   - **V0=4.75**
6. Measure the 5VDC (**H**) supply across the regulator IC terminals (the 3-terminal 7805 chip chip between the two canister capacitors).
   - **H=5.0**
7. From these values, the room temperature resistance (**R0**) of the thermistor can be calculated.
   - T0=26.1, H=5.0, V0=4.75, R0=V0*4700/(H-V0) (read **LINK CAUTION**)
     - **R0=89300**
8. In the ReplicatorG control panel, set the heater target temperature for a higher temperature and wait.
9. Once the heater reaches temperature and you see the heater activity LEDs cycle on and off a few times, read the new thermocouple temperature (**T1**) and thermistor voltage (**V1**) readings.
   - T1=155.1, H=5.0, V1=0.636, R1=V1*4700/(H-V1) (read **LINK CAUTION**)
     - **R1=684.968**
10. Calculate your first **beta1** value.
    - T0=26.1, R0=89300, T1=155.1, R1=684.968, ln(R1/R0)/((1/(T1+273.15))-(1/(T0+273.15))) (read **LINK CAUTION**)
      - **beta1=4838**
11. Set your extruder's thermistor parameters to your newly calculated values.
    - **T0=26**
    - **R0=89300**
    - **beta=beta1=4838**
12. Reset the extruder.
13. In the ReplicatorG control panel, set the heater's target temperature for **220C** and measure the thermocouple temperature (**T**) and thermistor voltage (**V**) when the heater

has settled and the activity LEDs have cycled off and on a few times.
    - T=193.0, H=5.0, V=0.310, R=V*4700/(H-V) (read **LINK CAUTION**)
        - **R=310.661**
    - T0=26.1, R0=89300, T=193.0, R=310.661, ln(R/R0)/((1/(T+273.15))-(1/(T0+273.15))) (read **LINK CAUTION**)
        - **beta=4732**
14. Set your extruder's thermistor parameters to these final calculated values.
    - **T0=26**
    - **R0=89300**
    - **beta=4732**
15. Reset the extruder.
16. In the ReplicatorG control panel, set the heater's target temperature for **220C** and confirm that both ReplicatorG and the thermocouple report 220C.

Depending on room conditions (breezes, ambient temperature, etc) you can expect to see fluctuations and minor differences between the readings, but the reading should be accurate enough now at your target extrusion temperature of 220C.

References

See Measuring Thermistor Beta for more *beta* measurement details.

Plastruder Usage

This page is intended as a general guide to the operation, maintenance, and repair of your MakerBot Plastruder.

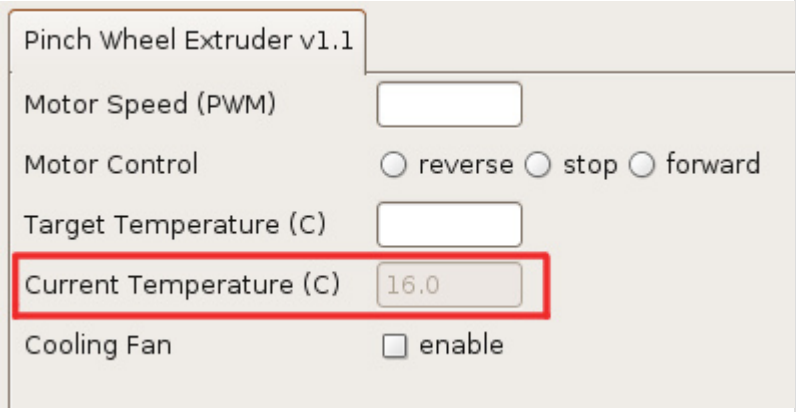
General Usage

Steps to First Extrusion

Once you have your extruder assembled, you'll want to get started right away. It's best to take it slow and test the various sub-systems before you do something that could potentially break it. This will also give you a feel for how to actually use the extruder as well.

Measure the Temperature

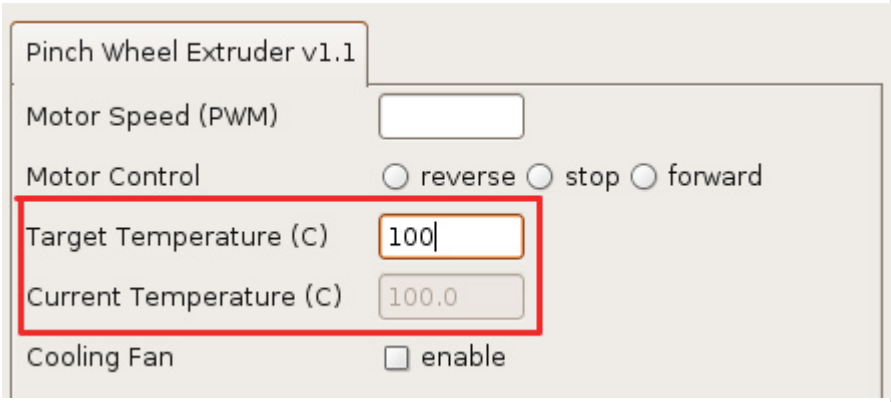
Measuring the temperature is really easy. Make sure you have the extruder wired up properly to the Extruder Controller, and then open the ReplicatorG software. It will immediately begin polling the extruder for its temperature and will update the status window. It should read something around 20 celsius which is about 68 fahrenheit.



If it reads something that doesn't make sense, jump to the troubleshooting section.

Initial Burn-in

If your temperature is reading correctly, it is now time to fire up the heater! Its best to choose a conservative temperature first and then slowly build your way up. That way you can detect a problem and hopefully fix therefore avoiding doing some sort of damage. The latest heater design is pretty foolproof, so you should be fine.



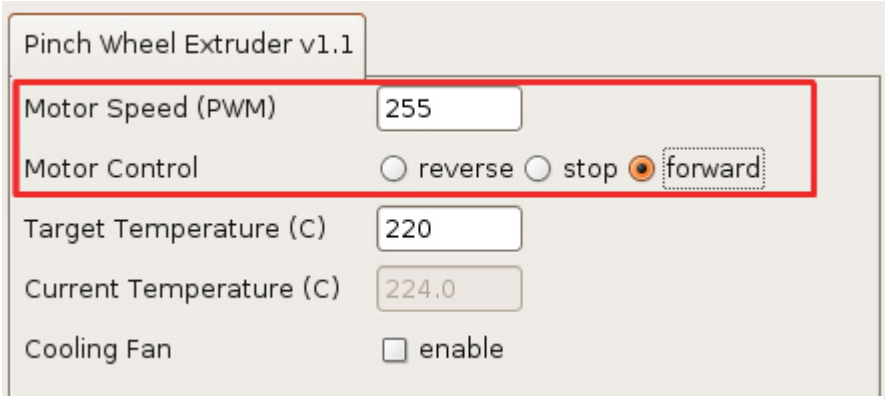
I suggest starting the heater at 50C, letting it heat up (watch the temperature and make sure it actually does rise from 20C to 50C). Let it maintain the 50C temperature for a few minutes. This will prove that it can indeed handle controlling its temperature.

Occasionally during the first startup, the heater does let off a little bit of smoke as the binder on the nichrome burns off. This is completely normal, but if it does get out of hand, simply unplug the extruder and let it cool down. You may want to have a fan setup to blow away any initial out gassings.

If that goes successfully, crank up the temperature to 100C, then to 150C, to 200C, and then finally to 220C.

Test the Motor

Now that your heater control is working properly, you will want to test the drive motor. Enter a PWM value into the speed box. The value should be between 127 and 255. I run my extruder motor at full speed, so I recommend using 255 as the value. Enter 255 and then click the 'forward' button. Your motor should turn on and rotate forward.



You'll want to watch it and verify that it is actually moving. If you peek down the filament feed hole, you should verify that the motor gear is moving in the right direction. You can also verify this from the side. If it is moving in the wrong direction, check out the troubleshooting guide.

First Extrusion

Now that your motor, heater, and temperature control have all been verified, its time to try for your first extrusion! This is a very exciting time, so feel free to do a little excitement dance to get yourself ready. I'll wait, its okay.

Alright, first triple-check that your Target Temperature is set to 220C (for ABS plastic) and that the heater barrel is at that temperature. If you are using a different plastic, make sure you know what temperature to extrude at.

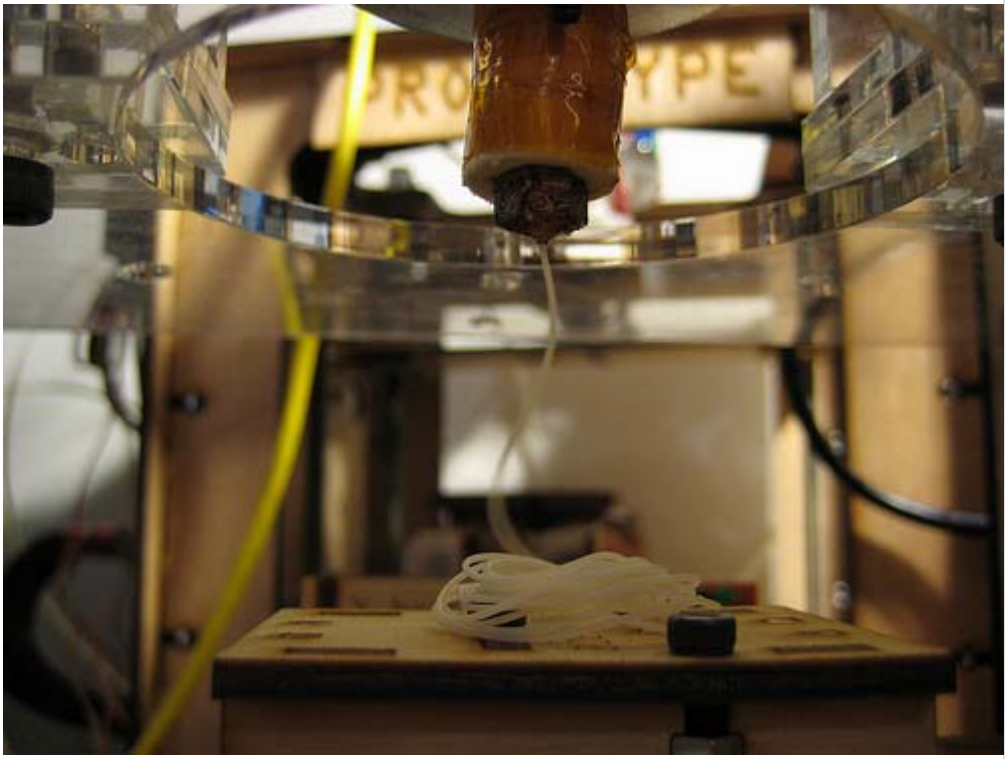
Now, turn your motor on forward at 255 pwm. You need to set the PWM first, then turn the motor on. Verify again that it is indeed moving.

Feed the Filament

Finally, get a long length of plastic filament that you will feed into the extruder and actually feed it into the extruder. The motor will change sound slightly since it is actually exerting force, so don't worry. Push gently on the filament and soon the motor will grip it and start pulling it into the extruder itself. You can pull against the filament to see if it has a good grip. You should not be able to pull it out of the extruder without using excessive force. That is good.

You should watch the filament move down through the extruder body, and can also see through the back of the extruder housing and see the notches slowly moving through the extruder. Alternatively you can either mark the filament with a marker or slightly dent it with some pliers to give you a reference to watch the filament as it is fed into the extruder.

It works!



It takes about 1-2 minutes for the filament to feed all the way through the extruder and come out the bottom. Be patient while this is happening. It will definitely start to extrude. Eventually, you'll see your very first extrusion come out of the nozzle! Congratulations, your extruder works! You should 'burn-in' your extruder and let it extrude for 5-10 minutes just to verify that it is actually working properly. Be careful that your filament does not pull all the way into the extruder housing as it is a bit of a pain to remove if it does.

If your extruder stops extruding during this first extrusion, check the troubleshooting guide for steps you can take to fix this.

Daily Printing Operation

Replacing the filament

The basic process to replace the filament is:

1. Heat up extruder to operating temperature
2. Reverse the extruder motor to pull filament out
3. Pull out old filament
4. Turn extruder motor on forward
5. Feed in new filament and wait for extrusion

If you want to be lazy and/or efficient, here is a pre-made GCcode script that you can run which will prompt you for the various steps:

```
M104 S220 (Heat up extruder to 220C.  Change if you use non-ABS)
M108 S255 (Set PWM speed to 255)
M06 T0 (Wait for extruder 0 to warm up)
M102 (Reverse the motor)
M00 (Click 'Yes' once the filament has been removed.)
```

```
M101 (Motor on, forward)
M00 (Insert the filament and click 'Yes' once it starts extruding.)
M103 (Motor off)
M104 S0 (Temperature 0, heater off.)
```

Keeping it Clean

It's important to keep your extruder clean for proper functioning. Always make sure you are using clean filament with no dust or debris. You may want to have the filament pass through a rag or something in order to remove the dust from it.

Also, during operation your extruder will probably pick up globs of plastic on the nozzle. These should only be removed when the nozzle is hot with a pair of tweezers. You can use needle nose pliers, but be very careful that you do not clamp the nozzle as you may destroy it accidentally.

Keeping Things Tight

Hopefully when you tightened down the idler wheel, you gave it a good twist. If you didn't, it may possibly work its way loose during normal operation. If this happens, you just tighten it back up. You'll need to remove the filament before tightening.

Depending on your tools, you may need to remove the electronics to tighten the idler pulley. If you have a 13mm wrench that fits between the board and the acrylic, then you can just use that. Otherwise, off with the electronics!

The rest of the nuts and bolts should be kept tight, especially the ones holding the heater barrel assembly to the extruder housing. Don't tighten things too much so that the acrylic breaks. A good rule of thumb is 1/4 or 1/3 of a turn past hand-tight.

Troubleshooting

My Extruder does not report the right temperature.

Reality Check #1: Is your thermistor actually hooked up?

The thermistor should be wired to the two-pin screw terminal labeled 'Thermistor'.

Reality Check #2: Is it actually your thermistor?

Your thermistor should have a resistance of ~80K at room temperature. Measure the resistance with a multimeter. If it reads low, like say 6-12 ohms, then you have hooked up the heater to the thermistor port instead. Swap the heater and thermistor (double check the heater resistance to make sure!!!).

If the multimeter reads as a short or as 0 ohms, then your thermistor is shorted. Unfortunately, you're going to have to take apart the heater barrel, pull the thermistor leads apart to fix the short, and then re-assemble it.

If your multimeter reads infinite resistance, or no connection, then one of your connections is bad and you'll need to re-attach the lead wires to the thermistor somehow. This involves taking

apart and re-assembling the heater barrel assembly.

My extruder does not heat up.

Reality Check #1: Is your heater hooked up?

The heater wires should be hooked up to the B+ and B- ports on the MOSFET output port. The polarity is not important, but it is important that its hooked up and screwed down nice and snugly.

If that doesn't fix it, make sure that you have your heater hooked up. Measure the resistance between the two ends of the heater wire. It should be from 6-12 ohms, depending on the length of nichrome you used. If it is much higher, you have hooked up the thermistor to the heater and should switch them (double check the thermistor resistance to make sure!!!)

If they are shorted, then you have a short and need to fix it. Unfortunately, you need to take apart the heater barrel to fix it.

If that doesn't fix it, or there is infinite resistance (no connection) then one of the joints may be bad. You'll have to disasseble the heater barrel for this as well.

My extruder motor is not running.

Reality Check #1: Is your motor hooked up?

The motor should be hooked up to output 1 of the h-bridge outputs. The red wire should be hooked up to 1A, and the black wire should be hooked up to 1B.

My extruder motor is running backwards.

Easy! Simply swap the red and black wires. Remember to turn the power off first!

My extruder has stopped extruding.

This can be a bit tricky. There are a few tricks / techniques to make it work again. Just be patient and you'll have a working extruder in no time.

New Extruders

If you had your first extrusion, but it stopped shortly afterwards, you might have debris in your extruder nozzle. This happens when you do not properly clean your barrel/nozzle before using it.

The solution is to reverse the filament, cut off all the filament from where it got chewed up and below, and run new filament in. The old filament that you pull out will also pull out most of the junk that is in the extruder. Do this a couple times and it should be totally free of debris. You may even see tiny particles on the surface of the melted filament when you pull it out. If you see that, then that is definitely your problem.

Does pushing on the filament start up extrusion again?

If it starts extrusion again, then awesome. Chances are that the drive gear just chewed up the

filament too much and lost traction. If you just had to push for a little bit to start extrusion and then the extruder continued to extrude then that was your problem.

If the extrusion starts, but stops as soon as you stop applying pressure, then most likely your idler wheel is not tight enough. I recommend removing the filament, tightening up the idler wheel, and then re-feeding the filament down through the extruder again.

Does your extruder slowly lose grip and not extrude very well?

Potential problem #1: Your heater barrel does not fix exactly into the PTFE barrel.

Some of the heater barrels in the latest batch are not beveled to match the internal structure of the PTFE. If you have a lathe, bevel the edge at 31 degrees (to match the standard 118 degree angle of a jobber bit) If you don't have a lathe, you can use a file to get the desired bevel as well To check to see if you need to do this fix, its pretty easy:

Remove the screws holding the heater barrel assembly to the heater barrel.
Cut the filament just above where it goes into the housing.
Turn the extruder motor on forward at 255 rpm to eject the filament along with the heater barrel assembly. no need to heat it up, as the whole assembly will be pushed out with the filament.
Unscrew the PTFE from the heater barrel and pull it off over the filament. If the plastic has flattened and 'pancaked' over the heater barrel, the barrel does not match the ptfe receptacle and you'll want to bevel the edge to eliminate this gap. you'll need to heat up the heater barrel and remove the filament first in order to get access and to be able to load filament later.

Potential problem #2: The idler wheel slot may be slightly undersized.

We tried to make it the perfect size, but it may be too conservative. Check the filament and see just how deep the teeth are. I press on the idler wheel moderately hard when tightening which may give me an extra 0.1 or 0.2 of a millimeter. If the teeth marks do not look deep, you may need to widen the slots on the retainer plate and the motor plate. Unfortunately you'll need to take apart your extruder for that. Once you've done that, then file (or dremel) away the slot in the direction of the pinch wheel pulley. That should give you the added grip to make it work nicely.

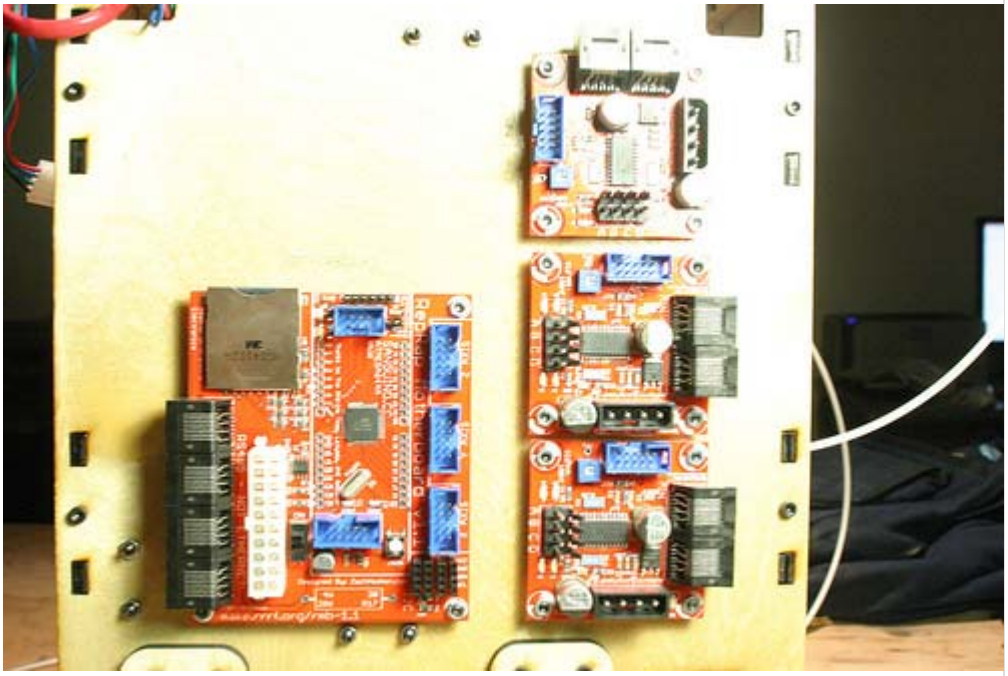
Does nothing work to start extrusion?

This could be bad. You may have a really bad blockage in the nozzle. If you're using ABS plastic, then your best bet is to take apart the entire heater barrel / nozzle assembly. You should then soak the nozzle and heater barrel in Acetone overnight. The acetone will dissolve the ABS and you can then thoroughly wash the nozzle / heater barrel to remove the blockage. It may be extreme, but it does work.

Cupcake Board And Cable Installation

Attach the motherboard and stepper drivers

Bolt the motherboard and the stepper drivers to the side of the Cupcake CNC as shown, using M3x16 bolts. Use the plastic spacers to put some space between the wood and the electronics.

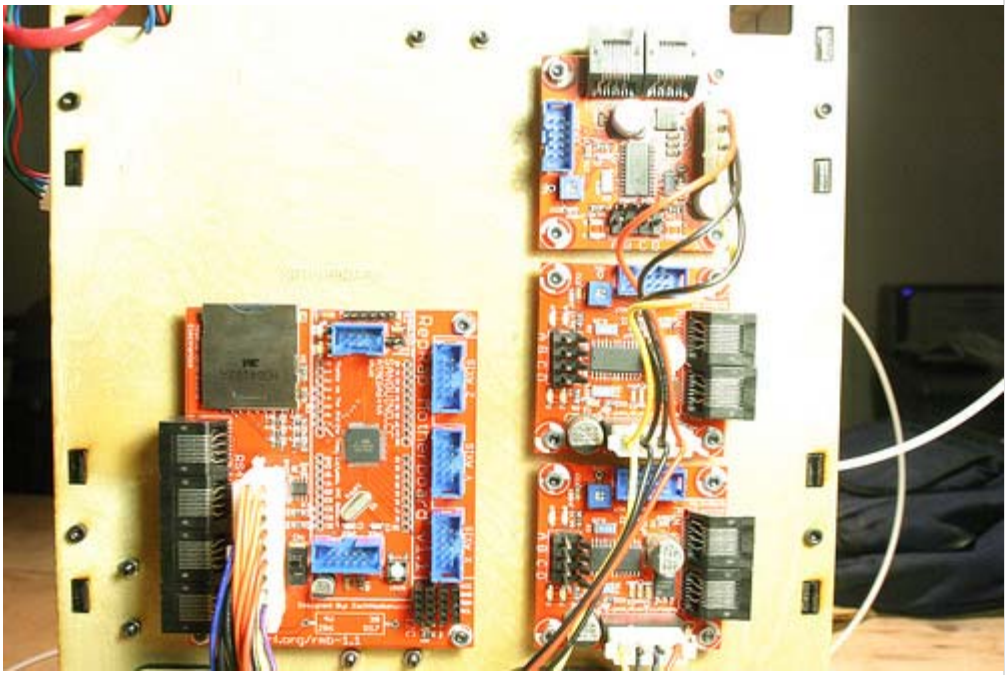


STOP! Check that the 110V/220V switch on your power supply is set correctly.

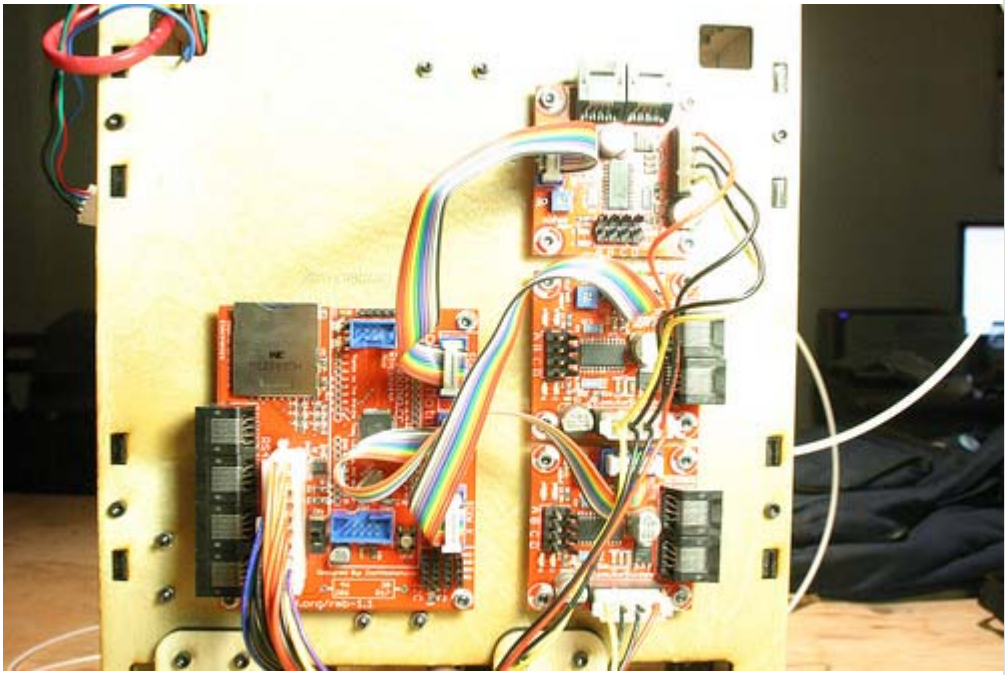
Hook up the power

Connect the four-pin molex connectors from your ATX power supply to each of the stepper boards. Connect the 20-pin connector to the motherboard. All the sockets are keyed, so it should be clear which way around each connector goes.

UPDATE: The ATX power supply in the Deluxe kit might have a connector that looks like it has too many conductors. Don't worry, the extra 4 pins are in a *separate* connector that actually slides down off of the main 20-pin connector!



Wire up the stepper boards



Use the ribbon cables with the IDC sockets to connect the stepper driver boards to the labeled X, Y, and Z connections on the motherboard.

Although there may be labels on the side of the Cupcake CNC indicating X, Y, and Z, you can hook up the stepper drivers up in any way you choose, as long as *each stepper (next step) is hooked up to the board wired to the corresponding socket on the motherboard*. In our example, we've decided to use the bottommost stepper driver as the Y driver, rather than the X driver, because the wires running to the Y axis stepper are just long enough to reach that bottommost board at their full extension.

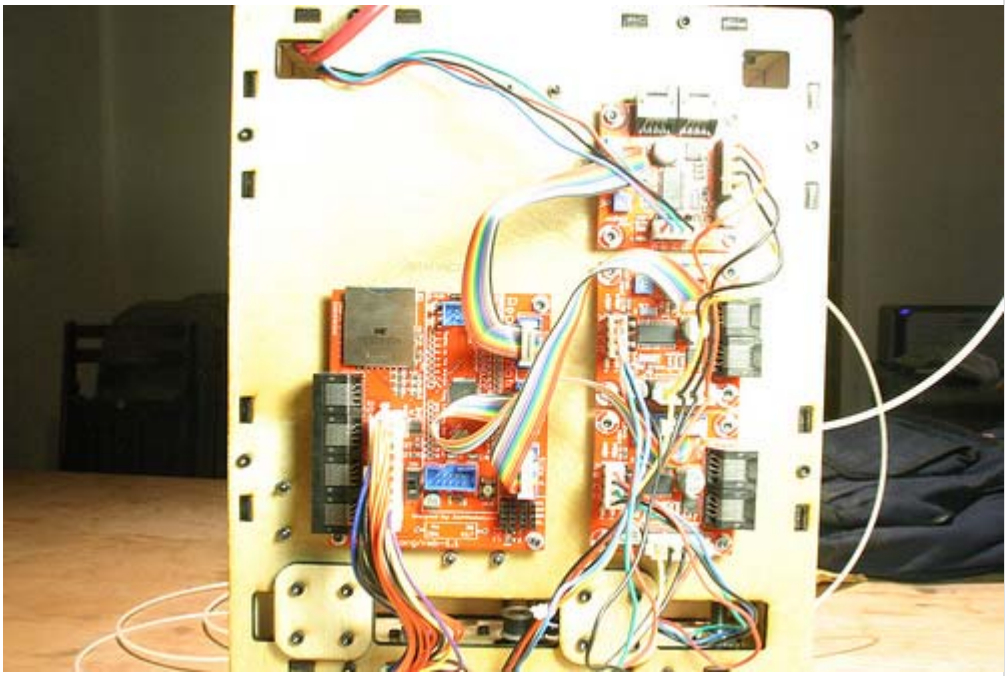
Note: Sometimes the ribbon cables do not come pre-assembled but as a cable and two snap-on endplugs. Each endplug has a small triangle engraving on it that points to one wire in the ribbon cable. Make sure that both endplugs' triangles point to the same color wire or you will have to make a new ribbon cable (the endplugs never come off after you snapped them

on).

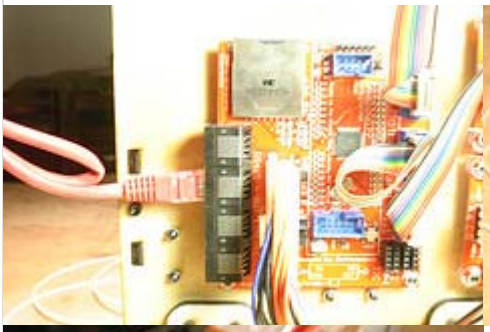
NOTE: In addition to paying attention to keeping the same color wire on the triangle, also pay attention to whether or not the IDC connector is flipped upside down or not. If you get it the wrong way and are picky about your wiring, you could be very upset when the wire is coming out of the wrong side of the PCB.

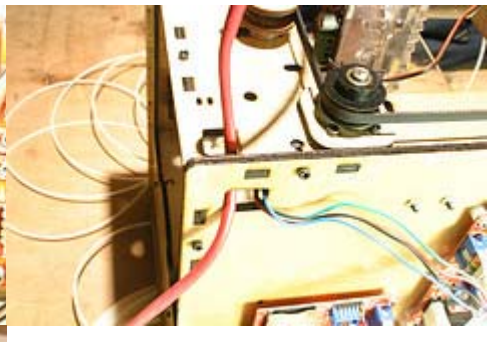
Attach the steppers

Attach the stepper connectors to the corresponding driver boards for each of the X, Y, and Z axis. One side of each connector should have a couple of small triangular ramps on it; these should meet the corresponding protrusions on the board when the connector is the right way around.



Connect the extruder





Plug one end of a patch cable into any of the RJ45 jacks on the motherboard, run it through the holes in the corner of the machine as shown, and plug the far end into the extruder.

Note: Do yourself a favor and use a shielded Cat5e patch cable to keep down on EMI from the stepper motors.

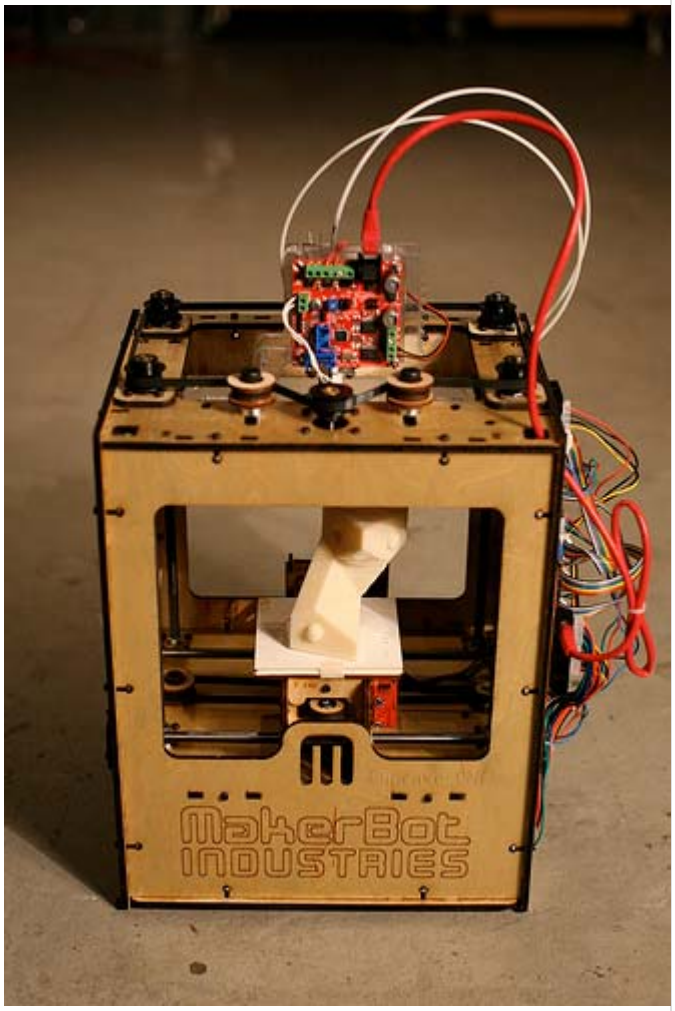
That's it! The core electronics of your Cupcake CNC are hooked up. Step back and revel in your MakerBot assembly skills!

Revel in MakerBot glory

Document!

Now is a great time to upload a picture of your MakerBot Cupcake CNC to the MakerBot Flickr Group at [http://flickr.com/groups/makerbot] Here's the first production model that we made! (Number 21)

You should also head over to thingiverse and click the "I made one" button on the MakerBot Cupcake CNC page! [http://www.thingiverse.com/thing:457]



Next steps

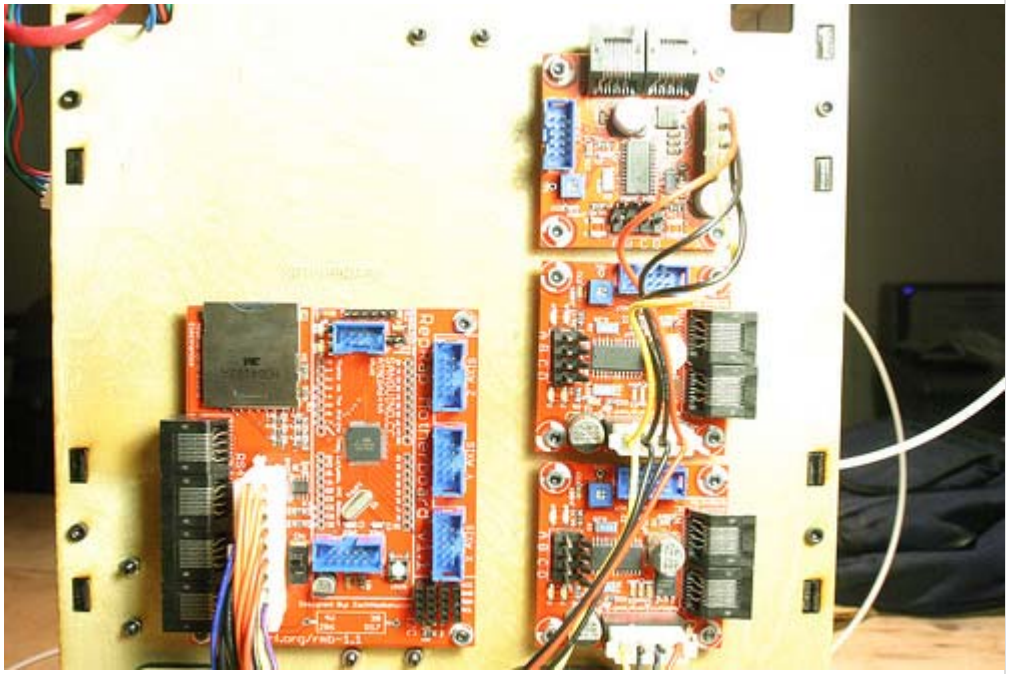
Once you're done smiling and staring at your fully assembled but yet motionless machine, you'll surely want to get it moving.
Don't shoot out - do this first:

- Download ReplicatorG and Skeinforge at http://replicat.org/
- Read the Tips and Tricks page, namely the Skeinforge section.

Cupcake Electronics Installation

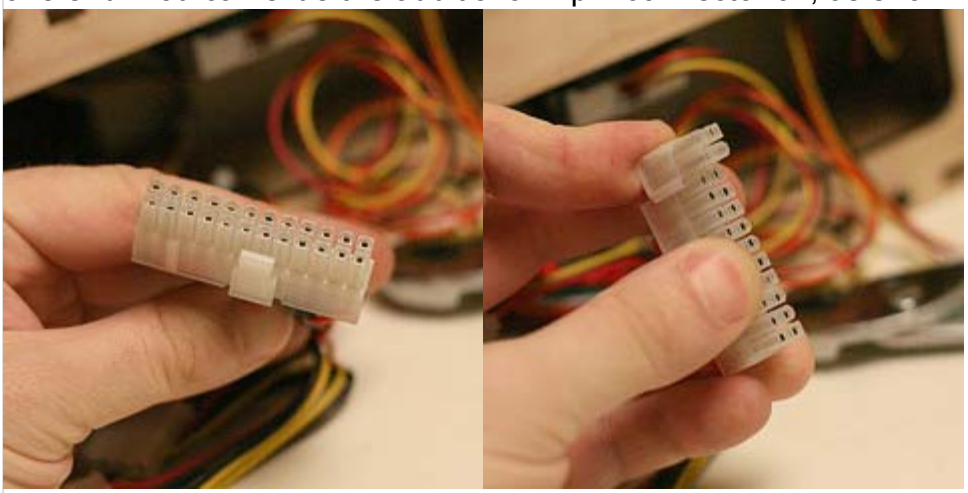
STOP! Check that the 110V/220V switch on your power supply is set correctly.

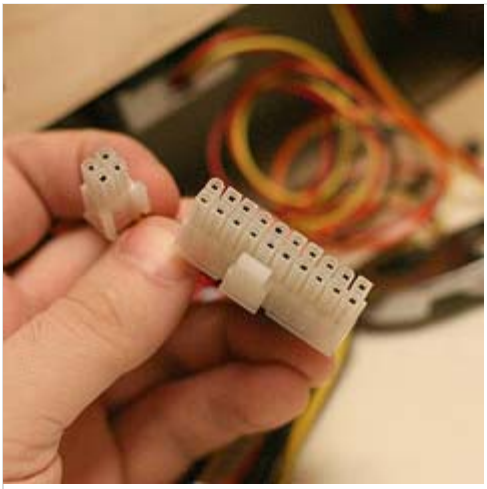
Connect the power supply



Connect the four-pin molex connectors from your ATX power supply to each of the stepper boards. Connect the 20-pin connector to the motherboard. All the sockets are keyed, so it should be clear which way around each connector goes.

Your power supply may have what appears to be a 24-pin connector. Don't panic! It's actually a 20 pin connector with an extra 4-pin connector attached on one end. You can slide the additional 4-pin connector off, as shown below.





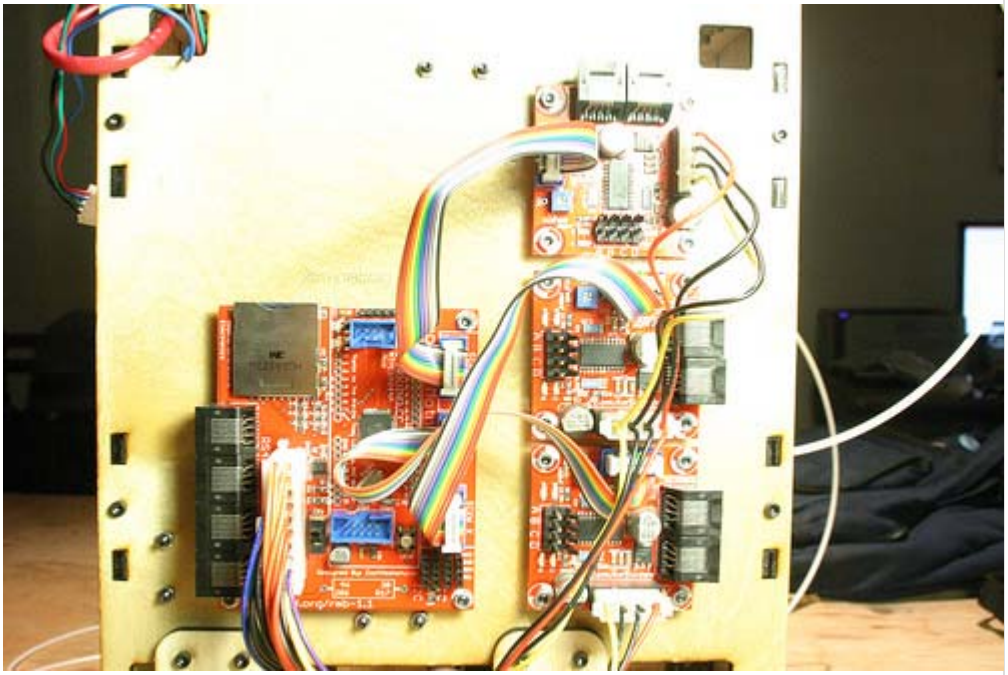
After that, find the molex connectors among the power supply wiring. The molex connector is a chunky 4-pin connector with a trapezoidal tip. It's the kind of power connector that plugs into an internal cd-rom drive in a computer, if that helps. Hook one 4-pin molex power connector up to each of the 3 stepper motor drivers. If you have a relay board, that also gets a molex. Be mindful that it is inadvisable to chain y-splitters — if you have multiple y-splitters, then connect each one to a separate molex plug off of the power supply. We advise that the Relay Board kit be served directly by the power supply when possible.

Assemble your ribbon cables

If you haven't done so already, assemble the ribbon cables that came with your stepper drivers. the directions on the RepRap wiki for details. Make sure that both ends of the cable are hooked up in the same way— the engraved arrow on the IDC connector should line up with the same colors on both ends.

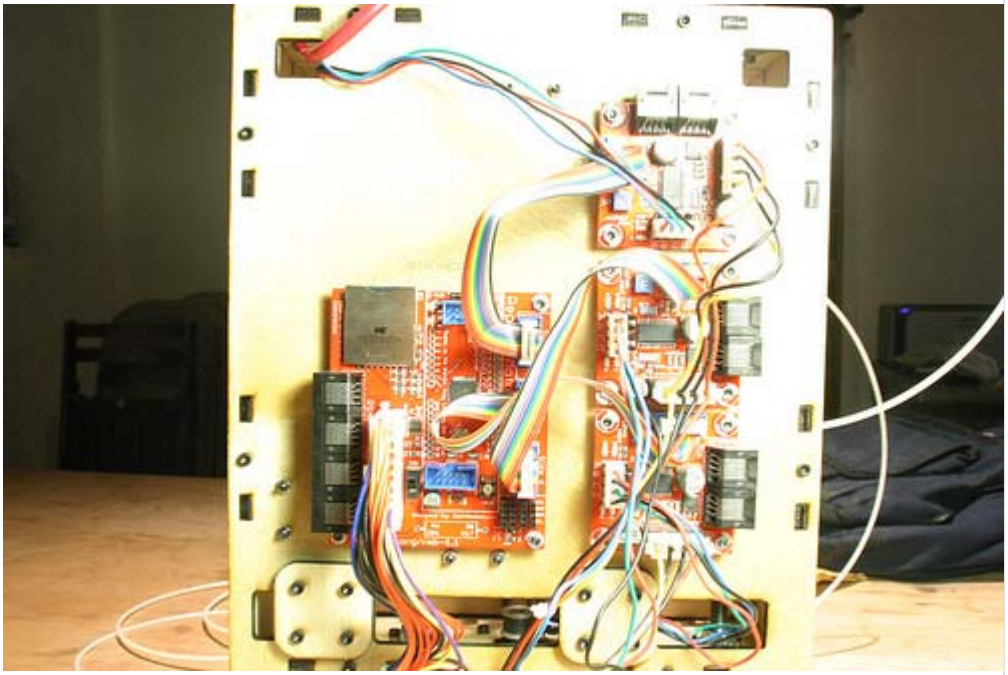
Wire up the stepper boards

NOTICE: DO NOT hook the Stepper Motor Drivers up to the Motherboard with the Cat5(ethernet)patch cables. This causes your Stepper Drivers to become damaged. Bad news!
Use the ribbon cables with the IDC sockets to connect the stepper driver boards to the labeled X, Y, and Z connections on the motherboard.



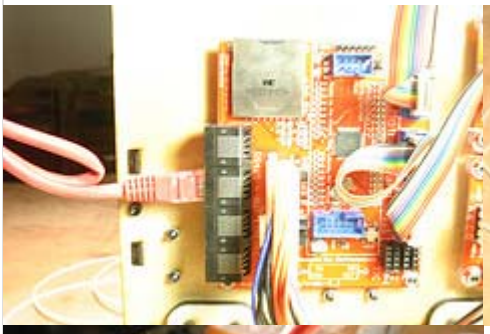
Hook up the steppers

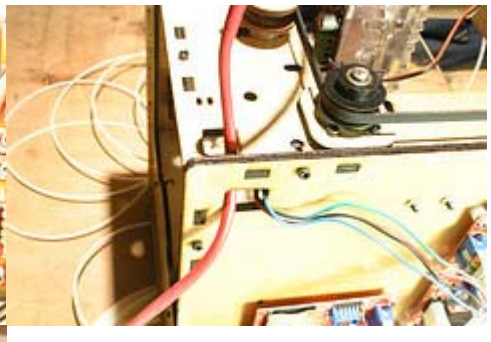
Attach the stepper connectors on the motherboard to the corresponding driver boards for each of the X, Y, and Z axis. One side of each connector should have a couple of small triangular ramps on it; these should meet the corresponding protrusions on the board when the connector is the right way around.



Connect the extruder

If you haven't assembled your plastruder yet, go here.





Plug one end of a patch cable into any of the RJ45 jacks on the motherboard, run it through the holes in the corner of the machine as shown, and plug the far end into the extruder.

Cupcake Calibration

Cupcake Calibration

Now that all the pieces are together, time to get things calibrated for optimal performance!

Axes - Mechanical

X and Y - Mechanical

1. Kits from MakerBot Industries ship with precision ground rods with a 10-micron finish that do not need to be smoothed at all. If you are supplying your own rods, you want them to be very smooth. Sand the rod supports down with some 300 or 400 grit sandpaper and then rub them with super super superfine steel wool
    - Shops specializing in auto body repair carry very fine sandpaper
2. Apply 3-in-1 oil to rod supports
3. Move the Z stage down until the printhead almost touches the build platform. Then slowly (manually) move the build platform along both X and Y axis while observing the distance between build platform and print head. It should remain constant. If does not, your X and/or Y axis are not exactly parallel to the build platform. Check and make sure none of the tabs or magnets or other lumps are sticking out of the top of the Y stage or bottom of the build platform. Push them in or shave them off with the supplied razor blade as appropriate. If it still isn't level, you can level it out by attaching some electrical tape to the bottom of the build platform (or to the top of the Y stage).
4. Check the tension on the X and Y platform belts. If they are too loose, the teeth will slip on the motor pully. If they are too tight, the machine will suffer from excess vibration and acoustic noise.

Z - Mechanical

1. Check each threaded rod for vertical (up/down) movement (too loose) or stiff movement (too tight). For each loose/tight threaded rod:
    1. Remove the pulley
        - Confirm that the rod is still loose or tight.
        - If the rod feels ok now, perhaps the pulley was too loose or too close to the bolt-heads underneath
    2. Undo the top Z Stage Bracket bolts
    3. Remove the Z Stage Bracket
    4. Loosen the two M8 nuts clamping the bearing in place.
    5. Raise the top M8 nut up a few mm and drop the bottom M8 nut so the bearing's top edge sits about 1mm below the cupcake top surface.
    6. Put the Z Stage Bracket back in place. Don't attach any M3 nuts yet!
    7. With one hand on top, firmly hold Z Stage Bracket down and use a finger to stop the threaded rod from rotating
    8. With the other hand underneath, slowly raise the bottom M8 nut until you just feel the bearing meet the bottom of the Z Stage Bracket.
    9. Keep the bottom M8 nut stationary on the threaded rod, remove the Z Stage Bracket and finger-tighten the top M8 nut back down until the bearing is firmly clamped.
    10. Wrench-tighten the M8 nuts so the bearing is well clamped
    11. Put the Z Stage Bracket back on and bolt it in place with the M3 nuts.
    12. Put the the pulley back on - check for M3 bolt-head clearance
    13. Check that the threaded rod turns smoothly and there's no vertical (up/down) movement.
2. Set all corners of the extruder platform to the same height
    1. Find a straight edge, such as a ruler.
    2. Place the straight edge flat on the platform at one corner such that the edge sits next to reference marks on the cupcake's frame.
    3. Pick a reference mark
    4. Lift the platform and adjust the nut's height so the straight edge lines up precisely with the reference mark
    5. Repeat for the other three other corners using the same relative reference mark as the first.
3. Apply 3-in-1 oil to threaded rod supports
4. For cupcake's with side-mounted circuit boards, check for clearance between the extruder platform and the backs of the bolts poking through. Add washers to the other side as required to make more clearance.

End Stops

1. With the machine powered on, put something inside the optical sensor of each endstop. Check that the LED on the endstop board lights up.

Axes - Electrical

X and Y - Electrical

1. Check stepper motor direction
    1. Position platform at X and Y axis mid-points
    2. Launch ReplicatorG
    3. Launch Control Panel
    4. Set step size to 5mm or smaller
    5. Click X+
        - Facing the Makerbot front panel, did the X axis move left?
        - If yes, great!
        - If opposite direction, use ReplicatorG to invert the direction under Machine -> Onboard Preferences
            - Alternatively unplug the X axis motor connector and plug it in upside down.[Be sure to power off to avoid damage to the stepper driver]
        - If it didn't move at all, check all your connections (link to general electrical debugging reference)
    6. Click Y+
        - Facing the Makerbot front panel, did the Y axis move toward you?
        - If yes, great!
        - If opposite direction, use ReplicatorG to invert the direction under Machine -> Onboard Preferences
        - Alternatively, unplug the Y axis motor connector and plug it in upside down [Be sure to power off to avoid damage to the stepper driver]
        - If it didn't move at all, check all your connections (link to general electrical debugging reference)

Z - Electrical

1. Manually position the Z-axis in the middle of the bot by pulling the belt before testing.
2. Set the step size to 1mm or smaller! (Some (very) old versions of the firmware had the bot defaulting to inches rather than millimeters. Even if this has happened to you, a 1mm step size will only move the bot an inch.)
3. Click Z+
    - If the platform moves up by a barely-perceptible amount, you're good!
    - If the platform moves down, unplug the Z axis motor connector and plug it in upside down.[Be sure to power off to avoid damage to the stepper driver]or reverse the direction in the software (see note below)
    - If the platform moves a long way up or down, update your firmware (need to tell HOW!).
4. Once the 1mm stepping appears to be working, set the step size to 5mm and alternate between Z+ and Z-.
    - If the platform moves by a barely-perceptible amount:
        - Confirm that nothing is blocking the movement by turning the stepper gear manually (may need to disable stepper motors from the control panel first)
        - On the Z Axis Stepper Driver board, turn the pot about a quarter-turn clockwise and try again - this increases the amount of current supplied to the stepper motor.
    - If the Z Axis Stepper Driver IC is getting very hot (don't burn your finger!):
        - Turn the pot about a quarter-turn counter-clockwise and try again.

Note: Quite a few users are running into reversed z-axis issues. Make sure that your newly assembled bot moves as directed above. If it doesn't, you can also adjust the setting for this in ReplicatorG (Machine > Motherboard Onboard Preferences > Invert Z axis).

End Stops - Electrical

1. Center each axis.
2. Set the step size to a large amount (20-50mm)
3. For both directions in each axis, set the axis moving, then trip the endstop in that direction.
4. If the movement isn't stopped immediately, reverse the endstop connections on the appropriate stepper board.

Extruder - Mechanical

1. add detail about idler wheel positioning, failure modes, etc.
2. add detail about PTFE/threaded rod alignment, cleaning, etc.

Extruder - Electrical

1. add thermistor checks
2. add heater checks

Extruder - Thermal

1. add checks for ABS temperature/lubricity, feed rate, etc.

Test Prints

1. add raft adhesion check [And tell what to do if raft lifts on corners]
2. [http://www.thingiverse.com/thing:2064 Set of Calibration Prints.
3. add tall object print test
4. add wide object print test and platform flatness test

Cupcake Endstop Installation

Summary

Endstops are optical switches that are installed at either end of each axis of motion. Endstop triggers which protrude from the stages fit into the slots in the switches when a stage moves all the way to one end of its travel. The endstop serve two purposes:

- to allow Cupcake CNC to calibrate itself when it first starts working, to make sure it has moved the build stages to the correct locations, and
- to shut off a motor if for some reason the firmware goes haywire and a stage tries to move too far in one direction.

A word on optical endstop reliability

One of the reasons we're transitioning away from using these endstops is that they can get triggered by all sorts of odd conditions— for example, some of the triggers go off if the bot is sitting in direct sunlight! If you're getting strange behavior with your endstops, check your ambient lighting conditions.

A brief note on going too far

It's actually possible to run the Cupcake CNC with no endstops at all! You can manually move the stages to the correct position before starting a job— in fact, when you're getting started, we recommend trying this technique. *But,* you may ask, *what if my Cupcake CNC tries to move a stage further than it's supposed to go?* Fear not! The steppers and belt couplings on Cupcake aren't powerful enough to cause permanent damage to your machine. At worst, you'll most likely hear a groaning or shuddering noise as either the stepper loses steps or the belt slips. We don't recommend letting Cupcake CNC run wild like this, of course, but if it happens once or twice, don't freak out! Just shut off the power to the Cupcake CNC as soon as you can. After repositioning the stages, turn it back on again and it should be just fine.

If you have your endstops installed and working, but Cupcake CNC *doesn't* try to stop a stage at the end of its expected travel, it could be because you have the endstop connections reversed (the 'maximum' endstop plugged into the 'minimum' connection and vice versa), or into the motor controller of the wrong stage (X endstops connected to the Y controller, for instance). Double check your connections!

Assembly

Build the endstops

Before you start, note that there are two different connectors that you can attach to each endstop— a three-pin pin header, and an RJ45 "ethernet-style" connector. You should have received a small bag in your electronics kit that includes two three-pin headers. For Cupcake

CNC, you'll need to solder together:

- Four (4) endstops using the RJ45 connectors, for the X axis and Z axis
- Two (2) endstops using the 3-pin connectors, for the Y axis

You'll need the 3-pin connectors because space on the X axis carriage, where the Y axis endstops are mounted, is tight and the RJ45 connectors are fairly large.

*When you install the 3-pin connectors, be sure to install them on the **bottom** of the board.* Be sure to check that you're installing the headers as shown in this picture!

One note about the endstop boards: the optical switches and the boards both have two holes in them. When you put the switches on the boards, try to get the holes to line up as well as possible.

That said, it's time to get building! Follow this link to instructions for assembling your optical endstops. Just remember— four RJ45 endstops, and two 3-pin header endstops!

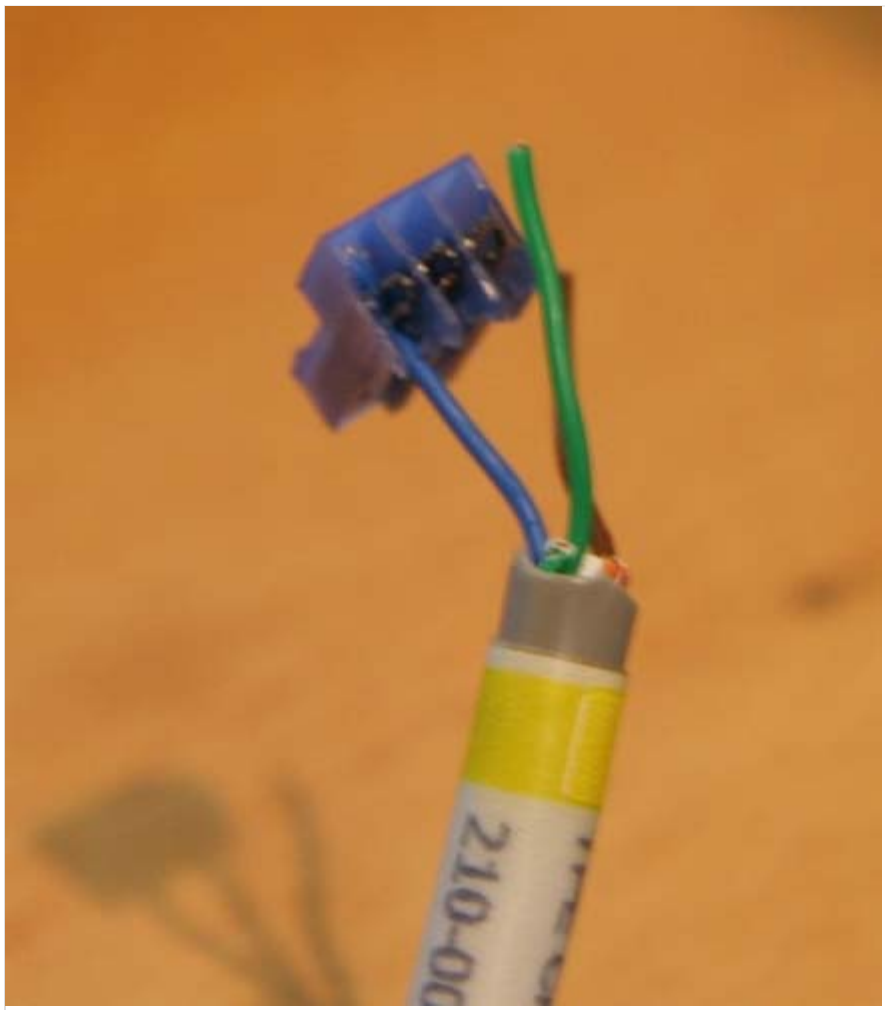
Build the Y endstop cables

Because the Y endstops use 3-pin headers instead of RJ45 connectors, you'll have to modify two of your RJ45 patch cables to use 3-pin connectors on one end. (You'll need to keep the RJ45 connector on the other end; that's the connection we use on the motor control boards.)

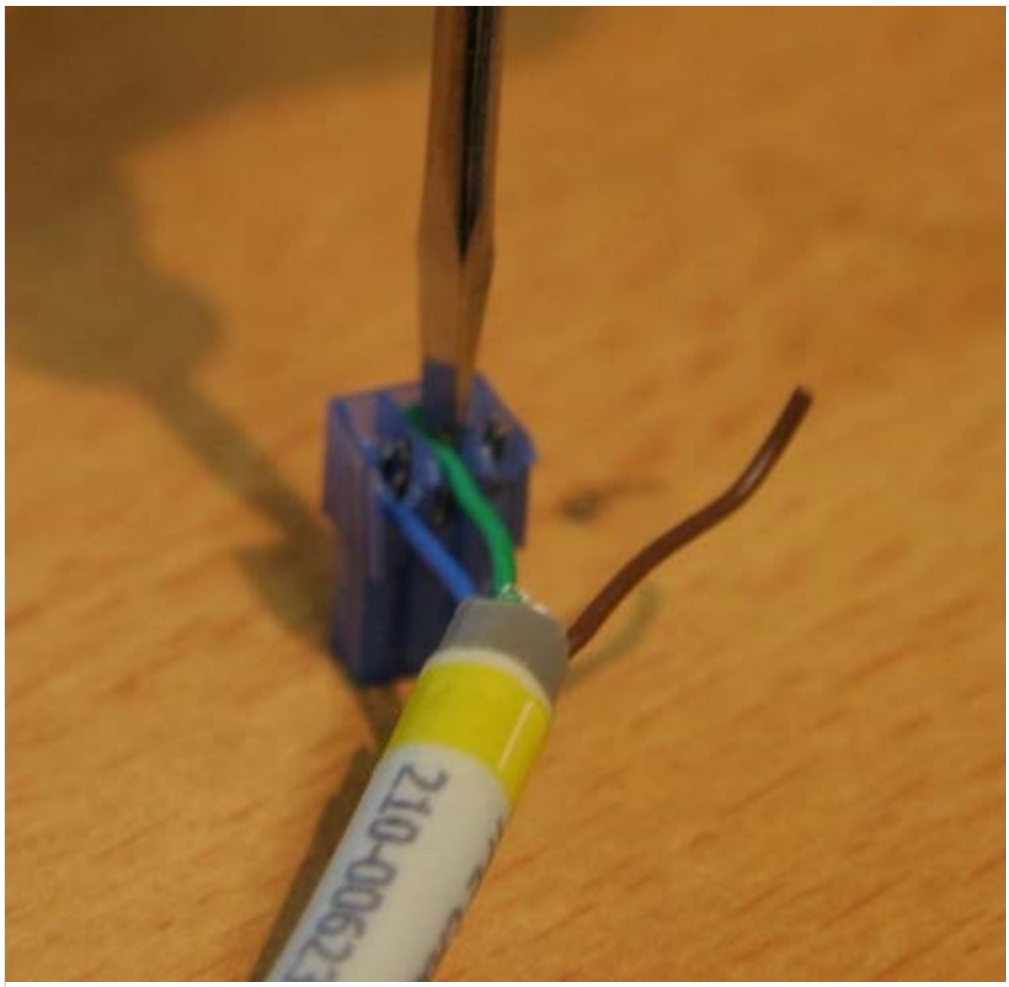
Take a cable and cut off one of the connectors. Use a wire stripper or a craft knife to cut off the outer insulation about one inch from the end.

Trim all the interior wires level with the outer insulation except for the blue, green, and brown wires. Do not strip these wires!

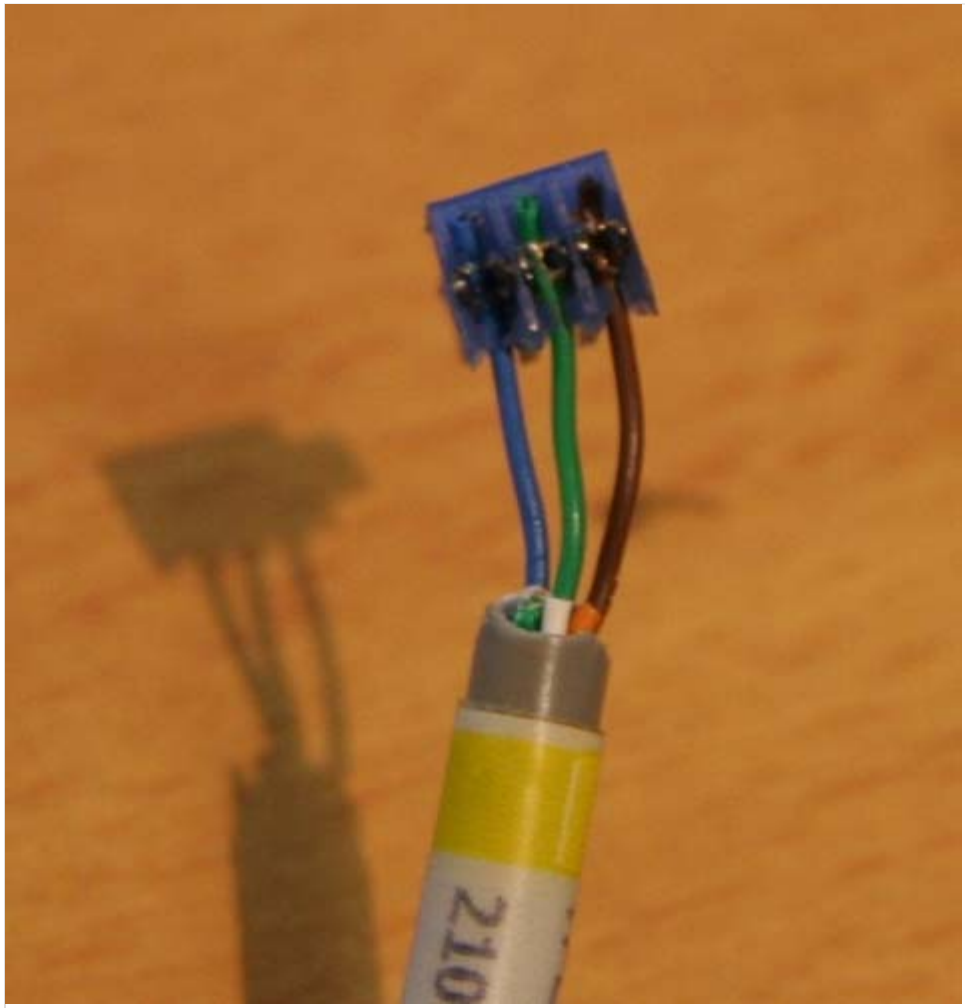
Take one of the three-pin connectors from an endstop kit. On one side, you'll notice very small numbers embossed in the plastic. These label the pins on the connector— 1, 2, and 3. You'll be connecting the blue (VCC) wire to pin 1, the green (signal) wire to pin 2, and the brown (ground) wire to pin 3.



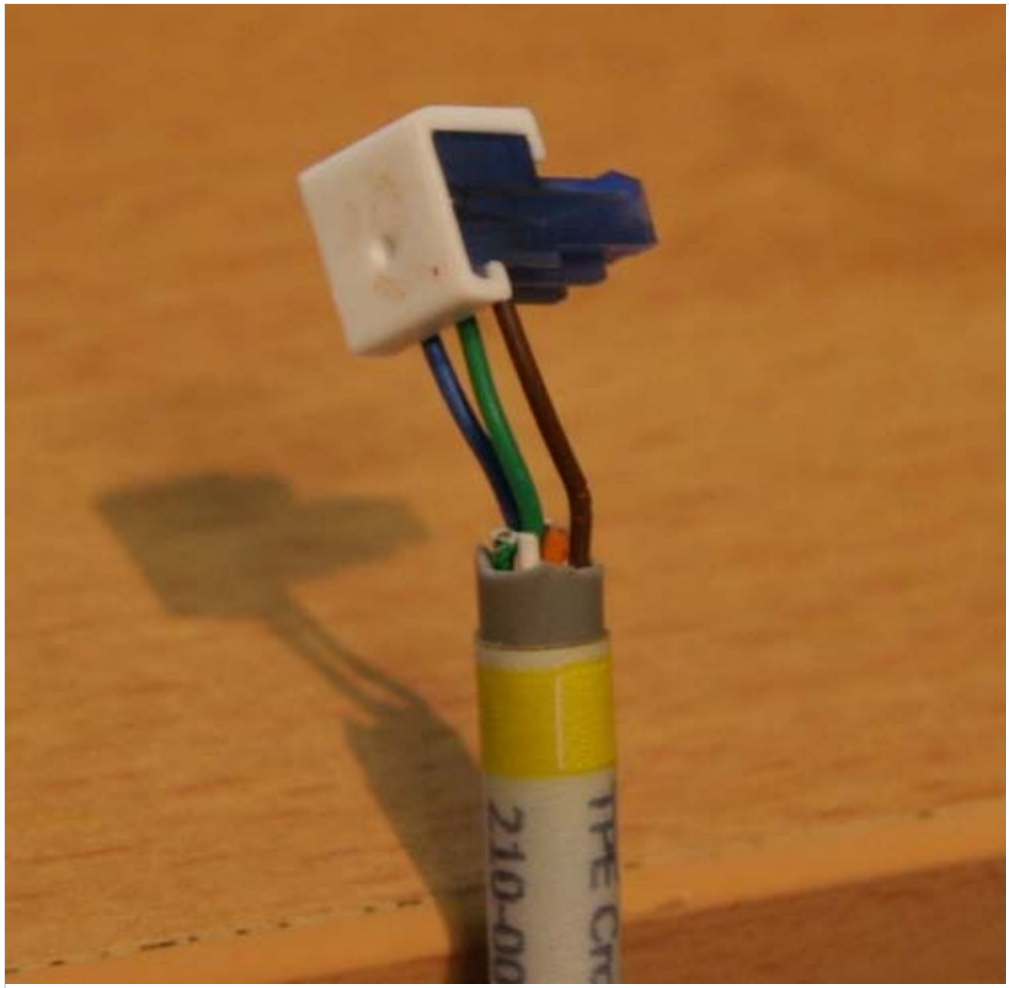
Take the tip of the blue wire, locate pin 1, and place the tip in the connector. The image shows the blue wire already done and the green wire getting arranged into position. Note that all wires besides the blue, green, and brown have been clipped clean and flush with the ethernet cable insulation.



With a small screwdriver or hex wrench, push the wire **firmly** down into the connector. The small metal edges in the connector will cut through the insulation in the wire and make contact with the conductor in the center. You need to get the metal edges to pierce the wire insulation and also get a tight enough grip that they won't pop off later.

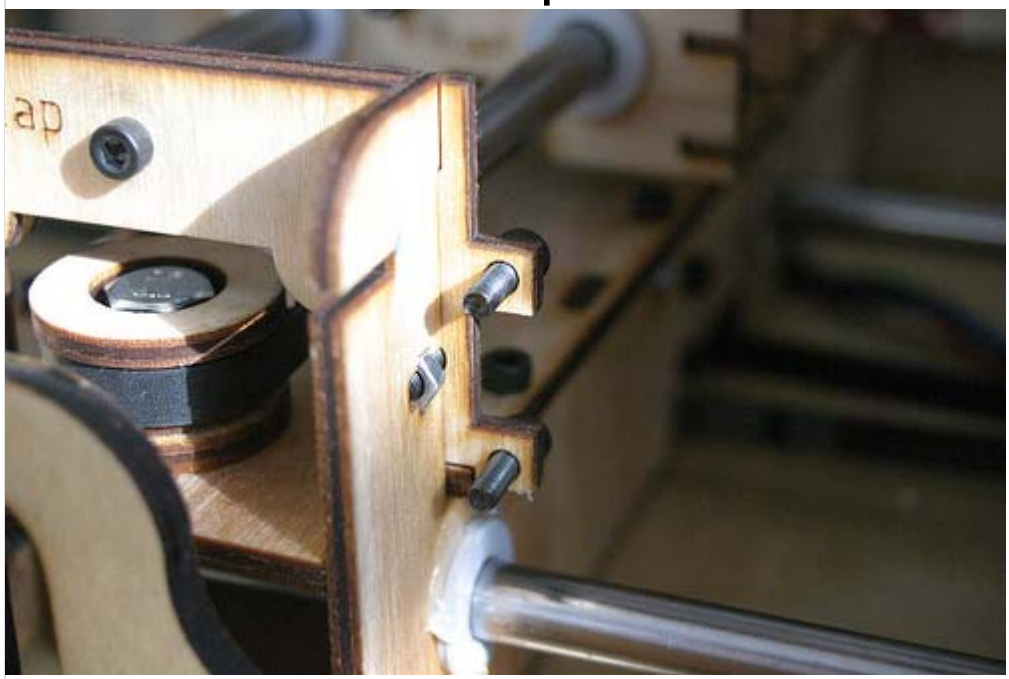


Continue until all three wires are done.

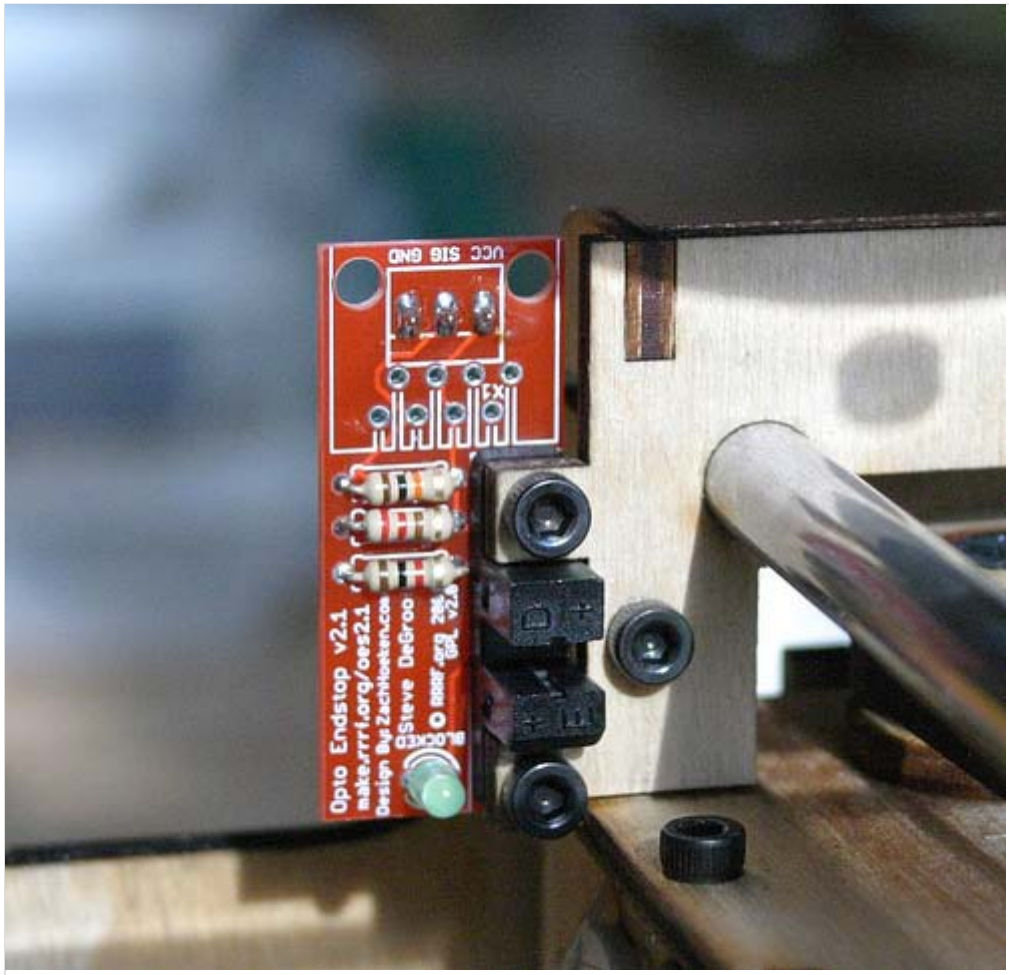


You can then snap on the small white endcap if desired.

Install the Y endstops

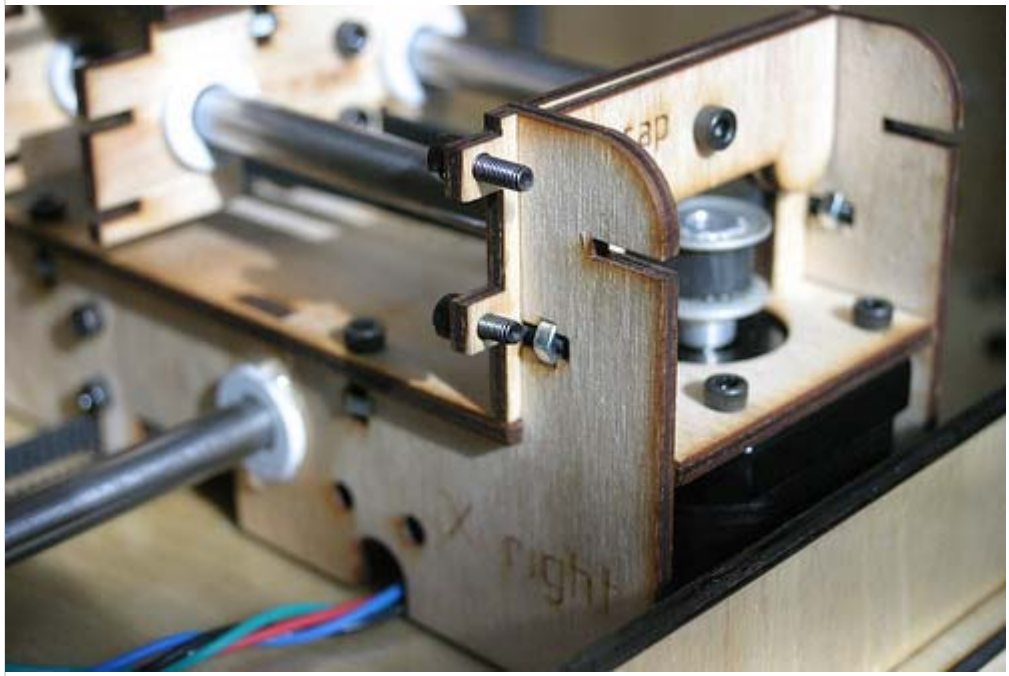


Run two M3x16 bolts through the holes in the endstop mount on the X front piece. The heads of the bolts should face the X stage.

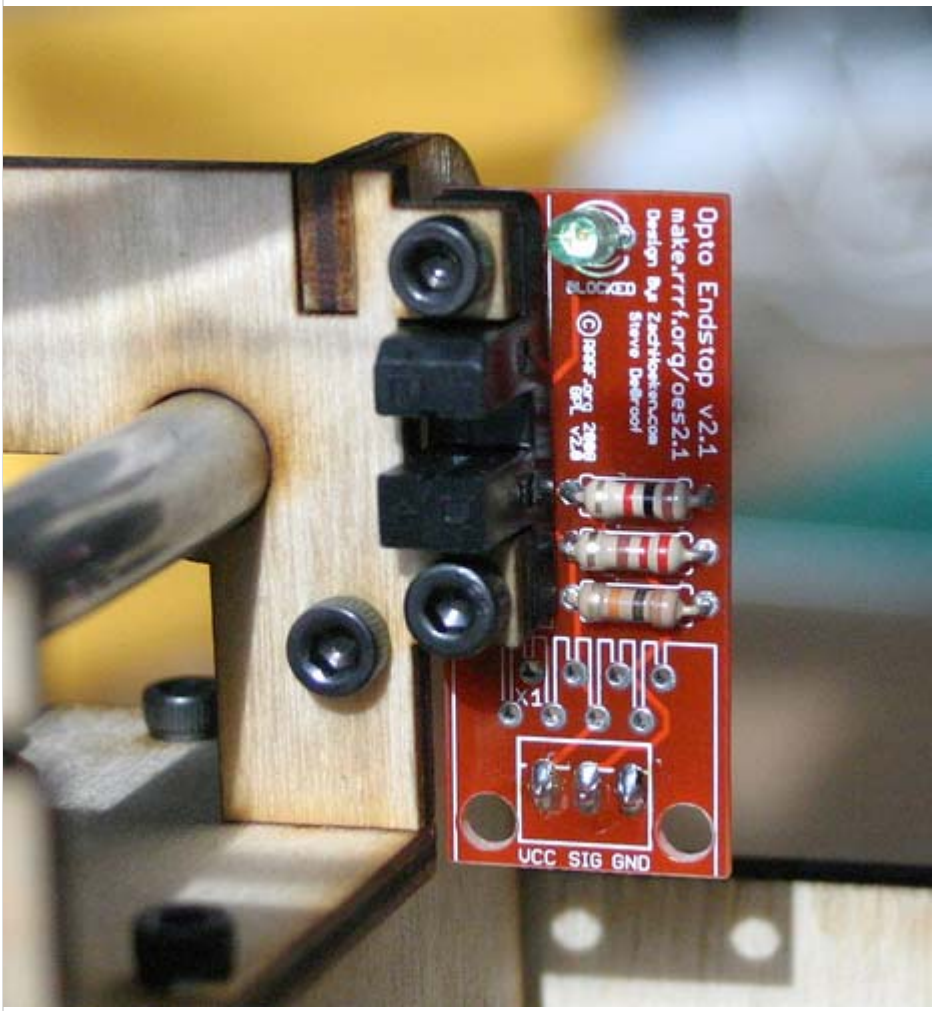


Put one of the endstops with a 3-pin header on the bolts as shown. Because the alignment is not perfect between the board and switch, you may need to screw the bolts in a bit to get the board on the bolts. Be careful not to break the wooden mount!

Use M3 nuts to fasten the endstop in place. Turn the nut to a position that doesn't short the contacts on the back of the board.



Run two M3x16 bolts through the holes in the endstop mount on the X back piece. The heads of the bolts should face the X stage.



Put one of the endstops with a 3-pin header on the bolts as shown. Use M3 nuts to fasten the endstop in place, as above.

Install the X endstops

Find the two M3 endstop mounting holes on the left side of the machine. They will be almost at the front of the machine, about halfway up.

Use two M3 bolts to mount an endstop on the inside of the Cupcake CNC, as shown. Use M3 nuts to fasten.

Find the two M3 endstop mounting holes on the right side of the machine. They will be almost at the front of the machine, about halfway up.

Use two M3 bolts to mount an endstop on the inside of the Cupcake CNC, as shown. Use M3 nuts to fasten.

Install the Z endstops

The Z endstops are both installed on the right side of the machine. The mounting holes are indicated in the picture.

Mount the top endstop on the inside of the machine, in the position shown.

Mount the bottom endstop on the inside of the machine, in the position shown.

This picture shows all the endstops on the right side of the makerbot.

Make some endstop triggers

Endstop triggers can be constructed of any long, reasonably thin, opaque object. Popsicle sticks (craft sticks) are popular choices. You can cut rectangles of thick card, as well. Paint your triggers matte black to make them a bit more reliable.

Install the endstop triggers

To install an endstop trigger, first move a stage almost all the way to one end of its travel. Then place the stick in the slot in such a way that it protrudes all the way into the appropriate endstop. Once it is in place, use a drop of hot glue or rubber cement to keep it there.

Install the Y stage endstop triggers

The Y endstop triggers sit in the slots in the Y stage.

Install the X stage endstop triggers

The X endstop triggers sit in the slots in the X stage.

Install the Z stage endstop triggers

There are no slots for the endstop triggers in the Z stage platform, so you'll need to improvise. A little bit of hot glue should hold them in place nicely.

Cupcake Motherboard Firmware Update

Cupcake Motherboard Firmware Update

Instructions for updating the Cupcake's Motherboard firmware.

Overview

This page describes how to update the Cupcake CNC's motherboard firmware. If you are using a preassembled board or updating a board that you already have firmware installed on, you should follow these instructions. However, if you've soldered your board together from a kit and are installing firmware for the first time, you will need to install the Arduino bootloader, as described here.

We now recommend installing pre-built firmware images from ReplicatorG.

Preparation

Get ReplicatorG

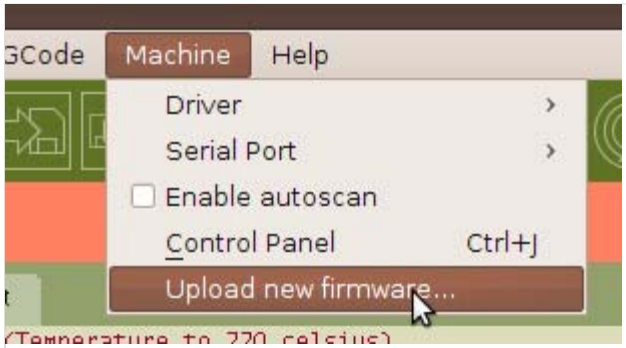
Download the latest version of ReplicatorG from the website. Older versions of ReplicatorG include the firmware in the download; later versions will automatically update their firmware from the internet.

Get the motherboard ready

- Make sure the motherboard is plugged into an ATX power supply.
- If there is an SD card in the SD slot, remove it before starting.
- Connect the Cupcake Motherboard to your computer with the USB to serial cable.

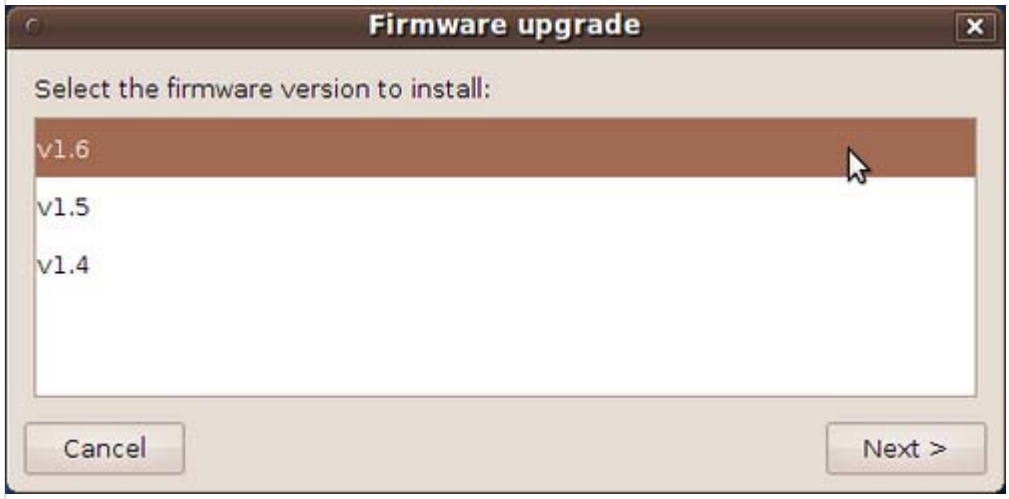
Installing the firmware

- Start ReplicatorG.

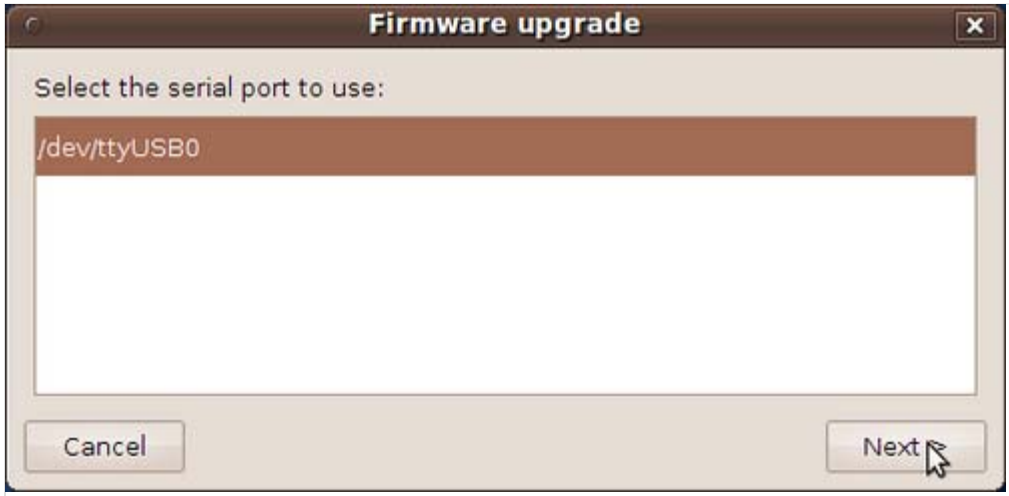


- Select "Machines > Update Firmware " from the menu.

- Select the board and version you're updating.



- Select the version of the firmware you'd like to upload. This should ordinarily be the latest version.



- Select the serial port your USB-serial cable is hooked up to. The names will vary from platform to platform.

- Read the instructions! You must manually push the reset button on the board at the same time as you click the "Upload" button.
- Be patient! It ordinarily take a minute or two to upload new firmware. You should see a message confirming success when it's done.

Fine tuning

After you have upgraded your firmware, it might be a good idea to double check your Firmware Preferences.

Troubleshooting

If you're having trouble uploading, here's some things to try:

- Make sure that the motherboard is hooked up to a power supply— it can't program itself without power.

Plastruder Firmware Update

Plastruder Firmware Update

Instructions for updating the Cupcake's plastruder firmware.

Overview

This page describes how to update the Cupcake CNC's plastruder firmware. If you are using a preassembled board or updating a board that you already have firmware installed on, you should follow these instructions. However, if you've soldered your board together from a kit and are installing firmware for the first time, you will need to install an Arduino bootloader, as described here.

We now recommend installing pre-built firmware images from ReplicatorG.

Preparation

Get ReplicatorG

Download the latest version of ReplicatorG from the website. Older versions of ReplicatorG include the firmware in the download; later versions will automatically update their firmware from the internet.

Prepare the Extruder Board

The firmware cannot be updated via the motherboard at this time. Here are the hardware preparation steps required to perform the update.

Plug the extruder board into motherboard

- Using one of the CAT5 ethernet-style cables, plug the extruder board into one of the motherboard's four RS485 jacks.
- Make sure that the motherboard is plugged into an ATX power supply.
- Turn on the ATX power supply.
- Turn on the motherboard power switch

Plug the USB2TTL Cable Into the Extruder

- Connect your USB2TTL cable into the **extruder board**'s six-pin serial header, next to the reset button

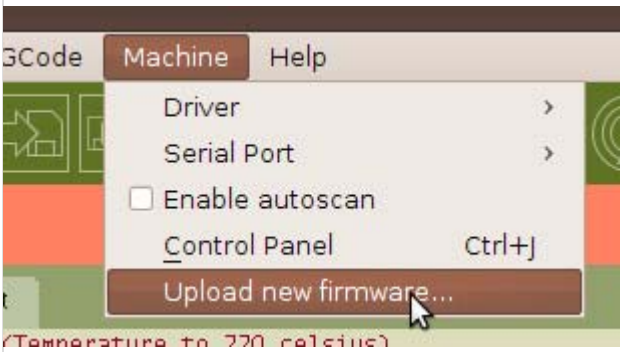
- Make sure the colors indicated on the board match up with the colors on the cable!

Turn on the motherboard power switch

- There is a 7805 voltage regulator on the extruder board that supplies the 5VDC needed to power the logic.
- If your USB2TTL cable supplies 5VDC you may not need to have the extruder plugged into the motherboard to update firmware.

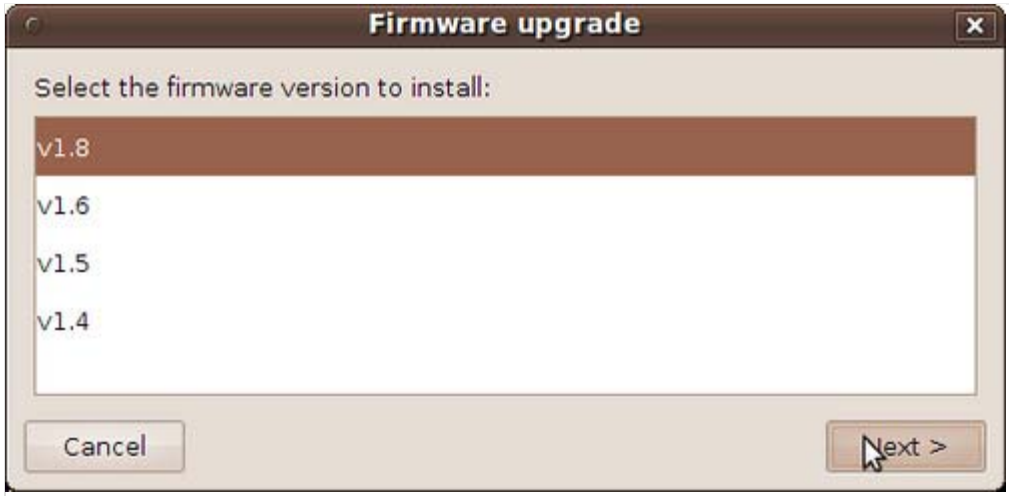
Installing the firmware

- Start ReplicatorG.

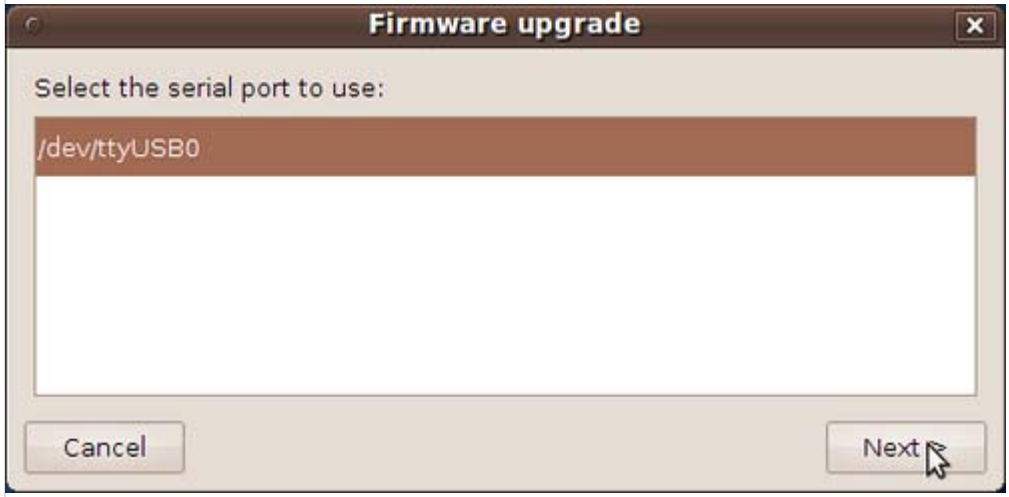


- Select "Machines > Update Firmware…" from the menu.

- Select the board and version you're updating.



- Select the version of the firmware you'd like to upload. This should ordinarily be the latest version.



- Select the serial port your USB-serial cable is hooked up to. The names will vary from platform to platform.

- Click on the upload buton. Be patient; it will usually take a minute or two to upload the firmware.
    - Note that in earlier versions of ReplicatorG, you needed to manually reset the

extruder board; this is no longer the case.
    - TC - some users when updating from 1.6 to 1.8 of the extruder firmware had to manually reset the board which requires clicking the reset button on the board just after clicking the upload button. This can take many attempts (someone took 8) to get the timing right.
- Be patient; it may take a minute or two to upload the firmware. When you're done, you should see a message indicating success.

Fine tuning

After you have upgraded your firmware, it might be a good idea to double check your Firmware Preferences.

Troubleshooting

If you're having trouble uploading, here's some things to try:

- Make sure that the motherboard is hooked up to a power supply— it can't program itself without power.
- Make sure the extruder board is connected to the motherboard through a patch cable.

Heated Build Platforms

What is it?

MakerBot Hotness is controlled heating of the build surface of the MakerBot CupCake CNC to minimize warping, improve 3D printing, enable larger object builds, and provide a host of assorted other goodies such as raft-free printing, easy object release from temperature responsive surfaces such as glass, …

Why do we need it?

warping… raft-badness…

Who's working on it?

Lots of people and groups are working on their own versions and designs. Hive76, Pleasant Software, MakerGear, AllArtBurns…

How to build and use?

The heated build platform can be constructed from a number of parts:

- the build surface, either the stock surface supplied with the cupcake or a replacement
- the build platform, which holds the build surface to the Y stage
- a heater element, either on the build platform or between the build platform and the build surface
- a temperature sensor
- a controller (either passive or active) to power the heater element and maintain the temperature
- possible software changes to set the temperature

MakerBot Cupcake Heated Build Platform v2.0

Build details are available on the wiki here as well as on Thingiverse

What are the different designs?

—ONLY POST YOUR MOST CURRENT OR BEST DESIGNS HERE, but feel free to link to a history of your designs on a different wiki page if you like —

MakerBot Hotness == Hive76 design, heating with electricity stabilized by silicone insulation

this is the first heated build stage design that started them all, designed through collaboration with the University of Pennsylvania.
http://www.hive76.org/handling-hot-build-surfaces

"Pleasant Warmth" - Design from Pleasant Software

Inspired by the success of the Hive76 design, I built this heated platform out of a 6mm aluminum plate, heated by 3x2.2Ω power resistors. The aluminum takes care of a uniform and stable heat distribution.
The design was the first driven and controlled by the Extruder Controller board (so no extra controller or power source needed).
The whole thing is documented in my blog:

- Canned Heat (Overall design)
- Living in times of warp-free printing Firmware changes
- How to connect the 2nd thermistor?
- Raftless (A Skeinforge tool, that helps printing objects without raft)

Meanwhile, the firmware changes for the second temperature zone are part of the official firmware. So you you can just get the most recent version of the extruder firmware (and ReplicatorG) from the MakerBot GitHub archives.

Please note, that the Raftless tool requires the newer version of Skeinforge ("created at 2009-11-06"). This version is available as part of the ReplicatorG archive. It doesn't work with the "official 0006 release"!

ssd2 (01/14/10):
Alternatively, you can eliminate the raft by setting the number of Base and Interface layers in the raft to zero, while still allowing the raft module to center the part and bring it to the build platform level.

zaggo (01/16/10):
The Raftless script not only switches off the raft, but let you slow down the printing of the 1st layer's perimeter loops. This helps a lot when printing complex (i.e. not rectangular) shapes without a raft.

Nichrome Aluminum

Similar to Pleasant Warmth, use kapton tape to attach 30cm of nichrome (enough to make 6-10 ohms, same as the extruder heater element) along with the thermistor to the bottom of a plate of aluminum, and heat and control it with the extruder using upgraded firmware. Use the build surface supplied with your machine or replace it with a glass or ceramic surface if you are using PLA.

Note that some care must be taken that:

- The nichrome wire doesn't directly touch wood where it could get hot
- The thermistor is not crushed between the platform and the Y stage
- The thermistor is in contact with the build platform and getting good readings (so you don't end up with thermal run-away), and is not ripped lose by the weight of its own wires.
- the wiring is carefully routed to not get tangled in the Y stage, or any of the stage motors or pull on the platform while it moves

It would also be nice if there was a modular plug for the wiring near the platform or mounted to it.

Connect the thermistor to the three-pin header on the Extruder Controller 2.2 board marked

"A6". The pin at the top, nearest the A6 label, is Ground. The middle pin is VCC (+5V). The bottom pin is Signal (connected to the A6 analog input of the processor). Connect the thermistor between Signal and Ground. Connect a 4.7KΩ resistor (color code Yellow-Purple-Red) between VCC and Signal. Connect a 10µF capacitor across the thermistor (from Signal to Ground). Make sure that the + side of the capacitor is connected to Signal and the - side is connected to Ground.

Note: The description of the Extruder Controller V2.2 board says that the top pin ("nearest the label A6") is Signal but the circuit board traces show that the top pin is Ground and the bottom pin is Signal.

MakerBot Cupcake Heated Build Platform v2.0

This is the second design to be sold in the MakerBot store.

Build details are available on the wiki here as well as on Thingiverse

The design utilizes traces on the PC board to generate heat and an aluminum plate with assistance from thermal paste to create a heated build surface.

The red LEDs are not required, but provide an opportunity to practice your soldering skills.

Roboteernat's FR4 and Nichrome wire heated build platform.

This design is available on Thingiverse with build details on his Nats Nonsense blog.

This design depends on readily available parts (except perhaps for the Copper Clad FR4).

next design here

How do I make one?

The two things you need are heat and control. Control is very important (no fires please!), and is generally accomplished with a thermistor or temperature sensing element for feedback. But there's a lot of room for creativity, you could get very crafty here… PTC heaters, hair dryers, … are all valid designs and some have even been successfully used in the field as reported on the makerbot operators listserv.

Links

- RepRap solution for heated bed

Missing Parts?

If you feel like you are missing a component- DON'T PANIC!

Many MakerBot products have a series of subkits- an item may not be immediately visible. Some items look very similar, and can be challenging to see the differences. Take a deep breath, make sure you have adequate light to handle small components, and slowly examine the component bags and parts. Check out the floor too, or under your keyboard.

Some commonly missed parts:

***Gold Magnets**- In the CupCake CNC Ultimate Kit the gold magnets ship in two locations. 5 gold magnets ship inside the "Build Surface Kit" and 10 Gold magnets ship packed away inside the "Hardware Burrito." Since they are magnetic, sometimes they are hidden underneath other metal components.

***Z-Motor Pulley or X-Idler Pulley**- These two pulleys are the same in every way but one- The bore hole of the Z-Motor pulley is a tiny bit smaller than the X-Idler Pulley bore hole. It is possible to use the X-Idler pulley on the Z-Motor shaft, but then the X-Idler bolt won't fit in the remaining brass pulley. Just swap them and you're back in shape. If you still have a bit of trouble fitting the Z-Motor pulley, you can sand inside the brass bore until it fits on more easily. There should never be any need to "drill out" a pulley to make items fit.

***MK5 Thermal Cape**- In some documentation photos the cape is mirrored mylar, but in later shipments it is made from clear mylar. It can be easy to miss as it is a clear plastic object inside a clear zip-lock bag, with the other custom bits kit for the MK5.

***Opto-Endstops**- The CupCake Ultimate and Starter don't come standard with endstops. The Opto-Endstops have some trouble under certain fluorescent light bulbs, so we discontinued shipping them in the early days of shipping CupCake CNCs. The Thing-O-Matic will ship standard with mechanical endstops. Optical and Mechanical endstops will be available for purchase under electronics in the store.

***Bearings**- The 608 skate bearings that come with the CupCake are shipped inside a small storage tube. Sometimes the tube is clear, sometimes the tube is black. When the tube is black it can be unclear what the tube is for, but just crack it open- it's full of bearings.

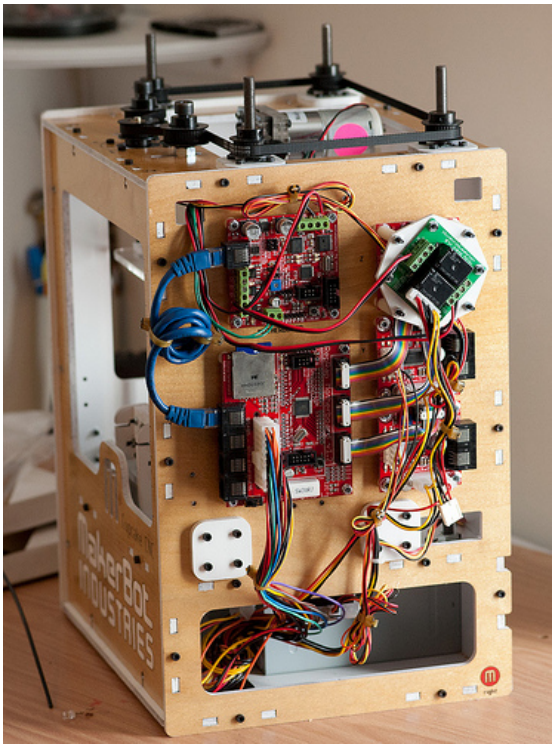
***Relay Board Kit**- With the CupCake CNC Ultimate Kit the "Relay Board Kit" ships *inside* the Automated Build Platform box. It's a white box identical to the box that the MK5 Plastruder comes in.

If you find and can determine that an item is definitely missing that you should have received- please send us an email describing the situation. You can contact us here:
www.makerbot.com/support

Board Positions

So much stuff!

The Cupcake Ultimate has several upgrades that didn't exist when we originally designed the Cupcake. Because of this, you need to do a bit of jockeying to get all of your boards nicely mounted on the machine. Here's a quick guide to a recommended setup.



This image is of a bot in the wild, from Lucas & Kent Weakley of Blue Sky Graphic Communciation.

So what do we see here? The extruder board is mounted above the motherboard. The motherboard has been left un-flipped for maximum wiring neatness — note that it will be hard to get that SD card out in that position. Our stepper motors are in their original positions, but the top one has the relay board mounted on top of it using the relay board mount kit.

Of course, this is only one way to get it done — some folks mount their boards in other places. Feel tree to try other setups if you like. The only place we don't recommend is mounted to the top of the machine, because all the heat from the build platform and extruder might just fry your board.

Pro tip: The wire organization is amazing on this bot, but that SD card is going to be tough to get to. It might be easier if the user added extra spacers to the motherboard, to raise it above the extruder controller, or if they just left the bottom-left spacer & screw off the extruder controller. Other than that, though…it's hard to find fault with this setup.