Ten Quick Steps to Modifying an Inexpensive ATX PSU for RepRap Use - with pictures!

First, please note that there is absolutely nothing to convert or modify if you are using one of the "ATX PSU Ready" controller electronics, such as the Generation 7 Electronics. You can use an ATX PSU "as is", saving both time and money.

That said, let's get hands on with an ATX PSU for our RepRap! In this case I took pictures of the modifications I made to an inexpensive ATX PSU I bought here in Spain in September 2014 for my P3Steel (a Prusa i3 variant) project, which uses the ubiquitous Arduino Mega 2560 + RAMPS 1.4 combination as its electronics. The total time required to modify an ATX PSU will of course vary but I would estimate it at around one evening, working at a leisurely pace. The following are generic instructions that apply in principle to any modern ATX PSU, you don't necessarily have to buy the same model as shown below.

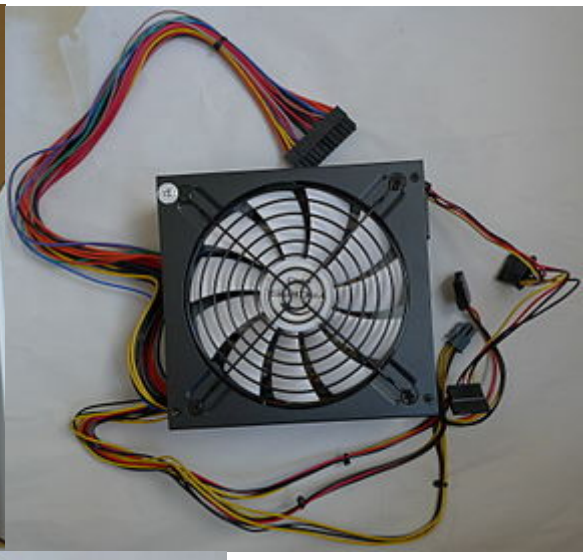
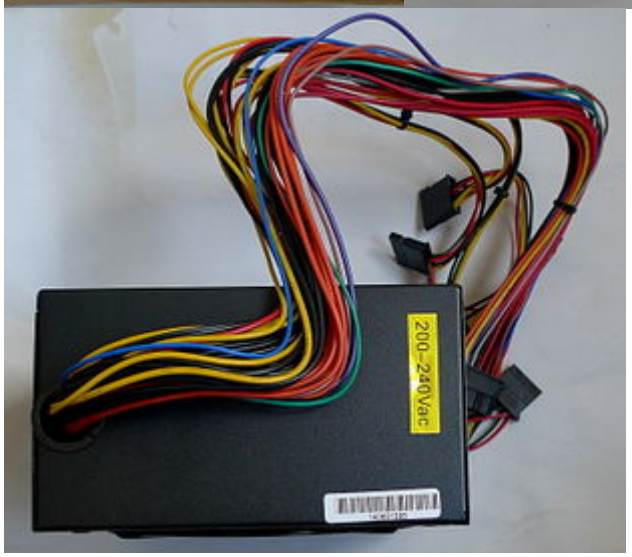
Note that by clicking on any of the thumbnail pictures below you have access to the full-size version (in case you want to check any detail).

Unboxing

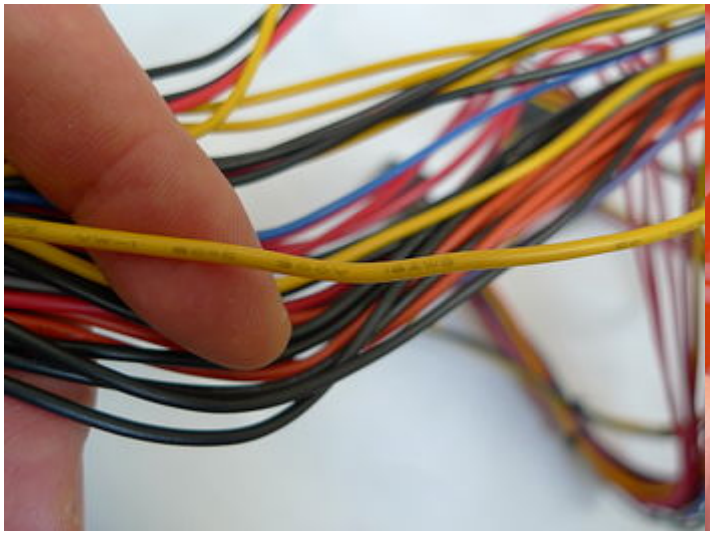
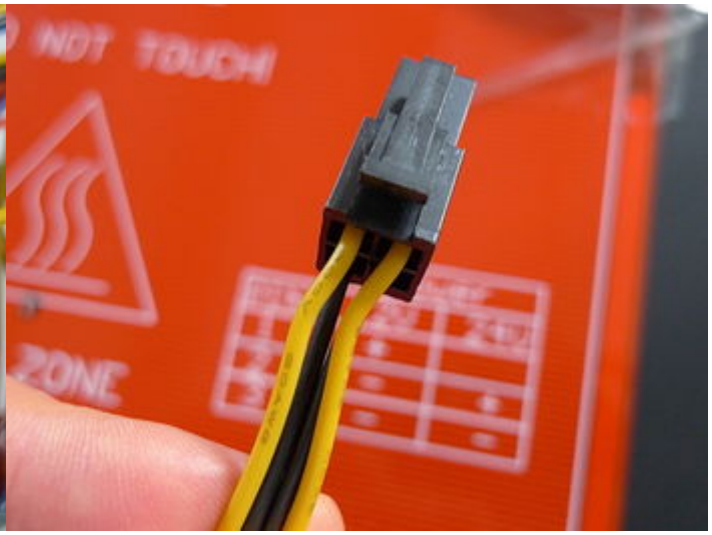
Here is the ATX PSU, still in its fancy box:

The back of the box lists the technical specifications and features for this ATX PSU. Note that despite the wonderful claims on the fancy box, this particular ATX PSU model only has passive PFC (doh!) and no guaranteed efficiency rating (bummer!), but it has a 140mm thermally regulated fan (good!) and it's painted black (just kidding!).

Let's take it out of the box and check what's included:

Well, we have the ATX PSU properly packaged in bubble wrap, a power cable (EU type, and really short as I found out later), a small plastic bag with four screws and... no manual or warranty certificate! The cables could be a little bit longer but they have an adequate length for RepRap use. They are not sleeved, but we'll work around that later. Also note there is a plastic protection for the cables exit from inside the PSU. And finally: 200~240V AC only (which is fine for Spain and most of the EU).

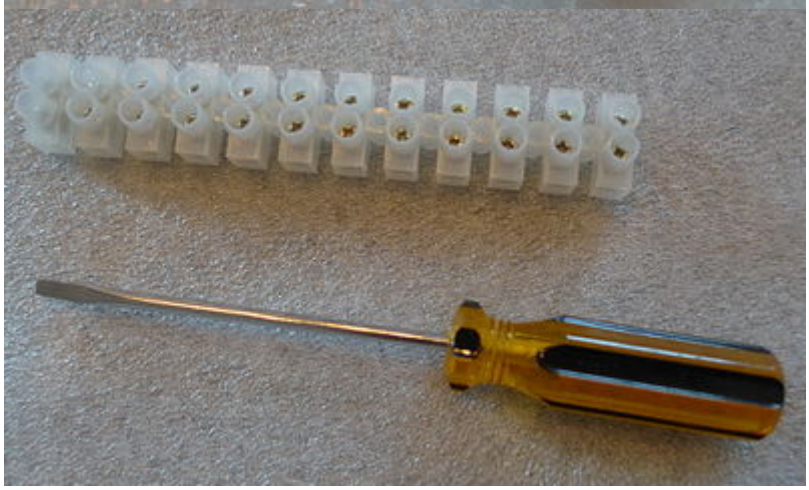
Yet another thing we can check during the unboxing is the wire gauge used for the cabling of our ATX PSU. Usually we'll find 22AWG to 16AWG cables in ATX PSUs (the smaller gauge the better), this one uses 18AWG and 20AWG (we are going to use 2x20AWG for our 12V@5A rail and 2x18AWG for our 12V@11A rail).

The label on one of its sides indicates the maximum power available for each rail. For RepRap use, the relevant figure we have to look for is the rating for the 12V rail, in this case, 27A or 324W: we are good! Also note the back of the ATX PSU has a proper On/Off switch and power cord receptacle. Again, good.

Tools and materials required

Make sure you have all of these at hand before you get started!

- Multimeter.
- Small cutting pliers and long-nose pliers.
- Screwdrivers.
- Soldering iron and some solder.
- 47 Ohm resistor (1/8W or 1/4W or 1/2W etc; any size will do).
- Terminal block strip (12 position, or 2 x 6 position).



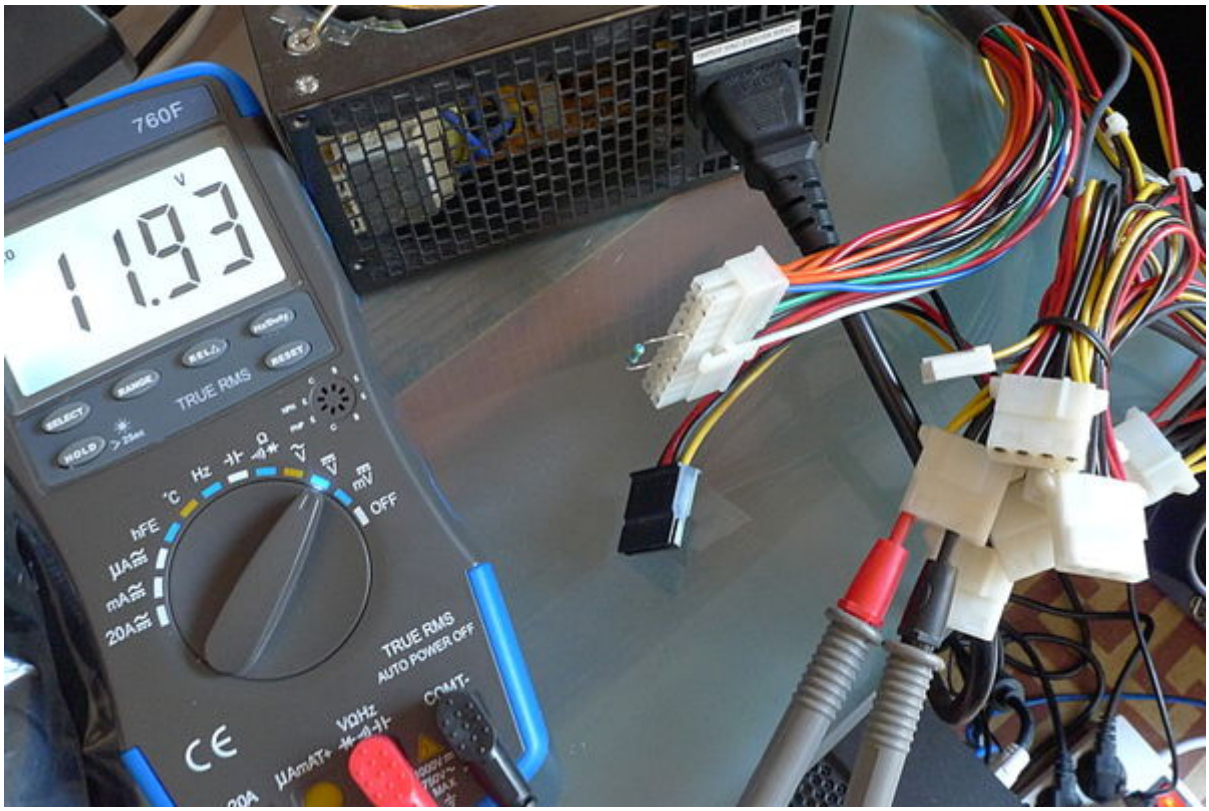

Auto
760F
-0.000
V
TRUE RMS
OFF
CE
20A
TRUE RMS
AUTO POWER OFF
COM

Preliminary Test

It's always a good idea to make a simple, quick preliminary test of our just unboxed ATX PSU i.e. turn it on and check that it does indeed work and that we get the correct voltages on all its outputs. Let's do this in a few simple steps:

- Examine the 24-pin motherboard power connector and find the green wire. This is the PS_ON wire and we have to bring it to a low logic level to softstart our ATX PSU. To do so, **we use a 47 Ohm resistor** inserted between the PS_ON (green) wire and any of the GND (black) wires. DO NOT use a paper clip! Inserting a paper clip between the wrong terminals could short the PSU and damage it, and you could severely hurt yourself in the process! Also at this point, **double-check** that you have correctly inserted the resistor between the green wire and one of the black wires.
- Make sure the On/Off switch is in the Off position and connect the mains AC power cable. Nothing should happen at this point.
- Connect a multimeter reading DC Volts between the yellow (+12V) and black (GND) wires in one of the Molex connectors. It should show 0V at this point.
- Now switch on the ATX PSU and check the multimeter: it should show approximately 12V +/- 5%. Also the PSU fan should be spinning. Now we know that the +12V rail is working.

The picture below is from the same test on an older ATX PSU (this test was done on our sample new ATX PSU with similar results, I just forgot to take some pictures then).



If you want, also check the +5V (red wire on the same Molex connector) rail. Although the +5V rail is not really required for a RepRap, it's always a good thing to have available in case we need it.

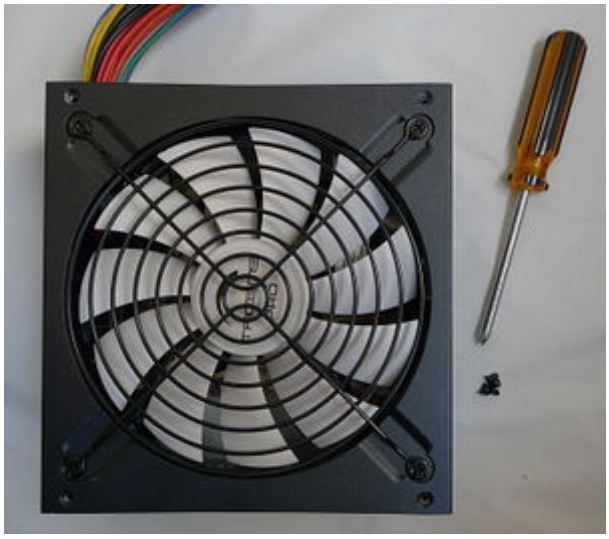
Opening the ATX PSU

Warning 1: from this point on we are voiding the warranty of this ATX PSU. If you absolutely don't want to void the warranty of your ATX PSU, check the alternative "No Modifications" method detailed below to connect it to your RepRap electronics.

Warning 2: YOU MUST ABSOLUTELY MAKE SURE THAT THE ATX PSU IS PHYSICALLY DISCONNECTED FROM THE MAINS AC POWER BEFORE OPENING IT AND DURING THE ENTIRE TIME IT IS OPEN. **FAILURE TO DO SO EXPOSES YOU TO SEVERE ELECTRICAL SHOCK!** Also, please wait 10 minutes after disconnecting the ATX PSU from mains AC power for the PSU's capacitors to discharge. This isn't strictly necessary nowadays since all modern ATX PSUs should have a circuit that self-discharges the bulk capacitors, but it doesn't hurt to be extra-careful.

In general, ATX PSUs are held together by just four small screws. Note that in the picture below, one of the screws is covered by a QC adhesive label, which we are just going to scratch away:

We now have removed the four screws, but the case still won't come apart!

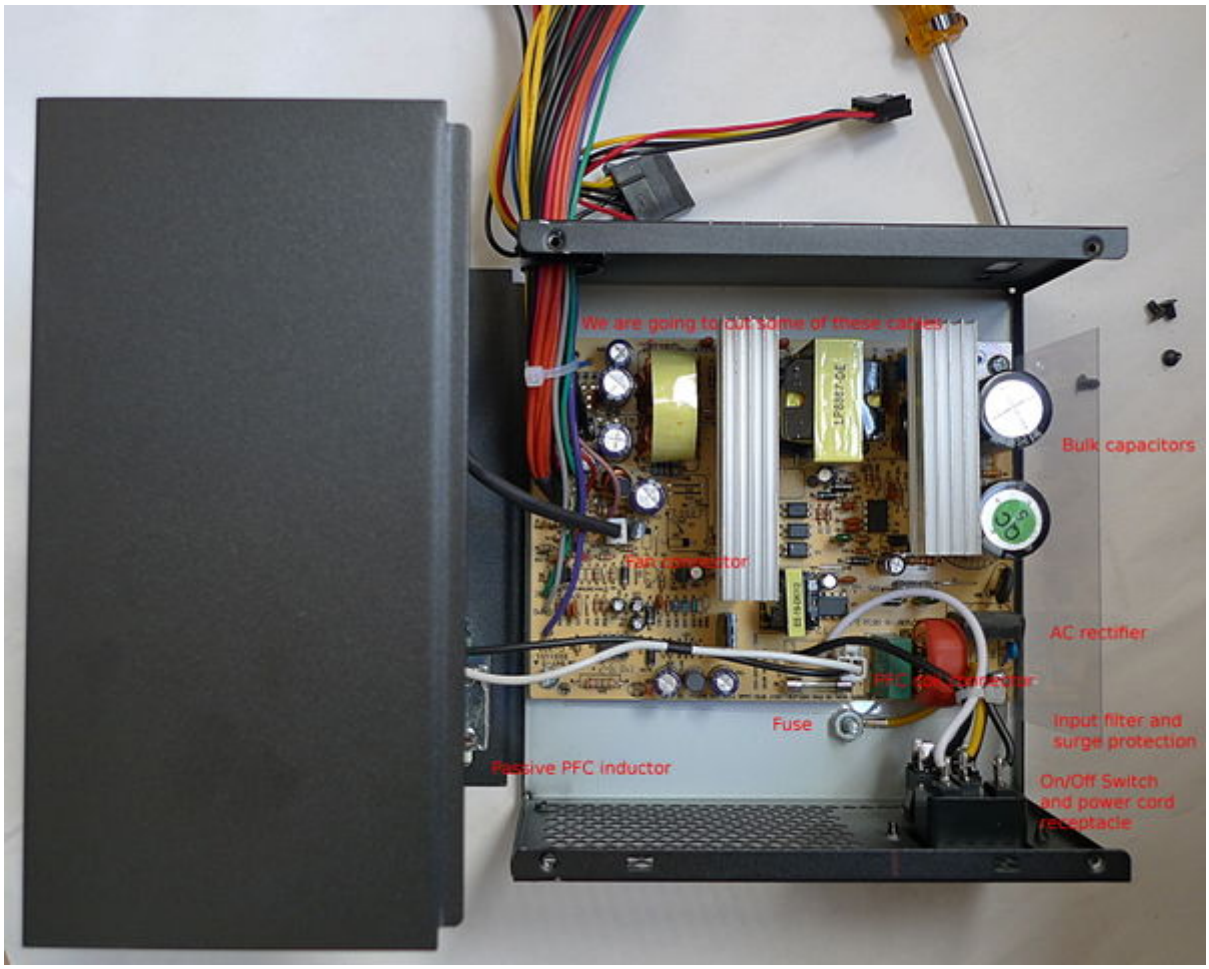


The two case halves are held together by pressure. Gently pry the case open with a flat screwdriver:

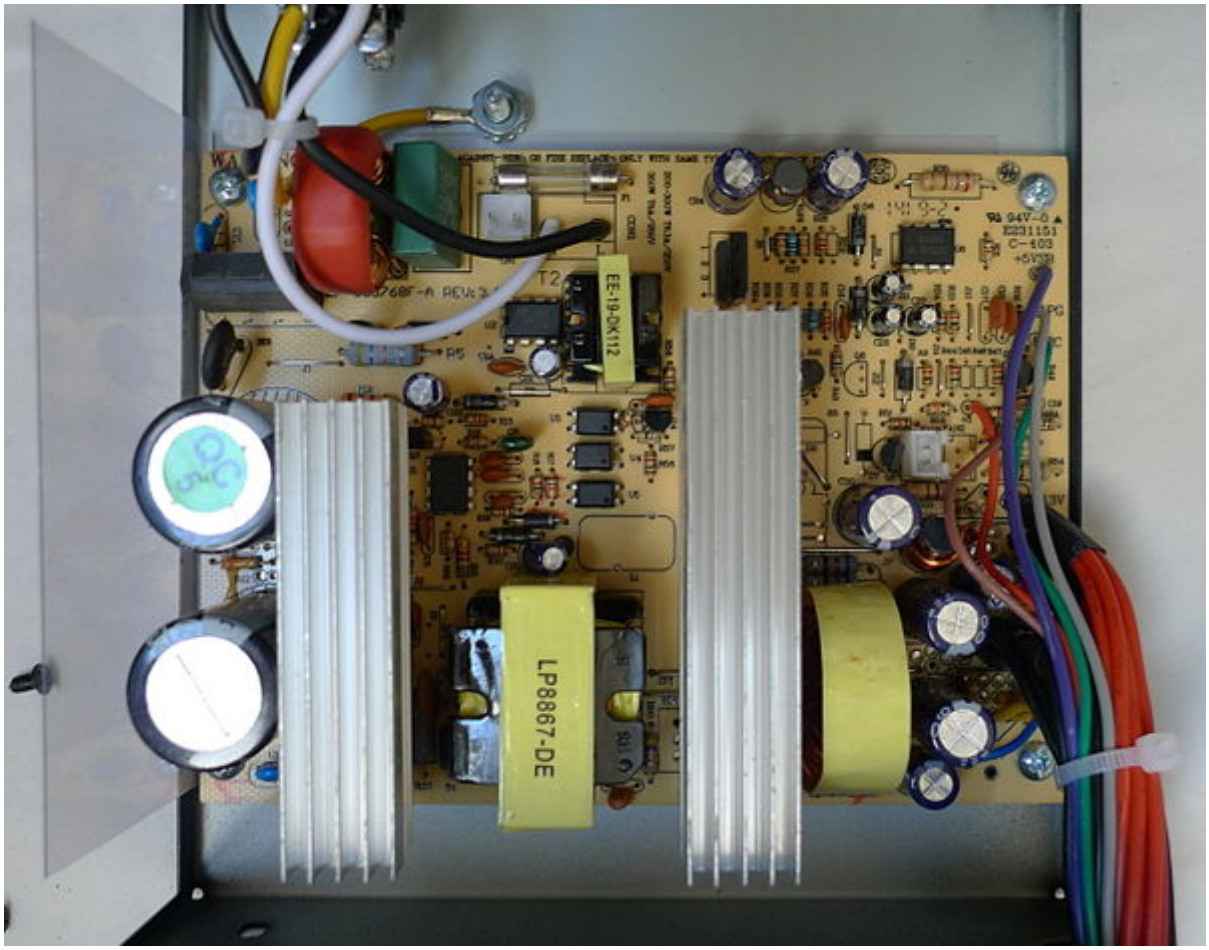
When the two case halves finally separate, be careful not to pull too strongly on the short fan cable!

Visual inspection of the PSU innards

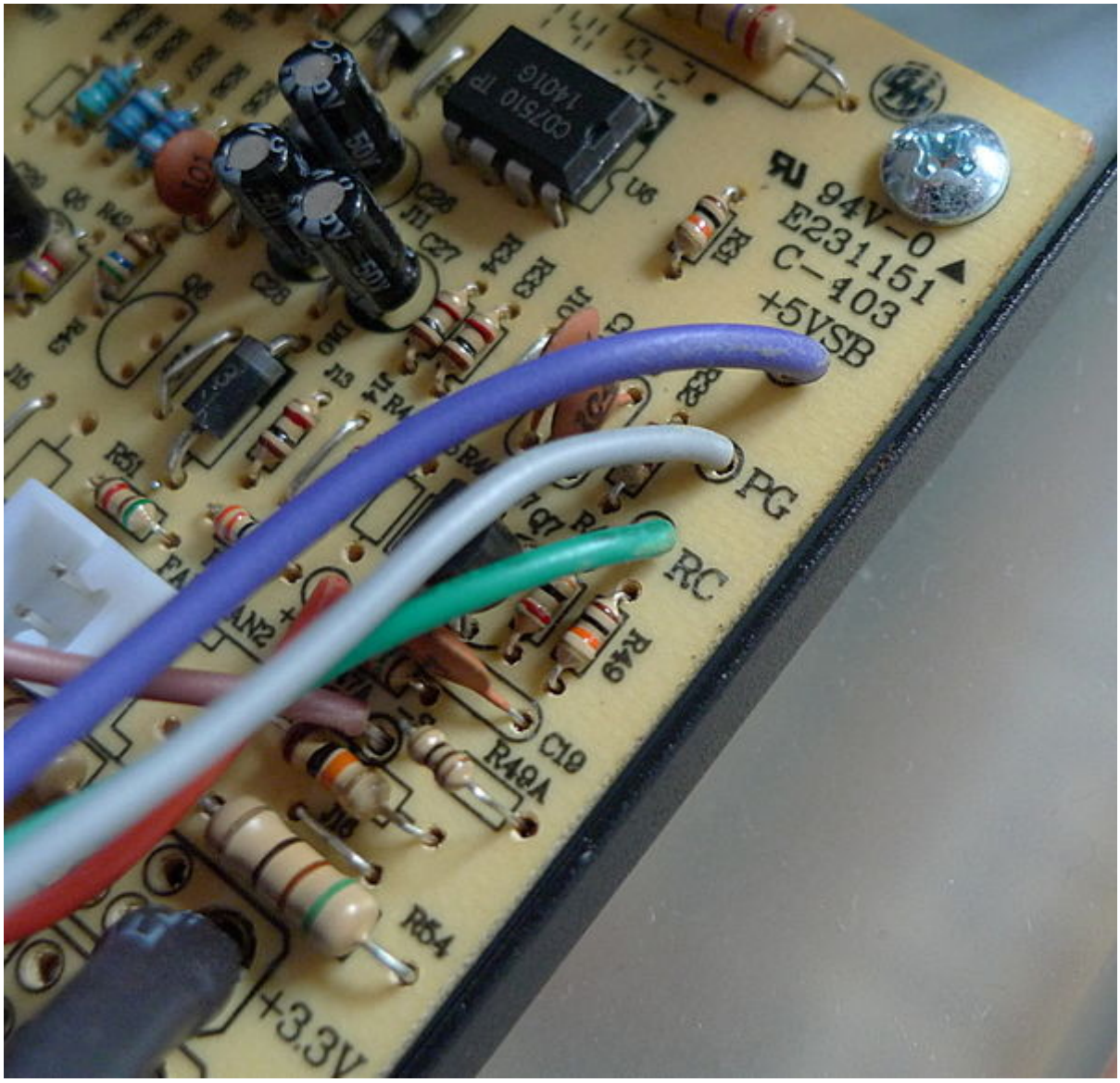
We have opened the ATX PSU and voided its warranty, so it doesn't hurt to take a look inside, right? First things first, note the exposed solder joints at the back of the power switch and power cord receptacle. This is why the PSU must absolutely be disconnected from mains power before you open it!



At this stage you should disconnect the connectors for the fan and passive PFC coil (not present if your PSU has active PFC). Use long-nose pliers for this, and be careful not to accidentally bump into other components on the PCB.



Let's take a closer look at the wires we are going to cut and those we aren't going to touch:

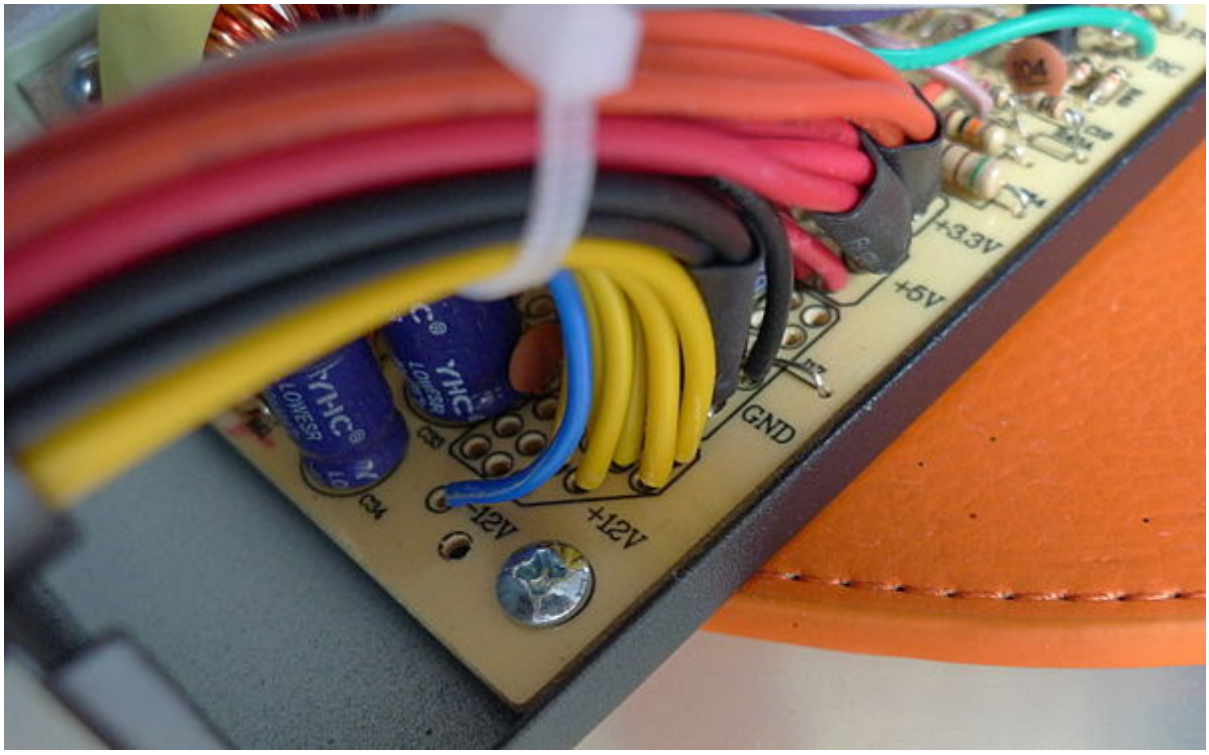


Purple: +5V_Standby, keep.

Grey: Power_Good, cut.

Green: PS_ON (wrongly labeled RC here), keep.

And here we see something unusual: there are two sense lines, one is labeled +S (orange) and the other is labeled -S (brown). On most ATX PSUs there is only one 3.3V_Sense line, and it usually is brown. **See the discussion below about the 3.3V_Sense line**, but for this particular power supply, I decided to cut the -S (brown) and keep a short (50~70mm) length for the +S (orange). Please adapt these instructions to your specific ATX PSU.



Blue: -12V, cut.

Yellow: +12V, keep all of them!

Black: GND, keep all of them.

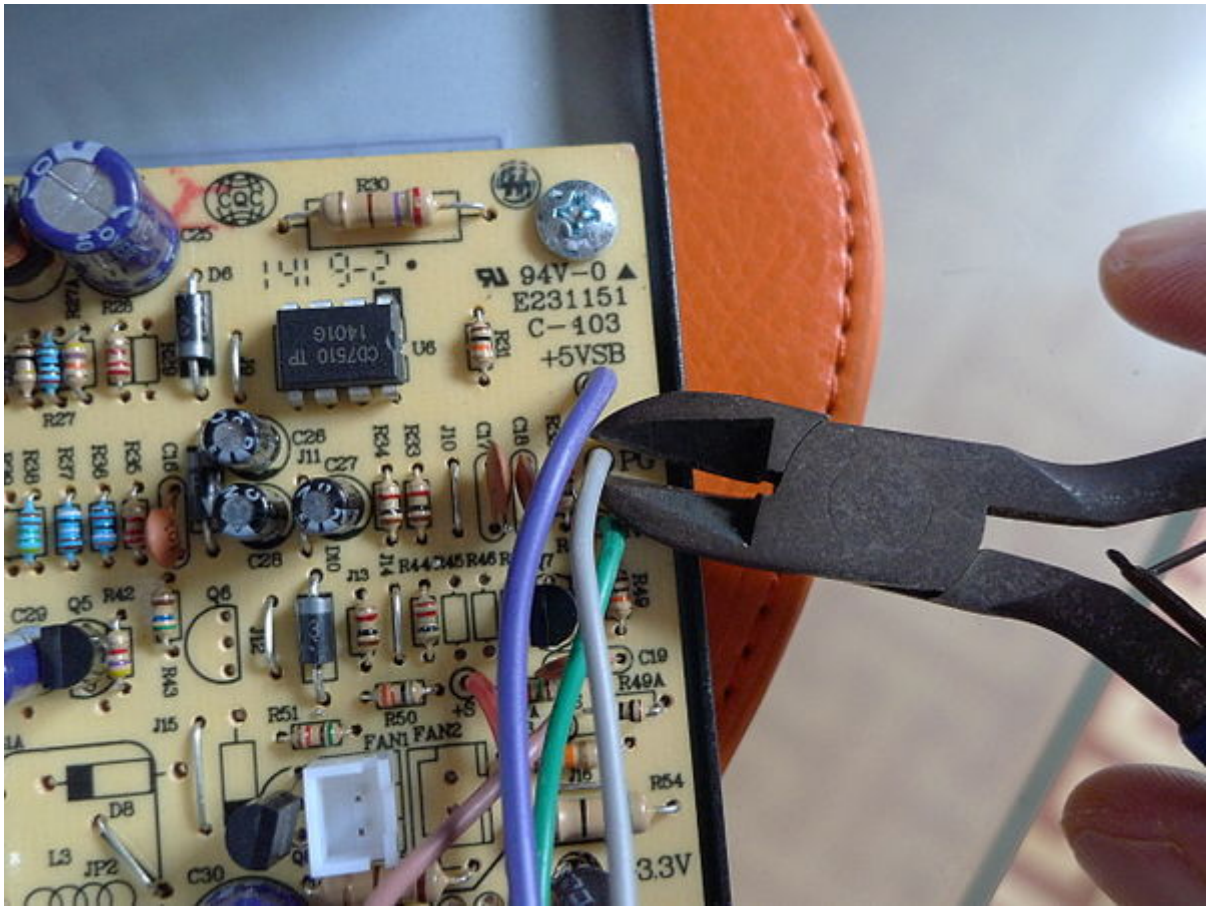
Red: +5V, cut some, keep some! Haha! How many and which ones? Well, I kept all the +5V wires that went to the Molex connectors, and then a couple more, and cut the rest.

Orange: 3.3V, cut them all but one (used to connect to the +3.3V_Sense).

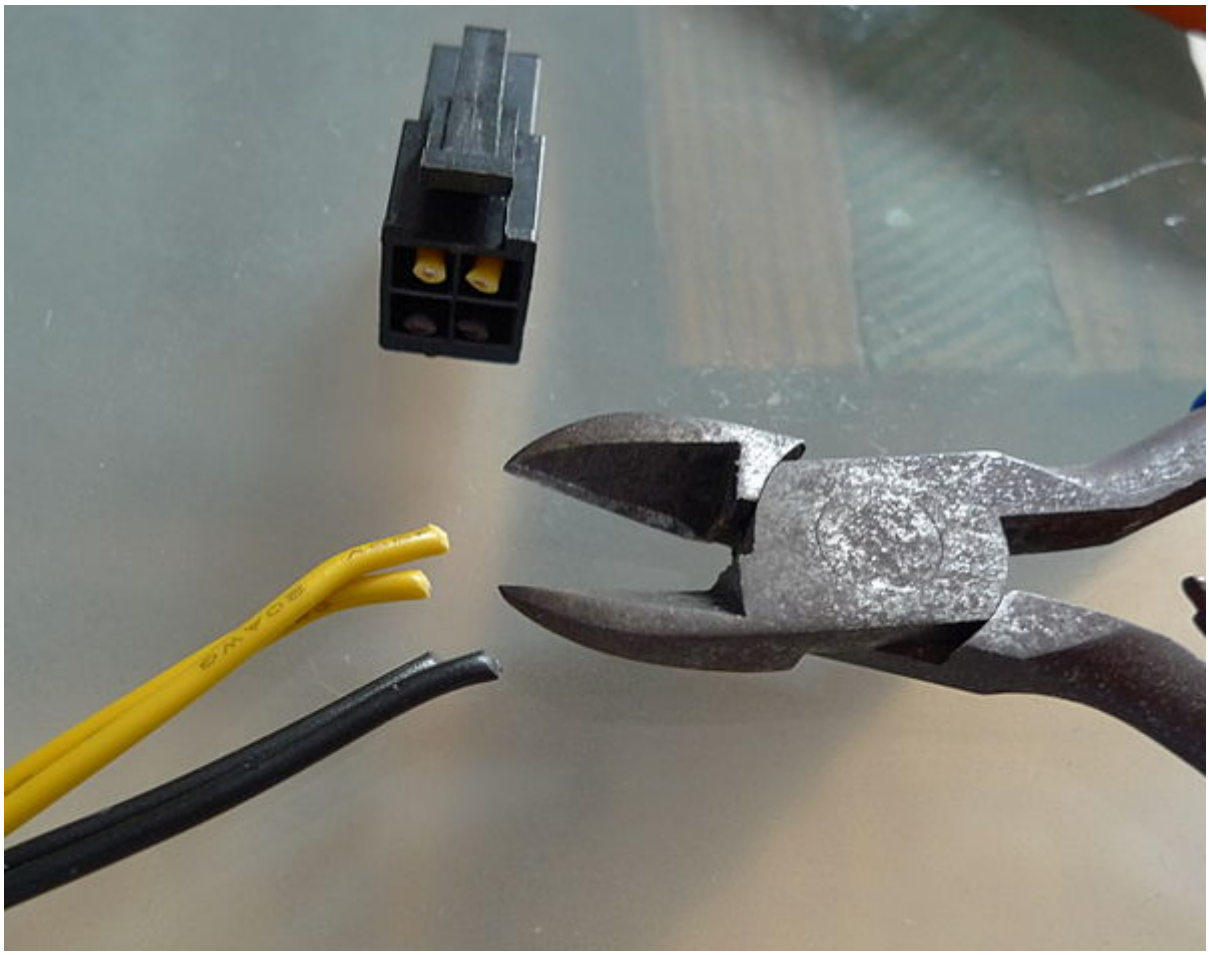
Now take a little break and come back with the cutting pliers ready for the next step!

Cutting unnecessary cables

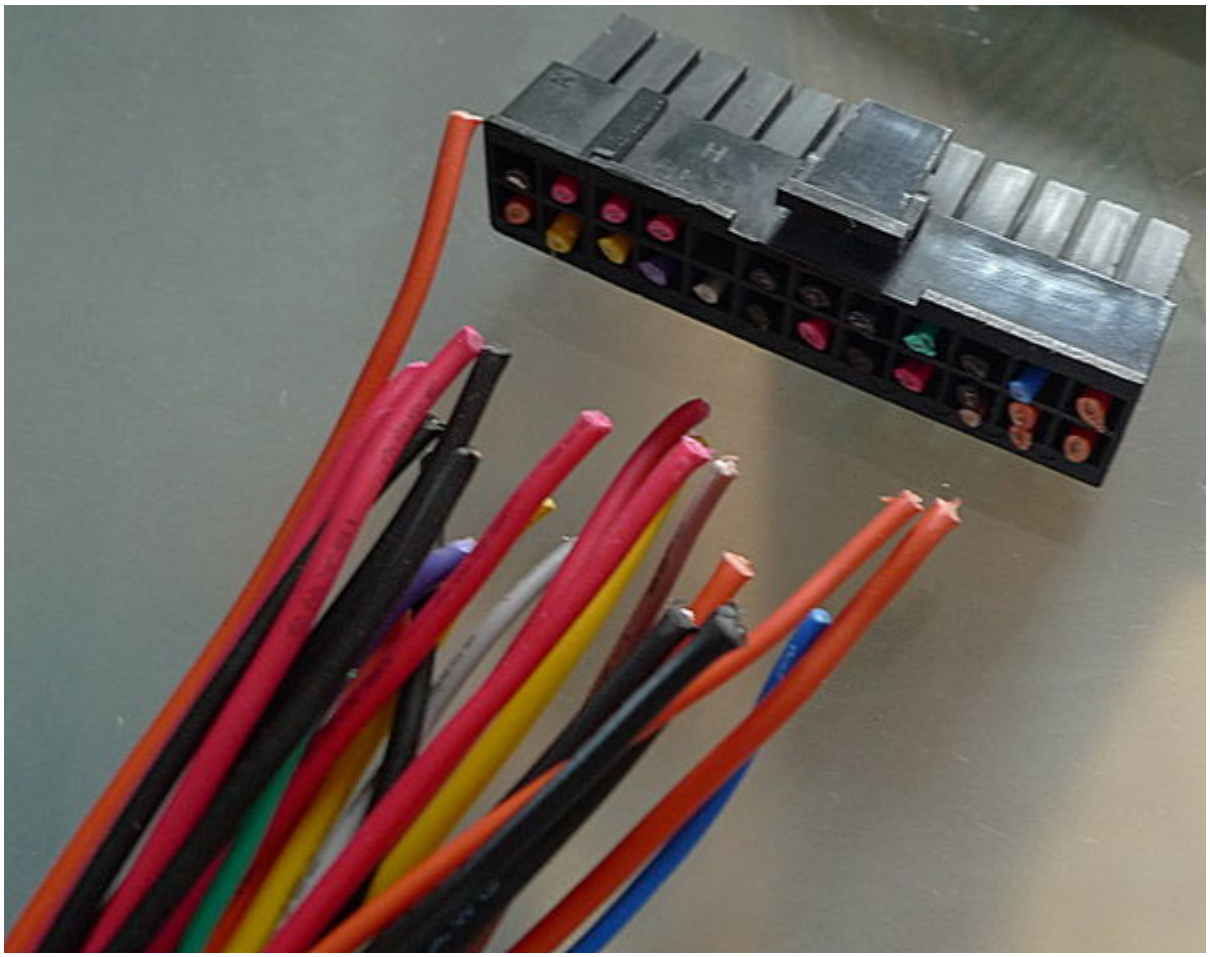
We can now cut all the cables we deemed unnecessary in the previous step. Be careful with any surrounding components and cut the cables flush at the PCB level:



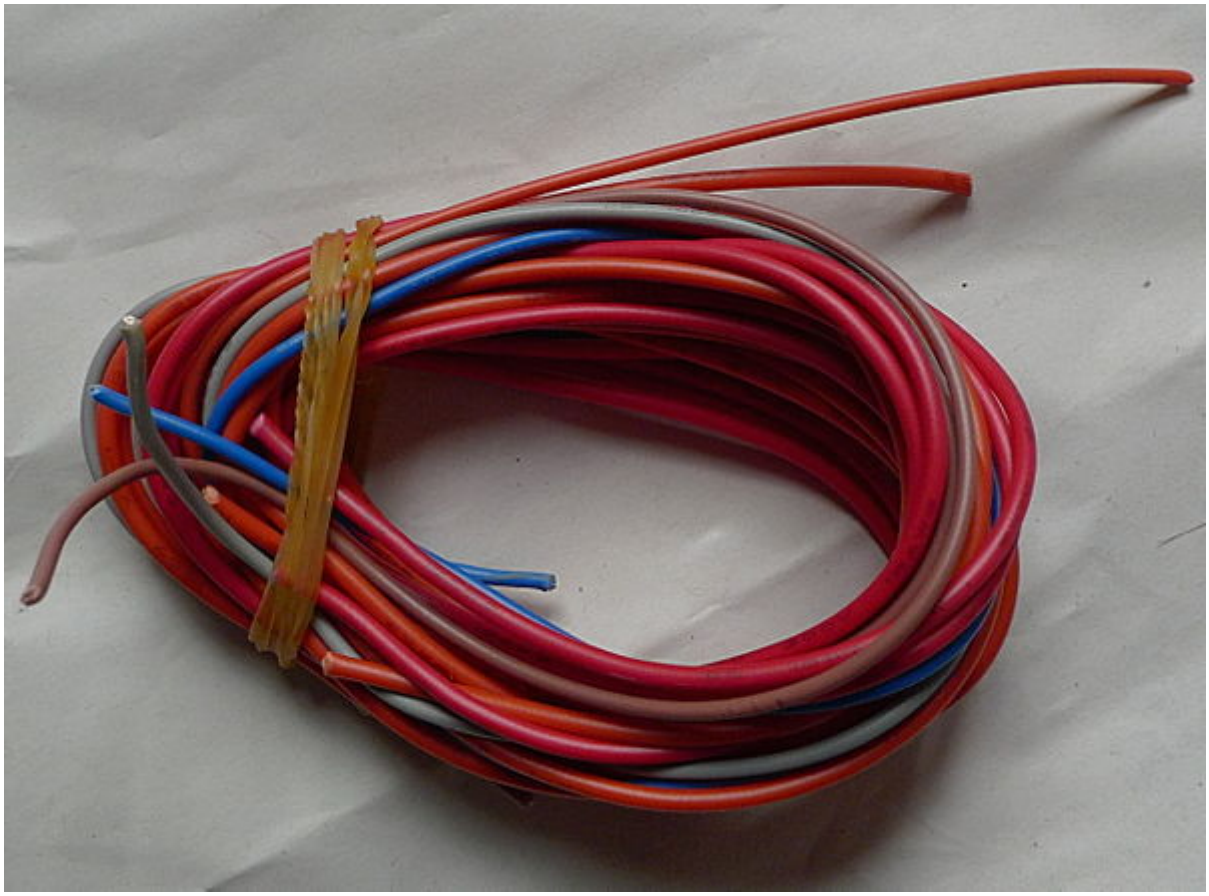
We also cut away the 12V connector to the motherboard. We are going to use these two pairs of 12V (yellow) and GND (black) 20AWG cables to make our 12V@5A rail for our RAMPS 1.4.



Cable massacre: we cut away all the cables to the main motherboard connector.



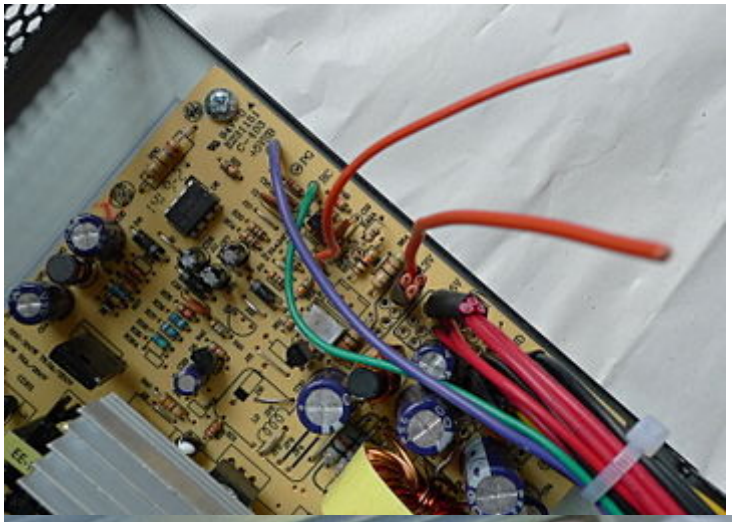
Obviously we don't throw away the cables we have just cut. Among other things they can be used to wire the heatbed for your RepRap.



(optional) Solder the 3.3V_Sense wire

ATX PSUs usually have a sense wire for the 3.3V rail; it is used to measure the voltage drop in the wires due to the high currents of the 3.3V rail, and a circuit in the PSU compensates for this voltage drop by continually adjusting the voltage of the 3.3V rail. Because modern ATX motherboards use much smaller currents from the 3.3V rail than older motherboards (from the e.g. Pentium 4 era), the 3.3V sense wire and its associated circuit are not considered very important nowadays. And for RepRap use, since we don't need 3.3V for anything, it is really irrelevant.

So in theory, we could just cut the 3.3V_Sense wire flush with the PSU PCB and forget about it. However to be 100% sure would require a circuit analysis and that would mean spending a lot more time than soldering two wires together: the 3.3V_Sense wire with one of the 3.3V wires. As you can see below after soldering the two wires together they should be insulated with a bit of electrical tape or heatshrink tubing. And now we can forget about it completely!



Last visual inspection and closing the ATX PSU

At this stage we have cut all the unnecessary wires and soldered (or not) the 3.3V_Sense wire (usually brown, here it was orange)) with one of the 3.3V wires (always orange), and insulated our solder joint.

Let's go through a short checklist so we can close the PSU once and for all and never have to deal with its internals again:

- All the components on the PCB are intact (we didn't damage anything).
- The 3.3V_Sense wire is properly soldered to a 3.3V wire and the solder joint is properly insulated, and we have tucked it away from the fan.
- None of the wires we have cut away is shorting against any component on the PCB.
- We only have the following wires coming out of the PSU: purple (+5SB), red (+5V), yellow (+12V), green (PS_ON), black (GND).
- We have reconnected the fan connector back to its original socket.
- We have reconnected the PFC coil connector (if we have a passive PFC PSU) back to its original socket.

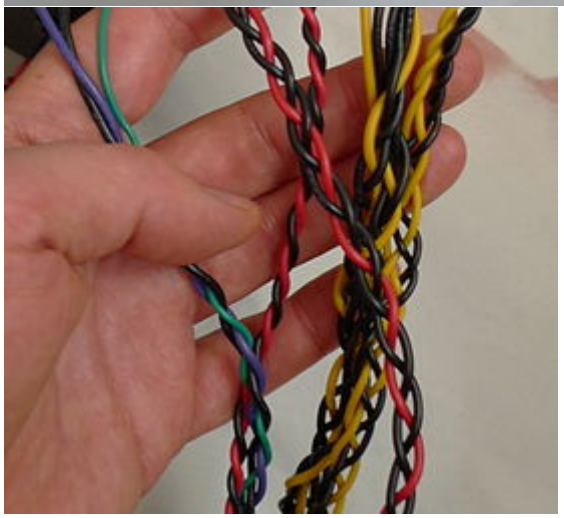
OK, we can now close the case of our ATX PSU. Remember that the pressure joints should be fit together just as they were originally:

And we screw back the four screws that hold the two case halves together:

Done!

(optional) Braid cables

Braiding cables is incredibly easy, requires just a few minutes of manual work, and avoids having tangles of loose wires running between the ATX PSU and the electronics of your RepRap. I recommend it, but of course this step is entirely optional. Here are a couple of pictures of the braided cables for this ATX PSU:

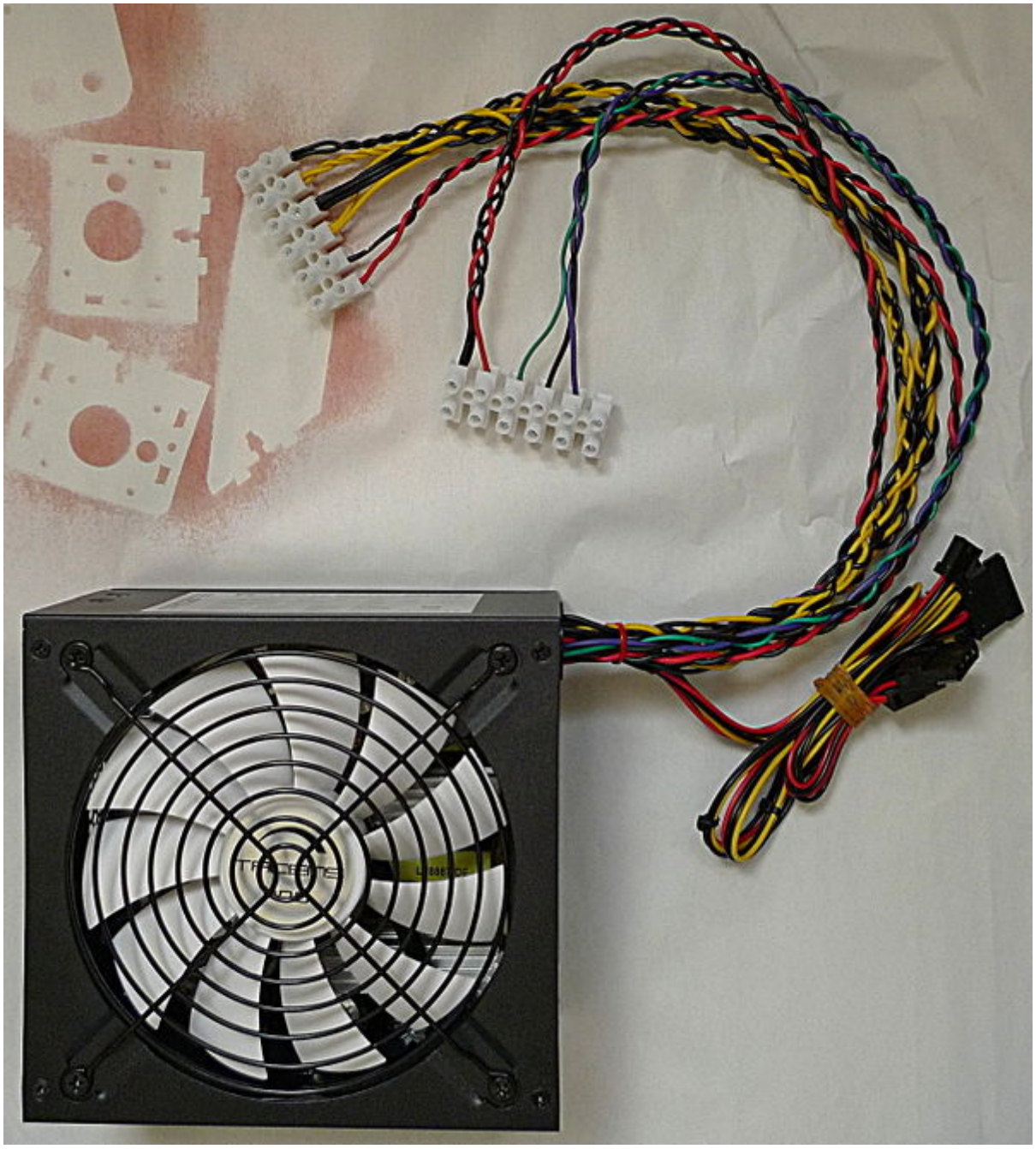


In the rightmost picture above you can see the various styles of braids I used: 2 strands (just twist two cables together), 3 strands (e.g. the purple, green and black braid), 4 strands (for the 12V @ 5A yellow-black braid) and 2 x 3 strands (for the 12V @ 11A yellow-black braid).

Add terminal block strip(s) and final test

Now we just screw all our wires in the 12-position (or 2 x 6-position) terminal block strip(s) and repeat the same test as above, this time connecting the 47 Ohm resistor between the two positions in our terminal block strip that correspond to PS_ON (green) and GND (black).

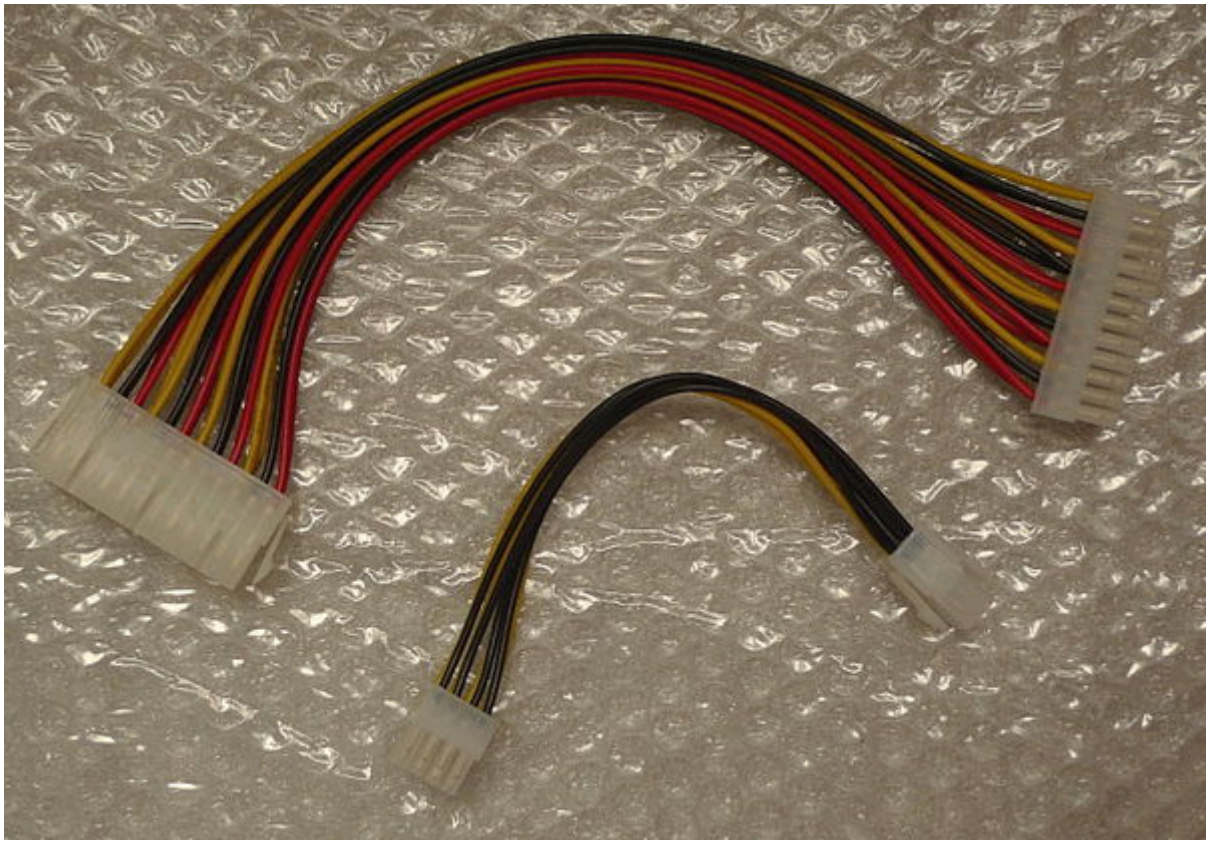
> *(note added by user FunnyBananas) Sometimes adding a dummy load on the 5v rail is required to maintain a steady power output. Around 10 watts is suitable (e.g car taillight, 4.7ohm resistor). In my case I had to put the load onto the 5v standby (purple) wire to ground, instead of the usual red wire to ground with the dummy load.*



Using an ATX PSU for your RepRap project without modifying it (and without voiding its warranty)

It is entirely possible to use any modern ATX PSU to power any RepRap without modifying the PSU in the least (in other words, without voiding its warranty). However, this requires the purchase of a pair of cables which may not be available locally (I had to order mine from China, and they took the usual 30 days to arrive), so take this into account when sourcing the parts for your 3D printer.

Basically we'll need a 24 pin female to male ATX power supply 30cm extension cable (approx. cost: $3), and either a couple of female Molex connectors or (as shown below), an ATX power supply CPU 4 pin female to 8 pin male adapter cable (approx. cost: $1.50). And of course an ATX PSU that meets our requirements and our budget!



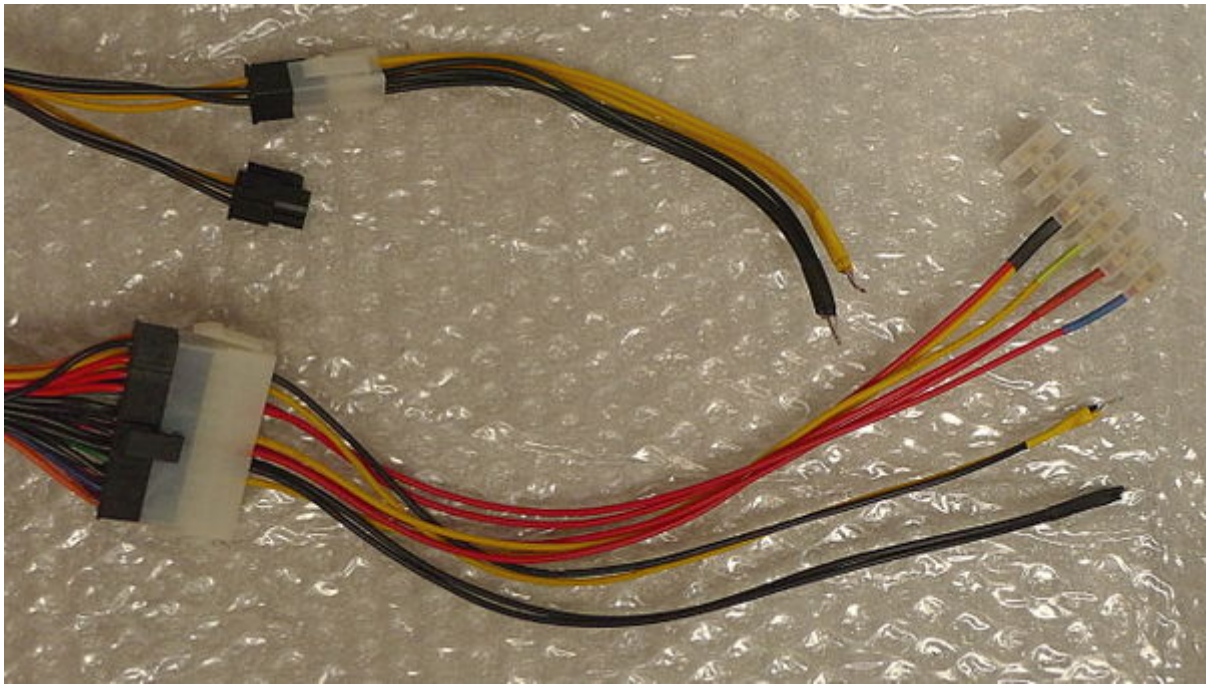
The ATX PSU is obviously quite easy to source just about anywhere in the world.

For this example we are going to use a **be quiet!** ATX PSU with active PFC, the least expensive PSU from their value line: the 300W System Power 7. There is no unboxing because **be quiet!** doesn't even ship these PSUs in a box, this one just came with some bubble wrap:

Do not mistake this for a low-quality ATX PSU, you really get what you pay for with a be quiet! PSU. Let's check its power ratings:

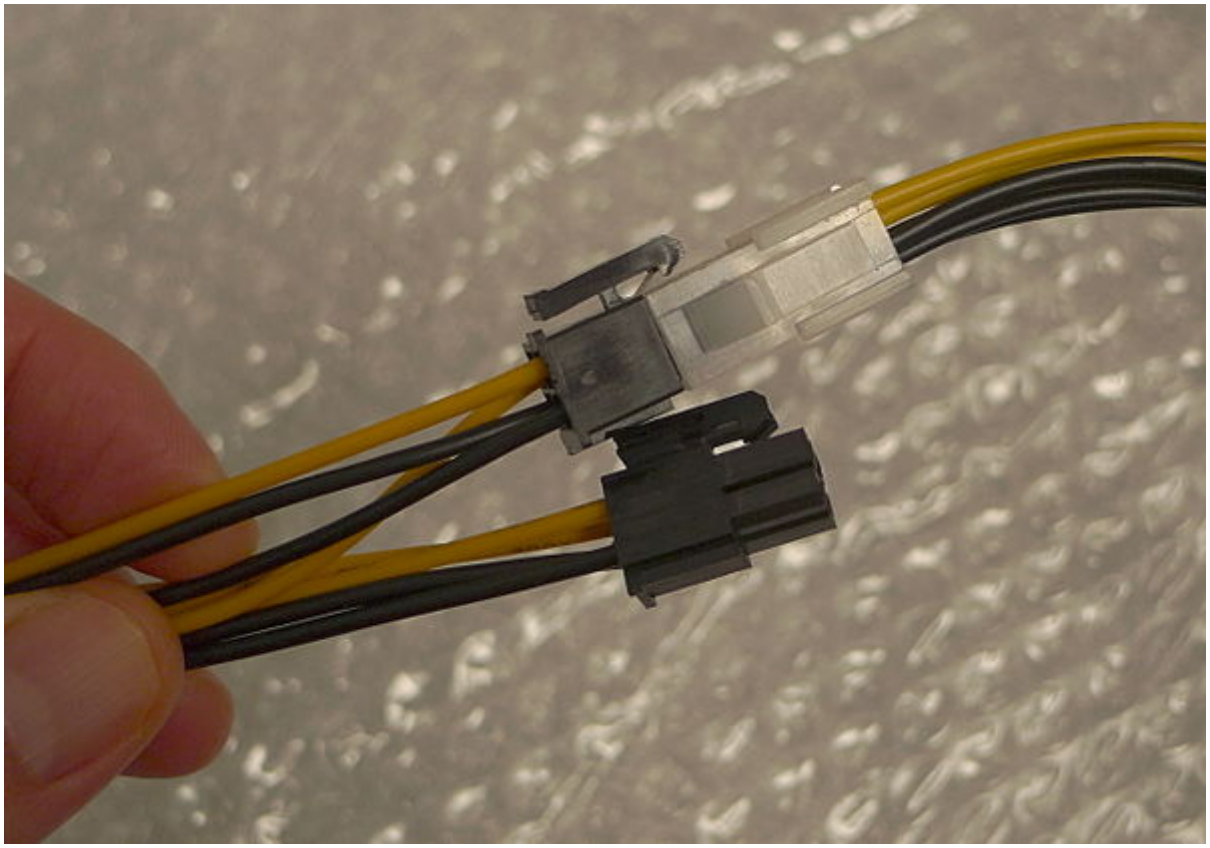
As we can see, it has two 12V rails, and the combined power we can draw from them is 288W. OK, we only need 240W and that already includes a safety margin, so we are good to use it for our RAMPS 1.4 electronics of our RepRap!

And here are our cables ready to be used with our RepRap printer:



Wow, that was fast! The truth is, it only took me about 30 minutes to get the cables ready, and I wasn't working particularly fast.

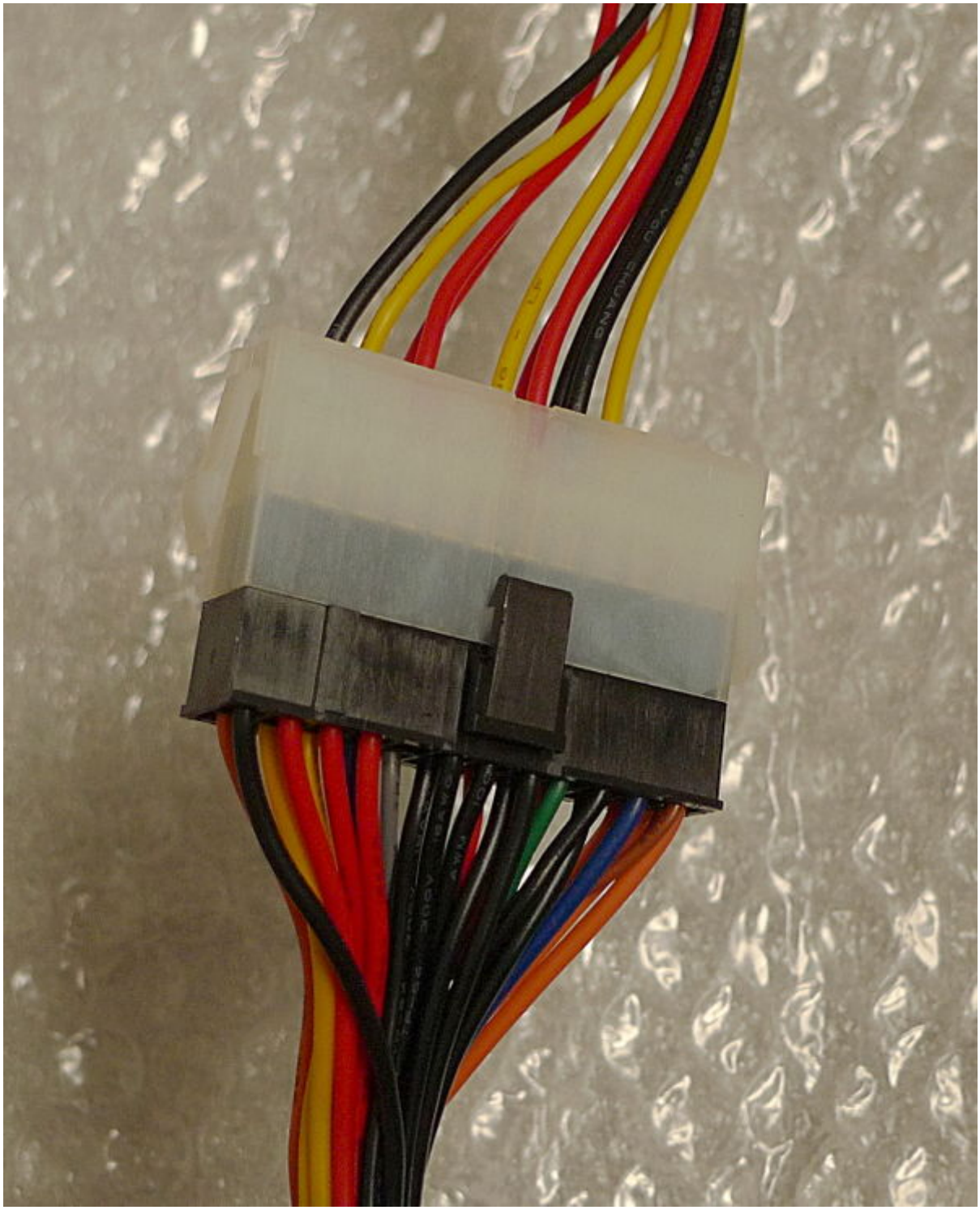
Let's take a look at the cables separately:



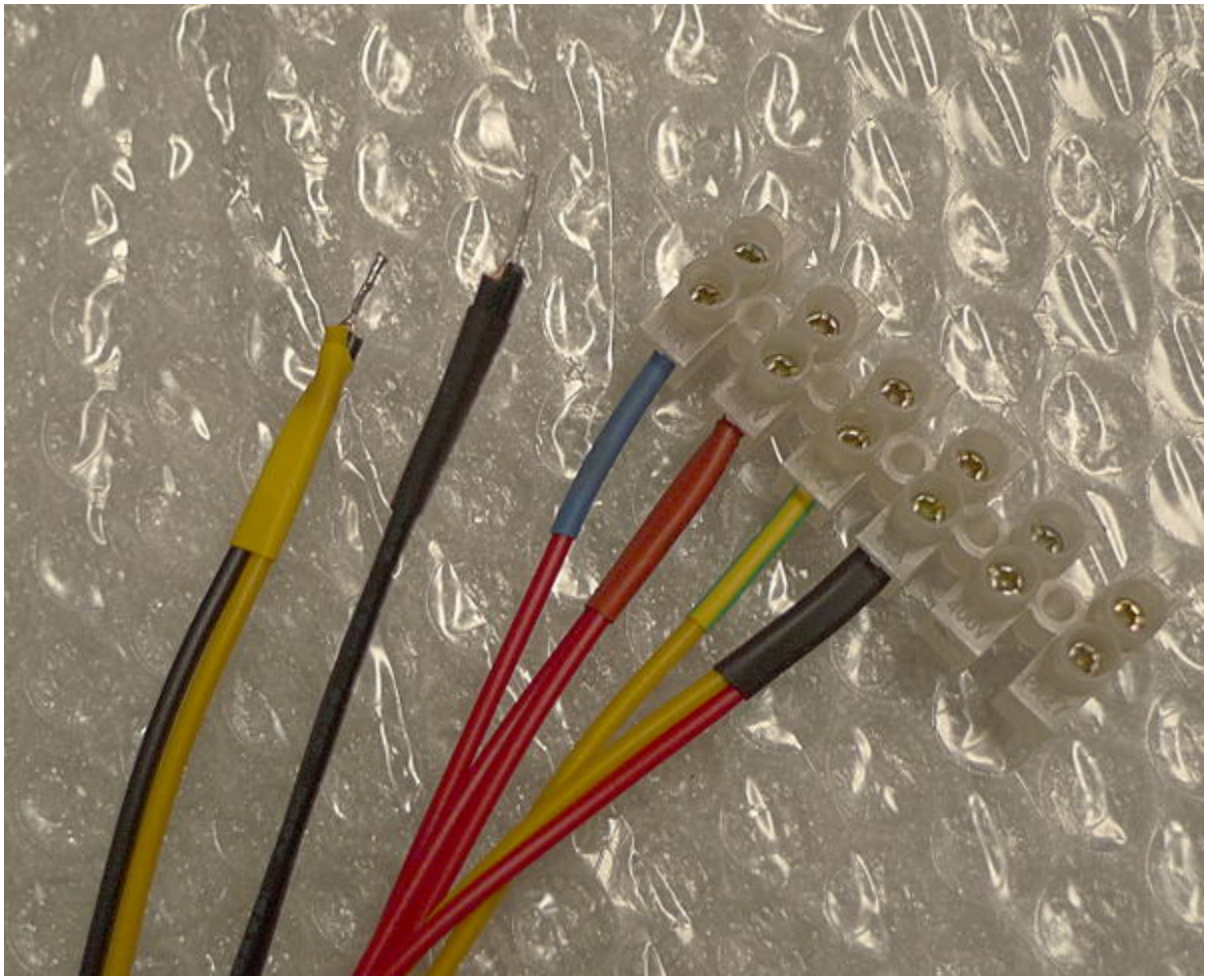
For the ATX power supply CPU 4 pin female to 8 pin male adapter cable, we only use the female connector. I just yanked the cables out of the male connector, bunched respectively the +12V and GND lines together, and soldered the ends. These are the +12V and GND cables that we are going to connect to our RAMPS board to power the heatbed.

OK, now let's take a look at the 24 pin female to male ATX power supply 30cm extension cable, because it's a little bit more complicated.

First, I yanked out all the cables from the male connector, which we are not going use. Now, obviously for the female connector we have to be selective about what cables we are going to use and which ones we can yank out. Since the lines in this extension cable are not color coded (damn!), we have to be extra-careful here. Simplest way is to plug the female connector into our ATX PSU's male connector:



And the other end of the extension cable now looks like this:



From left to right:

- + 12V to our RAMPS steppers/electronics.
- GND to our RAMPS steppers/electronics.

The terminal strip has, from left to right:

- +5V Standby (+5SB) for future use.
- +5V to power servos, USB LED lights or any other accessory.
- PS_ON so that we can remotely control our ATX PSU from the RAMPS.
- GND.

Since the wires are not color coded I used some colored shrink tube to help identify the cables.