Building A Specialized Power Supply

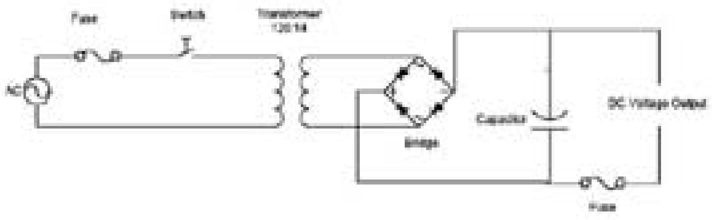
Hi ya'll, time to wander around again at the Monster-Hardware Secret Labs down in Silicon Holler - this time, we are going to make a hybrid power supply capable of pumping lots of juice. A buddy asked me to recently build him a power supply for his grandiose overclocking plans that include a peltier; he also does some occasional testing and mods on computer parts (that's putting it mildly!). herefore, the design criteria was such that the power supply needed to provide lots of amps at the common PC voltages, plus something a little higher for the big peltier he planned to use.

So… after thinking for a bit, I raided my scrap parts bin and did a little digging on the internet. Fortunately, in my "real job", I work at a power plant and have access to some people with a lot of knowledge and advice. I decided to make a hybrid box – using some existing components as well as designing a separate power supply within the main box. My plan was this – utilize an old AT power supply that was more than capable on the lower voltages, and build a separate section to handle the higher voltage needed by the peltier.

Before we begin, let's talk a little about safety and preparation. First, don't attempt a mod like this if you are not familiar with electrical principles and good safety habits. Touching the wrong component at the wrong spot at the wrong time can cause you to have the kind of day you would simply rather not have! Secondly, don't start unless you have the right tools and components to work with. Some substitutions are permissible, but some stuff just doesn't need to be skimped upon. Thirdly, you can build either half of this project since it is a hybrid, or the whole project. If you don't need everything here, you can easily cut it down somewhat. Lastly, Monster-Hardware built this project for US. If you build this project or something similar, you're building it for YOU – and you take responsibility for your own risk and rewards. This project will NOT get too deep into theory, but will simply show you the process I undertook. You can find plenty of theory and background on the web with even the simplest of Google searches.

To begin with, let's assemble some basic tools. You will need a soldering iron, screwdriver, drill and bits, voltage/resistance meter, wire crimpers and cut off tool, etc. You will also need some "consumables" such as terminals, heat shrink, electrical tape, miscellaneous screws, wire, and so forth. You'll need to read the entire article to get a complete idea of what you'll need depending on the portions of this power supply that you intend to include.

To start on the power supply, I sat down with a pencil and paper and thought out the process. Modifying the existing power supply would be relatively easy, and would involve more physical work than design. However, the peltier power supply section would have to be designed from the ground up. However, our task is simplified in that a pelt is a solid state device, and does not need a sophisticated and perfectly clean voltage waveform in order to operate. Therefore, I decided upon a classic DC power supply that was based on an AC transformer with a rectifier bridge and capacitor for smoothing. Here's the simple schematic; yes, you can design a power supply much more complex than this one but it is perfectly adequate to meet the design goals for this project.



The primary difficulty in building this portion of the power supply is getting the appropriate parts – the reason being, a peltier junction device needs only moderate voltage but high amperage. I knew that the peltier that this power supply was designed to feed would need to draw somewhere in the 20 amp range to be the most effective. Therefore, we would have to design the heart of the supply to handle this much with a little "fudge factor". I was able to order a 120:14 AC transformer from All Electronics for about $20.

They also had the bridge rectifier; I got a 35 amp model for about $4. I already had the capacitor on hand, but if you need one – try www.apexjr.com, who has then for only a few bucks. They have large caps and mounting rings at very reasonable prices, and I couldn't find anything appropriate at All Electronics. Lastly, I picked up an inline fuse holder at my local auto store for a couple of dollars. Make sure that you get one that will handle the amperage! Final last minute items from Radio Shack included a small switch, fuse block, fuse assortment, and AC fuse holder.

Next, I stripped off some wire sections and crimped on some terminals. I hooked everything up in a "test" configuration to make sure that all the components were good and that I had my connections down properly. Everything worked properly at the capacitor terminals, where the final voltage would be taken off.

After the initial testing run, it was time to prepare the box that I was going to put the hybrid power supply in. Once again, I raided my parts bin, where I had an old metal box that I had salvaged from a junkyard. I believe that it originally held some laboratory testing equipment – it measured about 10” to a side and about 8” tall. The top was hinged and locked down with a couple of hasps – perfect for this application. This meant that it could be easily opened to replace fuses if need be and yet be durable and strong. The side handles were a huge plus since I knew that this bad mama was going to be a little on the hefty side! Of course, the box was originally painted with that omnipresent hammered green metallic finish that’s common to industrial equipment, so I stripped everything down and lightly sanded everything. Painting would come later.

Next, I got out the AT power supply that I had salvaged from an old computer. You may already have one of these laying around; if not, you can certainly pick up a new one for less than $10-15. In fact, I’d bet that your local computer shop will have lots of these laying around, a good heavy duty serviceable used one will work just fine. The one I had was made for Intergraph and put out 40 amps at 5V, and 30 amps at 3.3V. Additionally, the 12V output at 5 amps would be useful to have available. At a total of 300 watts, this power supply is built a lot beefier than most other AT power supplies and based on the quality of the internals, is probably better than modern generic ATX power supplies as well.

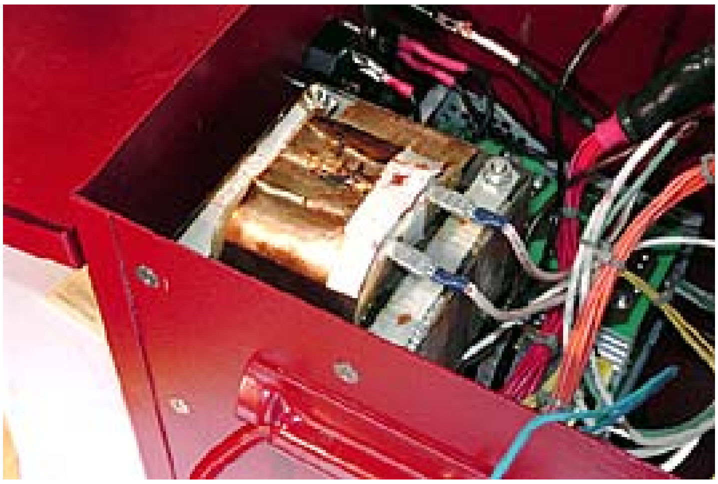
Once I had the cover off, I plugged it up and cut on the remote switch to power up the supply. I then tested the output leads and wrote down the voltage levels of each color. Once I had everything unplugged, I bundled the wire colors together into groups and soldered all the stripped leads together. Basically, I spliced onto the multiple output leads with a single heavy duty wire, 10 gauge for the larger amperages (3.3 and 5 volts) and 12 gauge for the smaller output (12 volts). The 10 GA wire is capable of handling about 55 amps and the 12 GA about 40 amps, so this might have been a bit of overkill but I had a large length of both already on hand, so that's what I used. I covered the entire joint with heat shrink for safety. The ground wire is common to all the "+ - plus" voltages, the negative voltages were not used in this project.

Next, I removed the power input plug. I did this carefully, because I planned to use it elsewhere in the box. I pulled out the internal AC feed wires and spliced in a longer length of heavy duty wire to give me some room to work with.

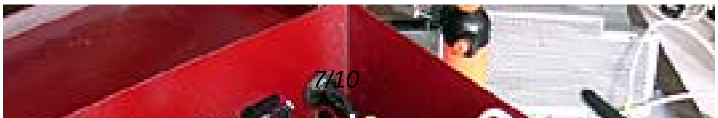
Once I got my wiring where I wanted it to be, I was able to test fit the old Intergraph power supply into my cube box, which I had primed by this time. This power supply has a huge benefit (for this project, anyway!) in that it has dual fans that are built in. This allowed me to cut a fitted oval into the back side of my cube box. I used a drill to make a pilot hole and then used a jigsaw with a metal blade to cut out all the large openings you will see. A jigsaw isn't technically required for this project, but it will make your life a lot easier. If you have patience and a tighter budget, you can use a rotary tool or even a coping saw. My refurbished jigsaw came from a Black and Decker factory outlet and cost about $12 even with a few blades thrown in. After the major holes were cut, I gave the cube box a top coat of metallic crimson.

It was time to fit the old AT power supply into the cube. Of course, I had to do a little bit of final trimming with my rotary tool to make everything fit perfectly. I also cut out a hole for the power plug inlet that I reused, and mounted it. I also cut out additional holes for the following: front blowhole (non-fan inlet), switch, fuse for the AC power, and the wires to the terminal strip. I hot-melt glued the AT power supply remote switch to the inside of its case; once it is on, the state of this supply will never change since it will be powered on and off by the main incoming AC switch.

Once the AT power supply was in, it was time to mount the remaining components for the peltier power supply. The largest thing left was the transformer; with the AT power supply taking up about half the interior room in the cube, I had to mount the transformer on the side wall. The hole pattern was laid out and holes drilled; I used countersunk 10-32 threaded machine screws and nuts to hold the transformer in place. The holes aren't in a square pattern, so I had to make sure that the correct output taps were oriented properly to access them later for final wiring. At this time, I wired in the power side of the transformer, and made the connections at the back for the power plug inlet, and inline power fuse and switch. Yeah, I can hear all you electrical engineers out there saying that I overdid it on the fuses, but since this is going in a home and most likely under someone's desk and forgotten about, I figure double redundancy is a good thing.



It was time to mount the external terminal block. While a bit unorthodox, I decided to use this as an output block since it would give me a lot of flexibility in wiring back to the external components such as the peltier. Additionally, I come from an industrial background and am familiar with using these. If you have a house pet or small child in your house, you might want to mount this internally to the cube. The terminal strip was held in place by a four small sheet metal screws through the predrilled holes. After the terminal strip was in place, I made up wire sections with terminals and wired in the fuse block and the power output leads to the AT power supply. BTW, that's not blood on the transformer but some extra winding insulation lacquer that ended up on the shield from the factory. It would not clean off no matter how hard I tried.



Once those were in place, it was time to mount the capacitor. This one was rated at 40VDC and 68,000 microfarads. This is one area in which you can be a little flexible. The capacitor smoothes out the waveform from the bridge; a larger capacitor will store more energy and will make the waveform flatter. However, the peltier device doesn't require ultra precision to operate, so the capacitor can be smaller if that's what you can find. I already had one on hand that was salvaged from a piece of stereo equipment, but once again, a capacitor of this size should cost less than $5. Don't bother with a small inline capacitor or "disc" type, get a large one that will handle the power. I mounted the bridge on the side of the cube, and I used an old heat sink base to give a little extra margin of heat dispersion. If you look carefully, you can see where I used some surplus Arctic Silver 3 on the heat sink. I also inserted the proper fuses at all fuse slots: 3 x 25A, 1 x 5A, and 1 x 3A for the input power. Don't forget to wire in the ground!

After everything was in place, I made the final wiring hookups and labeled the terminal strip. Here are two close up views of the back and front. The final voltage output on the transformer side of the cube power supply came out to about 18 volts. While this is a bit larger than the 14 VAC that was originally measured a the transformer, this is due to the effect of the large capacitor and the way a cheap multi-meter measures AC and DC voltage. The DC measurement is more accurate for meters of this type. Additionally, I mounted the final fan grille on the front at the blow hole.

Finally, the cube power supply was complete. It weighed out to about 20 lbs, so it was indeed very heavy and sturdy. In the preliminary tests, the output never budged even under load and neither part of the power supply never heated up appreciably. Let's just say that this power cube has a lot of "headroom" on its outputs! After some felt feet on the bottom, a brushing off of the dust, and closing the lid – we're done!

Conclusions:

Technically, this is actually an easy project. The working in of the AT power supply was mainly fit and finish, while the design of the peltier portion was modest at best. AS previously mentioned, you can easily modify this project by building only the half you need. The output voltage is can also be modified by using a different transformer, but make sure your components are all rated at the proper voltages. It will be difficult to find a transformer capable of 20-25 amps at voltage higher than the one used here. Rather, they can be found but at much more than $20.

My total out of pocket expense came to about $55 including all the shipping. Granted, I had some supplies already on hand and also utilized some used parts. However, you can clearly build your own peltier power supply much more cheaply than you can buy one. I do see room for improvement at the cost of a little bit of complexity – in retrospect, it would have been nice to had a power "on" LED on the front of the cube, also possibly a voltmeter for the peltier supply portion. Maybe next time!

Feel free to drop me a line if you have any questions or feedback – we always love to hear back from readers.