Bench Top Powersupply -- Part 3

"Almost done! In this part three we install the final parts, make the last connections, and do the final adjustments with the trimmer pots. Take your time (go-slow) with the trimmer pots for adjusting current! "

Where applicable, click on the picture for enlargements. Above you see the photo of my finished model. Looks good, performance is excellent, and I am very happy with it. Notice however that the panel meters are shown non-modified, meaning that I added and modified the stripes for the two settings after the picture was taken. I don't own a digital camera so am dependent on others to help me out.

Fig. 10

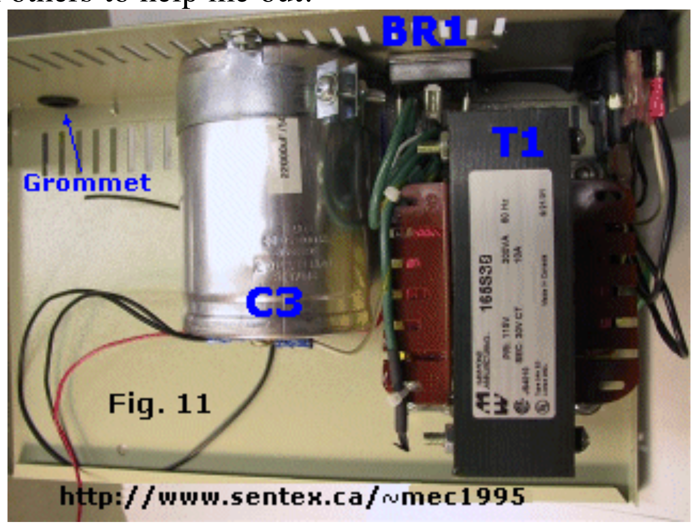


Fig. 11

I purchased a brand new transformer, model 165S30 manufactured by Hammond. It is of the regular kind. You can get a 'low-profile', horizontal type which mounts a bit lower. Whatever model you have or buy make sure it fits your case including the large capacitor. The 30V type is only required if you need the full 10A, otherwise a 22V-28V type will do fine. A CT (Center Tap) is NOT used.

The 165S30 transformer has 5 wires, the primary side has two black wires which are connected to your 115 vac. The secondary has 3 wires, in my case two green and one green/yellow. The green/yellow is not used. Isolated it with some heat shrink and tie it up, see Fig. 10. I never cut the wire off. The two green wires go to your Bridge Rectifier. It is probably marked 'AC' or '~'. Make sure the transformer makes good ground with the chassis, which in my case meant removing the paint. I then use a file to take the varnish off one bottom corner of the transformer. When you finish mounting the transformer into the case, take a multimeter or continuity tester and make sure the chassis of the transformer makes good connection with the chassis of the power supply.

The fuse is a 3.15A slow-blow type to prevent it blows when you switch on the power supply with a bit of load. This transformer is a real heavy one and weighs several pounds. If you're planning to use it with heavy loads, I would suggest to get one which can provide 12-15Amps at a desired voltage, but, the 10-amp transformer listed in the parts list will work. The difference is that the 10 amp transformer gets pretty hot if you use it at the maximum current. If you would have a 12-15 amp type it will only get a little warm. In my case, I do use the 10amp setting often but not for extended periods. Several minutes at best. Usually around 7 amps or so for charging purposes.

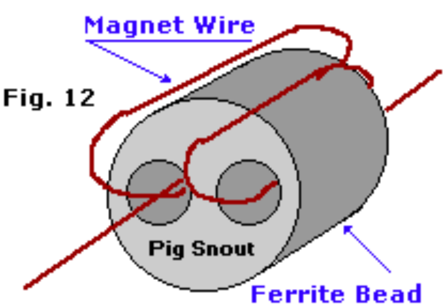
It is probably best to mount the Bridge Rectifier, fuse holder, and power cord first before bolting down the transformer. As you can see in Fig. 11, I used a mounting bracket for the large capacitor, this bracket is also mounted on the back panel so don't forget to drill the holes first. I used a 115vac receptacle, fuse, and on/off switch combination which I salvaged from an old UPS and the whole thing is mounted on the back panel. Crimp spades onto the two secondary green wires and mount the transformer. Connect those wires to the Bridge Rectifier as mentioned earlier. Install the large capacitor and wire up to the '+' and '-' of the Bridge Rectifier. From this point on all other '+' and '-' connections are taken from the large capacitor terminals. Use thick wire.
As mentioned earlier, instead of a Bridge Rectifier you could use four separate 'stud-mount' diodes and make your own bridge. The two anti-rattle capacitors, C1 and C2, should be mounted directly onto the transformer or the bridge rectifier for best performance. Power diode D3 is a very vital component in this power supply and so was chosen a bit over-rated to make sure it will perform satisfactory under all circumstances and temperature changes. You probably already know that a diode is temperature sensitive which is most noticeable in the 0.7Volt range. Since the same D3 also has a job of current limiting it is best to make sure this diode does not get too hot. So, we really want a solid diode of 20 amps minimum.

In case of a short circuit, there is at least 2.5 amps of current going through each power transistor, and that is a lot at about 60 to 70 watts of dissipating energy. That is why the 2N3772 power transistors come in which can dissipate 350 watts or so. And so, as a matter of speaking, at 30 volts we could well assured short out the output jacks and fry an egg on the output power transistors.

Now lets have a look at L1 & L2. L1, C9, L2, and C10 are soldered as close as possible to the output jacks. We even have to cut the solder leads as short as possible. C10 is soldered directly on to the '+' and '-' output jacks. C9 is soldered parallel over the L1/C10/L2 network. The two thick wires coming from the printed circuit board are soldered onto each leg of C9. Oh yeah, I mention again that the PCB has to be mounted **isolated** from the case. The common ground connection is connected to the '-' jack via L2. This is a little bit of tinkering but can be done easily. We are working here with 10 amps so worth all the efforts. The new PCB will have screw connections to make the connections easy.

I call the ferrite beads "pig snouts" because that's what it looks like to me, but hey, call it whatever you want. You need to make two of them. On the circuit diagram they are indicated as L1 and L2. One or two turns of thick magnet wire will do the trick. L1 and L2 will keep the output jacks clear of high-frequency interference. Can you omit them? Certainly if you don't care about that feature.

Fig. 12



By now you must be anxious to try everything out. Well, be patient, we're almost done. We still have to adjust the eight trim potentiometers on the pcb. And you really **need to sit down for it** and carefully take your time. Look for a time and place when you can do this quietly and undisturbed. The last thing you want is to open this heavy power supply up again and re-adjust it because of initial sloppy adjustments. So, take your time, go slow, and verify each adjustment until you're satisfied. The adjustments are done in a special sequence and if you keep yourself to this procedure then I doubt you would encounter any problems. Okay then, here goes it.

Adjustment procedures:

FIRST check for correct wiring from and to pcb, jacks, meters, and coolrib. Very important.
Before starting the adjustments, familiarize yourself with the trim pots on the printed circuit board and the

potentiometers on the front panel. The two on the front panel are R3 and R12, the others are on the pcb. I mention this to avoid confusion while doing the adjustments. If you wish, mark all the pots ahead of time by writing the 'R' numbers on a piece of scotch tape or something. It will help a lot!
Important: make sure to 'zero' the panel meters with the little plastic screw attached to the needle movement unit.

Open up the connection of the thick wire between the pcb and the positive of C3 and insert a small fuse of a couple hundred milliAmps. If you don't have a small fuse handy then you can also use a 1/2 watt 10-ohm resistor or something similar. Do NOT plug in the power supply yet! Turn all trim pots to the left (counter-clock-wise) all the way. Set the two potentiometers on the front panel about halfway. Set the two switches on the front panel (1/10A, 6/30V) to the low settings, meaning the current switch on 1 amp, and the volt switch on 6 volt.
Take your digital multimeter and secure its minus (black) lead on the minus output jack. Plug in the power supply and switch on the power. If all is well and there is no smoke, the main fuse and small temporary fuse on C3 remain okay, we can continue.

Put the plus (red) multimeter probe on topside of potentiometer R3. This is the position closest to the minus of C4 on the pcb. You have to measure there a voltage of precisely 6 volts.

Trimpot Adjustment Procedures

Trimpot	Adjustment Procedure	Measured Result
R2	top of R3	6 volt
R23	output	30 volt
R26	panelmeter adjust (M1)	full scale 30 volts
R24	panelmeter adjust (M1)	full scale 6 volts
R20	panelmeter adjust (M2)	set to same value as multimeter reading
R18	panelmeter adjust (M2)	set to same value as multimeter reading
R14	adjust until panelmeter reads 1 ampere	control with multimeter
R16	adjust until panelmeter reads 10 ampere	control with multimeter

If needed, this voltage can be adjusted by turning the R2 pot. Turning the potentiometer (R3) on the front panel will move the panelmeter but NOT the multimeter. If you move the red probe to the '+' output jack and you should find a variable voltage (via R3) between 0.7 and 6 Volt. Don't worry about the current meter at this time, it probably will not move at all because there is no current. All you do at this time is adjusting the low-voltage scale.
Leave the multimeter probes connected to the '+' and '-' output jacks and switch the Volt-switch (S2a) on the front panel to the 30 Volt position. You will see that the voltage makes a big jump upwards. We adjust R3 all the way to the right (clockwise) and adjust trimmer potentiometer R23 until your multimeter shows 30 volts. We now adjust R26 until the panel meter shows the same, 30 volts. Switch back to the 6-volt position and adjust the panel meter to 6-volt full-scale with R24. If you're done with this and you are satisfied then have beer on me for a job well done. You are half way finished!

Switch off the power, **unplug** the powercord. Remove the temporary fuse between the positive of C3 and the pcb and re-connect the wire to start adjustments on the current settings.
Switch the panel meters to the 6 volt and 1 amp positions and turn current-limiter R12 on the front panel all the way to the left (counter-clock-wise). Set the volt meter on the frontpanel to 4 volt with R3. Select a setting on your multimeter of 100 or 300 milli-amps dc. Take the red probe and insert a resistor of 39 ohm between the red probe and the '+' of the output jack. You will notice that current flows through that resistor. The panel meter also shows a bit of current and at the same time the needle of the panel-voltmeter falls back a little to about 2 volts or even lower. If that is the case you know your current limiter is working properly and you can continue with the adjustment procedures.
Remove the 39 ohm resistor. Switch your multimeter to the highest current setting (preferably 10A) and connect it directly to the '+' and '-' output jacks. The meter should show no more current than with the 39-

ohm resistor, even less this time. Carefully open up R12 (front panel) clockwise until you see increased current on both multimeter and panel meter. A good multimeter will go to at least 10 amps, but I guess the job can be done with 2 or 3 amps also. On the other hand It would be actually better to borrow a good multimeter from a friend or rental shop if you don't have one yourself.
Okay, on with it. Open R12, slowly, as far as possible and note the current reading. **REMEMBER** you are still at the 1A/6V setting! If there are no problems the current reading probably shows 1/2 amp or something in that area. Let it sit in that condition for awhile and observe the temperature of the large cool rib. It should warm up a little bit. If all is okay and still no smoke you can safely assume that the circuitry works correctly.

Before continuing:
Please be aware that 10 amp is a lot of current. Any carelessness on your part will cause damage, guaranteed! I can't stress enough to do these adjustments without disruption and with great care. Over-adjusting any of the current-trimpots or adjusting them too fast will surely blow one or more 2N3772 power transistors, or 2N6388, and possibly other related circuitry.
Okay, on with it--carefully.

The following adjustments have to be done in the correct sequence. Switch the power supply **OFF.** Set the panel switch to the 10-Amp setting and also the multimeter to as high a current setting as possible. Turn R12 all the way to the left (0 amp), the multimeter is still connected to the '+' and '-' output jacks on the front panel. Turn the power supply **ON**. You should notice almost no current at all. The setting of the 'Volt' potentiometer (R3) does not matter much at this time so don't worry about it. Carefully and slow adjust R12 to a high as possible value and stop when it shows about 5 amps on the multimeter. Adjust the panel meter with R20 until it shows the same value as the multimeter. When you're done the panel meter should show half way the 10-A scale. Just make sure that your multimeter can handle 10 amps. If not, then don't exceed that value with R12 or you blow up your multimeter. Adjusting the PS3010 at 5 or 8A is acceptable too.

Turn R12 again all the way to the left and flick the switch on the front panel to the 1-A setting. Adjust R12 all the way to the right and with R18 adjust the value of the multimeter with the value of the panel meter until they're equal.
In the mean time the coolrib is getting quite hot during all the adjustments in the 10-A settings. But that is done now. You have now adjusted six of the eight trimmer pots and so still two to go.
Remove the multimeter. Turn both potentiometers on the frontpanel (R3/R12) all the way to the left (0 position). Return the switches to the 1-A and 6-V settings. Short out the output jacks on the frontpanel with a piece of wire. Turn R12 all the way to the right and adjust R14 until the 'current' panel meter indicates precisely 1-amp (full scale).
That done, turn R12 back all the way to the left and place the current switch in the 10-A setting. Adjust the full scale of the panel meter with R16 until it shows exactly 10 amps. At this setting the cool rib heats up quickly so keep an eye on the temperature. You are done. Finished. I'll bet you are smiling now. After all, you now have an analog piece of equipment equal or better then the commercial unit(easily can cost $800+) and for a fraction of the cost!

AGAIN: Be careful when adjusting the 10A settings! Adjustments with the trim pots to adjust the current should be done very **SLOW** or you're guaranteed to blow one of the 2N3772 power transistors and/or other related components.

If it so happens that the PS3010 blows a power transistor, it will go to maximum current and may do damage to your multimeter, blow it's fuse, etc. Quickly switch the powersupply off, and unplug. Let everything sit for 10 minutes or so to drain the voltage off C3. If you have a diode-setting on your multimeter, use that position otherwise put it in the ohms setting. Put one probe on the base (base of Q2 to

Q5 are all connected together) and the other probe on the emitter of any of the 2N3772's. If any of the four are shorted it shows for all of them. To check which transistor it is, disconnect the four wires going to R6 to R9. Put your multimeter on the 'Diode' setting if possible and check each transistor between the 'base' and 'emitter'. You will find hopefully only one shorted transistor. Replace it, and re-do the current adjustment. To prevent repetition of the same, adjust the PS3010 at 5A is good enough.
I'm looking into protecting each of the transistors and maybe a warning indicator of sorts.

Inside the enclosure I keep a little plastic container which contains some spare parts just in case I need it in the future. The parts I use are the 723 IC, the zener diodes, 2N6388, and one 2N3772 power transistor. A medicine container will work real well. Why? Well, just because everything is so-called short-circuit-protected it does not mean it can't happen, for example by a power surge, abuse when in the 10A setting, or lightning. Murphy's applies here too. But on a positive note, this power supply is almost indestructible when used within its boundaries.

Now, what can you do with this power supply? Anything you want. Charge regular NiCad or Lead-Acid batteries, power your projects, check the current draw of a particular project, run all kinds of motors, styro-foam cutters, etc. It is limited only by your imagination.

Parts List:

Resistors:
1/4 Watt, Carbon, 5% (or better), unless otherwise indicated

```
            R1 = 470 ohm, 1/2 watt
            R2 = 2 K, trimmer pot
            R3 = 5 K, potmeter (lin)
            R4 = 560 ohm
            R5 = 47 ohm
    R6,R7,R8,R9 = 0.1 ohm, ww, 5%, 1-watt
        R10,R11 = 0.33 ohm, ww, 5%, 10-watt
            R12 = 470 ohm, potmeter (lin)
        R13,R22 = 820 ohm
        R14,R23 = 500 ohm, trimmer pot
            R15 = 150 ohm
            R16 = 100 ohm, trim pot
R17,R18,R19,R20 = see text
            R21 = 5K, metalfilm, 1% (2 10K parallel 1%)
R24,R25,R26,R27 = See Text (non-variable: 25K trim pot)
R28,R29,R30,R31 = 3.3K
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Capacitors:

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C1,C2 = 3.3 nF, ceramic                    C7 = 470pF, ceramic (see text)
   C3 = *8,200 uF/50V+, electrolytic       C8 = 10 uF/63V, electrolytic
   C4 = 1000 uF/63V, electrolytic          C9 = 1 uF, foil type, see text
C5,C6 = 4.7 uF/63V, electrolytic          C10 = 22 nF, ceramic
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Semiconductors:

```
   D1 = 1N4004
   D2 = 1N4148
   D3 = 1N3209 (or NTE5942) power diode, 15A+ (see text)
D5-D8 = Leds, (see text)
  ZD1 = 1N4754A, Zener, 1 watt, 39V
  ZD2 = 1N4736A, Zener, 250mW, 6.2/6.8V
   Q1 = 2N6388 (or NTE263)
Q2-Q5 = 2N3772 (or NTE181)
L1,L2 = Ferrite Bead (see text)
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  IC1 = 723 (not the cmos type!)
  BR1 = Bridge Rectifier (see text)
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Miscellaneous:

```
  M1,M2 = Panelmeter, see text
     T1 = Transformer, Hammond 165S30 (30VAC/10A)
     F1 = Fuse, 3.15A, slow-blow (depending on your transformer!)
     S1 = Toggle switch, ON-OFF, DPDT, sub-mini
S2(a-b) = Toggle switch, ON-ON, DPDT
S3(a-b) = Toggle switch, ON-ON, DPDT
     S4 = For use with one panelmeter: ON-ON, DPDT
Fuseholder, very large coolrib for the 4 power transistors, and Q1/D3 (isolated),
wire, solder, 2 knobs, instrument case, power cord, nylon stand-off's, etc.
The meter scales are re-scaled with rub-on lettering.
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Possible Component Substitutes:

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 D1 = 1N4004, 1N4005, 1N4007, BY127, NTE116, NTE125
 D2 = 1N4148, BAX13, BAX16, NTE519
 D3 = Possible types: MUR2510, MUR3010CT, NTE6246, NTE6247, etc.
ZD1 = 1N4754A, NTE5086A, ECG5086A
ZD2 = 1N4736A, NTE5071A
 Q1 = BD267A, TIP140, MJ2501, NTE263, NTE270
 Q2 = NTE181
IC1 = uA723, LM723, NE723, NTE923D
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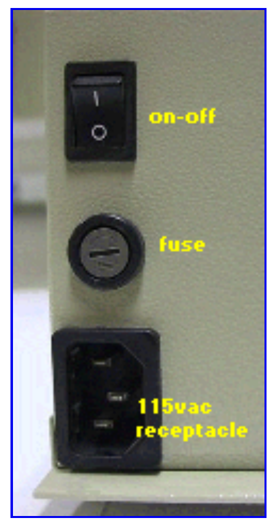
In regards to buying your parts: **You get what you pay for!** Buy decent components; the cheap 'made in China' parts will give you headaches somewhere down the road if your power supply fails because of it!

A KIT for this powersupply is available here: **[PS3010]**
Unfortunately the large 12" Heatsink, as shown above, is no longer available!

Last Minute changes and other important info:



- At the right you see the AC stuff I used. Came from a defective UPS unit. It contained the on/off switch, fuse-holder, an AC filter, and receptacle. Works just beautiful. Click on the picture for an enlarged view. The salvaged cool rib is a little smaller in width then the enclosure so was just a nice opportunity to get a more professional look. Click on the picture for an enlarged view.

Large 12" Heatsink. It has come to that. Too expensive to obtain (from a KIT point of view) and too expensive to ship with the KIT. Shipping rates have gone through the roof, on top of that there are tons of other restrictions. I decided it is not worth the hassle to I dropped it. The alternative to a full-blown heat-sink is to make your own. Just get a 12" long, thick piece of aluminum and bend it on one side. This gives you the space to mount everything. Or go on the hunt for a good coolrib. Just keep in mind that the coolrib (heatsink) is only required if the amperage exceeds a couple amps and above. The "AutoFan" circuit will do a good job to assist keeping everything cool.

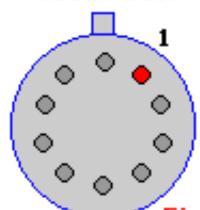


Fig. 13

- If you decide to use the older 'metal-can' version of the 723, the pin out is shown at the left. Just bent the legs in a 8-pin dip format, starting with pin 1 and it will work fine.

- For the Led's I personally choose green for the low scales (0-6V/0-1A) and red for the high scales (1-30V/1-10A). But hey, use whatever preference you have. High-brightness types is what I'm using, but again, use whatever you like.

- The bridge rectifier is one with a metal part attached for mounting on a coolrib. You can use 4 separate stud-mount diodes of 75V/12-15A minimum. They *MUST* be mounted *ISOLATED* on a coolrib.

- Powerdiode D3: I used an older "stud-mount" type of 35Amps because I had it available and it has to go onto the coolrib assembly. But use whatever you have laying around, just keep in mind it needs to be cooled and needs to be a minimum of 20A. The 1N3899 goes up to 40A, but is overkill if you have to purchase it. The 1N3209 is no longer available. **In the KIT this diode has been replaced with a 20Amp TO-220 model.**

- Don't forget to mount R10/R11 away from the PCB. I used 1/4" (5mm) ceramic stand-offs. R10/R11 will get hot.

- Transformer T1: The voltage coming from the 30Vac transformer is 30x1.44pp = 43.2 V. The LM723's maximum voltage is 37V. The circuitry connected to pin 12 of the 723 takes care of that and brings the voltage down to a safe level. If you don't need 10 amps or 30V, feel free to change it to whatever you like. Don't know if you can obtain the amperage with that low voltage. You may have to shop around. Otherwise get the 5A or 8A type. More than enough juice for most of our applications.

- C3 (picture): Big sucker, but was needed for my application. Mine is a computer-grade 22000uF at 50V. Came from a powersupply out of an old 'floor-model' tape-drive. But try anything decent you have or can obtain. A type of about 8000 to 10000uF will do fine. **The KIT contains a Philips 10,000uF/100V type (valued at $100-$240 depending on distributor)!** It is not new, but tested and verified. If you're thinking of combining two 4700uF or more capacitors, that's perfectly okay, just make sure that their values and working voltages ***ARE*** the same. (e.i. two 4700uF/63V caps in parallel will give 9400uF).

- Capacitor C7 is a so called 'compensation' capacitor and should not go beyond 1nF! Anything larger will result in poor or no current limit circuitry or the inability to respond to transients which would feed massive currents into the sense transistor (within the 723) whose E-B junction is directly across the (fractional-ohm in many cases) sense resistor. The correct capacitor value for C7 is around 470pF (0.47nF) and can be ceramic or film.
Check this link to Paul's website for the complete documentation on this: **[Paul's 723 faq]**

- Panel meters: I decided to stick with the analog panel meters. I like to see exactly what i'm doing and in this project they are just as accurate. The 'Volts' panelmeter will most likely be a 100-millivolt type with 30 or 60 scale stripes. The 'Amps' meter will probably be a 1-mA type with 50 or 100 stripes on the scale. The internal resistance (Ri) of the meters is not at all important since anything with a build-in resistor or resistance wire will be removed anyways.

- Coolrib. Here go the Transistors Q1 (2N6388), Q2 to Q5 (2N3772/NTE181), powerdiode D3, and the optional Fan(s). This coolrib is included in the KIT and pre-drilled for the semiconductors. If you wish, use a bit of BBQ black paint to make it look nice (before mounting the semiconductors). The mounting holes for the fan and attaching it to the enclosure is left to the builder. Extra holes are provided to feed the anode wire coming from D3, and fan(s). The thermistor is mounted on the solder-side. Secure it with a dab of silicon glue or something. Make sure the coolrib is mounted *isolated* from the enclosure. Nylon or ceramic standoff's are great!

- Cooling Fans: After some experimenting I decided to increase the 2 cpu fans with one more making the total 3. I also decided to exchange the cpu fans, depicted in the photograph, for a different type which is a bit larger and has more fins. My applications usually require 3 to 5 amps and so the whole cooling circuit with the fans now work like a charm. I will likely modify the circuit and use a more common op-amp such as the 741, and create a printed circuit board and parts layout for ease of use. Most types of thermistors will work so don't worry too much. You just may have to play with the series resistance a bit. No big deal.

- Optional 3mm Led (any color) and 1K8 resistor for the Automatic Fan control (The "Autofan" circuit is the simplest and works great using a 741!) Added this later after the front panel was already finished. Although you may be able to hear the fans when they kick in, I prefer a visual indicator as well. Secondly, I like bells and whistles...(grin).

- And finally, just remember that this powersupply has lots of wires, most of them all coming from the coolrib. It's very easy to make a wiring error, bad connection, wrong connection, etc. Just don't get frustrated. Sort out one problem at a time. Remember to check with your multimeter that *ALL* semiconductors are *isolated* from the coolrib. So when you have mounted your transistors and power diode, check to see that there is no-connection from its case to the coolrib. Put one test probe on the coolrib and with the other test probe touch the case of all transistors and D3 and check there is NO continuity. If you do have continuity somewhere check the mica washer and insulators. On the four power transistors check that one insulator is at the bottom on one side and one at the top on the other side (see pics). Don't forget the wiring for the fans and the thermistor if you decide to use the AutoFan temperature controller. If all that checks out, Then, when you have checked the wired-up semiconductors on the coolrib, check it again to make sure there is no wrong wiring connection shorting something out to the coolrib. Pay special attention to D3. To insulate it, first put the mica washer on, then the heatshrink. Use thermal heatsink compound on all of the semiconductors. When everything checks out take a brake and have a beer. You deserve it. After your brake continue and feed the bundle of wiring into the case via the hole and grommet and proceed with wiring connections. Use color-coded wire if you can and note all colors on your own schematic diagram. It really makes troubleshooting a pleasure later on when needed.

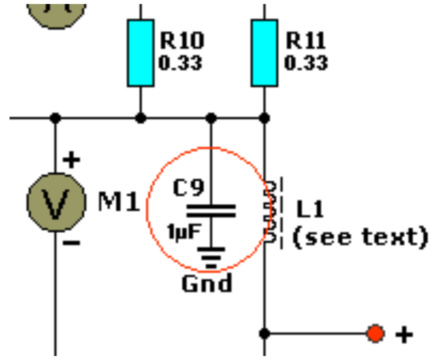
Troubleshooting:

Okay, you're convinced you did everything right and the PS3010 is still not working. Frustrating, yes! On all the problem emails most of it was sloppy or incorrect wiring, one case had the anode/cathode wiring to power diode D3 reversed. Several had a bad LM723 IC. I suggest to use a new 723. Saves on lots of headaches...
Below I have listed some common problems and suggestions for it. The new printed circuit board will have 'Test Points' on them to make troubleshooting easier (fall/winter 2008.)

Problem	Check	Notes
On/Off switch S1 does nothing	3.15A Fuse blown	Replace with 3.5A, cord plugged in?
One or more LED's are not lit	LED's	Connections are reversed
6V position shows 0V	C5, C6, D2, ZD1, IC1, R24	Replace if defective
6V not variable, stays at max	IC1, ZD2, R21, D2, C6, C7	Replace if necessary
6V only variable after switching PS3010 OFF (no load)	D3	Wires to anode/cathode reversed
723 blows at power up	T1, wiring	Check wiring,caps,ZD1,D1,ZD2
723 blows at power up	Wiring, C7, ZD2	Replace C7,R2,R22,R23,ZD2
No output voltage in 6V/30V	Q1,Q2,Q3,Q4,Q5,D2,C6,IC1	Replace if defective
30V position shows 0V	C5, R26, D2, C7, ZD1, ZD2, IC1	Replace if defective. (for IC1 switch OFF first!)
30V stays at max; not variable	IC1, ZD1, ZD2, D2, C6,	If IC1: switch off, remove

	C7	IC1, follow adjustment procedure for 6V
Current draw when varying R3 (no load)	Short to ground	PCB making contact with enclosure. Make sure PCB is isolated
Maximum current (no load)	Short, incorrect wiring Q1	Unplug. C9, Check wiring. If leads on Q1 were reversed, replace
Maximum current (no load) in all positions	Short. Check wiring, Q1-Q5	Replace 723 on all shorts

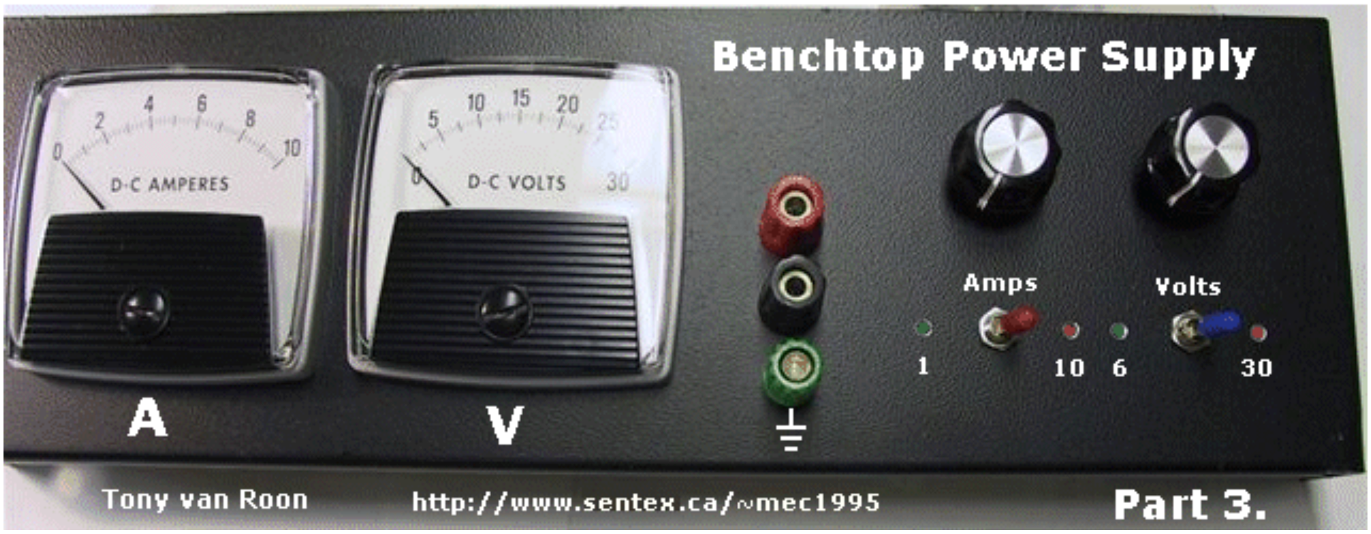
Case Histories:



Case #1. -- A client had the following problem: The PS3010 showed maximum voltage in the 6V and 30V ranges via the panel-meter. The panel meter for current showed nothing, so I assumed it was not shorted. As it turned out, it drew maximum current. In my client's case 12A which blew the main fuse in my Fluke multimeter twice before I noticed at a cost of $30 a piece! My first suspect were the power transistors (Q2-Q5) and the Darlington (Q1). Couldn't find the problem. Took the whole coolrib apart and rebuild it from the ground up with new transistors. Checked the power diode D3 which showed good. IC1 was defective and replaced it. I put the power back on and? No-go! Bloody h*ll! What gives? Frustrated I started troubleshooting the wiring and then stopped. No need for it. This powersupply was working before it ended up on my bench. I knew it must be a short somewhere else. I had another look at all other components and finally found the problem. The foil capacitor C9 was shorted. Upon closer examination it was an older type with a working voltage of 50V. Not enough for spikes or when powered in the 10A position. I replaced it with a polyester type and a 250V working voltage. Problem fixed!

Case #2. -- PS3010 came in the shop with only the 6V working but the needle on the panel meter slamming all the way to maximum. Potentiometer R3 on the front panel could not vary the voltage. Also seems to draw way too much current. In the 6V position the maximum current should not exceed 1 Amp. Before troubleshooting the 30V voltage position I had to fix the over-current first. I started trouble-shooting ZD1/ZD2,R4,R5, and the darlington Q1 (2N6388). All turned out to be good. I continued with the power transistors. Found a short. Disconnected the four wires connected from Q2,Q3,Q4,Q5 to the 0.1 ohm wire-wound resistors. Multimeter showed a short between base/emitter on Q4. Replaced the 2N3772 with a NTE181. That problem fixed. Now the not-working 30V voltage position. Since the 723 IC cost 0.50 cent or less, I just replaced it with a new LM723. No change. Checked the diode and zener diodes. ZD2, a 1N4736A 6.8V type, was shorted. Replaced it with a 1N4735A (6.2V) type. Problem fixed!

Case #3. -- Powersupply came in with no voltage or current in all settings. Client information indicated this powersupply used for high-amp application, between 5A and max (10A). Upon examination it appeared the track on the circuit board going to pin 4 of the LM723 IC was burned and blown away. D2, ZD2, and C7 were all defective. Replaced them. I removed the 723 also and replaced it with a new one. The LM723 IC wouldn't be trustworthy after these critical components were defect. Repaired the foil-track on pin 4. I inserted a 50 ohm wire-wound 10 watt resistor on the output jacks and put my multimeter in the 10A current setting. Carefully powered up the unit. Voltages seem to work with lots of current and behaving erratic. Turned the power off and re-examined the printed circuit board on the bottom side (foil-side). After some head-scratching found the problem. Customer build the powersupply very well and neatly but forgot to make sure the PCB was isolated from the case. After adding some large, non-metal washers on the stand-offs and verifying the pcb was isolated from the case, the powersupply worked perfectly after power-up.



And one final thing. Looking at the front panel above, you see three output jacks: Red (+), Black (-), and Green (chassis ground). The green jack can be omitted if you don't need a chassis ground, OR if you have a transformer without a 'CT' (Center Tap) connection. The 'CT' wire color on the transformer is either green or green/yellow and is located on the AC side (between the two black wires) and is connected to the enclosure and the green jack on the front panel. Just don't confuse the black jack with the green jack. Chassis ground is normally used to make a ground connection between different equipment, oscilloscope, or battery operated circuits. Your normal output jacks are the RED and the BLACK.

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Last Updated: September 25, 2010