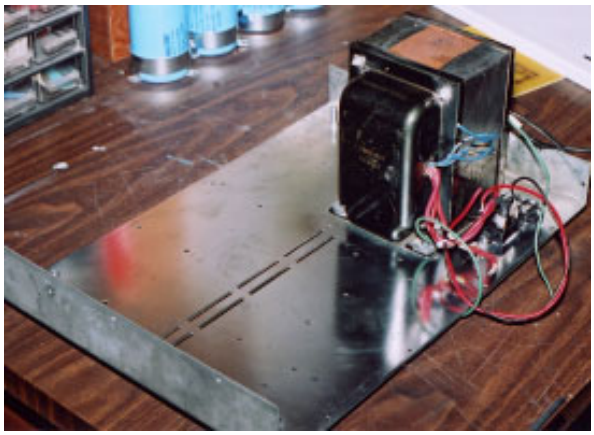
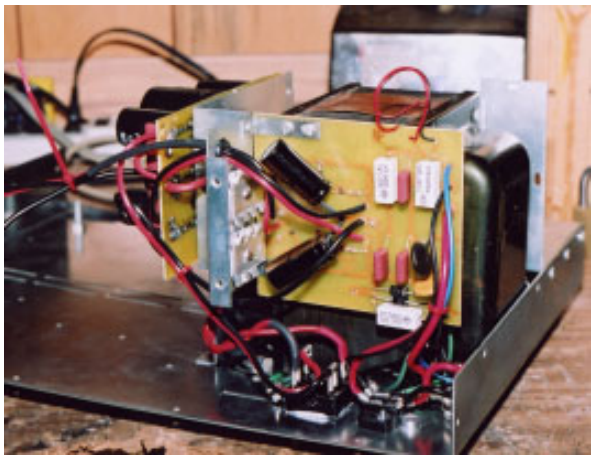
Dynaco 400 Assimilation

The Dynaco 400 was the Tyranasaurus Rex of power amps in 1973. I wanted one badly but I was bringing up children and settled for a more affordable Dynaco Stereo 80, which pumped out music for the next twenty-odd years. It also survived three teenaged boys. In 1998, I spotted a Dynaco 400 in a used equipment shop, paid way too much and dragged it home—all sixty pounds! Unfortunately, my 'Dynasaur 400' was seriously flawed. It had a nasty habit of going DC and destroying speakers. I spent more money unsuccessfully attempting to repair a unit with too many previous ham-handed repairs and modifications. Eventually I decided it was too old and complicated to fix and too big to use as a doorstop. Resistance was futile; it needed to be assimilated with newer technology.

I decided on a rebuild that would retain the outward appearance of this classic amplifier while replacing the innards with new components. After some looking around, I chose to upgrade using a couple of compact 200 W all-MOSFET amplifier modules from Marchand Electronics in Rochester N.Y. You can buy the PM224 modules as fully assembled and tested units, as kits with the PC boards and all parts or as bare PC boards. See the Marchand site for details, specifications and schematics.

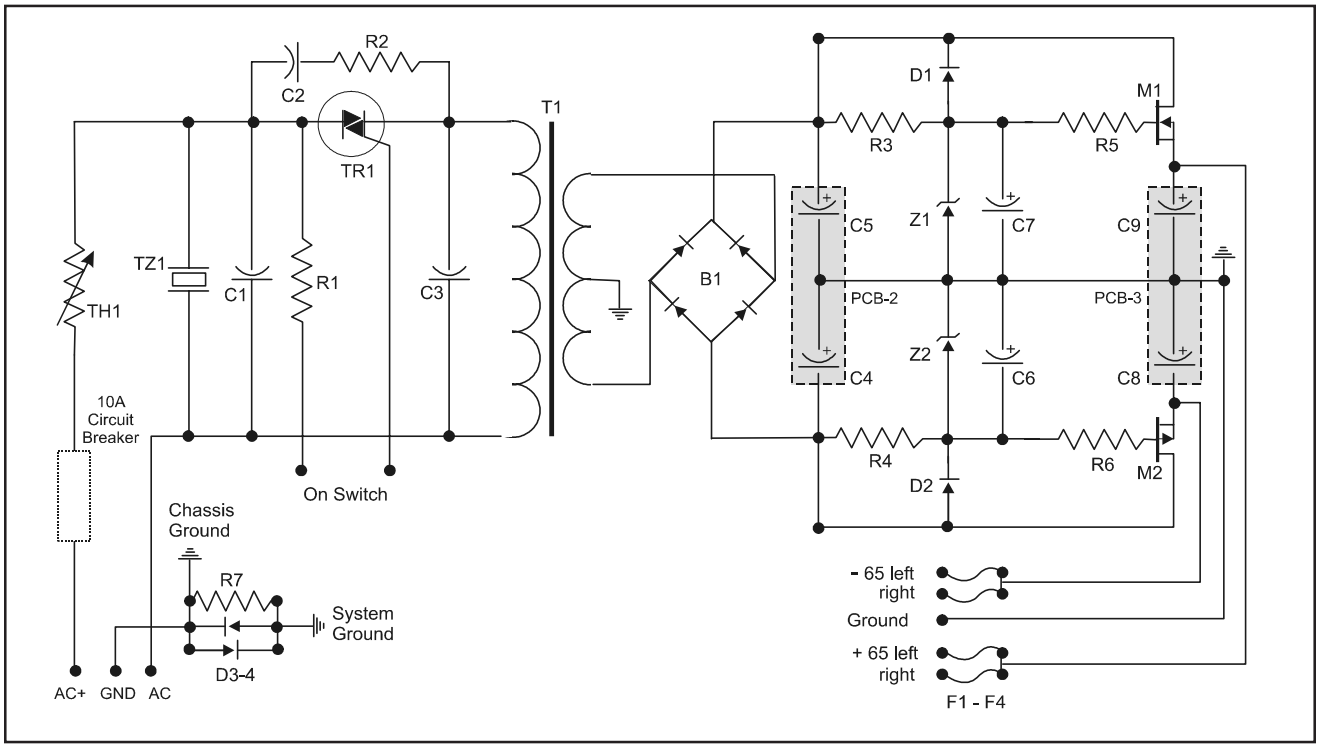
The rebuild is straightforward. Strip everything but the massive Hammond power transformer from the old chassis. Remove the faceplate and hinge the front part of the chassis forward. Clean the wiring from all front panel controls. Only the power switch and pilot light will be functional in the new amplifier. The old Dynaco yields about two hundred dollars in parts—a 1,000 VA transformer, heat sink, rectifier bridge, circuit breaker, switch, speaker fuses, connectors and a sturdy chassis with lovely big rubber feet. On a good day, you can pick up an old, one-channel-good Dyna 400 for fifty dollars on E-Bay; you'll have talk to the Teamsters about getting it to your place.





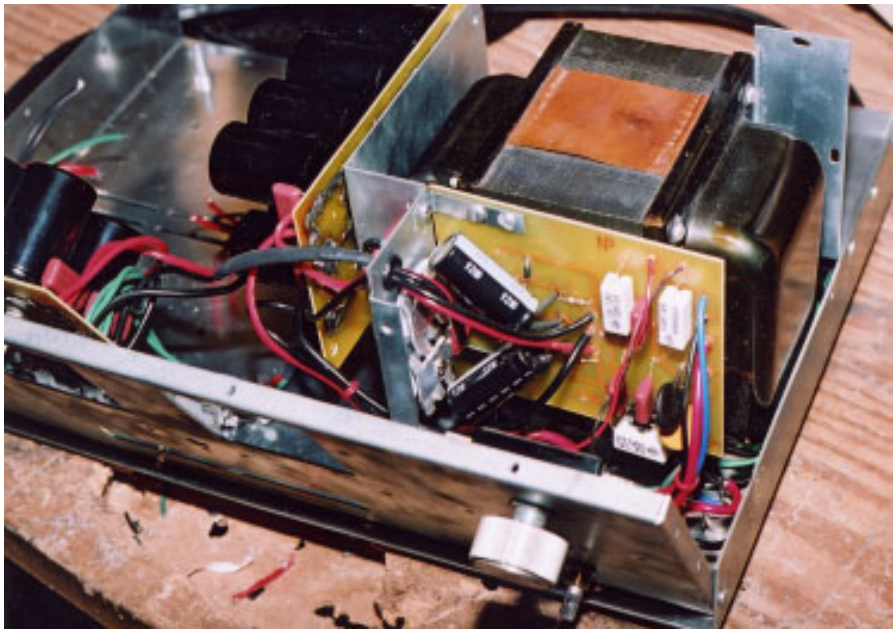
Despite the utility of the Dynaco's original fifteen amp power switch, I chose to use a triac to turn the amp on, believing that MOSFETS are more susceptible to switching spikes and noise than the transistors in the old amp. Audiophiles are, as Nelson Pass notes, a superstitious group. The triac power-on circuit is the same as that used in the Pass/Thagard *A75*. The voltage regulator circuit is taken from Pass' *'Complementary Zen'* design. Thanks for both.

Right, top - the bare chassis with Hammond transformer; bottom - PCB 1 mounted and voltage regulator MOSFETS bolted to the transformer shield.



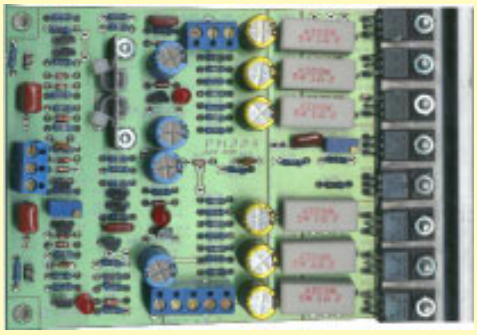
Regulated 65 V power supply for Marchand PM224 power amplifier modules

Replace the old Dynaco PC30 power distribution board in front of the transformer with the new combined power-on and voltage regulator board, PCB-1. Drill a couple of holes in the transformer shield to bolt down the large voltage regulator MOSFETS, as shown in the picture. I used two old heat sinks as washers on the top of these devices, but they really don't generate a lot of heat. Place insulating pads or mica washers underneath them. The large capacitors, C6 and C7, need to be bent over parallel to the board so that they clear the front panel—leave their legs long and cover with heat shrink wrap. Connect the power switch and pilot light. The original Dynaco pilot is a neon light with a dropping resistor. Connect it across the transformer primary.

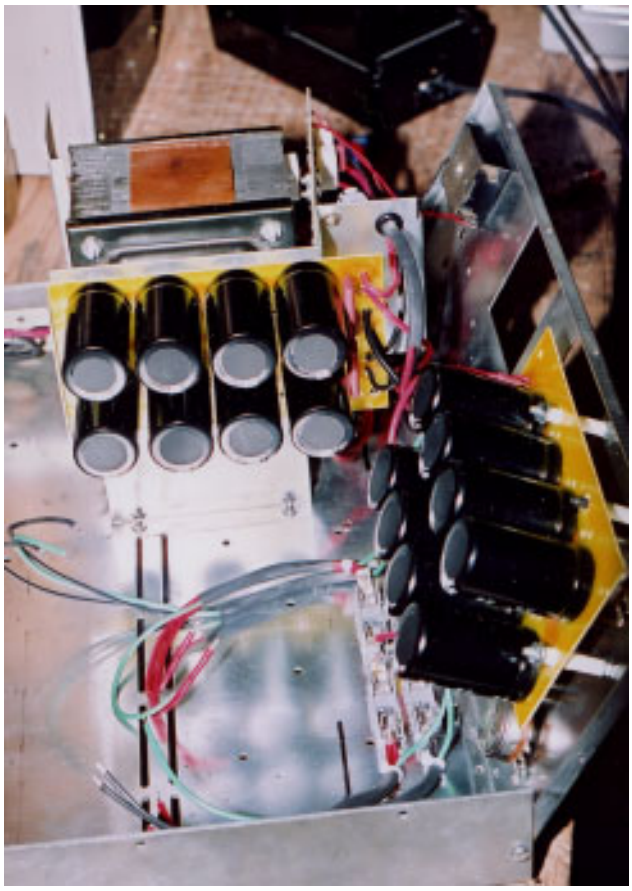


The front panel tilted forward for access to voltage regulator PCB 1

The unregulated side of the supply in my amp sits at about ±72 V. The voltage regulator section drops this to a very stable and noise-free ±62 V. This is not the 65 V specified in the design, but it is close enough. Both sets of filter capacitors are mounted on their own PC boards; 40,000 µF before the regulator and 60,000 µF after. PCB 2 fits on the far side of the transformer shield and PCB 3 on the inside of the front panel. You'll need some spacers to get the front-panel board to sit above the old amp's controls. Use the fuse block from the old amplifier for positive and negative supplies to the left and right amplifier modules.



PM224 Module: 200 W RMS into 4 or 8 Ohm. Better than 0.01% distortion at 1 KHz. Differential (Balanced) or Single Ended Inputs. AC or DC Coupling (jumper selectable).



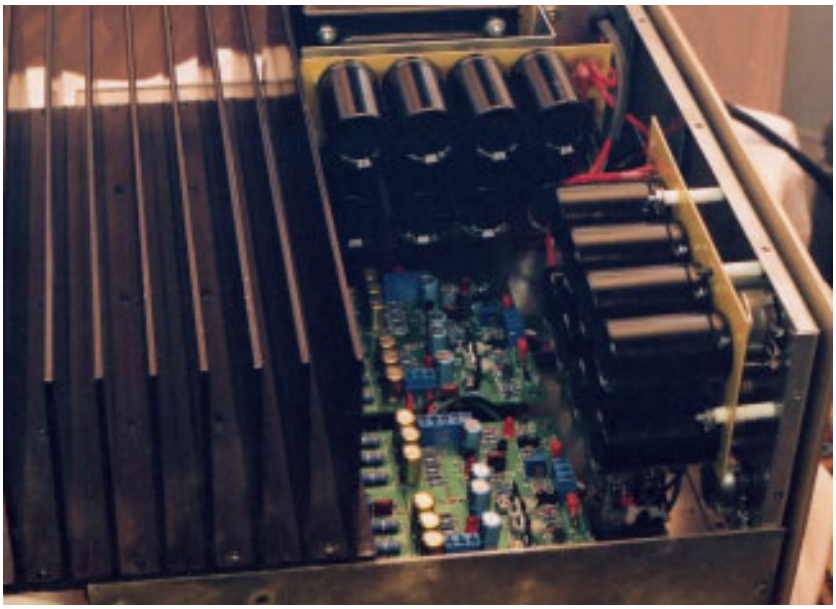
Power supply elements mounted and wiring ready for the modules and heat sink to be attached.

The two power amplifier modules from Marchand bolt directly onto the base of the oversized Dynaco heat sink. They sit an inch above the floor of the chassis when the heat sink is replaced. They are very compact and fit well. The inputs and outputs of the amp modules can be wired before sliding the heat sink back into the chassis. Thanks to quick-connect strips on the boards, hooking up power and ground wires is a two-minute job. As with the original amplifier, this one opens up nicely for service. The front panel tilts forward for access to the power supply. The heatsink and amplifier modules drop out as a single part once the power and ground wires are disconnected.

Power amp modules bolted to the heat sink.

For now, I am very happy with the rebuilding effort. In many respects, the rebuild performs better than the original amplifier and runs much cooler. For the budget-conscious, this is a 400 watt high-fidelity amplifier which costs less than a dollar a watt. For people who like to party, this amp really makes a couple of fifteen inch drivers jump. I'm sure glad the kids are not around to mess with my sound system any more.

Julian Evetts
julian@ibd.ab.ca
March 2005



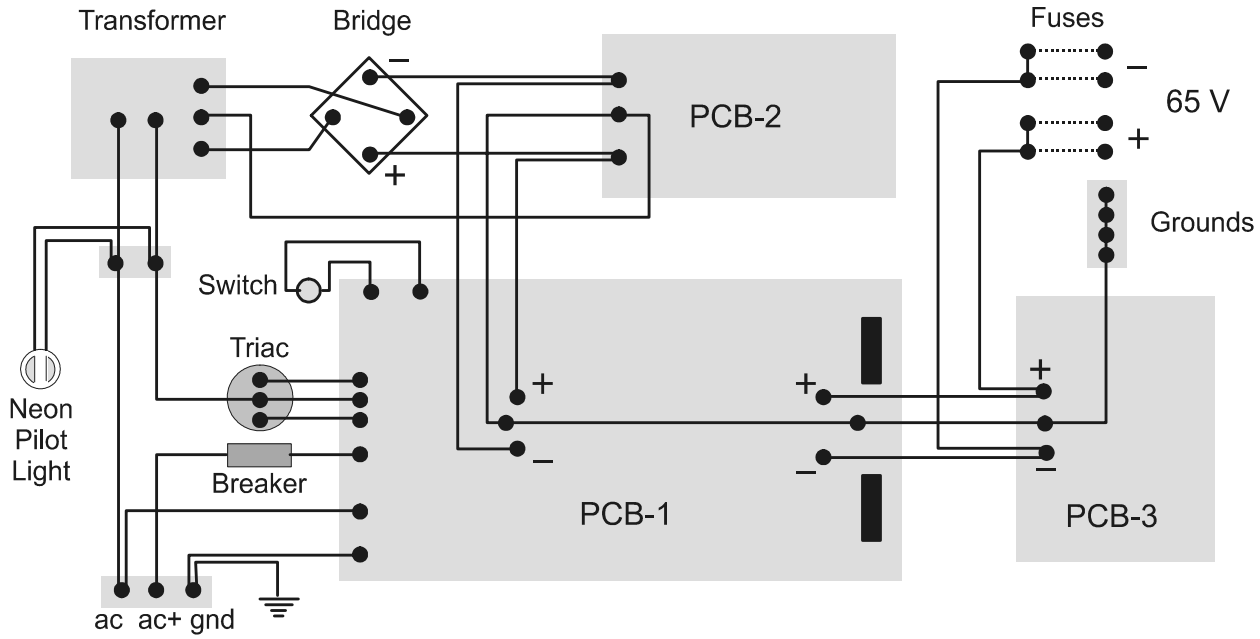
Assembled unit. PCB 3 on the right; PCB 2 at the rear; modules below

Sources:

Pass, Nelson, 'Zen Variations Part 5: The Complementary Zen,' *AudioXpress*, 34:10, Oct. 2003
Thagard, Norman and Pass, Nelson, 'Build the A75 Amplifier,' *Audio Amateur* 4/92 and 1/93
The Unofficial Dynaco Home Page - http://home.indy.net/~gregdunn/dynaco/
Marchand Electronics, Rochester, New York - http://www.marchandelec.com/
Manual - PM224 Power Amplifier Module - http://www.marchandelec.com/ftp/pm224man.pdf

Assimilated 'Dynasaur 400' unit returned to service. Shown here slowly burning in on a mix of Asterix, Orbital, Delerium, Enigma, and Infected Mushroom.

Parts List - Dynaco 400 Assimilation			
1	TH1	Thermisistor 2.5 Ω - 8 A	Inrush limiter – (Thermometrics CL 30)
1	TZ1	MOV - 250 V - 2,500 A	Transient voltage suppressor (Siemens 510K250)
1	T1	Transformer	Hammond 1,000 VA, 140 V, split secondary
1	B1	30 A – 250 V	Rectifier bridge
3	C1, 2, 3	.047 µF – 250V	Interference suppression capacitor – metalized film
8	C4,5	4,700 µF – 100V	Electrolytic (Panasonic TSUP - ECO-S2AP472DA) Capacitors (A-D) and (F-I) on PCB 2
2	C6, 7	1,000 µF – 100 V	Electrolytic – Axial - long leads
8	C8, 9	6,800 µF – 80 V	Electrolytic (Panasonic TSUP - ECO-S1KP682DA) Capacitors (A-D) and (F-I) on PCB 3
4	C4,5,8,9	0.1 µF – 250 V	Interference suppression capacitor – metalized film Capacitors (E) and (J) on both PCB 2 and 3
3	R1, 2, 7	5 Ω - 2 or 5 W	Small power resistors
2	R3, 4	2.2 kΩ - 1/4 W	Carbon
2	R5, 6	221 Ω - 1/4 W	Carbon
1	M1	IRFP 140	IR - MOSFET – N Channel– 23 A -100 V
1	M2	IRFP 9140	IR - MOSFET – P Channel – 23 A -100 V
2	-	-	Mounting kits or mica washers for M1,2 - TO-247 case
2	Z1,2	Zener diode 68 V – 1 W	
2	D1, 2	1N4004 - Diode – 1 A	
2	D3, 4	1N5401 - Diode – 3 A	
4	F1, 2, 3, 4	Fuses 3 A, fast blow	
*	Miscellaneous: terminal blocks; heatsink compound; wire; ties; hardware.		



65 V Power Supply - Block Diagram

Making Printed Circuit Boards for the Dynaco 400 Assimilation

It's easy to make good looking printed circuit boards using the photofabrication technique.

Print the Artwork - You will need a few sheets of ordinary transparency film—the kind they use to make slides for overhead projectors. Buy it at Staples or Office Depot. You can use a laser or an ink-jet, but make sure that the type of transparency film matches the printer. I find that I get the best results from inkjet film in an inkjet printer set to enhanced mode. The PCB artwork will print full size from this Acrobat file. The drawings are dimensioned so check them with a ruler to make sure your printer isn't scaling. Cut out the 4 x 6 design for the copper side of the filter capacitor boards and the 4 x 5 design for the copper side of PCB-1. The photosensitive boards are an inch larger on one side than the designs. Cut them to size after they have been etched.

Expose and develop the boards - Follow the instructions which come with the photosensitive boards. Expose and develop one board at a time. Remove the protective film from the copper side of the first presentitized board. Cover it with the artwork and lay a sheet of glass on top to keep the artwork snug to the board. Expose under a fluorescent light for about ten minutes. I always place text in the artwork for PC boards to make it less likely that I will reverse the artwork and produce a mirror image board.

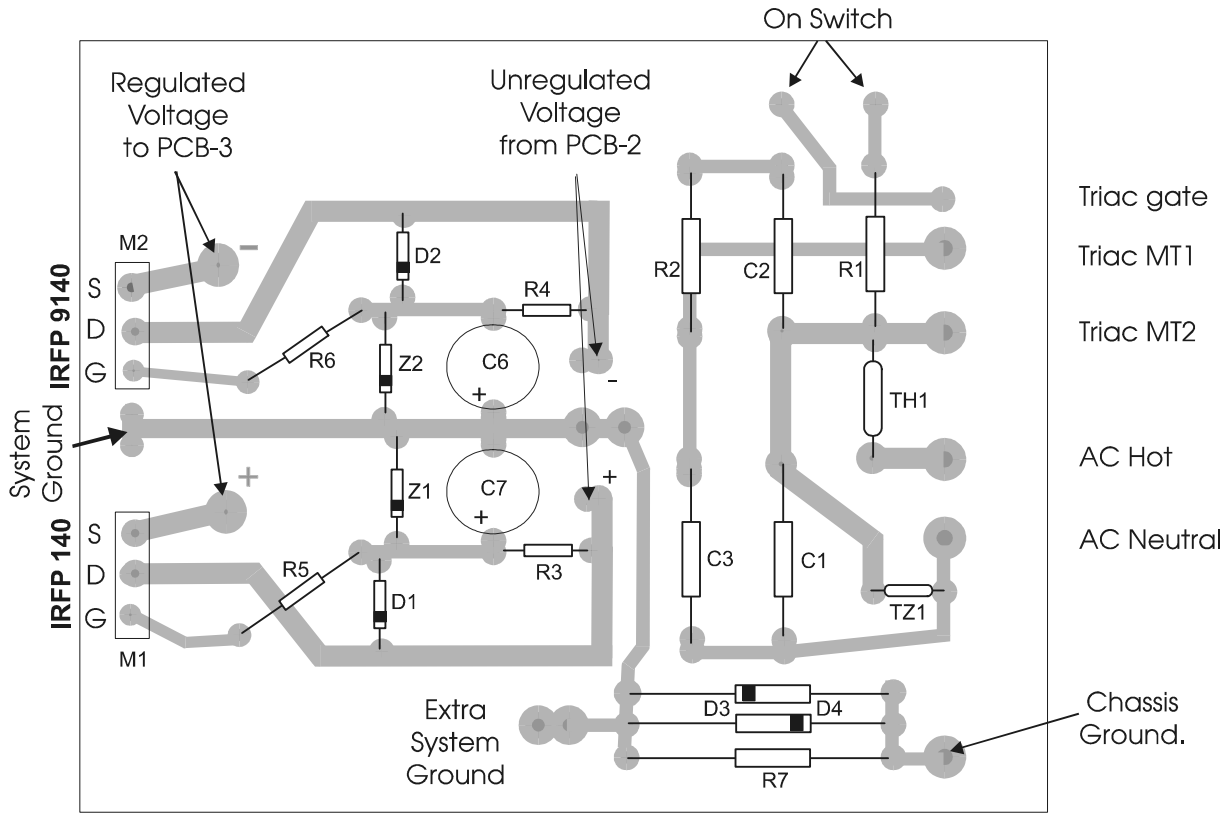
At the end of the exposure period, remove the glass and the artwork from the board. Dip the board in the developer solution and gently wash away the photo-resist to reveal the copper underneath. Rinse immediately and completely under cold running water to stop the process. Expose and develop the other two boards.

Etch the boards using the ferric chloride solution following the instructions on the label. This is the only chemical I have seen that will destroy a stainless steel sink, so be really careful. Kitchen sinks are used frequently, so your mother, lover, or significant-other will notice. Before starting, warm the etching solution by letting the bottle stand in hot water. Put the PC board or boards in the etching tray and cover with warm ferric chloride, Agitate to speed the etching process. When the copper around the design has etched away, rinse the board in cold water and scrub lightly with steel wool. Mark the boards and cut to final size—that's an inch off one edge of each board. Drill holes from the copper side of the boards and you're finished.

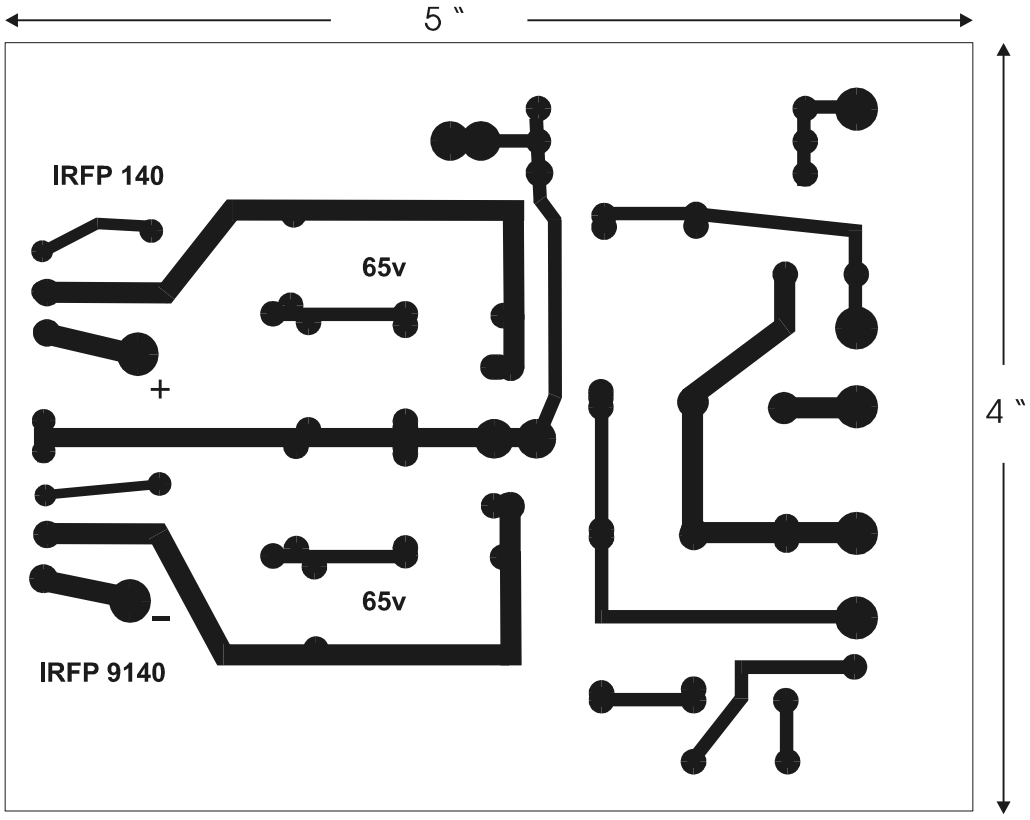
Photofabrication supplies - Buy a photofabrication kit. It has everything you will need: boards, developer, ferric chloride, gloves and a nifty developing-etching tray. (MG - 416K - Top of the page)

Otherwise:
- 1 – Developer (MG – 418)
- 1 – Ferric Chloride (MG-435)
- 1 – 4 x 6 presensitized single-sided PCB (MG – 606)
- 2 – 6 x 6 presensitized single-sided PCB (MG – 609)

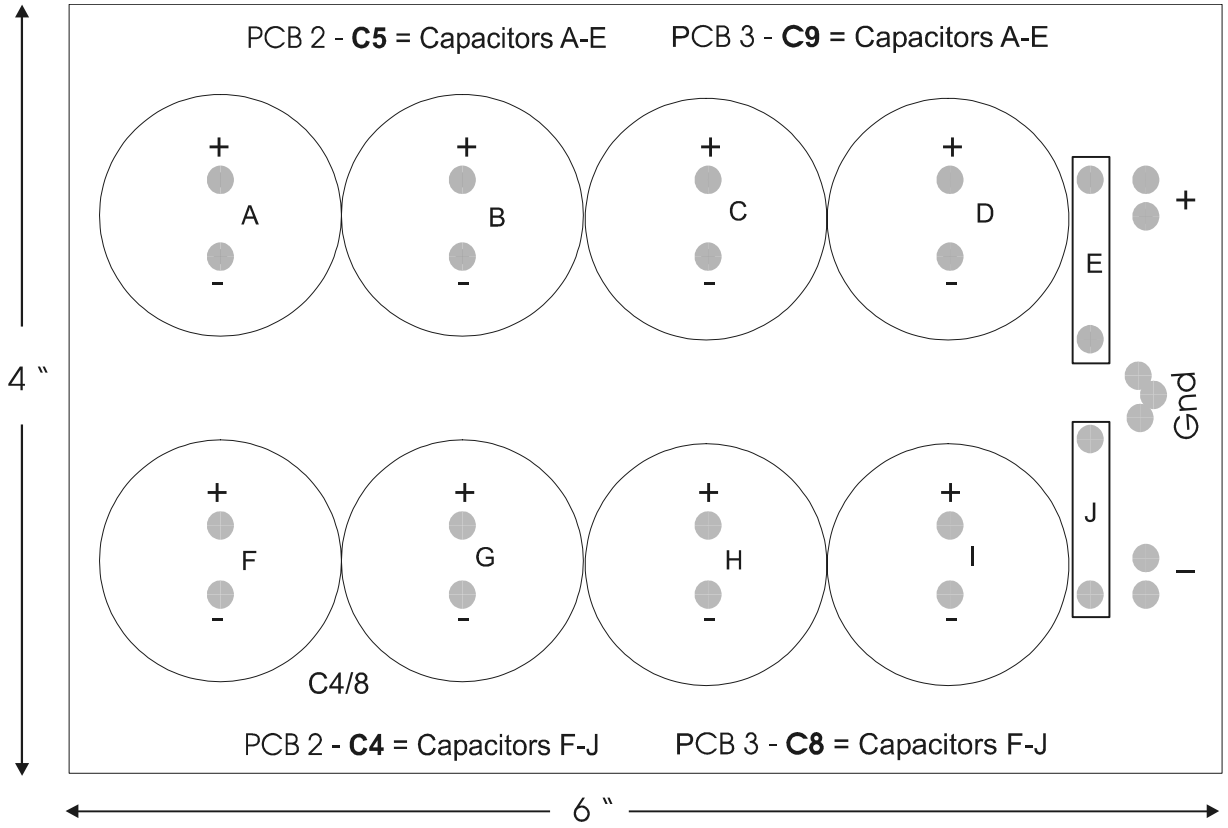
Still unsure? MG Chemicals has tutorials, videos and other helpful stuff at their prototyping centre: http://www.mgchemicals.com/techsupport/index_proto.html



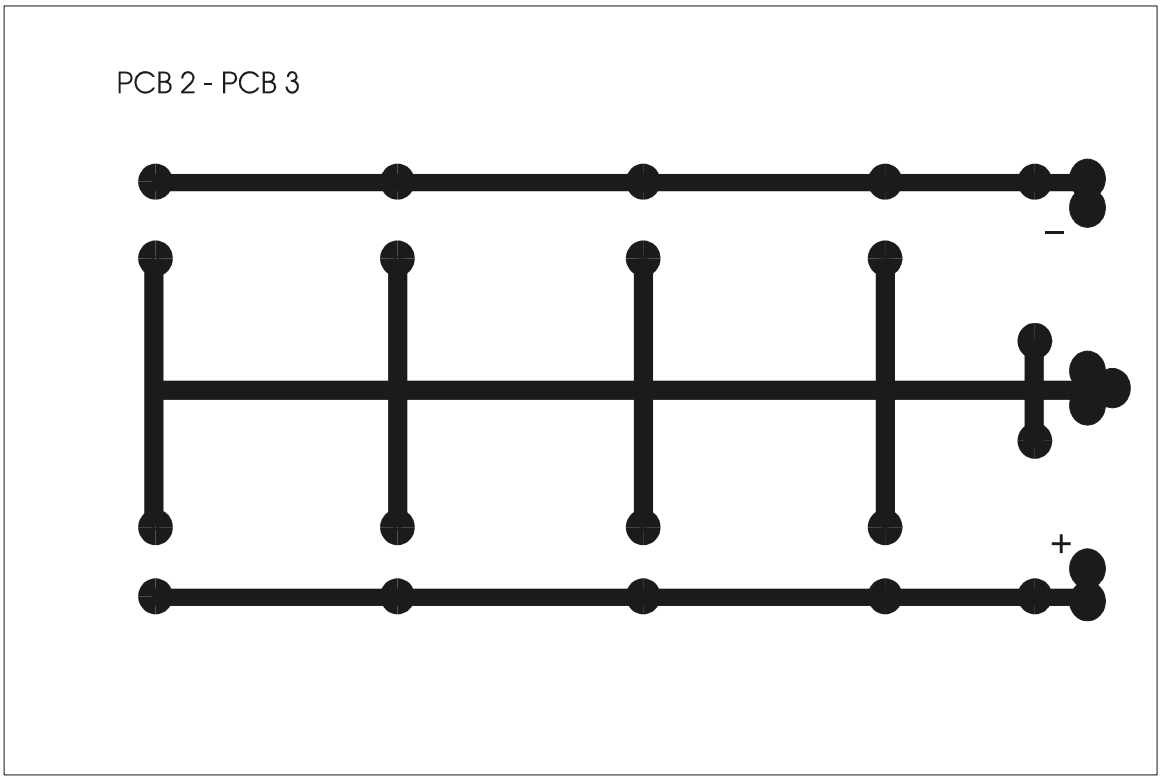
PCB 1 - Voltage regulator - top side



PCB 1 - Voltage regulator - copper side



PCBs 2 and 3 - Filter capacitors - top side



PCBs 2 and 3 - Filter capacitors - copper side