



Amplifier War and Peace

If you have noticed that “passive” components aren’t passive and find the idea of a simple power amp in which the signal goes through a very small number of components attractive, this “hybrid” amp may be for you.

By Simon Brown

Tchaikovsky rises to a crescendo. The cannons boom through the loudspeakers. But there’s something wrong here; it’s a piano concerto, not the *1812 Overture*! The “cannons” continue, out of time with the music, and now more like the continuous crackle of small-arms fire. A well-placed thump on the front left corner of the amplifier and Peace breaks out.

A ghost in the machine? My Fonz of *Happy Days* impression? More like a dubious solder joint or a fatally wounded capacitor. This valve/MOSFET hybrid amplifier is now a fickle beast. Twenty years of hardwired mods on modified PCBs has left it an irascible veteran. This makes me reluctant to do even minor exploratory surgery for fear of causing more complications. It’s time to rebuild the amp.

Twenty years ago I designed my original Valvet amplifier around Hitachi MOSFET devices. Modern power FETs have significantly better properties enabling the use of one complementary pair per channel where previously two had been needed. This has the dual advantage of providing a reduced capacitive load for the valve driver stage and avoiding the need to match parallel pairs of devices.

SHORT AND SWEET

A hybrid amp lets each device do what it’s good at. Valves can provide good voltage gain but are limited when it comes to current. Power MOSFETs are great at driving real-world loads, such as speakers.

So here is a 50W power amp with enough gain to be fully driven by a CD player without extra amplification. Yet you can view the circuit as one valve triode, one capacitor, and a MOSFET fol-

lower. It also manages acceptable distortion performance by maximizing the linearity of the circuits rather than relying on a bandage application of negative feedback. But I should point out that if you want an amplifier whose distortion has more noughts than a bagel factory, I suggest you shake your head sagely and move on to look for more of a “textbook” amp.

COMBINED FORCES

This amp (**Photo 1**) is a “hybrid” in many ways. There is the obvious way in which it uses both valves and MOSFETs. But it’s also a hybrid in its use of enriched Class A/B, which means it is running Class A up to a few watts. This is deliberate. The bottom bit of the transfer curve is the wart on the face of MOSFET specs that Bipolar Bullies like to point out (“MOSFETs have higher distortion than bipolar transistors”) before poking out their tongues. Running higher bias current moves you into a happier playground.

If you choose suitable heatsinks and voltage rails, you can run this design in “pure” Class A (or cooler if your budget points you that way). I have chosen the ~50W/8W Class A operating characteristics to suit my ~90dB/W speakers, and the heatsinks are simply the ones I have in stock that match my “mid”-size ezChassis chassis. **Table 1** shows alternative power and bias possibilities for a number of common transformer secondary windings and three heatsink sizes. Choose the bottom right option for a “pure” Class A amp.

THE CHARGE OF THE LED BRIGADE

The valve “driver” stage of this amp has evolved over the years. Originally it was a triode plus cathode follower before



PHOTO 1: The completed unit.

TABLE 1: VALVET POWER / BIAS OPTIONS.

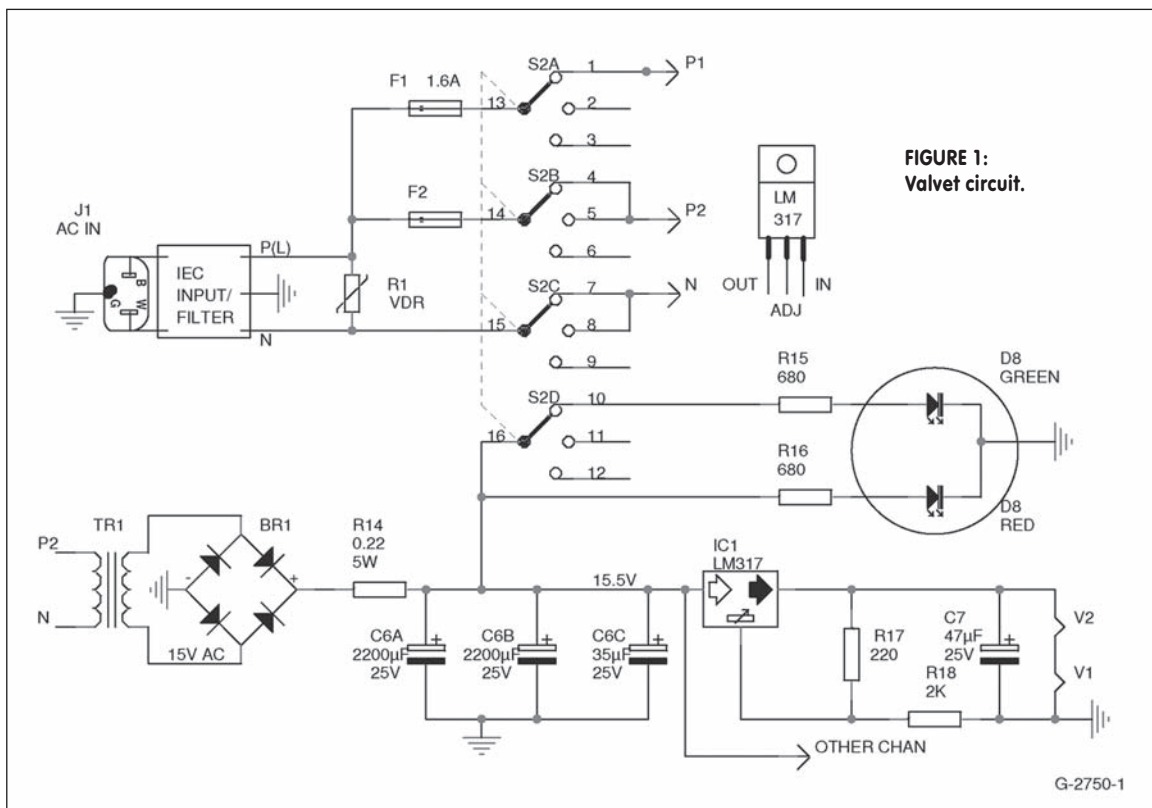
Heatsink Rating °C/W (for 30°C rise)	Heatsink Power /per heatsink (for 30°C rise)	Possible Bias Levels for DC Voltage rails /Set Voltage(TP2)		
		±40V (~30VAC)	±35V (~25VAC)	±23V (~18VAC)
0.65	46W	0.6A /0.26V	0.7A / 0.31V	1.2A /0.53V
0.42	70W	0.9A /0.4V	1.0A* /0.44V	1.5A /0.66V
0.33	90W	1.1A /0.48V	1.3A /0.57V	1.9A /0.84V
*As built	Aprox 8Ω power>	75W	50W	25W (~ClassA)

stepping up to a SRPP (Shunt Regulator Push-Pull¹) circuit. Then there was a significant improvement to a μ -follower^{2,3} despite my misgivings about the additional components. I had been considering adding a current source when I came across the β -follower⁴ (nice to see it reinvented in aX recently⁵). This proved even more effective. What you see here is effectively a hybrid of both of these two designs using LEDs to define bias voltages.

The other major change I've made since my older amp is

to the tube type. Power MOSFETs are relatively easy to drive, relative to big bipolar transistors, that is. They still make

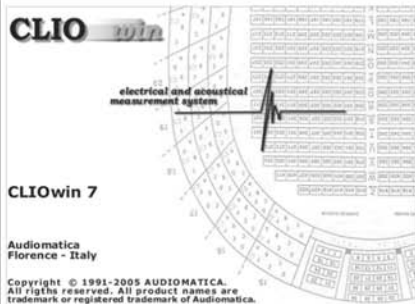
serious demands on the driving device, especially with their high levels of capacitance. 6DJ8/E88CCs, which were



CLIO win 7

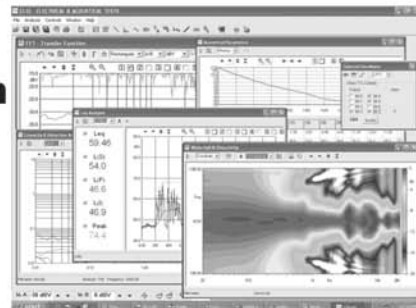


Turns your PC into the most complete easy-to-use electrical and acoustical measurement system



www.cliowin.com
www.audiomatica.com

■ **CLIOwin 7**, by Audiomatica, is the new measurement software for **CLIO**. We are proud to announce that several new features have been added to a measurement system that was already a reference.



Distortion & Linearity Analysis ■
FFT Live Transfer Function ■
Color Waterfall Analysis ■
ISO 3382 Acoustical Parameters ■

NEW FEATURES!

■ **Directivity Analysis Color Map**
 ■ **Directivity Polar Pattern**
 ■ **IEC 61672 Leq Analysis**
 ■ **Wow & Flutter Analysis**

■ **Powerful hardware control.** CLIOwin 7 fully exploits the capabilities of the SC-01 Signal Conditioner and of the QCBox Model 4 Amplifier&SwitchBox. This measuring instrument excels for signal interfacing, precision and reliability.



Two channels separate input monitor and control up to +40 dBV (280 Vpp) Programmable AC output generator with DC voltage

Input A dBfs 10 dBV Input B dBfs -40 dBV Out 10.0 dBu 46.1°C

Toroids for Audio



Tube Output

Toroidal transformers for tube output applications.

Electrostatic

Step-up toroidal transformers.

Solid State Power

Low noise, low inrush 500 to 2000VA.

Standard Power

Designed for general purpose applications. From 15 to 1500VA.



Part No. **PAT3025-SE**

Application **300B Single-ended**

Primary **2490 ohm**

Power **13W**

Secondary **4 & 8 ohm**

Ratio **24.96:1**

Pwr. Bandwidth **20Hz - 147kHz**

Insertion Loss **0.18dB**

Quality Factor **327,300**

Case **Aluminum**

Finish **Textured black**

Size **153 x 90mm**



PLITRON

MANUFACTURING INC

8-601 Magnetic Drive

Toronto, ON M3J 3J2

Canada

416-667-9914

FAX 667-8928

1-800-PLITRON(754-8766)

www.plitron.com

www.plitron.com

my favorite preamp tubes, are powerful (transconductance-wise) with reasonable gain, and can be low noise devices. So they seem good choices for a driver in a hybrid amplifier, as witnessed by their

use in a number of commercial amps. These are what I've used until now.

Recently I've started to question how these tubes behave when called upon to swing larger voltages. In looking at com-

VALVET PARTS LIST

	Value	Notes	Supplier	Part no
RESISTORS				
R1	2M2			
R2	330			
R3, R8	100k			
R4	100			
R5, 7, 24, 25	12k			
R6	82k			
R9, 10, 28-31	150			
R11-12, 14, 22	0.22 (5W)			
R23, 26, 27				
R13	10			
R15, 16	680			
R17	220			
R18	2k			
R19 (aka R22)	1M			
R20-21	560			
P1	100k log	Alps blue	RS	219-9146
P2	10k	10 turn		
P3	20k	10 turn		
CAPACITORS				
C1	4.7µF	16V min		
C2, 3	4.7µF	200V min		
C4	4.7µF	16V min		
C5	0.1µF	35V min		
C6	4400µF min	25V min		
C7	0.47µF	15V min		
C8, 9	100µF	350V min		
C10, 11	16µF min	350V min		
C12-15	4700µF	50V min		
	(1000µF Panasonic NHG)	RS		
C16-19	3300µF min	50V min	RS	339-6859
DIODES				
D1-3	red LED			
D4, 6	1N4148			
D5, 7	12V zener			
BR1	P04 6A			
BR2	UF4007 (x4) 1000V			
BR3, 4	35A/400V bridge			
BR5, 6	MBR1100TR Schottky		RS	469-0691
D8	red/green LED		RS	578-294
TRANSISTORS AND TUBES				
V1, 2	6SN7GT		(DBL)	433610
T1	BC558			
T2	IRFP140	T0-247	RS	254-0948
T3	IRFP9140	T0-247	RS	189-0949
Reg1	LM317	T0-220		
INRUSH SUPPRESS.				
	25R-2A (for230V)		RS	210-689
MISCELLANEOUS				
Sw1 (DBL)	rotary 433818	2P6W		
IEC1	6A/230V	mains filter/inlet	(DBL)	433817
VDR	275V (for 230V supply)			
F1	1.6A	(for 230V)		
F2	0.25A	(for230V)		
Sw2	rotary	4P3W	(DBL)	433819
L1	15H (380Ω)		Hammond	
F3, F4	3A			
HARDWARE				
heatsink	0.42C/W (30C rise)		DBL	433804
chassis	ezChassis 120mm		DBL	432006
valve mounting panel			DBL	432301
RCA sockets/speaker terminals/valve bases			(DBL)	
shaft extension kit 1/4"			DBL	433215
brass knobs	50mm (2") and 30mm		DBL	433008/9
handles	96mm black		DBL	433023

Supplier Notes:

I've included some RS part numbers for convenience (but it isn't the cheapest place to buy) www.rs-components.com or www.alliedelec.com in North America.

DBL is www.designbuildlisten.com.

(DBL) indicates this is available via DBL but is a generic component than can be bought anywhere (but listed here for convenience).

mon alternatives (I avoided using the sort of tube in which the entire world stock is in a locked cupboard of a locked room in a former KGB building), I decided to use the 6SN7GT because it is a linear valve with middling transconductance. Here I chose to parallel up both halves to improve its driving ability (and noise).

This proved to be not strictly necessary: the completed amp is 3dB down at around 500kHz (and 3Hz) and is very quiet. Gain is $\times 20$, so can usefully be driven to clipping (56V p-p, equivalent to 50W into 8 Ω) with the output of most CD players. Distortion is near the limits of my admittedly crude test gear (USB instruments DS1M12 USB oscilloscope/signal generator), but around 0.1% THD.

CAMPAIGN PLAN

I configured this as an integrated amp, but you can omit the inputs/switch and replace the potentiometer with a resistor. The pot is quite a high value (100k) to help my tube phono stage; reduce this to 47k if you have a more convention-

al preamp. R1 and so on ensures quiet when switching inputs. I like to use a six-way switch (for my <4 inputs), giving me "free" mutes at either end of the switch travel (or in the middle to reduce crosstalk).

I included an input/output connection after the potentiometer to run a subwoofer and to make it easy to bypass the pot in other systems. R2 is a grid-blocking resistor, which helps avoid any RF oscillation. This is probably not necessary, but is a pragmatic choice to leave it there. Solder it as close as physically possible to the grid. R9-10 play a similar role for the MOSFETs but are essential and again must be attached directly to the gate.

The actual operation of the SRPP/ μ -follower/ β -follower is open to some debate, so what follows is my interpretation. You can view V1 as "simply" a triode in which V2 and the current source T1 and so on combine to act as a very high impedance load, maximizing gain and linearity. The LEDs act as a low-noise biasing arrangement. V2, which also acts as a "cathode follower" to give

some grunt to drive the MOSFETs, does this job superbly as this operation is enhanced by the high impedance action of the current source.

The signal is then capacitor-coupled by C2-3 to the individual MOSFETs. This is because the MOSFETs must be biased with a DC voltage (around 3.7V) to get them to operate correctly. R5-8/P2-3 form this bias network. P3 adjusts the current flowing through the MOSFETs and thus the level of "Class A" operation. P2 adjusts the balance between the devices, ensuring you can adjust for negligible DC current through the speakers.

The FETs are operated in "source follower" mode, so theoretically "track" the input with no distortion (and no voltage gain). I chose the IRFP 140/9140 pair because they are well matched for capacitance. IRP540/9540 have similar specifications but in a smaller/cheaper package (TO-220). To me the larger (TO-247) package size is potentially important because it reduces the potential for transient thermal effects. However, I did use the smaller devices to get



Dyna^(tm) Clone Transformers...world's most popular and fastest selling Dynaco^(tm) replica transformers, priced competitively with generic massmarket transformers! Used by hobbyists, repairpersons and OEM's worldwide. Made in America's heartland by transformer professionals with over 50 years experience making private label and OEM transformers.

Dyna Clone output transformers are dimensionally identical and wound the same as the originals, with the same number of turns, sections and wire size, using the same patented Dynaco winding method, and made on the same core size and material. All have the requisite ultralinear screen taps.

Dyna Clone power transformers use improved insulation technology and 100% solids resin (no dripping wax!) impregnating to provide transformers that run cooler & quieter than the originals. Bolt in replacement installation, no cutting or drilling.

See and read more at www.triodeelectronics.com

Dyna Clone Power Transformers

PA211 Upgrade and Replacement transformer for Dynaco PAS2, PAS3 and PAS3X preamplifiers.

PA522 International export version of PA211 with "universal" 120/240V 50/60 Hz primary.

PA774 Upgrade and Replacement for ST35 and SCA35

PA060S Improved replacement power transformer for ST70

PA135 replacement power transformer for Dynaco (tm) Mark 4.

P782S replacement power transformer for Mark 3 and Mark 2

C354 Exact replacement for chokes in ST70, Mk2, Mk3 and Mk4

Dyna Clone Output Transformers...compare price,

quality, weight & specs to comparably priced mass market transformers. Why settle for generic when you can have a classic?

Z56548 Reproduction of the Z565 output transformer as used on the ST35 and SCA35 amplifiers, except that the output taps are **4 and 8 ohms**

A470S reproduction of the Dynaco A470 output transformer as used on the Dynaco (tm) ST70 and MkIV amplifiers

A431S a reproduction of the Dynaco A431 output transformer as used on the MkII and MkIII amplifiers and Sunn guitar/bass amplifiers.

Other stuff we sell: Tubes, Sockets, Other upgrade/replacement Parts.

the amp running OK.

My minimalist knife is evident at the output, where there is no inductor. Such is the advantage of a simple amplifier with no global NFB. I have left the “conventional” output filter C5/R13, which rolls off the output gently at high frequencies. I have no real evidence to say that it is necessary, similar to the grid resistor.

SUPPORT PERSONNEL

The diode/zener tree D4-7 protects against the MOSFETs being accidentally turned on hard. C4 performs a dual function, ensuring that both FET gates see the same voltage. It also acts in combination with the bias resistors to gently ramp up the voltage to the gates to gradually turn on the FETs (taking about 5s after the power is applied).

The rail fuses, which are open to debate, are essential when you first build the amp and may provide some long-term protection. But fuses have a nasty habit of blowing just because it's Tuesday. If only one blows, it can lead to a

nasty DC voltage at the output, so it may be wise to remove them once the amp is bedded in.

The dual LED is entirely optional and displays red when only the heaters are on and amber (both red and green halves on) when fully on.

POWER BLOCS

While the active part of this amp is simple, the need for three or four separate power supplies adds significantly to the complexity and cost (\$800 ballpark). This isn't entirely a bad thing as I'm a strong believer in having separate supplies for power amp driver and output stages—here they occur by default.

Input: IEC 1 is a combined IEC power inlet socket and filter unit rated at 6A (230V); it is snubbed by a voltage dependent resistor to further take out voltage transients. While both of these are optional, I recommend them or at least some form of input filtering. SW2 has a “standby” position that enables the heaters to be warmed prior to turning on the HT. Here I've used a separate heater

transformer, but if you have a combined HT/heater transformer, you may choose to switch the HT by relay, ideally with a delay mechanism.

Heater Supply: LM317 regulators provide a cheap, clean DC supply to the heaters, but because they are dissipating a couple of watts, they must be heatsinked. One of the nice aspects of 6SN7s (over 6DJ8/E88CCs) is that they can stand 200V from the heater to cathode, so there is no need to jack up the supply (or worse, limit the HT rail). However, if you are using “dual” 6SN7s as I have, with heaters in series, I suggest using the grounded heater for the lower valve. You may need to adjust the exact value of R14, depending on the “sag” of your heater transformer secondary.

HT Supply: I've shown a pretty conventional supply here based on a 230V transformer secondary to give ~300V. But if you are starting from scratch, you may consider running a rail closer to 400V (possible with the 200V heater/cathode voltage limit). The actual capacitor values are pretty arbitrary, but I don't

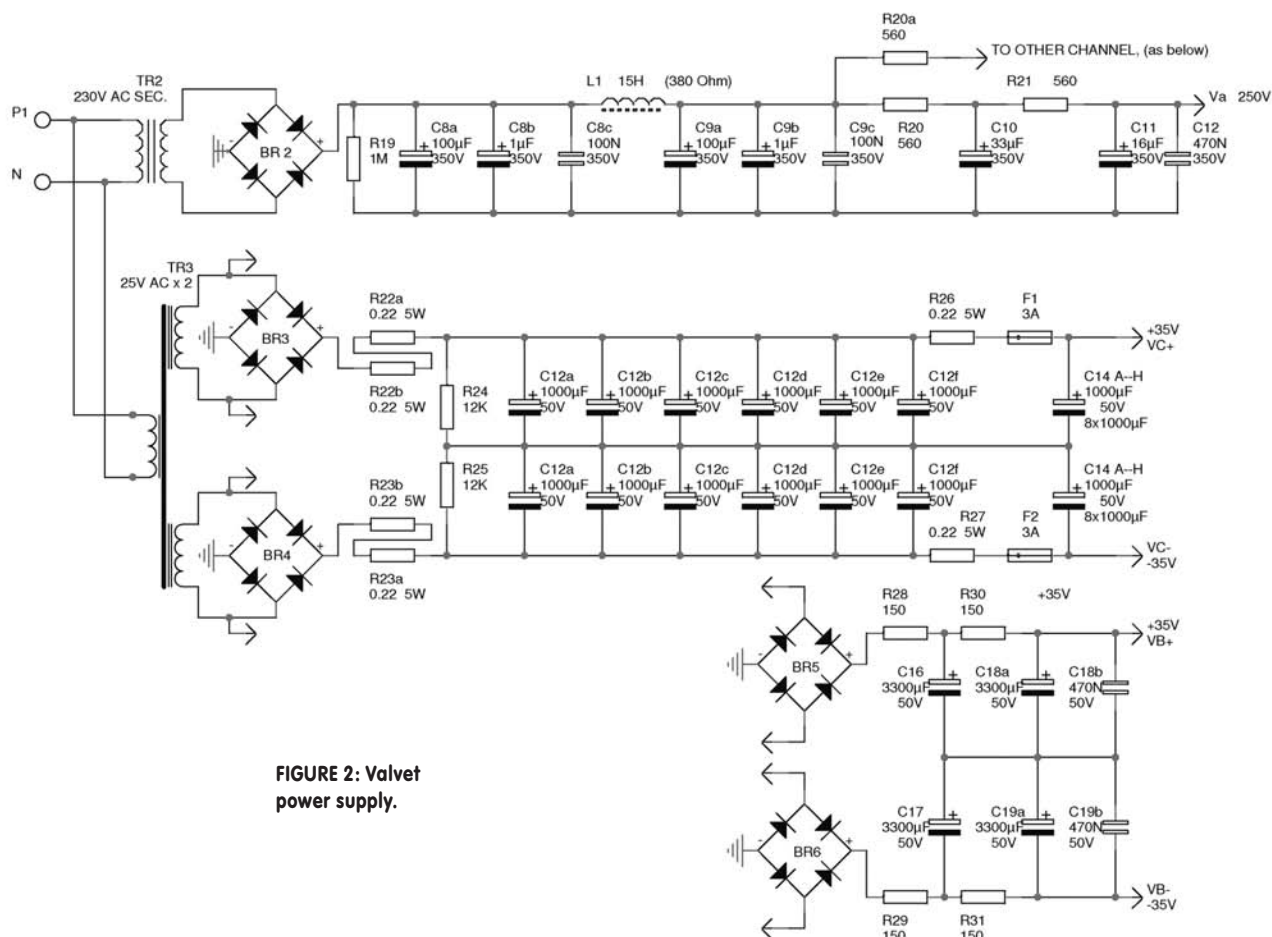


FIGURE 2: Valvet power supply.

G-2750-2

recommend using much less than I have here. If you want to avoid the inductor, you should consider more capacitance or a regulated HT supply.

MOSFET Bias Supply: Because I wanted to keep the biasing as stable as possible, I incorporated a separate power supply for the MOSFET biasing. This avoids the potential of being disturbed by the output. I haven't actually used a separate transformer (if you do, choose one to give slightly higher voltage rails than the main MOSFET supply), but the separate bridge rectifier alone gives good isolation. If all this seems unnecessary or expensive to you, you can attach the biasing resistors to the "main" voltage rails.

MOSFET Power Supply: Having been brought up in the 1980s low impedance school of amplifier design, I've now undergone somewhat of a sea change and can be caught sneaking resistors into power supplies. A small amount of resistance dramatically improves the effectiveness of the

filtering. The resistor immediately after a rectifier further helps by increasing the conduction angle of the diodes even if you "lose" voltage. But you're free to experiment without the resistors.

I chose to use banks of paralleled capacitors rather than single large value caps to give low impedance. I'd already (less scientifically) chosen these Panasonic NHG 1000 μ F (50V) capacitors before Paul Stamler's helpful article⁶ in *aX* which also uses them in parallel. I considered 10,000 μ F a minimum value,

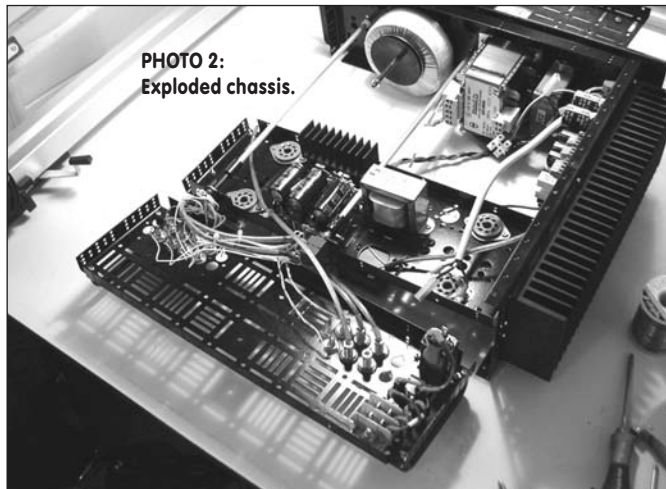
with money and space being the upper limit. I ended up using two 160VA transformers, which is about the minimum size I'd suggest for the bias level I used. These gave ~80W into 4 Ω before clipping. To avoid blowing fuses on power-up, I used a NTC thermistor in the feed to the MOSFET power-supply transformers.

Rectifier Choice: To avoid high-frequency noise from the rectifiers, I prefer to use Schottky diodes, but failing that, fast/soft recovery ones. If this is difficult or you remain skeptical,

use snubber capacitors across regular diodes. I originally planned to use a tube rectifier for the HT supply, but this limits the possible capacitance at its output (although it does provide a desirable slow HT start-up).

AN EXPLODING CHASSIS

I must declare my involvement in the ezChassis used here to house the Velvet (**Photo 2**). This is not surprising, since I designed it



AROUND the DCX-2496...

A DCX-2496 is THE affordable high performance audio DAC coupled with a powerful loudspeaker management processor. It is the ultimate tool for those seeking the audio perfection.

To improve on the audio performance of the DCX, **Selectronic** offers a range of high end kits for the DIYer. Very easy to assemble (no SMD) and minimally invasive on your DCX. The results are outstanding !

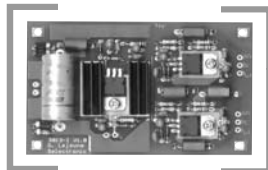
I/O board »

- Upgrade your DCX-2496 with this I/O board. Completely transparent, just Plug & Play. Uses top of the line circuitry.



« Precision analog power supply

- Decrease noise and improve stability with this supply designed for DSP circuits.



Ultra-low jitter clock »

- This clock circuit uses a high performance TCXO with less than 10ps jitter resulting in extremely detailed sound.



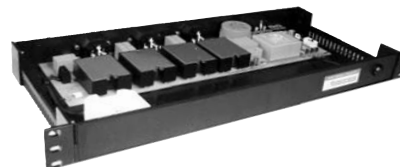
And MORE...

• 6-channel R/C volume control



- Highly transparent Technology uses pure "Class A" I/O audio J-FET buffers and special ALPS motorized pot • ± 3 dB level adjustment on each channel • Infrared R/C • Zin : 47k Ω • Zout : 600 Ω • Easy assembly • Compatible with any DSP or 5.1 system

• Sequential mains switch



- Switch your audio installation on or off without noise, thumps, or spikes • Turns on the various parts of your system in a safe order • Avoids dangerous transients in your speakers



Selectronic
L'UNIVERS ELECTRONIQUE

Outstanding kits for the DIYer

More information : www.dcx2496.fr / www.selectronic.fr

after frustration with previous amplifier projects. Of course, if you've got the time/skills, you can build it into any old box that suits you and skip this section.

Here I have used the 120mm (~5") high ezChassis and matching 100mm × 300mm (4" × 12") heatsinks. Part of my thinking behind ezChassis was to make it possible to remove individual panels for servicing. Many audio enthusiasts like me forever want to try out some improvement or other. This feature helped in construction because I was able to build and test it in modules before final assembly.

I haven't provided a "step by step" construction guide here; otherwise, this article would be considerably longer. In this form this amplifier is not suitable for a novice builder (but I may yet offer a PCB-based kit in the future). I will offer a few general comments, which won't be news to old campaigners:

- Build and test the tube driver separately. I built mine as a hard-wired unit including the coupling capacitors on one "Tube Mounting panel" (**Photo**

3). I can't pretend that I didn't need to drill any holes, but there were very few because this panel is provided with mounting holes for octal and B9A tube bases and a raft of slots and holes which proved useful. In hindsight, I should have mounted this panel vertically (not horizontally) to support the back end of the shaft extension.

- To keep the signal path short I used shaft extensions to mount the input switching and volume pot at the back of the chassis, enabling the back panel to be built up as another module. The front end is supported by the structural panel behind the cosmetic front panel (**Photo 4**). I found it easiest to install all the back panel components, including handles

(because the amp weighs ~35 lb) before attaching it to the other panels. Knock-outs are provided for the IEC mains entry and labels (supplied with ezChassis) are used to blank off unused holes (**Photo 5**).

- Because the panels have baked on paint, I locally scraped paint off (under screw heads) to ensure they were earthed.

- I built the power modules on PCB "spot" board (I don't know the "correct"

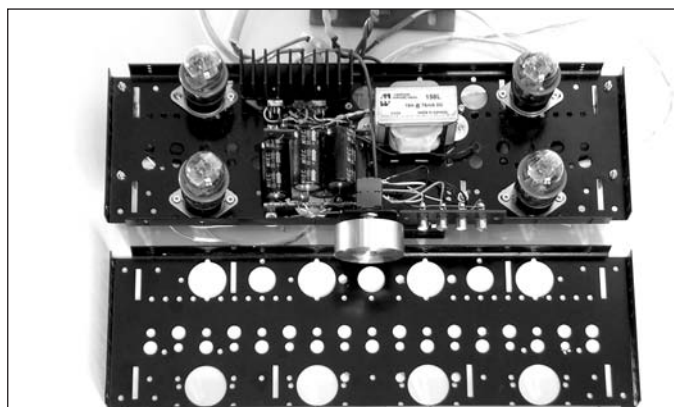


PHOTO 3: Tube mounting panel from above (and blank panel).

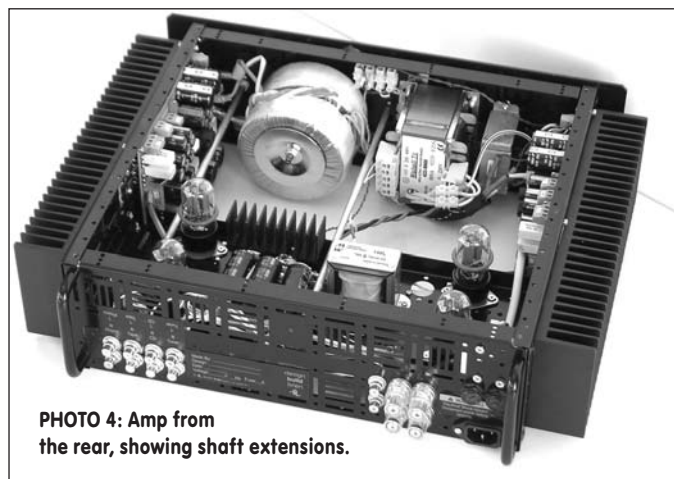


PHOTO 4: Amp from the rear, showing shaft extensions.

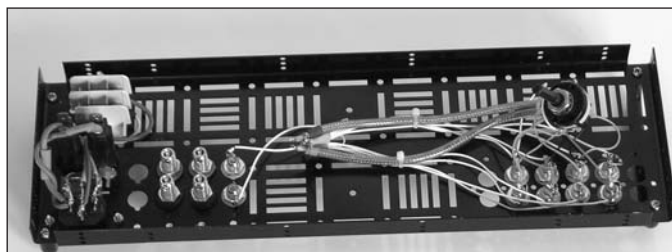


PHOTO 5: Back panel before installation (and labels).

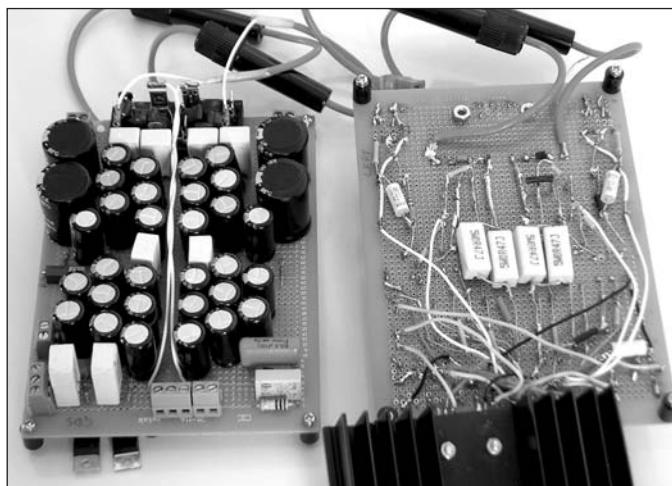


PHOTO 6: Power module on "spot board."

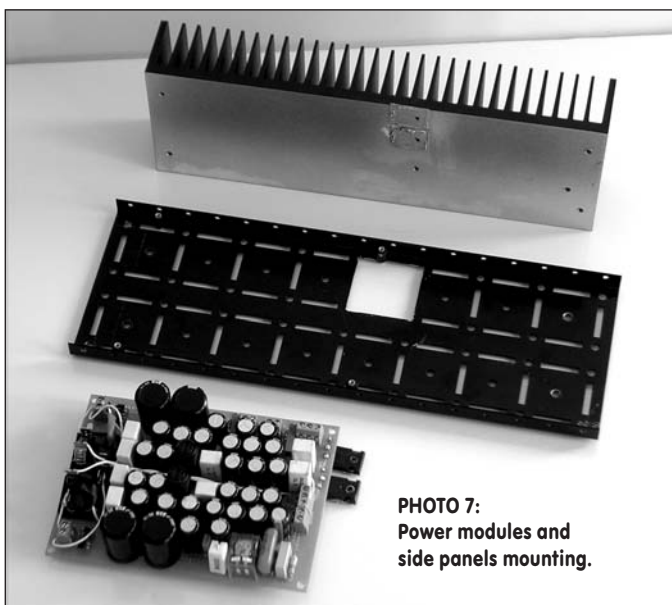


PHOTO 7: Power modules and side panels mounting.

[illegible]audioXpress March 2007 **21**



FIGURE 4: Distortion components of a 1kHz signal at 50W into 8Ω (54V pp).



PHOTO 8:
Complete amp
without cover.

name), which makes it easier to deal with wiring up all those capacitors. This board is a recent discovery for me and I'll enthuse about it to anyone.

I assume I'm not alone in spending hours hunting unintentional joins in "stripboard" and even more time replacing the components I blew up when I missed one. This board enables you to use the small solder pads around each hole to locate the components while enabling hard wiring. Its holes are at a standard pitch

that enables you to place many electronic components without drilling extra holes (**Photo 6**). I then mounted these boards on standoffs on the side panel with a section "knocked out" to access the heat-sinks (**Photo 7**).

• I (re)learned a lesson when building this amp. Don't recycle components. It's not worth it. I spent hours trying to figure out a problem with the HT supply. It was due to some dodgy capacitors.

TEST FIRING

As I mentioned, I built and tested the tube stage separately (heater first then HT). Similarly I strongly suggest a step-wise approach to each channel of the power section. I tend to use a protective RCD until I've confirmed that all is well (keeping my finger poised on the off button while looking for trouble).

• Before placing the FETs, try the other parts of the circuit. The independence of the bias supply enables that to be tested first. Check for the 6-9V adjustment across the gates (TP1) before turning down to the minimum value (around 6V). Next check the main MOSFET power supply before installing the FETs. With any power supply, I usually flick my multimeter over to AC volts after confirming the DC value; this is a simple noise/hum check. You should get a near zero reading (though my Fluke multimeter gives more sensible results here than my "El Cheapo" meter).

• After connecting the MOSFETs (and attaching them to the heatsink), check once again that P3 is adjusted to zero before powering up. You need two multimeters (even cheap ones) at a minimum, because it's pretty handy to be able to watch the gate voltage (TP1) at the same time as the bias voltage drop across R11-12 (TP2). There should be no voltage across these resistors when you start (the FETs are turned off).

Adjusting P3 upwards, when the gate voltage gets to around 7.2V current should start to flow through the FETs. But note that IR's datasheets give this turn-on point a very wide 4-8V tolerance, so do this very gradually. Stop at about 150mV and watch until you are sure it's stabilized. (You can do this without the valve driver stage or speakers connected.) This is about the minimum level of bias. I chose 0.44V (~1A)

The NEW

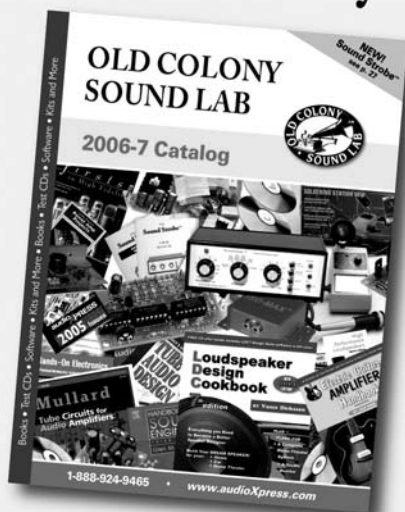
Old Colony Sound Laboratory CATALOG

You'll find:

- Over 150 books and CDs on audio technology
- New test CDs
- Software for design and measurement
- Sound Strobe and more test equipment

■ To receive your copy call
1-888-924-9465
or request one on-line at
www.audioXpress.com

NOW AVAILABLE!



Old Colony Sound Laboratory, PO Box 876, Peterborough, NH 03458-0876 USA
Toll-free: 888-924-9465 Phone: 603-924-9464 Fax: 603-924-9467
E-mail: custserv@audioXpress.com www.audioXpress.com

FIND THE ENTIRE PRODUCT SELECTION ON-LINE AT
www.audioXpress.com

for my heatsinks. You should watch very carefully over a few hours that it's stable (I checked on each start-up for the next few days).

- Check the DC offset across the output terminals and adjust P2 to get it near zero (I try to keep it below 50mV) before connecting speakers.

TCHAIKOVSKY ENCORE

Describing the sound of your own gear is full of obvious dangers. But suffice to say its sound is somewhat "hybrid" too, having a "valve" midrange but a "transistor" bass end (if a little "softer" due to the lack of global feedback). The Velvet amp (Photo 8) proved to be a nice match for a friend's Thor transmission line speakers, driving them comfortably. With my newly built Fostex full range driver speakers (93dB+), I've been caught grinning like a James Bond villain who has just perfected his Death Ray.

Conversely at home I hear musical detail I haven't noticed before. This isn't detail for its own sake but more the big musical picture, seeing how the parts/harmonies fit together in a coherent sense. One of the things that surprised me was how quiet the amp is. Other amps I've used are apparently silent, but here delicate music is audible against a dark background.

The new amp is great; it no longer makes cannon fodder of Tchaikovsky.

Thanks to Alan, Richard, Julian, John, Phil, and Jean for helping me with suggestions and support for the amp and this article.

Trademarks: "Velvet" and "ezChassis" are Trademarks of Design Build Listen Ltd. *aX*

REFERENCES

1. "Valve PreAmplifier," J.P. Guls, *Elektron*, March 1987.
2. Letter to the Editor, Christopher Paul, *The Audio Amateur* 4/85.
3. *The Tube Preamp Cookbook*, Allen Wright 1995.
4. *Valve Amplifiers*, Morgan Jones 2003, p. 126.
5. "Design a High Performance Valve-Based Line Amp," Chi C. Wong, *audioXpress* 10/05.
6. "Capacitor Bypass: Proceed Carefully," Paul Stamler, *aX* 5/05.

TEKTRON-ITALIA

Distributors:

USA & Canada:

Robin Wyatt

Basking Ridge, New Jersey, USA

Tel: +1-908-334-3241

Fax: +1-866-576-3912

Email: info@robbyattaudio.com

Web: <http://www.robbyattaudio.com>

Germany:

Frankfurter Hörergesellschaft

Peter Steinfadt

An der Luthereiche 8

D-63110, Rodgau, Germany

Tel: +49-171-58-03-718

Fax: +49-171-58-03-718

Email: info@hoergesellschaft.de

Web: <http://www.hoergesellschaft.de>

Singapore:

Aural Designs

1 Coleman Street, #03-11 The Adelphi,

Singapore 179803

Tel: +65-6339-0134

Fax: +65-6234-0134

Email: ADesigns@singnet.com.sg

Web: <http://www.aural-designs.com>

**Hi-End Tube Amplifiers
designed and handmade
one at a time in Italy**

www.tektron-italia.com



AUDIO TRANSFORMERS

AMERICA'S PREMIER COIL WINDER

Engineering • Rewinding • Prototypes

**McINTOSH - MARANTZ - HARMAN-KARDON
WESTERN ELECTRIC - TRIAD - ACRO SOUND
FISHER - CHICAGO - STANCOR - DYNACO
LANGEVIN - PEERLESS - FENDER - MARSHALL
ELECTROSTATIC TRANSFORMERS**

FAIRCHILD 660/670 RCA LIMITERS

**WE DESIGN AND BUILD TRANSFORMERS
FOR ANY POWER AMPLIFIER TUBE**

PHONE: [414] 774-6625 FAX: [414] 774-4425

AUDIO TRANSFORMERS

185 NORTH 85th STREET

WAUWATOSA, WI 53226-4601

E-mail: AUTRAN@AOL.com

NO CATALOG

CUSTOM WORK