

Beyond G4OEP: Improving a Flea-Powered Headphone Amp

This headphone amp upgrade adds four relay-selectable inputs, a numeric display, a phono-preamplifier stage, and an auxiliary output.



PHOTO 1: The G4OEP.

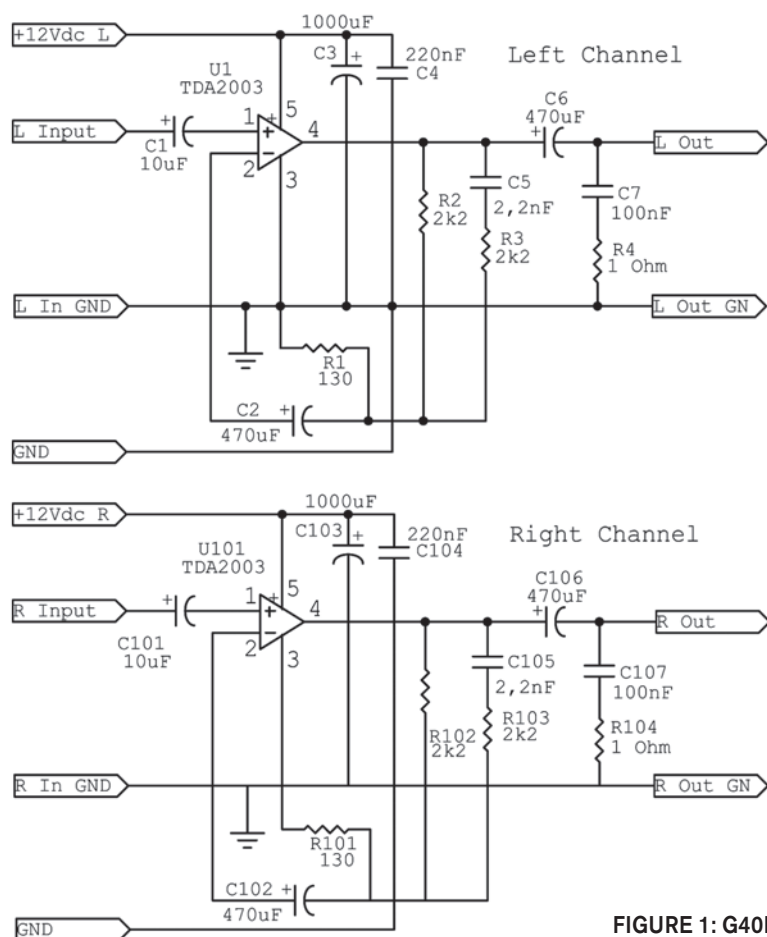


FIGURE 1: G4OEP.

First of all, I wish to thank Aren van Waarde (and Dr. Smith, a.k.a. G4OEP) for his article on the G4OEP (March '08, p. 36). Yes, I accepted Mr. van Waarde's challenge and built the headphone amp. After powering up the circuit, I was amazed what I heard!

This amp is so simple and clean—no magic—with a straightforward circuit (a little bit different from TDA2003 manufacturer suggested topology) that works very well.

I must confess that the circuit did not hold my attention at first look. After two weeks, I decided to search for the parts in my junk boxes and put everything together. The components are easy to find, with neither one “white-fly” nor esoteric “audio grade” component. In a few hours of heat and some smoke, the circuit was working very well, to my surprise. In fact, this simple circuit surpassed my expectations.

So, I decided to add the following improvements:

- Multiple selectable inputs
- Phono (MC) preamplifier with RIAA passive network
- Volume control
- Visual indication to selected input (a LED seven-segment subminiature display)
- Auxiliary output (to feed my single-ended “A-class” 47 triode mode amplifier)
- A reasonably fine-looking cabinet

CIRCUIT FEATURES

You can analyze these improvements separately in five parts:

1. The G4OEP, a TDA2003-based low-gain amplifier (see the *aX* article for more details)

2. Power supplies: two separate single +12V DC to each G4OEP and one dual $\pm 12V$ DC for the phono stage
3. The phono stage itself
4. The MUX and digital section
5. The cabinet

G4OEP

This is the same circuit as in the *aX* article. But, due to the difficulty of finding R1/R101 (130Ω), I mounted a 270Ω in parallel (135Ω), which worked fine. Basically it's a TDA car audio power amplifier operating at low gain so the quiescent point leads the amp to work at "A-class" in a very linear region of its transference curve. See **Fig. 1** and **Table 1**.

POWER SUPPLIES

As I said before, I used three power supplies. Two of them are identical (**Table 2** and **Fig. 2**), and a symmetrical (positive and negative) one for the phono stage (**Table 3** and **Fig. 3**). These small transformers rated to 500mA are so simple, like all the circuitry discussed here.

For the positive ones I used transformers rated to 110V AC/15V AC, single secondary coil. For the phono stage power supply, I used an 110V AC/15+15V AC center-tapped. In the symmetrical power supply for the phono stage, all transformers are in parallel with the mains, S0 and F1 circuit.

PHONO STAGE

I have found many interesting circuits at the ESP website. While searching for an RIAA passive network preamp, I encountered Mr. Elliot's web pages, which included an interesting topology that I changed by substituting the original Burr-Brown chips to the common TL074 (Texas Instruments). My objective was to simplify the original cir-

TABLE 1: CIRCUIT PARTS LIST

Component	Attributes	Designation
$10\mu F \times 25V$	Polyester	C1, C101
$470\mu F \times 16V$	Electrolytic	C2, C102, C6, C106
$1000\mu F \times 16V$	Electrolytic	C3, C103
$220nF \times 100V$	Polyester	C4, C104
$2.2nF \times 100V$	Polyester	C5, C105
$100nF \times 100V$	Polyester	C7, C107
TDA2003	Power car audio chip	U1, U101
130Ω	Metal film $\frac{1}{4}W$	R1, R101
2k2	Metal film $\frac{1}{4}W$	R2, R102, R3, R103
1Ω	Metal film 1W	R4, R104

TABLE 2: POSITIVE POWER SUPPLY

Components	Attributes	Designation
$100nF \times 250V$	Polyester	C1-4, C6, C101-4, C106
$4700\mu F \times 25V$	Electrolytic	C5, C7-9, C105, C107-9
1N4007	Si rectifier diode	D1-8
7812	1A positive regulator	U1, U2
1A	Glass $5 \times 20mm$	F1
$5 \times 20mm$	Fuse-holder panel mount	F1
110/220V-0/15V $\times 7.5VA$	Single secondary	T1, T2
IEC male plug 3-pin	Panel mounting	V AC

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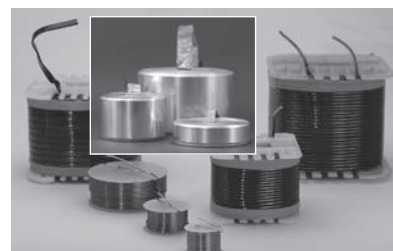
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TABLE 3: SYMMETRICAL POWER SUPPLY

Component	Attributes	Designation
100nF × 250V	Polyester	C1-4, C101-4
4700μF × 25V	Electrolytic	C5-7, C105-7
1N4007	Si rectifier diode	D1-4
78L12	400mW pos regulator	U1
79L12	400mW neg regulator	U2
110/220V 15/0/15V × 7.5VA	Center-tapped secondary	T1

TABLE 4: PHONO STAGE PARTS LIST

Components	Attributes	Designation
22μF × 16V	Electrolytic	C1, C3, C101, C103
22nF × 100V	Polyester	C2, C102
82nF × 100V	Polyester	C4, C104
1μF × 25V	Bipolarized	C5, C105
47k	1% metal film ¼W	R1, R101
2k2	1% metal film ¼W	R2, R102
4k7	1% metal film ¼W	R3, R103
180k	1% metal film ¼W	R4, R104
10k	1% metal film ¼W	R5, R105
2k7	1% metal film ¼W	R6, R106
100k	1% metal film ¼W	R7, R9, R107, R109
820Ω	1% metal film ¼W	R8, R108
TL074	Quad-operational amp	U1

cuitry that uses four single audio grade op amps from TL family (quad in a 14 DIP package).

The result was very good: No PCB layout, everything was mounted in a perfboard (pad pattern, instead of track pattern) with ground plane provided by aluminum foil (used for cooking and glued with glue-stick inside the cabinet and correct grounded in a single point). The schematics I used are in **Fig. 4**. See also **Table 4**.

At Mr. Elliot's website (<http://sound.westhost.com/project06.htm>), you can find more information about RIAA accuracy and other significant parameters. If you want to improve the phono pre-amplifier according to your needs, drop a note to *aX* and let us know what you did. The phono circuit has deep clean bass and affordable mids (voice is very clean), the highs are very honest, too. You will soon note the huge differences of recordings among your vinyl records.

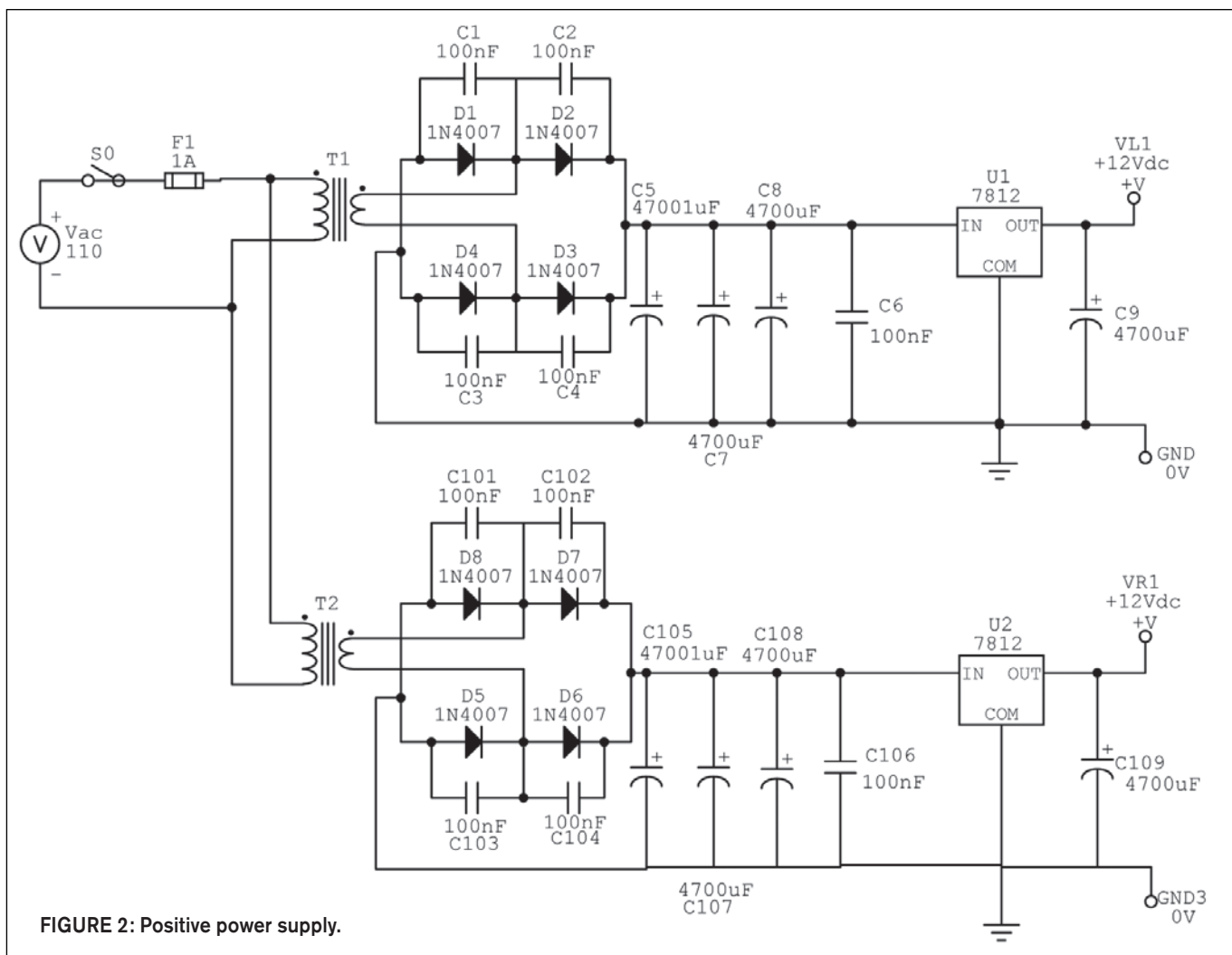


FIGURE 2: Positive power supply.

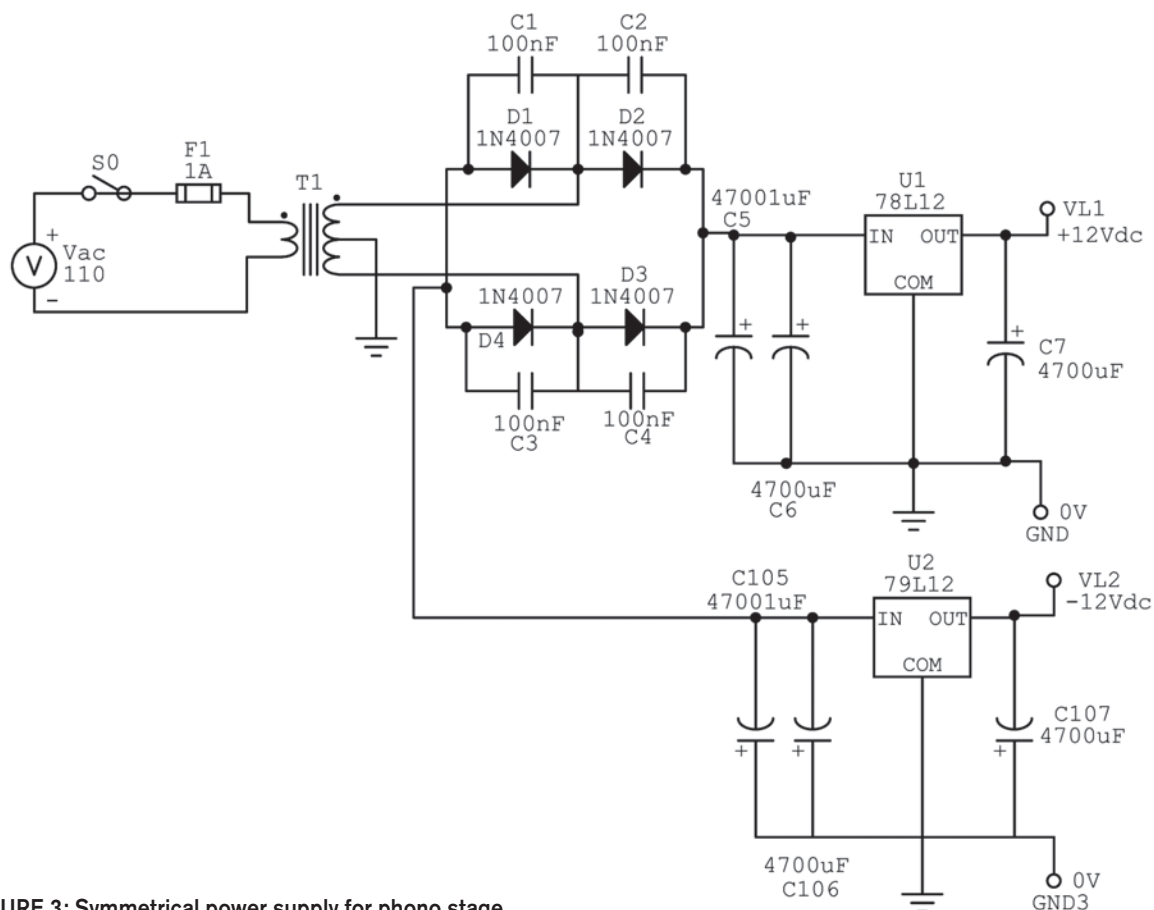


FIGURE 3: Symmetrical power supply for phono stage.

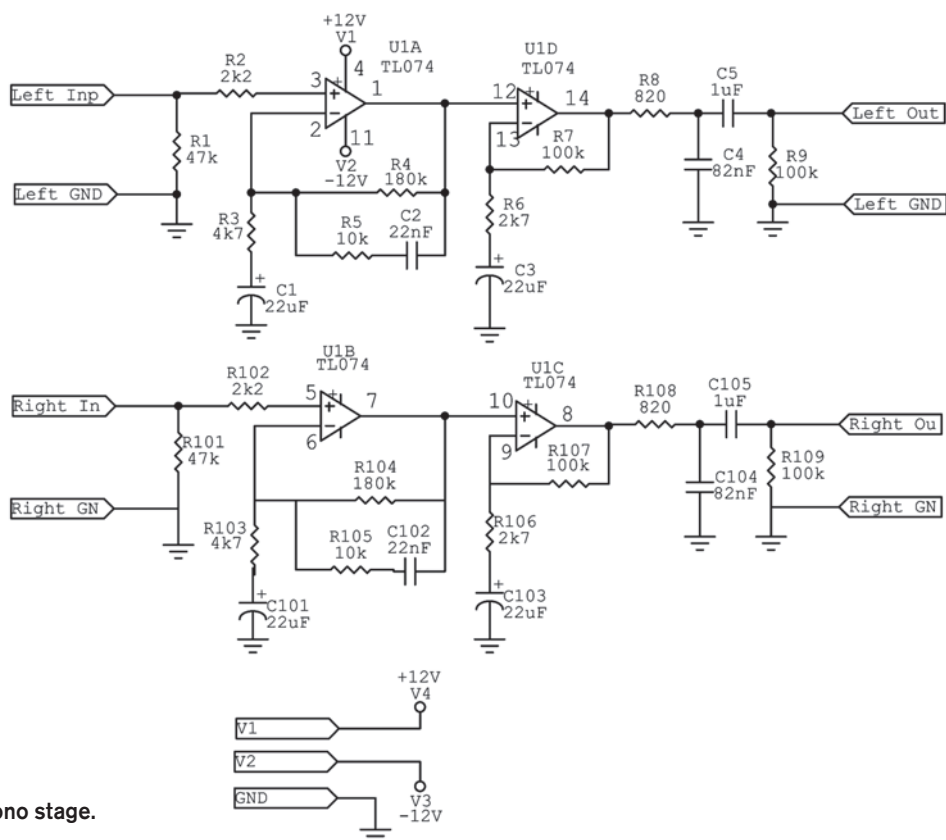


FIGURE 4: Phono stage.

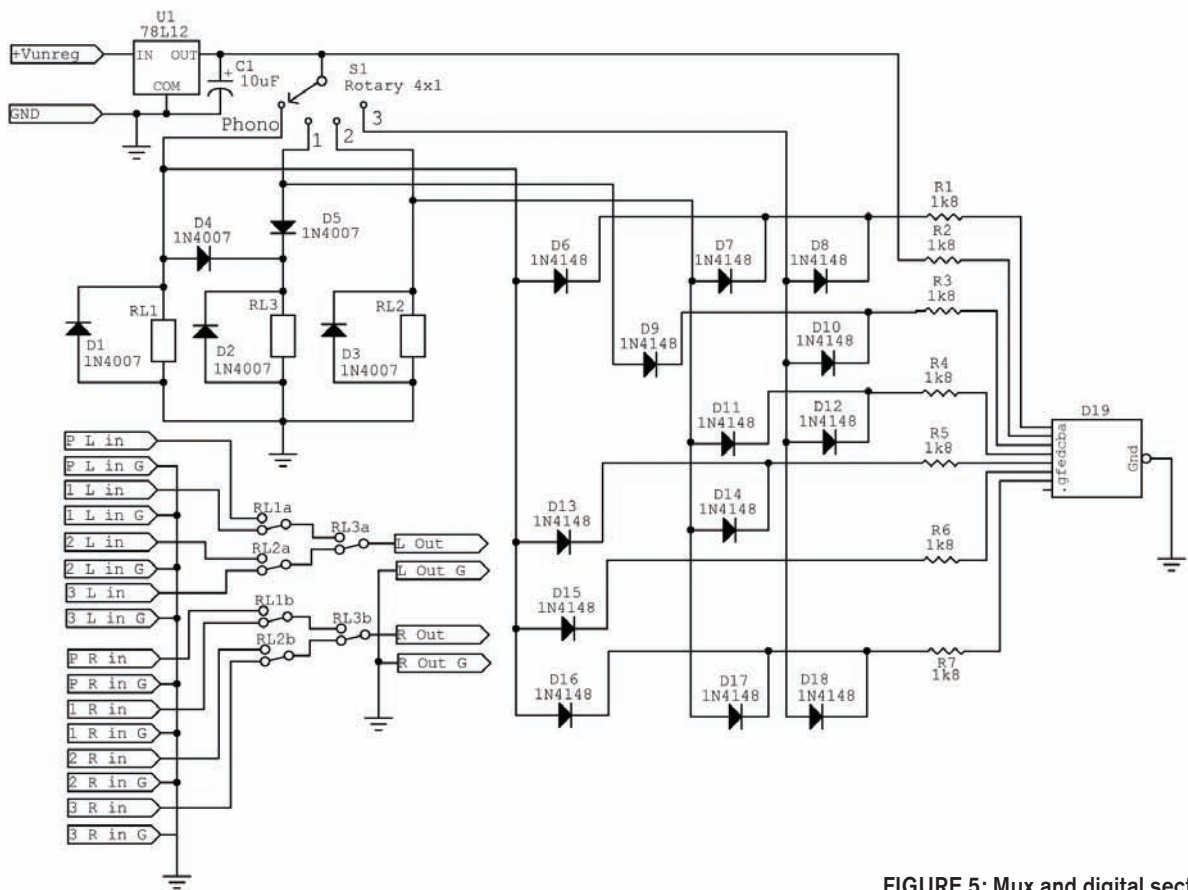


FIGURE 5: Mux and digital section.

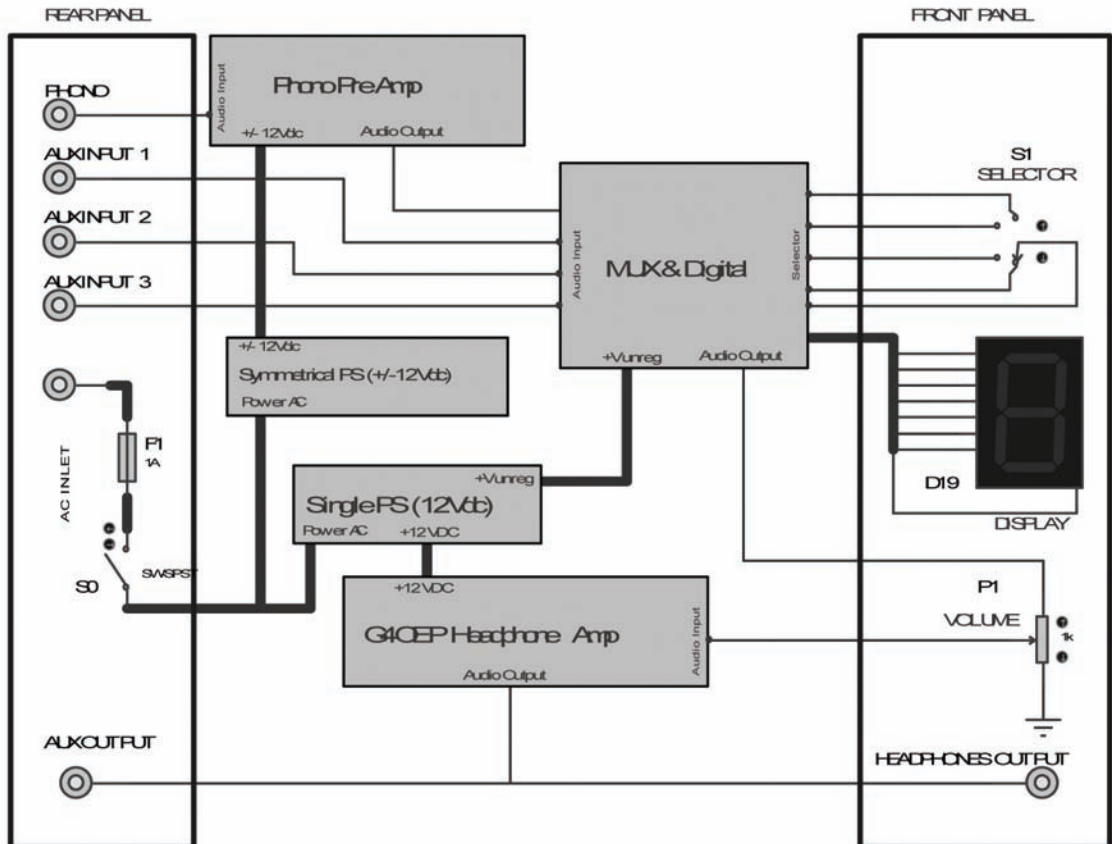


FIGURE 6: Connections diagram.

MUX AND DIGITAL SECTION

I needed to use my headphones with the following different sources: a Marantz CD-63SE CD player, a Pioneer VSX-4800 tuner, a Marantz SD-535 dual tape deck, and a turntable (Garrard B2-FG and/or a Thorens TD-166). So I decided to build a relay circuitry to do this and more. Small numbers around the selector switch were not an option, because I needed to see the selections from a distance. **Figure 5** and **Table 5** show the MUX and digital section.

I used three small sealed reversible relays with two sections NO-NC each, to do the job, commanded by the S1 rotary switch and the “OR logic” provided by some diodes in a simple and old-fashioned way. I used the same approach to command the D19 (seven-segment CC display). Depending on the S1 position, D19 displays “P” for phono input or “1,” “2,” or “3” for auxiliary direct inputs.

Note: If the switch is in the P (phono) position, all relays are displayed “off” in the schematics. This is to facilitate construction, regarding normally open (NO) and normally closed (NC) contacts, depending on the kind of relays you are using.

D19 is an LED seven-segment common-cathode (CC) device. I used a subminiature one (10mm × 7mm). As you can see, I used a LM78L12 TO-92 small regulator, because I supplied the power for this perfboard from unregulated +12V DC (in fact, 18V DC unregulated—taken before U1 or U2) from the G4OEP power supply. You can choose any one unregulated source to feed the MUX; left or right will work fine. I experienced no audible interference.

CONSTRUCTION

The cabinet is a simple MDF box with five faces, no bottom end, covered with Curupixa (pronounced Kooroopyshah, a Brazilian wood) darkened foil. I machined all holes in the MDF box from the inside before mounting. After machining, I covered the box and the wooden foil with contact glue (beware of poisonous vapors when using), let them dry for ten minutes, and carefully applied the foil over the box with a metallic, smooth, rounded mass to eliminate air bubbles between the MDF and the covering.

I then applied glue to a ground-plane made from aluminum cooking foil and covered the inner box surface with glue from a glue-stick. Some sanding work and carnauba-wax application guarantees a natural opaque finish.

I chose the chicken-head style knobs to give a vintage look to the G4OEP headphone amplifier. I also built a pair of acrylic round washers (30mm diameter, 2mm thickness, and 5mm in length) to put around the knobs, just for aesthetics; my intention was to illuminate with LEDs

from the backside when it is powered-up.

The small white square in **Photo 2** is the display, showing the selected input from the back-panel. Finally, a grounded 2mm aluminum plate covers the bottom side of the MDF box. Small rubber feet glued on this plate sustain everything. **Table 6** lists the final parts.

Figure 6 shows the system connections (one channel shown). I hope this little challenge encourages other *aX* readers to build their own units and share the results.

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TABLE 5: MUX AND DIGITAL SECTION PARTS LIST

Components	Attributes	Designation
10μF × 25V	Electrolytic	C1
1N4007	Si rectifier diode	D1-5
1N4148	Si signal diode	D6-D18
7-seg display cath comm	Subminiature red type	D19
78L12	400mW positive regulator	U1
1k8	metal film ¼W	R1-7
12V DC 2 reversible sealed	JX2RC2 Metaltex	RL1-3
Rotary switch	EV4X1	S1



PHOTO 2: Completed headphone amp.

TABLE 6: MISCELLANEOUS PARTS

Components	Attributes	Designation
100k	LOG dual potentiometer	P1
On-off switch	SPDT switch 220V AC at 1A	S0
Aluminum plate	150 × 260 × 2mm	
Aluminum foil	Half square meter	Ground plane
4 rubber feet	20 × 10mm	
RCA connector plate	4 dual female	4 selectable inputs
RCA connector plate	1 dual female	Auxiliary output
2 knobs	Chicken-head style/beige	Volume and Input selector
P-10 stereo jack output	Connector to headphones	
Power cord for IEC connector		
MDF 15mm thick box	190 × 95 × 270mm (DHW)	5 sides (without bottom side)
2 Acrylic washers	30mm diameter 2mm thick	