Audio Innovations P-2 phono amp modification.

by Peter van Willenswaard

The Audio Innovations P-2 phono preamplifier is the brother of the L-2 line amp. The L-2 is basically an L-1 fitted with an elaborate shunt regulated power supply, the amplifier part of the L-1 and the L-2 being identical. The P-2, however, is not a similar upgrade from the P-1: the P-2 amplifier part is a new design, with different valves plus a volume control and a line stage. See figure 1 for the schematic diagram of the P-2.

The P-2 does have the same shunt regulator as the L-2 in the power supply, but it is now preceded by a double pi-filter using two chokes instead of two power resistors. This makes sense, as the rectifier ripple suppression must be a lot more efficient here to get a low-hum supply for the phono stage.

The modification I described for the L-2's shunt supply (see the L-2 mod article on this site) also applies for the P-2, so I will not repeat that in detail here. There is one caveat, however. As chokes are used instead of resistors, the total DC resistance value from the shunt to the rectifier is considerably lower than it was in the L-2. This means that the current drawn by the shunt will be even more mains voltage dependent than in the L-2. Fortunately, the rectifier is now a valve (it was a solid-sate bridge in the L-2) which adds some 50 ohms, plus there are two 75 ohms resistors in series with the HT transformer wirings. Still, one might experiment inserting 10 W resistors of a few hundred ohms in series with the chokes, and then maybe short the 75 ohms resistors preceding the diode valve to raise the initial power supply voltage.

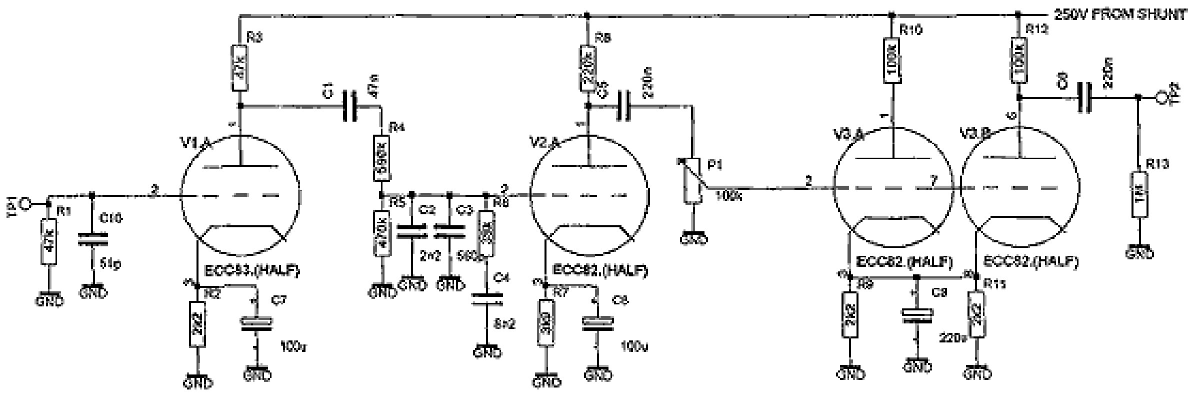

Figure 1.

Click for larger view

Also try the following: the removal of both OA2s (and the 5687) altogether! This seems counter-intuitive, as you kill this wonderful shunt part of the power supply, but I have witnessed on more than one occasion that a P-2 sounded better without than with. I can only speculate about the reason why; maybe a sensitive circuit like a phono stage doesn't like the vicinity of voltage stabilizer valves (OA2s), which do radiate to some extent? Anyway, the basic power supply with its valve rectification and the two chokes is already so nice that it apparently can do without the shunt's advantages.

Now let's evaluate the phono circuitry itself. As you can see in figure 1, all stages are fed directly from the shunt. That is very well if all were perfect, but if the 5687 or one of the OA2s is a bit noisy, this noise is directly transferred to the first and most sensitive stage (ECC83) of the phono. (I once observed some 30 mV of output hum due to a serious leakage between heater and cathode of a 5687, brand National, not my favorite....).

Also, the second valve is an ECC82 operating at 1 mA. This, in my view, is not a wise choice. The valve after a RIAA network must be almost as low noise as the input valve, due to the 20 dB attenuation of the network at mid frequencies and 26 dB at 4 kHz where the ear is most sensitive. Moreover, the RIAA network in the L-2 has an extra attenuation built-in: look at R4/R5! The gain of the ECC83 input valve plus this RIAA network will be about 6 dB at 1 kHz and 0 dB at 4 kHz, so the ECC82's noise should be better than that of the ECC83. But is worse. Far worse. Text books give various formulae for noise in triodes (expressed as an equivalent noise resistor Req), the simplest being Req = 2500/S (S in mA/V), a more elaborate one says Req = 3200*Ia/S^2 (Ia in mA, S again in mA/V). The Req for an ECC83 is about 1500 ohms, an ECC82 at 1 mA ends up somewhere between 5000 and 12800 ohms, implying a noise deterioration of between 5 and 9 dB, which is serious. I measured the L-2's S/N ratio at around 66-69 dB CCIR/RMS weighted with or without the input valve in its socket, which means that the measured noise stems entirely from the ECC82.

This, of course, calls for action. What I came up with is in figure 2. First, R3 has gone up to 120k to allow the ECC83 more 'breathing space' (it will act more linearly). This, plus changing R5 to a higher value to avoid unnecessary attenuation, implies a recalculation of R4 to 330k. I have retained the capacitor values of the original RIAA. V2 has become an ECC88. A grid stopper R11 was added to prevent spurious oscillation and R7, R8, C7 have been altered to suit the new valve. The ECC88 differs in pin-out from the ECC82 in that it wants 6.3 V of heater voltage between pins 4 and 5, not the 12.6 V meant for the ECC82. A 5 W 18 ohms resistor in series with the 88's heater will solve this problem (10 ohms in case you decide to use the very good sounding Svetlana 6N1P). Pin 9 (screen between triode halves) can be grounded.

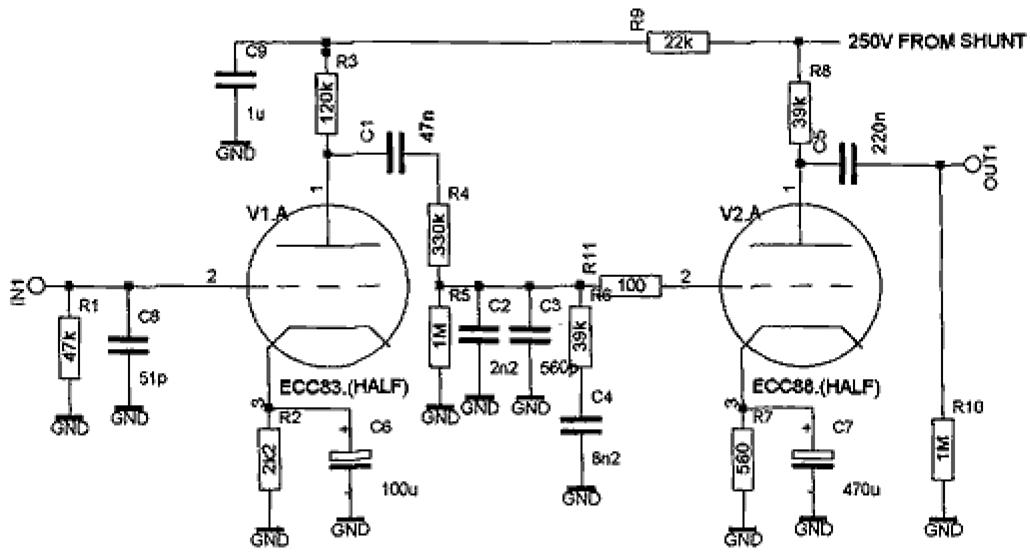

Figure 2.

As you can see, I have omitted V3, the line stage and the volume control. You only need these if you should be using the P-2 directly into an unsensitive power amp. If not, the extra components will only mean extra obstacles for our precious audio signals.

Note the insertion of an RC in the power supply line feeding V3. Though the 1 uF of C9 may look a small value, it is still 20x the value of C1 and thus large enough from that perspective. The RC corner frequency is 7.5 Hz and attenuation at 100 Hz is 25 dB, which is fair enough. So at 1 uF C1 need not be an electrolytic but can be made a film cap (I would choose paper-in-oil).

While you're at it, it might be wise to change the RIAA caps to higher quality. 2n8 (C2+C3) and 8n2 paper-in-oil caps would give a serious improvement, but you'll need to buy more than two of each as paper-in-oil caps vary widely in value, so they must be selected. Within 5% of the nominal value is to be taken as a minimum, I go for 2% or better. A less expensive alternative would be 630 V Siemens KP caps, which will offer some improvement over the caps fitted in the L-2 and which have the advantage of being very precise and thus essentially preclude the need of selection.

Some prefer the more dynamic sound (at the cost of a slightly diminished openness) of lower impedance RIAA networks. I've calculated such an alternative, see figure 3. C3 has moved to support C4 now, to make the not-standard value of 16.5 nF possible. R6 has got R6B as an assistant for the same reason. All these values are extremely critical if you want to end up with a proper RIAA equalization; only R4 (and associated resistors like R3 and R5) is less critical, and it mainly influences the bass behaviour.

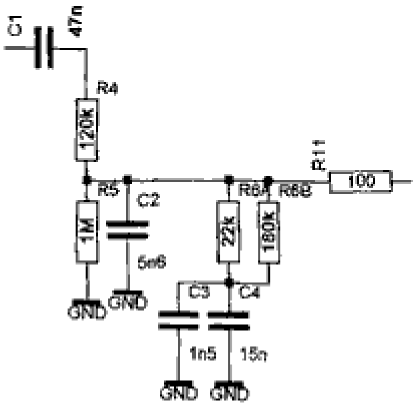

Figure 3.

If you want different RIAA values still, or end up with selected caps which are equal between channels but away from the specified values, you can calculate your own RIAA on one of the following web pages: www.kabusa.com/riaa.htm, www.anyek.com/equalization.html

Be aware that the input (series) resistor of the RIAA in a practical network is the result of the ideal input series resistor as given in RIAA calculations and a few associated ones like the internal Ri of the valve, its external anode resistor Ra (R3 in my schematics) and the grid leakage resistor of V2 (R5 in my schematics). I have drawn the situation in figure 4. The Ri of an ECC83 is about 70 k, you'll find this in data books, or in datasheets on the web. Ri and Ra are electrically in parallel, which gives 44 k. Add this to R3, which makes 374 k and parallel this value with R5. The resulting 272 k is then the net value for the RIAA calculation. For ultimate precision the Miller capacitor in V2 (40 pF in the configuration of fig.2) must be added to C2 when the values are entered in a RIAA calculation.

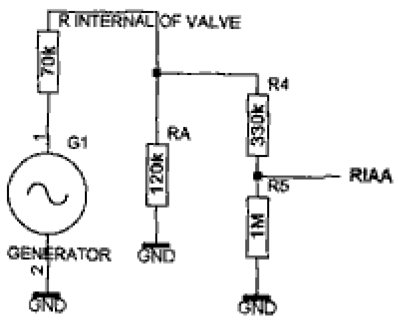

Figure 4.

The RIAA equalization of figure 2 (or 3) is within 0.05 dB exact between 100 Hz and 50 kHz, and rises slowly to +0.3 dB at 20 Hz. The original gain of the P-2 with its volume control set to max was 50 dB, my circuit of figure 2 still arrives at a healthy 42 dB. Noise of my circuit is -80 dB CCIR/RMS ref. 5 mV input with a selected low-noise ECC83 (most ECC83s are pretty silent, selecting them is no must), which is a 11-14 dB improvement over the original situation!

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