Following our description of the 12AX7 valve preamp in the November 2003 issue, we've had quite a few letters from readers asking if it can be adapted for use in a hifi preamplifier. It certainly can, and here are the details.

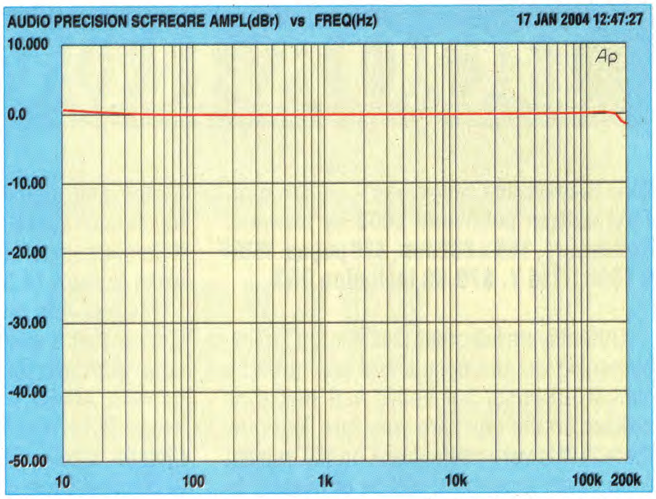


Fig.1: the frequency response features a slight rise in the low bass region and is just -1dB down at 180kHz.

Using the Valve Preamp in a hifi system

By JIM ROWE

This is the original 12AX7 valve preamplifier, as described in the November 2003 issue of SILICON CHIP. It's easy to modify for use as a hifi preamp.

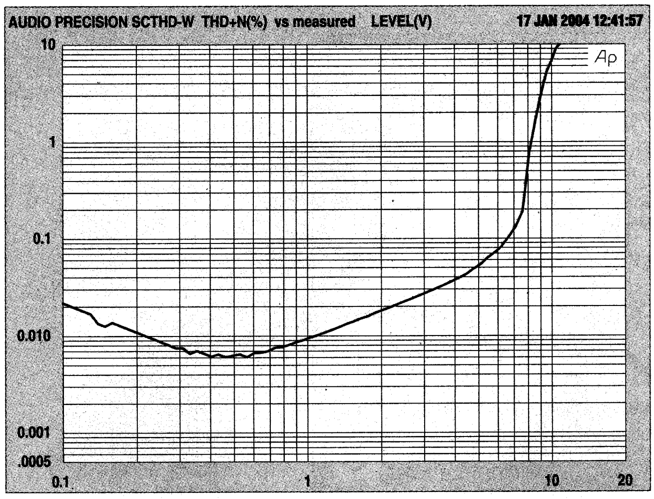


Fig.2: total harmonic distortion (THD) vs signal output. It's almost an order of magnitude better than before.

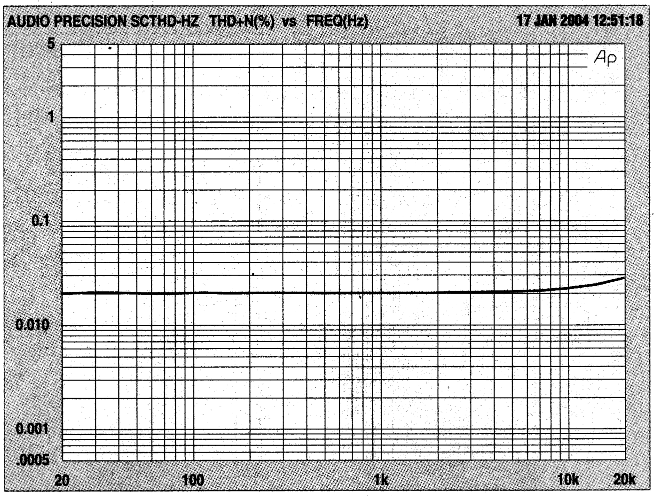


Fig.3: THD vs frequency at 2V output. Again, it's almost an order of magnitude better than the original circuit.

THE 12AX7 VALVE audio preamplifier in the November 2003 issue was "the project that we swore we would never do". This may have been a tad embarrassing but the project has proved to be surprisingly popular. It looks like quite a few more people than we expected did want to try out "valve sound" for themselves!

The November 2003 design was intended for use mainly with electric guitars and musical instruments, which is why we gave it a gain of about 60 times. But not long after the November issue appeared, we started to get letters and emails from people wanting to use two or more of the preamps with their hifi sound systems. They wanted to know how to adapt the basic preamp design for this kind of application.

As it stands, the original design has far more gain than is necessary and would be seriously overloaded by the signals from a CD player, tuner, cassette deck or whatever. To make it suitable for these "line level" signals, we need to lower the overall gain to about four times. As well, we needed to show how to fit a volume control, as the original preamp didn't provide one.

Performance

As you would expect, the changes to the circuit do bring about significant changes to the performance and these are all to the better. The frequency response is now even more extended, with the -1dB point now being 180kHz rather than 160kHz, although this is really academic. The new frequency response curve is shown in Fig.1 and this also has a very slight rise in the low bass region. Again, this is largely academic.

The biggest changes come about in the harmonic distortion and since the feedback in the modified circuit is much greater (ie, we increased the feedback to reduce the gain), we would expect to the harmonic distortion to be considerably lower. And indeed it is.

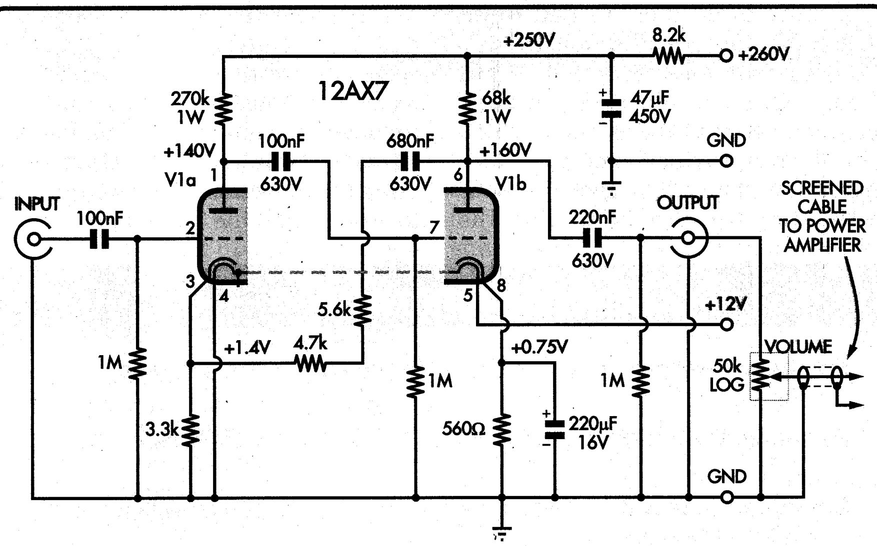
Fig.2 shows the total harmonic distortion (THD) plotted against signal amplitude and this demonstrates that is almost an order of magnitude better (ie, one tenth) than before. On the downside, the circuit can now only deliver just over 8V before clipping sets in (demonstrated by the vertically rising curve) and this is due to the increased loading of the feedback network on the plate circuit of the second triode.

Fig.3 shows THD versus frequency at a signal output level of 2V and again, it is almost an order of magnitude better than the original circuit.

Signal to noise ratio is also improved, to -99dB unweighted (22Hz to 22kHz) with respect to 2V output.

Circuit changes

In talking about the new design, we will assume that readers have access



SC ©2004 **12AX7 VALVE PREAMP** (MODIFIED FOR HI-FI USE)

Fig.4: the circuit changes are straightforward and involve changing six resistors and increasing the value of the feedback coupling capacitor to 680nF. A 50kΩ log pot has also been added for volume control.

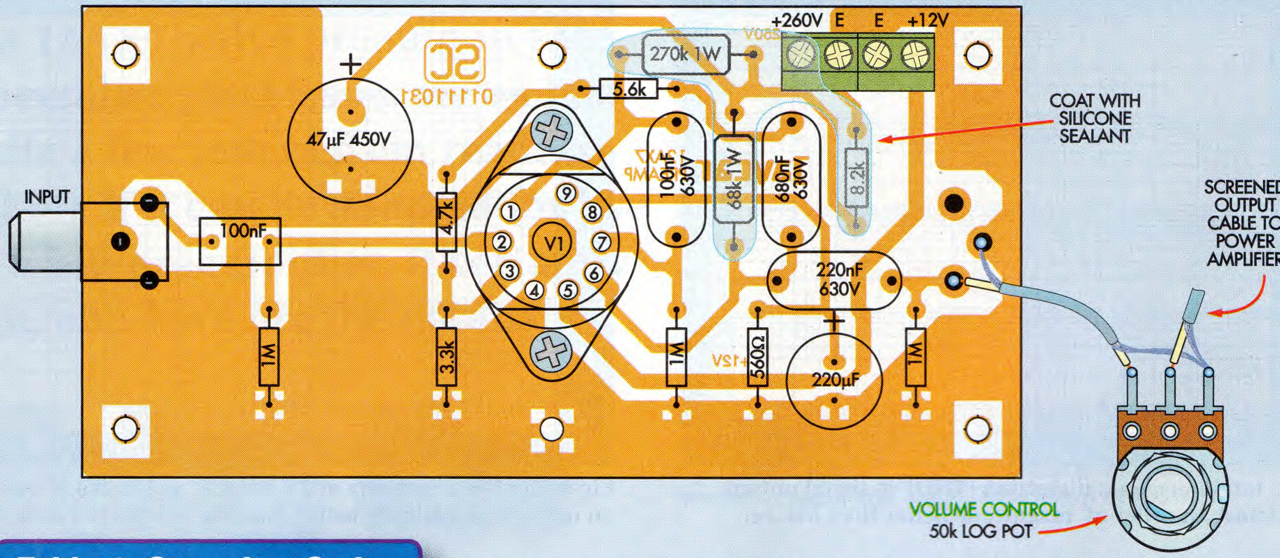


Fig.5: here's how to install the parts on the PC board and wire up the volume control. Make sure that the high-voltage components are covered with neutral-cure silicone sealant.

Table 1: Capacitor Codes

Value	µF Code	EIA Code	IEC Code
680nF	0.68µF	684	680n
220nF	0.22µF	224	220n
100nF	0.1µF	104	100n

to the full November 2003 article. Fortunately, it wasn't too difficult to modify the preamp design to lower the overall gain. As you can see from the modified circuit in Fig.4, we've mainly lowered the division ratio in the negative feedback voltage divider, to give a ratio of about 4:1 ((5.6kΩ + 4.7kΩ + 3.3kΩ)/3.3kΩ = 4.12) instead of the original 60:1.

In order to do this, we had to increase the value of the first triode's (V1a) cathode bias resistor to 3.3kΩ (from 1kΩ), so that the overall divider resistance wouldn't be too low – which would have provided excessive loading on the plate of the second triode (V1b). But because increasing the value of V1a's cathode resistor reduces that valve's plate current, we also had to increase the value of its plate load resistor, to bring its quiescent plate voltage back to around half the HT supply.

So that's why the plate load resistor for V1a is now 270kΩ, rather than the original 100kΩ. Even with these changes, the negative feedback divider still has a somewhat lower resistance than in the original design (ie, 13.6kΩ rather than 67kΩ).

To compensate for this additional loading on V1b, we've increased the quiescent plate current of that triode stage by reducing its cathode bias resistor to 560Ω (from 1kΩ) and also reduced the value of its plate load resistor to 68kΩ (from 100kΩ) to again bring the quiescent plate voltage back to around half the HT supply.

The only other circuit change has been to increase the value of the coupling capacitor between the plate of V1b and the negative feedback divider, to compensate for the lower divider resistance and ensure that the preamp's bass response is not degraded. The capacitor value has been increased to 680nF (from 220nF).

Volume control

What about the volume control? This is simply a 50kΩ log pot connected to the output of the preamp, as you can see from the circuit.

Of course, if you intend building two of these valve preamps for stereo, you'd use one half of a dual 50kΩ log pot for each channel.

We should also mention that although the plate current of both triode stages has been changed in this version of the preamp, the total HT current drain is almost exactly the same as that of the November 2003 version. So the HT power supply described in the November article is quite capable of running two of the modified preamps, for stereo operation.

In fact, it could be used to drive quite a few other valve stages, if that was ever required.

Construction

The modified preamp can be built up on the original PC board, because only the component values have changed. Almost all of the changed component

Performance

Frequency Response: +0.5dB at 16Hz and -1dB at 180kHz (see Fig.1)

Harmonic Distortion: 0.2% for output levels up to 6V RMS (see Figs.2 & 3)

Signal-to-noise Ratio: -99dB unweighted (22Hz to 22kHz) with respect to 2V RMS output

Voltage Gain: 4

Input Impedance: 1MΩ

Output Impedance: 600Ω approx. (before volume control) values have the same physical size as those in the original preamp, too, so in most cases it's simply a matter of fitting the different value parts into the board using the new overlay diagram as a guide.

The only exception to this is the 680nF 630V feedback coupling capacitor, which you'll find is somewhat larger than the original value of 220nF. You may have to bend the leads of this capacitor inwards so they'll go through the board holes, and you may even have to mount the capacitor "leaning over" so it will fit between the surrounding components.

As shown in the overlay diagram, the output RCA socket is no longer on the PC board, since in this version, the preamp output connects only to the volume control pot. You can then connect the output from the pot using a short length of screened audio cable to an RCA socket.

If you're building up dual preamps for stereo, they can be mounted side by side on the lid of a diecast metal box like the Jaycar HB-5046 (171 x 121 x 55mm), with the HT power supply and the dual volume control pot inside the box.

The output cables from the volume controls could be terminated at insulated single-hole-mounting RCA sockets fitted into the end of the box remote from the +12V power input, ready for a standard stereo lead to a stereo power amplifier. This would make quite a neat arrangement, while still allowing the preamp valves to be "on display".

Finally, note that the high-voltage components must be covered with neutral-cure silicone sealant, to guard against electric shock – see Fig.5. SC

Is It Really Necessary?

If your power amplifier has an input sensitivity of 1V RMS or less, for full power output, then strictly speaking, you don't really need a preamplifier of any sort for line level signals. All you need is a volume control.

However, since so many people have asked for this circuit, we have gone ahead and shown what needs to be done.