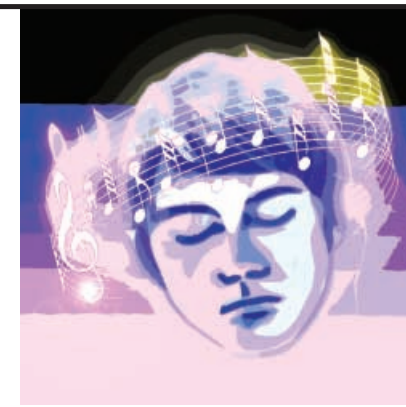
Special Feature

Stereo Headphone Monitor



by Terry de Vaux-Balbirnie

Usable as an add-on for last month's Sound Card Mixer or as a stand-alone unit

THIS circuit was designed to be built into the *Sound Card Mixer* (Feb '05). With it, the user may monitor the output using a pair of headphones and make accurate adjustments while recording is in progress. Some readers will not need this facility because their configuration already allows headphone monitoring. This is why the circuit was not included as part of the original design.

Equally useful to some readers is the ability to use the circuit as a self-contained unit. This will allow listening to the sound output from any Line level source, such as an electronic musical instrument, using headphones.

If the *Sound Card Mixer* has been constructed in the specified sloping-front case, there will be ample space inside to accommodate this new circuit and it may share its power supply. The additional current depends on various factors but it is likely to be in the region of 10mA to 15mA. The total current requirement of the Mixer will then rise to some 55mA. This will reduce the life of the battery pack so, for long periods of use, a larger set of batteries may be used. If these will not fit inside the case, they could be sited externally.

Stereo Amplifier

The Stereo Headphone Monitor is just a small stereo power amplifier. It provides sufficient output to operate a pair of standard headphones having an impedance of 32 ohms approximately. The unit is fitted with a volume control which allows the sound to be adjusted to a comfortable listening level. Using this does not affect the signal passing to a sound card or other device.

When built into the *Sound Card Mixer*, you could use headphones having a boom microphone attached. This would be ideal for commentaries and "voice overs". The advantages of adopting this method are that the hands are kept free and a constant speaking distance is maintained with the microphone.

Circuit Description

The full circuit diagram for the Stereo Headphone Monitor is shown in Fig.1. Integrated circuits IC1 and IC2 are the actual amplifiers. Two are required – one for each channel. These can provide 325mW into an 8Ω load. However, since headphones have a much greater impedance than this, the available output will be reduced. This does not matter because only a very small output is sufficient to fully load the headphones.

The circuit comprises two sections and a small number of components common to both. The part centred around IC1 is associated with the Left channel while that based on IC2 is responsible for the Right. Since these parts are identical, only a description of the left channel is needed. Note that components in the left channel (and those common to both) are labelled with single figures – for example, C1, C2, and C3 while in the right one, the corresponding components are prefixed with a "1" – C11, C12, C13, etc.

Power Supply

The power supply may consist of a 6V or 9V battery. If used as a stand-alone unit, four AA size alkaline cells would be satisfactory. Current flows via diode D1 to charge capacitor C5. Sudden surges of current occur on the sound peaks and batteries alone might not be able to provide these, especially when they are nearing the end of their life. This would result in distortion. The capacitor holds a reserve of charge which will provide any instantaneous current demands.

Diode D1 gives supply reverse-polarity protection and also isolates the power supply from that of the *Sound Card Mixer* if this is shared with it. The positive supply feed is made to IC1 pin 6. Pin 2 (the inverting input) is connected to 0V together with the actual 0V connection, pin 4.

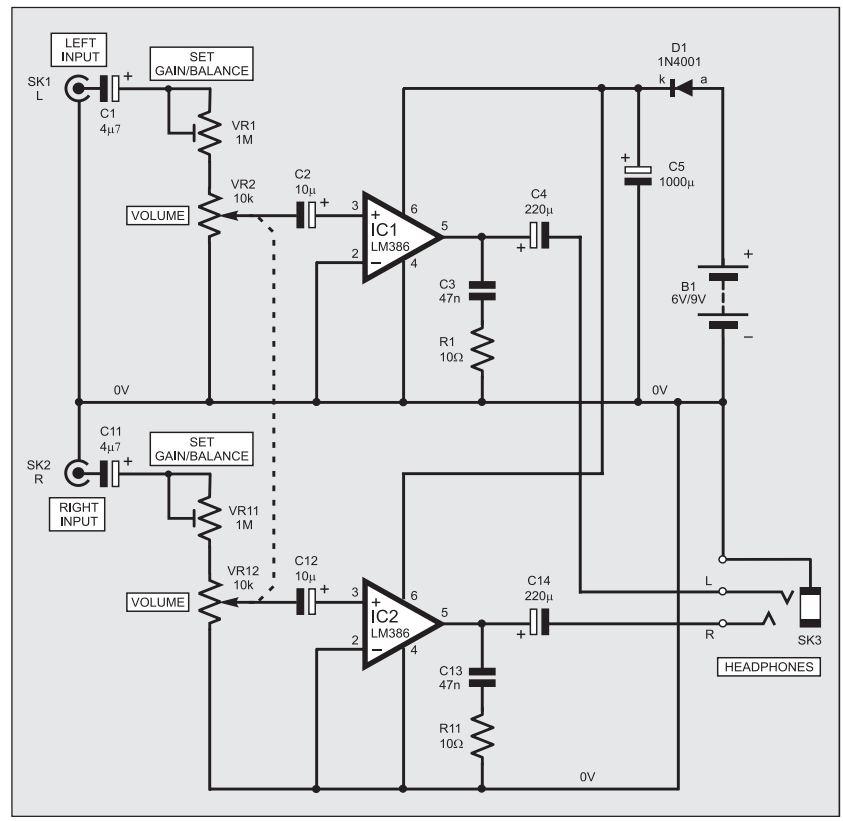


Fig.1. Complete circuit diagram for the Stereo Headphone Monitor.

The signal input is made to IC1 pin 3 (the non-inverting input). However, a line level signal would be too high and must first be reduced. This is carried out using a potential divider arrangement. The incoming a.c. (audio) signal flows through capacitor C1, preset potentiometer VR1 and rotary Volume control VR2 to the 0V line.

To the Maximum

Suppose VR1 is adjusted to maximum resistance (1MΩ). With VR2 at its minimum setting, the voltage at its sliding contact (wiper) will be zero. When VR2 is set to maximum, the signal voltage will be divided by 100 approximately. With preset VR1 adjusted to less than maximum resistance, a smaller amount of attenuation (reduction) is provided.

COMPONENTS

Resistors

R1, R11	10Ω (2 off) 0·25W 5% carbon film

Capacitors

C1, C11	4μ7 radial elect. 35V (2 off)
C2, C12	10μ radial elect. 16V (2 off)
C3, C13	47n ceramic disc, 5mm pitch (2 off)
C4, C14	220μ radial elect. 16V (2 off)
C5	1000μ radial elect. 16V

See SHOP TALK page

Potentiometers

VR1, VR11	1M carbon preset vertical (2 off)
VR2/VR12	10k min. dual-ganged rotary carbon, p.c.b mounting, with 5mm matrix pin spacing, log. (see text)

Semiconductors

D1	1N4001 50V 1A rectifier diode
IC1, IC2	LM386N-1 power amplifier (2 off)

Miscellaneous

SK1, SK2	phono socket (2 off) (see text)
SK3	3·5mm stereo jack socket (see text)
B1	AA-size alkaline cells (see text) (4 off)

Printed circuit board, available from the *EPE PCB Service*, code 490; metal case (see text); control knob; 8-pin d.i.l. sockets (2 off); PP3-type battery connector; connecting wire; solder, etc.

Approx. Cost Guidance Only **£11**

Preset VR1 will be adjusted at the end so that, when VR2 is at maximum, there is minimal distortion combined with sufficient volume. VR1 and VR11 will also be adjusted at the end of construction so that there is a balance (equality) in the volume between the left and right channels.

Note that VR2 (left Volume control) is one section of a dual (ganged) potentiometer. This is really two units controlled by a single spindle. The other section, VR12, is used as a Volume control for the right channel.

The signal "tapped off" by VR2's wiper is applied to IC1 input pin 3 via capacitor C2. There is a small bias (standing voltage) on this pin which is set automatically by internal components. This allows both the positive and negative parts of the input signal waveform to be amplified by swinging above and below this voltage.

The output appears at pin 5 and the signal flows via capacitor C4 to the left-hand headphone output. Capacitor C3 connected in series with resistor R1 stabilise the amplifier and prevent any oscillation that might otherwise occur.

Construction

Construction of the Stereo Headphone Monitor is based on a single-sided printed circuit board (p.c.b.). This board is available from the *EPE PCB Service*, code 490. The component layout and actual size copper master track pattern are shown in Fig.2.

Begin construction by soldering the two 8-pin i.c. sockets in position then add the fixed resistors and preset potentiometers (VR1/VR11). Follow with the capacitors – most of these are electrolytic and care must be taken to place them with the correct polarity as indicated. Add diode D1, taking care over its polarity.

Solder Volume control potentiometer VR2/VR12 in place. It would be better if this is a logarithmic (log) type because it provides an improved physiological response (angle of rotation against perceived change in volume). However, an ordinary linear (lin) unit would be satisfactory.

Assembly

Adjust presets VR1/VR11 to approximately mid-track position. Solder pieces of stranded connecting wire to the power supply and the input and output pads. Using coloured wires will help to avoid errors. Insert the i.c.s into their sockets. The completed p.c.b. is shown in the photograph.

The circuit panel is very small and light so may be mounted using the potentiometer bush fixing alone. If the circuit is to be used as an add-on unit for the *Sound Card Mixer*, decide on a suitable position for it inside the case. Remove the existing p.c.b. to prevent damage and move any wiring out of the way.

Drill holes for the potentiometer bush and headphone jack socket. In the prototype, the socket was mounted at the front of the unit because this avoids trailing wires.

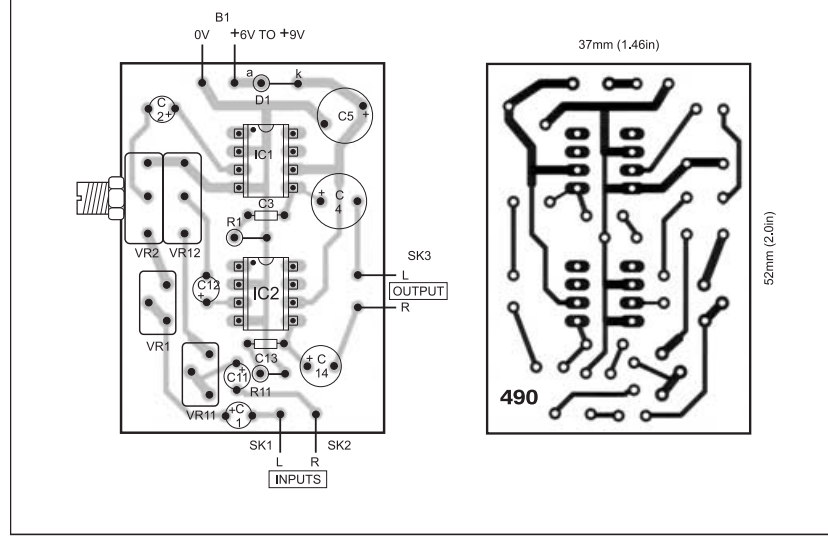
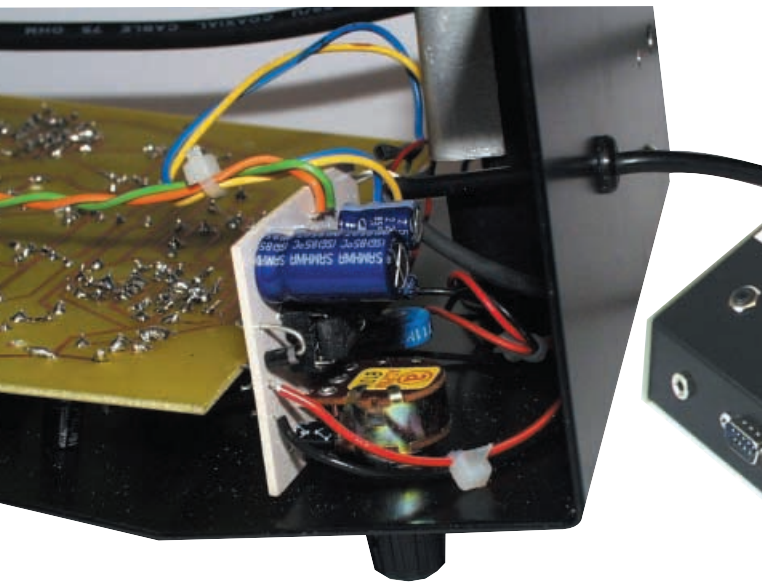


Fig.2. Printed circuit board top side component layout, wiring details and full-size underside copper master for the Stereo Headphone Monitor



The Stereo Headphone Monitor circuit board mounted at the rear of last month's Sound Card Mixer *project*

The knob on the top/back of last month's Sound Card Mixer is the volume control for the Headphone Monitor. The Headphone socket can be seen on the front edge of the case

Interwiring

If the unit is to be built into the *Sound Card Mixer* case, refer to Fig.3. This shows the connections needed to the existing wiring. The supply positive feed is made to the on-off switch (so that the switch controls both sections). The 0V connection is made to the rear solder tag. There are already connections made here so it will be best to desolder them, twist all the wires together and solder the joint again. Make sure this work is sound.

The left and right Monitor's input connections are made to the *Sound Card Mixer's* output wires (see Fig.3). In the prototype, the wires were cut at a convenient place and the new ones soldered to them. Heat shrinkable sleeving should be used to insulate the joints.

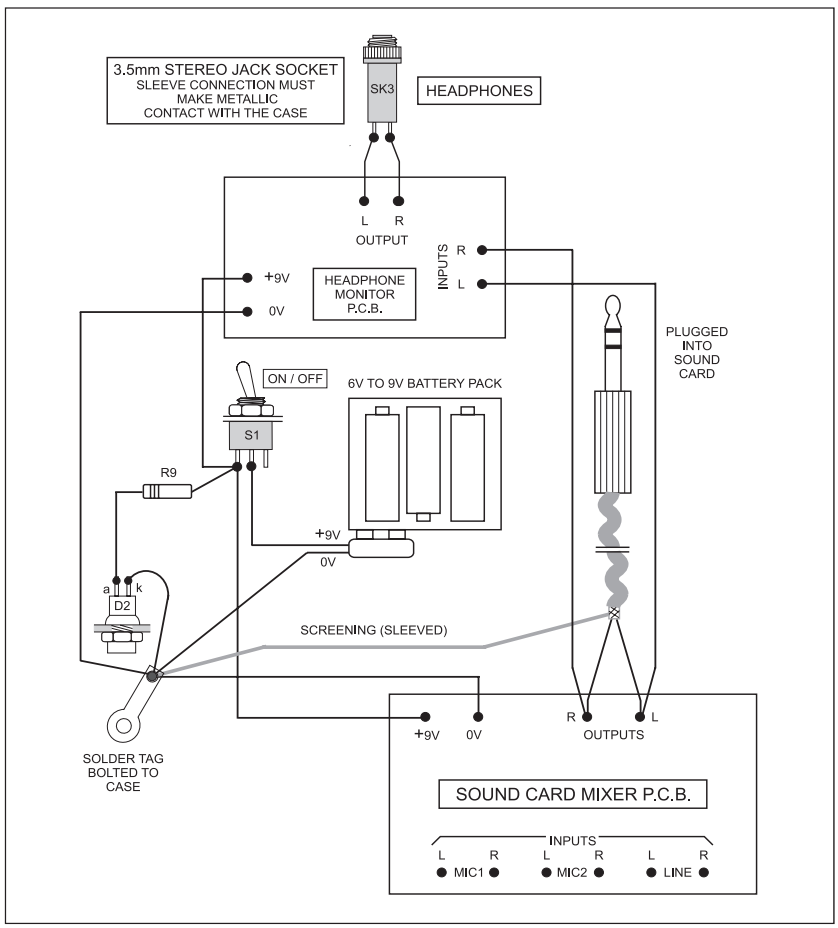


Fig.3. Interwiring between the Headphone Monitor and last month's Sound Card Mixer's components and circuit board

For the output (Headphone) socket SK3, use a 3·5mm stereo jack type (or as appropriate for the headphones used). The socket used in the prototype made an automatic sleeve connection with the metal case (0V). If this type is used, scrape away the paint around the hole on the inside of the case so that good electrical contact is made. If the socket is fully insulated and does not make a 0V connection in this way, the sleeve connection will need to be hard-wired to a 0V point (to the solder tag at one of the phono sockets for instance).

Free Standing

If the Monitor circuit is constructed as a free-standing unit, choose a suitable metal box large enough to accommodate the circuit panel, battery pack, on-off switch, phono input sockets and headphone jack socket. Drill the fixing holes for these parts and attach them. Make sure the soldered joints on the underside of the p.c.b. are kept several millimetres clear of the base of the box. This will prevent any short circuits with the metalwork.

Refer to Fig.4 which shows the internal wiring. The sleeve connections of the phono sockets, that of the headphones socket, the "0V" wire on the p.c.b. and the battery "0V" ("negative") wire, are inter-connected and must make metallic contact with the case ("earth") via a solder tag.

The sleeve connections of uninsulated "single hole fixing" phono sockets make an automatic connection with the metalwork. These are usually supplied with a solder tag and, fitted to one socket, may be used for all the 0V connections. Scrape away any paint around the fixing hole to make sure a good contact is made. If any of the sockets do not make the "earth" connection automatically, you will need to hard-wire them to a separate solder tag. Make sure this makes good electrical contact with the metal case.

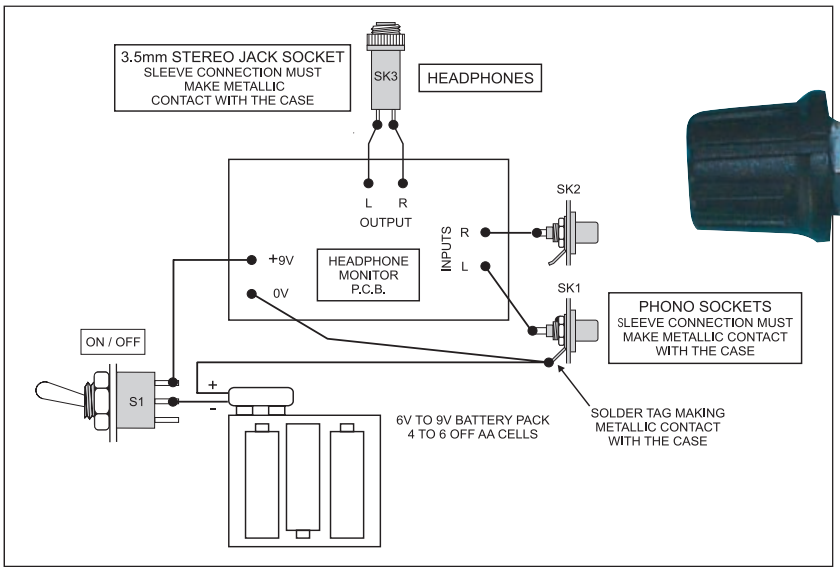
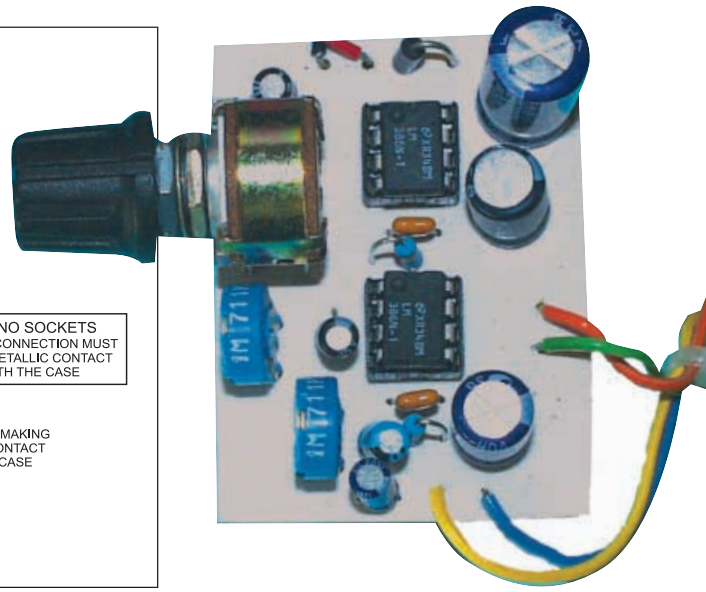


*Fig.4. Interwiring for the "stand-alone" version of the Headphone Monitor. The sleeve connections for the jack socket and phono sockets must make a good "earth" (0V) with the **metal** case*



The completed Headphone Monitor circuit board ready for mounting in a suitable metal case

Testing and Listening

Turn the Volume control to minimum (full anticlockwise rotation). Plug the headphones into the jack socket. Apply a Line level signal to the input and switch on the supply. A suitable signal may be obtained from a tape deck, CD player or possibly a camcorder's audio output.

Listen cautiously to the headphones in case there are any surprise loud noises. Advance the volume control and check the sound quality. If it is very weak despite the Volume control being set to the maximum, reduce the settings of presets VR1/VR11 equally by clockwise rotation of the sliding contacts (as viewed from the left-hand edge of the p.c.b.). You may need to remove the circuit panel to do this, or you might be able to do it with it in place using a thin screwdriver.

If the sound becomes very distorted as the volume is turned up, decrease the settings. Aim for maximum undistorted sound when the volume control is turned fully clockwise. Presets VR1/VR11 should also be individually adjusted for an equal volume between left and right channels. □