COMPUTER GAME HEADPHONE AMPLIFIER

A project by Paul Stenning which brings a little peace and quiet to a games machine owning household

The peace and quiet in our household has recently been shattered by the arrival of a Sega MegaDrive. For anyone who is not actually using the machine, the sound from Sonic the Hedgehog or whatever can soon become very monotonous and annoying. The obvious solution was a pair of headphones, but Sega did not feel it necessary to provide a suitable socket - nor did the manufacturers of our TV set!

There is only one audio/video output connector on the MegaDrive, and this is used for the RF modulator so that the unit can be connected to the TV. Fortunately this is a standard 9 pin mini-DIN connector, and the stereo audio output is on pins 8 and 9. So all we need is a low power stereo amplifier capable of driving a pair of headphones, and some method of allowing this to be connected to the 9 pin socket on the MegaDrive, along with the RF modulator. Since cable mounting mini-DIN sockets are not readily available, I decided to have a flying lead from the amplifier, fitted with a 9 pin plug to connect to the mega-drive. A 9 pin socket is then fitted to the back of the amplifier, for the modulator.

The amplifier itself is mains powered, and the prototype was left powered all the time because the power consumption is minimal. I initially considered powering the amplifier from the DC output on the MegaDrive 9 pin connector, but this is only 5V which is not really adequate, bearing in mind that it would need significant decoupling to get rid of the noise from the digital circuits.

PLEASE NOTE THAT ANY DAMAGE CAUSED BY CONNECTING UNAPPROVED DEVICES TO THE SEGA MEGADRIVE WOULD NOT BE COVERED BY THE GUARANTEE.

This amplifier may also be suitable for other computer games machines, although the audio/video connectors will be different. You will have to work out the necessary connections yourself!

Circuit operation

The complete circuit diagram is shown in figure 1. Only the left amplifier channel is shown, the right channel is identical with component references starting from 101.

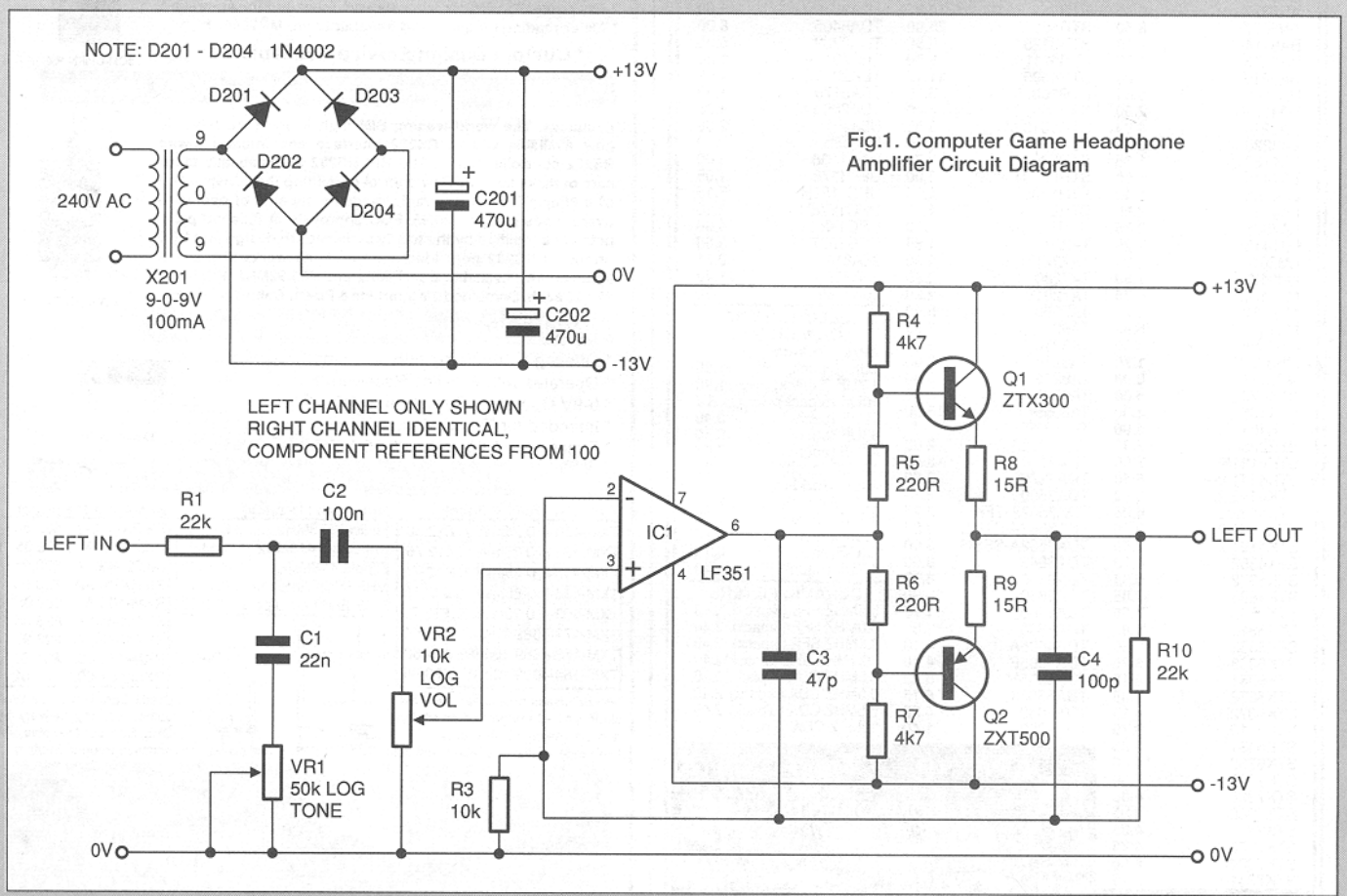


Fig.1. Computer Game Headphone Amplifier Circuit Diagram

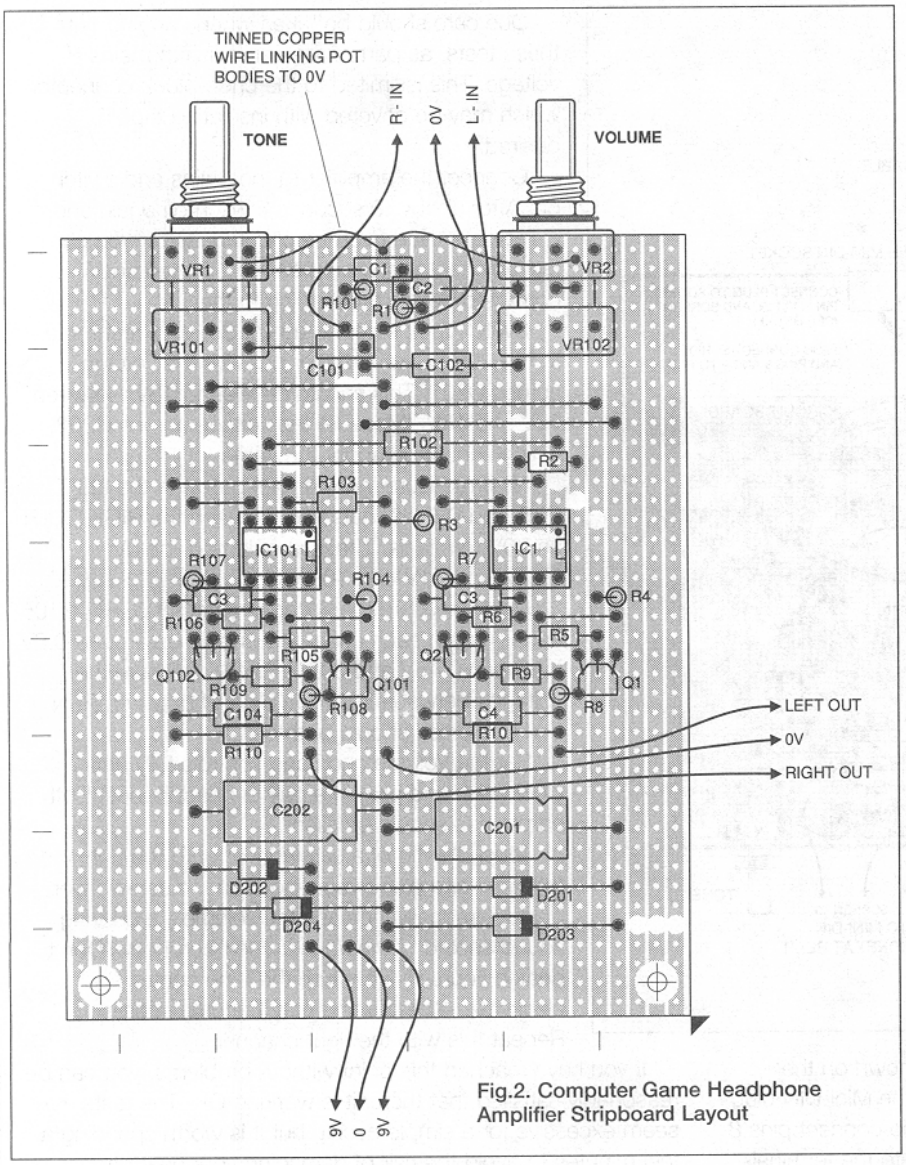


Fig.2. Computer Game Headphone Amplifier Stripboard Layout

Some of you may be wondering why I didn't use a dual power amplifier IC. The simple answer is that the unit was built using bits from my "junk box" - which contained plenty of op-amps and transistors, but no power amp chips! Two single op-amps were used in preference to one dual device because this simplifies the board layout.

R1, C1 and VR1 form a simple top-cut tone control. I had not originally planned to use any form of tone correction, but the sound through a pair of good quality headphones was found to be slightly fuzzy due to the audio signals being derived by digital methods. The tone control allows this effect to be minimized, although there is an inevitable reduction in the higher frequencies. C2, together with the track of VR2, causes the lower frequencies to be rolled off gently below about 30Hz.

The remainder of the amplifier is a standard non-inverting op-amp circuit with the addition of a class B push-pull output stage. The transistors TR1 and TR2 are held close to the point of conduction by R4 to R7. Cross-over distortion is removed by the use of a considerable amount of negative feedback (R10 and R3). This arrangement works well with a low gain low power amplifier such as this.

C3 and C4 gives additional negative feedback at high frequencies (above the audio range) to ensure stability. R8 and R9 limit the output current to a reasonable level if the output is short circuited. The overall gain of the unit with the volume control at maximum is approximately unity.

Obviously this is insufficient to drive the circuit into clipping, but gives more than adequate volume from the headphones. If you like having your ears blasted you could increase the values of R10 and R110 to 33K or even 47K - but I wouldn't recommend this unless you want to risk damaging your hearing!

The power supply is a conventional full wave split rail arrangement. This is not regulated due to the low current consumption of the amplifier. A 100mA transformer is adequate.

Construction

The circuit is constructed on a piece of stripboard. The layout is shown in figure 2.

Note that a few component leads and links pass underneath the pots, so the pots should be fitted last. Do not forget the 35 track cuts and the 12 wire links. The IC's are static sensitive and should be handled with the usual care. IC sockets may be used if desired, but since the IC's are cheap it is questionable whether sockets are really necessary. Terminal pins should be used for the off-board connections, as these allow the board to be fitted into the case before the wiring is started. The bodies of the two pots should be connected to the 0V rail with tinned copper wire as shown. This may either be soldered to the bodies after filing away a little of the plating, or positioned around the bushes so that it is clamped in place when the nuts are tightened.

Due to the use of mains power, a small metal case is recommended. This should be properly earthed, by means of a solder tag under one of the transformer fixing bolts. It may be convenient to choose a case which fits neatly underneath the Mega-Drive. This would allow the link wire to be kept short.

The circuit board is mounted in the case by the pot nuts and the two fixing nuts. Position this to one side so that the headphone socket can also be fitted on the front panel. A standard 0.25" socket was used on the prototype, but a 3.5mm socket could be used instead if this suits the plug on your headphones. Many new headphones are now fitted with a 3.5mm plug and supplied with an adaptor for use with 0.25" sockets. The rear panel should be fitted with a 9 pin Mini-DIN socket. Maplin stock a range of panel mounting types which are suitable. Two additional holes are needed, for the mains input cable and the Audio/Video cable from the MegaDrive. Both holes must be fitted with suitable grommets and the cables must be adequately supported with strain relief clips. The transformer should be positioned on the base of the case in a position well away from the audio input (Mini-DIN) connector, but close enough to the circuit board that the wires reach.

The interwiring is shown in figure 3. The Mini-DIN connectors are connected together with a length of thin 9 core screened cable. Connect pin 1 to pin 1, pin 2 to pin 2 etc, and use the screen of the cable to link the metal bodies of the connectors. Since this cable carries video signals it should be reasonably short (no more than about 1 metre).

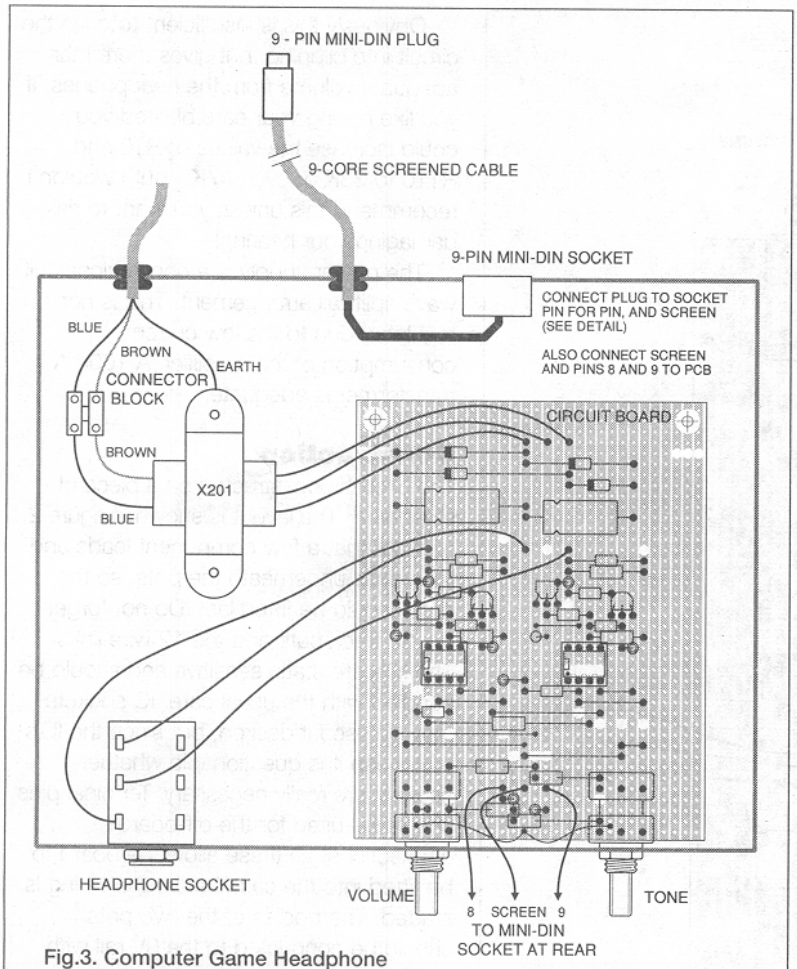


Fig.3. Computer Game Headphone Amplifier Wiring Diagram

The contact layout for the connectors is shown on the wiring diagram. Take care when soldering to the Mini-DIN plug and socket as the pins are close together. Also connect pins 8 and 9, and the screen of the Mini-DIN socket to the terminals indicated on the circuit board with a length of two-core screened cable. The cover of the Mini-DIN plug may need to be cut back a little to allow the plug to fit into the back of the MegaDrive.

Connect the transformer secondary to the circuit board pins as shown. If you are using one of the small types of transformer with flying leads, the secondary wires will be two of one colour and one of another colour (usually black). Connect the single coloured wire to the centre pin on the PCB. The primary leads are connected to the mains lead with a choc-block type connector. The earth lead should be connected to a solder tag fitted under one of the transformer mounting screws. The other end of the mains flex should be fitted with a 13A plug fitted with a 3A fuse.

The headphone socket connections assume the use of a cheap insulated 0.25" headphone socket. If you are using a different type of socket (such as a 3.5mm type) the connections may be different. In this case, the "Left Out" pin goes to the tip of the plug, the "Right Out" goes to the ring and "0V" goes to the sleeve.

Testing

If the unit has been built with care it should work first time without any problems. However it is worth carrying out a few simple voltage checks to ensure all is well before connecting the headphones and MegaDrive.

Due care should be taken when carrying out these tests, as part of the unit is live at mains voltage. This is limited to the choc-block connector which may be covered with insulating tape if desired.

Connect the amplifier to the mains and switch on. After about 20 seconds, switch off again and place your hand over the circuit board. If you can feel any heat this should be investigated and corrected before proceeding further.

Switch the power on again. Set your test meter to the 20V DC range and measure the voltage across C201. This should be around 13V (between 12V and 15V). Measure the voltage across C202, which should be about the same.

Now measure the voltages between the LEFT OUT and 0V terminals and between the RIGHT OUT and 0V terminals. These should both be 0V (between -0.1V and +0.1V).

Next, measure the voltages across R5, R6, R105 and R106. In each case, this should be around 0.6V (between 0.45V and 0.7V). Finally, measure the voltages between L-IN and 0V and between R-IN and 0V. These should both be 0V

Set the Volume and Tone controls fully anti-clockwise, and plug in a pair of headphones. Both earphones should be silent.

Touch the tip of a screwdriver onto the L-IN terminal, and place your finger on the screwdriver blade. Gradually increase the volume - a buzzing sound should be heard in the left earphone. Don't deafen yourself! Now turn the tone control clockwise - the buzzing may become sharper. Repeat this with the right channel.

If you have reached this point without problems, you can be reasonably satisfied that the unit is working OK. The tests may seem excessive for a simple circuit, but it is worth spending a few minutes to avoid the risk of damaging your headphones or even your MegaDrive.

You can now connect the unit to your MegaDrive and give it a functional check. If you cannot get a picture and/or sound from the TV set, switch off and check the wiring to the 9 pin connectors. If the TV works OK but you get no sound from one or both earphones, check the wiring from the circuit board to the 9 pin connector.

In use

There is not much to say about this. The volume should be kept to a reasonable level to avoid the possibility of headaches or even hearing damage. The tone control should initially be set fully clockwise (maximum treble) and may be backed off if necessary.

We have found that the cheaper headphones are perfectly adequate for use with this amplifier. In some respects they may be better than the "CD quality" types since they are less responsive to the highest frequencies and therefore do not emphasize the slight fuzziness caused by the digitising of the sound.

Partially or fully enclosed headphones are an advantage to the rest of the household, as they are not so prone to giving off that irritating tinny sound produced by Walkman earphones.

Also, please take note of the advice given in the instruction manual about the safe use of computer games consoles. In particular, don't sit too close to the TV, don't play in a

darkened room, take regular breaks, and stop playing IMMEDIATELY if you feel any ill effects such as dizziness, sickness or headaches. Ideally the games console should be in a communal room in the home such as the lounge, and not in a child's bedroom where he/she can play for hours alone.

I hope this amplifier brings a return to the peace and quiet you enjoyed previously!

Computer games headphone amplifier - use with Super Nintendo

With very slight modifications, the headphone amplifier can be used with a Super Nintendo Entertainment System (SNES).

The SNES has the RF modulator built-in, and has a separate Audio/Video output socket. This simplifies the connections somewhat, since the loop-in arrangement is not needed.

The amplifier is simply connected to the appropriate connections on Audio/Video output socket.

This socket is not a standard type, but a suitable plug can be fabricated.

The connector resembles the edge of a PCB, with six connection tongues on each side. This is recessed in a cut-out that is basically rectangular in shape, but with the corners cut. A locating recess is at the top. This socket is difficult to describe, the general shape is shown in the illustration.

Making a suitable plug

A small piece of 0.1" PCB edge connector can be filed down to fit into the socket. It may be worth buying a large connector, such as a 36-way type, as you will probably need to have two or three goes at it!

Having got it the right shape, solder a length of two core screened cable to the pins shown in the illustration.

There is no obvious method of protecting these connections. I potted the connections in epoxy resin (Araldite), using a mould made from cardboard lined with Sellotape.

This could then be painted black to make it look more professional. The result is a reasonable sized lump that supports the connections, and enables the plug to be gripped when being inserted or removed.

The other end of the cable is connected directly to the appropriate points on the amplifier PCB.

In use

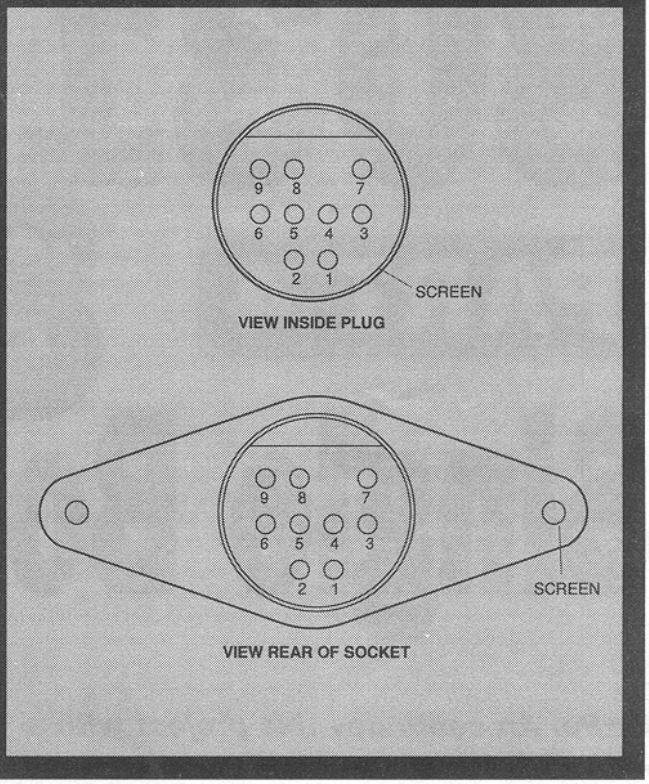
The first thing I noticed when testing the amplifier with the SNES, was that the sound quality is much better than that from the Sega Megadrive.

The digitising noise that was evident on the Sega audio output is completely absent on the SNES. Consequently the Tone control may be left fully clockwise (maximum treble), or even omitted altogether.

It is possible that I may have the Left and Right connections transposed since I do not have the official information from Nintendo.

I have not yet encountered any games where the connections are obviously wrong (or right), but it would be a simple matter to swap the connections at the amplifier end if necessary.

SNES connector plug.



PARTS LIST

Resistors (all 0.25W 5% or better)

R1,10,101,110	22K
R2,3,102,103	10K
R4,7,104,107	4K7
R5,6,105,106	220R
R8,9,108,109	15R
VR1+101	50K Log PCB Mounting Pot (1 off)
VR2+102	10K Log PCB Mounting Pot (1 off)

Capacitors

C1,101	22nF Polyester
C2,102	100nF Polyester
C3,103	47pF Polystyrene
C4,104	100pF Polystyrene
C201,202	470uF 16V Axial Elect

Semiconductors

IC1,101	LF351 Op-Amp
TR1,101	ZTX300 NPN Transistor
TR2,102	ZTX500 PNP Transistor
D201,202,203,204	1N4002 Rectifier Diode

Miscellaneous

9-0-9V 100mA Mains Transformer
0.25" Stereo Jack Socket
9 pin Mini-DIN Plug
9 pin Mini-DIN Socket
Choc-Block Connector
3 Core Mains Flex
Thin 9 Core Screened Cable (1 Metre)
Stripboard
Case
2 Knobs
Hook-Up Wire
Thin 2 Core Screened Cable
Tinned Copper Wire (about 24SWG)
13A Plug with 3A Fuse