Clean up the bass in your system with an . . .

Infrasonic Rumble Filter

Even though modern turntables have very low rumble output; rumble can still be a problem when listening to records; particularly with amplifiers having response down to DC. This low cost infrasonic rumble filter effectively removes all rumble noises below 20Hz and can give a substantial improvement to record reproduction in some circumstances.

by RON DE JONG

There are two types of rumble: that which you can hear and that which you can't. The latter is infrasonic rumble; involving frequencies below 20Hz. Rumble which you can hear, broadly involving the audio spectrum between 20Hz and 250Hz, is difficult to remove from any hifi system. You can minimise rumble in your system by employing a good quality turntable and by not unduly boosting the bass response.

But if there is rumble present on the record, then you are stuck with it.

Infrasonic rumble is quite another matter. While you may not be able to hear it directly because it lies below 20Hz, it can certainly be the cause of problems in your system. You can quickly gain an idea of whether infrasonic rumble is a problem in your system by removing the grilles from your loudspeakers and then playing a record.

It is possible that you will see the speaker cones wobbling at a low rate. If the record has any ripples in it or you are using bass boost, you may find that the cones wobble quite alarmingly, particularly if you have bass reflex enclosures. Now while you may not regard this as a problem, these very low frequency signals can be the cause of considerable intermodulation of the audible bass region. This intermodulation may take place in the amplifier as well as in the speakers themselves.

Problems with infrasonic rumble can be worse in DC coupled amplifiers, ie, those that have flat response right down to DC. And while most DC amplifiers have a low frequency filter, it generally offers only a modest rate of attenuation, typically 6dB/octave with a 3dB corner frequency of 20Hz. This means that the attenuation is likely to be about 8dB or less at 10Hz which is hardly adequate.

What is needed is a steep cut-off filter which means a rate of attenuation of 18dB/octave or more. With a 3dB point at 20Hz, as before, this will provide a really worthwhile attenuation of low frequencies to eliminate intermodulation. Our filter circuit does just that.

The filter is mounted on a small PC board which can be installed in a separate metal box or inside the amplifier or perhaps even another piece of equipment such as a graphic equaliser. Connections to the rumble filter could be made in the tape loop as with most other add on equipment. Alternatively some amplifiers provide pre-amp out and main amplifier in connections and the filter could be connected between these points. This can also be done with systems in which a separate preamplifier and power amplifier are used.

The performance of the filter circuit is shown in an accompanying panel. Notice that the signal-to-noise ratio is quite high and a good match for even the best preamplifiers and power amplifiers.

Frequency response of the rumble filter is shown in an accompanying graph. The rate of attenuation is 18dB/octave below the 3dB corner frequency of 20Hz. This means that the response at 5Hz is 36dB below reference. In short, infrasonic rumble is eliminated.

Just one integrated circuit provides all the active circuitry for the two channels of the rumble filter. A low cost and low noise uA4136 quad operational amplifier does the job, as shown in the circuit diagram which shows both channels.

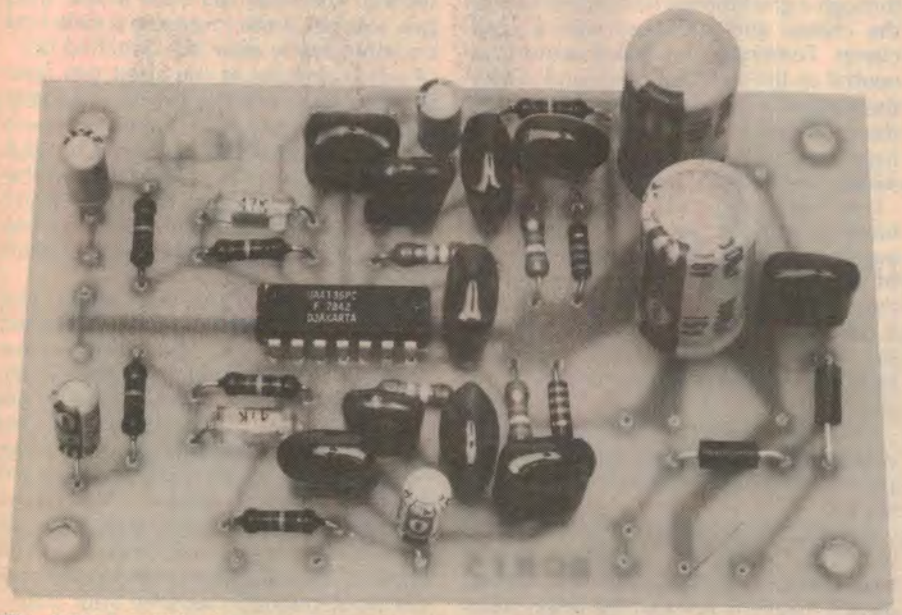
Two op amps are used as unity-gain inverting buffers to provide a low source impedance for the active filters, which are third-order Butterworth. The Butterworth configuration is used here as it has a maximally flat response within the pass-band (ie, above the rolloff point of 20Hz) and minimal phase distortion.

Operation of the filter can be understood by regarding the circuit in the following way. For high frequencies, say above 1kHz, the capacitors can be

We estimate that the current cost of parts for this project is approximately

$10

This includes sales tax.



This PCB should be housed in a small metal box or installed in the amplifier chassis.

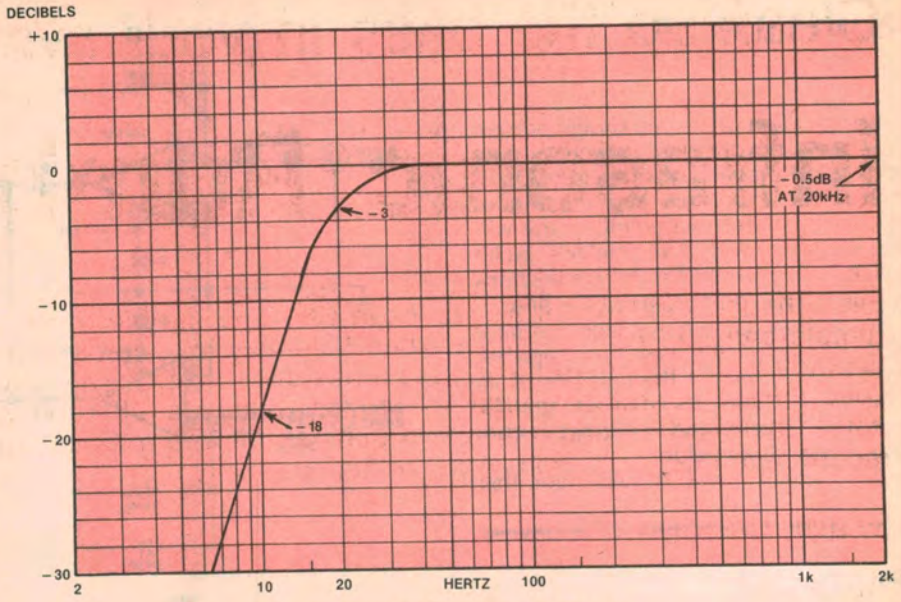
regarded as having low impedance and so the filter circuit works as a unity-gain inverter. At low frequencies the impedance of each of the relevant capacitors (0.1uF, .047uF) becomes appreciable and introduces losses into the signal path.

(A complete derivation of the filter design is given in the National Semiconductor Audio Handbook, in the chapter on "Floobydust".)

Power for the filter unit can be obtained in two ways as shown in the circuit diagram. Either a half-wave rectifier can be used with the power obtained from a 9V transformer winding or a obtained from the split supply of the preamplifier or amplifier. Provision has been made on the board for both configurations.

Typically the power supply of an amplifier will range between ±30 and ±60 volts so we have not specified a particular value for the resistors in the zener regulated supply. The value can be worked out using the formula shown on the circuit diagram, eg if the amplifier power supply was +40V then R = (40-12)/.015 = 1.8k. The resistor should also have an appropriate power rating, in the example above the power dissipated by the resistor is (40-12) × .15 = .42W so a 1W resistor would be used for a reasonable safety margin.

All the circuit components are accommodate on a small PCB measuring 63 x 97mm and coded 80rf5.



FREQUENCY RESPONSE OF RUMBLE FILTER

PERFORMANCE OF PROTOTYPE

Maximum input voltage:	5V RMS
Input impedance:	100k
Output Impedance:	less than 1k
Signal-to-noise ratio:	96db with respect to 1V RMS
Distortion at 1V RMS:	.0025% at 1kHz .012% at 10kHz .02% at 20kHz
Gain:	−0.5dB at 1kHz
Frequency response:	see graph

RUMBLE FILTER

Construction of the unit should present few difficulties. The only points to note are that the orientation of the uA4136 IC electrolytic capacitors and the diodes should be correct according to the wiring diagram, and that shielded audio cable must be used for the connections to the inputs and outputs of the filter.

For best signal-to-noise ratio the filter PCB should be installed in a separate metal box or within the confines of an amplifier, stereo receiver or graphic equaliser chassis and well away from transformer hum fields.

In conclusion, we should note that some readers may wish to raise the corner frequency of this filter to increase the attenuation of lower frequencies and thus bring about a reduction of audible rumble. For example, the corner frequency may be changed to 60Hz by merely scaling the capacitor values, ie, those marked 0.1uF are changed to .033uF and those marked .047uF are changed to .015uF.

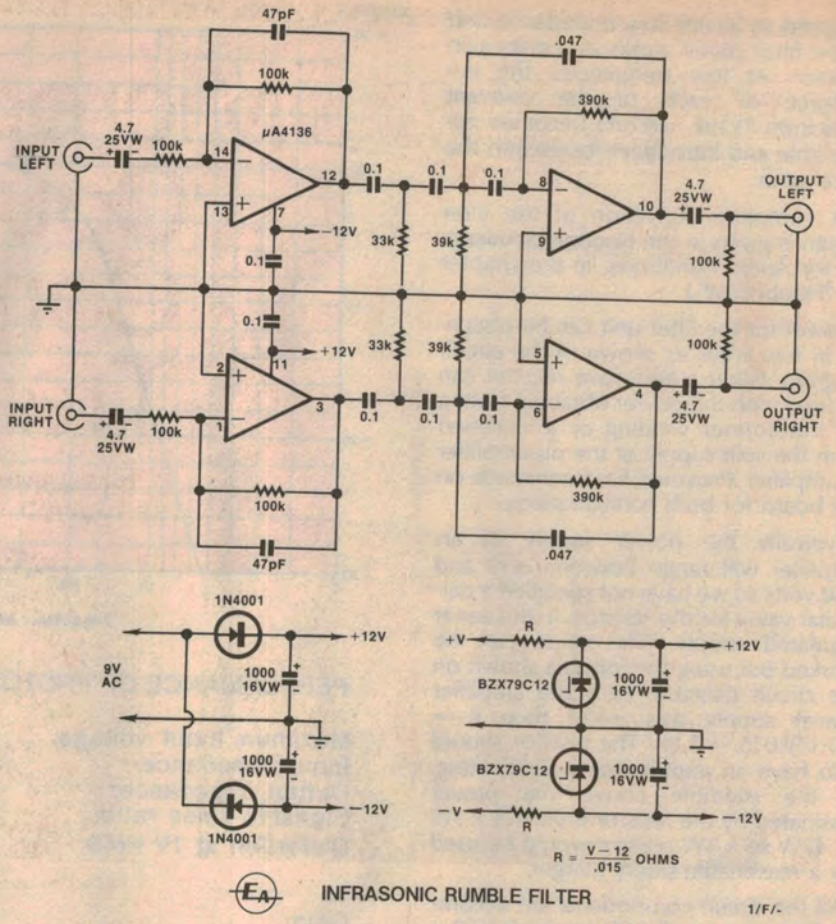
With these changes, the response is −18dB at 30Hz, −30dB at 20Hz, −48dB at 10Hz and −56dB at 5Hz.

PARTS LIST

1 PCB, 63 x 97mm, code 80rf5
1 uA4136 op amp
2 BZX79 C12 zener diodes (see text)
2 1N4001 diodes (see text)

CAPACITORS
2 1000uF 16VW PC electrolytics
4 4.7uF 25VW PC electrolytics
8 0.1uF greencap (metallised polyester)
2 0.047uF greencap
2 47pF polystyrene

RESISTORS (all ¼ watt 5%):
2 x 390k, 6 x 100k, 2 x 39k, 2 x 33k



INFRASONIC RUMBLE FILTER

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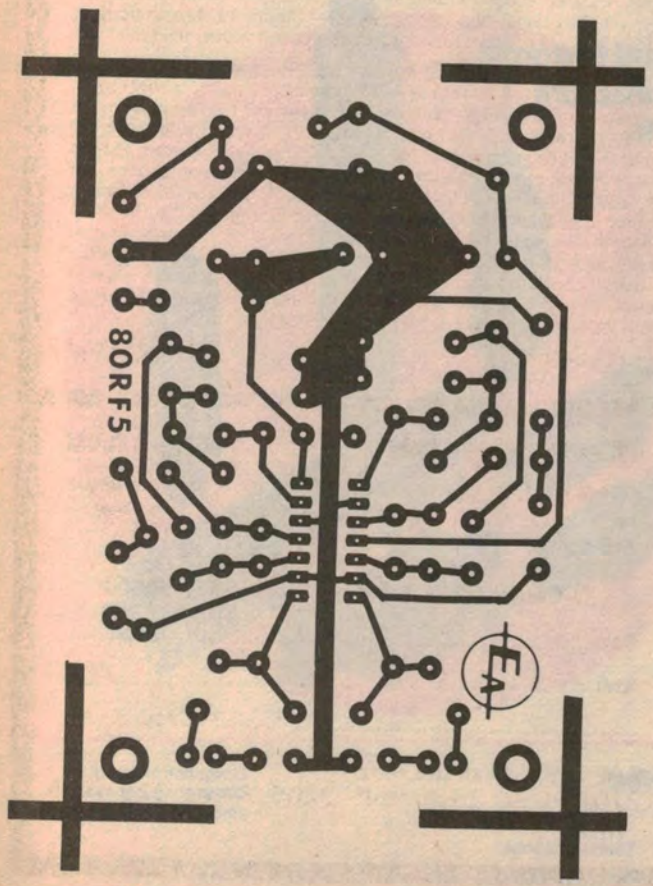
See the end of this article for modifications to the filter corner frequency.



At left is the actual size artowrk for the PCB.