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noise cancelling preamp

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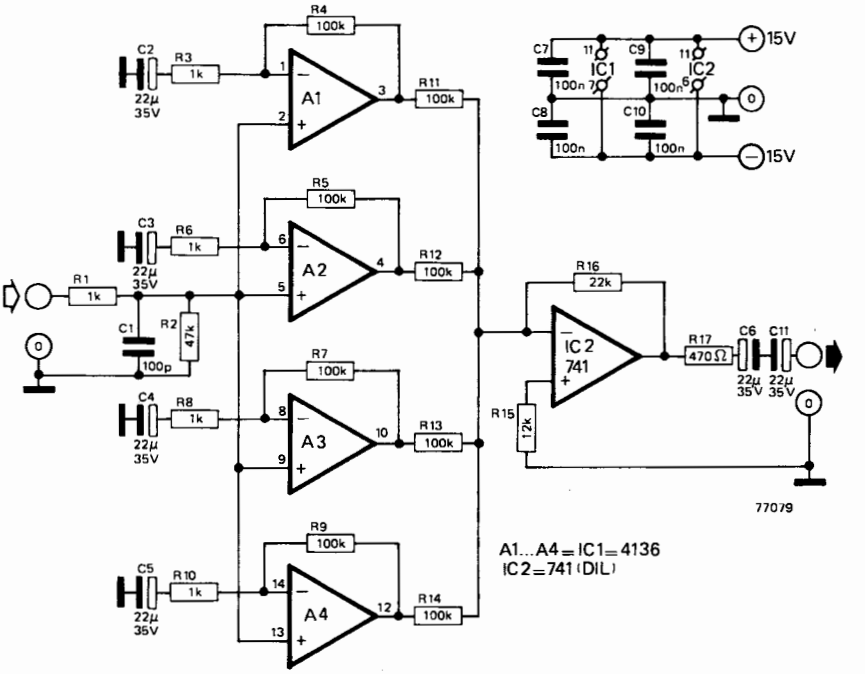

IC operational amplifiers seem to offer an attractively simple means of building audio preamps, but unfortunately ICs generally offer inferior noise performance to the best discrete circuits. However, as quad op-amp ICs are now available at modest cost a novel solution to this problem is possible.

If a number of identical amplifiers are fed with the same signal and the outputs are summed then, since the signals and the amplifiers are the same, there will be a high degree of correlation between them, and the total output signal will simply be the algebraic sum of the individual output signals. However, since the noise voltages generated by each amplifier are random they are uncorrelated and will tend to cancel, and it can be shown that the total noise output is only the geometric sum of the individual noise voltages.

The signal-to-noise ratio of the output signal is thus improved by a factor $\sqrt{n}$, where n is the number of amplifiers. Thus if four amplifiers are used, the signal-to-noise ratio is doubled, i.e. increased by 6 dB. This may not seem much of an improvement for the use of four amplifiers, but since the four amplifiers are contained in one relatively inexpensive IC the outlay in terms of money, space and constructional complexity is fairly small.

The circuit shows a practical implementation of this idea using a 4136 quad op-amp, with a 741 as the summing amplifier. The overall gain of the circuit is 100 and the output noise voltage measured over a frequency range 10 Hz to 15 kHz was 60 μV, which corresponds to an input noise level of 600 nV.

The system can easily be extended to give a greater noise reduction although since the noise reduction is equal only to the square root of the number of amplifiers a law of diminishing returns applies. However, using four ICs (16 amplifiers) a noise reduction of 12 dB is possible. This probably represents the maximum which is economically feasible, as even a further 6 dB reduction would require no less than 64 amplifiers!