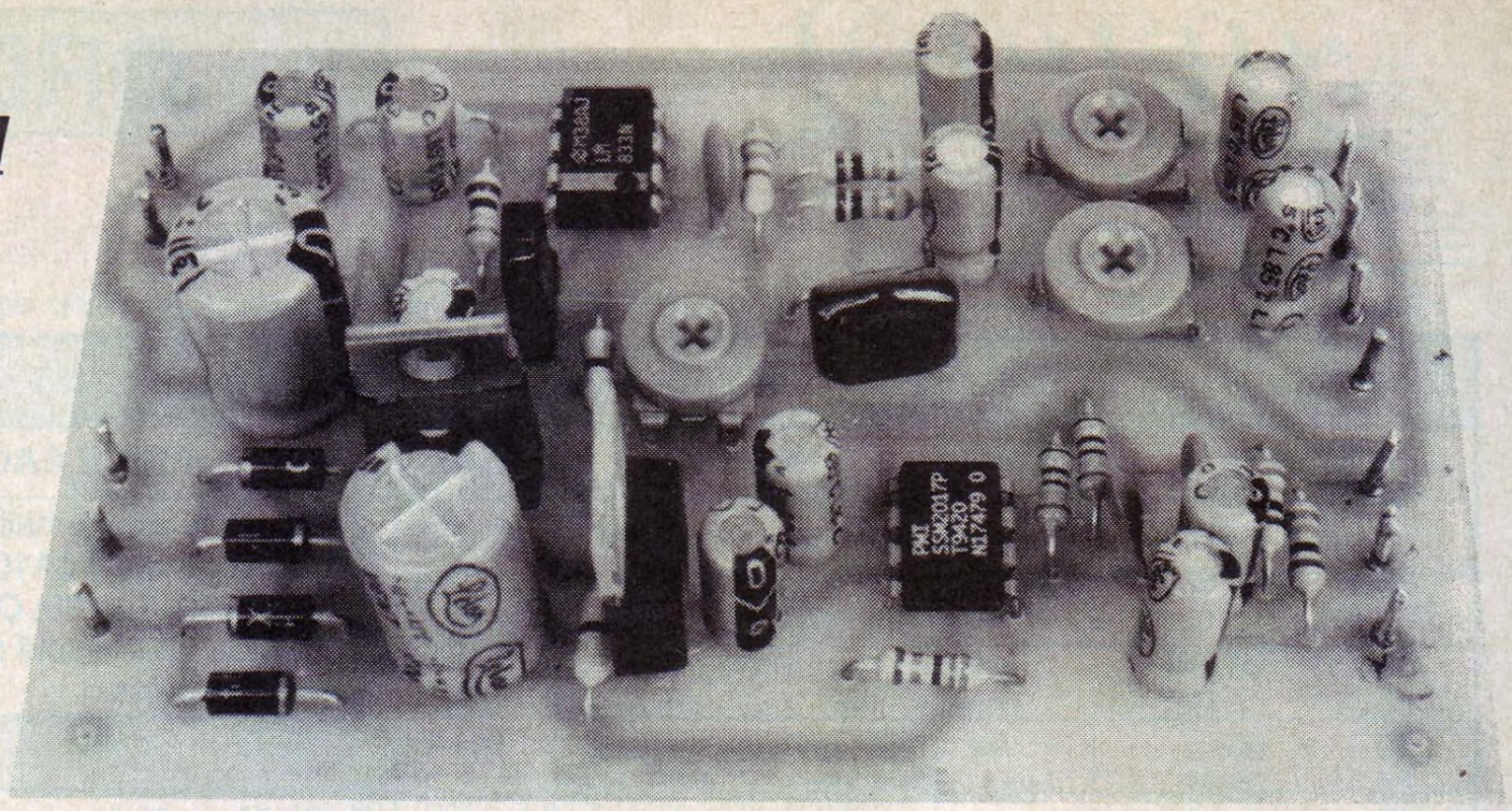
This multipurpose circuit is a balanced microphone preamplifier & line input mixer. It can operate from a variety of AC & DC supply voltages & has low noise & distortion.



By LEO SIMPSON

Balanced microphone preamplifier & line mixer

All professional public address systems use balanced microphone lines. These have the advantage of considerable immunity from hum and noise even when long lines are necessary. The disadvantage is that the preamplifier requires either an expensive balanced-to-unbalanced transformer or a fairly complex circuit involving two or three low noise op amp ICs.

This project gets around that problem by using the SSM2017 IC from Analog Devices. This chip has been specially designed as a balanced microphone preamplifier. The resulting circuit has high gain, low noise and very low distortion.

As presented here, the preamplifier is a small PC board measuring 90 x 56mm. It has two ICs, two 3-terminal regulators and a number of trimpots for level setting. As well as providing a pair of balanced inputs for a low impedance microphone, it also has provision for two line-level inputs. Fig.1 shows the complete circuit.

Performance of Prototype

Microphone Input

Gain 59.5dB

Signal-to-noise ratio ..... -74dB A-weighted with respect to 0.75mV input and 1V output; -71.5dB unweighted (22Hz to 22kHz); both measurements taken with a 50Ω balanced source.

Frequency Response ..... 180Hz to 20kHz, +0dB & -3dB

Auxiliary Inputs

Gain 13.5dB

Signal-to-noise ratio ..... -98.7dB A-weighted with respect to 0.24V input and 1V output; -96.7dB unweighted (22Hz to 22kHz); both measurements taken with a 600Ω unbalanced source.

Frequency response ..... 30Hz to 20kHz, +0dB & -3dB

Circuit operation

IC1, the SSM2017 balanced microphone preamplifier, requires very few external components for its basic operation and its gain is set to 200 (+46dB) by the 33Ω resistor (R3) between pins 1 & 8. The balanced input is AC-coupled via 10µF capacitors C1 & C2 which are there to block any DC signals and also to prevent any DC being applied to the microphone if the circuit is operated in single-supply mode. We'll explain that point in a moment.

The input impedance is set to about 1.3kΩ by two 680Ω resistors (R1 & R2), while C3 & C4 attenuate unwanted signals above the audio passband. The output of IC1 is AC-coupled by a 1µF capacitor to trimpot VR1 which acts as the microphone level control.

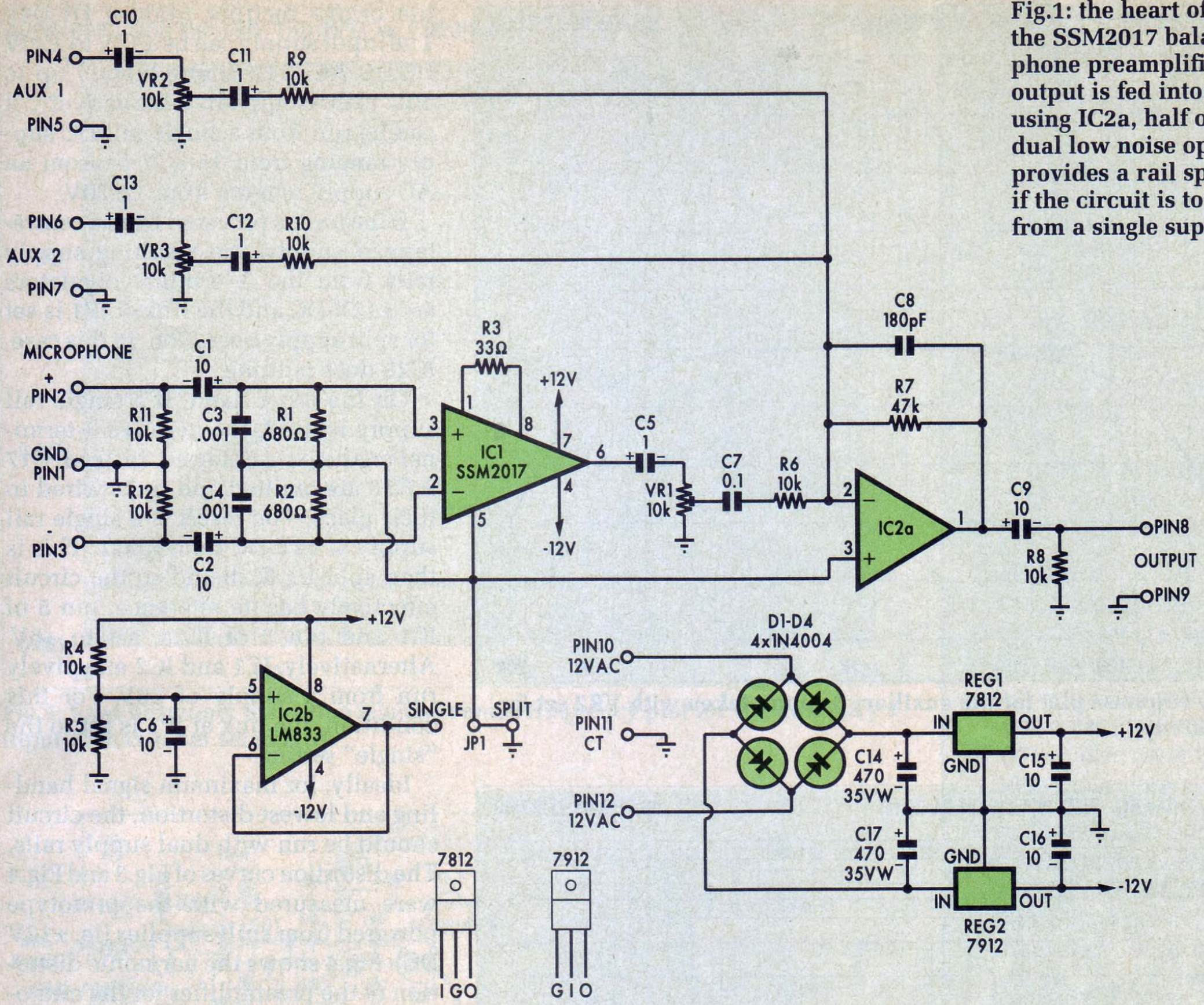


Fig.1: the heart of this circuit is the SSM2017 balanced microphone preamplifier (IC1). Its output is fed into a mixer stage using IC2a, half of an LM833 dual low noise op amp. IC2b, provides a rail splitting facility if the circuit is to be powered from a single supply rail.

BALANCED MICROPHONE PREAMPLIFIER

Line level signals are AC-coupled to trimpots VR2 & VR3 and these act as mixing controls for these signals. All three signals are fed to op amp IC2a which is a conventional mixer stage with its gain set to 4.7, the ratio of the 47kΩ feedback resistor (R7) to the 10kΩ mixing resistors.

The total gain of the preamplifier is therefore close to 940 (+59.5dB) which is more than sufficient for most microphone applications.

The bass response of the preamplifier is curtailed below 300Hz and is -3dB down at about 180Hz, mainly due to the interaction of C7 with R6. This rolloff is desirable for most microphone applications to prevent pick-up of building rumble and also to prevent serious overload by users who tend to blow into microphones. This rolloff can be seen in the frequency response plot of Fig.2.

By contrast, the high level inputs have a more of less normal bass response, with the -3dB point at just

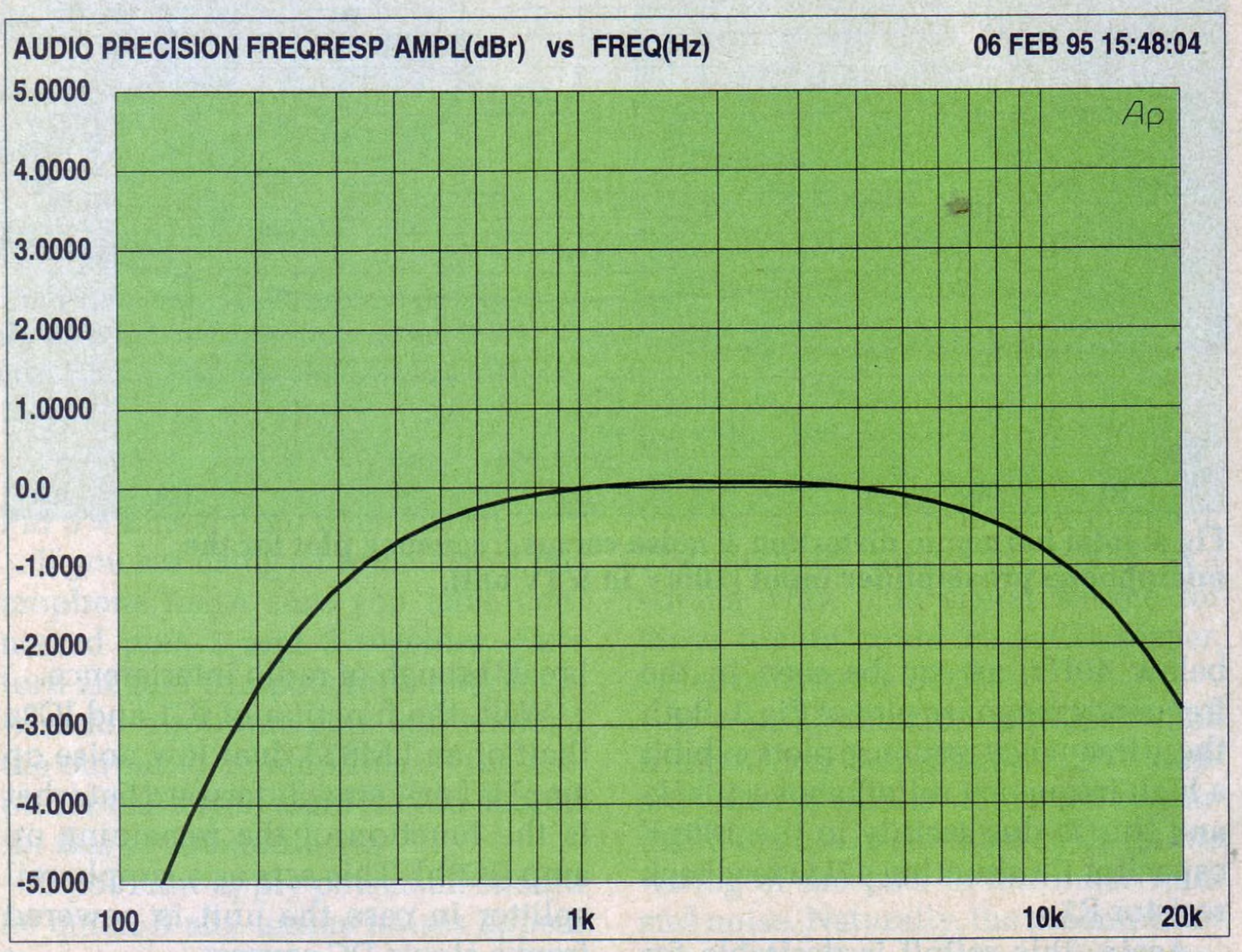


Fig.2: this graph shows the frequency response of the microphone preamplifier input, taken with VR1 set for maximum sensitivity. As shown, the response is 3dB down at 180Hz & 20kHz.

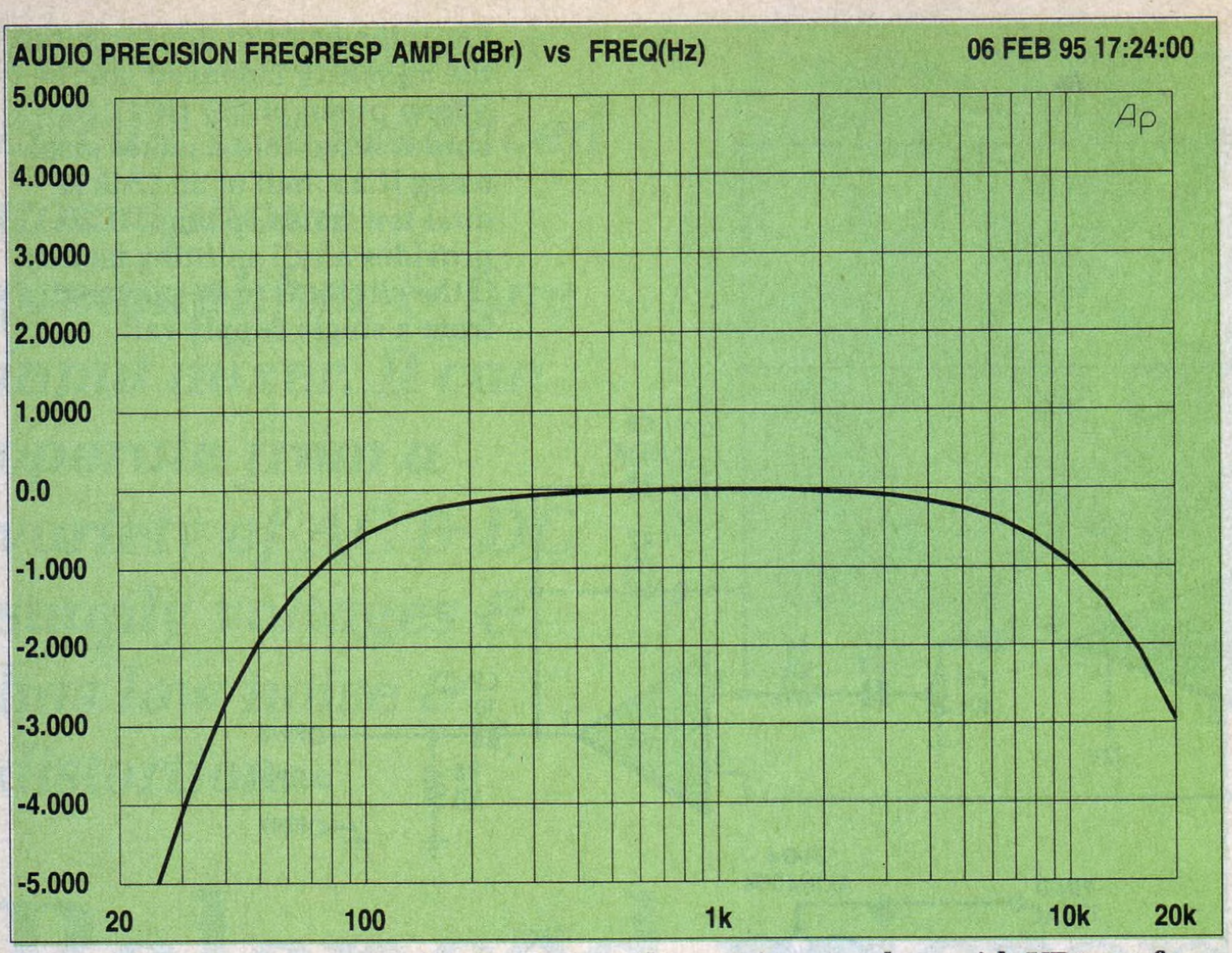


Fig.3: frequency response plot for the auxiliary 1 input, taken with VR2 set for maximum sensitivity.

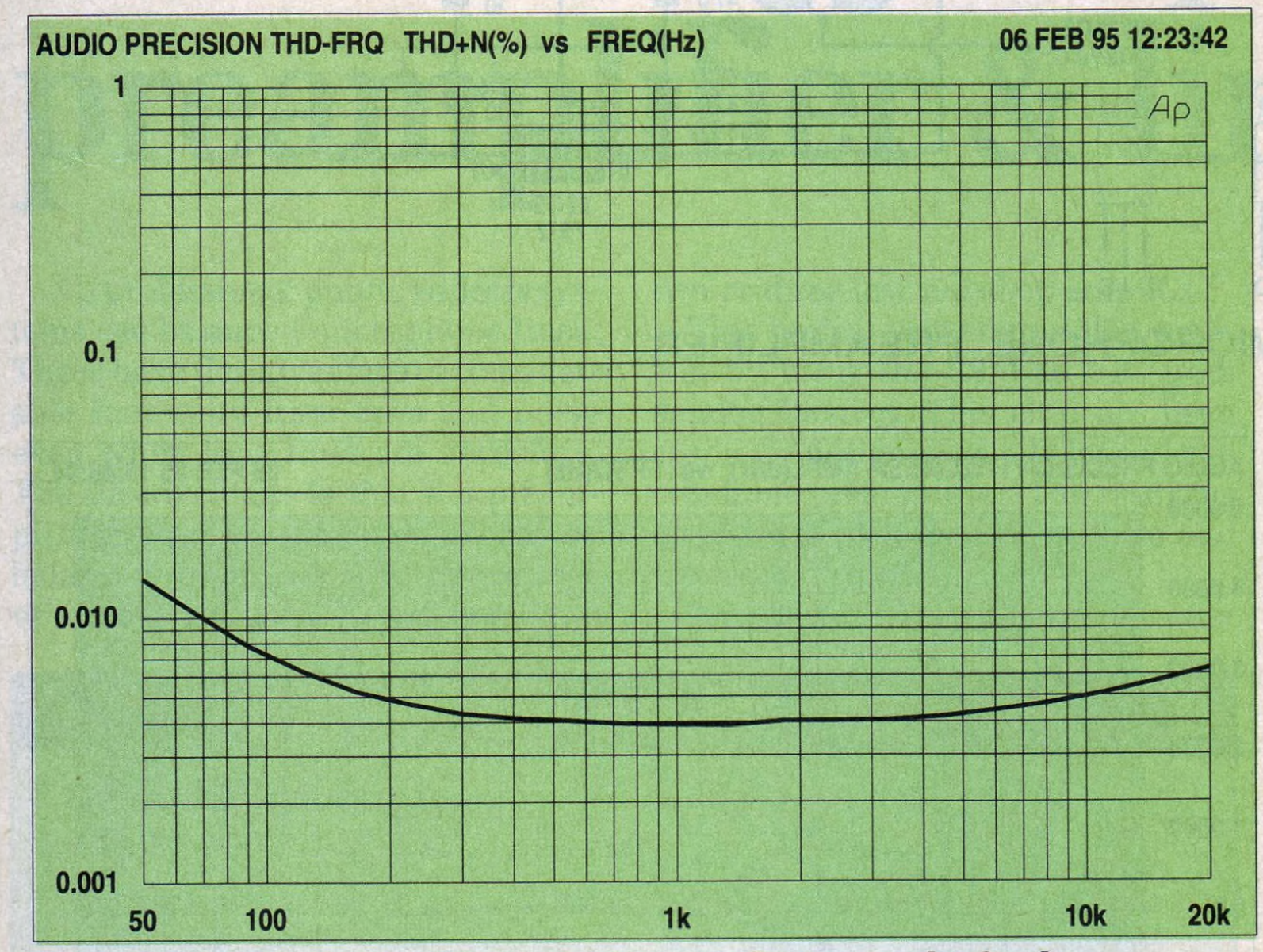


Fig.4: total harmonic distortion & noise versus frequency plot for the microphone preamplifier input (10mV in & 1V out).

below 40Hz, as can be seen in the frequency response plot of Fig.3. Both these frequency response plots exhibit a high frequency rolloff above 10kHz and this is due mainly to the 180pF capacitor C8 shunting 47kΩ feedback resistor R7.

Again, this rolloff is desirable for public address work, to keep noise to a minimum and also to minimise breakthrough of radio interference.

Well, the function of IC1 and IC2a (half of an LM833 dual low noise op amp) is fairly straightforward but what is the function of the remaining op amp (IC2b). This acts as a supply rail splitter in case the unit is powered from a single DC source.

The power supply section can accept an AC or DC input by virtue of the bridge rectifier (diodes D1-D4). The input supply can be ±12V to ±30V DC, or AC (24V centre-tapped up to 40V centre-tapped). Alternatively, it can be run from a single rail DC supply ranging from 15-30V or from an AC supply ranging from 12-20V.

If the unit is powered from a centre-tapped supply, the resulting supply rails from the 3-terminal regulators are ±12V DC and the link at JP1 is set for split supply operation. In this case, IC2b does nothing.

On the other hand, if a single rail supply is used, the negative 3-terminal regulator is not used. Instead, C17 & C16 are omitted and links wired in their place. The result is a single rail supply of 12V DC from REG1. This is then split by IC2b and so the circuit effectively has its reference, pin 5 of IC1 and pin 3 of IC2a, set to +6V. Alternatively, IC1 and IC2 effectively run from a supply of ±6V. For this condition, the link at JP1 is set to the "single" setting.

Ideally, for maximum signal handling and lowest distortion, the circuit should be run with dual supply rails. The distortion curves of Fig.3 and Fig.4 were measured with the prototype powered from spilt supplies (ie, ±12V DC). Fig.4 shows the harmonic distortion of the preamplifier for the microphone input (10mV in and with trimpot VR1 set for 1V out). Both VR2 & VR3 were set to maximum attenuation.

Fig.5 shows the harmonic distortion of the preamplifier for one of the line inputs. In this case, VR1 was set to zero, while the line input in question was 0.24V in and 1V out.

Construction

Assembly of the PC board is quite straightforward. We suggest installing the 12 PC pins and the 3-pin header first, followed by the links, resistors and diodes. This done, install the trimpots, the capacitors, ICs and regulators. Make sure that all polarised parts such as the electrolytic capacitors, diodes and other semiconductors are installed the right way around. If you don't make sure of this point, the circuit could be damaged when power is applied for the first time.

Before applying power to the finished board, check your work carefully to make sure that all components are correctly installed and that there are no solder bridges or missed

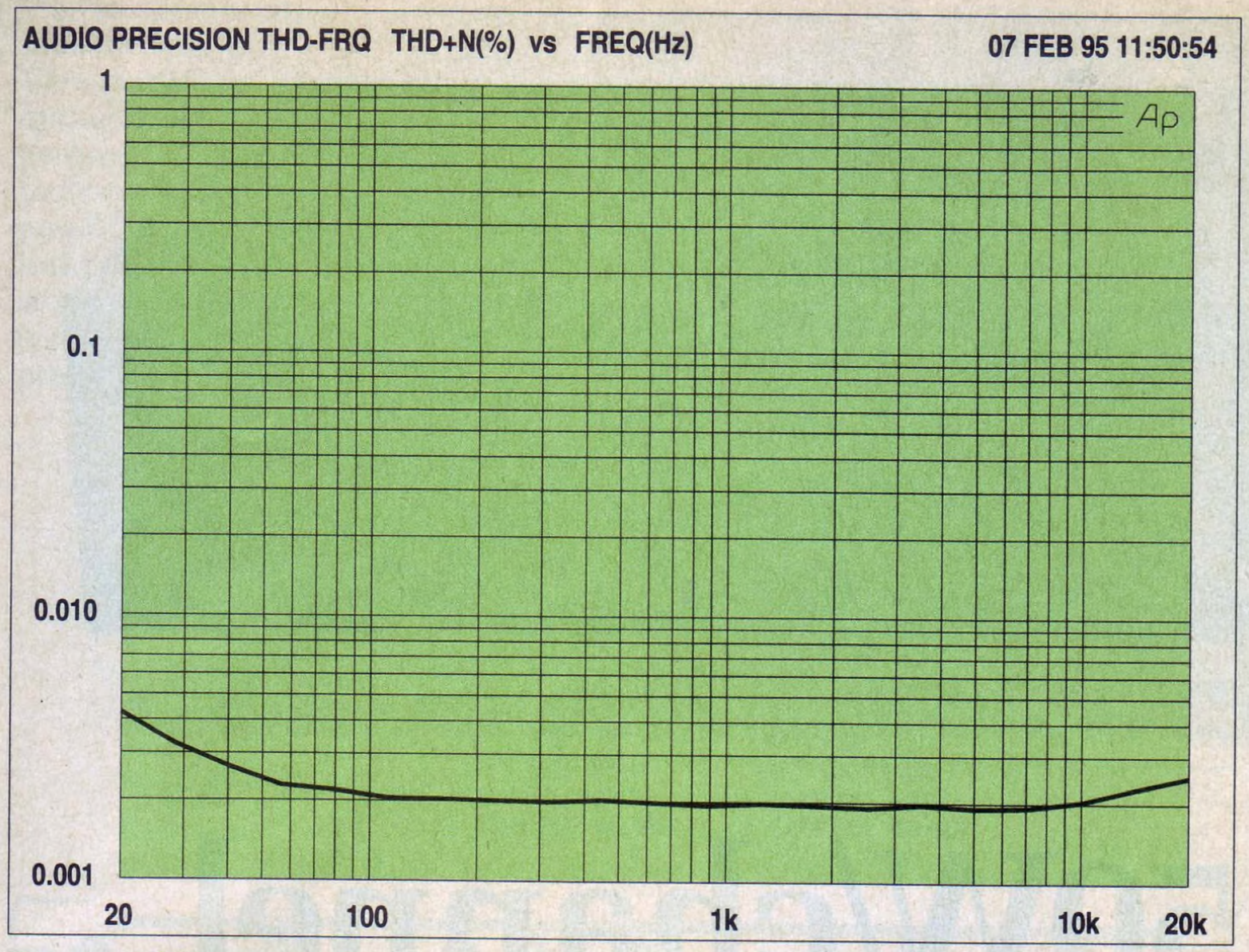


Fig.5: total harmonic distortion & noise versus frequency plot for the auxiliary 1 input at maximum sensitivity.

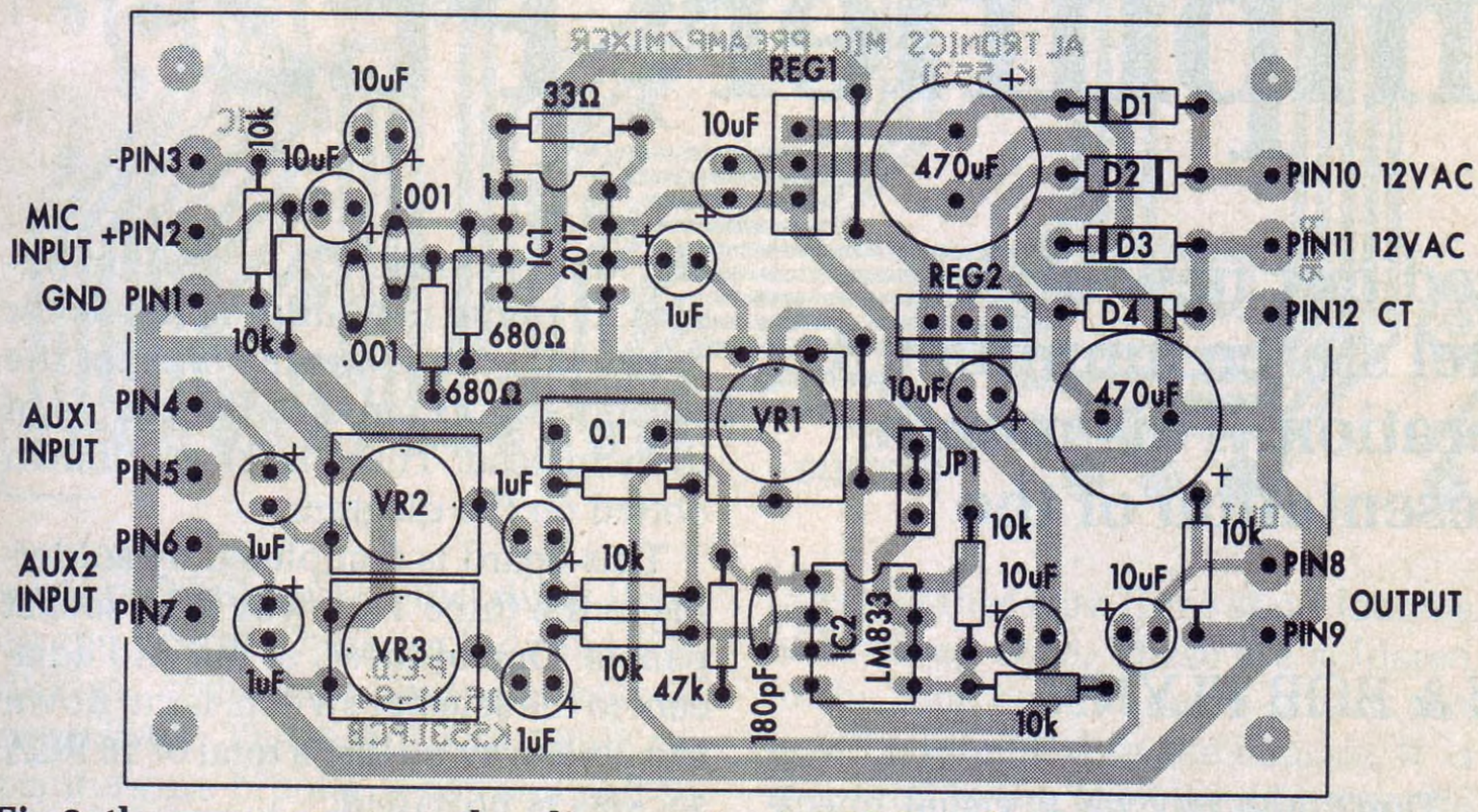


Fig.6: the component overlay diagram for the PC board. Make sure that the jumper is correctly installed for dual supply or single supply operation. VR1 sets the level for the microphone input, while VR2 & VR3 set the levels for the two auxiliary inputs.

PARTS LIST

1 PC board, code PED5531, 90 x 56mm
12 PC pins
1 3-pin header (JP1)
1 mini jumper
3 10kΩ horizontal trimpots (VR1-VR3)

Semiconductors
1 SSM2017 balanced microphone preamplifier (IC1)
1 LM833 dual low noise op amp (IC2)
1 7812 +12V regulator (REG1)
1 7912 -12V regulator (REG2)
4 1N4004 silicon diodes (D1-D4)

Capacitors
2 470µF 35VW electrolytic
6 10µF 35VW electrolytic
5 1µF 63VW electrolytic
1 0.1µF 100VW metallised polyester (greencap)
2 .001µF disc ceramic
1 180pF disc ceramic

Resistors (0.25W 5%)
1 47kΩ (yellow violet orange gold)
8 10kΩ (brown black orange gold)
2 680Ω (blue grey brown gold)
1 33Ω (orange orange black gold)

Where to buy the kit

This preamplifier has been designed and produced by Altronics. The kit is priced at $27.50 (Cat. K-5531) and is available from Altronics in Perth or from any of their resellers.

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solder joints on the underside.

If the unit is to be powered from a single supply, the 7912 regulator can be omitted and links installed in place of electrolytic capacitors C16 & C17. Make sure that the jumper has been set correctly as well.

Testing

Connect a microphone to the microphone input, making sure that the correct pins are used:
Pin 1 = Ground/Shield
Pin 2 = Signal Hot (In Phase)
Pin 3 = Signal Cold (Out Phase)

If you are using an unbalanced microphone make sure you have connected pins 1 and 3 together. Now turn all gain trimpots fully anticlockwise for minimum gain and connect the output to an amplifier. If the amplifier has a gain control, you should set this to about midway.

If you now apply power, all should be quiet. If any undue noises appear from the loudspeakers, switch off immediately and check your work carefully. All seems OK? Whilst talking into the microphone, you can then increase the gain adjusting trimpot VR1, until a suitable level is obtained. The auxiliary inputs are tested in a similar way. The signal source for these inputs could be a CD player, tuner or cassette deck.

If your application requires it, the trimpots can be replaced with standard pots. If this is done, we recommend the use of shielded cable for the wiring of the pots to minimise hum and noise. Naturally, the preamplifier should be situated away from any power transformers to minimise hum pick-up. **SC**