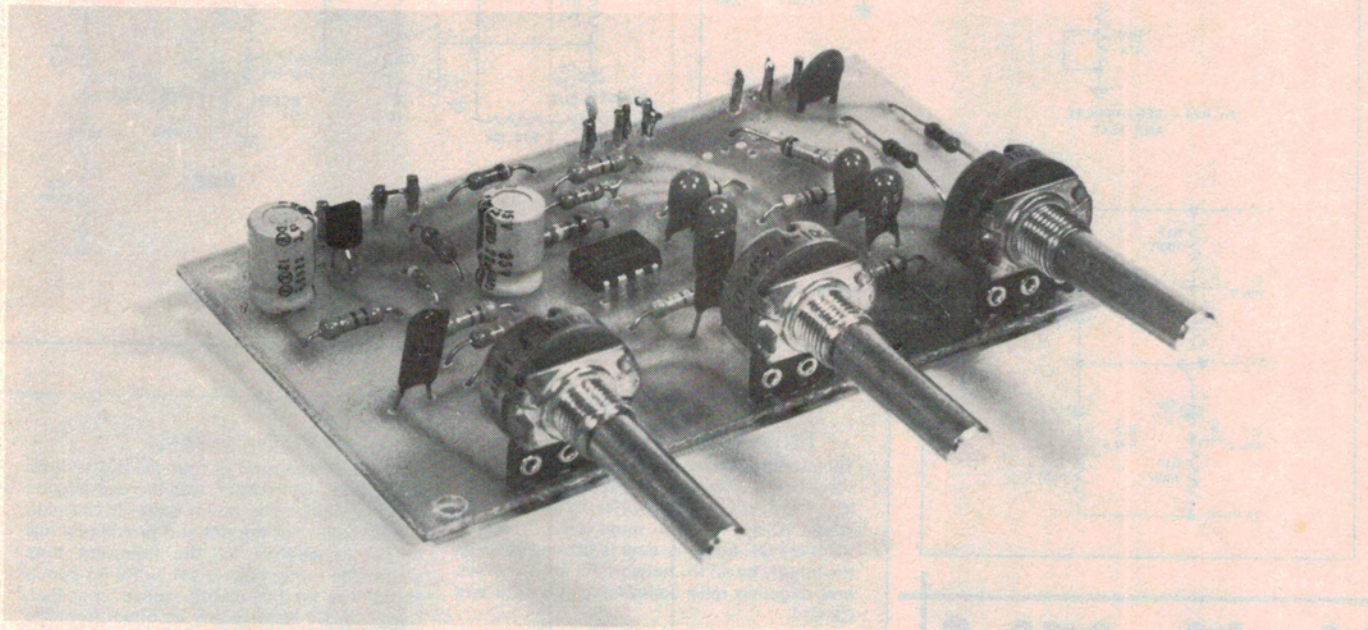
Versatile preamp module for a paging amplifier system

This project was designed as the preamp stage of a paging amplifier which will be described next month. We soon realised that the preamp itself was just what a number of readers had requested so it has been given a separate project number.



Geoff Nicholls

THE LAST balanced input preamp described in ETI was the ETI-461, published in December 1982. The '461 is a full instrumentation amplifier and has very good specifications suitable for virtually all balanced transducers. For most microphone work however, the simpler differential amplifier is generally adequate and is what I've chosen to use in this project. The ETI-461 article is recommended reading to clarify the pros and cons of each approach.

In this project I have provided a proper transformerless balanced input to allow professional, low impedance balanced mics to be used, with their inherent advantages of low hum and interference pickup. I have also provided bass and treble controls and a muting facility that allows push-to-talk dc switching without running the low level signal all over the place. This also allows many preamps to have their outputs summed without adding a lot of noise from unused inputs.

The unit is constructed on a pc board measuring just 60x100 mm. The level, bass and treble potentiometers are 17 mm diameter printed circuit mounting types that require a standard 9 mm mounting hole and have a standard 6.4 mm (¼") shaft. They are imported and distributed by Soanar. The board assembly may be mounted to a panel using the pots, although four holes around the board perimeter may be used as an alternative. 'Standard' pots may be used but the board will have to be mounted separately.

The differential input stage employs a single NE5534 with provision for either direct or capacitive coupling. the common-mode rejection ratio (CMRR) may be adjusted by means of an on-board trimpot or simply set by a resistor. A CMRR in excess of 115 dB may be achieved, but this is well in excess of the commom-mode noise commonly attained with balanced lines of around −60 dB. Hence, setting the CMRR with a fixed resistor beforehand will probably suffice in many circumstances.

A TL072/μA772 dual op-amp provides a buffer stage between the level control at the output of the 5534 and the tone control stage. The tone controls are not like the familiar 'hi'fi' controls. As this preamp is meant for voice work in a public address system, the bass breakpoint is set at 800 Hz and the treble breakpoint at 1200 Hz. The choices may seem surprising, but provide quite effective control. The boost and cut range is around +/−10 dB, which is adequate for the application.

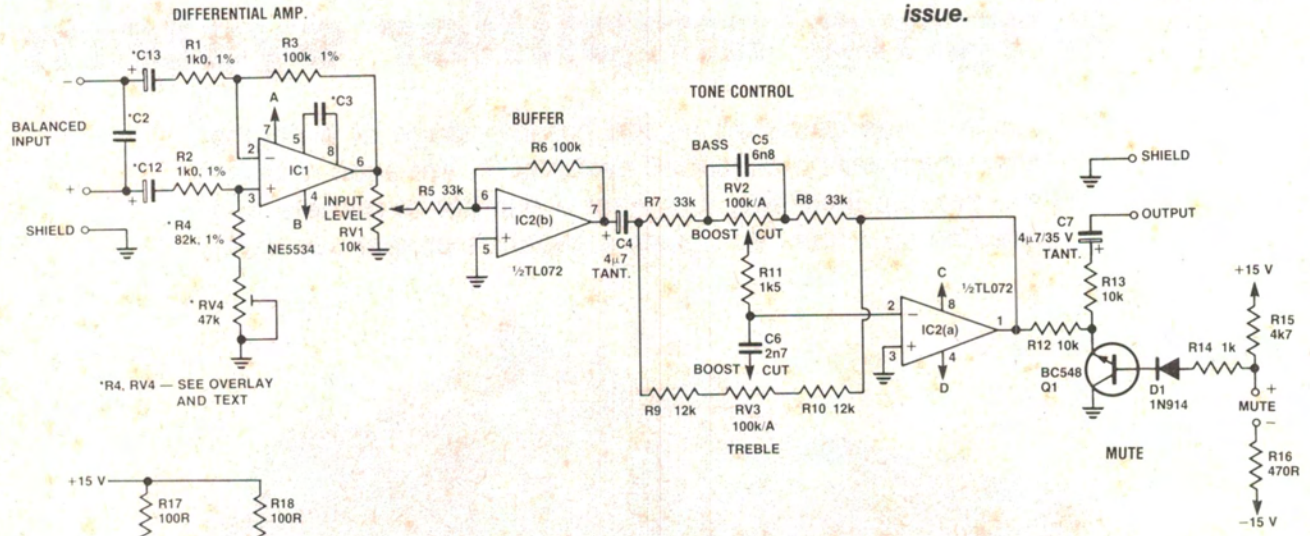
The mute circuit is adapted straight from David Tilbrook's Series 5000 preamp (why re-invent the wheel?).

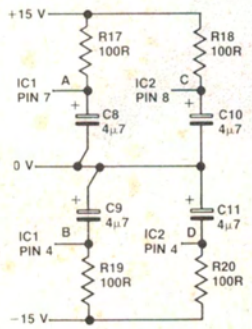
The output of this unit may be fed to the high level input of an existing preamp, such as the ETI-498, or even straight into a power amp. The dual rail power supply requires can be from 9 to 15 Vdc, so many existing supply rails should suffice. If you need a dual power supply module, then the ETI-581 (June 1977 and *30 Audio Projects)* will do nicely.

Construction

As always, first give the pc board a thorough inpsection and correct any faults, such as incorrectly drilled or undrilled holes, track 'bridges' or breaks, etc. Start with the link near RV1 and then install all the resistors and pots. The recommended pots are pc mounting types and the board can be supported by them alone if required. The pads for RV4 (if used) have been laid out to allow all common trimpots to mount with ▶

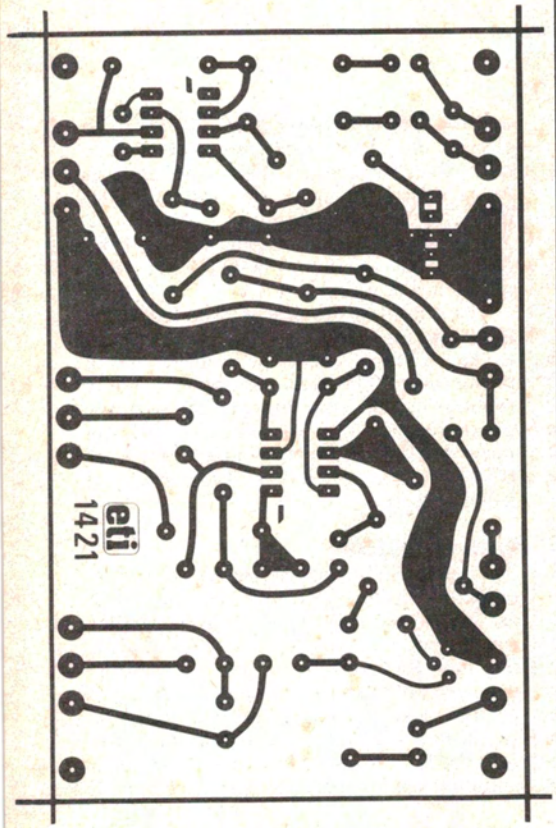
*For a guide to buying components and kits see **SHOP AROUND** this issue.*





POWER SUPPLY DECOUPLING

Circuit. The connection of C1 is explained on page 97.



HOW IT WORKS — ETI 1421

The preamp can be divided into four sections comprising the differential input amplifier IC1, the level control buffer IC2b, the tone stage IC2a and the mute circuit, which involves Q1. Each op-amp is decoupled from the supply by an RC network for both positive and negative rails comprising R17-R20 and C8-C11.

DIFFERENTIAL INPUT AMPLIFIER

The standard single op-amp differential amp circuit is used with provision for ac coupling capacitors C12 and C13. These capacitors are not necessary with normal balanced microphones but have been included on the pc board so that the project may be more versatile. A high capacitance low voltage electrolytic capacitor such as 47µ/6 V or similar should be alright, although the ac common-mode rejection and stage distortion will inevitably be degraded if the capacitors are used. Capacitor C2 terminates the input for high frequency signals and improves the stability of the stage.

The gain of the differential amp is set by the ratio of R3/R1 (provided R1=R2 and R3=R4) and is 100, or 40 dB for normal balanced microphones. Other gain values may be achieved by changing the resistors, but if a gain of less than three is used then capacitor C3 (22 pF) must be fitted to ensure stability.

The common-mode rejection can be optimised by fitting RV4 (use a 22k trimpot) and changing R4 to 92k, 1%. This will allow a common-mode rejection ratio of over 100 dB to be achieved, although in practice the balanced cable running to the input will limit the CMRR to about 60 dB. A 100 nF ceramic capacitor C1, (not shown on the circuit) should be mounted on the input socket between the cable shield and the chassis for electrostatic screening.

LEVEL CONTROL BUFFER

The differential amp output feeds the level control pot, RV1, which sets the overall gain of the preamp. The buffer stage IC1b, minimises loading of the pot and provides a low output impedance for the following tone stage. The buffer gain is set by R6/R5 and is about five for the circuit values specified. Capacitor C4 isolates any dc offset from the preceding stages before the bass control. Without ac coupling here, if the bass control were set on boost, any offset would be amplified as well, possibly driving the next stage into output saturation.

TONE CONTROL STAGE

This stage was designed using the National Audio Handbook (1977) 'Alternative Bass Design Active Tone Control' data which is detailed in Figure 2.14.16 in that book. The roll-off frequencies were chosen to suit voice signals and are lower than most designs, having breakpoints of approximately 800 Hz and 1200 Hz. The maximum boost and cut is about plus and minus 10 dB respectively, which is enough for microphone work.

MUTE CIRCUIT

This section is identical to the muting in the Series 5000 preamp as designed by David Tilbrook and described in ETI October 1981, page 36. Resistor R15 supplies base current to Q1 which clamps the junction of R12/R13 to 0 V to mute the preamp, unless the MUTE is disabled by a push-to-talk switch. A link across the MUTE terminals will allow signals to pass.

Several preamps can be connected to a summing amplifier (virtual earth) by simply connecting all outputs together. If the output is required to be dc-coupled then C7 may be deleted.

PARTS LIST — ETI 1421

NOTE: list for low-Z balanced mic input.

Resistors.....all ½ or ¼ W 5% unless noted.
- R1, R2.....1k0 1% metal film
- R3, R4.....100k 1% metal film
- R5,7,8.....33k
- R6.....150k
- R9, R10.....12k
- R11.....1k5
- R12,13,15.....4k7
- R14.....1k
- R16.....470R
- R17,18,19,20.....100R
- RV1.....10k/C pc mount pot . . . AUST C-10k T Z (see below)
- RV2, RV3.....100k/A pc mount pot . . . AUST A-100k T X (see below)
- RV4.....22k trimpot, optional (see text).

NOTE: The pc mount pots are from Soanar. Normal pots may be used, although the board will have to be mounted separately.

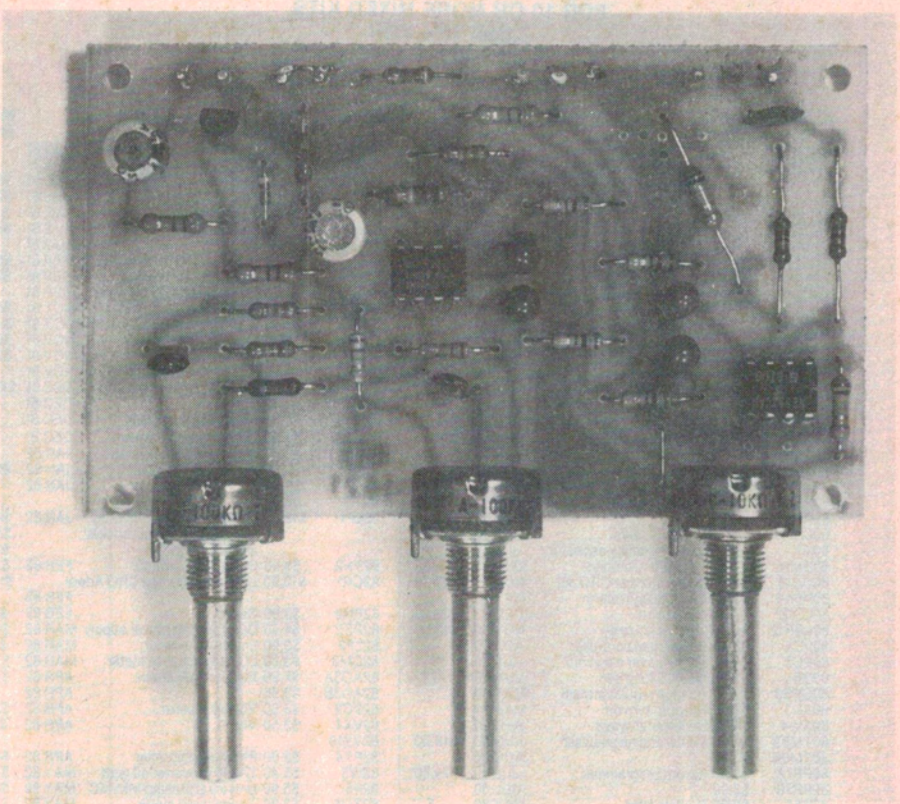
Capacitors
- C1.....100n ceramic
- C2.....4n7 ceramic
- C3.....22p, see text
- C4,7,8,9,10,11.....4µ7/35 V tag tantalum
- C5.....6n8 polyester
- C6.....2n7 polyester
- C12, C13.....4µ7/6 V, see text

Semiconductors
- IC1.....NE5534A low noise op-amp
- IC2.....µA772, TL072 FET-input dual op-amp
- Q1.....BC548, BC108
- D1.....1N914, 1N4148

Miscellaneous

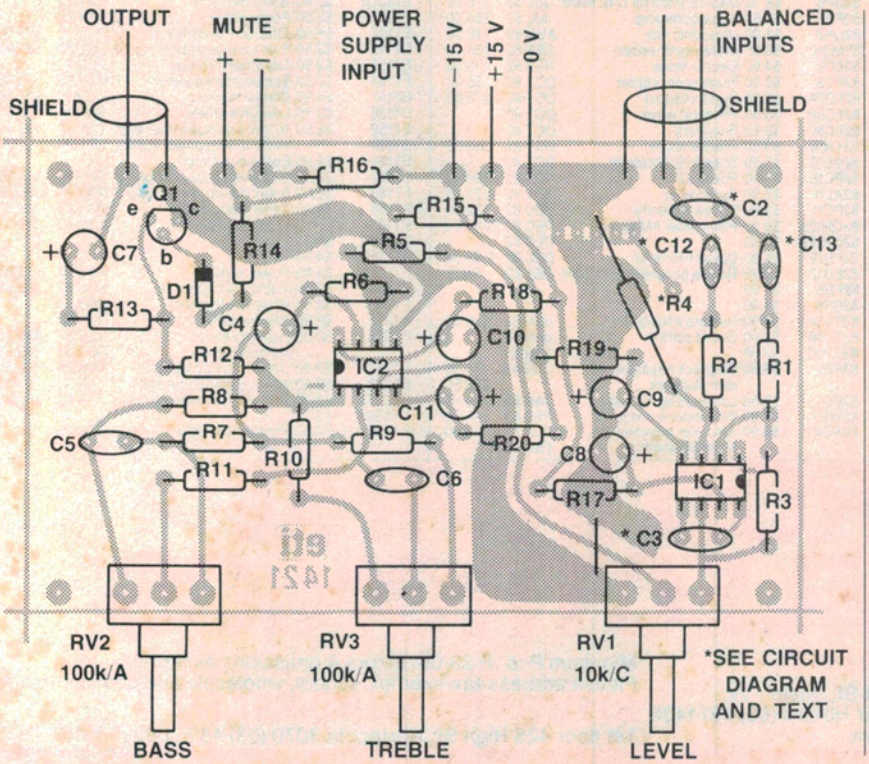
ETI-1421 printed circuit board; optional XLR 3-pin socket; hookup wire, pot knobs, pc pins, etc.

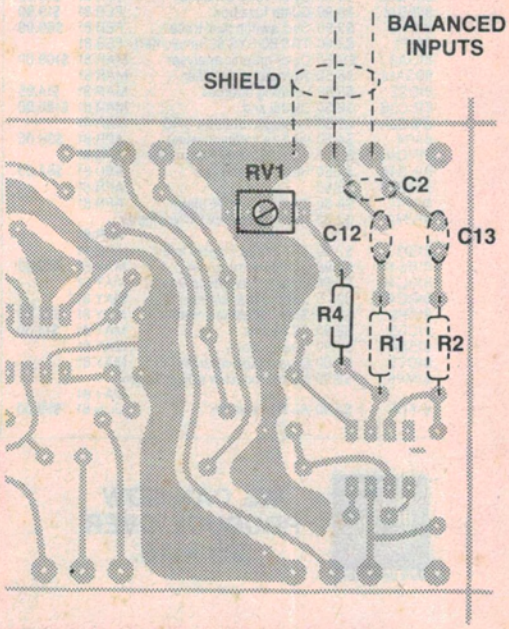
Price estimate: $18-$20



the screwdriver side towards the rear where it is accessible. The electrolytic capacitors are polarised and their orientation should be checked before soldering, as should the semiconductors. The two 8-pin IC sites on the pc board have pin 1 marked on the copper side to aid constructors. I used pc pins for the off-board connections.

If the project is to be used exclusively with low impedance balanced mics then ▶





CMRR trimmer. Alternative overlay showing the positions of RV1 and R4. With a normal vertically mounted miniature trimpot, the screwdriver adjustment slot should face away from the rotary post (towards rear of board). ▶

capacitors C12 and C13 can be left out and resistors R1 and R2 installed to bypass the extra pads. Similarly, if the mute function is not required then Q1, D1, R14, R15 and R16 may be deleted.

Check out

Basically, to check it out, all you need is a power supply and headphones. Set the level control at minimum and the tone control at centre rotation. If you've installed the common-mode adjustment trimpot, set it at halfway. Hookup a power supply (anything from +/−9 to +/−15 volts) and the headphones and link the MUTE terminals. Advancing the level control with the input open will increase the noise in the headphones. Touching one input pin should result in a loud burst of hum. Removing the link from the mute terminals should immediately cut the output.

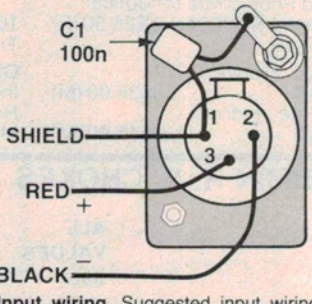
If you have a mic and an amplifier on hand, hook it up and give it a try out.

Common-mode adjustment

The common-mode rejection ratio (CMRR) is obtained by dividing the differential gain by the common-mode gain. This section is only for constructors who have opted to fit the common mode rejection trimpot RV4. If used, RV4 should be 22k and R4 should be 91k, 1%.

Set the level control to maximum and centre the tone controls. (i.e: 'flat' position). Connect the two balanced inputs together and apply a 1 kHz signal of about 10 Vp-p between then and the shield. Monitor the differential amplifier output at pin 6 of IC1 and adjust RV4 to minimize the common-mode gain. The prototype achieved a CMRR of 117 dB, but it was a fiddly adjustment.

Alternatively you may connect a balanced mic and listen to the preamp through a headphone amplifier while adjusting RV4 for minimum hum. ●



Input wiring. Suggested input wiring. Pin 1 of the Cannon socket goes to the board common track, which **should not** be connected to the chassis. C1 ties the chassis to the common for ac signals, avoiding 'earth loops' via chassis connections.