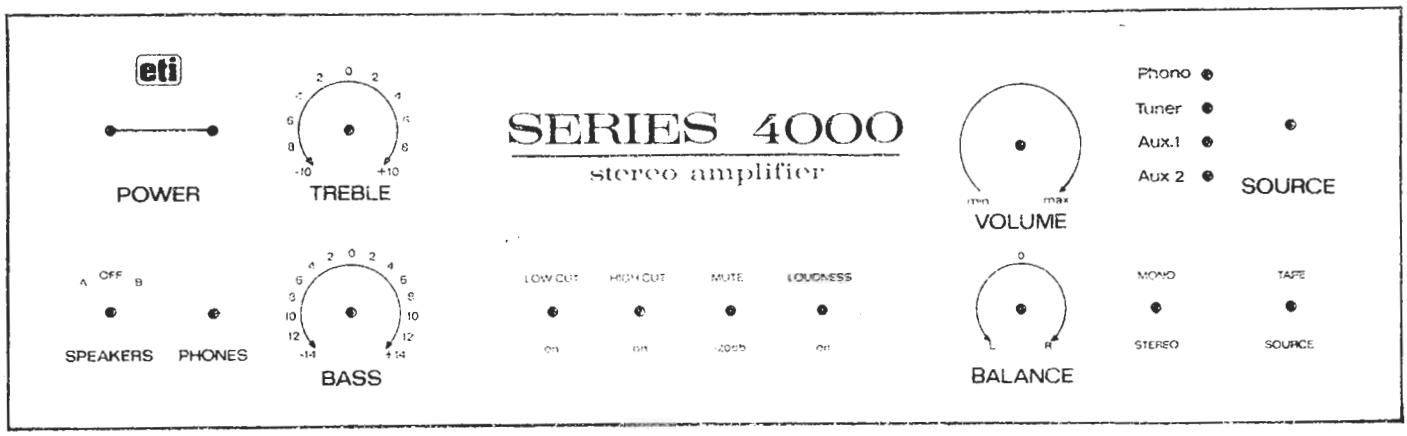
High Performance Stereo Preamplifier

This project is designed to complement our 60 watt low distortion amplifier module and forms part of a complete stereo system, our "Series 4000" project—to be described in a forthcoming issue.



THIS stereo preamplifier is designed to drive two 60 watt, low distortion amplifier modules (ETI 470), described last month.

The requirements for this preamplifier/control unit were set down after many hours of office discussion. In fact it would be fair to say that the final design was evolved, rather than conceived.

Amongst the first requirements were low hum and noise and low distortion — much lower distortion than the amplifier modules it would be required to drive. Low distortion in a preamplifier is relatively easy to achieve and makes the subsequent addition of a high quality class A headphone amplifier worthwhile.

In the final design, we feel we have achieved performance figures well up front amongst commercial equipment.

Features considered essential included loudness, high cut and low cut filters. These are common in commercial preamp/control units but lacking on most kit designs. The low cut filter incorporated in our design will effectively reduce bass rumble while the high cut filter is useful for reducing tape hiss or 'monkey chatter' and heterodynes from an AM tuner.

The disc amplifier stage of a preamp must be capable of handling very high input signals before clipping to preserve dynamic range, especially as moving coil cartridges with voltage boosting transformers and/or amplifiers are finding increasing popularity. The disc input of this design can handle 400 mV peak-to-peak before clipping, giving it a dynamic range in excess of 100 dB!

Finally, and by far the most difficult of our requirements to implement, was the idea that all switches and potentiometers be mounted directly onto the pc board, with as few links and external leads as possible. All this, while preserving an attractive and stylish front panel layout! The advantage of this is that assembly is easy, and straightforward and there is less room for wiring errors to creep in and, should it be necessary, the board can be removed for servicing in its complete, functional form. All interconnections to and from the board are via RCA sockets using standard audio 'jumper' leads.

The 60 watt power amplifier module and this preamp/control unit project form the basis of our "Series 4000" high performance stereo amplifier project, complete details of which we plan to present next issue.

CONSTRUCTION

All the components, including the pots, switches and LEDs, are mounted onto the pc board. The board is then fixed, component side forward, behind the mounting panel of the case using standard 25 mm spacers and countersunk screws. A dummy facia — with the control markings etc on it, is subsequently held in place by the switch nuts.

If all directions are followed, then construction is quite straightforward — it's easier to do than describe!

Firstly, the mounting panel and facia must be cut and drilled to the dimensions shown on the drawing (or, you can mount everything off board, as shown at the end of this article). The drilled pc board may be used as a template. Dimensions shown in brackets refer to the facia panel which must be cut slightly smaller if you wish to use the same case for your stereo as we have.

The holes for the pot shafts are only 7 mm in diameter on the facia panel to ensure correct knob alignment. Countersunk holes are drilled in the mounting panel, but not in the facia, for the bolts securing the pc board through the spacers.

Once the mounting panel and facia are drilled, carefully check the alignment of all holes with the corresponding holes in the pc board. The drilling must be reasonably accurate.

ETI 471 – STEREO PREAMPLIFIER SPECIFICATIONS (Measured on prototype)

Distortion	0.015% at 1 kHz 0.015% at 10 kHz (For all inputs, with 500 mV RMS output – distortion is mainly 2nd harmonic).
Hum and Noise	83 dB unweighted (With respect to 10 mV phono input).
Frequency Response	Phono: Within 0.5 dB of RIAA from 20 Hz to 20 kHz (Follows new IEC curve). Other inputs: 20 Hz to 20 kHz ± 0.5 dB Subsonic rolloff: 6 dB/octave below 20 Hz
Output	7 V p-p before clipping
Tape output	150 mV RMS
Sensitivity	For 500 mV RMS output phono: 3 mV RMS other: 150 mV RMS (Phono overload level is 400 mV p-p).
Tone controls	Bass: ± 13 dB at 50 Hz Treble: ± 11 dB at 10 kHz
Filters	High: 6 dB/octave, –3 dB at 5 kHz Low: 6 dB/octave, –3 dB at 100 Hz
Loudness	8 dB boost at 15 kHz and 10 kHz.
Mute switch	20 dB attenuation

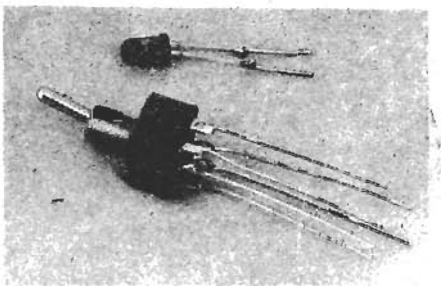
Once this mechanical work is completed the components may be mounted on the pc board. Start with the RCA sockets. Take care not to use too much force on the nuts and check that electrical contact has been made to the ground plane of the pcb using an ohm-meter. Join the centre pin of the RCA sockets to the pc board pads using lengths of tinned copper wire – refer to the overlay.

Mount the potentiometers next so that their terminals are directly above the pads on the pc board. The lower pot terminals can be cut, bent down and soldered directly onto the pads. Connect the upper pot terminals to the pc board, as shown in the overlay, using tinned copper wire.

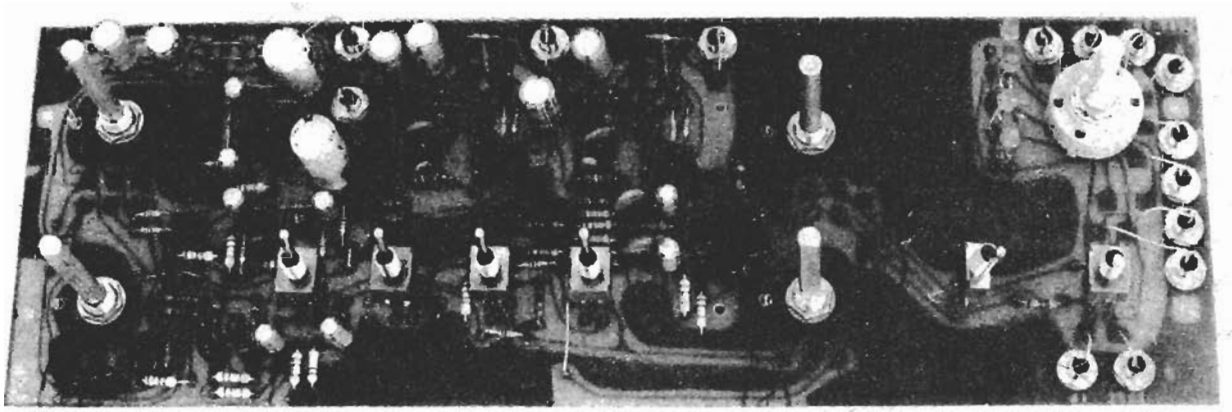
All switches are mounted on the board using pig tail leads. The rotary is a type commonly available almost anywhere. When mounting switches on the pcb, make sure all switch and pot bushings are in the same plane.

Once the major parts are assembled onto the pc board, all the minor components may be loaded and soldered in place. Make sure that any large components (electrolytics particularly) are less than 25 mm high, otherwise they will foul the front panel. Check that all transistors, tantalums and electrolytics are correctly oriented. Refer to the overlay as you proceed.

The switches and LEDs must be mounted and spaced correctly off the pc board. Solder 50 mm lengths of tinned copper wire onto each of the switch terminals and LED leads (see illustration). Pass the wires through the ▶



Above: The switches and LEDs have lengths of wire soldered on to them so that they can be inserted into the pcb before being attached to the front panel. They can then be soldered in place. This procedure ensures that there is no strain on the joints. Below: the completed unit. Full details of metalwork will be given in a later article, in which we will describe how to use this preamp with two of the ETI 470 60W units to build a high-performance, low cost stereo amplifier.



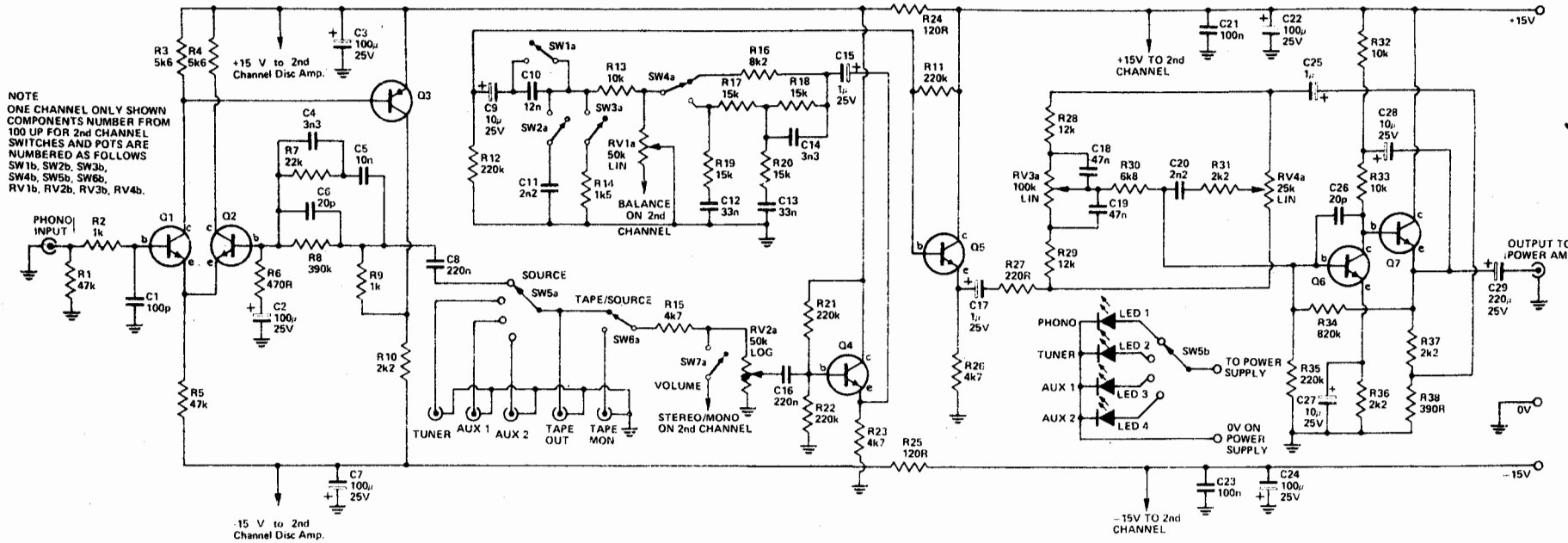


Fig. 1. Preamplifier circuit diagram. Only one channel has been shown for clarity. The component numbering of the other channel begins at 101.

HOW IT WORKS

The signal from a magnetic cartridge is fed to the base of Q1 via a low pass filter, (R2 and C1) for attenuation of radio frequencies. Q1 and Q2 form a differential pair, each half operating at low collector current to minimise noise. The output of the differential pair is taken from the collector of Q1 and further amplified by Q3. Feedback is taken to the base of Q2, the negative input of the differential pair, through the RIAA equalisation network. Overall gain of the phono stage is set by the ratio of the feedback network impedance to the value of R6.

Subsonic bass roll-off of 6 dB/octave, to conform to the new IEC 65 specification, is achieved by a high pass filter consisting of C8 and RV2.

Output from the disc preamplifier is then fed via the Source Switch (SW5), Tape-Source switch (SW6), R15 and the volume control (RV2), to an emitter follower, Q4. This emitter follower presents a high impedance for the aux inputs and a constant impedance for driving the filters.

When switched in, the loudness network boosts the high and low frequencies with respect to the midrange. In actual fact, all frequencies are attenuated but the midrange is attenuated more. When the loudness is switched out, R16 approximates the impedance of the network.

Muting is achieved by switching R14 to earth. The ratio of R14 to R13 sets the attenuation to 20 dB. C11 shunts high frequencies to earth for high cut, while C10 reduces low frequency content when switched in, providing low cut.

A second emitter follower, Q5, presents a constant impedance to the filters and acts as a low impedance source to the tone control stage.

A Baxandall tone stage is used here, a common circuit in many designs. Q6 is a gain stage with a bootstrapped collector load, via C28, to the output. Bootstrapping increases the gain by increasing the effective collection load impedance. Q7 is an emitter follower connected directly to the collector of Q6. This provides a very low output impedance. DC bias for Q6 is taken from the output.

Some of the output signal is fed back to the tone controls and split into high and low frequencies by RV3 and RV4. By adjusting the controls the percentage of the input to the negative feedback signal appearing at the base of Q6 can be varied, thereby varying the overall gain of the amplifier at either high or low frequencies. The gain of the tone stage is set by the ratio of R37 to R38. As R38 is reduced in value the negative feedback is reduced and therefore the overall gain is increased.

To preserve the very low output impedance of the pre-amplifier the balance control is placed ahead of, rather than after, the tone stage.

Power supply filtering and decoupling is provided by 100 μF capacitors and resistors in each rail.

Source indication is by LEDs from the spare section of the source switch. No current limiting resistor is on the pc board for the LEDs as one will be included in the power supply. (To be described).

corresponding pc board holes for these components but do not solder them in place yet. Check that the LED leads are the right way round.

Assemble the pc board onto the case mounting panel (using the 25 mm spacers and countersunk screws). Place the facia over the front panel, securing it in place with the switch nuts (three hands and a prehensile nose might help! . . a little sticky tape and deft juggling is all that's really necessary). Once you've got it all together the protruding wires may be soldered to the pc board. Ensure that no short circuits have occurred.

That completes the assembly. For servicing purposes the pc board and all switches, LEDs and pots — all the operating controls — may be removed simply by undoing several nuts, removing the facia and the countersunk screws beneath.

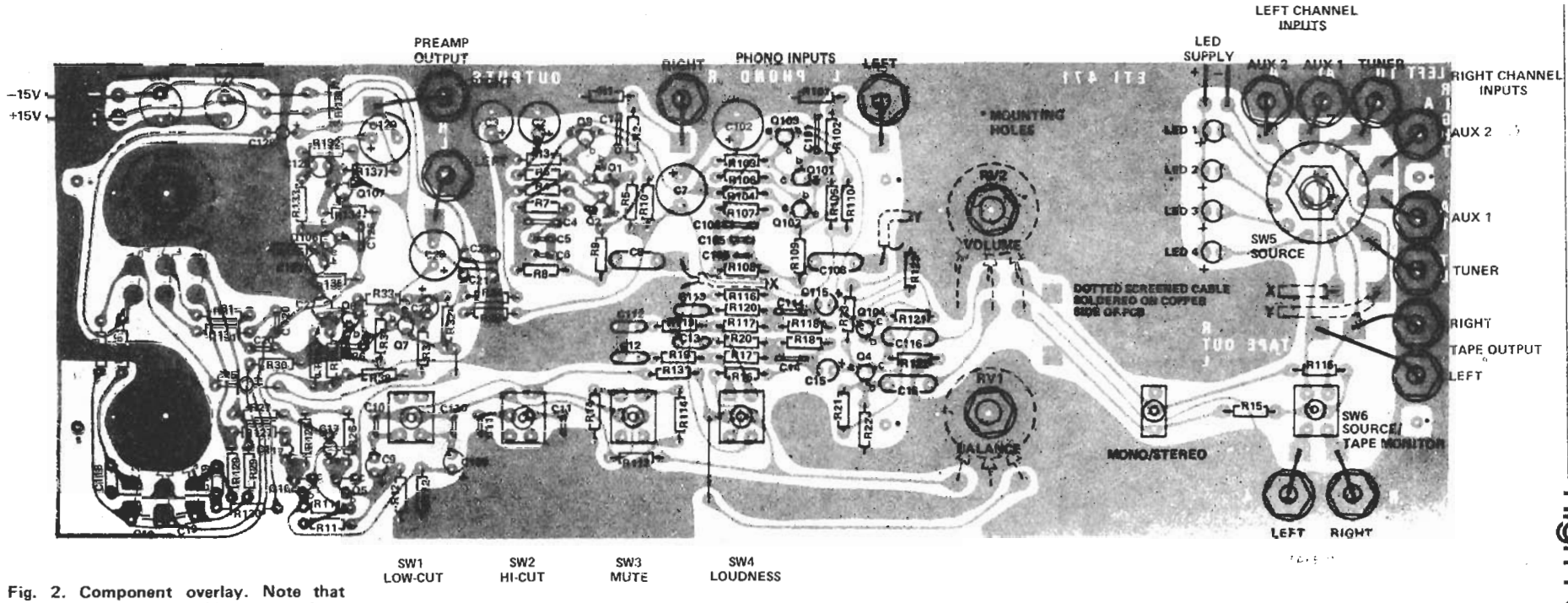


Fig. 2. Component overlay. Note that lengths of shielded cable are used to connect the outputs of the disc preamplifiers to the selector switch.

PARTS LIST

Resistors all ¼W 5%

R1, R101 . . . 47k
R2, R102 . . . 1k
R3, R4, R103, R104 . . . . . 5k6
R5, R105 . . . 47k
R6, R106 . . . 470R
R7, R107 . . . 22k
R8, R108 . . . 390k
R9, R109 . . . 1k
R10, R110 . . . 2k2
R11, R12, R111, R112 . . 220k
R13, R113 . . . 10k
R14, R114 . . . 1k5
R15, R115 . . . 4k7
R16, R116 . . . 8k2
R17 – R20, R117, R120 . . 15k
R21, R22, R121, R122 . . 220k
R23, R123 . . . 4k7
R24, R25 . . . 120R
R26, R126 . . . 4k7
R27, R127 . . . 220R
R28, R29, R128, R129 . . 12k
R30, R130 . . . 6k8
R31, R131 . . . 2k2
R32, R33, R132, R133 . . 10k
R34, R134 . . . 820k
R35, R135 . . . 220k
R36, R37, R136, R137 . . 2k2
R38, R138 . . . 390R

Potentiometers

RV1 . . . . . 50k single linear
RV2 . . . . . 50k dual log
RV3 . . . . . 100k dual linear
RV4 . . . . . 25k dual linear

Capacitors

C1, C101 . . . . 100p ceramic
C2, C3, C102 . 100µ 25V electro
C4, C104 . . . . 3n3 mylar
C5, C105 . . . . 10n mylar
C6, C106 . . . . 20p ceramic
C7 . . . . . 100µ 25V electro
C8, C108 . . . . 220n greencap
C9, C109 . . . . 10µ 25V electro
C10, C110 . . . 12n mylar
C11, C111 . . . 2n2 mylar
C12, C13, C112, C113 . . 33n mylar
C14, C114 . . . 3n3 mylar
C15, C115 . . . 1µ 25V tantalum
C16, C116 . . . 220n mylar
C17, C117 . . . 1µ 25V tantalum
C18, C19, C118, C119 . . 47n mylar
C20, C120 . . . 2n2 mylar
C21 . . . . . 100n mylar
C22 . . . . . 100µ 25V electro
C23 . . . . . 100n mylar
C24 . . . . . 100µ 25V electro
C25, C125 . . . 1µ 25V tantalum
C26, C126 . . . 20p ceramic
C27, C28, C127, C128 . . 10µ 25V electro
C29, C129 . . . 220µ 25V electro

Semiconductors

Q1, Q2, Q101, Q102 . . MPS 6515
Q3, Q103 . . . 2N5086
Q4–Q7, Q104 –Q107 . . . . . MPS 6515

LED1–LED4 . red LED

Switches . . . . (see text)

SW1–SW4 . . . DpDT min toggle switch
SW5. . . . . 3 pole 4 pos rotary switch
SW6. . . . . DpDT min toggle switch
SW7. . . . . spdt min toggle switch

Miscellaneous

14 RCA panel mounting single hole sockets, ETI 471 pcb, tinned copper wire, length shielded cable, 25 mm spacers, 30 mm screws, nuts, mounting panel and facia plate.