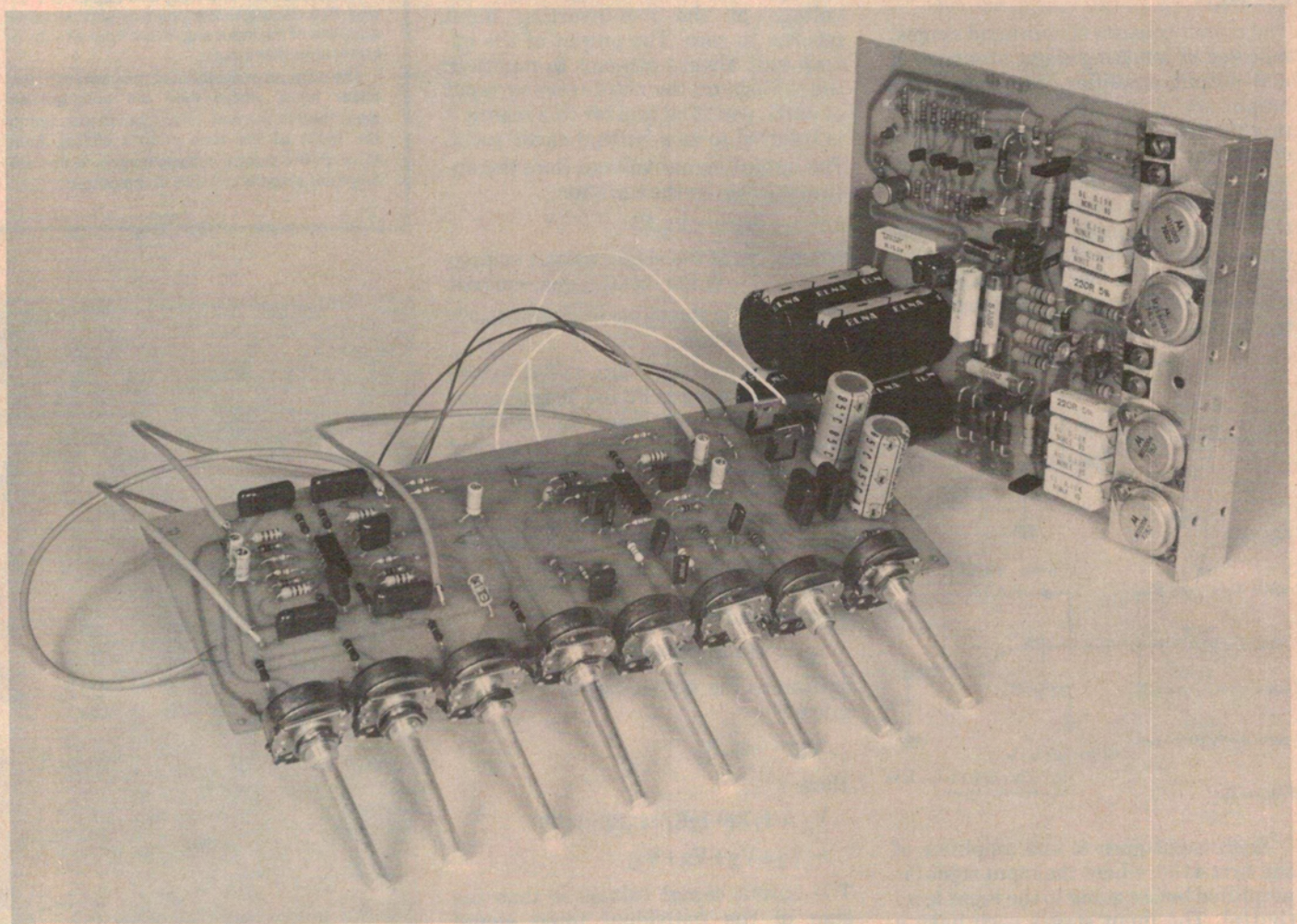
Four-input guitar/mic preamp to suit the ETI-466 module

Featuring simple construction and versatile operation, this preamp has been designed to mate with our 300 W 'Brute' power amp.

David Tilbrook



HAVING published the ETI-466 300 W power amplifier in February this year, we have had many requests for a guitar preamp capable of driving the module to full output. The biggest demand seems to be for a four-input preamp with bass, presence and treble controls followed by a master volume control. We are presenting the project as a printed circuit board rather than mounting the pc board in a chassis, as we feel most constructors will want to organise a chassis to meet their own requirements.

SPECIFICATIONS 4-INPUT PREAMP ETI-467

Hum and noise	76 dB below 50 mV input signal (20 kHz bandwidth)
Frequency response	30 Hz to 30 kHz, +/– 1 dB
Tone controls	Bass: +/– 17 dB @ 50 Hz Presence: +/– 22 dB @ 1.5 kHz Treble: +/– 22 dB @ 10 kHz
Max. output before clipping	20 V peak to peak

The power transformer recommended for use with the 466 power amp has an additional 15-0-15 volt winding that can be used to power this project if desired. For this reason we have included all the power supply components on the pc board, including voltage regulators. If the project is being constructed as a separate, stand-alone preamplifier, a small 12-0-12 volt power transformer can be used, such as the one specified in the parts list.

Design

The circuit consists of four input stages, followed by a mixing stage, tone control and output amplifier. The four input amplifiers drive the output of the mixing stage. This feeds the tone control circuit and then the final volume control and output amplifier. The 4136 quad operational amplifier IC was used throughout the project, mainly for the convenience of the quad package. One IC is used for the four input stages and the other for the mixing stage, tone control and output amplifer.

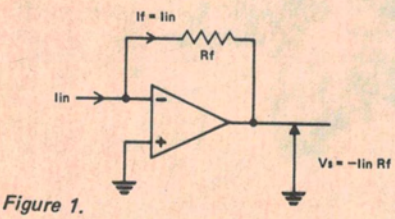


Figure 1.

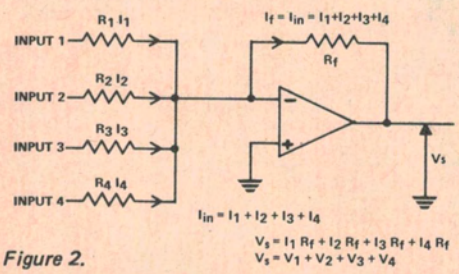


Figure 2.

Each input goes to one amplifier of the first 4136, where the input signal is amplified before going to the input level control. The input stages each have a gain of 20 dB, so a typical input level of around 50 mV will be amplified to 500 mV before being applied to the input level controls. With the input controls set at midway position the output from the potentiometers will be reduced to around 50 mV again. Without the input amplifiers, this signal voltage would be only 5 mV, causing a dramatic decrease in signal-to-noise ratio. The input amplifiers have an input impedance of 100k which should suit the vast majority of guitars. The outputs of the input level controls are fed to a 'virtual earth' point formed by the feedback loop around another op-amp. This is probably the most common technique used for mixer stages at audio frequencies and allows signal voltages or currents to be added independently. Figure 1 shows the circuit of an ideal op-amp with negative feedback applied through resistor R_f. If a positive-going current is passed into the non-inverting (−ve) input, the output of the op-amp will swing negative, pulling current through the resistor R_f, until the voltage at the non-inverting input returns to zero. The output of the op-amp will always attempt to maintain the voltage on the non-inverting input at earth potential and for this reason it is referred to as a 'virtual earth' point. The output signal voltage from the op-amp is given by the equation,

$$V_s = -I_{in}R_f$$

Where: V_s is the signal output voltage
I_{in} is the input signal current
and R_f is the value of the feedback resistor.

If input resistors are added to the circuit as shown in Figure 2, the signal current from each input will be determined by the input signal voltage and the particular input resistor. Since the non-inverting input is a virtual earth point, the current through each input resistor will not be affected by the other input currents. The total input current simply becomes the sum of all the individual input currents. So,

$$I_{in} = I_1+I_2+I_3+I_4$$

and since the output signal voltage is given by:

$$V_s = -I_{in}R_f$$

then

$$V_s = I_1R_f+I_2R_f+I_3R_f+I_4R_f$$
$$= V_1+V_2+V_3+V_4.$$

The output signal voltage is thus the sum of the individual input signal voltages — exactly what is required of a mixing stage.

The output of the mixer is fed to the input of the tone control circuit. The bass, presence and treble controls are formed by including a potentiometer and a suitable R-C combination in the feedback loop of an op-amp. The potentiometer varies the amount of feedback around the op-amp and this has the effect of altering the frequency response of the circuit.

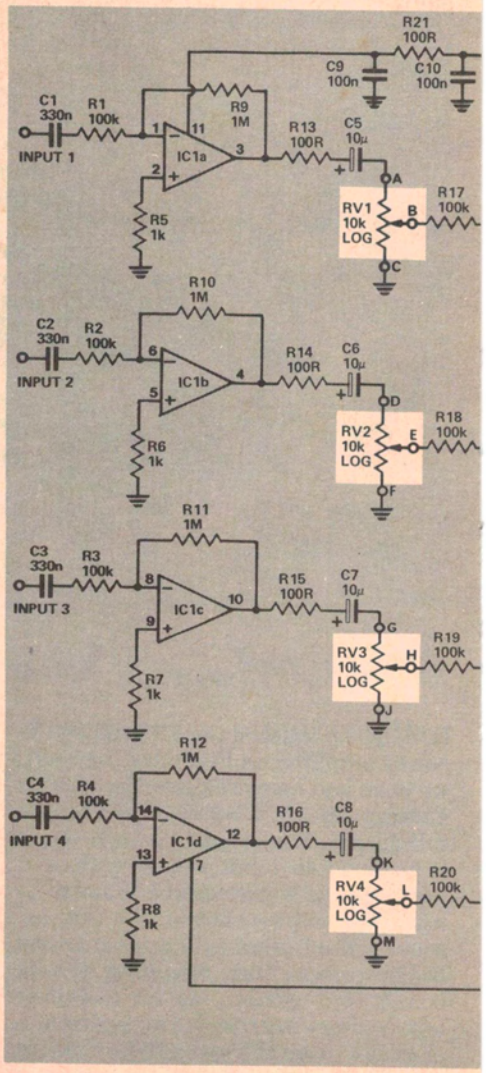
We judged that most guitarists would

HOW IT WORKS

The four input stages each use one section of a 4136 quad operational amplifier. These op-amps are internally compensated and require no external compensation capacitor. The input stages are configured as inverting amplifiers with a gain of 10 (20 dB) set by the ratio of the input resistor to the feedback resistor. The 100 ohm resistor in series with the output of each op-amp isolates any reactance on the output from the feedback loop, ensuring maximum freedom from instabilities that might otherwise cause oscillation.

Resistors R21 and R22, and capacitors C9 and C10 decouple the positive and negative supplies of the input amplifiers from all subsequent amplifier stages.

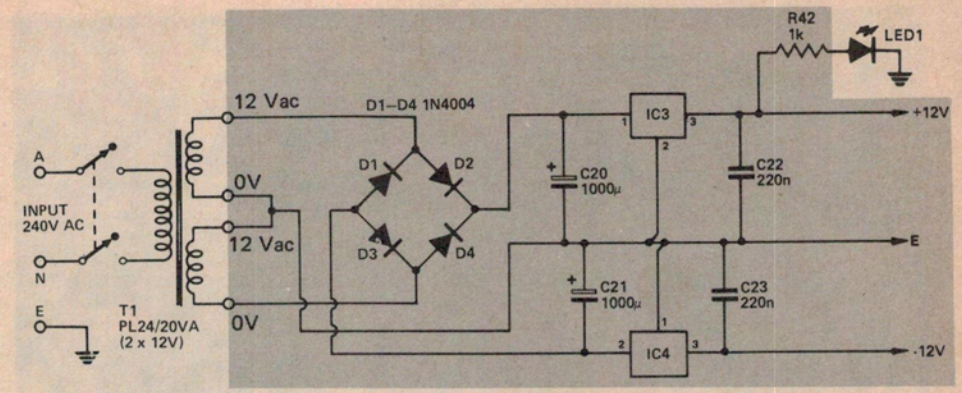
The outputs of the input stages are fed to the mixer input where they are summed as described in the text. The signal is then fed to the input of the tone control circuit, then through the master volume control to the last amplifier stage and finally to the output.



— ETI 467

The tone control stage works in a very similar way to the mixer stage. The signal currents in the bass, presence and treble circuits are summed at the non-inverting (−ve) input of the op-amp without interacting with one another, so the tone control really consists of three circuits operating simultaneously and these can be analysed separately. In each control, the potentiometer and the two resistors connected to each end of it, form the effective input and feedback resistance. The position of the wiper will determine the overall gain of the circuit. If a capacitor is now added, either across the potentiometer or in series with its wiper, a low pass or high pass frequency response, respectively, is obtained. The presence control simply consists of both a low pass and a high pass in the one circuit, forming a variable bandpass filter.

The power supply circuit is simple and uses commonly available IC voltage regulators to ensure stable voltage rails and minimise hum levels.



TANTALUM CAPACITOR

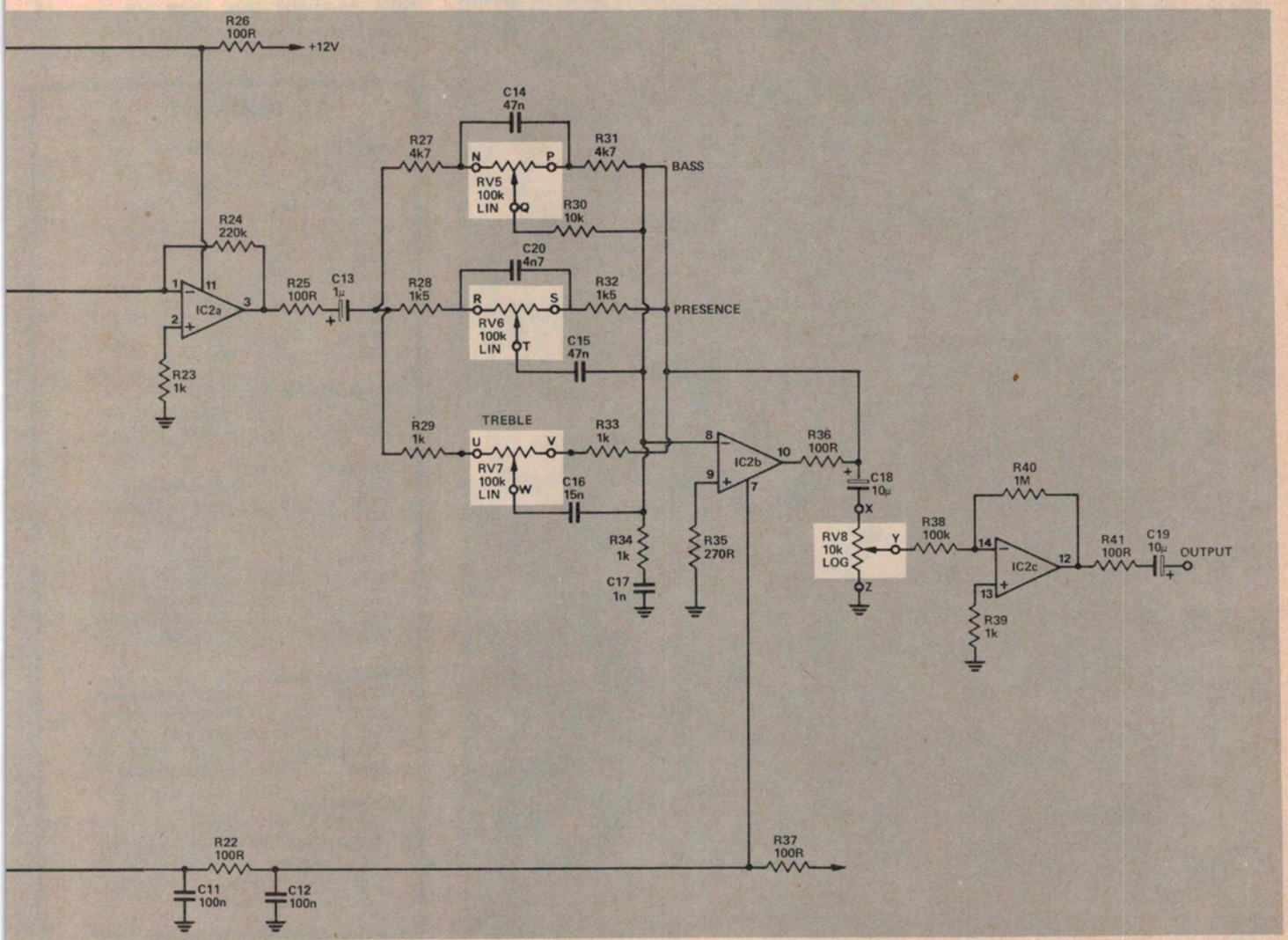
DOT

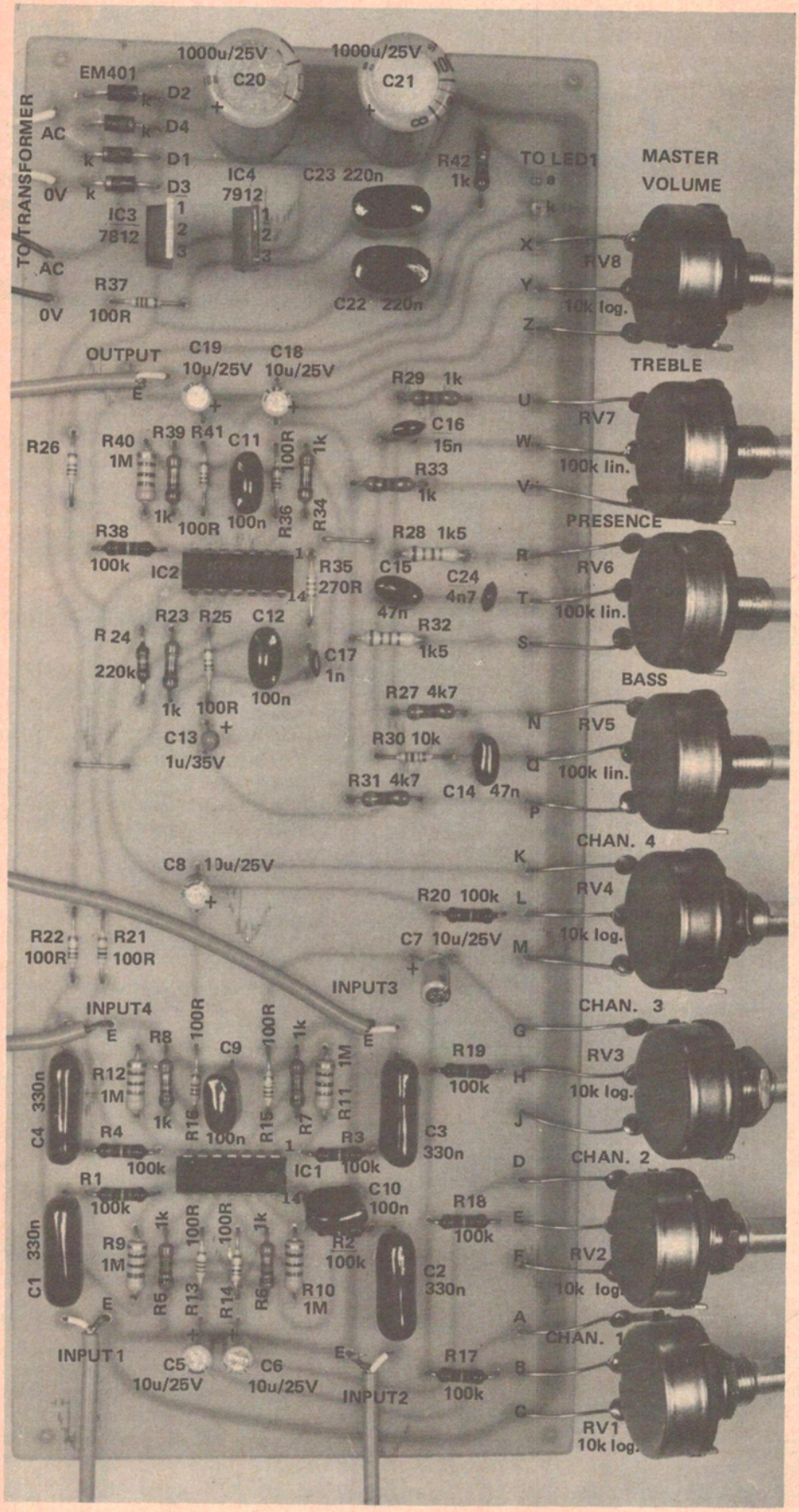
I.C. REGULATOR
7812, 7912

DIODE 1N4004

BAND

QUAD OP-AMP 4136
TOP VIEW





want a tone control that gives a relatively large amount of boost and cut, considerably larger than most hi-fi tone controls. The bass control has over 16 dB of boost and cut, while the presence and treble controls give over 20 dB.

The output of the tone control circuit goes to the master volume control and then to the final amplifier stage. The output impedance of the circuit is around 100 ohms and the maximum output voltage is 200 volts peak to peak, more than adequate to drive a power amplifier.

Construction

All the construction is restricted to the printed circuit board and so is relatively straightforward. We recommend you use our pc board, otherwise stability and ground-loop problems may occur.

Mount the resistors and non-polarised capacitors first. Next mount the tantalum and electrolytic capacitors, ensuring that they are inserted with the correct orientation. Most electrolytic capacitors have their negative

PARTS LIST

Resistors all ¼W, 5%

R1,2,3,4,17, 18,19,20,38	100k
R5,6,7,8,23,29, 33,34,39,42	1k
R9,10,11,12,40	1M
R13,14,15,16,21 22,25,26,36,37,41	100R
R24	220k
R27,31	4k7
R28,32	1k5
R30	10k

Potentiometers

RV1,2,3,4,8	10k log.
RV5,6,7	100k lin.

Capacitors

C1,2,3,4	330n greencap
C5,6,7,8,18,19	10u, 25 V electro
C9,10,11,12	100n greencap
C13	1u, 35 V tantalum
C14,15	47n greencap
C16	15n greencap
C17	1n greencap
C20,21	1000u/25 V electro
C22,C23	220n greencap

Semiconductors

IC1,IC2	4136 quad op-amp
IC3	7812 +ve 12 V reg.
IC4	7912 −ve 12 V reg.
D1,D2,D3,D4	EM401, 1N4001 or sim.
LED1	TIL220 or similar LED

Miscellaneous

Transformer (if required) — 2 x 12 V, 0.8A Ferguson PL24/20 VA (plus mains cord, cable clamp, plug etc); pc board — ETI 467; five phone jack sockets; eight knobs; DPST 240 Vac switch (if required).

lead identified by a black arrow on the body of the capacitor. The polarity of tantalum capacitors is indicated by the position of the dot, as shown in the drawing accompanying the circuit diagram. Mount the power supply diodes and ICs next. Again, be certain these components are inserted with the correct orientation.

If the preamplifier is being constructed in a metal chassis, such as a 19-inch (483 mm) rack mounting cabinet for example, a separate power transformer is needed. This should be mounted on the chassis as far away from the pc board as possible. The input jacks will probably be mounted on the front panel and this will automatically connect the chassis to the signal earth at this point. If you experience any problems with hum in the finished unit this will probably be the cause. The solution is to try to obtain jack sockets that are insulated from the chassis, then experiment with the earthing arrangement. In most applications there should be no problems with hum, we have experimented by varying the position of the board with respect to its power transformer and it does not seem to be particularly sensitive.

Shielded cable should be used between the board and the input and output sockets. In the prototype unit the potentiometers are wired with short lengths of tinned copper wire. If the distance between the pc board and the pots is increased by more than a couple of centimetres, the connections to the pots should be made using shielded cable.

There is no special set-up procedure needed, but check all the components on the printed circuit board before applying power.

Using it

Turn all the input controls and the output volume control *fully counter-clockwise* and set the three tone controls to their mid positions. Connect the output of the preamplifier to the input of the ETI-466 (or what-have-you) power amplifier before turning the power amp on. This will prevent any momentary injection of hum into the power amp which could damage your loudspeakers. Plug in a guitar and turn up the input control for the channel you are using. Now, gradually increase the output volume control until the required volume is achieved. The tone controls may be adjusted to your liking, a bit of experimentation will show up what suits you and your system. ●