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Guitar practice amplifier

Simple construction, low cost, good performance and superb neighbour relations are the features of this project!

David Tilbrook



THIS PROJECT has been designed to enable guitarists to put in long hours of practice and still keep that high power amp in the cupboard, where it belongs! It is a compact amp capable of about 7W into a 4 ohm load. This is enough power for practice purposes and just think of the greatly improved relations you will have with your neighbours.

We were in a considerable quandary as to how to present the project, whether it should be done as a complete practice unit with inbuilt speaker or simply as an amplifier to be connected to an external speaker. Finally we chose a compromise. The pc board has been designed in such a way that it can be used as a totally self-contained unit. The heatsinks for the output stage have been mounted on the pc board so that the only components separate to the board are the power transformer, 240 volt power switch controls, input and output jacks. We have shown the project mounted in its own box with power transformer but it should be a simple matter to construct the whole

unit inside a small loudspeaker cabinet.

The unit has two inputs so that two guitars can be mixed together using the relative settings of the two input level controls. A pre-amp output enables your main high power amp to be driven from the guitar practice amp using the practice amp as foldback.

We provided the pc board with the necessary circuitry for a battery input but you might elect not to use this feature. If so diode D8 and the battery switch can be omitted with points 'A' and 'C' connected together by a wire link.

Construction

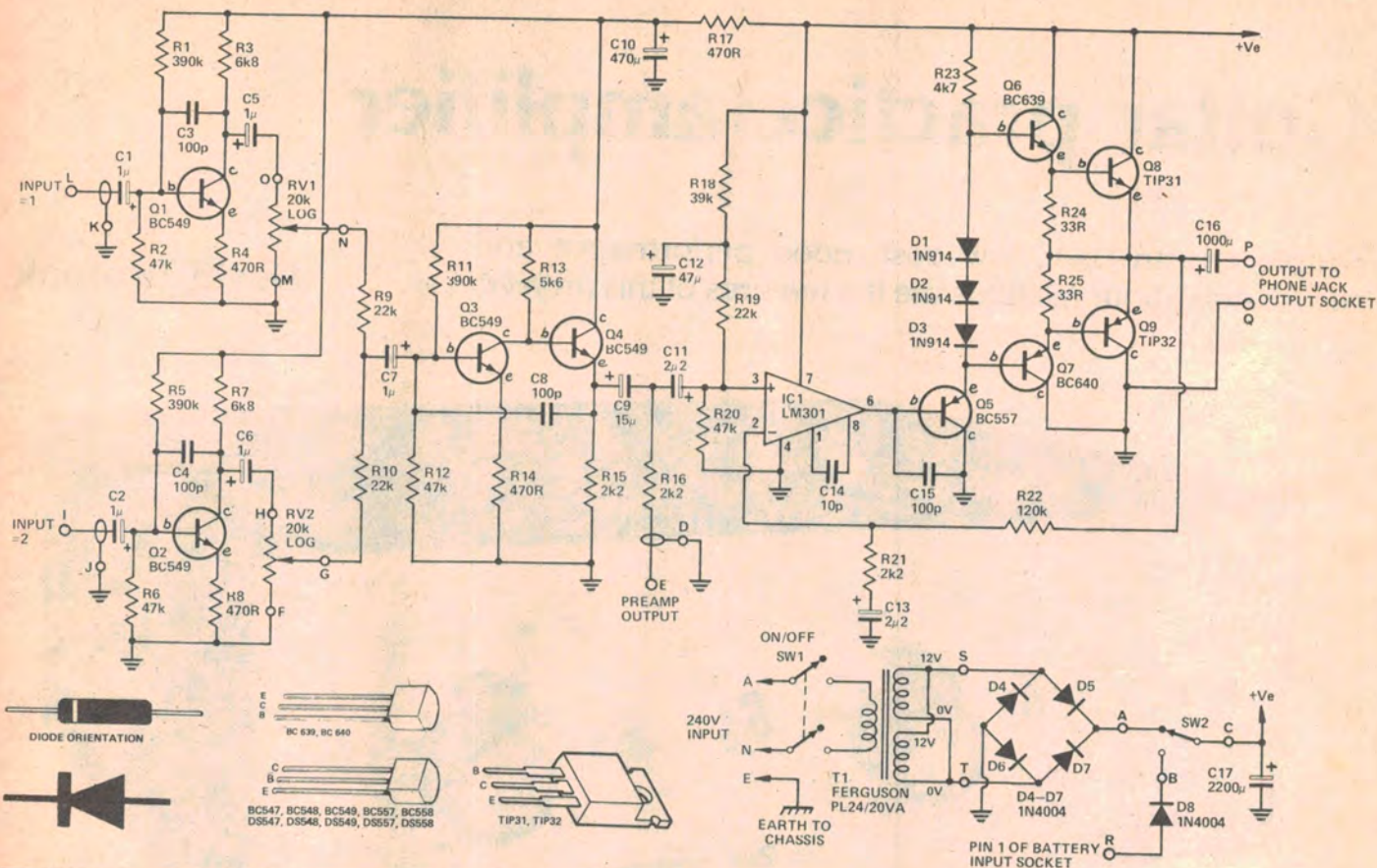
Construction of the project is reasonably simple since it is almost entirely devoted to construction of the pc board. Start as always by mounting the resistors and non-polarised capacitors. Mount the tantalum and electrolytic capacitors next, being careful to orient them correctly. These components could be irreparably damaged if inserted the

wrong way around. Mount the LM301 IC transistors and diodes, again being careful to insert these the correct way round. Finally the output devices can be mounted. Cut the centre (collector) lead off. This lead is connected to the case of the transistor internally, so in this case, electrical connection is made through the mounting screw that also serves to hold the heat sink in place. Place the heatsinks on the pc board and secure with the lower nut and bolt (not used to mount the transistors). Bend the leads of the output transistors and, using a small amount of thermal compound (non-toxic, such as Bevaloid GS13), mount the transistors with the leads protruding through the pcb.

Secure each transistor with a nut and bolt through both the transistor 'flag' and heatsink. Use a star washer between the head of the bolt and the copper pad on the pc board to ensure good electrical contact.

The prototype unit was constructed in a steel box measuring approx. 250 x 210 x 80 mm. Mount the pots and ►

Project 452



HOW IT WORKS

The two input stages formed around Q1 and Q2 are identical. Resistors R1, R2 and R4 form a very stable biasing configuration around Q1. The gain of this type of circuit is determined by the values of R3 and R4 (specifically, the gain is R3/R4). The load impedance on the output of the input stages is in parallel with R3, effectively decreasing the total value of impedance from collector to ground. Remember that, as far as signal is concerned, the positive supply rail is a short circuit to ground, since it is connected to ground through a 2200 uF capacitor. When all these factors are taken into account the gain of the first stage is about 10 since the impedance from collector to ground is about 4k7.

The signal which should be around 200 mV is then applied to the input of the second stage through potentiometers RV1 and RV2. The 22k resistors R9 and R10 prevent the output of one of the stages being shorted to ground when the other is turned right down.

The second stage works in exactly the same manner as the input stages; resistors R11, R12 and R14 forming the bias network for Q3. The voltage present on the collector of Q3 is around 9V which is approximately half the supply voltage. This is used to bias Q4 which is an emitter

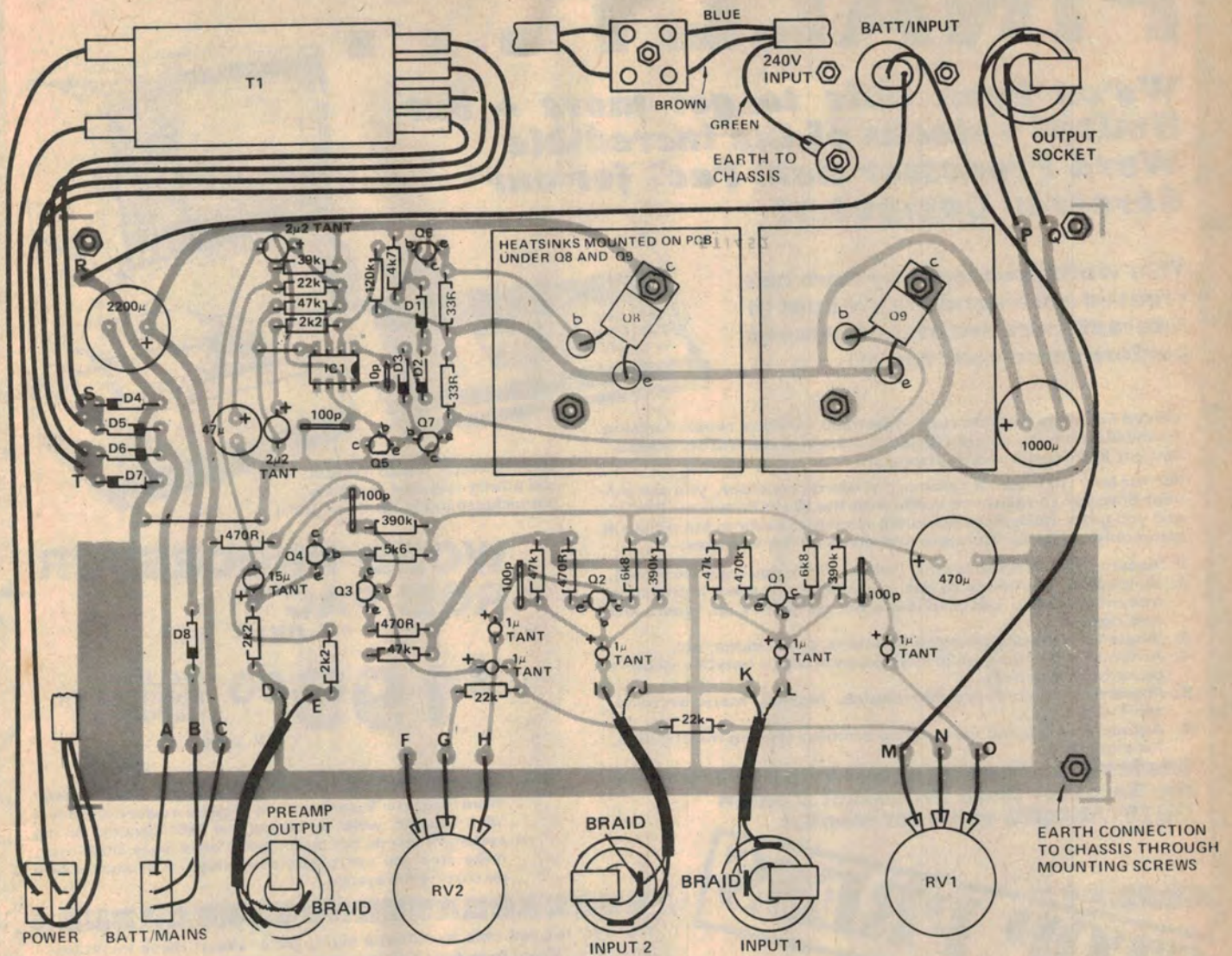
follower. This type of amplifier has no voltage gain but provides a low output impedance to drive the pre-amp output socket. Q3 has a gain of approx. 10. If the volume controls RV1 and RV2 are used in their middle positions the voltage out will be around one tenth of the voltage at their inputs since these are logarithmic pots. So, the signal voltages into Q3 should be in the order of 20 mV. This will be amplified to a level of 200 mV and applied to the input of the power amp. The power amp has been designed to deliver full power with an input voltage of 300 mV, so the amp should be easily driven to full output with usable settings.

Since this is a guitar amplifier, it will spend most of its life hard into clipping. The output stage had to be robust! The basis of the output stage is the LM301 IC op-amp. This device gives all of the voltage gain in the power amp. The output of the IC is fed through a voltage follower Q5. This has no voltage gain and, like Q4, serves to decrease the impedance feeding the output stage. The three diodes, D1, D2 and D3, maintain 1.8 volts between the bases of Q6 and Q7. Each of these transistors will drop approximately 0.6 volts across their base-emitter junctions. This leaves a total of 0.6 volts to be dropped by the two 33R resistors, R24

and R25. Since these are of equal value they will each drop 0.3 volts and hold this voltage across the base-emitter junctions of the two output transistors Q8 and Q9. As these transistors require 0.6 volts to turn on they will remain off until the applied signal voltage causes the voltages on their bases to rise above 0.6 V. The extra 0.3 volts needed to turn on the output devices will be supplied by a mere 10 mA of current through the 33R resistors. Resistor R22 forms a feedback loop around the entire output stage to decrease distortion, stabilise the dc output voltage and set the overall gain of the power stage. (A process too difficult to go into here).

The op-amp will at all times attempt to make the dc voltage at the output equal to that voltage set up on its positive input. This voltage is determined by the potential divider formed by R18, R19 and R20. Since this is also the main input to the power amp any noise which might be on the positive supply rail (and supplies can get very noisy sometimes!) will be communicated directly to the input of the power amp, only to be amplified and applied to the loudspeaker. Capacitor C12 prevents this from happening by bypassing to ground any noise above a frequency of around 0.1 Hz.

guitar practice amplifier



PARTS LIST - ETI 452

Resistors all 1/4W, 5%

R1	390k
R2	47k
R3	6k8
R4	470R
R5	390k
R6	47k
R7	6k8
R8	470R
R9, R10	22k
R11	390k
R12	47k
R13	5k6
R14	470R
R15, R16	2k2
R17	470R
R18	39k
R19	22k
R20	47k
R21	2k2
R22	120k
R23	4k7

R24, R25	33R
RV1, RV2	20k log potentiometer

Capacitors

C1, C2	1µ 35V tantalum
C3, C4	100p disc ceramic
C5-C7	1µ 35V tantalum
C8	100p disc ceramic
C9	15µ 16V tantalum
C10	470µ 25V electrolytic
C11	2µ2 35V tantalum
C12	47µ 25V electrolytic
C13	2µ2 35V tantalum
C14	10p disc ceramic
C15	100p disc ceramic
C16	1000µ 25V electrolytic
C17	2200µ 25V electrolytic

Semiconductors

Q1-Q4	BC549, BC109, DS549
Q5	BC557, BC179, DS557
Q6	BC639

Q7	BC640
Q8	TIP31
Q9	TIP32

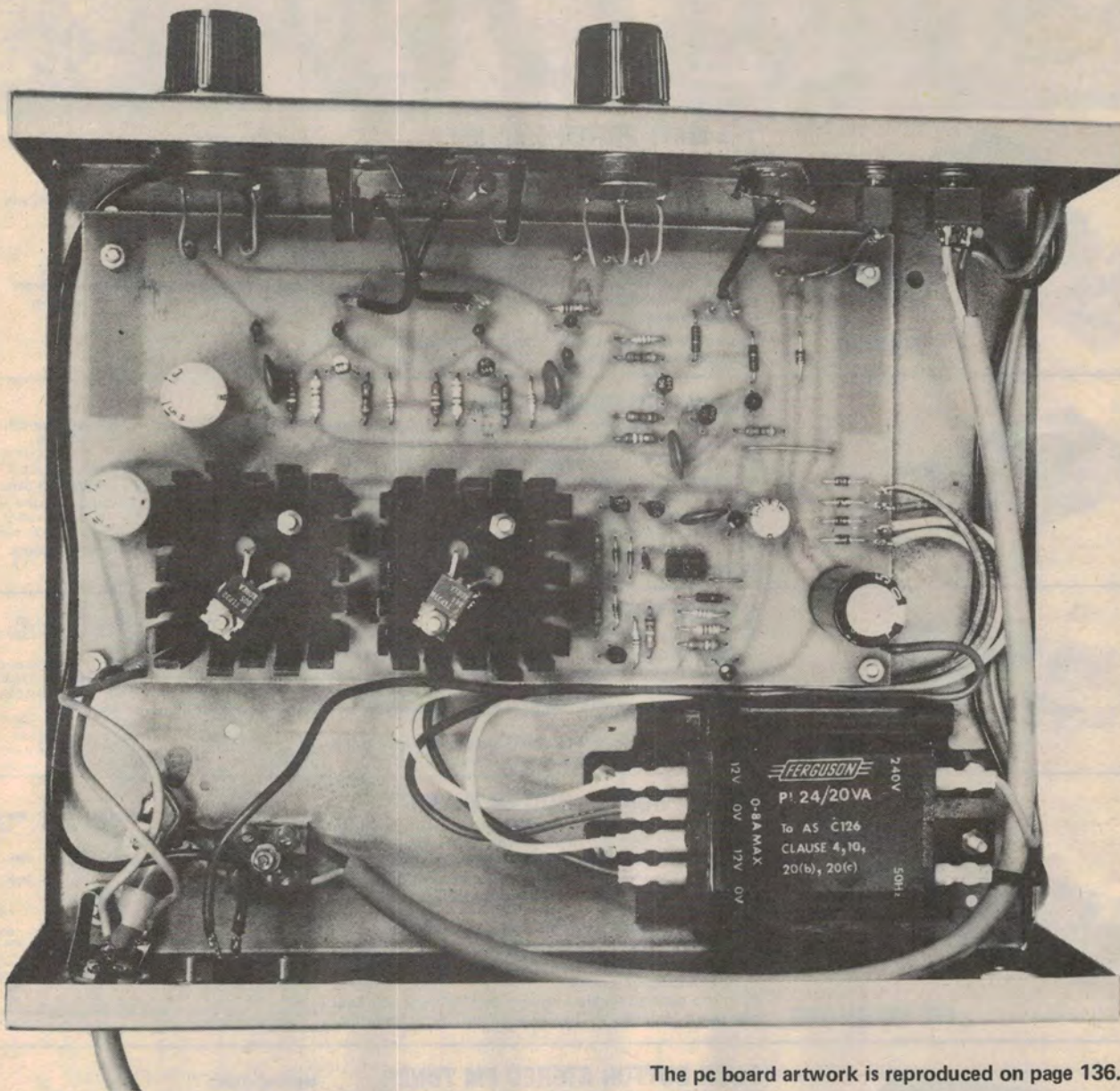
D1-D3	1N914
D4-D8	1N4004

IC1 LM301 op-amp

Miscellaneous

Box to suit, pc board - ETI 452, power transformer 12V @ 1.5 amps Ferguson PL24/20VA or similar, 2 x TO3 type heatsinks for pc board mounting, mains flex and plug, 2 pin DIN sockets (chassis mounting, speaker socket), DPDT 240V switch (power on/off), DPST switch (battery/mains switch), four phone jacks (mono), two knobs, grommets, nuts, bolts, pc board pins, four pc board mounting spacers.

guitar practice amplifier



The pc board artwork is reproduced on page 136.

switches to the front panel, using the pot and switch nuts to secure the front escutcheon if you have one. Mount the output and battery input sockets on the rear panel. If you are using a battery input socket use something different to the output socket (which is usually a two pin DIN socket or a 6.5 mm jack socket) to avoid confusion.

Mount the power transformer and make the 240 volt connections. The mains lead should be terminated immediately inside the case into a terminal block and the earth lead secured firmly to the chassis by a solder lug bolted to the case using a star washer. This lead must be the longest. A length of 240 volt cable should be

used between the terminal block and the power switch. The Ferguson transformer specified comes supplied with cables to make its 240 connections. Solder these to the power switch as shown in the wiring diagram, then wrap the whole switch with insulation tape or enclose in large diameter heat shrink tubing so that no 240 volt connection is exposed.

Finally, the fully-loaded pc board can be secured into the case using short metal spacers. If pc board pins are used, all the connections to the board can be made after the board has been mounted. Connect the front panel controls, rear panel sockets and input sockets as shown in the wiring diagram.

Use short lengths of shielded cable to make the connections to the two inputs and the pre-amp output.

Powering up

Make a final check of the wiring and pc board. If all is well, apply power. A slight turn-on thump should be heard at the moment of turn on. If the 'Input 1' volume control is now wound up some hiss should be heard from the loudspeaker. Do the same check on the other input. There is no set up procedure since the power amp stage is operating in class B and requires no bias adjustment. ●