Nov. 1980
$1.60* NZ $1.75

PRIZES, PRIZES, PRIZES in great Maruni contest

eti ELECTRONICS TODAY INTERNATIONAL

COMPACT STEREO

Easy to build, low cost amp delivers 20 W/ch

Electronic thermometer

Soil moisture indicator

Pinball electronics

POWER MOSFETS – technology & techniques

Soundout 200 W stereo amp reviewed

Audiosound AM101 tuner

Series 3000 compact stereo amplifier

Phil Wait

"Small is beautiful" when you have a premium on space, but there's no need to sacrifice performance. This amp delivers 20 W/channel, has low distortion and costs less than $90!

THE TREND to living in 'compact' accommodation such as units, town houses and inner city terraces, has led to a demand for appropriately sized household goods and furniture — including hi-fi equipment. The major hi-fi manufacturers all leapt into this market last year, releasing various combinations of separate components and integrated arrangements generally tailored to a size to stack conveniently on a shelf or bench top and not take up precious space.

This project is aimed at those readers who want something to fill that requirement but want to 'roll their own' to save money or just to gain the satisfaction of having done it themselves.

Apart from that, this project is ideal for the beginner with a little construction experience who wants a 'meaty' project to tackle. This unit is quite simple to build as the majority of components are mounted on a single printed circuit board and the interwiring has been simplified with the use of 'ribbon' cable.

Despite the low price, compared to other such projects around, this unit is not a 'cheap' amplifier. The performance is demonstrably better than similar amplifiers that cost a great deal more and it can be teamed with some of

SPECIFICATIONS

Power output
25 W RMS; one channel driven
20 W RMS, both channels driven

Distortion (refer to graph)
1kHz: 0.03% @ full power
0.013% @ 12W RMS
10 kHz: 0.08% @ full power

Frequency response
Phono: within 1 dB, RIAA
Other inputs: within ±0.5 dB
from 10 Hz to 20 kHz; −3 dB @ 40 kHz

Hum
Phono: −60 dB w.r.t. 10 mV input
Other inputs: −70 dB w.r.t. 200 mV input

Noise
Phono: −80 dB w.r.t. 10 mV input
Other inputs: −86 dB w.r.t. 200 mV input

Tone controls (see text)
Bass: ±10 dB @ 50 Hz
Treble: ±10 dB @ 12 kHz

Slew rate
15 V/μs

Separation
Phono: 46 dB
Other inputs: 40 dB

Sensitivity
Phono: 2.5 mV for full output
Other inputs: 200 mV for full output

Tape output level
200 mV

our previously published hi-fi projects to obtain quite a respectable hi-fi set up.

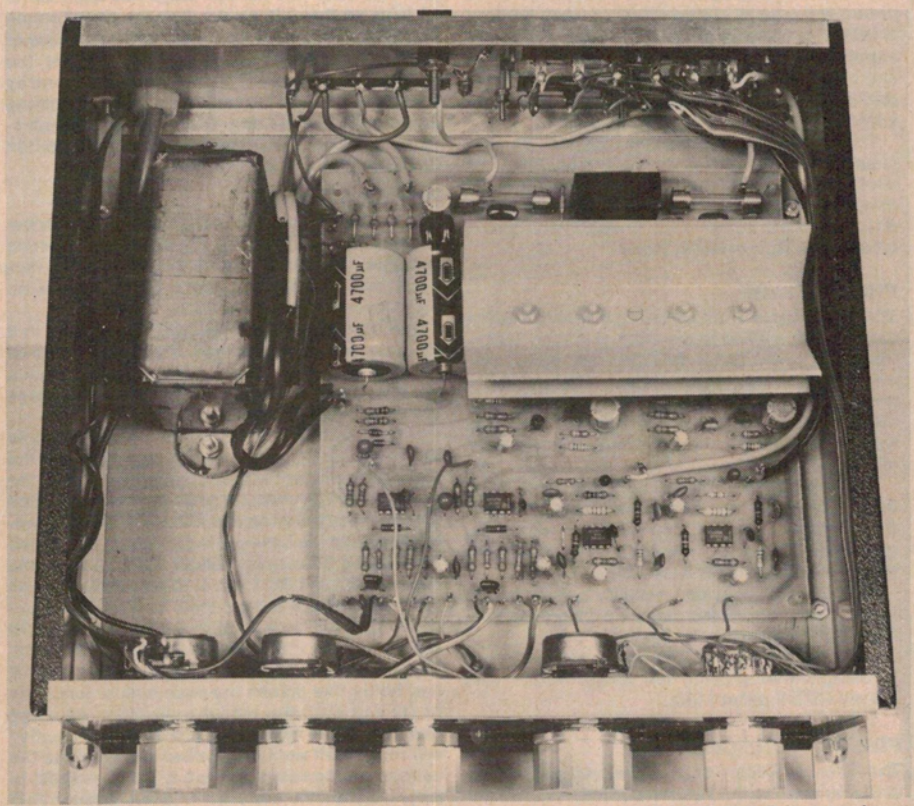
The design

Overall design is fairly conventional, except for the output stage, but we have paid attention to such details as transient intermodulation and slew limiting distortion as well as keeping total harmonic distortion within acceptably low limits.

The preamp stages employ common integrated circuits op-amps. The power amplifiers employ a differential input stage driving a complementary-symmetry class-B power stage. The output devices are TIP31C/TIP32C 'flatpack' transistors arranged such that a simple heatsink can be mounted on the pc board — which can be seen in the internal photograph. A conventional transformer/bridge rectifier power supply is used and speaker anti-thump circuitry is provided too.

The output stage of each channel is capable of delivering 25 watts (single channel) into an 8 ohm load. If you're building the amplifier as a Christmas present for your kids, in the interest of tranquillity, family relations and the sanity of the family cat(/dog/budgie/goanna) the power output might seem 15 - 20 watts too much. By the simple expedient of using a lower voltage transformer and changing a few resistors, the amp will deliver only five watts(*). This also reduces the heatsink requirement and the overall price (as the transformer's less expensive). The two different types of transformer are given in the parts list.

*Psst — kids. If the old fella has built you a five watt amp you can make it up to a 20 W/ch amp without much fuss. Read on.

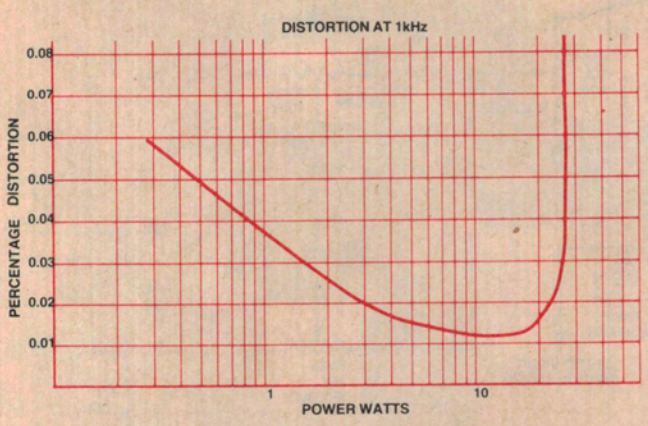


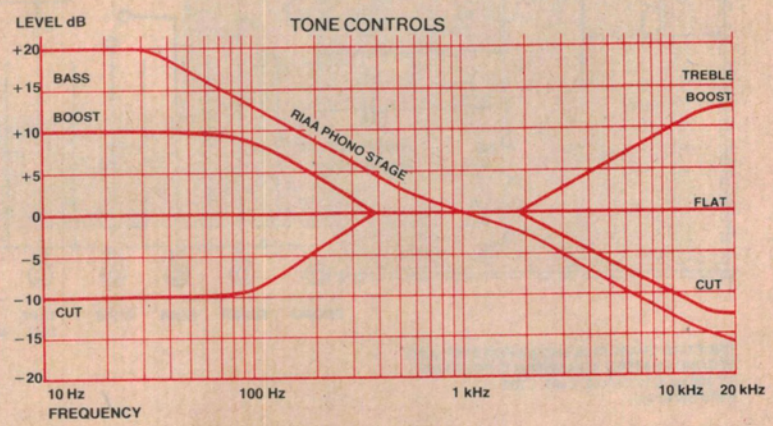
Internal view of the completed project shows the general layout and obvious simplicity — almost everything's on the pc board. We haven't anything much to say about the external appearance as it speaks for itself! Scotchcal transfers for the front and rear panels will be available from suppliers — see Shoparound on p.83.

When you turn an amplifier on or off, a loud thump may come from the speaker. This transient may have sufficient energy to destroy the speaker! It is caused by the supply line voltage rising (at switch-on) or falling (at switch-off) at different rates. This may cause the output to the speaker to swing wildly between the positive and negative supply rails under the worst-case conditions — spectacular, but costly if your speakers can't handle it. Consequently, we have provided an anti-thump circuit which only connects the speakers after a short delay whenever the amplifier is turned on. When the unit is turned off, the speakers are immediately disconnected, before the supply rails have a chance to fall appreciably.

Construction

We chose to assemble the amplifier in a Horwood instrument case measuring 255 mm by 255 mm by 78 mm overall. These are supplied with black, vinyl covered steel top and side panels and plain aluminium front and rear panels. Handles are attached either side of the ▶





HOW IT WORKS — ETI 476

This amplifier employs common IC op-amps in the phono and preamp stages driving a class-B power amplifier employing discrete circuitry. The power supply is conventional, employing a transformer and bridge rectifier with capacitor-input filters to derive positive and negative supply rails and incorporating a speaker anti-thump circuit.

The following description applies to one channel only as both channels are identical, except for component numbering. Components are numbers IC1, R1, C1 etc in one channel, IC101, R101, C101 etc in the other. Ganged controls are labelled SW1a, b or RV1a, b etc.

PHONO STAGE

The phono input, from a moving magnet turntable cartridge, is applied to the input of IC1, an LM301, via an R-C network (C1, R1) which provides a roll-off at subsonic frequencies. The feedback network for IC1 (R3, R4, R5, R6 and C4, C5) provides the correct RIAA compensation. Output from this stage goes to the Source switch, SW1, via C7/R7.

Resistor R7 maintains the negative side of C7 at 0 V to prevent speaker thump when operating the Source switch. The purpose of C6 is to reduce the gain of IC1 to unity at dc so that the dc offset at its output is maintained at a low value.

Capacitor C3 provides stability compensation for IC1. Resistor R2 and capacitor C2 provides RF interference immunity for the input of IC1.

Overall gain of the phono amp is about 300 and is designed to provide full power output with 2.5 mV RMS input at 1 kHz.

PREAMP-TONE CONTROL

The Source Switch selects the various inputs, applying them to the Volume Control, RV1, via the Tape Monitor Switch, SW2.

Output from the Volume Control passes to the input of the preamp-tone control stage via C8. Conventional tone control circuitry around the feedback of IC1 provides boost and cut at 12 kHz for Treble and 50 Hz for Bass. However, unlike conventional controls we have only provided a range of +/− 10 dB for reasons explained in the text.

General gain for this stage is around 10, and input sensitivity is 200 mV RMS for full power output. The slew rate for this stage has been set at 15 V/us so that it is slower than the power amplifier. This has been done by selecting the value of the compensation capacitor, C11 to limit the speed to that required. The R-C network formed by R15 and C12 provides additional slew rate limiting at the output of the tone control stage. This technique avoids transient intermodulation distortion developing in the power amplifier.

POWER AMPLIFIER

Keen-eyed readers will recognise similarities between this circuit and the ETI-452 Guitar Practice Amplifier (Jan 1980) and the ETI-453 General Purpose Amplifier Module (April 1980). There's no need to re-invent the wheel!

Ten transistors are employed (Q1 to Q10) in a discrete component design. Transistors Q1 and Q2 form a differential input stage. Q4 provides a constant current source for the input stage emitters, biased by R24 and LED1.

Output from the preamp-tone control stage is applied to the Balance control, and thence to the input of the power amplifier stage via C13 to the base of Q1. The collector of Q1 is directly coupled to the base of Q3, an emitter follower which is directly coupled to the base of the pre-driver, Q5. Diodes D1, D2 and D3 maintain about 1.8 V between the bases of Q7 and Q8. Each of these transistors will drop about 0.6 V across their base-emitter junctions. This leaves a total of 0.6 V to be dropped across the two 27 ohm resistors R27 and R28. Since these are of equal value, each drops 0.3 V and holds this across the base-emitter junctions of Q9 and Q10, the output transistors. As these two transistors require 0.6 V to be biased on, they will remain off until the applied signal raises the voltage on the bases above 0.6 V (with respect to 0 V). Only a little more than 10 mA through R27 and R28 will supply the extra 0.3 V to turn on the output transistors.

Transistor Q6 provides a constant current sink (or source, depending on your point of view) for the collector current of Q5, increasing the gain of the drive stage, Q5, and decreasing distortion. There is approximately a one volt drop across R26 (and incidentally, R19).

Emitter ballast resistors are included in the output stage, these being resistors R29, 30 and R31, 32. Their main purpose is to help prevent thermal runaway in this application and stabilise the gain of each output transistor. They play a secondary role as fuses in the event of a fault condition causing heavy conduction in the output devices. Hence, the text advises these resistors be mounted up off the pc board on their leads.

Negative feedback is supplied by the potential divider formed by resistors R23 and R20. The capacitor C3 represents a short circuit to the common rail (0 V) for ac signals in the audio range. Gain of the stage across the audio range is thus the ratio of R23 to R20, about 12 in this case. At very low frequencies the impedance of C3 increases, decreasing the gain of the power amplifier by increasing the amount of negative feedback. Capacitor C16 increases the speed of the ac feedback at high frequencies.

The base of Q1 is tied to 0 V and as the whole amplifier is dc-coupled, the quiescent output voltage will be held to a value less than about 50 mV.

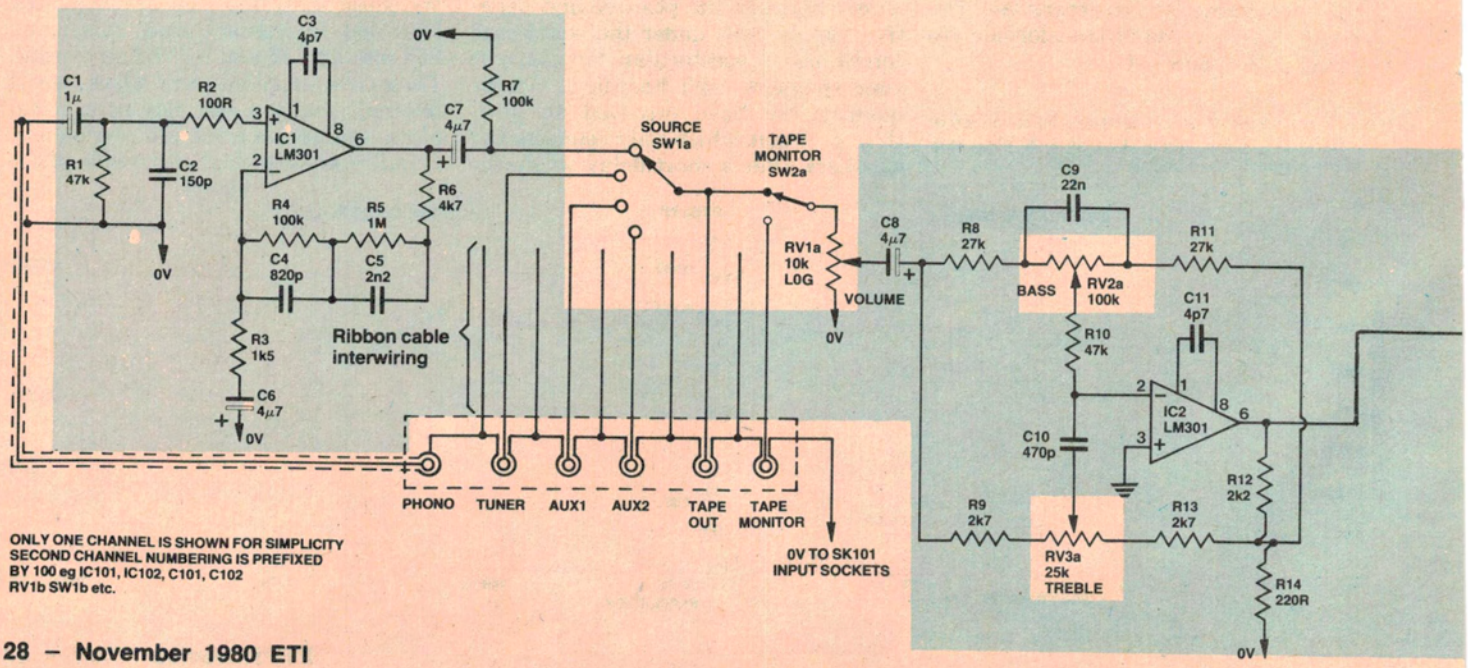
Output from the power stage is taken via a set of contacts on the anti-thump relay and a 2 A fuse, for speaker protection. The R-C network R33 and C17 provides output phase lage compensation.

The output stage devices — a TIP31C and complementary TIP32C — operate in pure class-B, the effects of crossover distortion being reduced by the feedback arrangements. These devices will deliver 25 W into an 8 ohm load. Only a modest heatsink is required as quiescent dissipation is low. The output devices are operated close to their SOAR limit under certain conditions, but no problems should arise. Lower power output can be arranged by reducing the supply rail voltage (see text).

POWER SUPPLY

The 240 Vac mains input is applied to the primary of the power transformer via the power switch, SW3, which isolates both active and neutral leads. A 'spike' suppression capacitor (C26) is connected on the mains input side of the power switch.

The secondary of the mains transformer consists of two windings connected in series, the 'centre tap' providing the 0 V return line. A bridge rectifier comprising diodes D4 to D7 provides positive and negative supply rails. The main supply rail voltages will depend on the transformer chosen for the desired power output as per the text.



ONLY ONE CHANNEL IS SHOWN FOR SIMPLICITY
SECOND CHANNEL NUMBERING IS PREFIXED
BY 100 eg IC101, IC102, C101, C102
RV1b SW1b etc.

Smoothing for each supply rail is provided by C20 and C21. Capacitors C22 and C23 reduce the supply rail impedances at high frequencies. The phono and preamp-tone control stages require +/– 12 Vdc supply rails and these are derived by conventional shunt zener regulators involving R36, R37, ZD1 and ZD2. Capacitors C24 and C25 provide bypassing for these supply rails. LED2 is a 'power on' indicator.

ANTI-THUMP

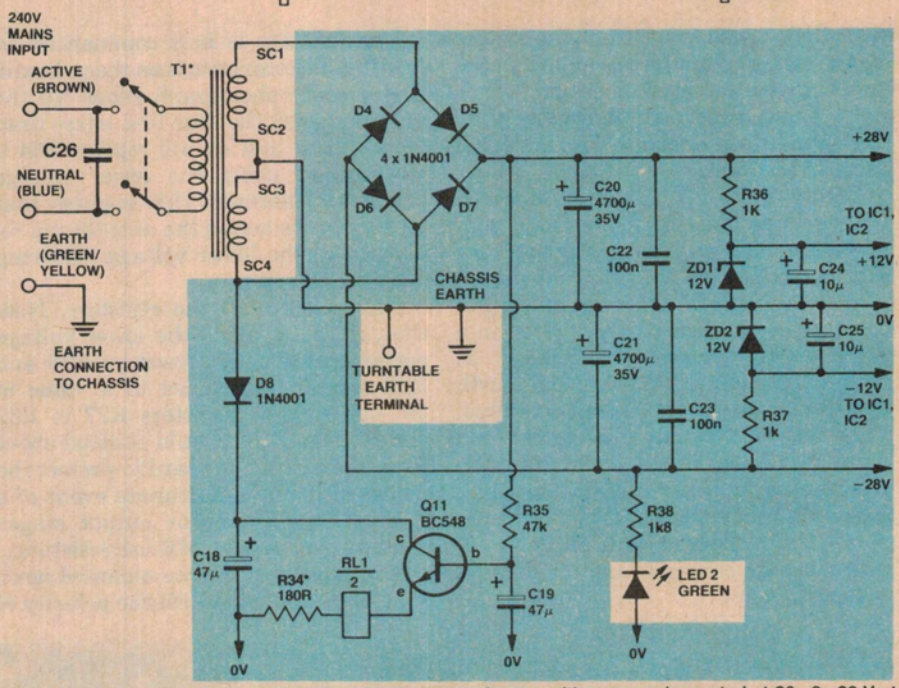
The anti-thump circuit involves D8, Q11, C18 and C19, R34 and R35 plus RL1. The object is to isolate the speakers from the power amplifier until the supply rails have stabilised following switch on and to isolate the speakers once again when the amplifier is turned off, before the supply rails have decayed.

The relay RL1 has two sets of contacts which are connected normally open. These contacts are in series with each channel's speaker output line, between the power output stage and the speaker protection fuse.

At switch on, D8 rectifies one side of the transformer secondary, rapidly charging C18, establishing collector supply for Q11 before the bridge rectifier smoothing capacitors have time to charge to a significant voltage. Until such time as C20 charges to 12 volts, Q11 has no base bias and is turned off. Thus, relay RL1 remains unoperated. As the voltage on C20 rises, capacitor C19 will charge via R35. When the voltage on C19 rises to about 12 V, Q11 will turn on and RL1 will operate, connecting the speakers. The R-C network formed by R35/C19 provides a time delay such that the voltage on C19 will only reach about 12 V after the voltage across C20 has risen to the full supply voltage. The delay is several seconds.

When the unit is switched off, C18 will rapidly discharge and the current through RL1 will drop below that required to hold it operated well before the supply smoothing capacitors (C20 and C21) discharge.

Resistor R34 limits the current through the relay to a safe maximum value when Q11 is on. Note that it is not required if the lower voltage transformer is used.

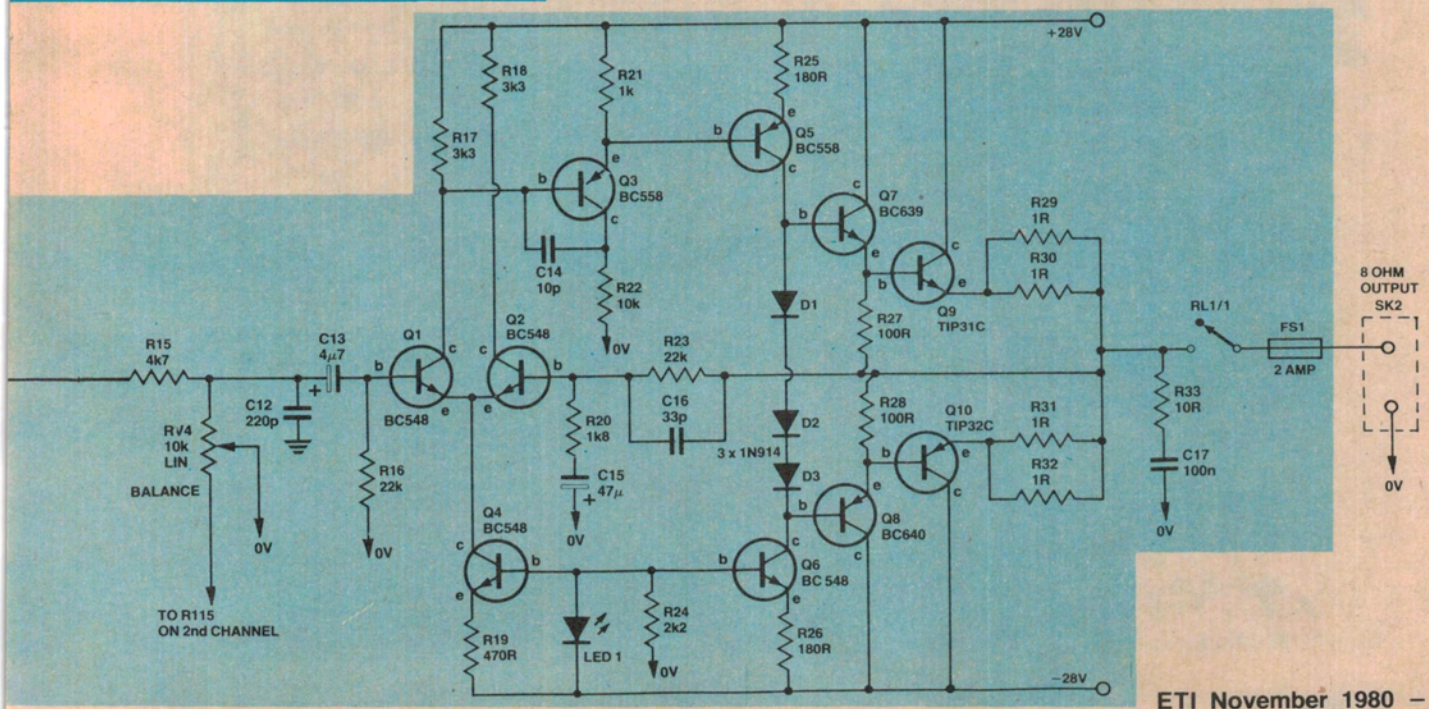


Power supply and speaker anti-thump circuit. A transformer with a secondary rated at 20 - 0 - 20 V at 1.5 A will provide 20 W per channel. For 5 W per channel operation, a 12 - o - 12 V at 0.8 A transformer is required. In the latter case, reduce the values of R36 and R37 to 390 ohms each and short out R34.

front panel and these can be obtained in plain aluminium or black anodised. We made up a black Scotchcal label with white lettering (i.e: 'reverse') for the front panel and used brushed satin aluminium knobs.The whole effect is quite attractive.

The layout of the controls on the front panel is kept quite simple. There are only two toggle switches — power and tape monitor. A stereo/mono switch was thought unnecessary as it would add to the cost and clutter up the simple front panel layout. They are rarely used these days in any case. The rear panel holds the input and output connectors, power cord and an earth terminal for other equipment such as a turntable, headamp or whatever.

We used an internally-mounted heatsink for the four output stage devices, made from a sheet of 16 gauge aluminium. This heatsink is the minimum recommended for 20W/channel opera-▶



tion. If you wish, the output transistors can be mounted on the rear panel, in the space above the speaker output terminals. Their leads may be connected to the pc board with hookup wire or ribbon cable in this case.

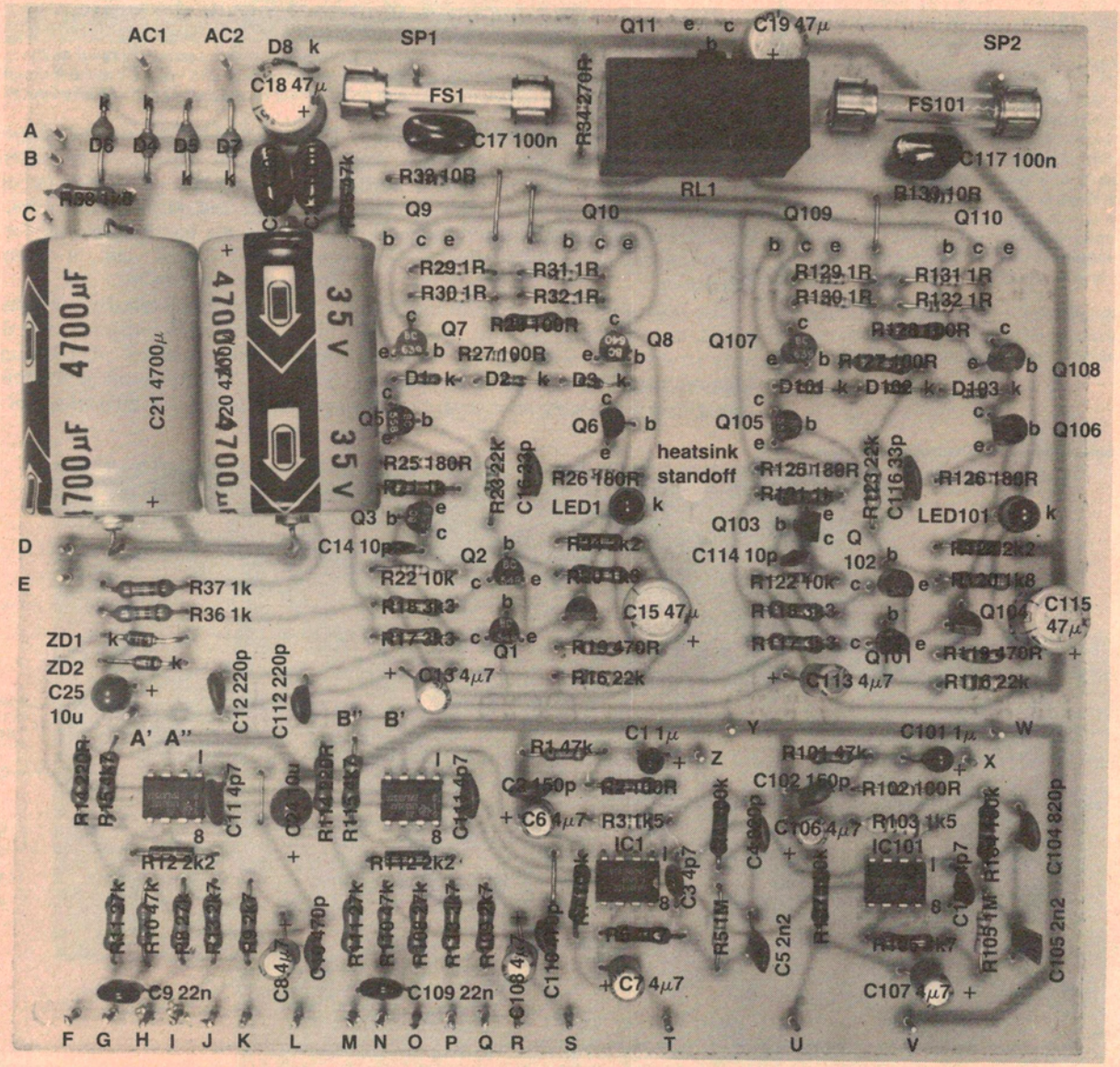
You will notice from the internal photographs that the phono input connection to the pc board is made with shielded cable, but the other inputs are made via a length of 20-wire ribbon or rainbow cable. This cable is wired in a signal-earth-signal-earth fashion so that each signal wire has an earth either side to provide some shielding. This we tried as an experiment and found it very successful. It simplifies the wiring enormously compared to using individual shielded cables. There was only a slight degradation in the cross-talk between channels and no increase in hum levels.

Construction is best commenced by loading the components on the pc board. The overlay photograph shows all the details. Insert the four link wires first. Note that a link should replace R34 if you intend using the lower voltage power transformer. This ensures that 12 V appears across the anti-thump relay coil at the lower voltage, ensuring correct operation.

Next mount all the resistors. Note that, if you're using the lower voltage power transformer, resistors R36 and R37 should be reduced to a value of 390 ohms each. Resistors R27 to R32 and R127 to R132 should be stood about 4 - 5 mm above the board to protect the pc board in the unfortunate event of a fault in the driver or output stages causing overheating of these resistors.

The capacitors can be mounted next. As usual, take care with the polarity of the electrolytic and tantalum capacitors. The lead length on the low value ceramic capacitors C3, C11, C14 and C103, C111, C114 should be kept as short as possible. Mount them so that the body of the component is right down on the pc board. The mains transient suppression capacitor is mounted off the pc board, but this is discussed later.

Now you can mount all the semiconductors, except the output transistors. Here too, take care with the orientation of the devices. The pinouts of the BD639s and BD640s do not have the base lead between the emitter and collector leads like most small signal transistors, so take care with these devices. Pay particular attention to the orientation of the diodes D1 to D3 and D101 to D103 as these set the voltages on the bases of the output transistors. If they are inserted the wrong way round



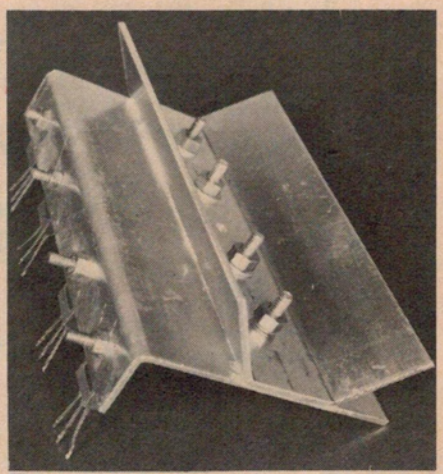
(or are open circuit for some reason) the output transistors won't last long, as we found out to our detriment! Apart from the disappointment, the smell is dreadful! If in doubt, use a multimeter to check the diode. Remember that the *positive* lead of an ohmmeter has the internal battery *negative* connected to it. Thus, this lead will be connected to the *cathode* of the diode when the ohmmeter indicates a low resistance (i.e: diode conducting).

Mount the relay, fuse clips and fuses next. Some fuse clips are hard to solder so to prevent overheating the pc board, first file the plating off the edge of the pins on each clip before you attempt to solder them in.

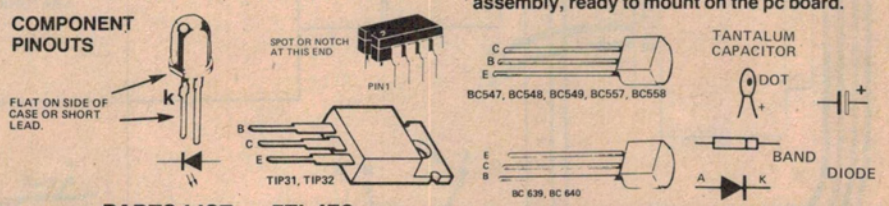
For all the external connections to the board we used pc board pins. They aren't essential, but they do make it considerably easier to wire the board to the other components. These pins are mounted at this stage.

If you haven't already noticed, there are two pads on the board, just above IC2 and IC102, that appear to have no purpose. Circuit-wise, these pads are located at the input to the power stage of each channel and are marked A' and B' on the overlay photograph. By breaking the track between the points marked A' and A", and B' and B", the preamp output and power amp input can be separated to provide connections for "preamp out — main in" sockets so that equipment such as a graphic equaliser may be used in conjunction with this unit. For those readers including this provision, the output impedance of any equipment used to drive the power stages of this unit should be between 4k and 10k.

The output stage transistors are mounted on the board last of all. If you mount them as we have done, drill and bend up the aluminium heatsink first. The accompanying drawing gives all the details. The 'fin' mounts on top of the L piece and the two are held tightly together with four nuts and bolts. Smear thermal compound between the two mating surfaces and insert the bolts with their heads on the side that will face the pc board. Make sure that the surface on which the transistors mount is both smooth and flat. Smooth the surface with emery paper if necessary. By the way, don't paint the heatsink. We painted ours to experiment with colour photographs inside the completed unit and found it adversely affected the thermal capacity of the heatsink. ▶



The transistors mounted on the heatsink assembly, ready to mount on the pc board.



PARTS LIST — ETI 476

Resistors all ½W, 5%

R1, 10, 35, 101	47k
R110	47k
R2, 27, 28, 102	100R
R127, 128	100R
R3, 103	1k5
R4, 7, 104, 107	100k
R5, 105	1M
R6, 15, 106, 115	4k7
R8, 11, 108, 111	27k
R9, 13, 109, 113	2k7
R12, 24	2k2
R112, 124	2k2
R14, 114	220R
R16, 23,	22k
R116, 123	22k
R17, 18	3k3
R117, 118	3k3
R19, 119	470R
R20, 120, 38	1k8
R21, 36, 37, 121	1k
R22, 122	10k
R25, 26, 125	180R
R126, 34	180R see text
R29 - 32	1R
R129 - 132	1R
R33, 133	10R

Capacitors

C1, 101	1u electro or tantalum
C2, 102	150p ceramic
C3, 103, 11, 111	4p7 ceramic
C4, 104	820p ceramic
C5, 105	2n2 greencap
C6, 7, 8, 13, 106	4u7, 16V electrolytic
C107, 108, 113	4u7, 16V electrolytic
C9, 109	22n greencap
C10, 110	470p ceramic
C12, 112	220p ceramic
C14, 114	10p ceramic
C15, 115	47u, 16V electrolytic
C16, 116	33p ceramic
C17, 22, 23, 117	100n greencap
C122, 123	100n greencap
C18, 19	47u, 35V electrolytic
C20	4700u, 35V electrolytic
C24, 25	10u, 16V tantalum
C26	10n to 100n, 240VAC Rated capacitor (value not critical)

Semiconductors

IC1, 101	LM301
IC2, 102	LM301
Q1, 2, 4, 6, 11	BC548, BC108
Q101, 102, 104, 106	BC548, BC108
Q3, 5, 103, 105	BC558, BC178
Q7, Q107	BC639
Q8, 108	BC640
Q9, 109	TIP31C
Q10, 110	TIP32C
D1 - D3, D8	1N914, 1N4148
D101 - 103	1N914, 1N4148
D4, 5, 6, 7	1N4001, A14A or sim.
ZD1, 2	12V, 400mW zener diode
LED1, 101	red LED, TIL220R or sim.
LED2	green LED TIL220G or sim.

Potentiometers

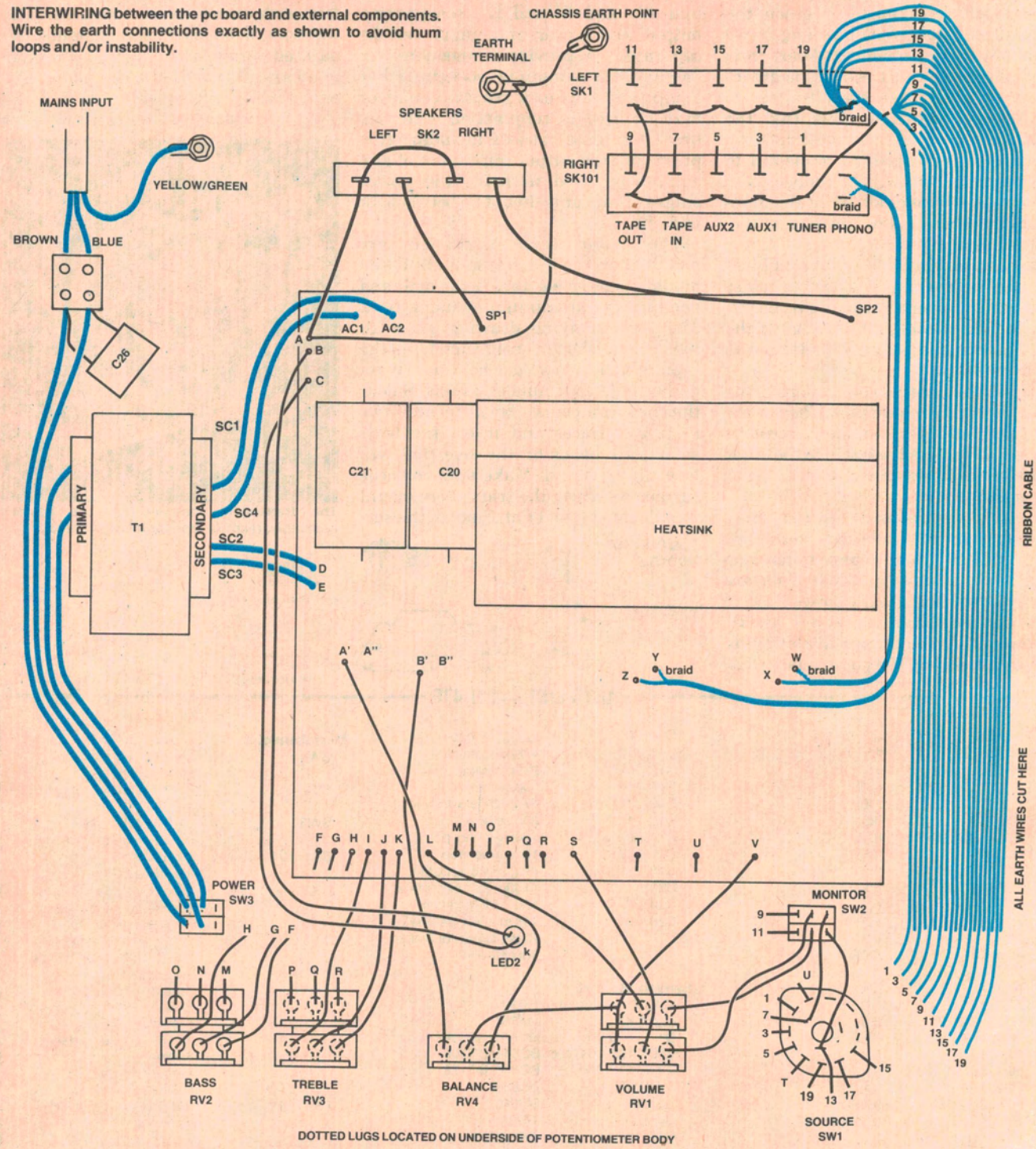
RV1	10k dual gang log.
RV2	100k dual gang lin.
RV3	25k dual gang lin.
RV4	10k single gang lin.

Miscellaneous

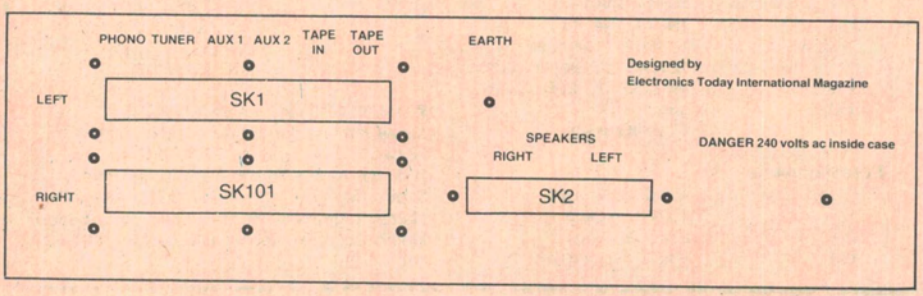
SW1	two pole, four position wafer switch
SW2	DPDT miniature toggle switch
SW3	DPST 240V rated miniature toggle switch
SK1, 101	six RCA sockets on insulated panel
SK2	set of spring contact speaker terminals on insulated panel
T1	For 25 Watts output 20 - 0 - 20V secondary at 1.5 amps Ferguson type PF3993 or similar For 5 Watts output 12 - 0 - 12V secondary at 800mA Ferguson type PL24/20VA or sim.
FS1, 101	2 Amp, 3AG fuses with pc board mounting clips
RL1	DPDT pc board mounting relay with 12 Volt coil, Takamisawa type VB 12 STAN or Pye 265/12/G2V

ETI 476 pc board, heatsink (see text), black screw terminal for turntable earth connection, Horwood case type 93/10/V (255 mm wide x 255 mm deep x 76 mm high), power cord and 3 pin plug, four 12 mm pc board standoffs, clamping grommet for power cord, nuts, bolts, length 20 wire ribbon cable, length shielded cable.

INTERWIRING between the pc board and external components. Wire the earth connections exactly as shown to avoid hum loops and/or instability.



DOTTED LUGS LOCATED ON UNDERSIDE OF POTENTIOMETER BODY



SW1	POSITION FUNCTION	LEFT	RIGHT
1	PHONO	U	T
2	TUNER	1	19
3	AUX 1	3	17
4	AUX 2	5	15
—	TAPE OUT	9	11
—	TAPE IN	7	13

Source and monitor tape switches wiring legend.

Mount the output transistors as shown in the accompanying diagram. Note that a mica or plastic washer and insulating bush must be used with each one. Smear a small amount of thermal compound on both sides of the mica or plastic washer before you mount and screw the bolts down firmly to get good thermal contact between the transistor body and the heatsink.

Check that you have the transistors in the correct order and check also that there are no shorts between the collector pins and the heatsink.

Before the heatsink/transistors assembly can be mounted, bolt a 25 mm standoff pillar on the pc board as indicated on the overlay photograph. This is to secure the heatsink and relieve stress on the transistor leads.

Once you have the heatsink and output transistors all together, bring the assembly to the pc board and insert the leads of the transistors in the appropriate holes. A small pair of needle-nose pliers helps here. Push the transistor leads through the board such that they protrude about 2mm on the copper side of the board. Bolt the heatsink to the standoff and then solder the transistor leads.

That completes the pc board assembly.

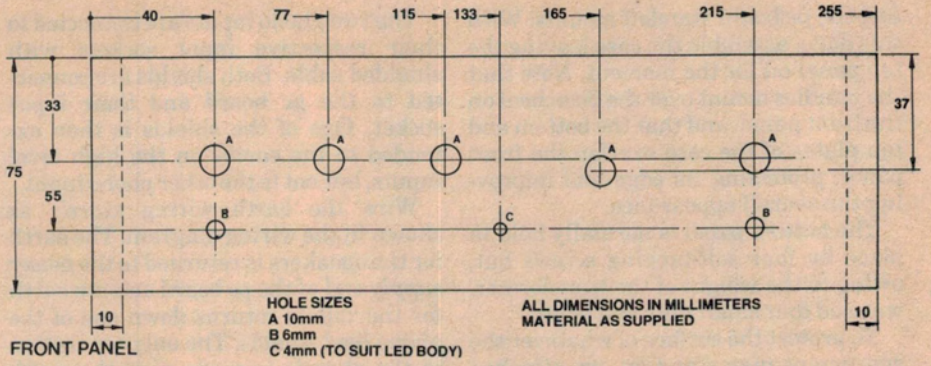
Next step is the metalwork. If you have purchased a pre-drilled case, just check that all fits and there are no burrs. If you've purchased an undrilled case, first thing to do is to disassemble it and scribe the hole positions on the front and rear panels as per the metalwork drawings. If you're going to use a Scotchcal front panel, this may be used as a template for drilling with the added assurance that all will fit when the holes are drilled. Don't take the backing off the Scotchcal at this stage as once it is stuck down to anything, you can't remove it without damaging the panel.

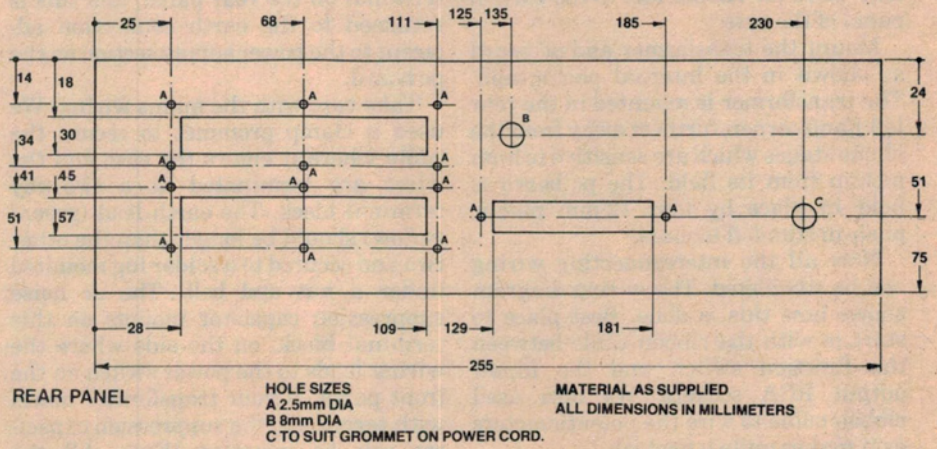
Carefully drill and de-burr all the holes. Slots are cut in the rear panel to accommodate the strips of RCA input/output connectors and the speaker connector strip. These can be cut using a 'nibbling' tool, which requires a single hole to be drilled, or by drilling a succession of holes and filing the edges of the slot straight.

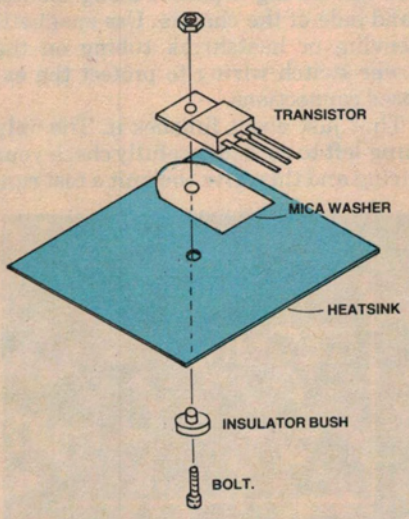
With the front panel drilling completed, the Scotchcal can be positioned and stuck down. Take care, making sure that it is properly aligned. With the Scotchcal in position, mount the front panel components, noting the potentiometers are slightly angled to ensure the centre of their range corresponds to the centre of the knob pointer. The bass control faces upside down to the other controls so that its terminals face away from the power switch. Note that the power and tape monitor toggle switches are sideways operating.

Mount the rear panel components next, making sure there are no shorts between the terminals and the chassis.

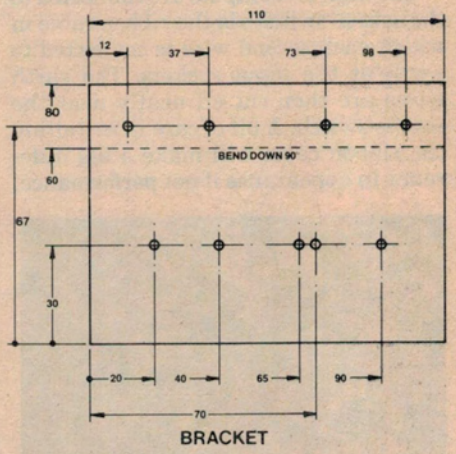
The bottom panel of the case needs to be drilled to suit the transformer mounting holes, mains terminal block ▶

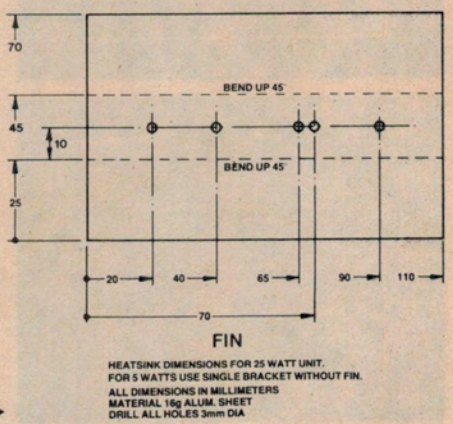






Assembling a flatpack transistor to a heatsink.





and the pc board standoff mounts. With this done, assemble the case leaving the top panel off for the moment. Note that the handles mount over the Scotchcal on the front panel, and that the bottom and top plates of the case overlap the front panel, protecting its edge and improving the overall appearance.

The bottom panel is normally held in place by four self-tapping screws but, owing to the weight of the transformer, we used four small nuts and bolts.

To protect the surface of whatever the equipment may stand on, we attached four 'stick-on' rubber feet to the bottom panel of the case.

Mount the transformer and pc board as shown in the internal photograph. The transformer is mounted in the rear left hand corner, furthest away from the phono stages which are sensitive to hum pickup from its field. The pc board is held in place by four 12 mm plastic push-in standoff mounts.

Now all the interconnecting wiring can be completed. The wiring diagram shows how this is done. Best place to start is with the ribbon cable between the function switch and the input/output RCA sockets. We also used ribbon cable to wire the potentiometers as it makes quite a neat job.

The high level inputs are connected to the source switch via the ribbon cable in which each second wire is connected to earth at the input sockets. The earth wires are then cut off neatly near the source switch. A bit of care in installing the ribbon cable will make a big difference in appearance if not performance.

The two phono inputs are connected to their respective input sockets with shielded cable. Both shields are connected to the pc board and their input socket. One of the shields is then extended to the earths on the high level inputs, but not to the other phono input.

Wire the earth wiring *exactly* as shown in the wiring diagram. The earth for the speakers is returned to the *power supply* end of the pc board and the earth for the inputs returns down one of the phono lead shields. The only connection to the chassis is made near the earth terminal on the rear panel, and this is returned to the earth connection adjacent to the power supply section on the pc board.

Take care with the mains wiring. We used a clamp grommet to secure the cable where it enters the case and the wires are terminated at a two-way terminal block. The earth lead (green/yellow) should be longer than the other two and secured to a solder lug mounted under a nut and bolt. The ac noise suppression capacitor mounts on this terminal block, on the side where the wiring leads to the power switch on the front panel. If your transformer comes with terminals, the suppression capacitor can be mounted there. All the 240 Vac wiring is passed along the left hand side of the chassis. Use spaghetti sleeving or heatshrink tubing on the power switch wiring to protect the exposed connections.

That just about finishes it. The only thing left to do is to carefully check your wiring and then give the unit a test run.

With no inputs and no speakers connected, turn the unit on. The LED on the front panel should light as should the two LEDs on the pc board. With a sensitive multimeter, check the voltage on the output terminals of each channel. You should read no more than 100 mV. Because the output stage operates in class-B there is no bias adjustment.

If all is well, turn the unit off, connect loudspeakers and a turntable or tape deck and you're ready to rock!

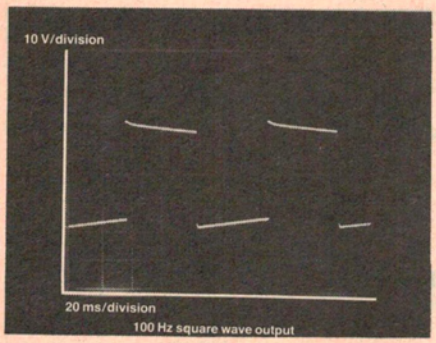
Trials

We gave the unit a thorough trial, running it into 'odd' loads etc, running it heavily into clipping and conducting extensive listening tests. The accompanying photographs taken from the oscilloscope in our lab show how the amplifier performs with square wave drive at different frequencies throughout the audio range plus one shot showing the amplifier's output when driven into clipping with a sine wave input. Performance of the unit is clearly very good.

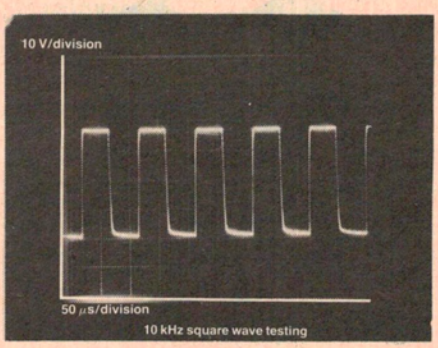
Just to convince ourselves, and you skeptics amongst the readers, we have also included a photograph taken from the screen of a Hewlett Packard model 3580A spectrum analyser we have on loan from Tech-Rentals for some development work (you'll be seeing more about it in the months to come — keep reading!). As you can see, this amplifier has quite a creditable performance.

For listening tests we used a pair of our Series 4000/2 three-way loudspeakers in an average sort of domestic environment with a Sansui turntable and Shure M91 cartridge. Overall sound is very clean, with well defined bass and crisp top end and it was obvious that any sonic 'faults' were not contributed by the amplifier. The unit drove the Series 4000/2 speakers effortlessly to levels liable to raise neighbour complaints!

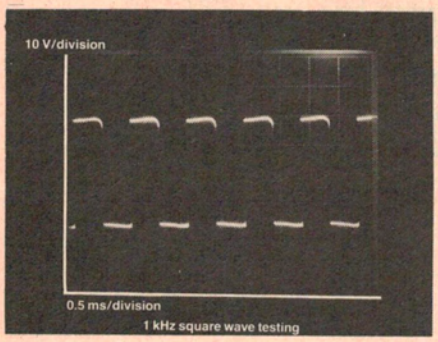
We think you'll be as pleased with the Series 3000 Compact Stereo Amplifier as we are. ●



100 Hz square wave output



10 kHz square wave testing



1 kHz square wave testing