

Build this Utility-PA Amplifier at low cost: Special Offer!

Here's a handy little utility amplifier ideally suited for a small PA system. It's the first of a series of audio projects which feature a new power amplifier module using Fairchild's new "bimesar" silicon power transistors. And you will be able to obtain the complete kit of transistors for the power module from Fairchild Australia Pty Ltd at a special low price!

by **GEORGE HUGHES** and **JAMIESON ROWE**

When we were gathering the information together for our news story in the May issue (p.17) announcing Fairchild Australia's new range of "bimesar" silicon power transistors, we were particularly impressed by the tremendous electrical ruggedness of the bimesar devices. The dual epitaxial collector / epitaxial base construction used for the devices makes them very tolerant of transients and short-term overloads, even of quite gross proportions.

The devices are in fact so rugged that they can be quite adequately protected from damage by a normal fast-acting fuse. This coupled with the simpler heat sinking made possible by their 200°C junction temperature rating makes them very suitable for use in audio power amplifiers.

We were so impressed with the suitability of the devices for audio use that we began to look into the idea of using them to produce a flexible and multi-purpose "building brick" power amplifier module, one that could be used singly for mono applications, or in combinations for stereo and perhaps quadraphonic systems. Our work along these lines was spurred by applications data which Fairchild themselves published shortly after our news story.

To cut a long explanation short, we have now developed the power amplifier module, which is based on one of Fairchild's application designs. The little utility amplifier described in this article is the first project using it, and will be followed in later issues by other projects.

As a special offer to assist E-A readers in building this project and those which will

follow, Fairchild Australia is undertaking to supply complete kits of the transistors used in the basic power amplifier module, at a special low price. There are seven transistors in the module, including the two bimesar output transistors, and together these would normally cost about \$6. By filling in the special offer coupon provided in this article, you will be able to obtain the kit for \$3.50. This figure includes postage, packing and sales tax.

The coupon and remittance should be posted to Fairchild's office in Victoria, at PO Box 151, Croydon 3136.

The offer also extends to readers in New Zealand, who should send the coupon to Fairchild New Zealand (Limited), at 1 Gordon Road, Otahuhu. Unfortunately it will be necessary to charge New Zealand readers a further 50c per kit to cover the cost of import duty, but the resulting kit price of \$4.00 will still represent a considerable saving.

New Zealand readers will also be able to obtain the kits at the special price of \$4.00 from John Gilbert, Anzac Avenue, Auckland; or from Tisco N.Z. Ltd at PO Box 102, Wellington; PO Box 823, Hastings; PO Box 1145, Hamilton; PO Box 2006, Dunedin; PO Box 1712, Christchurch; and PO Box 1355, Palmerston North. The above suppliers will also have a printed wiring board available for the module, at \$1.20.

Please note that Fairchild Australia and Fairchild New Zealand will only be able to supply kits at the special offer prices when the orders are made via the order coupon printed in this and following articles in



SPECIFICATION

Output 12 watts RMS into 8 ohms, for less than 0.8% THD.

Output 9 watts RMS into 15 ohms, for less than 0.5% THD.

Frequency response 30Hz — 17kHz, power bandwidth the same.

Signal to noise ratio: 56dB auxiliary input, 54dB mic input.

Output impedance approximately 0.1 ohms.

Mic input 5mV at 50k impedance.

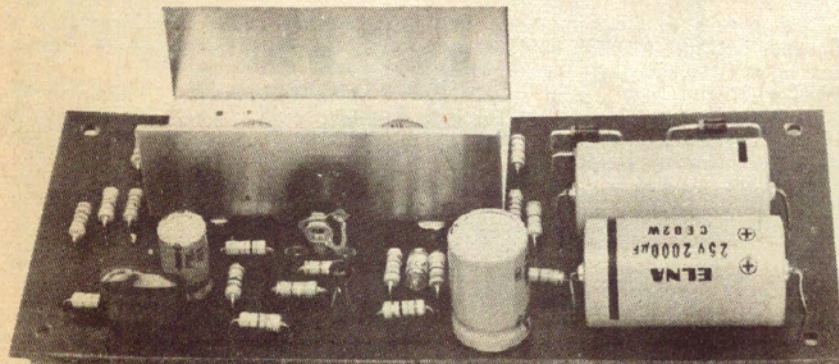
Auxiliary input 80mV at greater than 1M impedance.

"Electronics Australia". Fairchild cannot undertake to enter into any technical correspondence regarding the kits, and will not be able to supply kits at prices lower than the specified offer prices to individuals or organisations exempt from sales tax. The kits will not be available from "Electronics Australia" offices.

As may be seen from the circuit diagram, the new audio module consists of a complete silicon power amplifier, together with all of the necessary power supply components and wiring except the mains transformer. All of the module components, including the output transistors and their heatsink, are mounted on a printed wiring board measuring 6¾in x 3in (172 x 77mm). The code number for the board pattern is 72 / sa9, and boards should be available shortly from the usual suppliers.

The power amplifier used in the module features a rather novel circuit configuration. Complementary NPN and PNP transistors are used in both the output and driven stages, with a centre-tapped power supply to allow direct coupling to the loudspeaker voice coil. But in contrast with the usual arrangement where the output transistors and drivers are both connected in the emitter-follower configuration, they are here connected in common emitter mode.

A worthwhile advantage of this configuration is that it allows the two output transistor collectors to be directly connected to a common heatsink. The substantially constant-current biasing for the output transistors also enables full advantage to be taken of the 200°C junction temperature rating of the bimesar output



A close-up shot of the new power amplifier module using "bimesar" output transistors. The wiring board measures 6¾in x 3in (172 x 77mm).

We have provided the module with its own on-board rectifier bridge and reservoir capacitors to simplify multiple usage. This way, the only change needed to use the modules in pairs for stereo or in a group of four for quadrasonic work is to select a transformer of the appropriate rating. Thus we have used a Ferguson type PF3133 for this mono amplifier, but one would use the A & R type PT6672 or a similar unit for stereo, etc. For multiple use, the fact that each module will have its own reservoir capacitors should keep channel cross-talk to a very low level, despite the simple power supply circuitry.

With the power transformer specified above, the module is able to deliver an output of 12W into an 8-ohm load for less than 0.9% total harmonic distortion, and 9W into a 15-ohm load for less than 0.5% distortion. As noted earlier, these figures are determined mainly by the power transformer regulation, the module itself being capable of somewhat higher output with a larger transformer.

For the present project we have added further input circuitry to the basic module to turn it into a mono utility amplifier suitable for small PA and paging systems, record playing, and similar applications.

An amplifier-impedance matching stage is fitted directly ahead of the module input. This is preceded by a simple mixing circuit and a mic preamp stage, so that the complete circuit can accept signals from both a crystal-ceramic pickup and a dynamic mic, and can mix between them.

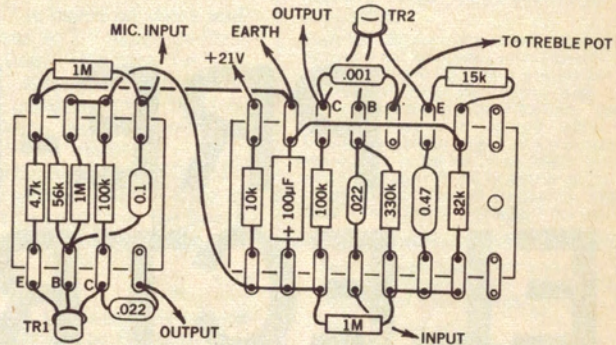
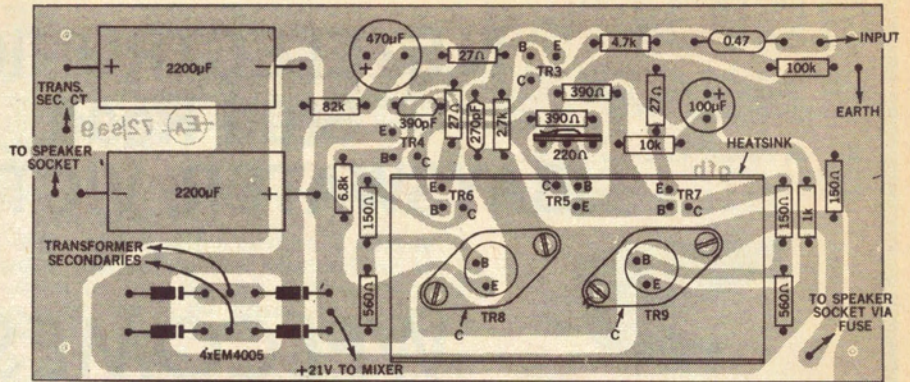
Input sensitivity of the pickup input is approximately 80mV RMS for full output, which should cope with even the lowest output ceramic cartridges. Input impedance is above 1M, which should ensure quite good bass response. Note that this input of the unit is marked "auxiliary" as it would be equally suitable for signals from radio tuners, tape recorders and other sources.

The input sensitivity of the mic input is approximately 5mV RMS for full output, which should cope with most dynamic mics. Input impedance is approximately 50k.

Both the mixing amplifier and the mic preamp stages use low-noise NPN transistors such as the SE4010, BC209C or BC109C. A treble-cut tone control is wired across the output of the mixing amplifier to allow the response to be rolled off if desired.

Frequency response of the complete amplifier is 3dB down at 30Hz and 17kHz, and the power bandwidth is the same. Signal to noise ratio is 56dB for the auxiliary input, and 54dB for the mic input.

The completed amplifier is housed in a



At top is a diagram to aid in wiring the module printed board, while immediately above are the two smaller wiring panels.

case virtually identical with that used for the "10-plus-10" amplifier of November 1968 and April 1969, except that fewer holes are used on the rear panel. A different front panel escutcheon will be required, of course, and we will be making negatives of the panel available via the Information Service at a cost of \$1.00 each.

The main amplifier module of the unit is mounted on the baseplate of the case, at the rear alongside the power transformer. The mixing amplifier, control wiring and mic preamp are mounted near the front of the baseplate, with a tinfoil shield covering them to obviate hum induction.

The mic preamp stage is mounted on a 4-lug-long section of miniature resistor panel, while the mixing amplifier is on an 8-lug-long section of the same panel. A small 2-lug tagstrip is used to anchor the tie point of the 1M mixing resistors.

Wiring the amplifier module on the printed board should present few problems

even for the tyro, as we have prepared a wiring diagram to guide in placing all the parts and making all the connections. There are similar diagrams to assist in wiring up the two input stages.

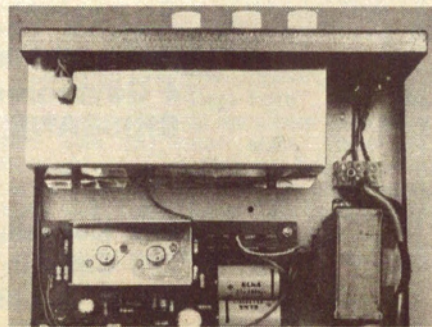
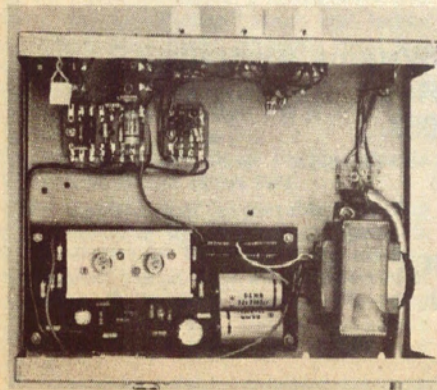
Don't be surprised if when you buy the printed wiring board for this project, you are actually sold a combination board with two identical patterns side-by-side. We are in fact recommending this to board manufacturers in order to lower the cost of later stereo projects using the module. For this project it is a simple matter to cut the board in half with a hacksaw, giving you a spare board for some other project.

Probably the best place to start when assembling the amplifier is the module itself.

First mount all of the minor components on the board except the bias transistor and the two driver transistors, carefully checking to make sure that you have each component in the correct position and correctly orientated before you solder its connections.

Then mount the power transistors on the heatsink, using a little silicone grease under them for maximum heat transfer. Tighten them initially with the fingers, using 1/8 in Whit brass countersunk screws with 3/16 in long tapped brass spacers as nuts. You will find that the countersunk heads of the screws tend to locate the transistors on the heatsink correctly in relation to the pin holes. Tighten them firmly with a suitable tool.

The bias transistor and the two driver transistors are all mounted under the heatsink when it is attached to the board, with their rounded plastic "glob-tops" resting in dimples in the underside of the heatsink formed with a large-diameter drill. Before attaching the power transistors



At left and above are views of the amplifier, with and without shield.

and their heatsink the three small transistors are placed in position on the board, but not soldered. Place a small dab of silicone grease on the top of each to ensure a good thermal bond to the heatsink when it is over them. Then add the heatsink, fastening it into position with four brass nuts on the foil side of the board.

Then, working again from the foil side of the board, push each of the three small transistors into the dimples of the heatsink and solder its leads to the appropriate foil pads. Finally the power transistor pins can also be soldered.

Make up the preamplifier sections, and mount these in position, using a nut as a spacer at the underside of the tagboard. Other components such as the main board, power transformer, input and output receptacles, potentiometers, power switch and bezel can now be mounted and interconnected.

Then if everything seems in order, connect an 8-ohm or 15-ohm loudspeaker to the output. Set the bias current preset pot on the module board to mid position, plug the power lead into a 240V outlet, and switch on. If the amplifier is in proper DC balance, you will simply hear a small "thump" in the speaker, followed by a continuous but barely audible hiss. You may have to listen closely with your ear to the speaker to hear this.

A finger on each input in turn with the volume controls at mid position should produce some kind of hum, indicating that the preamplifier and amplifier circuits are active.

The quiescent current of the driver and output stages may need some adjustment to remove crossover distortion. If there seems to be an edginess in the amplifier's output, particularly at low levels, the current should be increased by turning the preset pot slowly clockwise as viewed from the

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Please send me . . . "Power Offer" transistor kits, at \$3.50 each (\$4.00 in New Zealand). Enclosed is a cheque or money order for . . . I understand that the price includes packing and postage.

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Send this coupon, together with your remittance, in an envelope marked "POWER OFFER", to Fairchild Australia Pty Ltd, PO Box 151, Croydon, Victoria 3136. New Zealand readers send to Fairchild New Zealand (Ltd), 1 Gordon Road, Otahuhu, Auckland, or other distributors as listed on page 26.

front of the board. Turn the pot just far enough to remove the distortion, and leave it at that. If the quiescent current is increased too far, the power transistors will run at a needlessly high temperature.

If you want to check the actual quiescent current, the best way to do this is to cut the positive supply conductor on the board, and connect a current meter into circuit. The conductor should be cut carefully with a razor blade, where it runs around the heatsink mounting nut nearest the rectifier diodes and just near the 5.6k resistor. The current flowing here should be approximately 15 milliamps for no signal.

Don't forget to re-join the conductor after this check, by running solder generously

across the cut for the full width of the copper.

To assist readers in troubleshooting, we have indicated typical values for voltages in the amplifier circuit, and readers equipped with a 20,000 ohm / volt meter should have no trouble in locating any troubles that may occur. It must be remembered that readings cannot be taken in some parts of the preamplifier stages using such a meter. This is because the meter's internal resistance will modify the voltages due to loading. However the voltages nominated are indicative that everything is operating properly.

YOU'LL NEED THESE COMPONENTS:

- 1 Metal case and front panel (see text).
- 1 Printed wiring board, code 72 / sa9.
- 1 Power transformer, 240V to 30V CT at 500mA.
- 1 SPST miniature toggle switch.
- 1 Neon indicator bezel (240V).
- 1 Miniature fuse holder and 1.5A fast-acting fuse.
- 2 Phone jack sockets
- 1 Polarised 2-pin socket with plug for speaker.

SEMICONDUCTORS

- 1 Fairchild silicon power kit, comprising one each AY8171, AY9171, 2N3643, 2N3838A, 2N3565, and SE4010. transistors.
- 2 SE4010, BC209C, BC109C or similar low noise NPN transistor.
- 4 BY126-50, EM4005, SD4005 or similar 1A / 50V silicon diode.

RESISTORS

- Half watt, 5%: 3 x 27 ohm, 3 x 150 ohm, 2 x 390 ohm, 2 x 560 ohm, 1 x 1k, 1 x 2.7k, 2 x 4.7k, 1 x 6.8k, 2 x 10k, 1 x 15k, 1 x 56k, 2 x 82k, 3 x 100k, 1 x 330k, 5 x 1M.
- 1 220 ohm tab pot (board mounting).
- 1 500k carbon pot
- 2 2M log carbon pots.

CAPACITORS

- 2 2200uF 25V electrolytic
- 1 470uF 16V single-ended electrolytic
- 1 100uF 16V single-ended electrolytic
- 1 100uF 25V electrolytic
- 2 0.47uF 100V polyester.
- 1 0.1uF 100V polyester.
- 2 .022uF 100V polyester.
- 1 390pF polystyrene.
- 1 270pF polystyrene.

MISCELLANEOUS

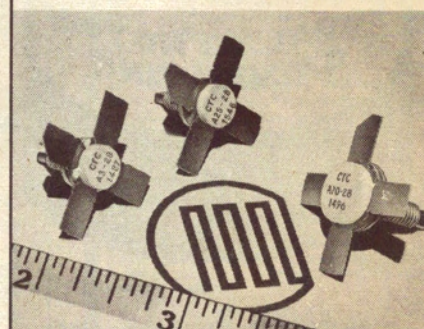
- 4 1/8" whit x 5/16" in c/sunk brass screws, 3 control knobs, 4 1/8" whit x 3/16" threaded brass spacers, rubber feet, grommet for power lead-in, length power lead and power plug, 4-lug-long and 8-lug-long sections of miniature resisted panel, scrap aluminium for heatsink, sundry mounting screws and nuts, hookup wire, etc.

Note: Resistor wattage ratings and capacitor voltage ratings are those used in the prototype. Components with higher ratings may generally be used, providing they are physically compatible. Components with lower ratings may be used in some cases, providing the ratings are not exceeded.



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