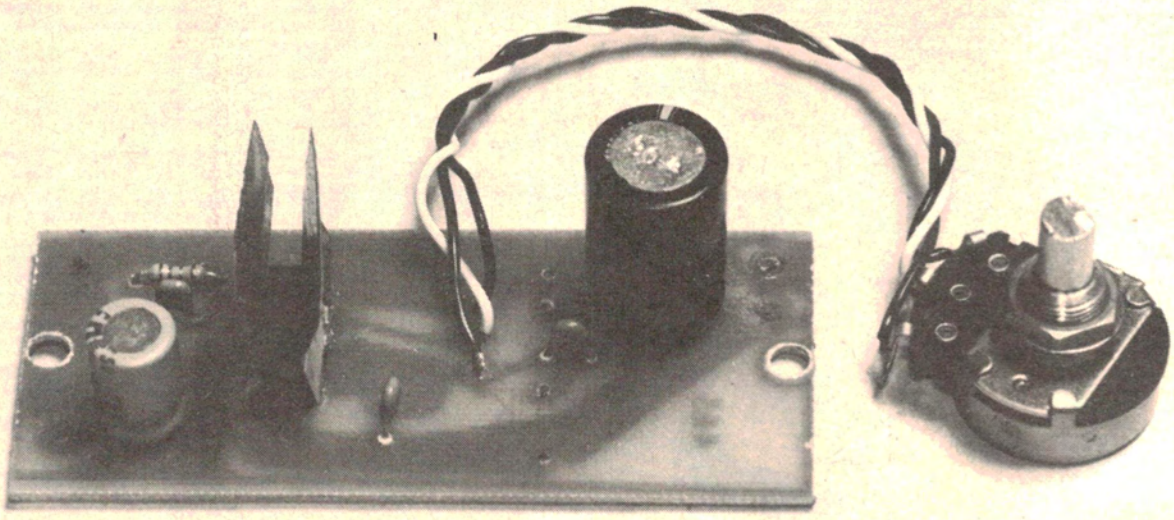


A general purpose IC audio amplifier module

This is an ideal project for the beginner. In fact, most constructors will find it handy to have at least one around. A general purpose small audio amplifier finds many useful applications. Just two described here are an intercom and a 'baby minder'.

Geoff Nicholls

A VERY USEFUL object for any electronics enthusiast to have around is a simple audio amplifier. It can be used to test the operation of many circuits or employed in some practical item of equipment — such as an intercom.

This simple, yet versatile, module is easy to construct and can be powered from a variety of supply voltages, depending on your application. It will drive loudspeakers of 4, 8 or 16 ohms impedance and can deliver a maximum output of five watts.

The project has been designed around an integrated circuit audio power amplifier, the LM380 (from National Semiconductor) or the uA380 (from Fairchild). This is quite a versatile little IC and, using it, an audio amplifier is very simple indeed to make.

The '380 is generally available in a 14-pin dual-in-line package, and this is what I have employed here. An 8-pin version is available, but cannot be used in the pc board I have designed for this project. Pins 3, 4 and 5 plus 10, 11 and 12 of the 14-pin package are all connected together by a copper bar inside the '380 package, on which the chip is mounted. These pins can be soldered to a large area of copper on the pc board to act as a heatsink in relatively low power applications.

Where the full power output capability of the '380 may be used, copper shim or tinplate heatsink 'flags' are soldered to these pins to get rid of more heat and keep the temperature of the IC down.

The '380 has a gain of 50 times. That is, it will amplify the input signal level by 50, which is a gain of 34 decibels (34 dB). That is:

$$\text{Gain in dB} = 20 \log_{10}(50)$$
$$= 20 \times 1.7$$
$$= 34 \text{ dB}.$$

The gain of the '380 is fixed by the manufacturer. But what if you want a volume control, as is so often necessary on an audio amplifier? That can be simply arranged by connecting a potentiometer as a voltage divider to the input of the IC. You can see how that's done from the circuit and construction diagrams.

You can use this project to amplify the output of a crystal set or one-transistor receiver to loudspeaker level simply by connecting the output directly to the input of the module.

You can make a 'baby minder' — for keeping an ear on the baby in its cot, from another room — as shown later in this article, or you can make a simple intercom — which is also illustrated later. Another article in this issue shows how to use the module in a loudhailer.

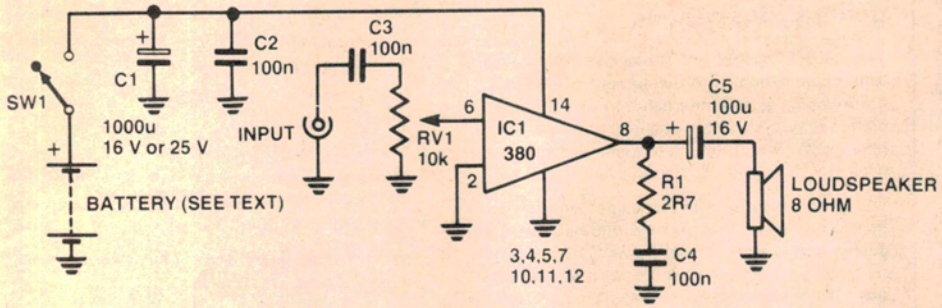
Right, let's get down to the business of building it.

Construction

As you can see from the overlay and wiring diagrams, there's very little to it. Start with the pc board. Whether you've made your own or purchased one, just give it a quick check-over to make sure all the holes are drilled correctly, that there are no small copper 'bridges' between closely spaced tracks (particularly between the IC pins) and no tiny cracks in any tracks. It's unlikely you'll have trouble, but it's always a good idea to check, *before* you run into trouble!

Note that mounting holes are located at either end of the board. These should be drilled to suit a 4 BA bolt, or whatever size you are using.

You can commence assembling the board by soldering resistor R1 in place, followed by capacitors C2, C3 and C4. All components



HOW IT WORKS — ETI-464

There's not much you can say about this! The whole job is done by the '380 IC audio power amplifier. The input is coupled to the '380 via a capacitor (C3) and the volume control, RV1. The latter is just a voltage divider, applying less or more voltage to the IC's input as the potentiometer is varied, thus varying the volume.

The output of IC1, pin 8, is biased at half the supply rail (e.g: it will be at 4.5 V if the supply is 9 V). For this reason, the output is capacitively coupled to the loudspeaker via a large value electrolytic capacitor, C5. This presents a low impedance in series with the loudspeaker, which is a relatively low impedance device.

Any tendency to instability of the amplifier is suppressed by the network of R1-C4 connected from the output to common.

The supply rail is bypassed by an electrolytic capacitor, C1, at the low frequencies, and a greencap or ceramic capacitor, C2, at the higher audio frequencies.

Note that provision has been made on the pc board for powering an electret type microphone, simply by adding a resistor adjacent to C3.

mount on the non-copper side of the board. Next identify the positive and negative leads of the two electrolytic capacitors. These are 'polarised' devices and can only go in one way. Solder them in place, putting the positive lead of each in the hole marked with a '+' on the overlay diagram.

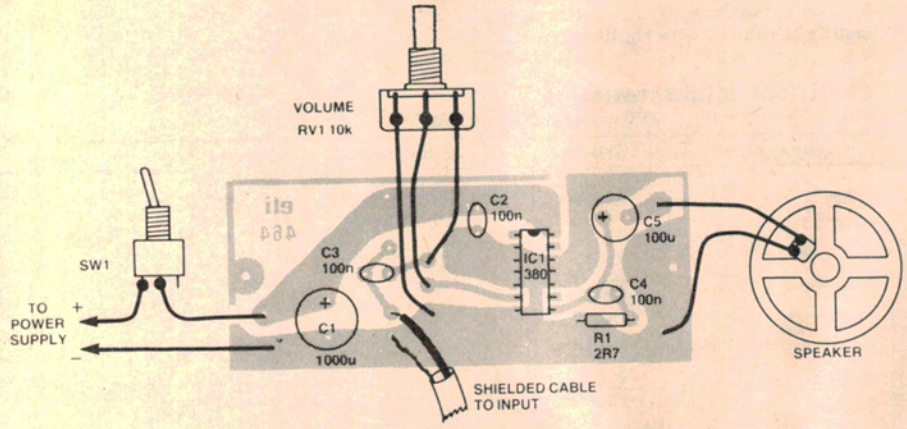
The '380 IC can be soldered in place next. Make sure you place it in the board the right way round before soldering the pins. Do not use an IC socket as the board is designed to act parially as a heatsink and pins 3, 4, 5, 10, 11 and 12 *must* be soldered to the copper area for this purpose.

The heatsink flags can be constructed next if you need to use them. Use heavy gauge copper 'shim' or tinplate sheet (obtainable at hardware and motor spares stores). Two are required and the dimensions and cutting details are shown in the accompanying diagram.

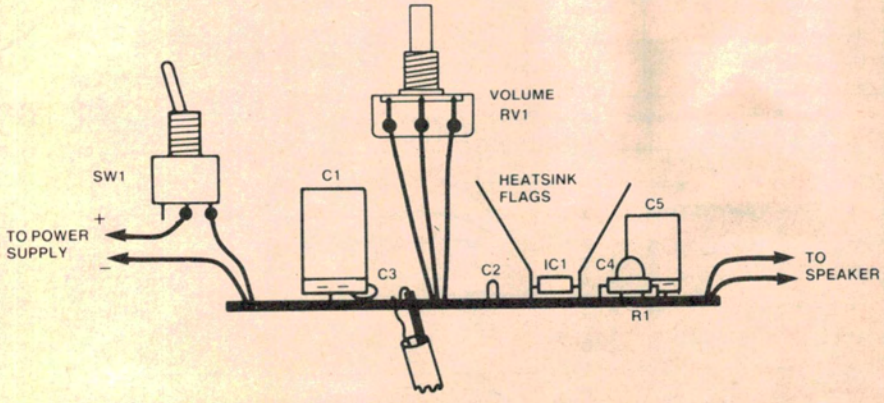
General details for wiring up the speaker, volume control and an on/off switch are also provided with the overlay diagram. Note that the input lead should be run in shielded cable, in general, especially if this lead needs to be more than 300 mm or so long. This prevents hum pickup from house mains wiring. For short runs, a pair of tightly twisted hookup wires will suffice.

This module will drive any size loudspeaker, from the tiny 50 mm 'transistor radio' types to 400 mm diameter 'monsters'. In fact, the larger a loudspeaker, the more sensitive it's likely to be and the louder it will sound! You don't need more power to drive a larger loudspeaker, despite what you might at first think.

The bigger loudspeakers generally have a more powerful magnet than the smaller types. This makes them more sensitive to the currents flowing in the voice coil. This and the larger cone combine to produce a louder sound. ▶

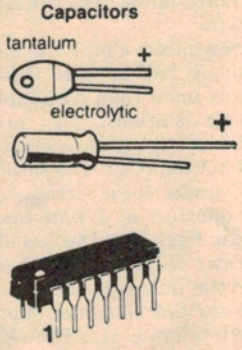


Overlay and wiring diagram. Showing component placement and general wiring details.



Side view. Showing assembly of the heatsink flags.

COMPONENT PINOUTS



PARTS LIST — ETI-464

Resistors ..... all ¼ or ½ W/5%
R1 ..... 2R7
RV1 ..... 10k log. pot.

Capacitors
C1 ..... 1000u/16 VW or 25 VW RB electro.
C2,C4 ..... 100n ceramic bypass
C3 ..... 100n greencap
C5 ..... 100u/16 VW RB electro.

Semiconductors
IC1 ..... LM380

Miscellaneous
ETI-464 pc board; SPST switch; shielded cable; wire, etc.

Price estimate $7-$8

Testing it

The easiest way to test it is simply to connect a 9 V battery to the module and turn up the volume control. Then, touch your finger to the 'top' end of the volume control — the right hand lug when looking at the rear of the pot. You should hear hum and noise, or perhaps a loud 'blurting' sound. If not, check that the battery is connected the right way round and that the speaker and volume control wires are all intact and correct. Check that you have the IC correctly orientated.

Connecting a 9 V battery in reverse to the module is unlikely to destroy the IC, but any higher supply voltage connected in reverse sure will, so watch this point.

If the amplifier tends to be unstable, 'squealing' or otherwise 'acting up', try connecting a 4u7/16 V tantalum capacitor between pin 1 of the IC and the adjacent grounded area of the pc board, directly on the underside of the board. The positive lead goes to pin 1. Keep the lead lengths short. This should cure it.

Always keep the amplifier's input leads away from the speaker leads, to avoid feedback which may result in 'howl round' — an uncomfortable whistling or howling sound that is affected by moving the leads.

Power supplies

This module can be powered form batteries, a suitable plugpack or transformer and rectifier to suit yourself. The power output depends on the supply voltage and the speaker impedance. As stated earlier, the '380 can drive 4, 8 or 16 ohm speakers. By far the better speaker to use is an 8 ohm impedance type. Fortunately, they're also the most common type.

Powered from a nine volt battery, you will get about half a watt (500 mW) output, which is more than adequate for 'personal' listening stations; e.g: providing loudspeaker output from a crystal set or one-transistor radio, etc. The power dissipated by the IC under these circumstances is about three quarters of a watt maximum, so no heatsink flags would be necessary. The module draws only about 5 mA with no signal (called the 'quiescent current').

The *absolute maximum* supply voltage the IC will tolerate is 22 V. With an 8 ohm speaker, the project will deliver five watts output, which is remarkably loud! Under these circumstances, the power dissipated by the '380 will be a little over three watts maximum and heatsink flags will definitely be necessary. The quiescent current is about 8 mA on a 22 V supply.

A plugpack or transformer and rectifier supply suitable for powering this module should provide 12 Vdc at 200 mA or so. Using such a supply, the project will deliver about one to 1½ watts to an eight ohm speaker, which is quite suitable for an intercom, for example. The heatsink flags are not entirely necessary with this sort of application, especially in an intercom where the amplifier is only used intermittently.

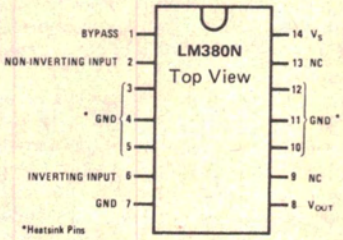
Two nine volt batteries connected in series will supply 18 Vdc or so to the module, which will deliver about three watts to an 8 ohm speaker. Heatsink flags are necessary in this case. Note that, when using a 4 ohm speaker, the supply should not exceed 15 volts.

LM380 audio power amplifier general description

The LM380 is a power audio amplifier for consumer application. In order to hold system cost to a minimum, gain is internally fixed at 34 dB. A unique input stage allows inputs to be ground referenced. The output is automatically self entering to one half the supply voltage.

The output is short circuit proof with internal thermal limiting. The package outline is standard dual-in-line. A copper lead frame is used with the center three pins on either side comprising a heat sink. This makes the device easy to use in standard p-c layout.

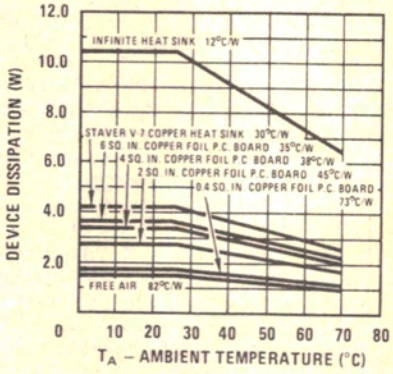
Uses include simple phonograph amplifiers, intercoms, line drivers, teaching machine outputs, alarms, ultrasonic drivers, TV sound systems, AM-FM radio, small servo drivers, power converters,etc.



features

- Wide supply voltage range
- Voltage gain fixed at 50
- High peak current capability
- Input referenced to GND
- High input impedance
- Low distortion
- Quiescent output voltage is at one-half of the supply voltage
- Standard dual-in-line package

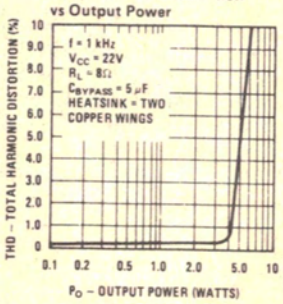
Device Dissipation vs Ambient Temperature



absolute maximum ratings

Supply Voltage	22V
Peak Current	1.3A
Package Dissipation 14-Pin DIP (Notes 6 and 7)	10W
Input Voltage	±0.5V
Storage Temperature	−65°C to +150°C
Operating Temperature	0°C to +70°C
Junction Temperature	+150°C
Lead Temperature (Soldering, 10 sec)	+300°C

Total Harmonic Distortion vs Output Power

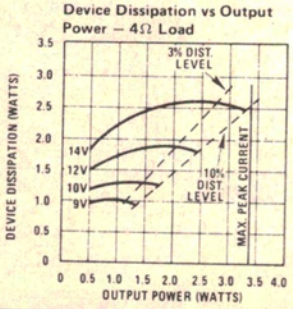


electrical characteristics

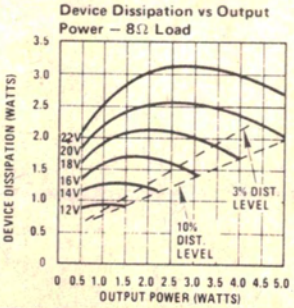
Note 1: V_S = 18V and T_A = 25°C unless otherwise specified.

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Output Power	$P_{OUT(RMS)}$	R_L = 8Ω, THD = 3%	2.5			W
Gain	A_V		40	50	60	V/V
Output Voltage Swing	V_{OUT}	R_L = 8Ω		14		V_{pp}
Input Resistance	Z_{IN}			150k		Ω
Total Harmonic Distortion	THD			0.2		%
Power Supply Rejection Ratio	PSRR			38		dB
Supply Voltage	V_S		8		22	V
Bandwidth	BW	P_{OUT} = 2W, R_L = 8Ω		100k		Hz
Quiescent Supply Current	I_Q			7	25	mA
Quiescent Output Voltage	V_{OUTQ}		8	9.0	10	V
Bias Current	I_{BIAS}	Inputs Floating		100		nA
Short Circuit Current	I_{SC}			1.3		A

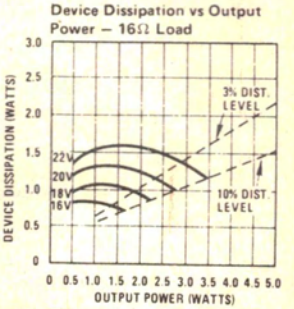
Device Dissipation vs Output Power – 4Ω Load



Device Dissipation vs Output Power – 8Ω Load



Device Dissipation vs Output Power – 16Ω Load



A 'baby minder'

You can 'keep an ear' on a baby asleep (or supposed to be!) in its cot in another room by organising some sort of microphone to pick up sounds from the baby's room to be amplified and heard in another room.

The general wiring diagram for a baby minder is shown in Figure 1. Here, a small 8 ohm loudspeaker is employed as a microphone — and they're remarkably effective. A transformer is needed to 'step up' the tiny voltages produced by the speaker-microphone. A suitable type is generally described as a 'transistor output transformer, 1k centre-tapped to 8 ohm'. Dick Smith Electronics lists a suitable type — cat. no. M-0216. Altronics have a similar one. Tandy lists one also, no. 273-1380.

The '8 ohm' side is connected to the speaker-microphone — this is the side with just two leads. The 1k side of the transformer is connected to the input of the module. Mount the transformer close to the module. The module could be mounted in a suitable cabinet with the speaker, volume controls and on/off switch mounted on the front.

The speaker-microphone could be mounted in a small jiffy box placed in a convenient position in the baby's room, near the cot. This connects to the amplifier via a length of 'twisted pair' cable or light 'figure-8' flex. Try and avoid running this lead adjacent to house mains wiring to avoid possible hum pickup.

I have specified an 8 ohm speaker as a microphone as it is of such a low impedance that the possibility of hum pickup on the cable between the microphone and the amplifier is greatly reduced.

You can either use a battery supply or a 12 Vdc plugpack.

Intercom

The general details for wiring a simple intercom are shown in Figure 2. You'll need two single-pole, double-throw (SPDT) toggle switches with a spring return. Double-pole types are also suitable, just use one side (e.g: C&K type 7208 or similar). You'll also need an M-0216 transformer, or similar, as for the Figure 1 circuit.

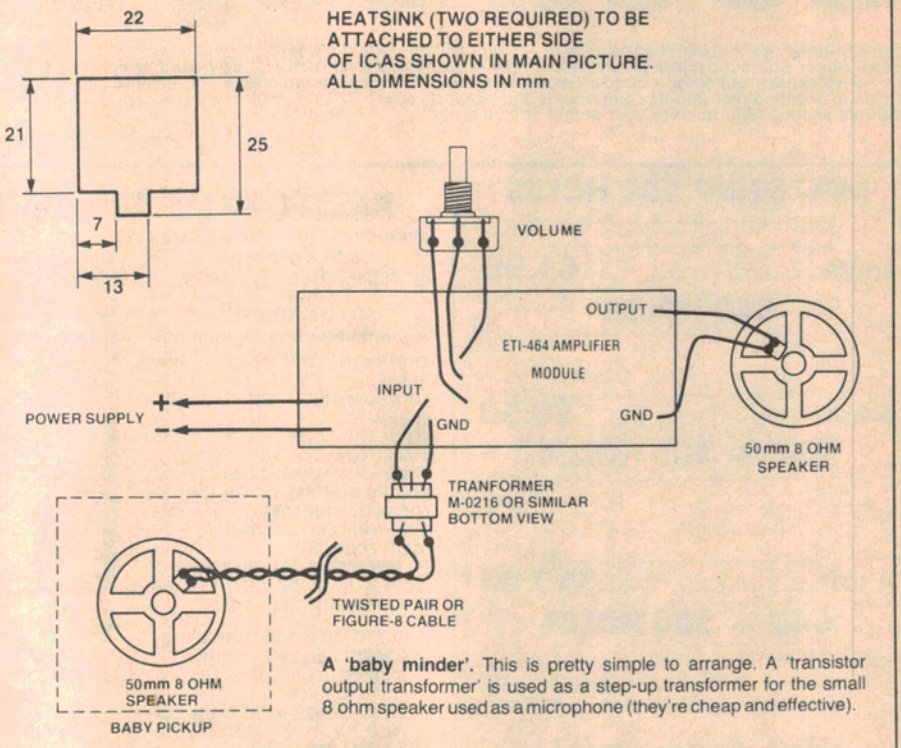
Two small 8 ohm speakers are used as both speaker and microphone at each end of the intercom.

A volume control is necessary on an intercom and a small 'trimpot' can be mounted on the pc board where the volume control connections are made. The hole spacings are suitably placed for soldering a common vertical mounting trimpot in place. Use on of the same value — i.e: 10k. Test out the intercom and set the volume control to suit yourself.

A suitable cable can be made by twisting together three strands of light hookup wire or buying a suitable length of light multicore cable. Note how the various common, or earth, connections are made to the one ground point on the pc board.

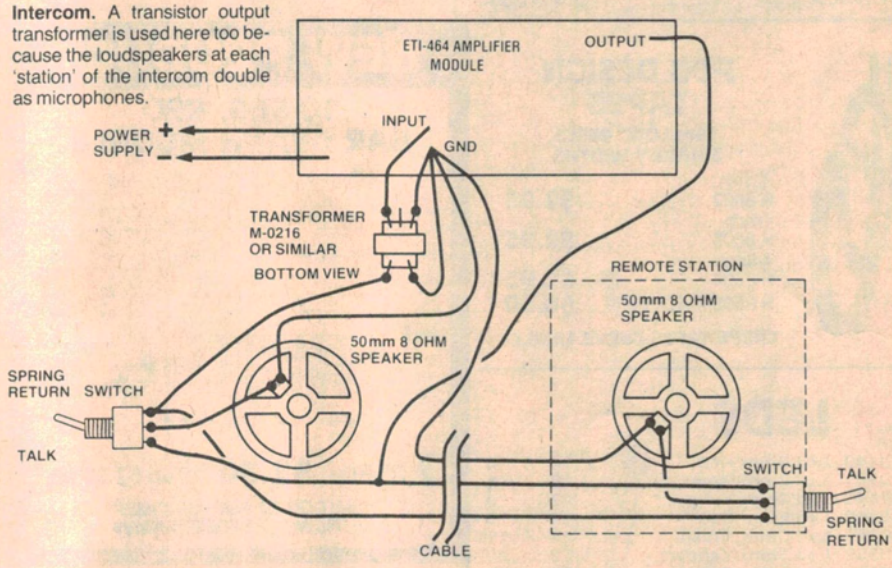
Conclusion

Well, I've described how to build yourself a general purpose audio amp module and how to use it in a couple of applications — the rest is up to you. Have fun! ●



A 'baby minder'. This is pretty simple to arrange. A 'transistor output transformer' is used as a step-up transformer for the small 8 ohm speaker used as a microphone (they're cheap and effective).

Intercom. A transistor output transformer is used here too because the loudspeakers at each 'station' of the intercom double as microphones.



Printed circuit artwork. Full-size reproduction of the pc board layout.