Utility Amplifier-Supply for the experimenter's bench

Here is a small utility amplifier and power supply unit which would be an ideal project for both the home experimenter and the radio club member. Low in cost, it is easily built, as most of the components are mounted on a small printed wiring board.

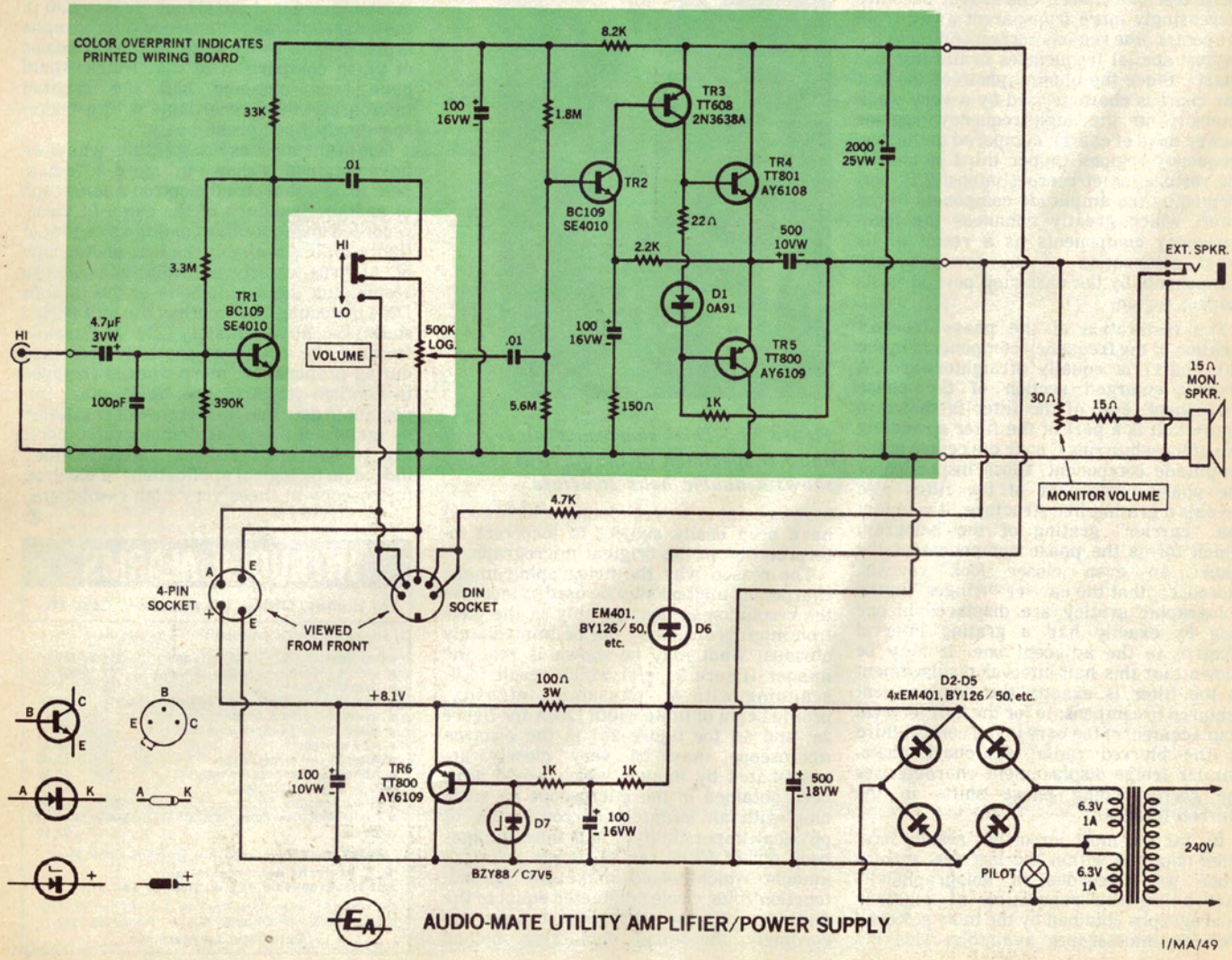
by JAMIESON ROWE

How often have you wanted to try out quickly an interesting new transistor circuit idea, and been frustrated because you didn't have either a convenient power supply or a suitable audio amplifier? If this has ever happened to you, you'll surely agree that two of the most useful things to have on the experimenter's bench are a low voltage DC power supply and a general purpose audio amplifier.

The little unit shown in the photographs and described below has been designed to provide both these useful facilities at low cost. We have dubbed it the "Audio-Mate".

The Audio-Mate comprises a fully solid state general purpose audio amplifier, together with a regulated and filtered DC power supply capable of supplying 8 volts at up to 100 milliamps. The amplifier has a wide frequency response, and includes a microphone preamp which may be switched into circuit when required. An inbuilt

Above is a view of the Audio-Mate complete in its case. Below is the circuit.



monitor speaker is fitted, but there is also a jack socket to allow the use of an external speaker when desired. In addition there is a 5-pin DIN socket so that both input and output of the amplifier may be connected conveniently to a tape recorder.

The power supply section of the Audio-Mate uses a simple shunt regulator circuit which is inherently protected against damage due to short-circuits. It is therefore well suited for use on the experimental bench, where accidental shorts can often occur. The output is well filtered, and the 100mA current capacity is adequate for the majority of low power receiver, converter, oscillator and audio circuits.

The uses of the Audio-Mate are really only limited by the builder's imagination. The unit would be ideal for the radio experimenter, allowing him to try out an endless variety of simple "front ends" without fuss and with a minimum of delay. The experimenter keen on electronic music and sound effects circuits can also use it to try out ideas quickly and easily.

In association with a high-quality external loudspeaker, it can be used with a gramophone turntable and pickup for record playing. It is also well suited for use with a battery operated tape recorder, whether reel type or cassette, as it can supply the recorder with power while at the same time boosting its audio output. It can be used as a nursery monitor system, and even pressed into service in an emergency as a low power indoor public address system. Fitted with a detector probe, it may be used as a simple signal tracer when servicing radio and television receivers. Radio amateurs can also use it as a modulator for use with low power solid state transmitters.

In short, the Audio-Mate is a very versatile little unit which would be an asset to any experimental bench. It would also be very suitable as a constructional project by youth radio clubs, as it is easily built up at low cost, and provides valuable experience in basic electronic construction.

The amplifier section of the Audio-Mate is very straightforward, using a total of only five transistors. Almost all of the components are mounted on a small printed wiring board, which is the same board as used in the Silicon Transistor Intercom of August 1971.

The main section of the amplifier uses four low cost silicon transistors in a standard direct-coupled transformerless circuit. A BC109 or similar NPN transistor is used as an input voltage amplifier, with a TT608 or similar PNP device following as a driver for the complementary-symmetry output stage using a TT800-TT801 or similar pair. Both DC and AC negative feedback are applied to the amplifier by means of the 2.2K resistor between the output emitters and the emitter of the input stage. The feedback stabilises gain and the DC operating conditions, improves frequency response and reduces noise and distortion.

The basic amplifier has a power output capability of approximately 1.5 watts, which it will deliver into any load between 8 and 16 ohms. It has a voltage gain of 15 times, and thus requires less than 350 millivolts for full output. The frequency response is quite wide, being 3dB down at approximately 40Hz and 150KHz, and distortion is low.

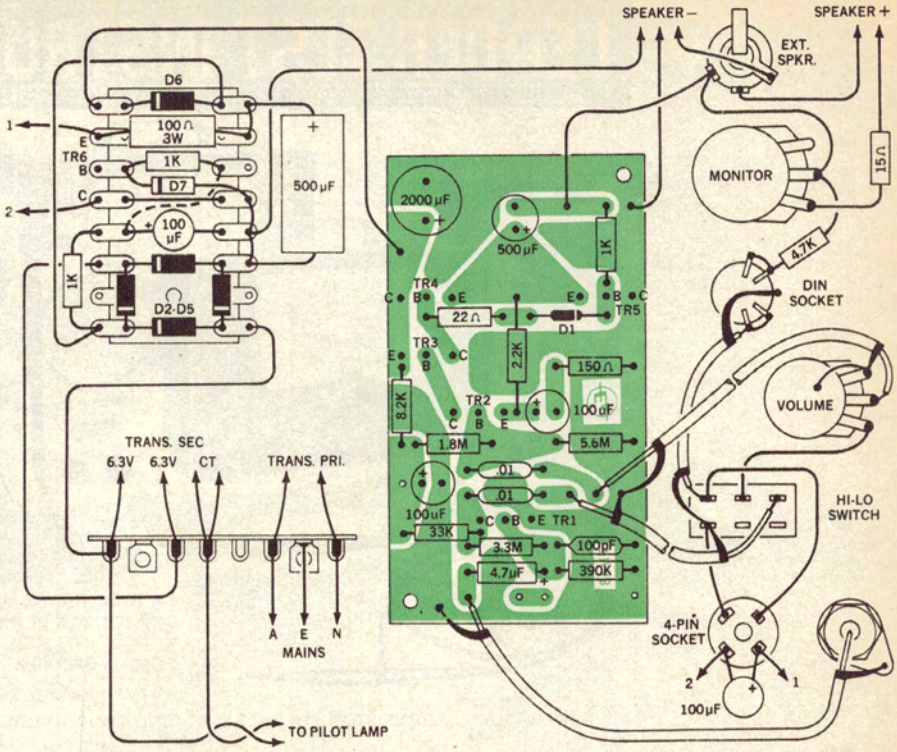
The microphone preamp stage uses a

single BC109 or similar low-noise NPN transistor in a standard common emitter configuration, and is mounted on the main amplifier board. The preamp has an input impedance of about 3K, and is usable with most medium to high impedance microphones. The voltage gain depends upon the impedance of the microphone or other signal source, because of the negative feedback introduced by the 3.3M bias resistor between collector and base; it will be more than 100 times for low impedance microphones, but drops as the source impedance rises.

A volume control potentiometer is fitted to the input of the main amplifier section, with a slider switch which connects to top of the pot to either the "LO" input connectors or the output of the preamp (whose input is the "HI" input). Two different LO inputs are provided, with parallel connections. One input is available at the appropriate pins of the 5-pin DIN socket, while the other is via two pins of a miniature 4-pin socket. The other two pins of this socket are used for the output of the 8V power supply, so that the socket provides a convenient way of connecting to experimental receivers and other circuits.

The output of the amplifier is taken through a 4.7K isolating resistor to the 5-pin DIN socket, to provide a recording output, and also to the jack socket provided for an external speaker. The contacts of the jack are connected so that when an external speaker is not used the output of the amplifier is connected directly to the 10-ohm internal speaker. However when an external speaker is plugged in the direct connection to the internal speaker is broken, and the speaker receives power instead via a series 15-ohm fixed resistor and a 30-ohm variable. This allows the internal speaker to be used for monitoring, without it absorbing more than a minor proportion of the amplifier's modest output.

Power for the complete Audio-Mate is supplied by a simple stepdown transformer and bridge rectifier circuit using four 1 amp silicon diodes. A 500uF capacitor is used as the main rectifier reservoir, but a separate 2000uF capacitor is used as a separate reservoir for the amplifier section. The 2000uF capacitor is charged via a fifth diode which tends to isolate the two capacitors, allowing the class-B output stage of the amplifier to draw quite high transient currents (supplied by the 2000uF capacitor) without significantly disturbing the output voltage of the main supply. This simplifies the design of the 8V regulator circuit.



The wiring diagram for the Audio-Mate, showing the placement of all components mounted on the wiring board and miniature resistor panel.

The regulator circuit itself is very straightforward, and uses a single TT800 or similar medium power PNP transistor in a shunt circuit. The transistor is in fact used as an "upside down" emitter follower, with an R-C filter circuit and a zener diode used to stabilise the base voltage. As the transistor is connected across the output of the supply, it is not embarrassed in the least by a short-circuit across the output terminals. In fact it dissipates most power when the supply is unloaded, and progressively less power as loading is applied; with a short circuit, it merely cuts off.

As the photographs show, the Audio-Mate is constructed in a standard small instrument case. The case measures 7½in x 5in x 4in (19cm x 13.7cm x 10.2cm), and has a wrap-around front panel.

Most of the wiring is mounted within the case itself, with only the monitor speaker, controls and input-output connectors mounted on the front panel. The power transformer is mounted on one side of the case, near the rear, with its leads terminated on a miniature 8-lug tagstrip immediately in front. The small printed board for the amplifier is mounted on the bottom of the case, with the power supply wiring mounted above it on the case rear, supported by an 8-lug section of miniature resistor panel.

The wiring and assembly of the unit should present few problems, even for the beginner. The Audio-Mate is a very straightforward device, and its wiring is not

LIST OF PARTS

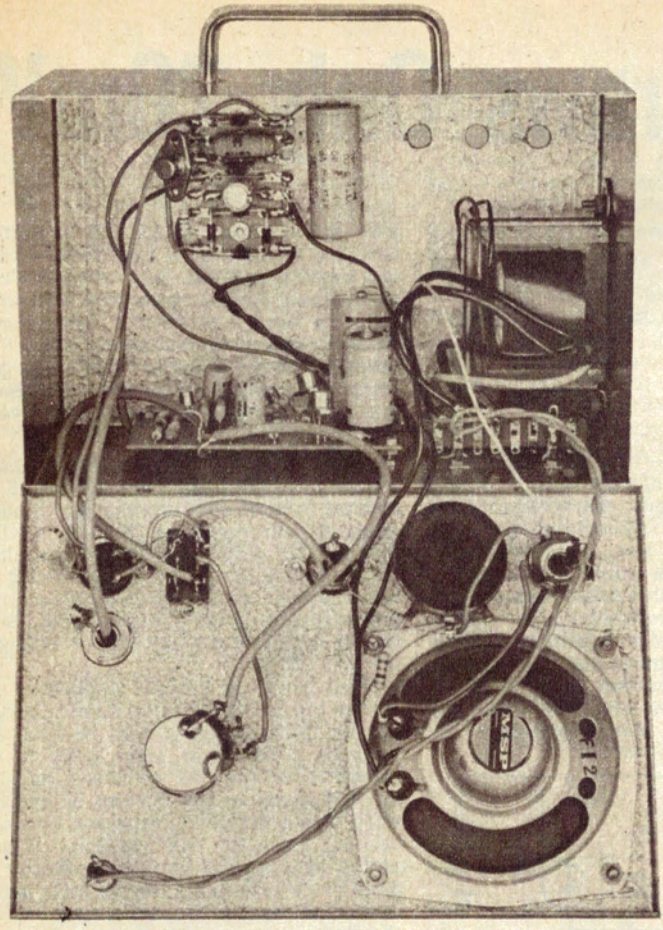
1 Instrument Case, 7½in x 5in x 4in, with wrap-around panel.
1 Step-down transformer, 240V to 6.3V plus 6.3V or 12.6V CT at 1A.
1 Printed wiring board, 71/a8.
1 3-inch loudspeaker, 15 ohms.
1 Slider switch, SPDT.
1 5-pin DIN socket.
1 Miniature 4-pin socket.
1 Jack socket with N/C contact.
1 Insulated microphone socket.
1 Miniature pilot bezel, 6V 50mA.

SEMICONDUCTORS
5 EM401, BY126 or similar diodes.
1 OA91 or similar diode.
1 BZY88/C7V5 or similar zener.
2 BC109, SE4010 or similar.
1 TT608, 2N3638A or similar.
2 TT800, AY6109 or similar.
1 TT801, AY6108 or similar.

CAPACITORS
1 100pF polystyrene.
2 .01uF 100V polyester.
1 4.7uF 3VW electrolytic.
2 100uF 10VW electrolytic.
2 100uF 16VW electrolytic.
2 500uF 18VW electrolytic.
1 2000uF 25VW electrolytic.

RESISTORS
1 15ohms ½watt
1 22ohms ½watt.
1 100ohms 3watt.
1 150ohms ½watt.
3 1K ½watt.
1 2.2K ½watt.
1 4.7K ½watt.
1 8.2K ½watt.
1 33K ½watt.
1 390K ½watt.
1 1.8M ½watt.
1 3.3M ½watt.
1 5.6M ½watt
1 30ohm wirewound pot.
1 500K log pot.

MISCELLANEOUS
Mains cord and 3-pin plug; handle and rubber feet for case; miniature 8-lug tagstrip, 8-lug section of miniature resistor panel; 4in x 4in square of expanded aluminium or similar material for speaker grille; 2 knobs for controls; connecting wire, screws, nuts, clamps for mains cord, solder, etc.
NOTE: Resistor wattage ratings and capacitor voltage ratings are those used for our prototype. Components with higher ratings may generally be used, providing they are physically compatible. Components with lower rating may be used in some cases, providing the ratings are not exceeded.



A view inside the Audio-Mate case, with the rear of the front panel also visible. Note the power supply wiring mounted on the rear of the case, and the transformer on the right-hand end.

critical. In any case we have prepared a complete wiring diagram to guide the constructor and minimise any possible problems.

However, there are a few points to bear in mind when assembling a piece of equipment of this type. One is that the mains cord should be brought into the case via a carefully de-burred hole in the rear, the hole being fitted with a suitable rubber grommet. Upon entry the cord should also be securely anchored using a "C" clamp, to prevent strain and possible breakage of the connections. The earth wire should be connected reliably to the case of the unit, with the wire terminations arranged so that if the cord clamp should loosen, the earth connection would be the last to break.

The amplifier printed board is attached to the bottom of the case via two ⅛in Whitworth screws, with additional nuts used to space the board approximately ¼in above the metal for clearance. The board is quite small and light, and two screws are adequate to secure it in this way.

The microphone socket should be insulated from the front panel, and its "earthy" side taken to the earthed copper of the wiring board via the shield braid of the wire between the two. Similarly care should be taken to wire the shield braids of the other shielded wires so that they do not form continuous earth loops. These precautions will ensure that the completed amplifier has a negligible hum level.

When the Audio-Mate is completed, it should be possible to switch it on and obtain full operation immediately. There are no adjustments to be made, although the cautious constructor may wish to make a couple of quick measurements to make sure that everything is in order.

Only three measurements need be made, and if these check out satisfactorily, all should be well. The first is to measure the voltage at the junction of the two output transistor emitters in the amplifier, with reference to earth. Using a 20,000 ohm per volt multimeter or similar this point should measure between 8 and 10 volts.

Next the quiescent current of the amplifier as a whole could be measured, by breaking the positive lead running from the printed board to the power supply diode, and inserting a multimeter set to a 100mA or higher current range. The current should read from 40 to 60 milliamps.

If the current is much lower than 40 milliamps, the amplifier may produce cross-over distortion, while if the current is significantly greater than 60mA (say 80mA or more), it may exhibit a tendency to thermal instability and "runaway". If necessary the value of the small resistor (at present 22 ohms) in series with the OA91 biasing diode may be altered to bring the current within the correct range. Increasing the value of the resistor will increase the current, and vice-versa.

A final check would be to measure the output voltage of the power supply regulator. This should be close to 8 volts. If it does not approximate this figure, but instead is around 1 volt, the most likely cause is that you have wired the zener diode in circuit with reversed polarity!