

13.8V transceiver power supply

Looking for a 13.8V power supply for your amateur band transceiver? This easy-to-build unit will power both the UHF "Explorer" and VHF "Commander" transceivers recently described in EA and comes in a matching case.

by PHILIP WATSON

As with the two transceiver kits, the power supply kit is being marketed by Dick Smith Electronics, and is packaged in the same plastic case as the transceivers; a nice touch for those who like to maintain a neat appearance on the shack operating table.

On the other hand its use is not restricted to these two units. It is quite suitable for use with most 2m or 70cm transceivers requiring 13.8V at 2A; typically, commercial units with an RF power output rating of around 10W. The next step up, into the 25 or 30W class, would require something larger, such as the VK Powermate, described in EA in December 1983.

The circuit for the new power supply is just about as simple as one could get for a unit of its ratings and performance

figures. In fact, some may regard it as a little too simple, but some worthwhile additions are possible, and easily implemented. We will discuss these later.

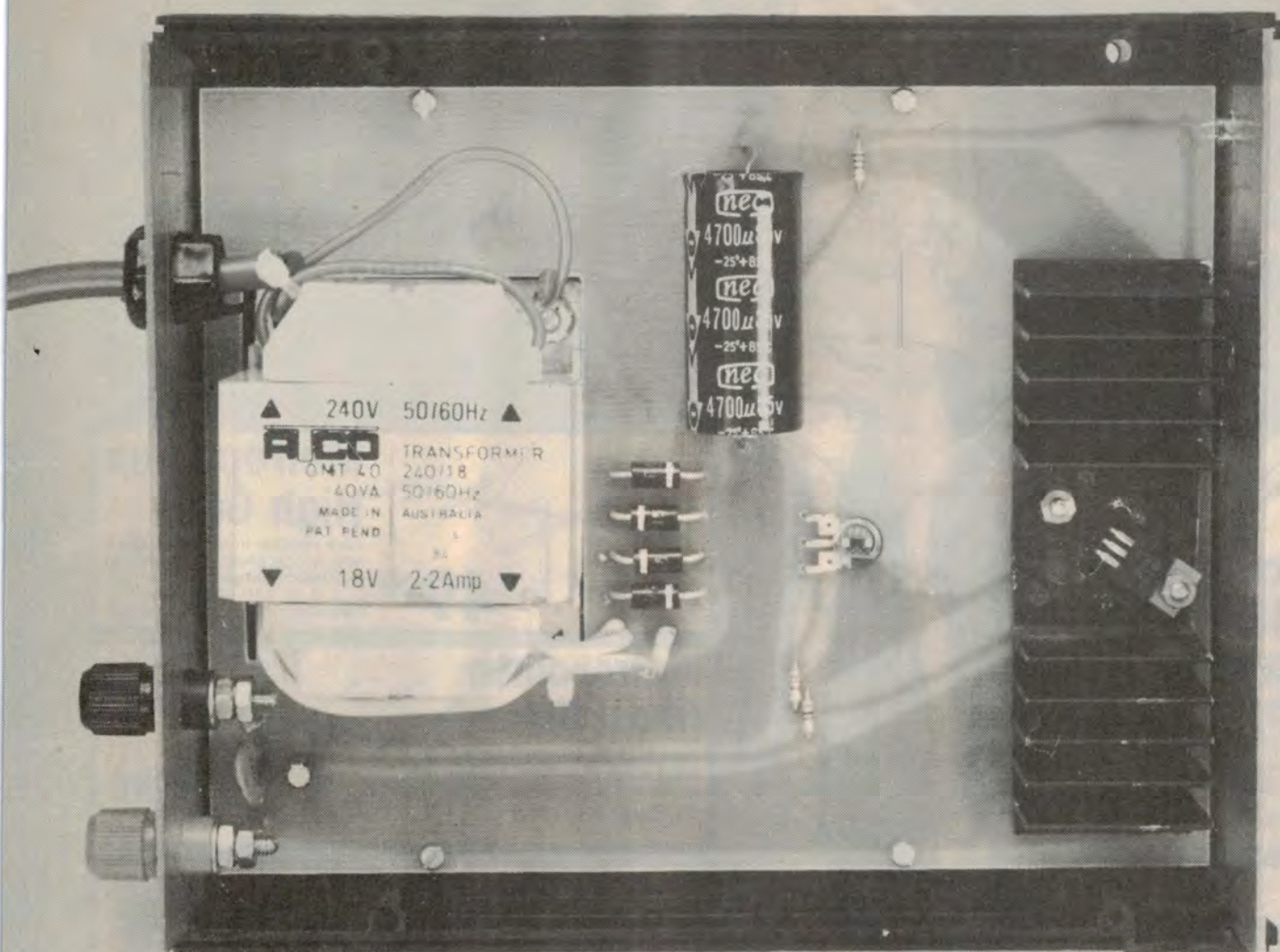
The heart of the unit is the National Semiconductor LM350T adjustable regulator. This has a rating of 3A with an output voltage variable from 1.2V to 33V, with only a minimum of external components. It is self-protecting, with internal current limiting, thermal overload protection, and safe area (power dissipation) protection.

Used in a simple circuit such as this, the regulator still offers an impressive performance: voltage output drops by only 10mV from no load to 2A; ripple and noise is 15mV p-p at 2A, rising to 100mV p-p at 2.5A; and input voltage regulation holds down to 220VAC.

As a matter of interest the ripple rejection ratio for the LM350, as given in the data sheet, is 65dB when used as shown. This can be increased, in theory at least, to 86dB by bypassing the adjustment terminal with a 10 μ F capacitor. More about this idea later in the article.

The operation of the regulator is perhaps best explained with the aid of the simplified diagram in Fig.1. This shows it as consisting of a power transistor in an emitter follower configuration, with the base being fed from the output of an operational amplifier. The input to the operational amplifier is taken from the output of the emitter follower, thus making it a feedback system. More specifically, the op amp monitors the voltage across R2 and adjusts the drive to the power transistor to keep the output voltage within tight limits.

The whole system is so adjusted that it strives to maintain a constant value of about 1.25V across R2 which means that, in turn, it also maintains a constant current through R2 and thus, by definition, the same constant current through R1. By selecting the value of R1 we can nominate the voltage which will



Use this photograph in conjunction with the circuit when wiring up the supply.

appear between the "OUT" terminal and the negative rail, which will be 1.25V higher than the voltage across R1.

Let us now consider what happens if the output voltage (between "OUT" and negative rail) tends to vary, due to either variations in the input voltage or variations in the load current. Let's say the voltage tends to rise. This would have the effect of trying to force more current through the R2, R1 network and increasing the voltage across R2. But the feedback network will have none of this; it will immediately pull down the forward bias on the transistor, thus lowering the output voltage until the requisite 1.25V is restored across R2.

Similarly, if the voltage should tend to fall, the reverse corrective action would occur. This is a greatly simplified explanation of both the regulator circuitry and the manner in which it functions in the circuit, but it should give the reader at least a basic grasp of what is involved. It also explains how the LM350T can precisely control the voltage between its output and "Adj" pins, while negligible

current actually flows into or out of the "Adj" connection.

In the present circuit R1 is a 1kΩ resistor and R2 is made up of an 82Ω resistor and a 100Ω trimpot. This is adjusted to give the required 13.8V at the output terminals, using an accurate voltmeter.

The remainder of the circuit is almost basic in its simplicity and calls for little comment. More important from the constructor's point of view is the hardware supplied with the kit and the method of assembling it.

Mains transformer

One of the most important components is the transformer, partly by reason of its construction and partly because of the manner of mounting it. It is an Australian made "Atco" brand unit, rated at 18V, 2.2A. Apart from being a compact unit it has the attractive feature that both the input and output connections are via well shrouded screw terminals. This allows the constructor to fit his own leads and, in the case of the mains connections, allows the cable leads

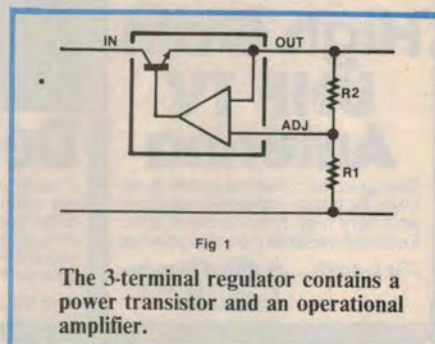


Fig 1

The 3-terminal regulator contains a power transistor and an operational amplifier.

to be taken directly into the transformer, thus avoiding the need for insulated terminal blocks.

Unfortunately, mounting the transformer presented a minor problem. It was too high to allow it to be mounted on a printed board, as normally supported in this plastic case. On the other hand, it could be accommodated if it was mounted directly on the lower half of the case, and this is what has been done, the printed board being supplied with a rectangular cut-out, so that it fits around the transformer.

The next problem was to avoid using mounting screws to hold the

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transformer, since these would protrude on the underside of the case. The solution was to affix the transformer to the case using a strip of double-sided adhesive. This is supplied with the kit.

The adhesive is about 25mm wide and a single strip is fitted from corner to corner of the transformer, this combination then being applied to the case. The adhesion is very good and difficult to break, so it is important to select the correct position first time.

The only objection to this arrangement is that the cut-out in the board used in our sample model was not quite large enough to clear the top of the transformer, particularly the terminal covers. This would mean that the board would have to be wired — and preferably tested with temporary connections — and mounted in place before the transformer was fitted.

It would also mean that, in the event that subsequent service was required, it would be difficult to get at the underside of the board.

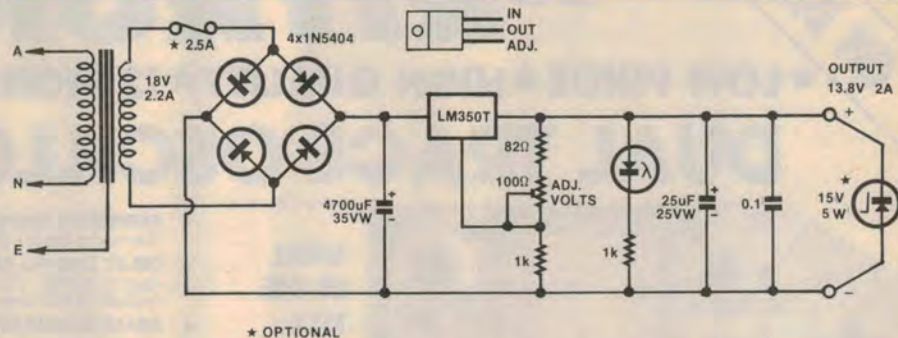
We raised this point with Dick Smith Electronics and they have arranged to have this cut-out enlarged slightly, both for boards in stock and future supplies. However, the constructor would be wise to check this point carefully and, if an undersize cut-out is encountered, to enlarge it slightly, using a file.

Note that one of the transformer mountings holes is fitted with a nut and bolt holding a solder lug, this being used to connect the transformer frame to the mains earth (green and yellow) wire. The screw needs to be countersunk and a lock washer should be fitted to secure the connection.

The rectifier is a conventional bridge arrangement using four 1N5404 diodes, and the output is filtered by a 4700 μ F capacitor. This is followed by the LM350T regulator, the voltage adjusting resistor network, and a 25 μ F electrolytic and a 0.1 μ F ceramic capacitor in parallel across the output terminals. A LED indicator with a 1k Ω limiting resistor completes the picture.

The only other major structural item is the finned heatsink for the LM350T. This is bolted to the board in such a way that it makes contact with the positive rail, the body of the LM350T being the Vout terminal and which is bolted to the heatsink in both electrical and thermal contact.

Construction should not pose any special difficulties, apart from the few minor points already discussed. The polarity of both electrolytic capacitors is marked on the board, and the orientation of the rectifier diodes can be clearly seen



The circuit consists of a bridge rectifier driving an adjustable 3-terminal regulator.

in the photograph. The LED polarity is indicated by the positive lead being the longer one.

Optional protection circuitry

Earlier we mentioned possible additions to the circuit. One of these is a fuse to protect the transformer in the event of any failure likely to overload it. While there is no provision for a holder on the board, an in-line fuse holder could easily be added to the longer of the two low voltage leads from the transformer to the board. A fuse rating of 2.5A is suggested.

An alternative approach would be to cut the positive rail between the 4700 μ F capacitor positive connection and the heatsink, then mount a fuse clip either side of this cut. Electrically, this position has some advantage, particularly if the second protective device, about to be discussed, is fitted.

This second protective device is mainly for the benefit of the transceiver, or other load. In the event of a failure of the regulator or associated components it would be possible for the full output voltage from the rectifier to be applied to the output terminals; around 18V or possibly higher, resulting in damage to the transceiver.

A simple solution to this problem is to fit a heavy duty zener diode across the output terminals, its voltage rating being high enough to clear the normal 13.8V, but low enough to allow it to be activated before a dangerous voltage is applied to the transceiver. If it is activated it will appear as a virtual short circuit to the power supply and blow the fuse.

In readily available types a 15V, 5W unit appears to be a good compromise, although a slightly lower voltage would be better. The next lowest value in 5W units is 13V, which is too low, but the addition of a couple of heavy duty diodes (eg, 1N5404) would raise this to 14.2V

— a nice value if you feel that the extra trouble is justified.

Regardless of which arrangement you use, it is important that it not be connected before the output voltage has been set. And, if subsequent adjustment should be required, it would be wise to disconnect the zener until it is completed.

The third suggestion concerns improved ripple rejection, as already mentioned. In most cases this should not be necessary, because the performance from the circuit as it stands is very good. Only in the event that it is used with equipment which may be lacking in internal filtering, or is unduly sensitive for some other reason, should it be necessary to consider this approach.

The modification is quite simple and involves fitting a 10 μ F electrolytic capacitor between the adjust terminal and the negative rail. Tried in our own laboratory, there is no doubt that it makes a significant reduction, to the point where the ripple becomes comparable with the noise, making it difficult to measure accurately. It dropped the level from the previously mentioned 15mV p-p to something around 2.5mV p-p; a very worthwhile improvement.

Our only worry concerning this modification was the possibility that it might introduce instability into the regulator system, particularly when used in the vicinity of a strong RF carrier. Happily, an on-air test using a typical 10W 2M commercial transceiver revealed no sign of any such problems, and we feel that, should such an addition seem to be desirable, it would be safe to go ahead and use it.

Which is about all that needs to be said about what is, basically, a very simple project. The kit price is \$49.50 which, with the addition of a couple of hours work, will result in a very effective power supply for either the UHF or VHF transceiver.