PROJECT

Variable Stabilized Power Supply

A 0-12V general-purpose regulated power supply.

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The circuit diagram of the second project, a Variable Stabilized Power Supply, is shown in Fig. 1. Here a transformer is required giving an output of 15V to 18V at 2A, plus a winding giving 5V to 6V at a current of 10mA. *The windings must be separate*. A separate small transformer can be used.

The main secondary output from the transformer T1 is rectified by the bridge REC1 in the usual way and smoothed by capacitor C1. The peak voltage across C1 can be up to 25V if you use an 18V transformer and a minimum working voltage of 35V should be selected. The capacitor specified has such a working level and a ripple rating of 3A; this last figure is as important as the former.

This unregulated supply is connected to the regulator system consisting of integrated circuit IC1 and the series pass transistor TR2, with its base bias controlled by TR1. IC1 is a high gain amplifier functioning as a differential comparator.

The non-inverting input (pin 3) of IC1 is fed from potentiometer VR1 which is connected across the Zener diode D1. The Zener maintains a stable 13V across its ends; the slider of VR1 can therefore be varied between 0V and 13V.

The inverting input (pin 2) to the IC1 is connected to the stabilized output of the supply. Whatever the potential at the slider of VR1 happens to be, this is compared with the output potential and any difference is detected and amplified by IC1.

The output of IC1 then adjusts the base voltage of TR1 in such a way that the difference is reduced (theoretically) to zero. Hence the output voltage is held at whatever voltage setting has been selected by VR1.

A 13V reference Zener used as the output is always slightly less than this reference because of the drop across TR2. An output of up to 12V can therefore be obtained. If the output tends to change for any reason, that change will be immediately corrected, so the output will be *stabilized*.

Thermal Trip

As this simple circuit does not incorporate a current limiting feature (as later designs will) a thermal trip X1 is included in the positive feed line following the rectifier. This will trip at a current of 2A so the unit will be protected against inadvertent short-circuits or serious overload.

You can, if you wish, replace this trip with a panel mounted 2A fuse. This saves a little money, but is not so convenient as the trip and after a few blowouts, might lead to the insertion of a larger rated fuse because of the frustration, and so to more expensive disasters.

Diode D2 across the output terminals is also protective in that it prevents reverse high voltage spikes from being fed back into the unit from inductive loads such as motors.

Negative Supply

So that the unit can be adjusted down to zero volts, a negative supply line is provided (see Fig. 3.8). This is obtained from the additional secondary winding of the transformer T1.

After rectification by the single diode D3, smoothing is carried out by capacitor C2 and a Zener diode D4 maintains a steady 4.3V feeding the negative supply pin (4) of IC1. The value of resistor R5 is given for the specified transformer; if you use an alternative transformer where the secondary may be greater than 6V, you may have to modify this value to ensure that the Zener does not exceed its power rating (500mW) under no-load conditions.

The actual current drawn from this negative rail is very small (about 3mA) and there is no problem with the ripple rating of capacitor C2.

Construction

The construction of the Variable Stabilized Power Supply is reasonably straightforward with most of the components mounted on a single printed circuit board (PCB). The full size copper foil master pattern for this board is shown in Fig. 2, together with the component positioning on the topside.

There is no close packing of the parts, and unless you prefer to obtain your board ready made, it is a simple matter to make one for yourself using either etch-resistant transfers.

When assembling the board, great care must be taken to ensure that the rectifier REC1 is correctly oriented. It can go in any one of four ways and only one is the right way. The same applies to the Zener diodes D1 and D4, the diodes D2 and D3, and the electrolytic capacitors. Notice that C2 has its *positive* end to the ground or chassis line.

Fit Vero pins at positions XX, YY, TT, PQS and CBE for later wiring to the transformer T1, the trip X1, the control potentiometer VR1, and the pass transistor TR2 respectively. Fit a corrugated TO39 type heatsink to transistor TR1. Also fit pins to the plus and minus output points. Drill two bolt holes at points K.

A small heatsink for the rectifier REC1 itself is recommended if you are thinking of drawing currents up to 1.5V for any extended period. This is a simple piece of 16 gauge aluminum 3" (76mm) long by 1" (25mm) wide, bent as shown in Fig. 3 and secured to the rectifier by way of its central hole and a countersunk screw and nut. Do this *before* soldering the rectifier to the board.

Once everything is on the board, it has to be fitted to the main aluminum heatsink which carries the power transistor TR2. The aluminum is cut, bent and drilled to the dimensions given in Fig. 4 and then sprayed matt black as for the earlier project. You can use your mica or silicone-rubber insulating washer as a

PARTS LIST

VARIABLE VOLTAGE UNIT

Resistors

R1 .... 1k5
R2,3 .... 6k8
R4 .... 4k7
R5 .... 1k8

Potentiometer

VR1 .... 5k linear

Capacitors

C1 .... 2200u, 35V
C2 .... 470u, 16V
C3 .... 220n
C4 .... 100u, 25V

Semiconductors

D1 .... 13V 1W zener
D2,3 .... 1N4001
D4 .... 4.3V zener, 500mW
TR1 .... BFY50, 2N2219 npn
TR2 .... 2N3055, 2N3771 npn
IC1 .... 741 op amp
REC1 2A bridge rectifier, VS247, etc

Miscellaneous

S1 .... DPDT switch
LP1 .... Neon pilot light
ME1 .... 0-15V meter
15-18V 2A transformer, plus 5-6V 50mA filament transformer
Case, PCB, 2A circuit breaker, heatsink

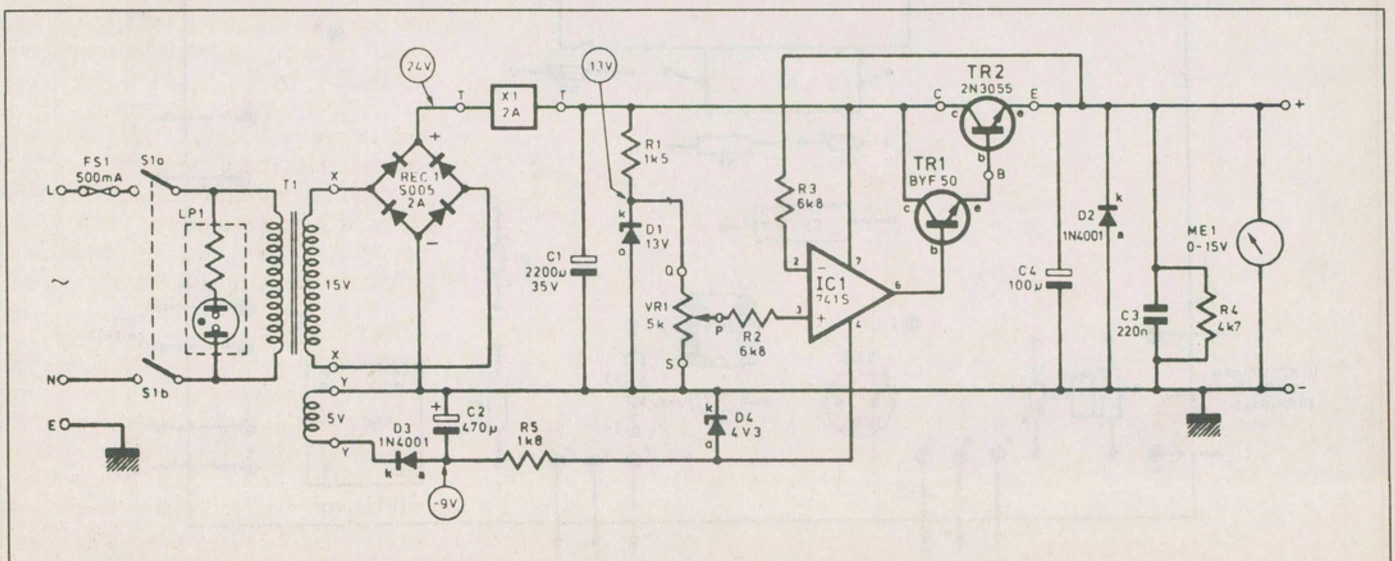


Fig. 1. The complete cicrcuit diagram for the 0-12V Variable Stabilized Supply.

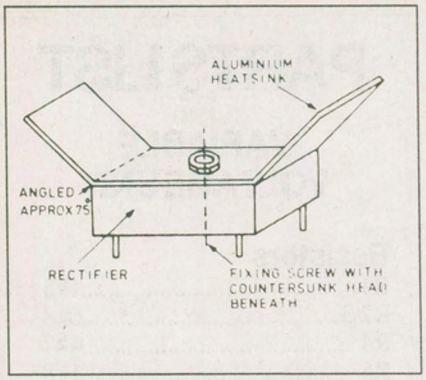


Fig. 3. Mounting the small aluminum heatsink on the bridge rectifier.

template for the transistor mounting holes, making sure there is adequate clearance round the base and emitter pins.

The board is now placed against the heatsink and the two fixing hole positions marked through; keep the top edge of the board in line with the top edge of the heatsink. None of this is particularly critical and can be judged by eye well enough.

The 2N3055 transistor should now be mounted on the aluminum, using the usual insulating bushes and washer. A soldering tag is fitted under the upper nut so that connection can be made to the collector (the case) of transistor TR2.

Check that the transistor is not shorting to the aluminum, and then solder flexible leads to the collector tag and the base and emitter pins for later connection to the board. Use three colours for this so as to avoid any future confusion.

The board can now be screwed to the heatsink using half-inch spacers and the three leads from TR2 brought over the top edge of the board and soldered to the appropriate Vero pins at the points C (collector), B (base) and E (emitter). Fig. 5 shows the general appearance of the completed mounting.

Boxing Up

The case mentioned in the components list

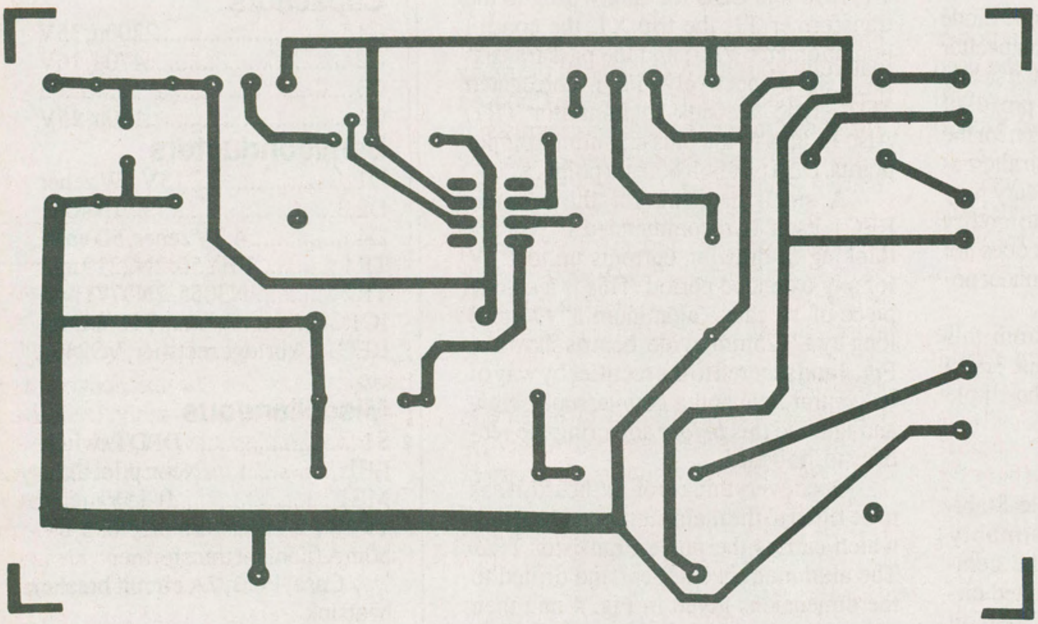
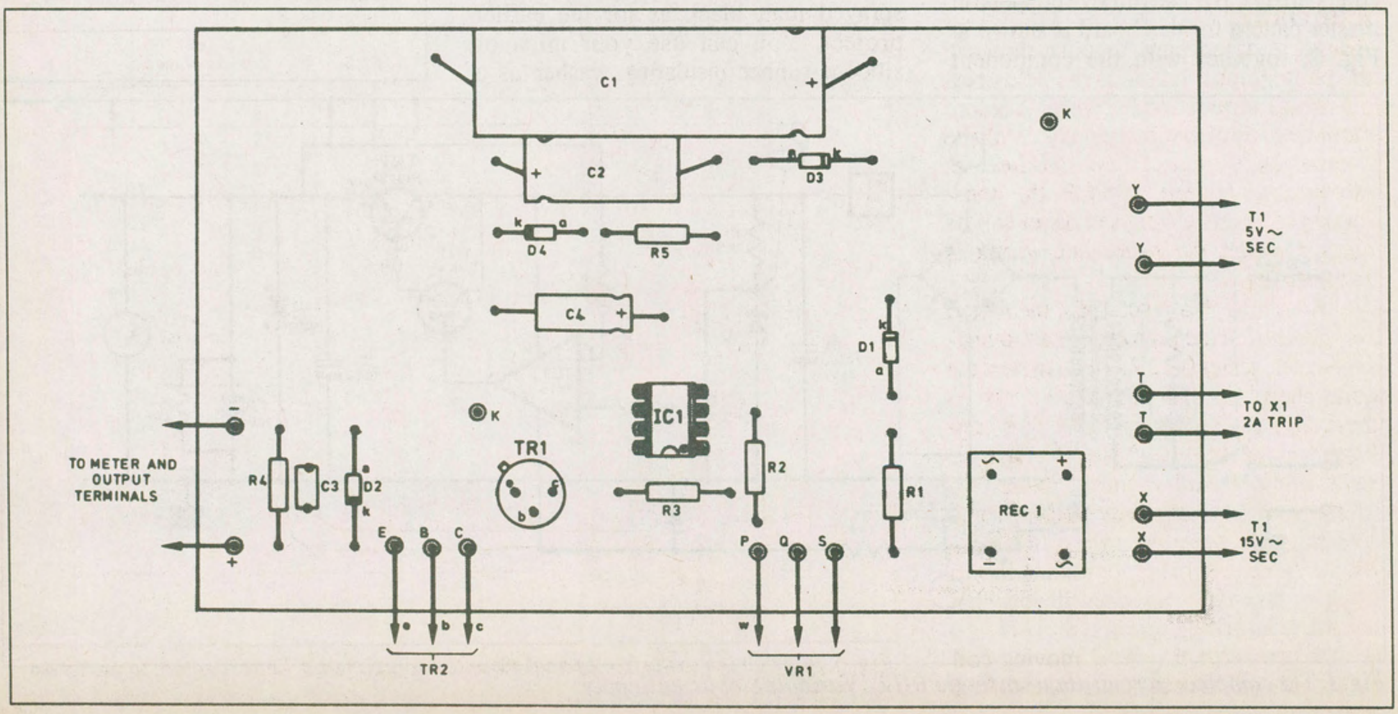


Fig. 2. Full-sized PCB foil master drawing, foil side and (below) the component side layout diagram. A small heatsink should be clipped onto TR1.



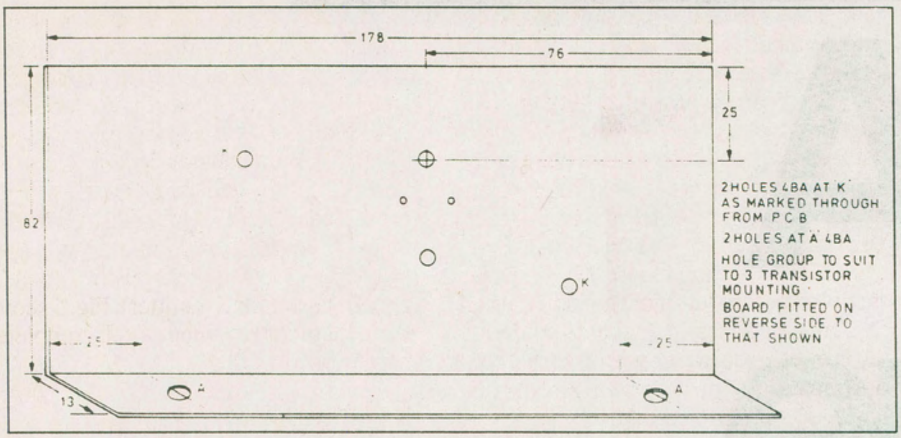


Fig.4. drilling details and dimensions of the main heatsink.

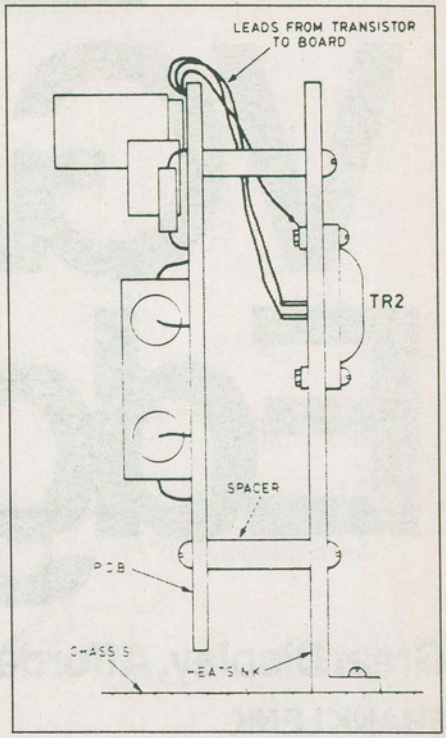


Fig.5. Mounting the circuit board on the main heatsink.

makes an attractive housing for this power supply, but any alternative may be used provided it measures at least 8" (203mm) by 4" (102mm) by 6in. (152mm) back to front. The front panel carries the meter (which is optional — you may prefer to calibrate directly onto a panel scale), the thermal trip X1, the voltage control VR1, the power on/off switch and indicator neon and the DC output terminals.

If you use the specified case, the transformer and the printed board should be mounted on the internal chassis provided with these cases in the positions indicated in the photographs. Exact placings are not critical but should not be as far to the rear of the chassis as possible so that room is left for the inwardly projecting components mounted on the rear of the front panel.

Interwiring

A suggested front panel layout is shown in the photographs; lettering can be carried out using Letraset or other systems before mounting any of the components. With the internal chassis now screwed into the case, interwiring between the PCB, the transformer secondaries and the panel can be quickly made; the panel interwiring is shown in Fig. 6.

A word at this point about the meter: the one used in the prototype is a moving-iron meter, scales 0-15V. These meters are quite cheap as analogue instruments go these days and the fact that the scale is non-linear and the movement does not have the smoothness found in more expensive moving-coil units is no great hardship in the present usage. Over the bulk of the scale length there is a good approximation to linearity, anyway, and it does till you what is coming out of the terminals.

If you wish to use a moving-coil meter, you will have to hunt around to find one scaled 0-15V (or thereabouts); alternatively, you can rescale one of the many units available from parts stores. Choose a 1mA basic meter, then add a series resistor to convert it to a voltmeter to suit the new scaling. A small preset is useful here.

You can if you wish, of course, omit the meter entirely and draw yourself a panel scale calibrated 0-12V (or 0-15V). It is not a difficult job to mark a scale off against an external voltmeter as monitor.

Testing

There is little to go wrong with this simple power supply unit and it should work correctly right away. If you want to get up to 15V output, replace D1 with a 16V type, and you may have to replace D4 also with a 4.7V type. Nothing else needs any modification.

Typical voltage levels are shown in the circuit diagram of Fig. 3.8. These can be used as a guide if the unit does not work properly and will probably enable any gross fault to be quickly located.

The most likely causes of difficulty are the old favorites of reversed diodes or electrolytics, so watch out for these particularly. The output current is nominally 1.5A as maximum, but 2A can be drawn for periods not exceeding ten minutes or so.

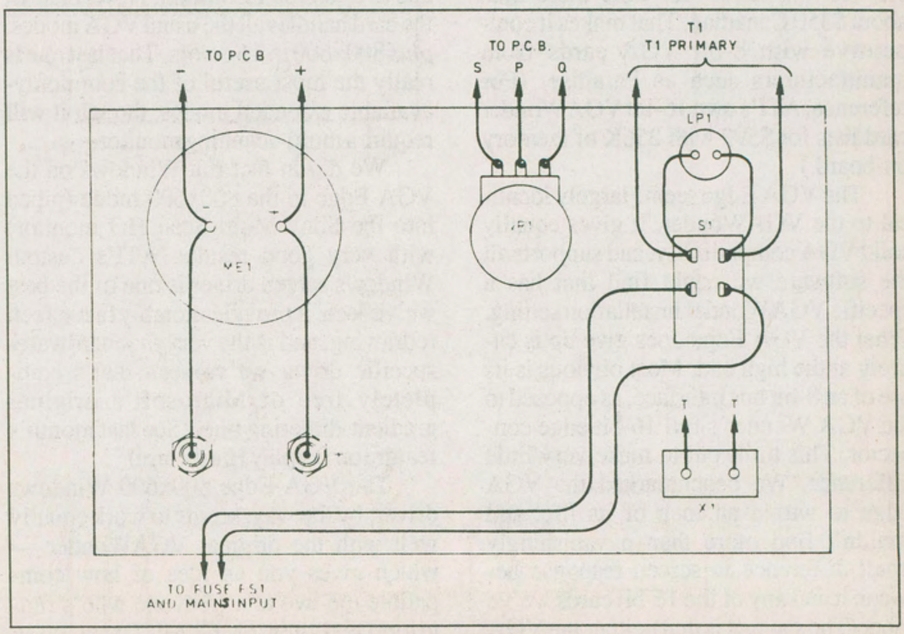


Fig.6. Interwiring to the front panel mounted components. Letters relate to points on the PCB.