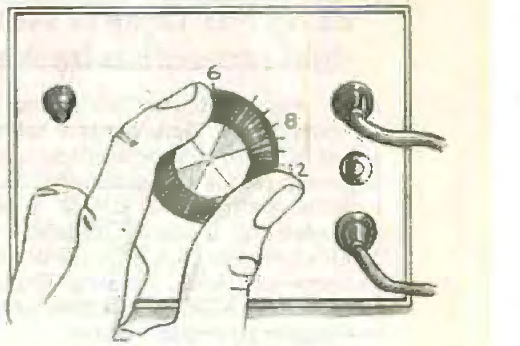
VARIABLE DUAL POWER SUPPLY



TONY SERCOMBE

Fully variable from ±3V to ±15V, this 500mA workshop tool is short-circuit proof, and highly useful!

SOME time ago the author urgently needed a split level power supply and for quickness copied a previously published circuit. It worked well, with one exception, that it had no protection against accidental short circuits.

In the author's case, these could happen with the negative output, mainly due to the fact that on most of his printed circuit boards the negative and earth lines were in close proximity. The slightest contact between the two would cause instant destruction of the negative feed transistor. So, on the last occasion this occurred, it was decided to revisit the circuit, and the design described here is the result of that investigation.

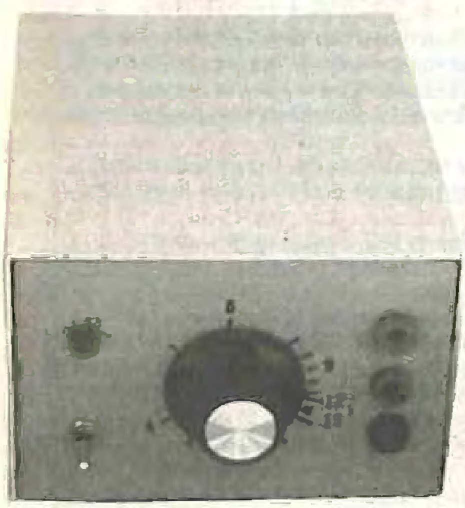
CIRCUIT DESCRIPTION

As can be seen from the circuit diagram in Fig.1, a centre-tapped transformer (T1) is used so that both positive and negative voltages may be obtained from the bridge rectifier (REC1). Capacitors C1 and C2 smooth the rectified voltage. Resistors R1 and R2 provide a discharge path when the power supply is switched off.

Two LM301 op.amps are used as the controlling elements, the negative controller (IC2) being slaved from the positive controller (IC1), the latter acting as the master in conjunction with potentiometer VR1, which sets the output voltages.

A reference supply voltage for the op.amps is obtained from Zener diodes D1 and D2, which set it at ±18V. Variable d.c. feedback is applied to pin 2 of IC1 via VR1. Thus, as the feedback is increased the output drops, and when decreased it rises. IC2 is controlled by the output of IC1 and thus adjusts the negative line accordingly.

The outputs of each of the op.amps feed the bases of Darlington transistors TR1 and TR3, via resistors R12 and R9 respectively. The outputs from the transistors are then fed via low value (1Ω) resistors to the power output sockets. Capacitors C7 to C10 help to smooth any high-frequency spikes or noise at the output sockets. Resistors R15 and R16 provide a discharge path when the unit is switched off.



CURRENT LIMITING

The purpose of transistors TR2 and TR4 is to limit the current that can be drawn should an excessive load be presented to the unit's outputs. As more current is drawn, an increasing voltage drop occurs across resistors R13 and R14, so driving the base of TR2 more positive than its emitter, and the base of TR4 more negative.

These transistors now start to turn on, so shunting the bases of TR1 and TR3, having the effect of turning them off in extreme cases. The current drawn by TR2 and TR4 is restricted to a safe maximum limit by resistors R12 and R10 in series with the outputs of the op.amps. The resistors also serve to prevent the op.amp outputs being sunk almost to ground in the event of a complete short circuit.

The power supply will stand a total short circuit at its outputs, with no damage being caused to them, or to the transformer or rectifier.

It should be noted that resistors R10 and R11 across the output and feedback connections of the op.amps should be matched to at least one per cent to maintain sensible tracking between the two outputs. It may well be worth measuring several samples with a multimeter to get identically matching values.

A wirewound potentiometer is recommended for VR1 since the resolution is likely to be better in this application.

CONSTRUCTION

Since this unit is mains powered, great care should be exercised in its construction. If in any doubt about constructing it, consult a qualified electrician. Mains voltages can be lethal if abused.

Details of the printed circuit board component positions and track layout are shown in Fig.2. This board is available from the *EPE PCB Service*, code 242.

It is a wise precaution to use sockets for the op.amps as they would otherwise be very difficult to remove without damaging the p.c.b., should this become necessary.

Although not used in the prototype, a 0V to 20V moving coil meter could be wired across the outputs, with a changeover switch to select which output is monitored. However, these are quite expensive and the prototype used a calibrated scale drawn around the knob for potentiometer VR1. If done with care, this method can have a very neat appearance, and is probably accurate enough for most purposes. Otherwise, the output may be monitored with a multimeter.

A metal case should be used to house the power supply, and this should be connected to the mains supply earth via the power cable. The mains fuse can be of the cartridge type mounted on the back panel. A cable clamp must be used for the mains input cable.

For the prototype, 4mm single sockets were used as the d.c. power output connectors. Other types of socket may be used to suit individual requirements.

TESTING

Once the p.c.b. has been assembled, fully check for any mistakes, and for the good quality of the soldering. On the prototype, the mains transformer was pop-riveted close to the edge of the long side of the case, and the p.c.b. was secured to the base with self-adhesive p.c.b. supports. However, it is best not to fully fix the p.c.b. until testing is complete.

A piece of insulating plastic sheet should be cut to just under the size of the p.c.b. and placed between it and the case floor. These sheets are readily obtainable from model shops.

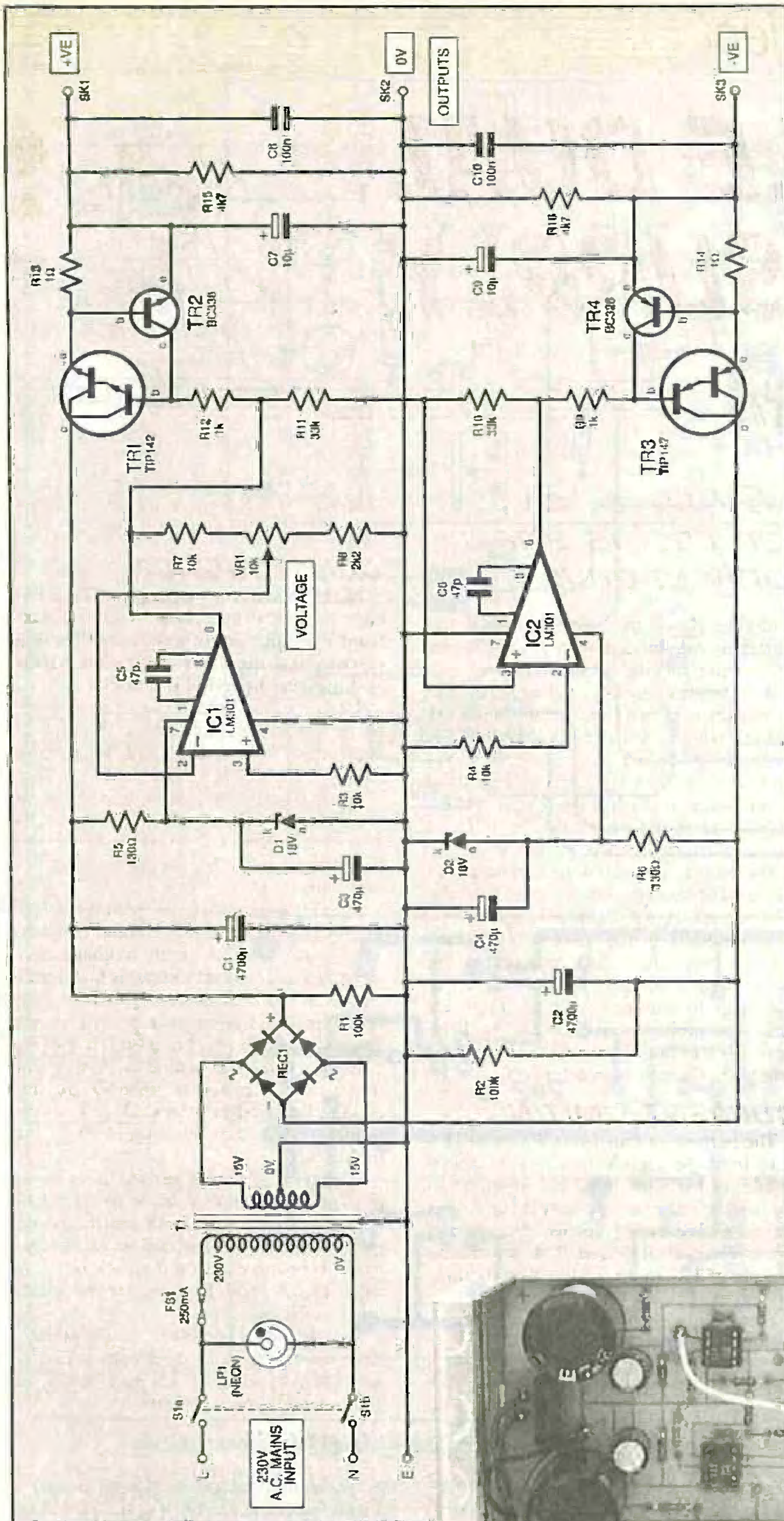


Fig.1. Complete circuit diagram for the Variable Dual Power Supply.

When all the connections to the board from the control panel have been completed and checked, and the mains cable fitted, the unit is ready for testing. Connect a voltmeter, set to a range of about 20V d.c., across the positive output and 0V, and switch on the power supply.

COMPONENTS

See SHOP TALK page

Resistors

R1, R2	100k (2 off)
R3, R4, R7	10k (3 off)
R5, R6	130Ω (2 off)
R8	2k2
R9, R12	1k (2 off)
R10, R11	33k 1% (see text) (2 off)
R13, R14	1Ω 0·6W (2 off)
R15, R16	4k7 (2 off)

All 0.25W 5% carbon film unless stated.

Potentiometer

VR1	10k wirewound

Capacitors

C1, C2	4700μ radial elect. 35V (2 off)
C3, C4	470μ radial elect. 25V (2 off)
C5, C6	47p ceramic (2 off)
C7, C9	10μ radial elect. 25V (2 off)
C8, C10	100n ceramic (2 off)

Semiconductors

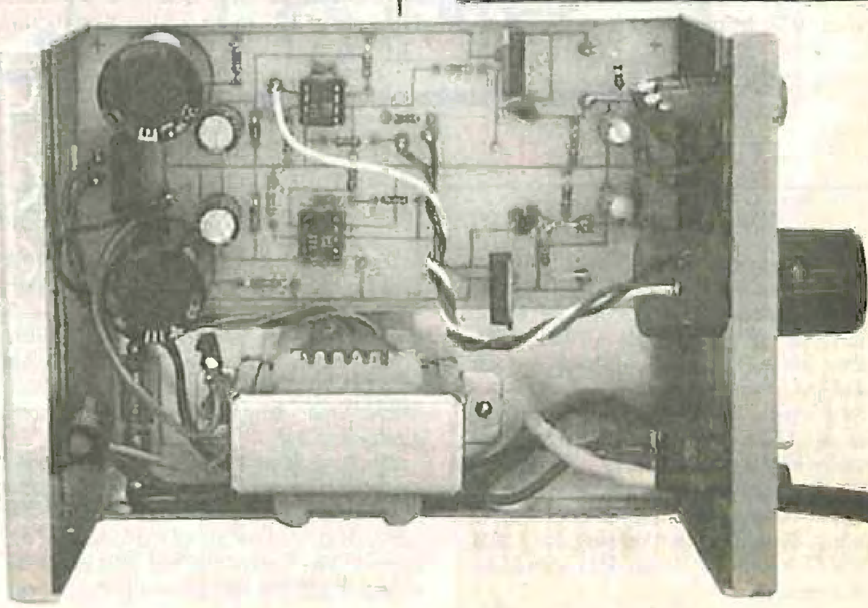
TR1	TIP142 *npn* Darlington transistor
TR2	BC338 *npn* transistor
TR3	TIP147 *pnp* Darlington transistor
TR4	BC328 *pnp* transistor
IC1, IC2	LM301 op.amp (2 off)

Miscellaneous

FS1	250mA fuse, anti-surge, 20mm
LP1	mains rated neon lamp, panel mounting
REC1	bridge rectifier, 50V 1A (in-line pins)
S1	s.p.s.t. mains rated toggle switch
SK1 to SK3	4mm single socket (see text) (3 off)
T1	mains transformer, 15V-0-15V sec, 500mA

Printed circuit board, available from the *EPE PCB Service*, code 242; metal case, size to suit; cable clamp; 20mm panel mounting fuseholder; knob; printed circuit board supports, self-adhesive (4 off); plastic insulating sheet (see text); connecting wire; solder, etc.

Approx. Cost Guidance Only* £31 *excluding case



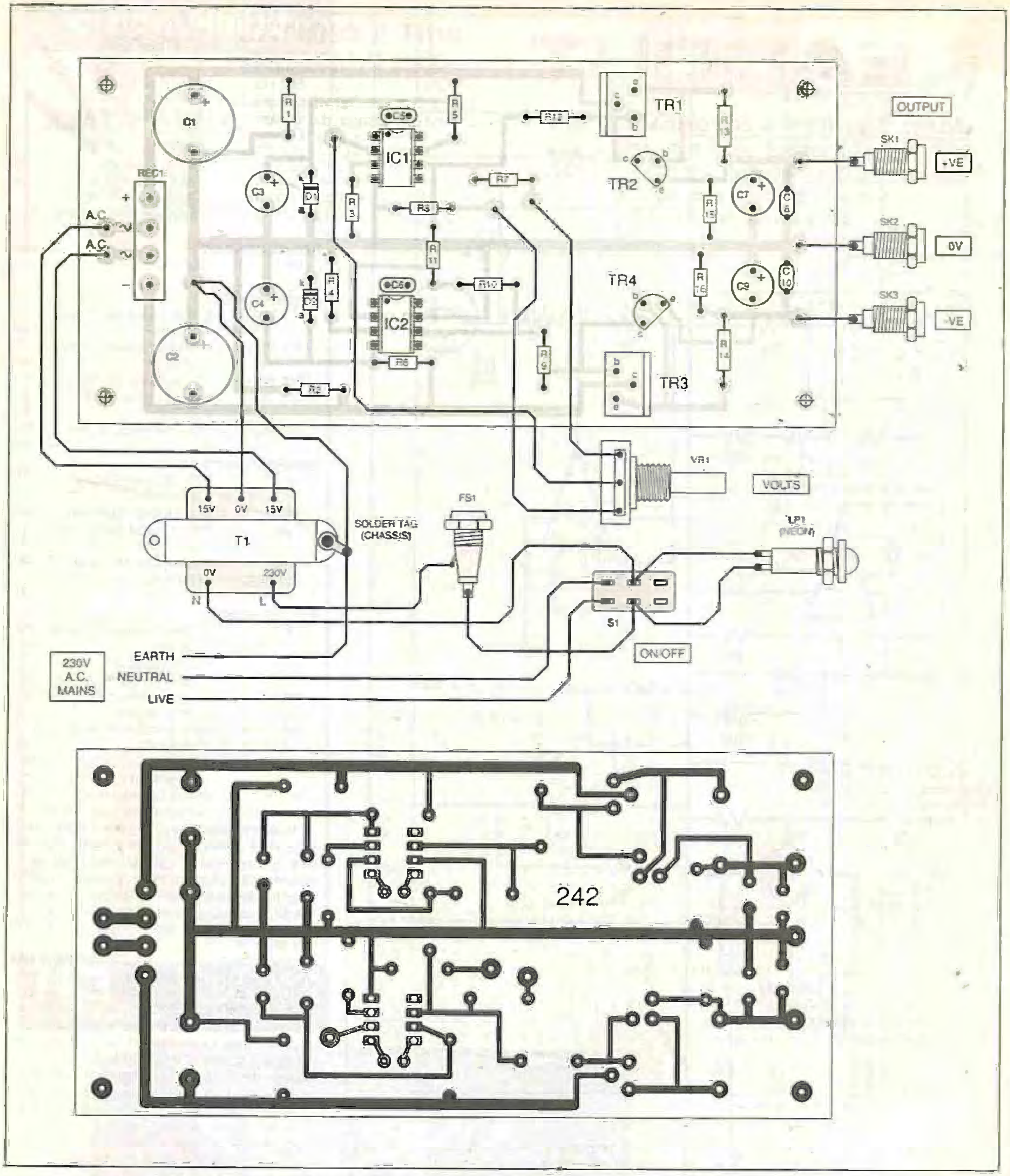


Fig.2. Component layout and full size copper foil master track pattern, plus off-board connection details.

The minimum setting (fully counter-clockwise) of potentiometer VR1 should result in reading of about 3V (2.8V in the prototype). If about 15V is indicated, reverse the outer connecting leads at each end of the potentiometer track.

Now check the negative voltage output. This should (inversely) match the positive output within a few millivolts. Component tolerances will inevitably have some effect here, but the outputs should track together sensibly. Should this not happen, the actual values of resistors R10 and R11 should be re-examined.

If all is well, and assuming that a built-in panel meter is not being used, the Voltage scale for VR1 may now be marked. Use as large a knob as possible with a pointer printed on, so that an easily readable scale may be drawn. Set the control at minimum rotation and, using a water-based pen, mark a reference dot.

Using your multimeter across the positive output, notate this voltage at the minimum scale setting. Do similarly at 1V intervals around the arc of movement of the control. The maximum end will get a bit cramped and for this reason perhaps only the "standard" voltages need to be annotated with figures, at 5V, 6V, 9V, 12V and 15V positions.

A spirit-based pen can now be used to draw small freehand lines to indicate all points at 1V intervals. Next remove the knob and the potentiometer, and gently rub the water-based dots away with a moist cloth.

Now apply rub-down figures, burnish and lacquer. The control potentiometer can then be refitted, setting the knob to the start mark, with the control fully counter-clockwise. The power supply is now ready for use. □