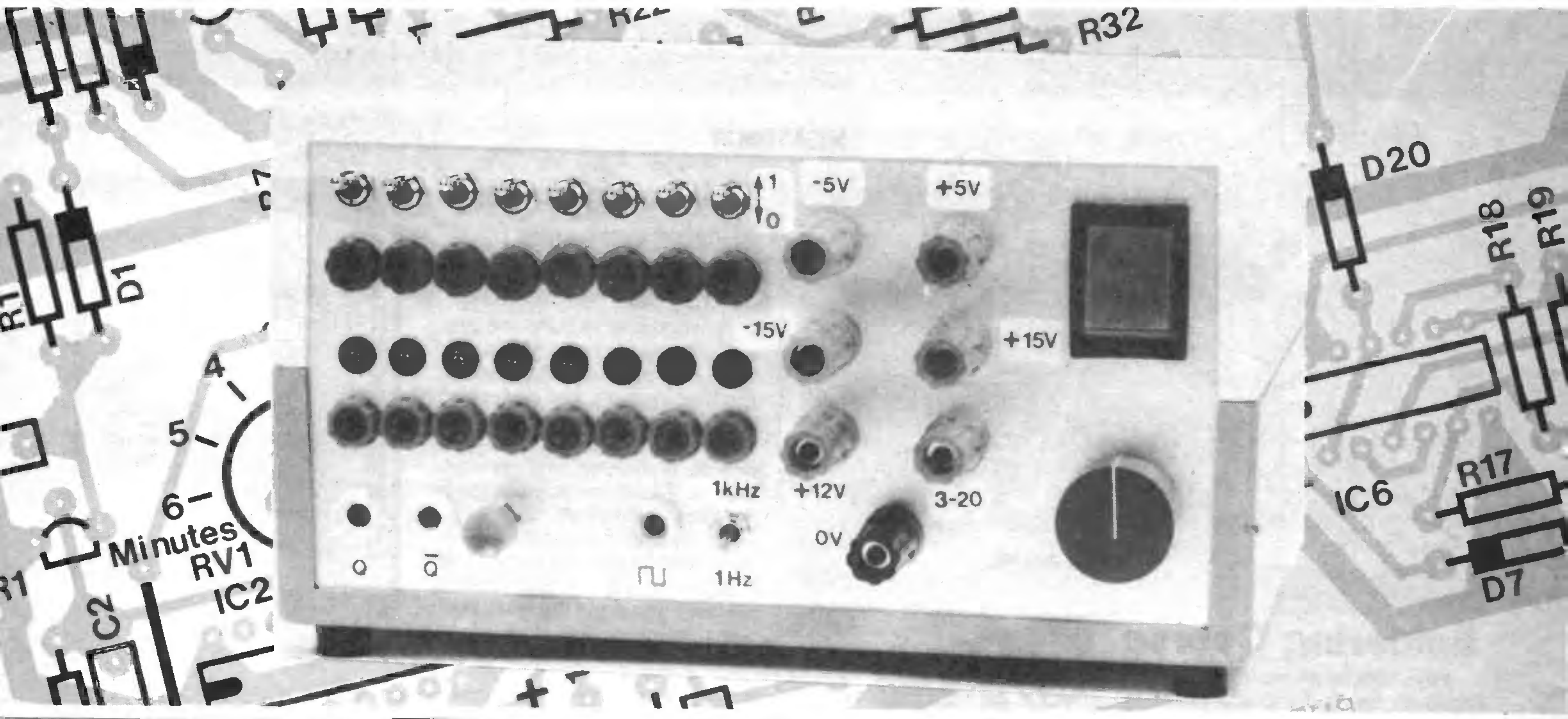


The Maplin MINILAB

by Graham Dixey C.Eng., M.I.E.R.E.

Introduction

The idea for 'Minilab' developed from the need, or desire, to test and experiment with a wide range of digital and linear circuits. This usually necessitates a variety of different supply voltages. For example, when experimenting with op-amps, a dual 15V supply is needed; TTL digital circuits require a +5V supply and some other digital circuits need +12V and -5V e.g. microprocessors and related chips. An infinite variety of linear circuits exist that need unspecified voltages, but usually they are in the range 0 to +20V. The fixed voltages mentioned need to be held within close limits while the same is true of the variable supply once it has been set to a given value; in other words, regulated supplies are essential.

Before the advent of 'chip regulators' such a design to meet all of the foregoing requirements simultaneously would have been rather complex. The general availability of chip regulators that cover a wide range of voltages and current ratings e.g. 7805 (+5V, 1A) or 79L05 (-5V, 100mA) make design and construction simple — there are few external components. The L200 variable voltage regulator is a boon since a very simple variable voltage stabilised supply with current limit facility can now be built at very low cost. In this design the variable voltage supply can deliver a nominal +3 to +20V at 0.45A, though you may well get up to 24V out, and if you want more current, the regulator can give you up to 2A; however, you will have to reduce R4 to about 0.25 ohms and this will also assume that the other outputs are not loaded at the same time, since the

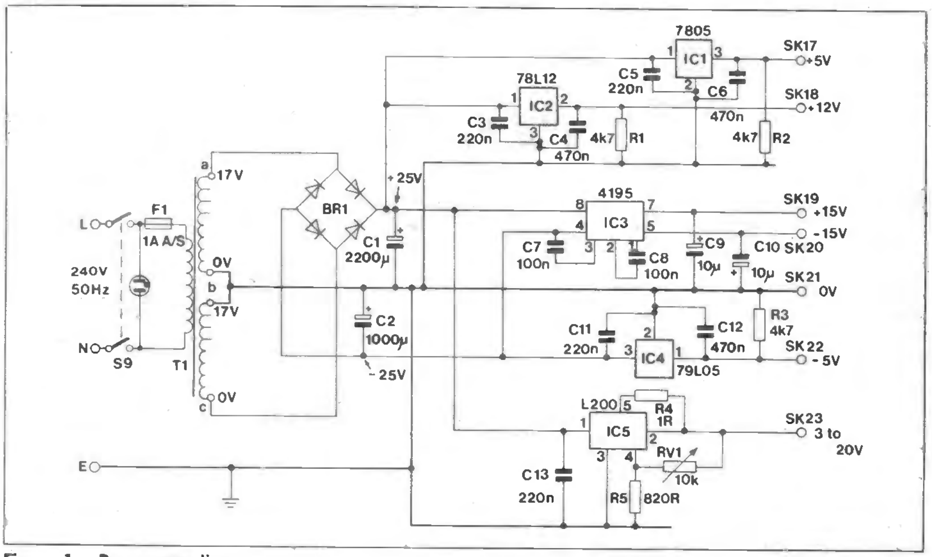


Figure 1. Power supplies.

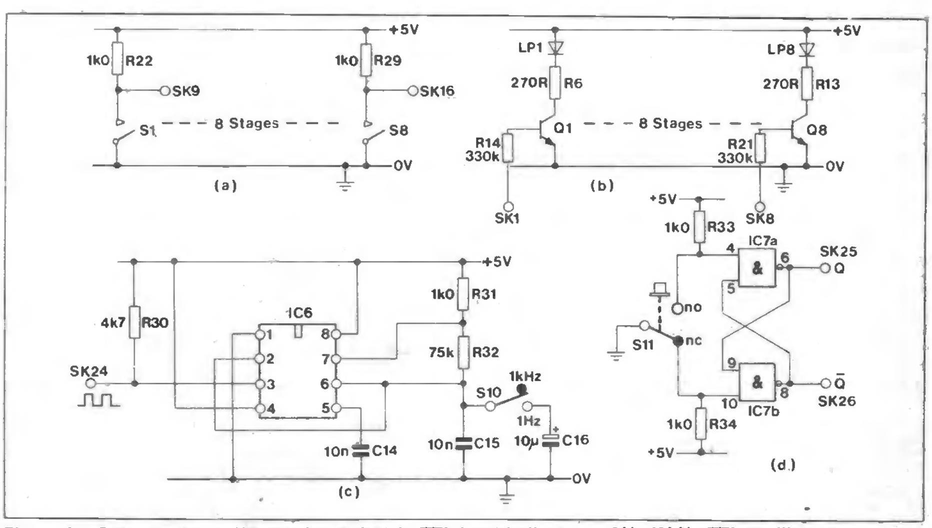


Figure 2. TTL circuits a. TTL level switches b. TTL level indicator c. 1Hz/1kHz TTL oscillator d. de-bounced TTL switch.

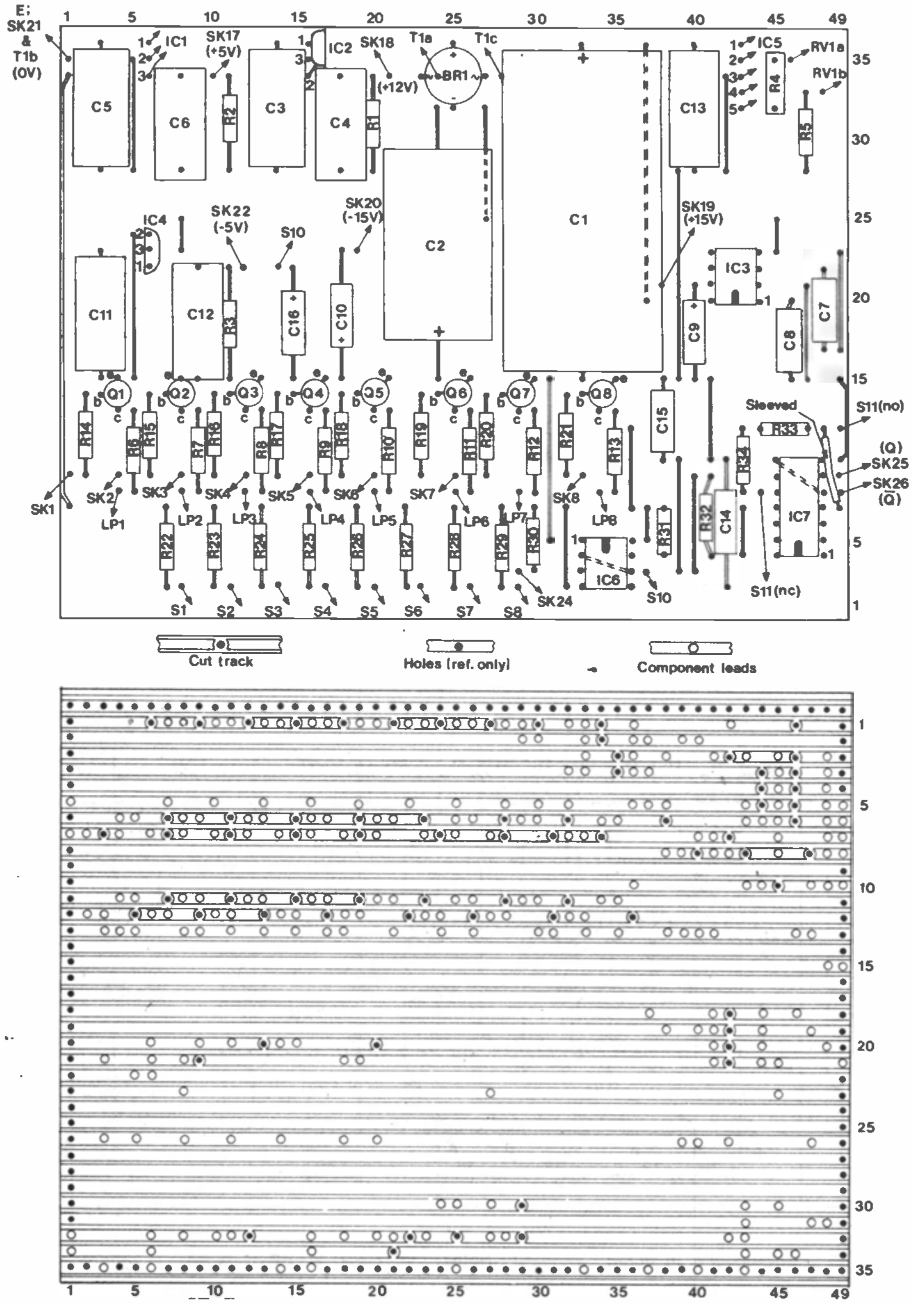
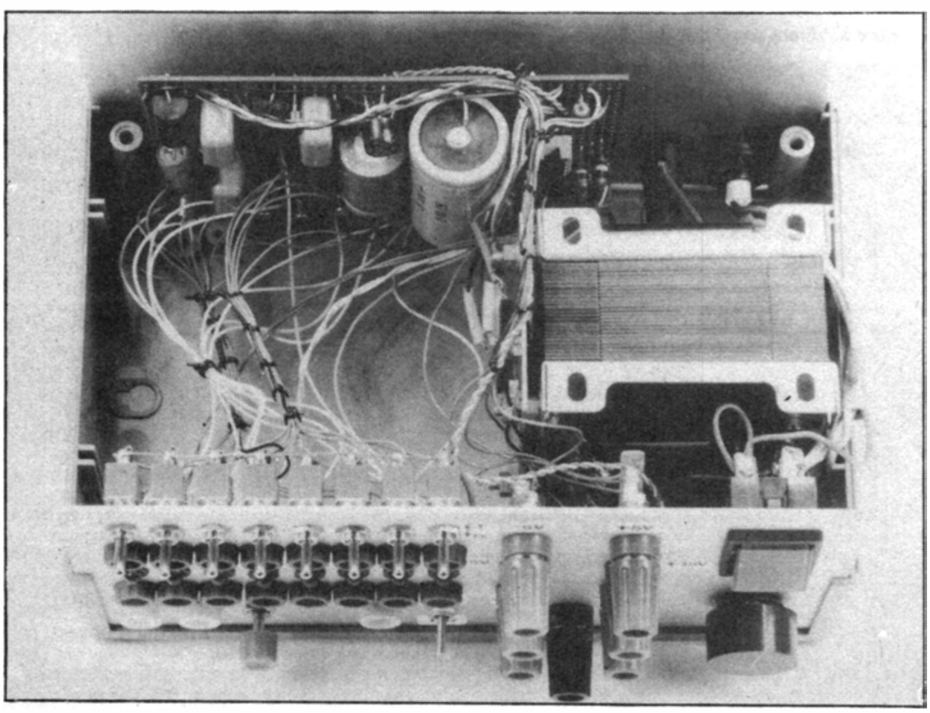


Figure 3. Circuit board details.



limiting factor is the transformer and rectifier, both of which have a rating of 2A.

While a multichannel power supply is useful in its own right, I thought it a good idea to incorporate a few extra, useful but simply provided facilities at the same time.

As a start, there is a set of switches and related sockets that allow the setting-up of eight independent logic levels as inputs to any circuit or system e.g. as variables A, B, C . . . X, Y, Z to a logic gate circuit; or as an 8-bit input to the input/output port of a micro-computer.

Along similar lines is the set of LEDs and associated sockets that will monitor logic levels, whether in a TTL gate circuit, at the outputs of a counter or shift register, or at a microcomputer's input/output port.

In order to study counter or shift register operation a TTL clock input is required. A 1Hz/1kHz square-wave generator provides this facility but there is also a 'debounced' switch so that the operation of such circuits can be observed 'pulse at a time'.

All of the above facilities are shown on the circuits of Figures 1 and 2.

Construction and Testing

As good a starting point as any is the circuit board, which is 0.1" pitch Veroboard, the actual matrix being 49 holes by 36 holes. Use the lower diagram of Figure 3 to identify the 'cut holes' and deal with these first. Then, returning to the face of the board, identify the position of all wire links; fit these (use 22 s.w.g. or 24 s.w.g. T.C.W.), not forgetting those short links beneath the sockets of IC6 and IC7; also noting the sleeved link adjacent to IC7. After this the component order is not too important; a suggested one is: IC sockets, resistors, capacitors, bridge rectifier, transistors and, for the moment, nothing else. Stop now and check that what you have done is correct. What you do next depends upon your level of self-confidence. If you wish to proceed with caution you could, for example, follow the following plan.

First, wire the two transformer secondaries in series (link shown as T1b in Figure 1). Then connect the other two secondary connections (T1a and T1c) to the bridge rectifier (Figure 3) and fit a temporary mains lead and plug. Observing due precautions with regard to personal safety, plug in and check with a DC voltmeter that you have 25V across each of the reservoir capacitors C1 and C2, noting the polarities of these voltages. If these measure correctly then at least the transformer, rectifier and smoothing circuit is alright. Now disconnect from the mains and hook up the connections to IC1 (the heatsink doesn't matter at the moment). Plug in again and check that you have +5V where you should have on the board. Repeat this procedure for IC2-IC5 in turn until you have all the supplies working; for IC5 you will have to hook up temporary connections to the 10k pot. If all is well you can test the transistor switches Q1 to Q8 by temporarily fitting an LED from each of R6-13 to +5V in turn and each time, using an insulated wire link, touching +5V onto the socket side of each of the base resistors to check whether the LED lights or not.

Concerning the hardware, a standard Verobox is suggested in which there is ample room for the transformer, heatsink and circuit board. The transformer is mounted at the extreme right hand end of the box, long axis vertical and with the mains tappings adjacent to the mains switch. The heatsink (Figure 4) is mounted vertically on the free end of the transformer with four screws, nuts and washers. The heatsink must be spaced off from the transformer frame to prevent the screws which mount IC1 and IC5 from touching the transformer laminations; this is easily done with a small tubular spacer or simply an extra nut behind the heatsink. These two ICs must be mounted on the heatsink by means of a TO220 mounting kit for each (mica washer and plastic bush) to insulate them from each other and from the heatsink itself (N.B. these mounting kits are termed 'TO66 plastic' in the Maplin catalogue and the appropriate part number is given in the parts list). The circuit board can be mounted at the rear of the box using a small angle bracket at each end. The redundant holes in ROW 1 can be opened up where required and there should be no risk of short circuits to any components on ROW 2 if the brackets are fitted right at the ends of the board. If the components face forward the board can sit quite close to the back panel and wiring from the board to the front panel can be carried out without any undue difficulty. Naturally these wires (all identified in Figure 3) are connected to the circuit board before it is mounted in place; estimate a little more for the length of

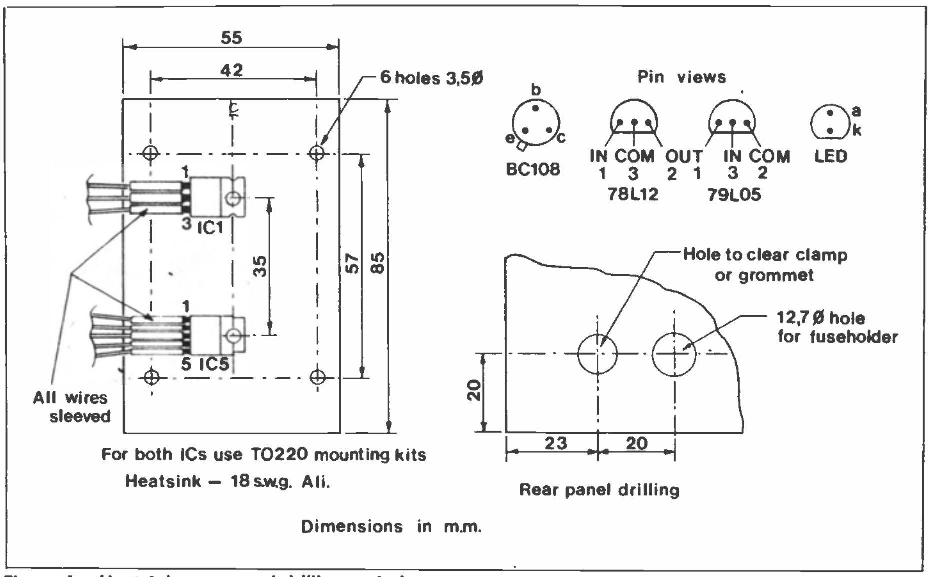


Figure 4. Heatsink, rear panel drilling and pin-outs.

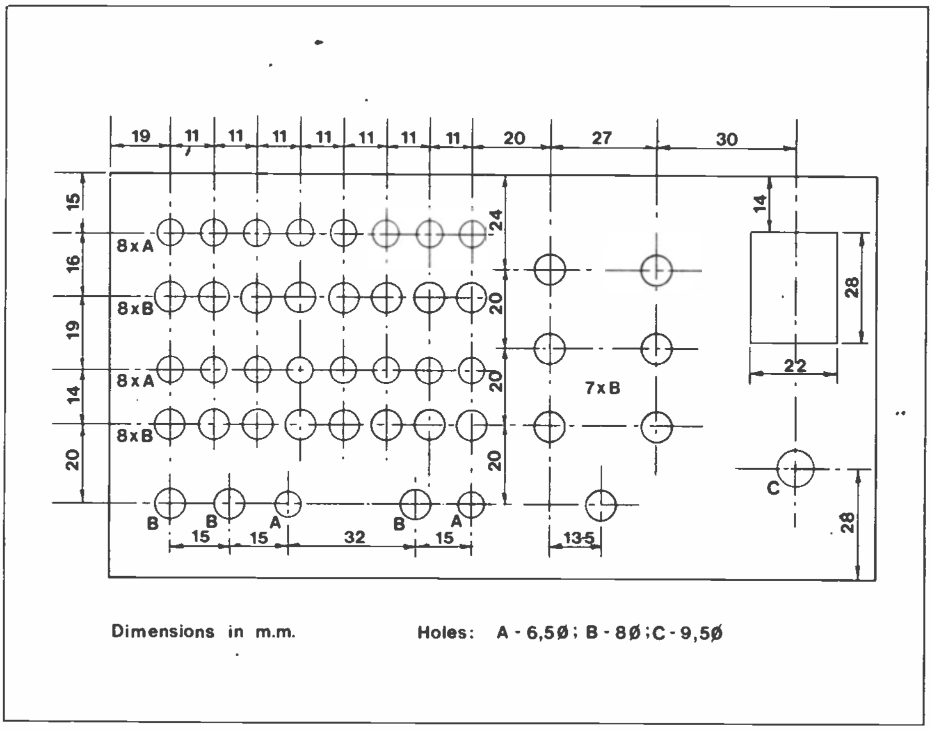


Figure 5. Front panel drilling.

PARTS LIST FOR MINILAB

Resistors — All ½W 5% carbon unless specified

R1,2,3,30	4k7	4 off	(S4K7)
R4 (3W wirewound)	1R		(W1R)
R5	820R		(S820R)
R6-13	270R	8 off	(S270R)
R14-21	330k	8 off	(S330K)
R22-29,31,33,34	1k0	11 off	(S1K)
R32 (metal film 0.4W)	75k		(M75K)
RV1	10k linear pot.		(FW02C)

Capacitors

C1	2200uF 40V elect.		(FB91Y)
C2	1000uF 25V elect.		(FB83E)
C3,5,11,13	220nF polyester	4 off	(BX78K)
C4,6,12	470nF polyester	3 off	(BX80B)
C7,8	100nF polyester	2 off	(BX76H)
C9,10,16	10uF 25V elect.	3 off	(FB22Y)
C14,15	10nF polyester	2 off	(BX70M)

Semiconductors

Q1-Q8	BC108	8 off	(QB32K)
IC1	7805		(QL31J)
IC2	78L12		(WQ77J)
IC3	4195		(XX02C)
IC4	79L05		(WQ85J)
IC5	L200		(YY74R)
IC6	555		(QH66W)
IC7	7400		(QX37S)
BR1	W01		(QL38R)
LP1-8	LED	8 off	(WL27E)
—	Clip for above	8 off	(YY40T)

Miscellaneous

T1	Transformer 0-17V; 0-17V @ 2A		(WB22Y)
—	Case (Verobox)		(LL07H)
S1-8,10	Sub. min. toggle switch	9 off	(FH00A)
S9	Mains switch DPST (with neon)		(YR70M)
S11	Min. push-button switch SPDT		(BK68Y)
	10mm cap green		(BK71N)
SK1-8	4mm socket — green	8 off	(HF72P)
SK9-16	4 mm socket — brown	8 off	(HF71N)
SK17,18,19,23	4mm terminal — red	4 off	(HF07H)
SK20,22	4mm terminal — blue	2 off	(HF03D)
SK21	4mm terminal — black		(HF02C)
SK24	4mm socket — yellow		(HF75S)
SK25,26	4mm socket — white	2 off	(HF74R)
	DIL socket 8-pin	2 off	(BL17T)
	DIL socket 14-pin		(BL18U)
	Mounting kit TO220	2 off	(WR23A)
F1	Fuseholder 20mm		(RX96E)
	1A antisurge fuse		(WR19V)
	Veroboard 10347		(FL09K)

A complete kit of all parts, excluding the case, is available for this project.
Order As LK09K (Minilab kit). Price £32.50.

each wire than is actually needed. As a tip to make life that bit easier, the two wires to the pot. are best wired to the pot. first and then to the circuit board, since the pot. tends to be obscured by the transformer once the front panel has been dropped into place.

There is little comment to make on the front panel wiring except to point out the bus-bars used to common the anodes of the LEDs (and taken to the +5V terminal SK17) and a similar bus-bar on switches S1-S8, which is taken to the 0V terminal SK21. Figure 6 shows all of these details and identifies the position of all front panel components. The front panel drilling details appear on Figure 5.

The rear panel has only two holes (details in Figure 4), which are for the mains cable clamp or grommet and the fuseholder. This is best drilled and put aside until all else is finished. This simply means wiring from the circuit board to the front panel, dropping the rear panel into place, completing the mains wiring via fuse F1 and testing the complete 'Minilab' to see that the following facilities exist:

+5V @ 1A	Eight TTL outputs
±5V @ 100mA	Eight TTL inputs
+12V @ 100mA	1Hz/1kHz TTL oscillator
+15V @ 50mA	One bounce-free, TTL pair of complementary outputs (Q and $\bar{Q}$)
+3V to +20V @ 450mA	

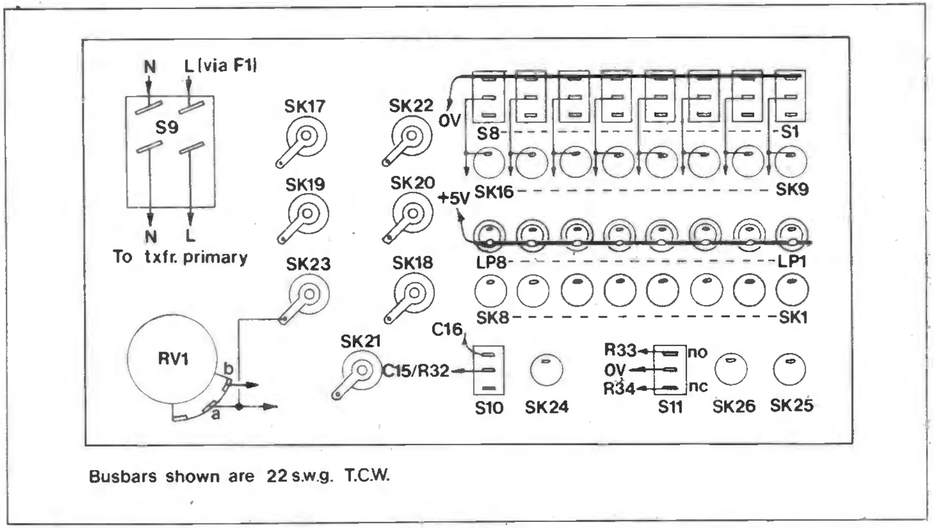


Figure 6. Front panel rear view — component identification.