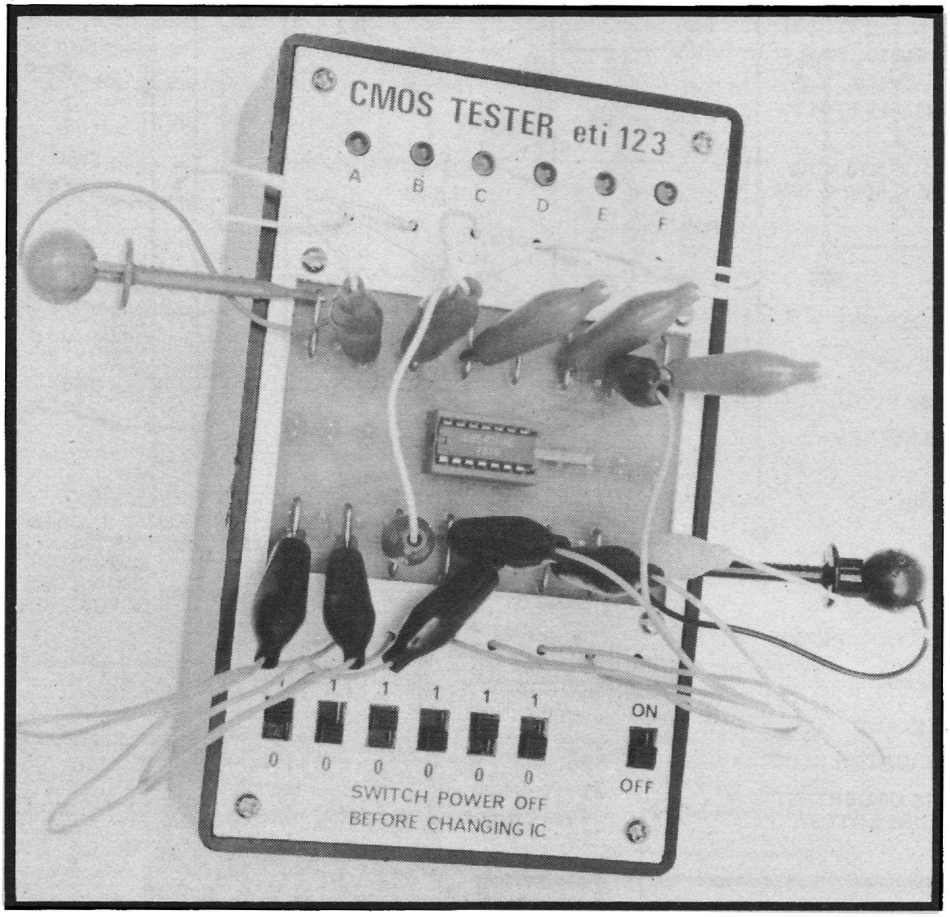
SIMPLE CMOS TESTER

An inexpensive unit for the hobbyist.



eti PROJECT 123

NOW THAT the use of CMOS logic is becoming widespread there is an obvious need for a simple CMOS tester suitable for the hobbyist. In last month's issue we described a sophisticated tester for both CMOS and TTL. That particular instrument is very versatile but may be too expensive for many budding experimenters and we have therefore designed this simpler instrument to cater for their needs.

A simple CMOS tester, although being inexpensive, must be capable of performing the majority of tests required for CMOS logic without causing any damage to the ICs under test or being damaged itself. It must also use only those components which are readily available to the average home constructor. The ETI 123 Tester fulfills all these requirements.

The tester circuitry draws very little current except for that drawn by the LEDs. Even the LEDs only draw current whilst a device is actually under test. For this reason we thought that the expense of a mains power supply was unwarranted and chose to use batteries instead. For those who would rather operate the unit from a mains derived supply, one capable of supplying anywhere between 5 and 12 volts at up to 40 milliamps will be suitable. Another major expense, that of providing a large number of programming switches to set up the test conditions, has been alleviated by using flying leads fitted with alligator clips to connect to the IC under test.

Several steps have been taken to prevent damage to the IC by the tester and conversely, damage to the tester by the IC. Firstly each pin of the test socket is fitted with a static discharge resistor to earth. A current limiting resistor, R 37, is in series with the supply so that the tester is protected against damage due to possible excessive current into an internal short in the test IC. This limiting resistor also ensures that current through the input-protection diodes on the IC does not exceed the specified limit of 10 mA.

Only readily available components are used in the tester and, in fact the ICs used are available from at least four different manufacturers.

To test simple gate functions, eg NAND gates, NOR gates, we need at least four switches and a logic level detector but for the more complex functions, eg multipliers, we need at least six switches and six level detectors. A clock – pulse generator is required for the testing of flip flop and other clocked devices. This pulse generator must be free of the contact bounce that is typically encountered with mechanical switches. For this reason we used a pair of CMOS NAND gates wired as an astable multivibrator to generate a continuous train of pulses. This may be used to increment counters and to shift data in shift registers. As it is a CMOS circuit it is perfectly suited to driving other CMOS devices.

CONSTRUCTION

We recommend that the printed-circuit boards as specified be used as construction is thereby greatly simplified. The printed-circuit boards should be assembled as detailed in the component overlay diagrams. Switches SW1 to SW7 should be mounted by first glueing two strips of printed-circuit board to the front panel (copper side out). The switches may then be soldered to the copper side of the board. This procedure avoids the necessity of having 14 screw heads visible on the front panel.

The test socket is mounted on the non-copper side of board 123b. This board also carries links Lk1 to Lk16 which connect directly to the pins of the test socket. These links are also mounted on the non-copper side of the board and should be of reasonably heavy gauge tinned-copper wire, and should be installed such that sufficient room is under the link to enable test leads to be attached to them by means of alligator clips or Eazy hooks. Resistors R1 to R16 are mounted on the *copper* side of this board so that they are not visible when the board is bolted to the front panel. The top two screws, nearest to the LEDs, should be 18 to 25 mm long so that board 123a may also be mounted on them later.

On board 123a, mount and solder in position on the component side of the

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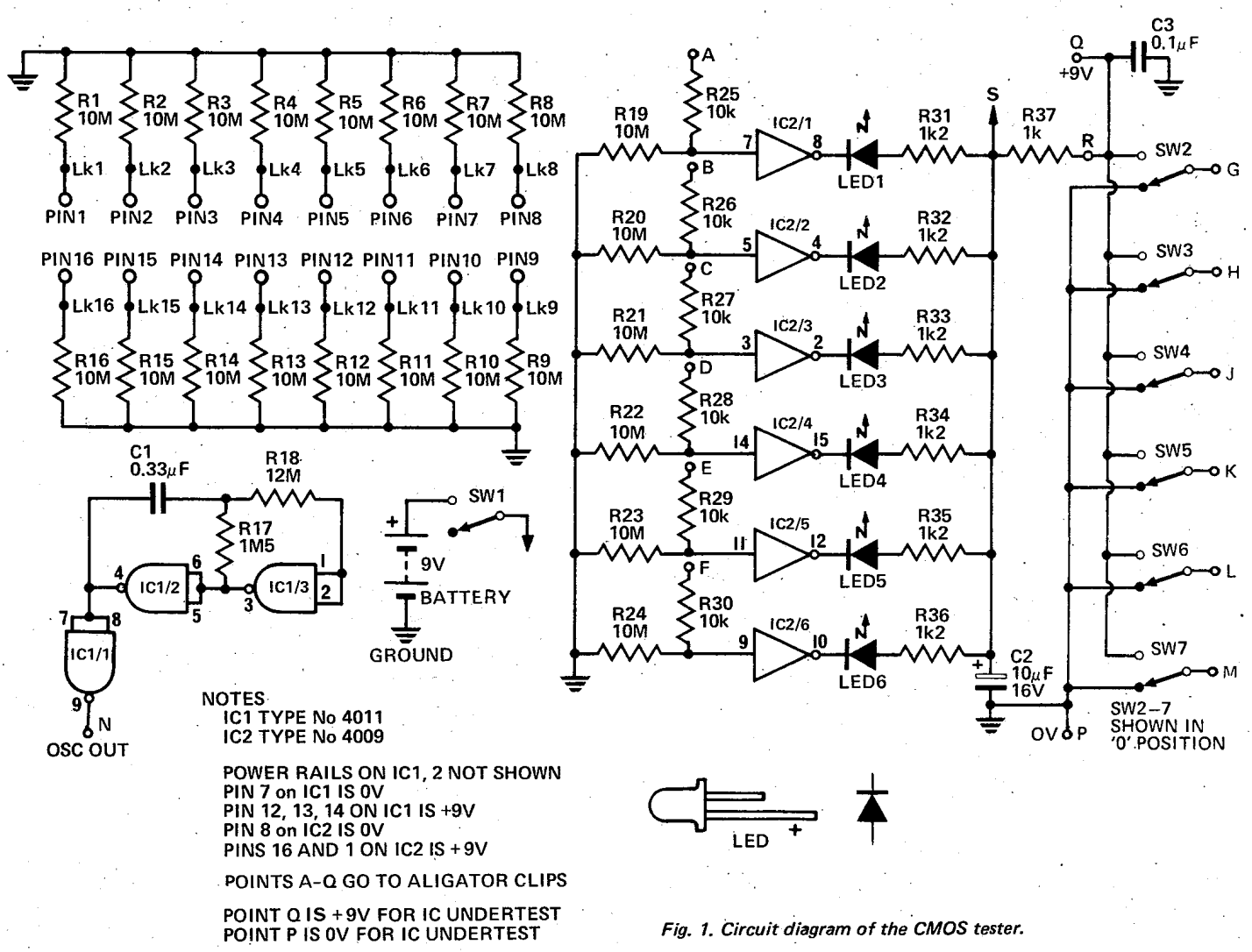

NOTES
IC1 TYPE No 4011
IC2 TYPE No 4009

POWER RAILS ON IC1, 2 NOT SHOWN
PIN 7 on IC1 IS 0V
PIN 12, 13, 14 ON IC1 IS +9V
PIN 8 on IC2 IS 0V
PINS 16 AND 1 ON IC2 IS +9V

POINTS A-Q GO TO ALIGATOR CLIPS

POINT Q IS +9V FOR IC UNDERTEST
POINT P IS 0V FOR IC UNDERTEST

Fig. 1. Circuit diagram of the CMOS tester.

HOW IT WORKS – ETI 123

The ETI 123 CMOS tester can be described in three separate sections. Firstly there is the test socket for the device under test. The test socket is mounted on a printed circuit board which also holds a 10 megohm static-discharge resistor to protect each pin of the IC. Each IC pin is also connected to a surface mounted link by which connections can be made to the IC.

The next major section of the tester contains detectors which monitor the voltage at each pin of the IC. Each detector consists of a CMOS inverter which derives an LED indicator. When the voltage at the input of the inverter is greater than half the supply voltage the LED will be alight. Conversely the LED will be off when the voltage at the input to the inverter is below half supply voltage. Resistors R19 to R30 protect IC2 against static charges and from the condition where a detector has no input. Resistors R31 to R36 set the operating currents for the LEDS.

The final section contains switches SW2 to SW7 and a clock oscillator. The output of the switches can be either 0 volts or +9 volts that is, a logic '0' or a logic '1'. These outputs are made available at test leads which may be connected to the IC under test as required. To protect the tester against internal shorts on the IC under test, and incorrect connections, R37 has been inserted in series with the supply rail to limit the current that may be drawn to a level which cannot cause any damage.

IC 1/2 and IC 2/3 are wired as an astable multivibrator where the frequency of oscillation is determined by the time constant of C1 and R17, whilst R18 is used to protect the input of IC 1/3 from any voltage excursions past the supply rails. IC 1/1 is used as an inverting buffer and the output of the circuit is made available at the front panel by means of a lead and alligator clip.

PARTS LIST — ETI 123

R37	Resistor	1k	¼ Watt	5%
R31-36	"	1.2k	"	"
R25-30	"	10k	"	"
R17	"	1.5M	"	"
R1-16	"	10M	"	"
R19-24	"	10M	"	"
R18	"	12M	"	"

C3 Capacitor 0.1µF polyester
C1 " 0.33µF "
C2 " 10µF 16 electrolytic
IC1 Integrated Circuit 4011 (CMOS)
IC2 " " 4009 (CMOS)
LED 1-6 Light Emitting Diode RL 4484 or similar
SW1-7 Miniature slider switch 2 pole 2 position.
IC Socket 16 pin DIL (preferably with IC removing slide)
Case 160 x 90 x 50 mm plastic box with aluminium front panel UBI
Alligator clips (15)
Battery 9 volts (6 size AA cells)

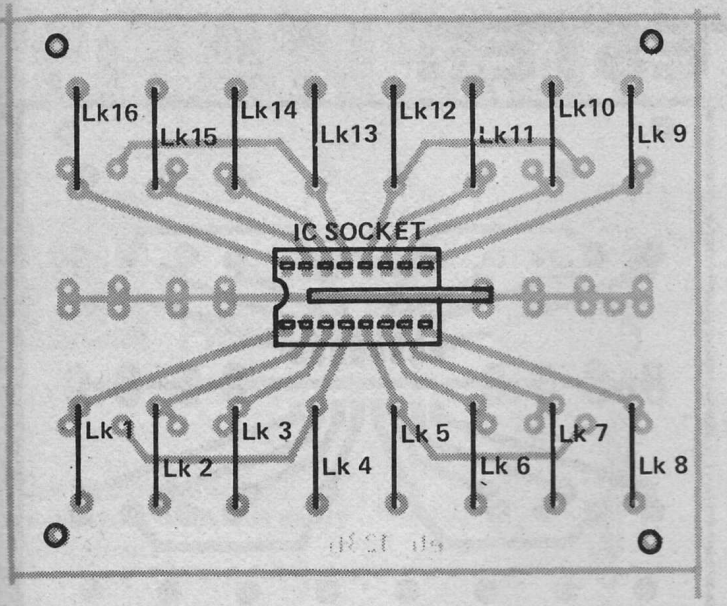

Fig. 2. Component overlay for the test-socket board ETI-123b, non-copper side.

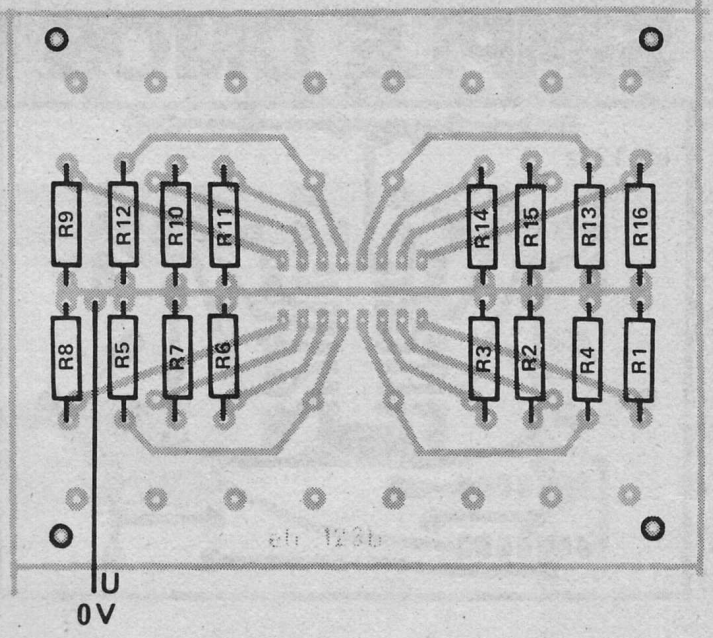

Fig. 3. Component overlay for the copper side of board ETI-123b.

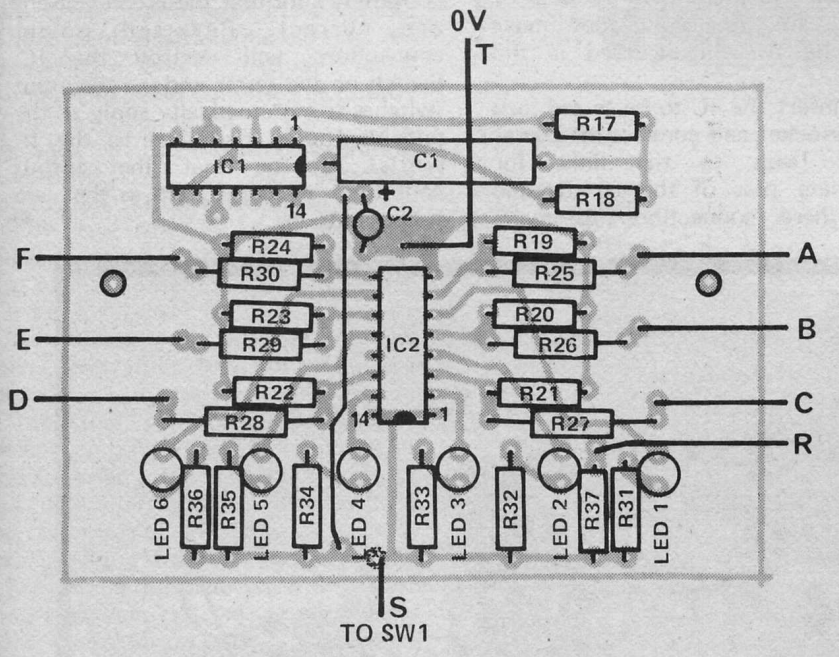

Fig. 4. Component overlay for board ETI-123a. Note that C1 may need to be mounted on reverse side, and that the LEDs should be mounted as detailed in the text.

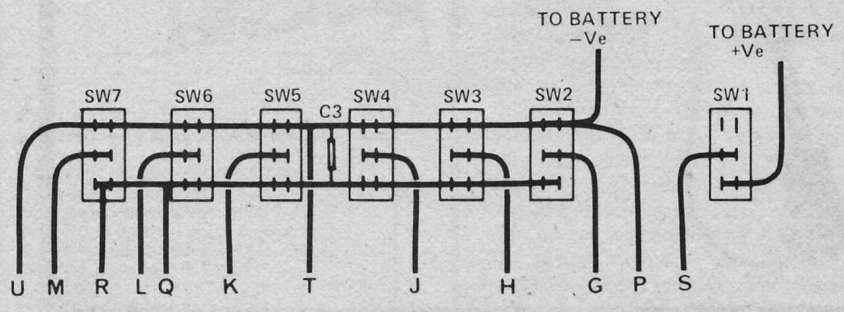

Fig. 5. Switch interconnection diagram. Note that C3 is mounted across one of the switches.

board, all components with the exception of the LEDs and capacitor C1. As C1 needs to be a polyester type it may be physically too big to be mounted on the component side without fouling the front panel and should therefore be mounted on the copper side. The LEDs should be inserted in their positions but not yet soldered. Temporarily mount the board in position such that the LEDs protrude through their correct holes in the front panel. Keeping the front panel face down, solder the LEDs into the board. Remove the board and solder 150 mm lengths of hookup wire to the points marked A to F on the overlay and pass these leads through the corresponding holes in the front panel. Do the same for the leads G, H. J. K L M P and Q from switches SW2 to SW7 using a different coloured wire to that used previously. These wires should also be passed through the appropriate holes in the front panel.

Finally solder alligator clips or Eazy hooks to the ends of all these leads and connect supply and earth leads to the 123b board. Check both boards for wiring errors or errors in component insertion before bolting board 123a in position. The battery may then be connected and the unit is ready for use.

Note that if the type UB1 box is used as in our protype the top corners of the 123a board may have to have the corners trimmed off at 45 degrees so that the board will fit in the box

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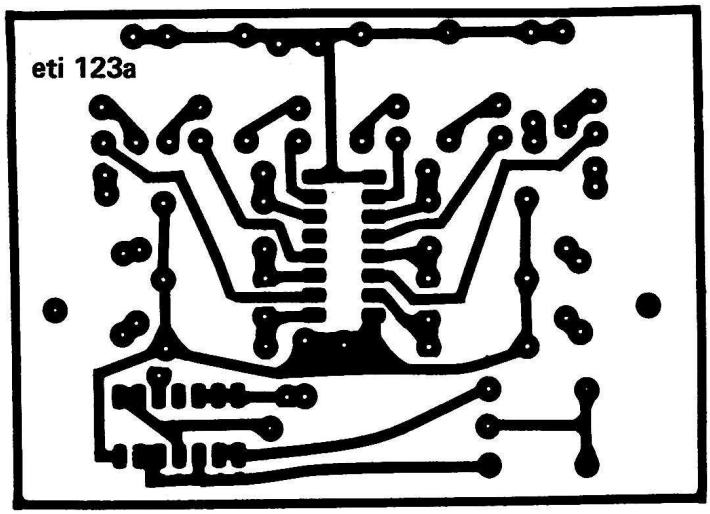


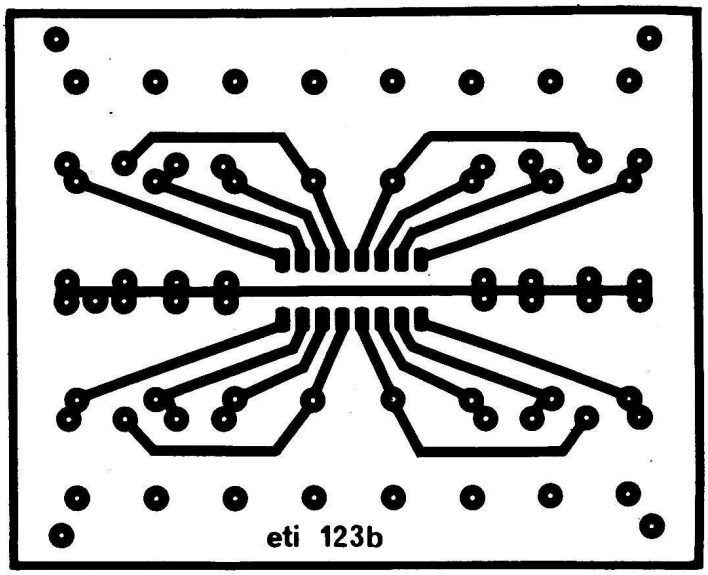


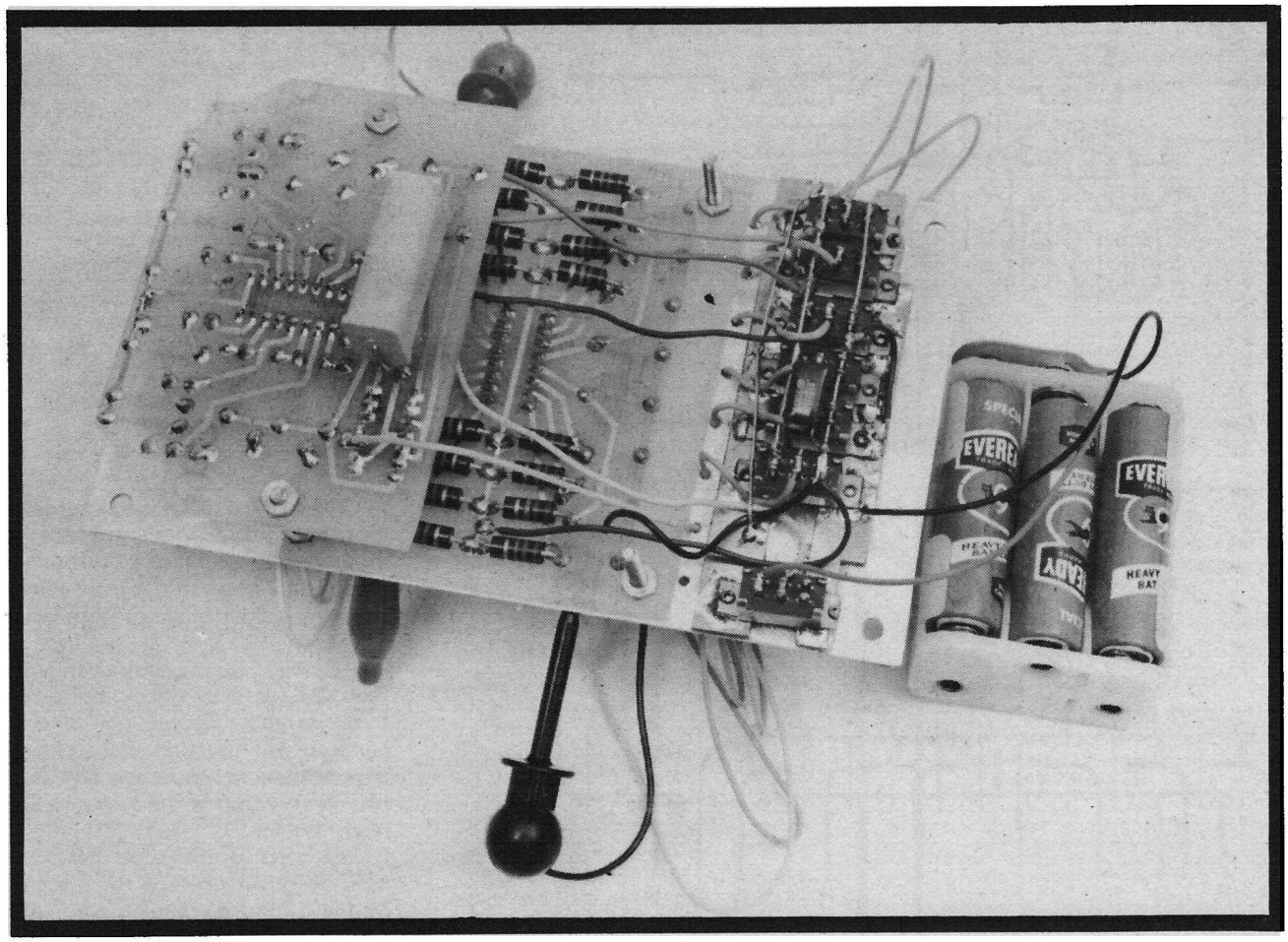
Fig. 6. Printed-circuit board layout – ETI 123a. Full size 88 x 63 mm. *Fig. 7. Printed-circuit board layout – ETI 123b. Full size 88 x 71 mm.*

without fouling the mounting pillars for the front panel.

OPERATION

Before testing or inserting any IC make sure that the power is switched off. Set up the operating conditions for the IC to be tested either by consulting the manufacturers data or by duplicating the conditions under which the IC will be used in the circuit.

Next insert the IC to be tested into the test socket and connect the power supply leads to the links for appropriate pins of the IC. Double check these connections to make absolutely sure that these connections are correct. Reversed power connections will destroy the IC. Switch on the tester and use the input switches to systematically apply all the possible input conditions to the IC whilst noting that the output conditions of the IC are as they are supposed to be. ●



Internal view of the tester. Note how the top board is mounted (see text).