

Test CMOS and TTL with this versatile instrument.



WARNING:

When using the tester, remember that manufacturers recommend that CMOS ICs should not be inserted or removed from a circuit without first switching off the power supply.

EXPERIMENTERS often damage ICs in the process of developing a new circuit and often try a new IC in a circuit that is not working to eliminate that as a possible cause. The result of this is that one usually finishes up with a box full of ICs which are of dubious value. To sort out these ICs one must use a tester that is capable of testing the wide range of differing ICs that are available in the most commonly used families.

Until recently the most commonly used family has been TTL. But CMOS is rapidly gaining widespread usage and any tester, to be of value these days, must be able to test both these families. The ETI Logic Tester is capable of testing both families, and is also capable of being used to breadboard and test simple circuits based on single ICs.

An LED indicator is associated with each pin of the IC under test and these are arranged around the perimeter of a box representing the IC under test. This allows a small card, which has the

schematic of the particular IC drawn on it, to be fitted to the front of the tester as an aid to the interpretation of the LED test indications.

CONSTRUCTION

The most expensive single component in the tester, after the transformer, is the case. For this reason we decided to make a wooden case and a plain aluminium front panel. Some people may however wish to mount the unit in a diecast box and for this reason the printed circuit board has been sized to fit in a standard 222 x 146 x 51 mm die-cast box. The following description is for a wooden box specifically, but applies equally well to the metal box.

The printed-circuit board is mounted to the rear of the front panel, copper side to the panel, such that the LEDs and patch pins, mounted on the printed-circuit board, project through the front panel. This greatly simplifies construction as it saves some 48 leads and solder joints. The switches are secured to the front panel by first glueing two pieces of printed-circuit

board to the rear of the board and then soldering the switches to the copper side of the board. This procedure avoids the necessity of a multitude of screws passing through the front panel.

The printed-circuit board should be assembled with the aid of the component overlay by fitting all components with the exception of IC1, 5, 6 and 7, and LEDs 1 through 16, and the patch pins. Check that the ICs are orientated correctly as are also C2, 5, 7, 9 and D1, 2 and 3. Now solder these parts into position using the least amount of heat necessary on ICs 2, 3 and 4.

Position the LEDs and patch pins onto the copper side of the board but do not solder them in place as yet. Now fit the board to the front panel so that the pins and LEDs protrude through the panel evenly. Secure the pins and LEDs in position by using a very small drop of five minute epoxy for each, on the component side of the

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HOW IT WORKS.

The tester consists of four basic sections. The socket for the IC under test, the output level-detect logic, oscillators and switches for the inputs, and the power supply.

The socket for the IC under test has the pins in each row electrically connected to each other. These rows are the groups of five holes which are perpendicular to the central groove on the socket. Each row (ie, each pin on the IC under test) is connected via a 10 megohm resistor to ground to prevent the build up of static charges. The resistors also hold all unconnected inputs at ground potential thus preventing any damage to the IC.

Each row is also connected to a pin

on the front panel. Test connections are made to these pins by patchable links from the oscillator and test switches so that the correct test conditions may be set up.

Resistors R19-26 and R43-R50 connect each row (ie pin) to a logic level detector, ICs 5, 6, and 7. These CMOS hex-inverters buffer each pin and drive an LED to indicate the logic state of the pin. When the logic voltage on a pin is high the LED will be alight. Resistors R19 to R26 and R43 to 50 protect the internal diodes of ICs 5, 6 and 7 against the possibility of a pin being taken above the positive supply voltage or below ground potential. Resistors R11 to R18 and R51 to R58 in conjunction with the five volt supply set the

operating currents for the LEDs.

A 555, IC4, is used as an astable oscillator which initially charges C8 via R9 and R10 until the 2/3 supply threshold is reached. C8 is then discharged via R9 and pin 7 of the 555 to the lower threshold of 1/3 supply volts. Switch SW6, when operated, puts a larger value of capacitance into the circuit which gives a frequency of about one hertz. This is slow enough so that the eye can follow each logic state transition. The high speed operation is used for checking very long counters and shift registers and can also be used in conjunction with an oscilloscope. The square wave output of the oscillator is made available at a

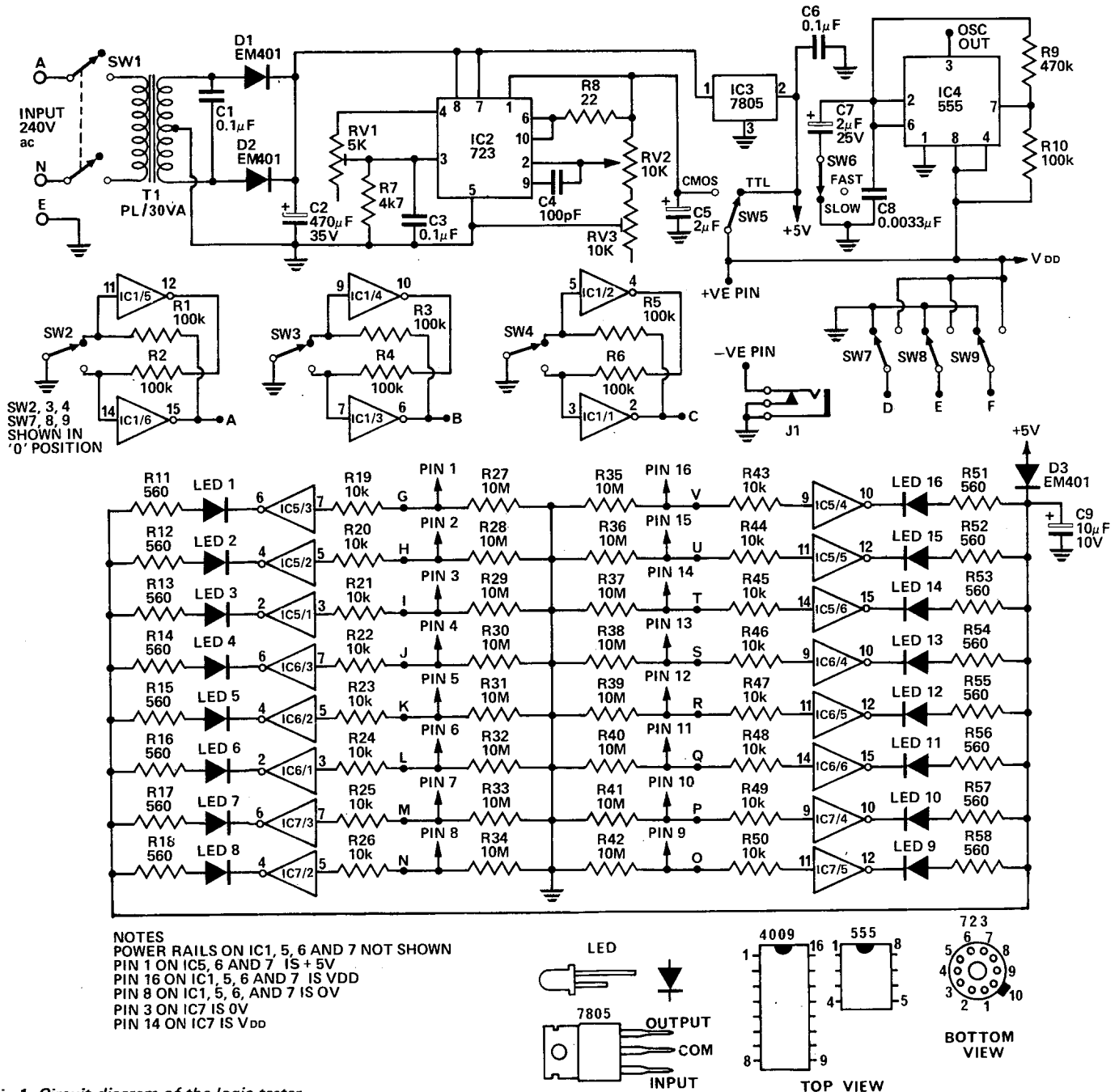


Fig. 1. Circuit diagram of the logic tester.

patch-pin on the front panel.

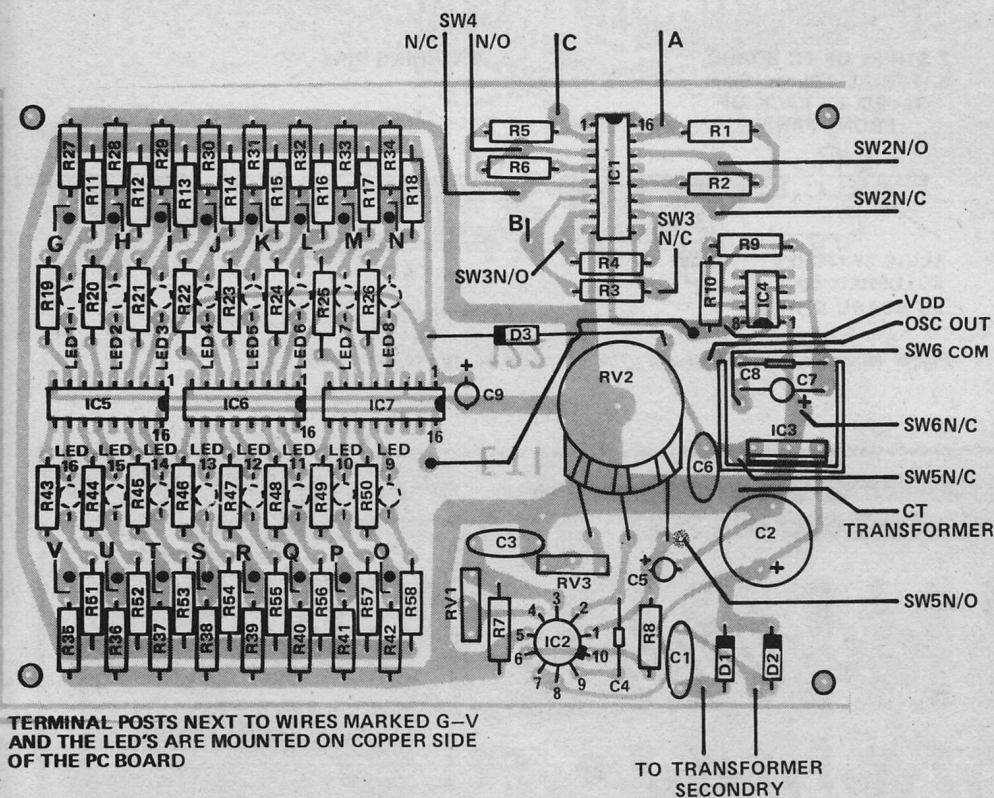
There are six further output pins on the front panel three of which, D, E and F, are set to negative or positive supply by means of toggle switches. As there is no debounce logic associated with these pins they can only be used to set up static conditions and not for clocking counters and shift registers. The remaining three pins are also programmed by switches but these switches are connected to IC1 which contains three RS flip-flops to effectively remove any contact bounce of the switches. This operates as follows. If initially the input of IC 1/5 is earthed by SW2 its output will be high and hence the output of IC

1/6 will be low. When IC 1/6 SW2 is operated again it earths the input of IC 1/6 sending the output of IC 1/6 and input of IC 1/5 high and the output of IC 1/5 low. Since the input of IC 1/6 is connected to the output of IC 1/5 it is held low even if the contacts of SW2 bounce several times when the switch is operated. Thus the output at A is one single transition from high to low (low to high when next the switch is operated). The output of the three debounced switches are labelled on the front panel as A, B, and C.

In the power supply diodes D1 and D2 full-wave rectify the output from the power transformer. The output from the rectifier is smoothed by C2

and regulated to five volts by IC3. The resulting five volt supply is used to drive the LED indicators and to power the TTL device under test. Integrated circuit IC2, a type 723, is a regulator the minimum output of which is set to five volts by RV1 and the maximum of 15 volts by RV3. Front panel control RV2 allows the output voltage to be adjusted between five and 15 volts. The current limit on the output is set to 30 mA by means of R8. SW5 selects the high current five volt supply for testing TTL or the low current variable supply for CMOS. Terminal J1 in the negative supply lead is provided for checking the current drawn by the IC under test. ●

Fig. 2. How the components are mounted on the pc board.



TERMINAL POSTS NEXT TO WIRES MARKED G-V AND THE LED'S ARE MOUNTED ON COPPER SIDE OF THE PC BOARD

TO TRANSFORMER SECONDARY

PARTS LIST — ETI 122

R8	Resistor	22Ω	1/4W	5%
R11,18	"	560	"	"
R51,58	"	560	"	"
R7	"	4 k7	"	"
R19,26	"	10 k	"	"
R43,50	"	10 k	"	"
R1,6	"	100 k	"	"
R10	"	100 k	"	"
R9	"	470 k	"	"
R27,42	"	10 M	"	"
RV1	Potentiometer	5 k	Trim type	"
RV3	"	10 k	"	"
RV2	"	10 k	Linear	"
C4	Capacitor	100 pF	Ceramic	"
C8	"	0.0033μF	polyester	"
C1,3,6	"	0.1μF	"	"
C5,7	"	2μF	25V electro	"
C9	"	10μF	10V	"
C2	"	470μF	35V	"
D1,2,3	Diode	EM401 or similar		
LED 1 — LED 16	Light Emitting Diodes	RL4484 or similar		
IC1,5,6,7	Integrated Circuit	4009 (CMOS)		
IC2	"	Circuit 723 (metal can case)		
IC3	"	Circuit 7805 (TO-220 case)		
IC4	"	Circuit 555		
J1	Jack	small earpiece type		
SW1	DPST	toggle 240V rated		
SW2-SW9	miniature slider switch	2 pole 2 position		

PC BOARD ETI 122

IC Socket SK20 see text
 Wooden case see text
 Transformer 240 V primary 30V CT secondary
 or 2 x 15 V windings
 PL30/20VA
 25 patching Pin McMurdo type FT-1 feed throughs
 front panel
 3 core flex and plug
 heatsink for IC3 (see Fig.6)

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board. Do not glue the LEDs to the front panel. Once the glue has set, carefully remove the board from the front panel and then solder the LEDs and pins into position. Fit 250 mm long leads to the board for later connection to the switches and power transformer and then, using a minimum amount of heat, solder ICs 1, 5, 6 and 7 into position.

If using the recommended test socket prepare it by removing the paper from the rear of the socket, cut the paper in half and then remove about 12 mm from each side. The paper is then replaced on each side so that leads can now be soldered to the metal forming the pins of each row. The front panel must also be cut out so that these leads may be passed through. Now affix the socket to the front panel and install the printed circuit board.

Mount the transformer into the base of the box and interconnect the board and switches etc.

The wooden box was constructed from 12 mm thick pineboard such that the outside dimensions were 225 x 148 x 70 mm. We finished our box with coloured Estapol high-gloss

enamel which resulted in a very pleasing final appearance.

DESIGN FEATURES.

There are several design requirements which must be met in a unit which is designed to test both CMOS and TTL devices. These may be summarized as follows.

- 1) The unit must be capable of correctly testing both types of logic.
- 2) Simple gate functions should be tested by go no/go checks and complex functions such as counters and shift registers should also be reliably checked.
- 3) There should be the least possible chance of damaging the device during testing.
- 4) CMOS ICs must be testable with a variety of supply voltages.
- 5) A clock oscillator and a means of setting up the input conditions must be provided.

One of the major design difficulties with a unit such as this is coping with the many different pin configurations

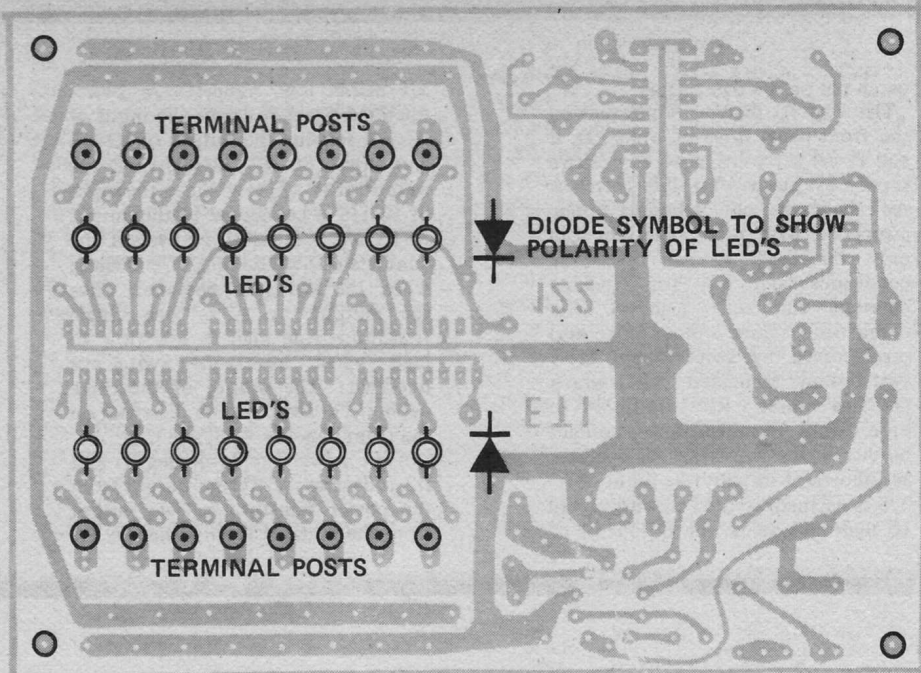


Fig. 4. Positioning of LEDs and terminal posts on the copper side of the printed-circuit board.

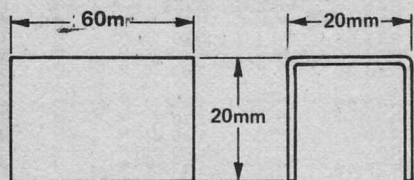


Fig. 6. Heatsink for IC3. The IC is mounted (by a screw) through a 3.2 mm hole in the base of the heatsink (see photograph of inside of unit).

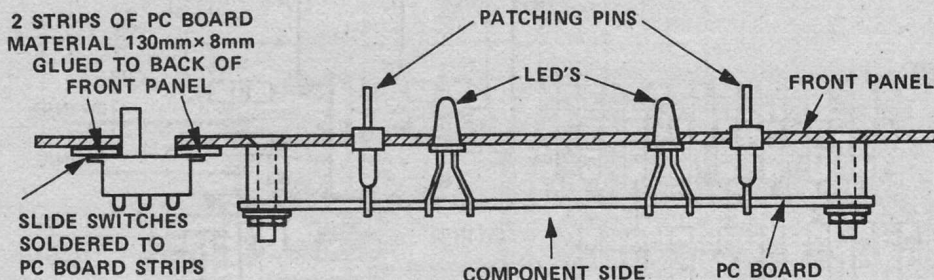


Fig. 5. How the front panel and printed-circuit board are assembled.

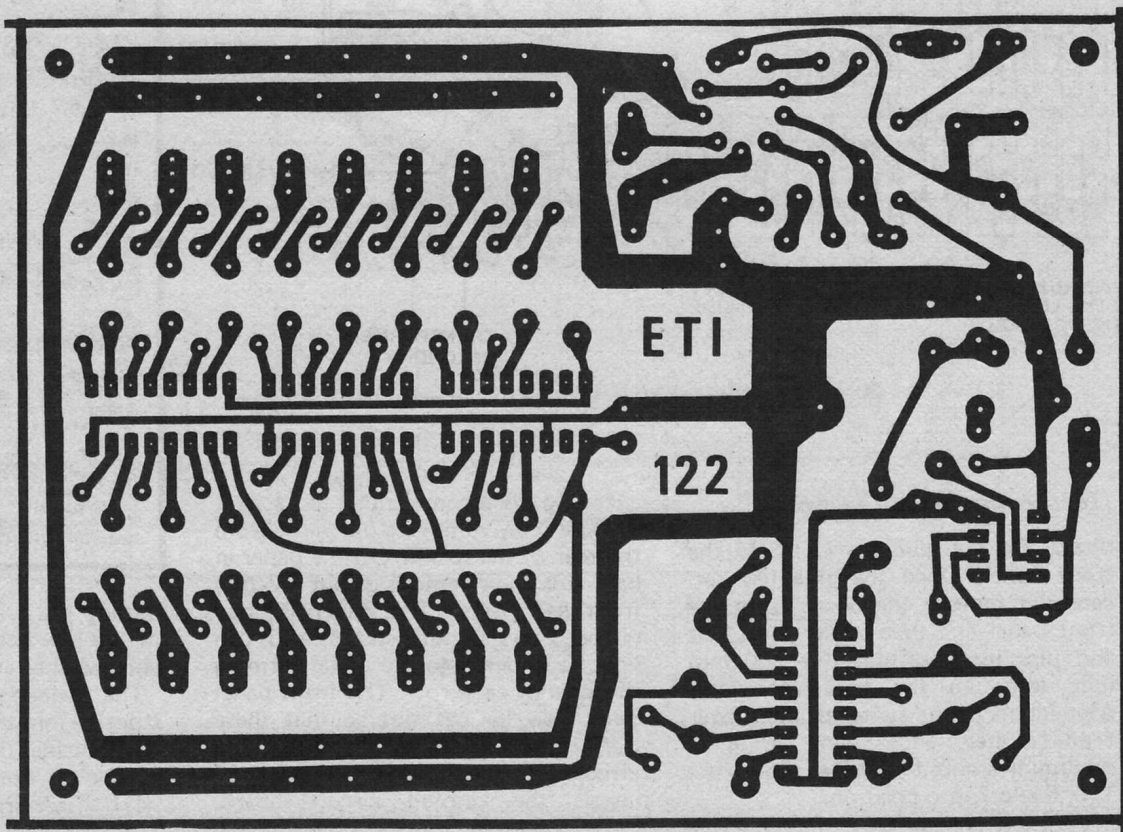


Fig. 7. Printed circuit-board artwork. Full size 142 x 104 mm.

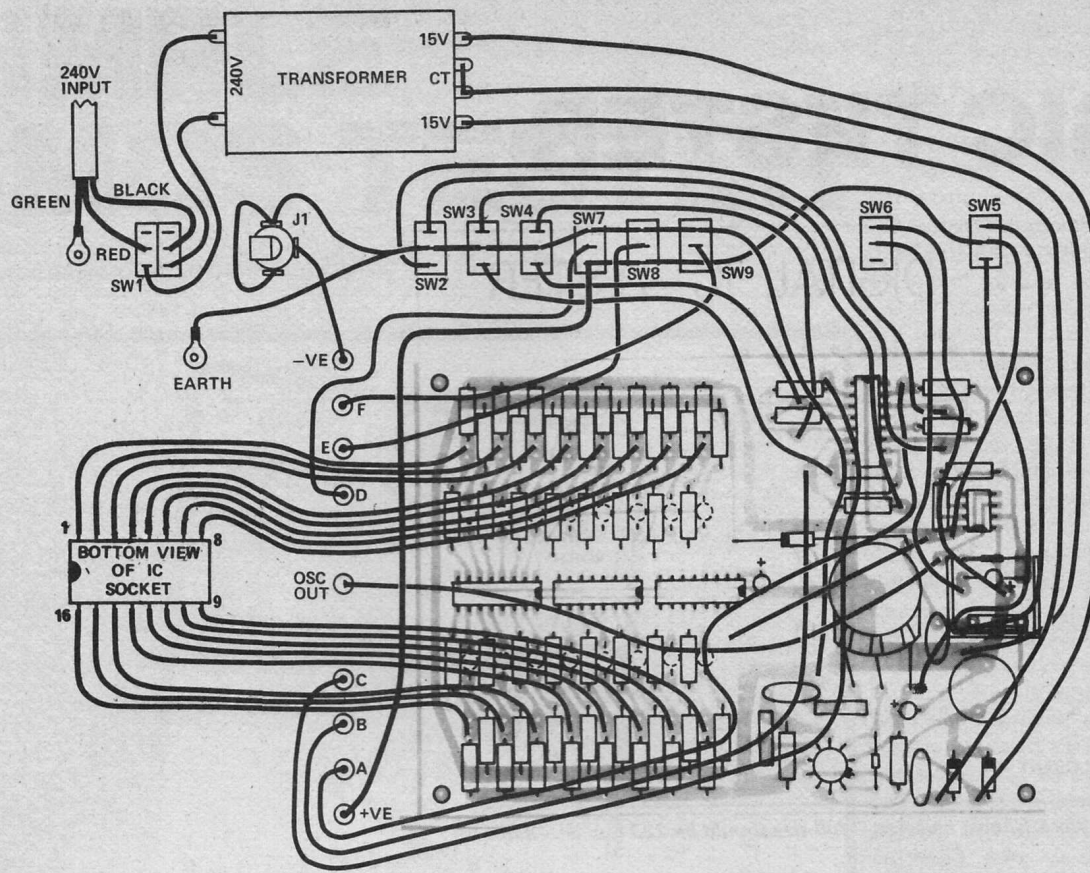
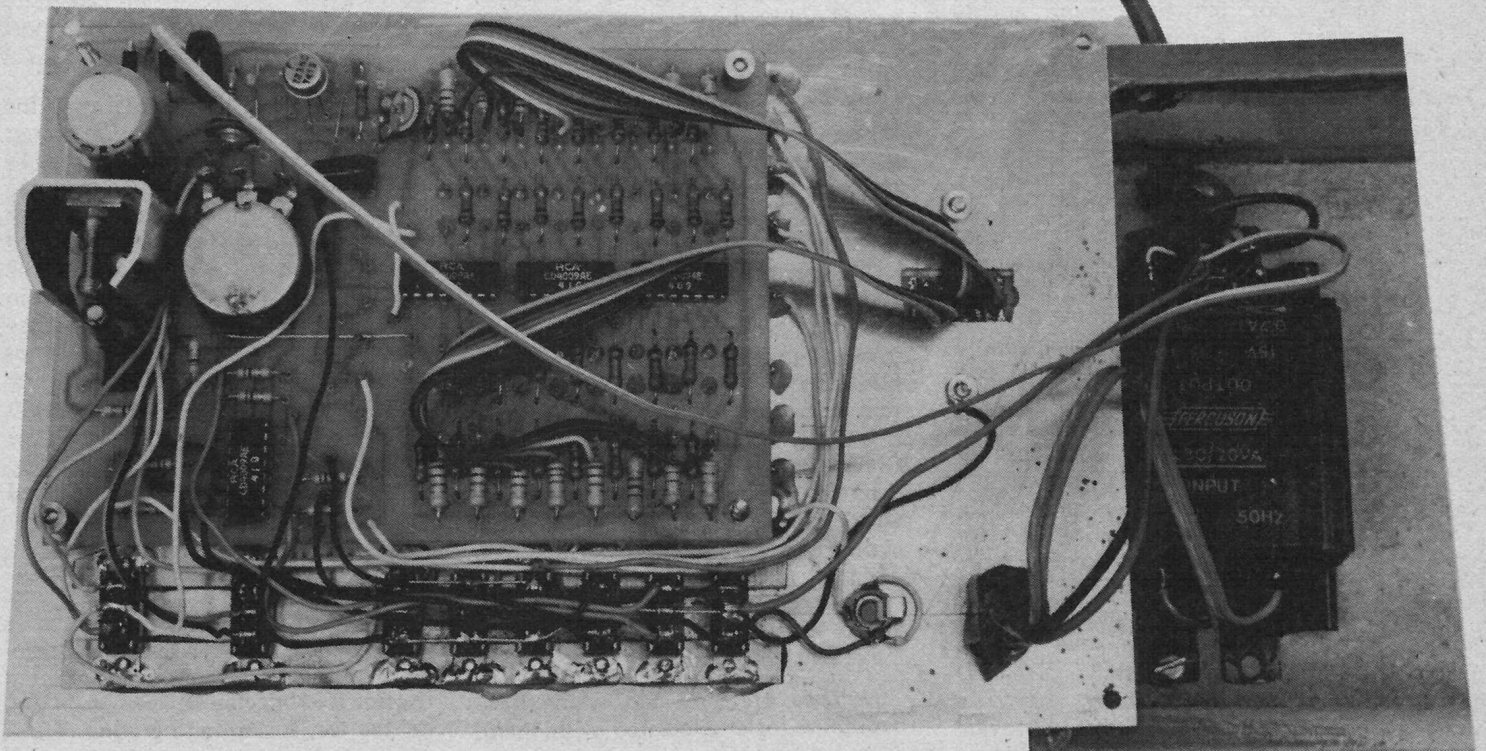


Fig. 3. Wiring diagram of complete unit.

LOGIC TESTER



LOGIC TESTER

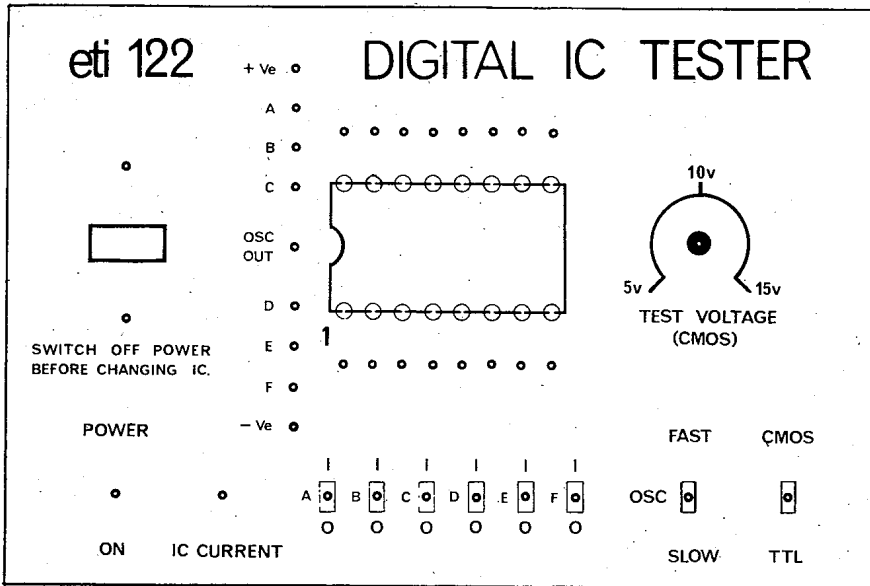


Fig.8. Front panel artwork (shown half-size — full size should be 223 mm x 148 mm).

of the differing functional requirements (eg a shift register versus a two-input NAND gate) of devices within the one family, as well as those between different families. A multi-way switch could be used for each input pin but would greatly increase the expense of the unit. A good alternative is to use patchable links, and this is the approach that we have chosen to use in our unit. In addition we have used a small breadboard socket as the test socket, rather than a standard 16 pin dual-in-line socket, as this allows us to improvise special test circuits for the more complex logic ICs, and the means to breadboard simple circuits.

The need for a variable power supply for CMOS testing presented two additional problems. The first of these was the danger of plugging a TTL IC into the unit when it is set up for CMOS and for some higher supply voltage than the five volts required for TTL. Secondly the LEDs used for monitoring each pin would draw more current as the supply voltage increased. The current ratio could be as high as four to one and a corresponding variation of LED intensity would occur. To overcome this problem it was decided to provide a second supply of five volts to operate the LEDs which will also

provide the higher current required by TTL for its operation. The other supply is a variable one for testing CMOS and is not capable of supplying more than 30 mA. Thus a TTL gate inadvertently connected to this supply would not be damaged.

The regulator used for the five-volt supply is a three terminal IC which has built in current limiting and thermal shutdown. It will not therefore be damaged by a short circuit due to testing a faulty IC. It is not possible to construct a discrete design, as cheaply, that has the same performance.

Next we need a device that will detect the state of each pin on the device under test and drive an LED to indicate that state. The device has to be driven by TTL and CMOS outputs, that is, by voltages anywhere between 5 and 15 volts. A suitable IC is the CMOS 4009 IC which has six inverters in one package. Each inverter will monitor a pin without drawing appreciable current. The 4009 is also designed to translate logic levels. Thus we may use it to monitor a 5 to 15 volt input level at its input but provide a five volt signal only at its output.

Switches are provided which have debounce logic associated with them. This is necessary so that single bounce free rise and fall transitions can be

generated for the testing of more complex logic. The debounce logic must be capable of operating on 5 to 15 volts and of sinking at least two milliamps for TTL tests. The 4009 IC with its high output current capability was again considered to be most suitable for this task.

We would also like to have used the 4009 as the oscillator, but RCA do not recommend using CMOS that has a high output capability in a linear mode as the power dissipation of the device may be exceeded. The oscillator must provide pulses that swing between the positive and negative supply rails (in order to drive CMOS) and must be capable of sinking the two milliamps required by TTL. It must also be capable of operating on supply voltages of 5 to 15 volts. Since the standard CMOS devices cannot provide the current requirement it was decided to use a 555 IC as the oscillator.

CMOS devices should not be operated with inputs left floating as some devices may drift into the linear mode and be destroyed by excessive power dissipation. For this reason a 10 megohm resistor is connected between each pin, on the test socket, and ground. These resistors also conduct away any static charge that may build up.