

Digital event timer — 2

Construction

by P. A. Birnie

The construction is based on two double-sided printed circuit boards, (see Fig. 7.) which are made from 1mm glass fibre. The layouts can be drawn using an etch resist pen although the accuracy required presents a few difficulties. Both boards should be first drilled using

a 0.8mm bit and a piece of 0.1in Veroboard as a template. The tracks are then drawn in on both sides of the board. Care must be taken to ensure registration between both sides of the board.

The display is mounted on the p.c.b.

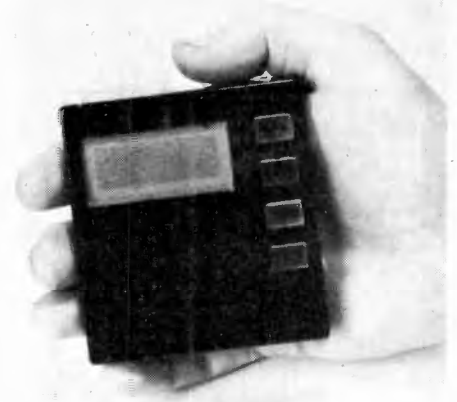
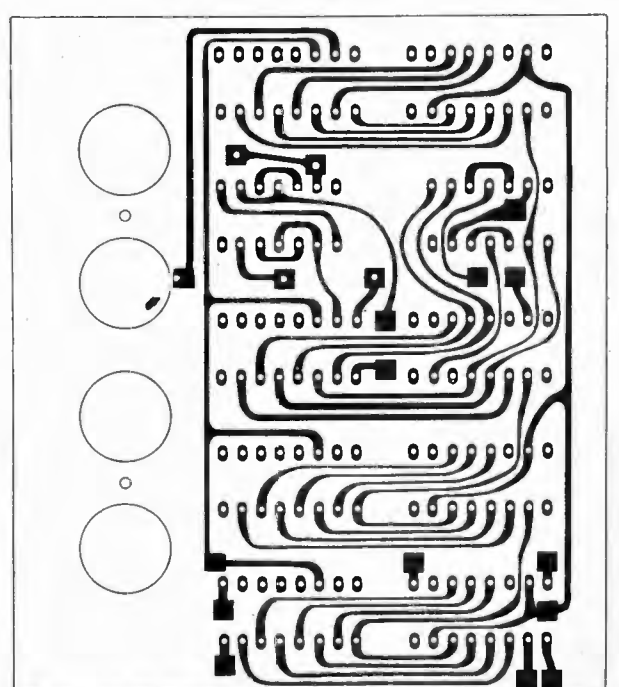
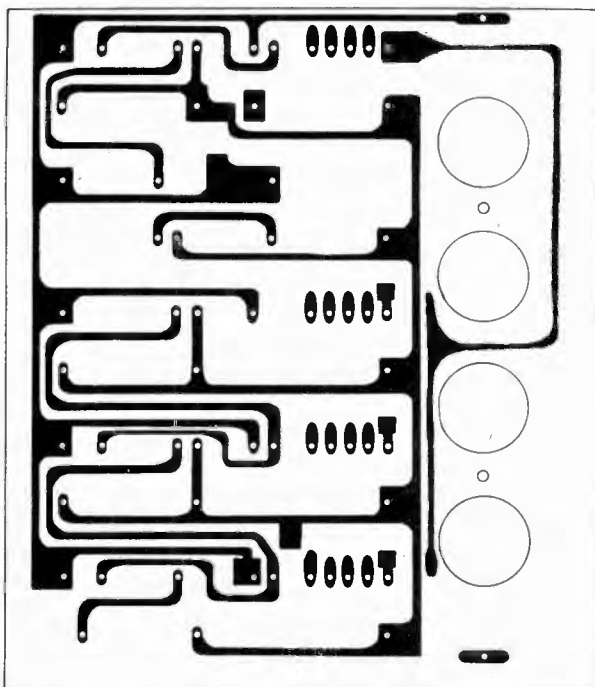
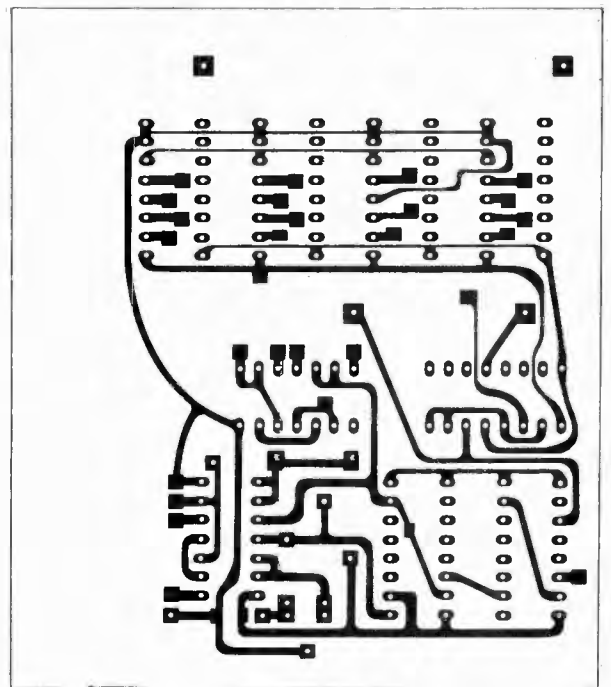
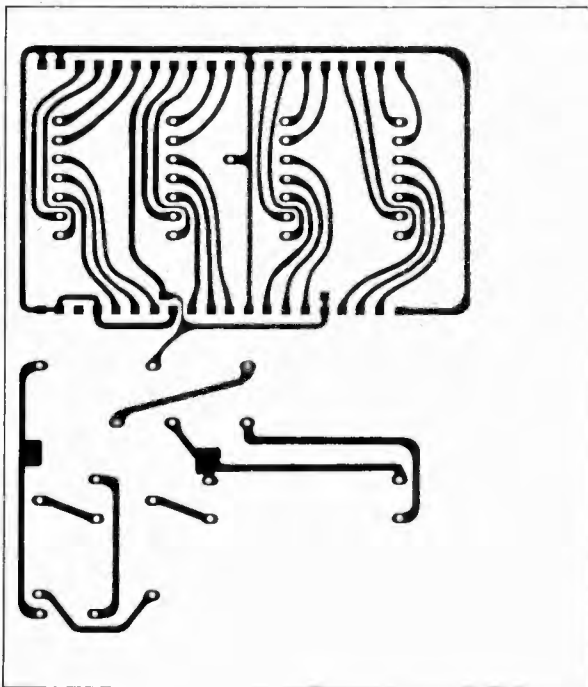
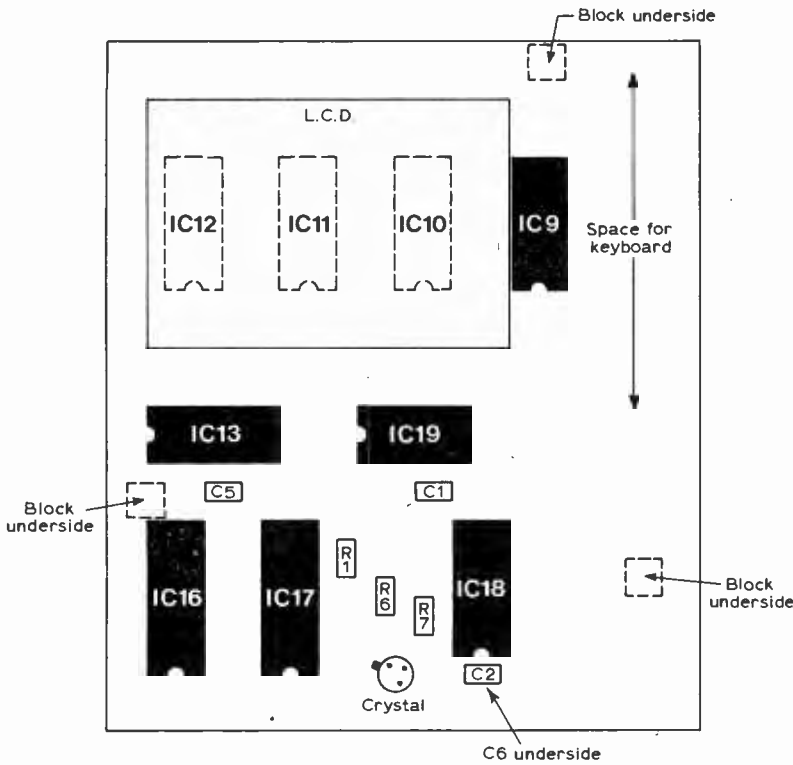


Fig. 7. Printed circuit board layout diagram actual size. Note that due to inaccuracies of the printing process and small distortions in the paper, correct registration of the layouts cannot be guaranteed.



(a) board 1



(b) board 2

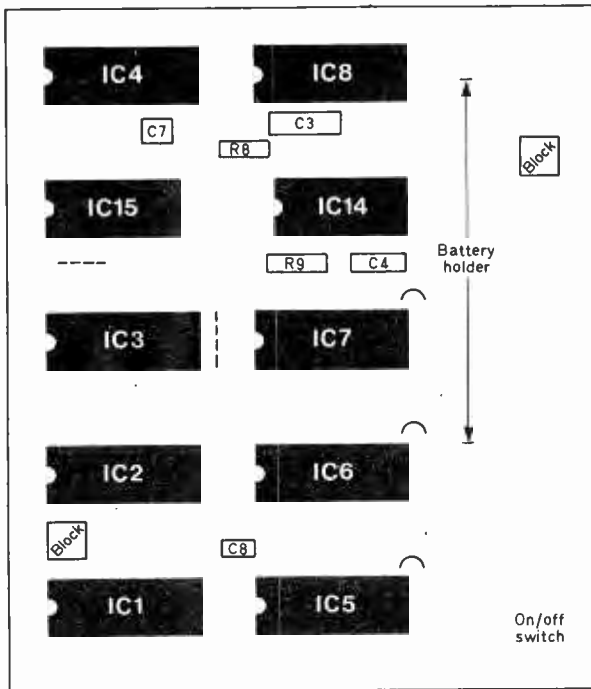


Fig. 8. Component location diagrams. Some of the discrete components are mounted on undrilled pads. Capacitors $C_{5,6,7,8}$ decouple the supply. Five links are fitted on board (b), three on top and two underneath as shown.

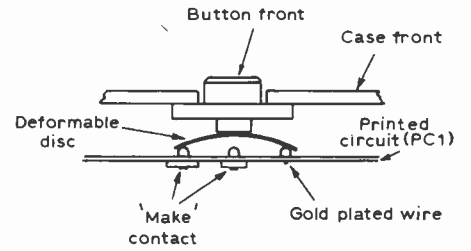


Fig. 9. Button mechanism as used in calculator keyboards.

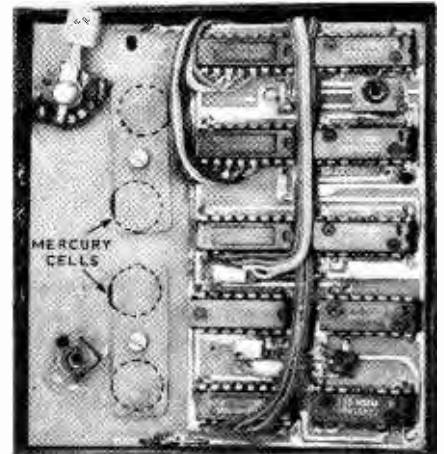


Fig. 10. Component side of p.c.b.2, showing the mounting position of four mercury cells, two blocks for securing the back plate, and the change-over battery switch.

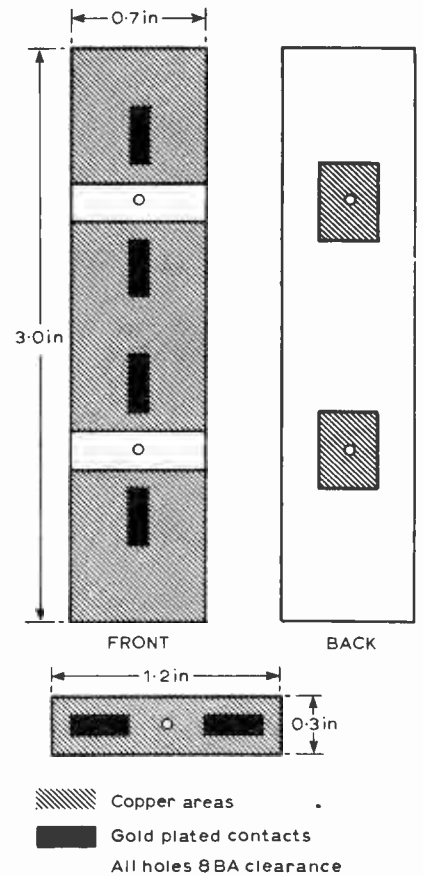


Fig. 11. Construction details for the ancillary p.c.bs. Boards 4 and 5 are identical and single sided. Board 3 is double sided, the back areas of copper are used to solder the 8BA nuts in place.

using Soldercon i.c.-socket pins. Thirty six of the sockets are mounted and soldered onto the component side of the board and these should be trimmed to remove the unwanted pin. Four socket pins go through the board and are soldered on both sides. All of the pins should be kept in the carrier while they are soldered in place as this makes alignment easier.

The 19 i.c.s should be mounted as shown in Fig. 8(a) and (b) using an earthed soldering iron and taking the normal c.m.o.s. precautions. Some of the discrete components do not have holes drilled in the board and these are soldered onto pads on the component side. The TO5 can crystal is mounted upside down with the legs bent over and through 180°. When mounting the display great care should be taken because the pins are delicate. Orientation of the display can be determined by examining the read-out under strong light. If any of the sockets become detached during insertion, it is safer to continue, and resolder the sockets when the display is in place. Links interconnect pin 9 of IC_{5, 6, 7, 8} via a track on the component side as shown in Fig. 8(b), pin 11 of IC₁₅ to pin 15 of IC₁₃, and pin 9 of IC₁₄ to pin 1 of IC₇ via pads on the track side of the board.

Switches in the prototype were constructed from a scrap calculator keyboard, and the mechanism, which is based on a flexible disc of gold-plated metal, is shown in Fig. 9. Construction details of the switches are not given because these components can be adapted to suit the individual.

Four RM675H mercury cells are mounted on p.c.b.2 as shown in Fig. 10. Three small boards are made using 1mm double sided fibre glass, see Fig. 11, and two of these have the copper removed from one side. Gold battery-contacts are made by carefully removing the gold-plated edge connector strips from a scrap board. These strips should be cleaned and soldered in the appropriate positions. It is important to use only a small amount of solder, otherwise contact will be made with the solder rather than the gold. Two 8BA clearance holes are drilled in board 3 and 8BA nuts are soldered to square pads on this board. Using two narrow strips of 1mm Perspex as spacers, board 3 is glued to the non component side of board 2, ensuring that the gold pads align with the 0.5in holes. To make subsequent construction easier, a flying lead is soldered to each end of p.c.b.3 before assembly. The four cells are placed into the cavities which now exist so that the top flying lead is at +5.2V with respect to the bottom lead. Boards 4 and 5 are screwed to board 3 using short 8BA screws threading into the nuts already provided.

A change-over switch is needed for the battery because when the power is turned off the decoupling capacitors supply sufficient current to operate the stopwatch for about 8 seconds. After

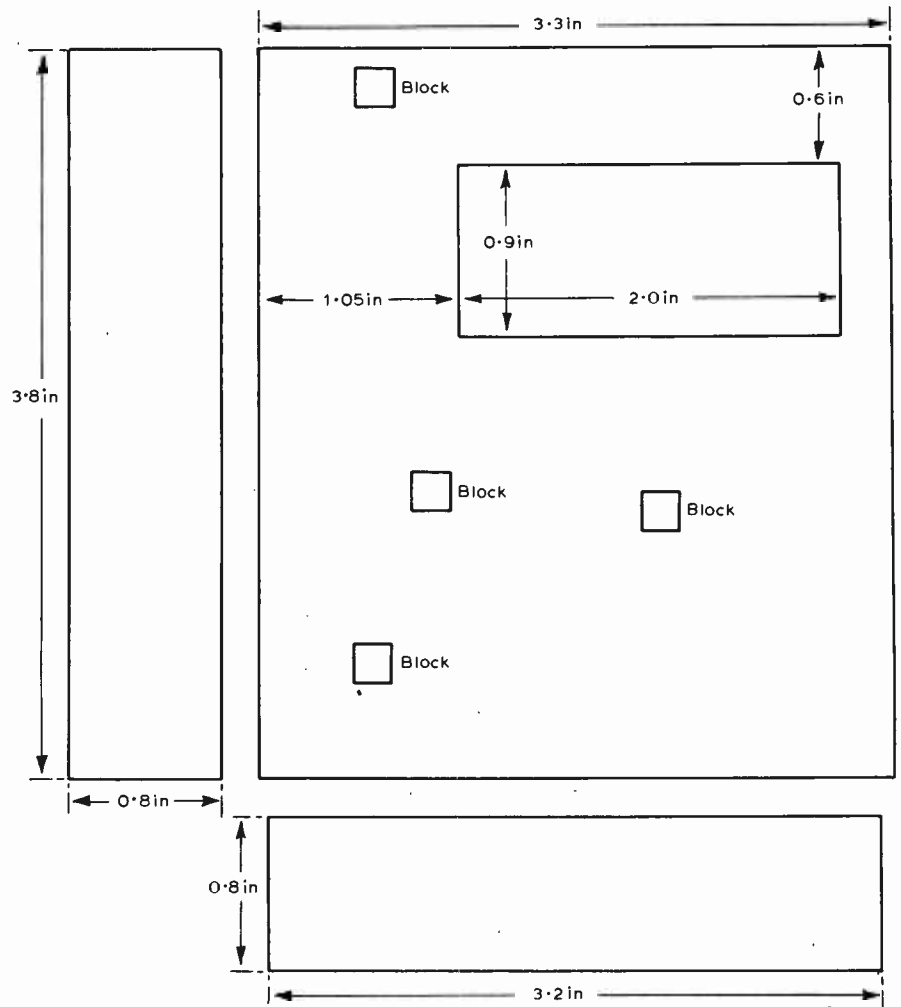


Fig. 12. Case construction details. Panels are cut from 1mm black Perspex by scoring and snapping over a block. The back plate has the same overall dimensions as the front.

this period the crystal oscillator stops and d.c. is applied to the display for a few seconds. To prevent this potentially damaging situation a 1kΩ resistor is placed across the supply when the switch is in the off position. The switch is connected to board 2 so that the toggle projects out of the case.

Case construction

The author's case was made from 1/8in black Perspex and Fig. 12 shows the parts required. The panels should be cut from a Perspex sheet by scoring deeply with a sharp knife and snapping off over a block of wood. This produces a clean edge which should be smoothed off using fine wet and dry paper. Holes for the buttons and display should be cut using the completed p.c.b.1 as a guide. When the case has been glued using a Perspex cement three blocks are built to support board 1. The blocks are glued to the front plate as indicated in Fig. 12, but exact positions require checking to

Connection on p.c.b.1	Signal	Connection on p.c.b.2
IC ₁₉ : 14	+5.2V	IC ₁ : 16
IC ₁₈ : 7	EARTH	IC ₅ : 8
IC ₁₇ : 7	RESET	IC ₁ : 15
IC ₁₉ : 11	RESET	IC ₁₅ : 13
IC ₁₉ : 8	SELECT X	IC ₅ : 9
IC ₁₉ : 10	SELECT Y	IC ₅ : 14
IC ₁₉ : 2	ENABLE X	IC ₁ : 1
IC ₁₈ : 6	ENABLE Y	IC ₁ : 9
IC ₁₆ : 14	10Hz	IC ₁ : 2
IC ₉ : 5		²⁰ IC ₅ : 10
IC ₉ : 3	TENTHS	²¹ IC ₅ : 11
IC ₉ : 2	SECONDS	²² IC ₅ : 12
IC ₉ : 4		²³ IC ₅ : 13
IC ₁₀ : 5	UNITS	²⁰ IC ₆ : 10
IC ₁₀ : 3	SECONDS	²¹ IC ₆ : 11
IC ₁₀ : 2		²² IC ₆ : 12
IC ₁₀ : 4		²³ IC ₆ : 13
IC ₁₁ : 5	TENS	²⁰ IC ₇ : 10
IC ₁₁ : 3	SECONDS	²¹ IC ₇ : 11
IC ₁₁ : 2		²² IC ₇ : 12
IC ₁₂ : 5	UNITS	²⁰ IC ₈ : 10
IC ₁₂ : 3	MINUTES	²¹ IC ₈ : 11
IC ₁₂ : 2		²² IC ₈ : 12
IC ₁₂ : 4		²³ IC ₈ : 13
IC ₁₃ : 3	TENS MINUTES	²⁰ IC ₇ : 13
IC ₁₈ : 5		
IC ₁₀ : 1		
IC ₁₉ : 6		
IC ₁₈ : 1		

Keypad connections
 RUN
 SPLIT
 X
 Y

ensure that no projections exist on the non-component side of board 1. Holes are carefully drilled through this board and into the blocks to accommodate self tapping screws. A similar approach is adopted for board 2 except that the blocks are glued, using Araldite, to board 1 as shown in Fig. 8. Care should be taken not to cut or bridge any pads while drilling the p.c.bs. The back of the case is also secured to board 2 by Perspex blocks. If the block positions shown in Fig. 8 are not used, board 1 should be supported around the push-button switches to prevent excessive flexing during use. The case can be polished using metal polish or T-cut.

Final assembly and testing

The two main component boards are interconnected by two groups of miniature flat ribbon cable as listed in the table. Pads are provided on both sides of the boards for these wires. The first group contains 16 wires interconnecting the outputs of the data selector stages to the display decoder drivers. The second group of wires provides clock and control signals from board 1 to board 2. Connections from the four push-buttons to board 1 are also shown. Final connections are by flying leads from the battery holder to the positive supply rail on board 2, and the negative supply rail, via a multimeter, to the switch. After a final check, and with the multimeter on the 10mA range, switch on. An initial large deflection should take place as all the decoupling capacitors charge. The current should then drop to about $200\mu\text{A}$ and the display should be active. If this is the case, the button functions can be tested. When all of the operations have been success-

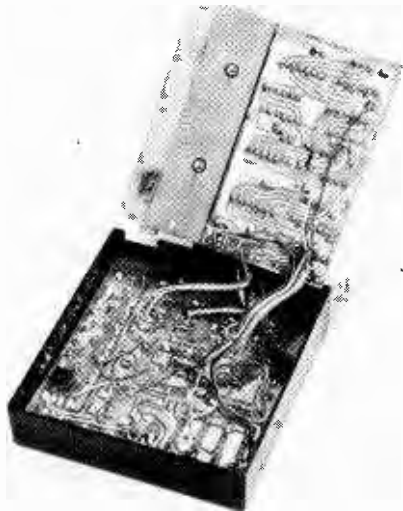


Fig. 13. Internal view of the timer with p.c.b.2 hinged open. Board 2 is supported on board 1 by three Perspex blocks.

fully tested the two boards should be inserted into the case and secured in position. It should be noted that the display segments have a relatively long response time. This is normal especially in warm ambient temperatures. It is possible to use other liquid crystal displays in this design provided that they use the same drive of five volts r.m.s.

Printed circuit boards

Two double-sided p.c.bs will be available for this design. The boards, which are based on the author's layouts, are priced at £6.00 for the set and are available from M. R. Sagin at 11 Villiers Road, London N.W.2.