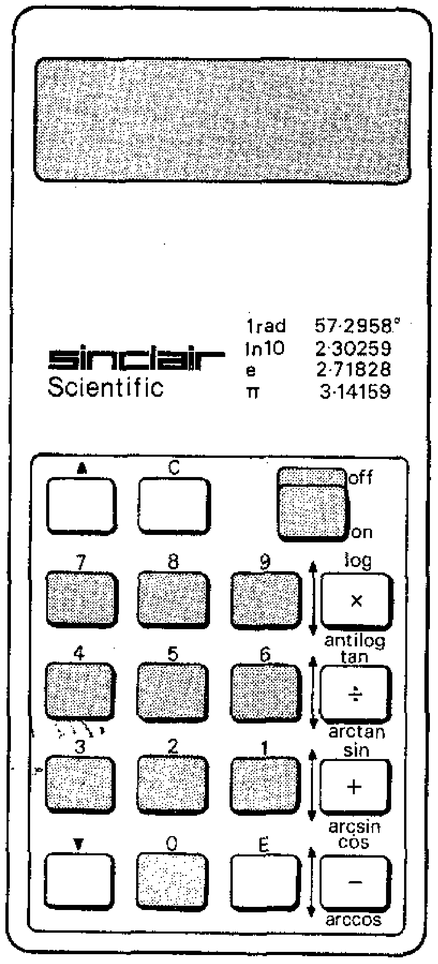
Sinclair Scientific Calculator

Assembly Instructions



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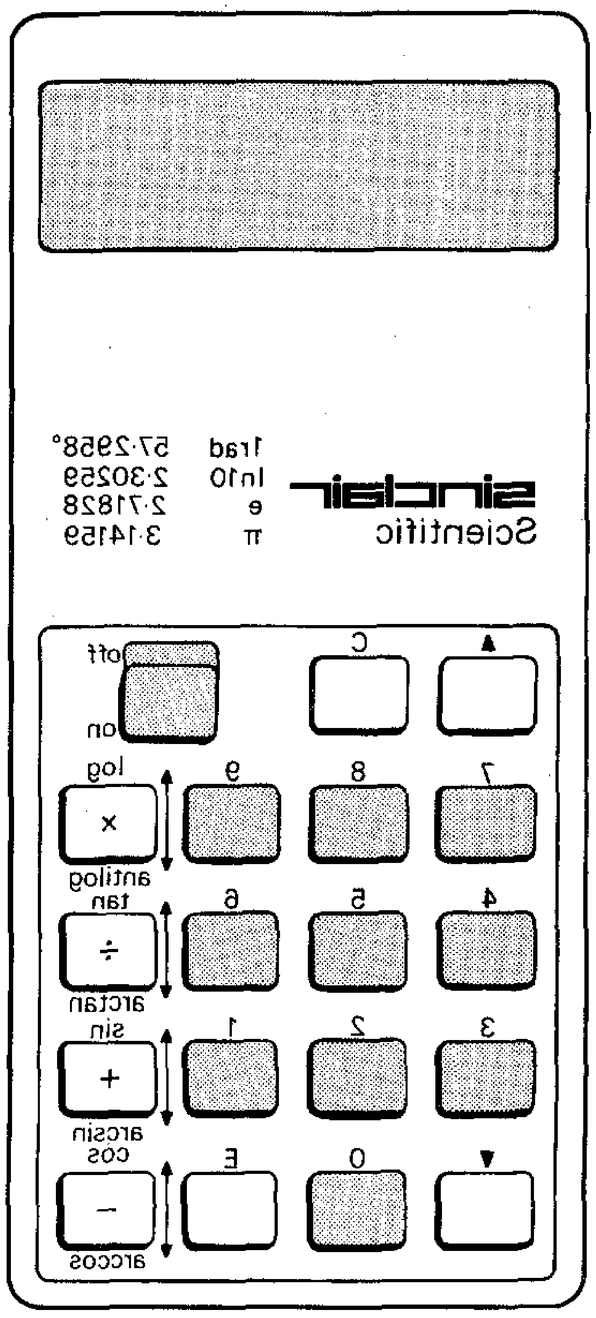
This illustration shows (in mirror image) positions of push buttons.



Open out flap

Construction steps

The steps are numbered: tick each one as you complete it. The letters refer to the explanatory notes and diagrams in the text which begin on page 8.

	Step	Note	
☐	1	A	Fit battery clips.
☐	2	B	Bend and fit R1, R2, R3, R4, R5.
☐	3	B	Bend and fit D1, D2 and D3.
☐	4	C	Fit IFC1.
☐	5	C	Fit IFC2.
☐	6	D	Fit coil (L1).
☐	7	E	Fit display. Note method of connecting this.
☐	8	F	Bend and fit C1, C2 and C3.
☐	9	C	Fit main calculator chip IC1. Note special precautions when handling this.
			PCB Assembly is now complete.
☐	10	G	Assemble case and insert batteries.
☐	11		Switch calculator on and use it.

For components position, see Master Diagram 1 on page 22.

Components List

COMPONENTS FOR PCB ASSEMBLY

Component	No. used to identify in this manual	Value or description	Colour marking or other identification
Resistors			Bands: (see diagram and note on page 9)
			1 2 3 4
	R1	100Ω	Brown Black Brown Gold
	R2	470Ω	Yellow Violet Brown Gold
	R3	100Ω	Brown Black Brown Gold
	R4	150K	Brown Green Yellow Gold
	R5	4K7	Yellow Violet Red Go
	note: R4 will be sent in some kits, see page 9		
Capacitors			
	C1	10μF	16v 10μF
	C2	1μF	100v 1μF or 63v 1μF
	C3	33μF or 22μ	16v 33μF or 16v 22μF
Diodes			
	D1,D2,D3	1N9 14E or 1544 see page 9	
Transistors and Integrated Circuits (ICs)			
		Display	Glassy 'bubbled' pack
	IC1	Calculator chip	Pack with 28 leads
	IFC1	Driver IC	Pack with 16 leads
	IFC2	Driver IC	Pack with 8 leads
Coil	L1		see page 10
Battery Clips	A (1 in kit)		
	B (2 in kit)		See page 8
	C (1 in kit)		
	D (1 in kit)		

Printed circuit board (PCB)
Length of Solderwick (for correcting errors)
Solder
Display foam, 30 x 3mm
Battery foam, 30 x 40mm, 2 off
Battery identification label

PARTS FOR CASE AND KEYBOARD

Case top and bottom	
Window	Violet plastic moulding
Shroud	
Keyboard grid	
Push buttons (20 in kit)	
Plastic dust plate	Opaque plastic, no holes
Contact plate (2 pieces)	Metal plate, circular dimples
Separator plate	Clear plastic, holes

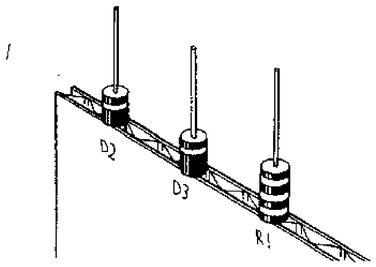
Contact backing plates, upper and lower (see note on page 12).
Battery cover plate

Preliminary

1. Read instructions throughly. Make sure you understand them.

2. Identify printed circuit board (PCB), and make sure you know on which side the components fit: all the components except the display are positioned *under* the board and soldered *above* the board.

3. Identify all components: it may help to insert resistors, diodes etc. into the channels in the end of a piece of corrugated paper as shown in the diagram – or you can stick them into the polystyrene your kit was packed in – and write on the cardboard to identify them.



Contents

Introduction

The Sinclair Cambridge will present no difficulty in building if you have a small soldering iron, a steady hand and a keen eye, provided you can solder and follow the instructions carefully.

Before starting, therefore, read the instructions right through. Make sure you understand them properly, and that you have the necessary tools for the job. The most difficult step is probably fitting the display: if you can do this you should have no other problems.

If you are not confident of your own ability to assemble the calculator, take a look at the guarantee conditions and service charges at the end of this manual, and remember that you can return the kit untouched with cash balance for a built version.

The easiest assembly order is that given on page 3.

Soldering and general assembly

These instructions assume you can solder and have the necessary tools to work on equipment as small as the calculator. Although the components are tiny the calculator is really very simple to assemble, but it is not a good kit to start your electronic assembly experience off, simply because it is so small.

It may be of interest that Sinclair manufacture a small two-transistor radio of similar ease of construction to the calculator. It is called the 'Sinclair Micromatic' and is available from most electronic component shops (or direct from Sinclair) at £2.34. If you can build this easily you should have no problem on the calculator.

Make sure your soldering iron's bit is small enough to make the joints with, and that it is of the correct temperature, or you will make bad joints or overheat something.

Use only the solder provided. Apply the solder and the soldering iron simultaneously to the joint to be soldered: do not carry the solder to the joint on the iron since the special flux in the solder will burn away.

Also included in the kit you will find a length of 'Solderwick' – a metal braiding specially impregnated with flux. It is used for removing solder from joints which have been made incorrectly. To use it, lay the end of it on top of the joint and apply a clean, solder-free iron, on top of the wick. The wick will absorb the surplus solder leaving the joint free again. Cut off the end of the wick which is covered with solder, and the rest of the wick is ready for further use.

Tools necessary

1. Soldering iron: You will require a sub-miniature iron with a very small bit, $\frac{1}{16}$" or smaller. A suitable iron would be the Antex model CN with $\frac{3}{64}$" bit. The iron must be properly earthed and of the correct voltage for your mains, so that it does not run too cold or too hot.

Make sure you have the correct iron: if you use a larger one you will not be able to build the kit.

2. Wire cutters: You will need a small pair of these suitable for very small electronic work, or you can use a pair of nail-clippers.

3. Tweezers and sharp-nosed pair of pliers: You can make the calculator without these, but both will be useful.

Special safety precautions

Heat: Modern transistors and other components are not as easily damaged by excess heat as is commonly believed, so no special precautions are needed. However, do make joints as quickly as you can, make sure that the soldering iron is clean and that you do not get dirt or grease on the board or components.

Take extra care with the display: the lenses on this are plastic and will be badly marked if hot solder is dropped on them, or if they are overheated.

Static electricity: This can be a great problem. It is encountered in dry atmospheres, especially where carpets of man-made fibres are fitted. In such circumstances, simply walking around can cause a static charge on the body which will discharge through any object you touch. If you are charged, even slightly, and pick up the main calculator chip, the discharge through this will damage it.

Other sources of static electricity are clothing of nylon or other man-made fibre, and even the act of combing your hair.

As a safety precaution the calculator chip is supplied packed in special foam rubber which is conducting to short out any such discharges. Do not remove it from this until you are about to use it and do not handle it more than necessary.

Make sure your soldering iron is properly earthed.

As an additional precaution you can work on a metal sheet, such as an old tin tray or a biscuit tin lid, or even a sheet of cooking foil spread out on the table.

Before starting assembly touch the tip of the soldering iron onto the metal and touch the metal with the tip of your finger at the same time. Do this from time to time during assembly and in particular if you get up for any reason during assembly.

This will ensure that there are no static charges around: they have all gone to earth through the soldering iron.

Dos and Don'ts

Do wash your hands before assembly: dirt and grease on the board make soldering hard and joints unreliable.

Do check each component's position and that it is the correct way round *before* you solder it: once soldered a mistake will be hard to rectify.

Do inspect the final board assembly before caseing. Make sure joints look bright and well soldered. Check that there are

no solder bridges, splashes or whiskers of solder. Check both sides of the board. Make sure keyboard plate and contacts are clean.

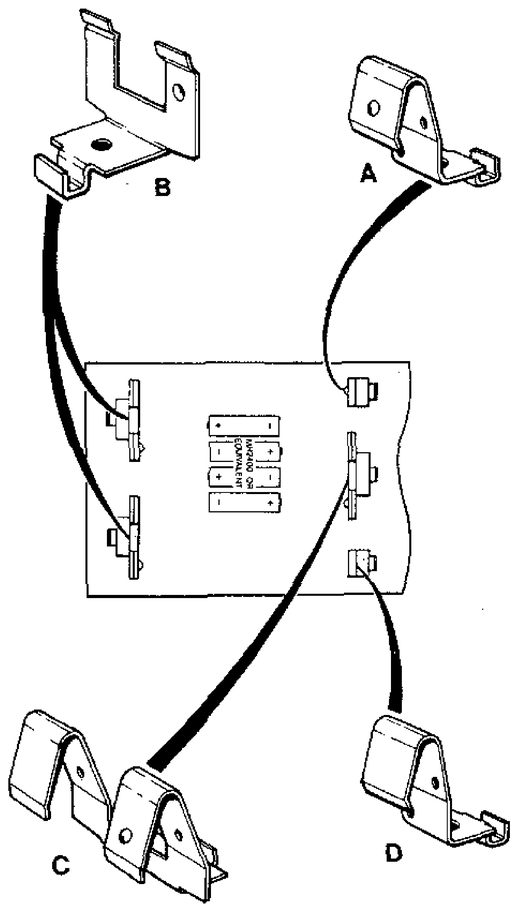
Don't be in too much of a hurry to finish: you'll only make mistakes!

Don't solder except where components go, as the board holes are treated to make the necessary connections from one side to the other.

Constructional notes

Important: These notes do not give best sequence of assembly: they are intended to clarify steps in the construction order on page 3.

A Battery clips
Note: there are four separate types, one 'A', two 'B' one 'C' and one 'D'. Note where they fit in the diagram below, note also that they must fit in facing the way shown. The size of the clips is exaggerated for clarity.

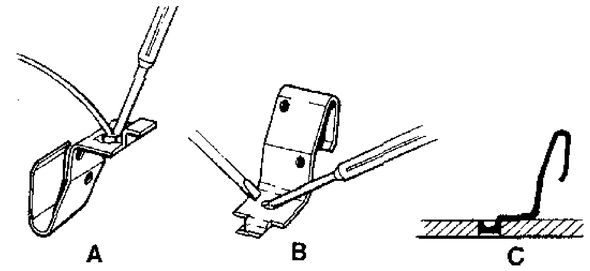


The diagram below shows how to fit the clips:

a: tin the clip as shown before fitting – don't use too much solder.

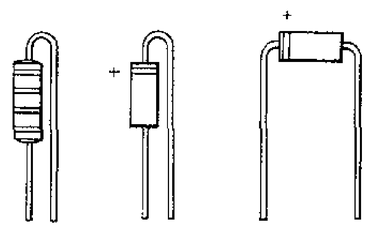
b: fit the clip on the board and press it down with the iron. Now press the clip firmly in place with a screwdriver or similar tool, remove the iron and hold the clip steady while it cools.

Diagram (c) shows how the clip locates in the p.c.b. cut out.



Take care fitting these, since it is possible to damage the board at this stage. If you do cause damage, do not proceed but get a new board.

B Resistors and diodes
The resistors, R1 – R5, are identified by coloured bands on their bodies, as shown in the components list. Note that the gold band may be silver or absent altogether on some of the resistors. Colouring of the numbered bands is shown in the components list. Bend the component leads as shown in the figure.



Resistors do not have to be any particular way round.

Diodes are a similar shape to resistors but have only one band or sometimes two painted on the outside of their body. This band identifies the + end of the diode and the diode must be put in circuit the correct way round or it will not work. In Master Diagram 1, the + end of diodes is indicated by a + sign.

Note that R4 is only needed with some IC1s: these chips are pretested and your kit will only include R4 if one is required. If R4 is absent it should be replaced by a wire link made from a discarded component lead.

C ICs
Make sure these are the correct way round. Although they will fit the board both ways they will only work in one way. There is an identifying groove at one end of the body of IFC1 (left-hand end in Master Diagram 1). Fit the IC with this groove nearest to R2.

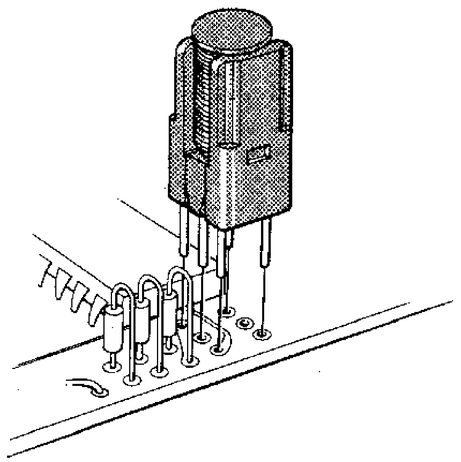
The main calculator chip (IC1) is identified by a similar groove (right-hand end in Master Diagram 1), which should fit nearest the edge of the board. Note the special precautions (page 7) when fitting this IC.

IFC2 has a circular dimple near to pin 1 for identification. Fit this IC with the dimple nearest to D1.

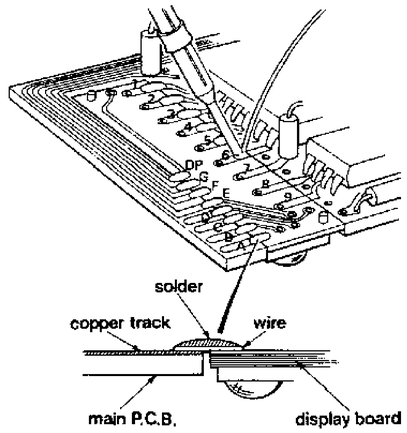
The ICs can be clearly seen in the main layout (Master Diagram 1).

Take great care to fit these ICs in properly: make sure they are the correct way round and in the correct side of the board: you will find them almost impossible to remove if you make a mistake.

D Coil – L1



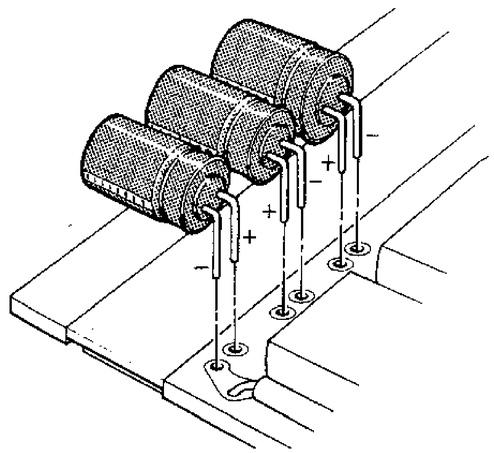
E Display
The display fits into the slot in the main board. Make sure the contacts on the display meet up as shown with the contacts at the edge of the slot. Whilst it is possible to bridge over the joint between board and display contacts only with solder it may be easier to use a piece of wire as shown.



Use one of the leads snipped off a component. Lay this across the two contacts to be soldered and then solder it.

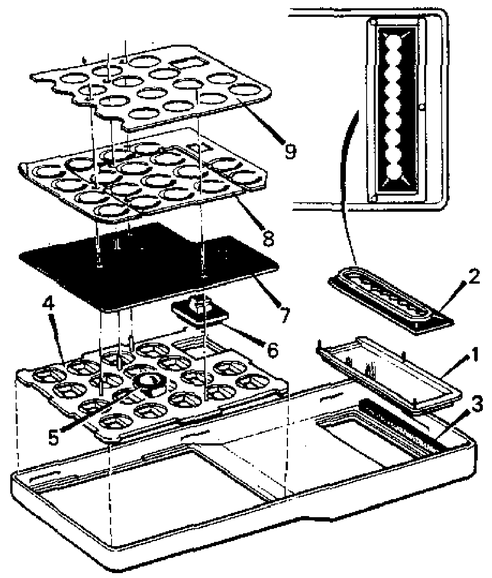
If these joints are made properly the display will be firmly held so will need no further fixing.

F C1, C2 and C3
These components must fit only one way round so make sure the – and + leads fit into the holes as shown. Take care to get each capacitor in the correct position.



G Assemble case in the following order

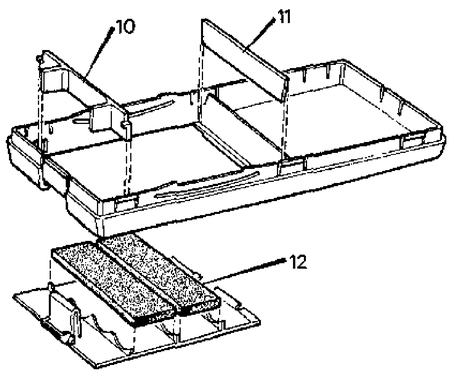
1. Window – edge cut-out
2. Shroud
3. *Peel the backing paper off the display foam and* stick it in place on the inside of the case top.
4. Keyboard grid: drops into the cut-out in the case top
5. Locate the 18 push buttons: see diagram pages 1 and 2
6. Locate the on/off switch knob
7. *Plastic dust sheet*
8. Metal contact plate (2 pieces)
9. Separator plate



10 *Lower battery contact backing plate: this should be* located in the slots provided in the case bottom. Note: on some cases this backing plate is an integral part of the case lower

11 Upper battery contact backing plate, should be *similarly inserted*

12 The two pieces of self adhesive foam should be laid *across* the inside of the battery cover



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13 Locate the assembled circuit board into the case top.

14 The on/off switch contact should now be inserted in the direction of the arrow shown.

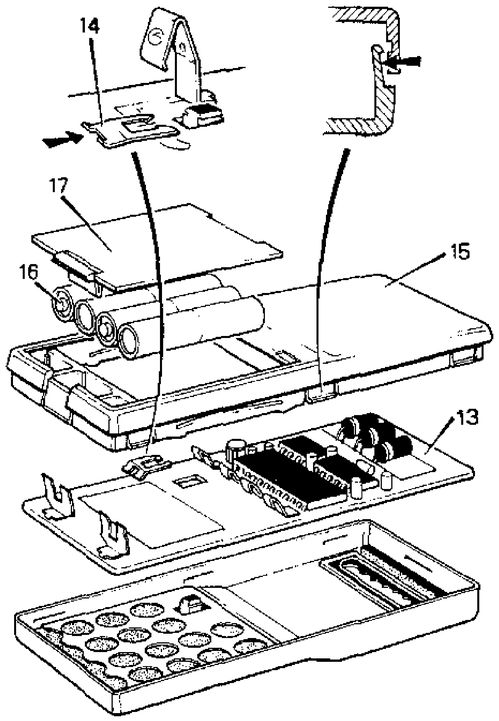
15 The two case halves should now be fitted together (take great care not to trap the battery contacts on the upper and lower backing plates) and pressed firmly home, when they will 'click' together, leaving a *1/16" channel all around the* calculator.

16 The batteries may now be fitted, taking care not to insert incorrectly, for although this will not damage the calculator, it will prevent it from working until the situation is rectified

17 The battery cover may now be *fitted – again this* should spring into position.
The calculator is now ready for use.

18 Once the calculator is working properly, apply a hot soldering iron to each of the four plastic lugs which locate the keyboard assembly in the main board. Press each lug down, to flatten it, with the soldering iron whilst firmly squeezing keyboard assembly together with finger and thumb. The four lugs will then hold the keyboard firmly together preventing the ingress of dirt.

19 Finally – peel the paper backing from the battery lable and stick it into place.



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Fault finding

Should your machine not work after assembly the following notes may be helpful should you wish to try and find the fault yourself. We should however warn you to take care: it is not easy to unsolder from the board used as the holes are plated right through: damage caused in 'repairing' a fault cannot be covered under guarantee.

Display

The circuit diagram gives a key to segment and digit identification. Each digit consists of seven segments (lettered A – G) and a decimal point: terminals are *indicated on page 11.*

Each segment consists of a light emitting diode (L.E.D.) with two leads. One lead of each A segment is connected to the A terminal. Likewise one lead of each B segment is connected to B and so on.

The second connection to every segment in digit 2 is connected to terminal 2 and so on with digits 3 etc. Thus if IC1 wants to light up segment C on digit 3 it applies a pulse of voltage across connection C and 3 (via IFC2). The IC then pulses the next segment on the digit and so, by rapidly scanning segments and digits, causes a number to appear on the display. The chart below shows which segments are used to form each digit.

Segments illuminated

Digit to be formed	A	B	C	D	E	F	G
1		×	×				
2	×	×		×	×		×
3	×	×	×	×			×
4		×	×			×	×
5	×		×	×		×	×
6	×		×	×	×	×	×
7	×	×	×				
8	×	×	×	×	×	×	×
9	×	×	×	×		×	×
0	×	×	×	×	×	×	

Display Faults (refer to circuit diagram for key to segment and digit identification).

One segment on every digit does not glow: e.g. segment A on every digit will not light. This will be caused by a poor contact to segment A (connections are indicated on page 11). If decimal point will not light, then *DP* is badly connected and so on.

One digit will not light: this will be caused by a bad connection to one of the digit connections (2-9 on page 11).

Numbers appear incorrectly e.g. 1 appears as ⌟, 2 appears as ⊐, 4 appears as ⊔, 7 as ⌝. This would indicate a bridge of solder or wire between segment contacts C and D.

Display very dim (barely legible): possibly one cell wrong way round.

Weak display and batteries get hot: Contact plate (metal) and separator (clear plastic) are in wrong order: separator should be between the board and the contact plate.

Calculations erratic: can be caused by a damaged IC1 but can also be caused by a bad joint. Go over all the joints to IC1 again with a soldering iron.

Some buttons do not cause entry or operation: more than likely you have dirt or grease on the contacts. Dismantle the keyboard and clean the contact plate with white spirit and the board contact area with wadding metal polish. Polish it up with a soft, clean rag. Make sure you leave no polish on the board. Do not handle this area whilst reassembling.

Connections to IC1 are shown on the circuit diagram:-

a to g	:	segment outputs to display
N/C	:	*no connection*
D1 to D9	:	digit outputs to display
Ko, KN	:	keyboard input common lines
TEST	:	used in testing IC1 during manufacture
V_{GG}	:	−16v dc input
V_{DD}	:	−8v dc input
Vss	:	0v input
ϕC	:	internal 'clock' timing

Case will not click together at top right corner. This is invariably caused by the window being placed the wrong way round.

Conditions of return of calculators

Any calculator returned to Sinclair Radionics Limited for any reason whatsoever can only be given speedy attention under normal conditions of guarantee and service if the following requirements are met:

1. The calculator must be properly packed and sent postage prepaid.

2. Address the parcel to Sinclair Radionics Limited, Service Department 11K, St. Ives, Huntingdon PE 17 4HJ.

3. Include a letter stating contents of parcel (use the form included with these instructions).

4. Overseas service will be returned by surface mail, unless airmail has been prepaid.

Guarantee conditions

These conditions will differ on calculators sold by agents in countries other than the UK.

There is a Money Refund Guarantee on all kit machines purchased direct from Sinclair Radionics. We give an undertaking to refund your money if you return the kit untouched and undamaged to us within three weeks of receiving it.

Kits which have been partially or completely assembled are not included in this offer, when any refund or allowance made will be dependent upon the state of the returned item.

There is also a Service Guarantee: should your calculator not work after you have built it, Sinclair Radionics Limited will service it for you at a fixed charge of £2.50.

This offer assumes that the calculator is serviceable and does *not* include replacement parts which will be charged extra, at our discretion.

All prices include V.A.T.

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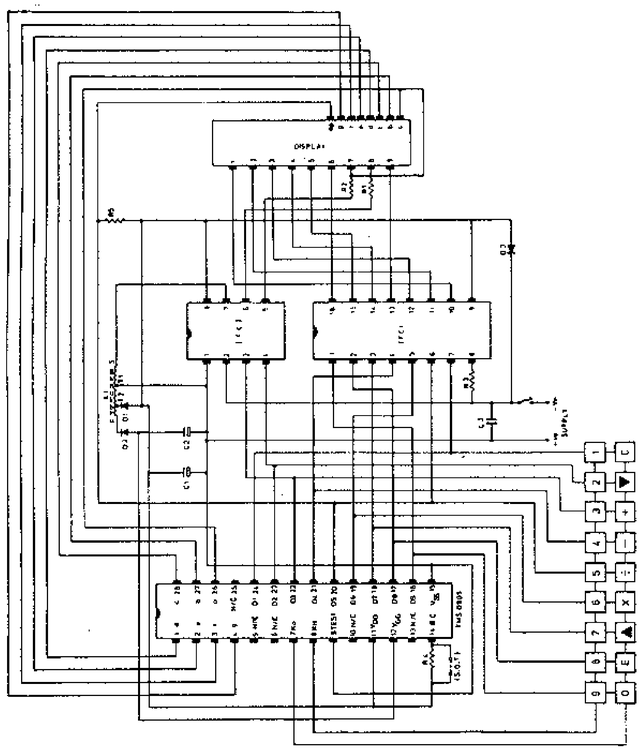
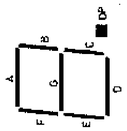
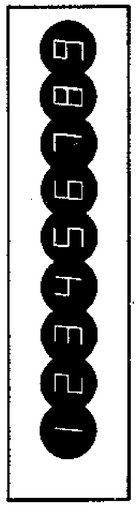
Circuit diagram





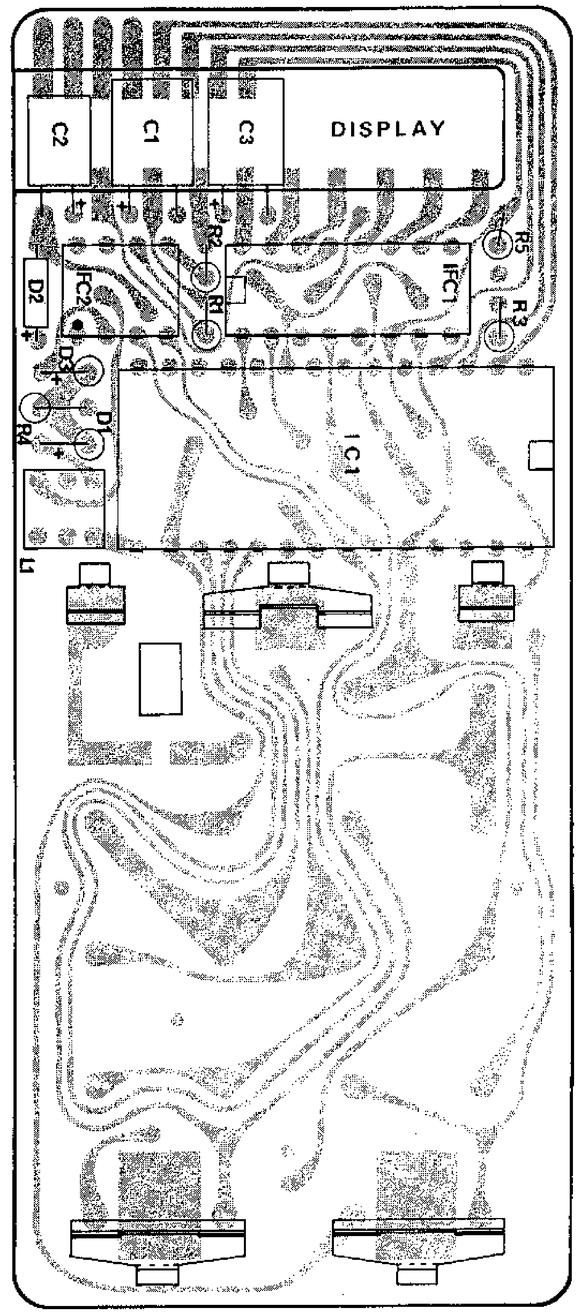
SEGMENT IDENTIFICATION



DIGIT IDENTIFICATION

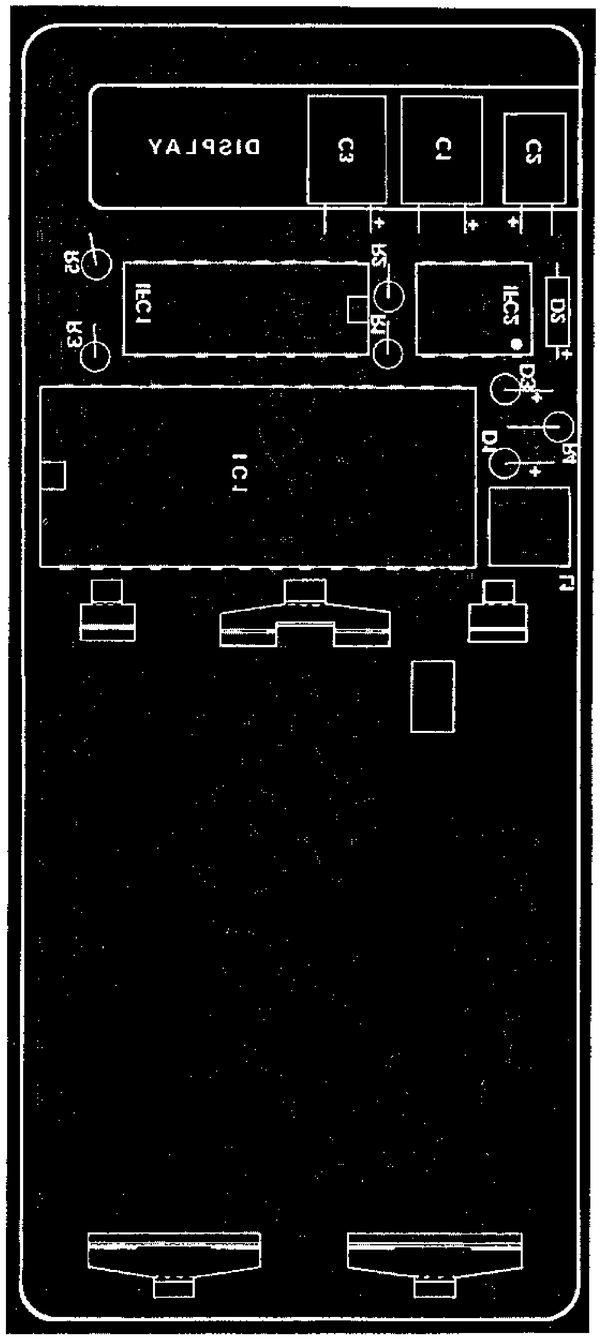
Master Diagram 1 – underside of PCB

Location of components, showing copper beneath components. Do not solder on this side of the board, except for display and battery clip.



Master Diagram 2 – top side of PCB

Shows components (in mirror image) as seen through board.
Solder this side.



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