The Wireless World Desk Calculator

Part 2: Construction and operation

by Roger Alexander and Brian Crank†*

Most of the constructional articles in *Wireless World* leave room for the reader to exercise his own expertise and imagination. We would not normally give detailed instructions unless there was some aspect which was particularly critical from the electrical performance point of view. With this desk calculator the situation is somewhat different. A kit of parts, complete to the last detail, is available and the object of this articles is to explain how the kit should be assembled. Each and every part in the kit has only one correct place in the finished calculator, therefore this article must of necessity comprise a very detailed list of instructions.

At the end of the article operating instructions are included in the form of worked examples, including a few typical electronics calculations.

The kit for the *Wireless World* Desk Calculator can be obtained from Advance Electronics Ltd, Calculator Division, Raynham Road, Bishop's Stortford, Herts, price £39.25 plus 75p postage & packing. Send a crossed cheque, postal or money order for the full amount with your order. The kit is supplied packed in polystyrene mouldings with all the individual components neatly laid out in a polystyrene tray. An internal view of the calculator giving the positions of the majority of components is shown in Fig. 12 and the finished machine in Fig. 13.

Points to watch

The two large expanded polystyrene mouldings and the cardboard box in which the kit is packed should not be discarded as they are designed to protect the completed calculator during storage or in the post should there be any need to return the calculator for servicing.§

There are two very critical aspects of the construction, one of which must be understood by the constructor *before the kit is unpacked.* It will be noticed that the calculator integrated circuit (TMS1802NC) is

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§The calculator kit is fully guaranteed against defective parts. If inspection reveals faulty components, they should be returned to Advance Electronics with the appropriate description and part numbers and they will be replaced under the guarantee. If the completed calculator should fail to function properly and attempts to find and cure the trouble prove ineffective, then the instrument may be returned to Advance for repair. A small service charge will be made where the defect is not covered by the terms of the guarantee included in each kit.

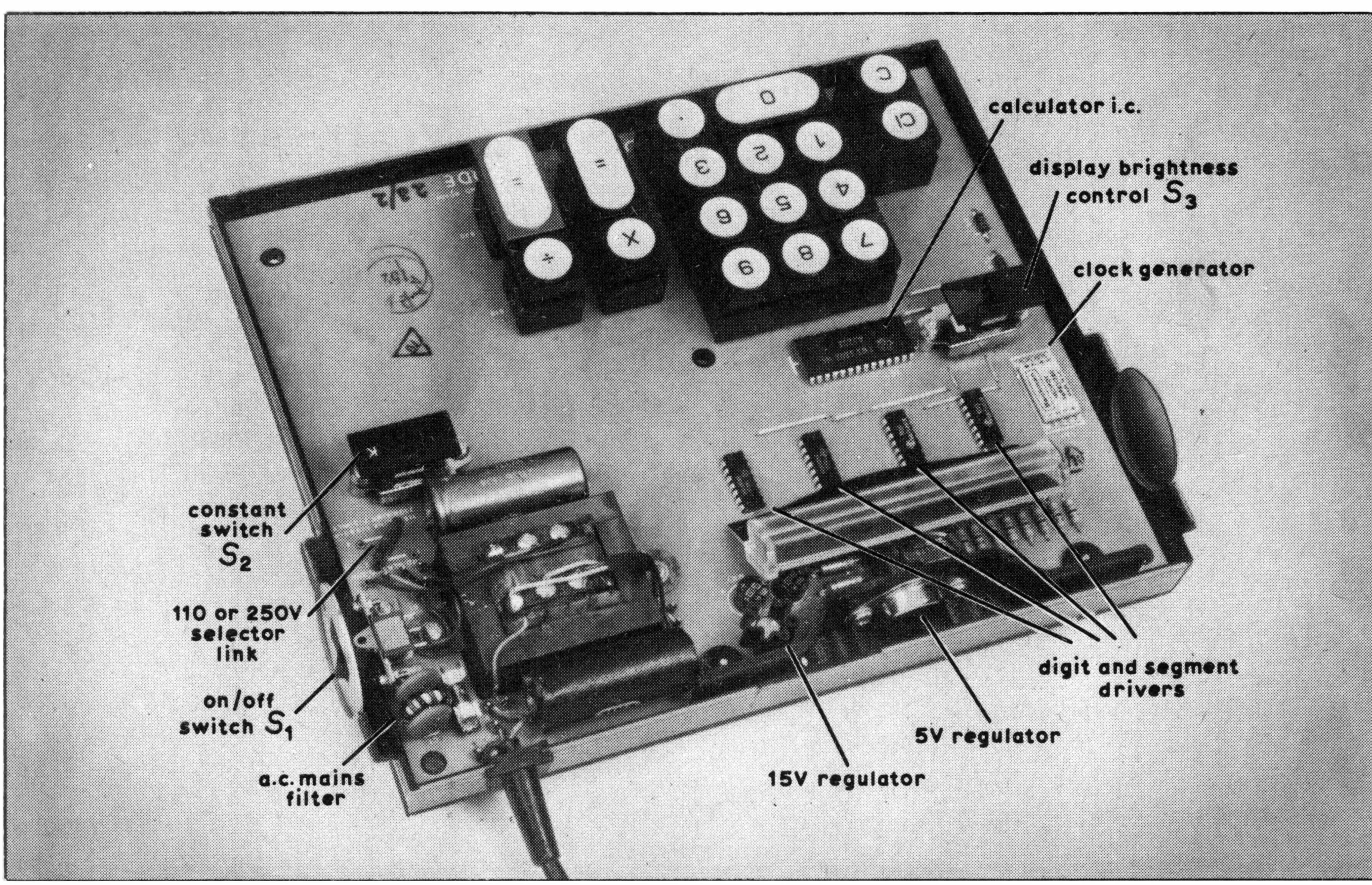


Fig. 12. Internal view of the calculator.

supplied with its leads embedded in what looks like ordinary black plastic foam material. The foam is in fact impregnated with a highly conductive material which short circuits all the leads during transport and handling. The reason for this is obvious when one considers the construction of the m.o.s. transistors in the i.c. The gate electrode of each m.o.s.f.e.t. is formed from a small metalized area insulated from the silicon chip by a very thin layer of silicon oxide. The impedance of the gates is extremely high and it is very easy to connect to the gate leadout wires a source of high voltage sufficient to puncture the oxide layer and destroy the i.c. Such voltage sources include static charges on nylon clothing or even bodily static charges. Anyone who has lived with a nylon carpet will know that such bodily static charges can be considerable, especially when one touches an earthed object or some object at a lower potential. Other sources of destructive high voltage can arise from capacitive coupling to the mains or, most important, unearthed soldering irons. Any attempt to solder the TMS1802NC calculator i.c. into the printed circuit board with an unearthed soldering iron will result in the instant destruction of the i.c. The TMS1802NC is by far the most expensive single item in the kit and to ensure it is not damaged the following precautions must be observed:

- Do not remove the black foam until the i.c. is to be soldered into the circuit board.
- Before removing the i.c. from the foam touch some earthed object to discharge any personal static charges.
- Grip the plastic package between the thumb and forefinger without touching the leadout wires.
- Only use a soldering iron of the highest quality which is connected to a *reliable* earth.

We apologize to readers with experience in handling m.o.s. l.s.i.cs for labouring these points, but, as such devices may not be commonly used by some constructors, they will be the first to realize the importance of strictly adhering to the rules above.

The second critical point concerns the l.e.d. numerical displays. There are nine display packages which have to be mounted side-by-side on a small printed circuit board which plugs into the main mother board. Each package measures about 6.9 by 5.6 mm and has nine leadout wires. This means that 81 soldered joints have to be made in a space 55 × 13mm (2.2 × 0.52 inches). This requires a steady hand and a soldering iron with a bit diameter not greater than 1 or 2mm; if it has a chisel head so much the better. This should not present a problem as a larger bit can be turned down to the correct diameter in an electric drill and finally shaped with a file.

There are two other requirements for the soldering iron: it must have a fairly long bit if some of the wires are to be connected without melting the insulation on others and it must be of low wattage to prevent damage to the very narrow tracks on the circuit boards. About 15W is ideal.

If you are in any doubt at all about your soldering iron, buy a new one as it will cost you less than £2.

All components, including the i.cs, should be mounted as tightly to the board as possible if the proper performance is to be achieved. It is a good plan *not to* bend component leads over by 90° on the soldering side of the printed circuit board as this is not necessary for good connection and makes component removal very difficult during servicing or during the correction of mistakes.

Access to the individual components packed inside the two case halves is by removing the single screw at the centre of the base of the bottom half of the case.

In the detailed instructions which follow open parentheses ( ) have been placed before each item for the constructor to tick as each task is completed as an *aide mémoire*.

Assembly

Upper case half (Fig. 14)

( ) Remove the five strips of self-adhesive packing foam fitted inside the upper half of the case and discard.

( ) Place a piece of gauze over the slots on the inside at the rear of the case and fix in position by *lightly* touching it at about 50mm (2in) intervals with the tip of a soldering iron. The idea is to melt a small portion of the plastics case just below the gauze so that the gauze is held in position

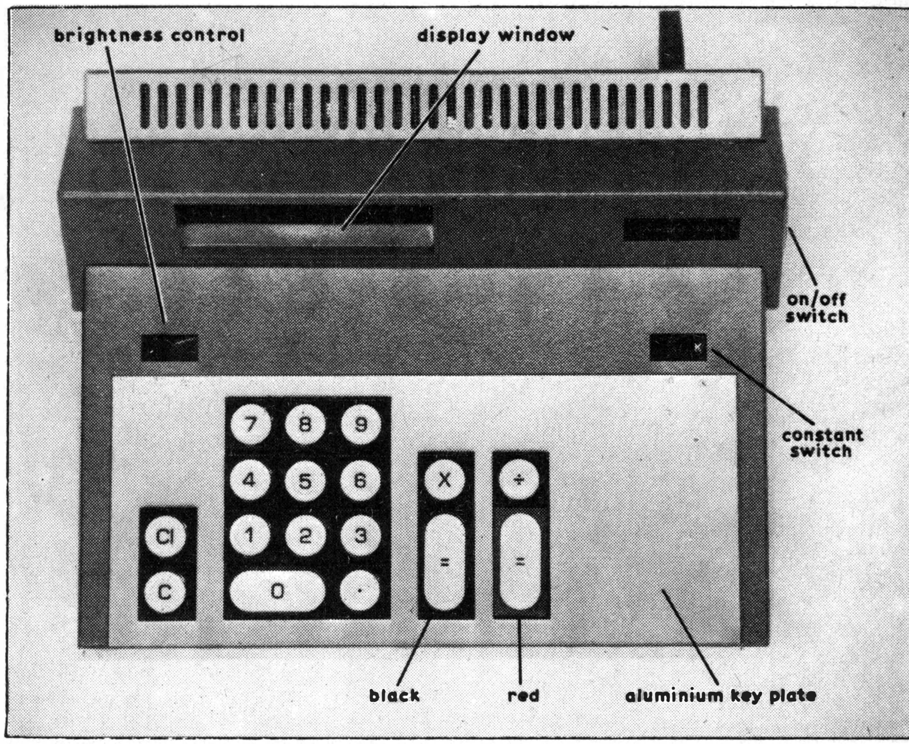


Fig. 13. The completed calculator showing the positions of the various keys and switches.

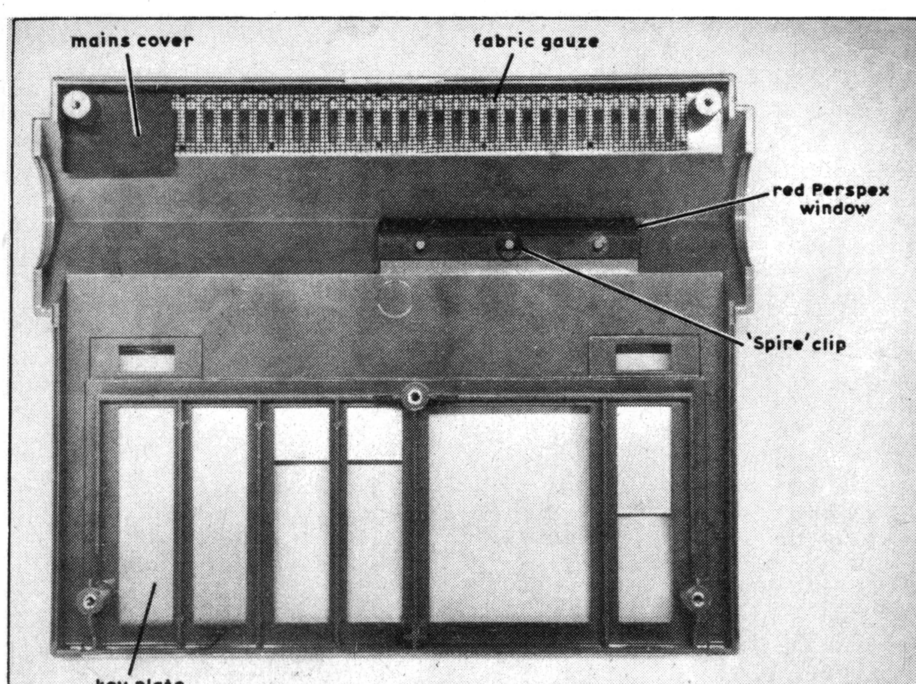


Fig. 14. Upper case half. The mains cover is not fitted until a late stage in the assembly procedure.

when the plastic sets. The emphasis is on the word lightly.

( ) Push the red Perspex window on to the three lugs and retain in position with a Spire clip on the centre lug. The concave side of the clip should face downwards.

( ) Remove the backing paper from the self-adhesive label 'Wireless World' and place in position in the indentation on the right-hand side of the case front (Fig. 13).

( ) Remove the backing paper from the large aluminium self-adhesive key plate and fit into position on the top of the case half. The best way to do this is to hold the plate at an angle of about 45° relative to the top of the case, locate the rear edge of the plate into the groove, and then bring the plate down into position. Press the plate down firmly to ensure good adhesion. *The plate has a thin protective layer of plastic; do not remove this until construction is completed.*

Lower case half (Fig. 15)

( ) Fix a piece of gauze over the slots on the inside of the case half in the same manner as before. This time remove a small piece of gauze from around the bulge in the case.

( ) Attach the self-adhesive serial number label to the indentation on the underside of the case half.

( ) Attach the self-adhesive lower plate (a piece of angle aluminium) to the case without removing the protective film.

( ) Push the two small rubber feet into the slots underneath the case with a small screwdriver.

5V regulator and heat sink sub-assembly (Fig. 16)

( ) Referring to Fig. 16 fit the 5V regulator (L005) to the heat sink (it will fit only one way) and bolt into position using two 6.32, 9.5mm ($\frac{3}{8}$in) long screws, using a plain washer and nut on one side and a solder tag, wavy washer and nut on the other. With the heat sink in the position shown in Fig. 16 (mounting lugs downwards) the solder tag should be on the left hand screw.

( ) With the heat sink in the position described, solder a red wire to the top lead out, a black wire to the bottom lead out and a yellow wire to the solder tag.
(Please observe the colour coding as the task of the engineers at Advance Electronics will be made easier should your calculator ever need servicing).

( ) Insulate each connection with one of the small sleeves supplied (do not use the large sleeve).
Place the heat sink assembly on one side.

Mains switch sub-assembly (Fig. 17)

( ) Mount the switch to the bracket using two 8BA, 6mm ($\frac{1}{4}$in) long, screws using plain washers, shake proof washers and nuts. The photograph shows the exact method of assembly.

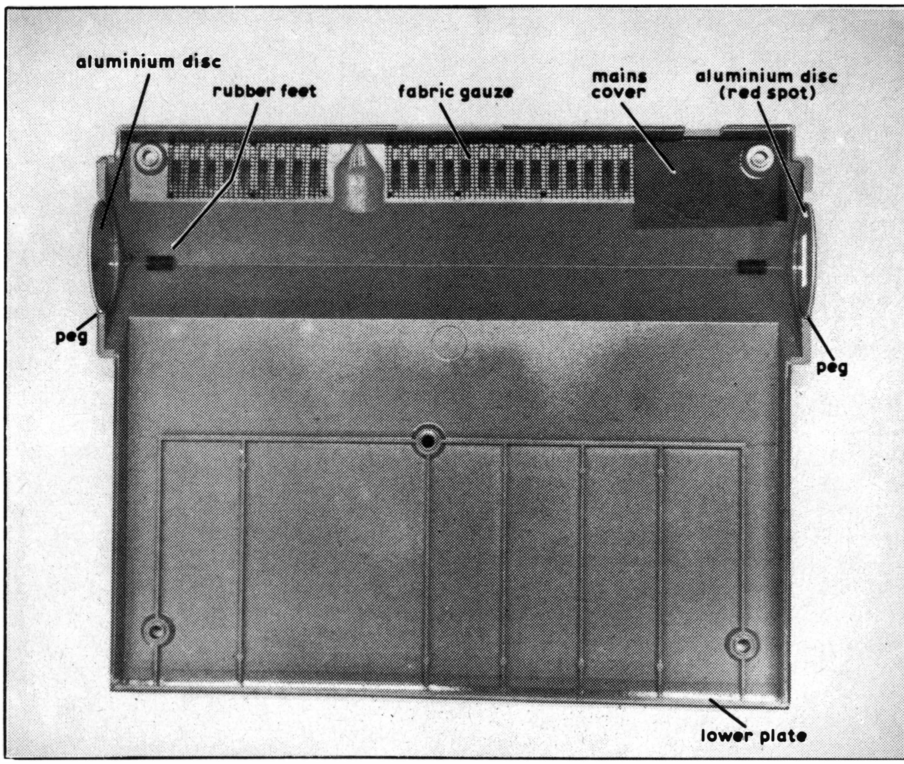
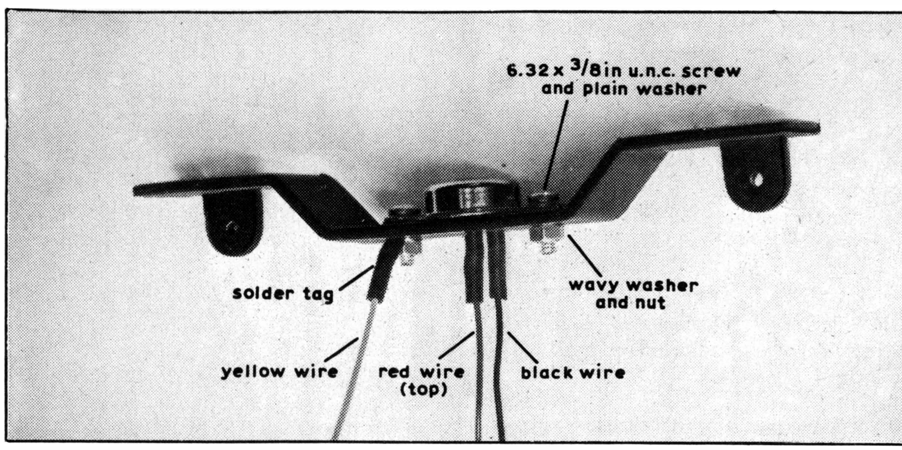


Fig. 15. Lower case half. Note the position of the cut-away in the gauze.



( ) Solder red wires to the terminals indicated in the photograph.
Place the assembly on one side.

Main circuit board (Fig. 18)

( ) Solder eight bare tinned copper wire links into position between holes connected by continuous white lines on the main circuit board (marked L on the photograph). *Do not solder links in the places marked '+ volts', '− volts' and '5 volts'.*

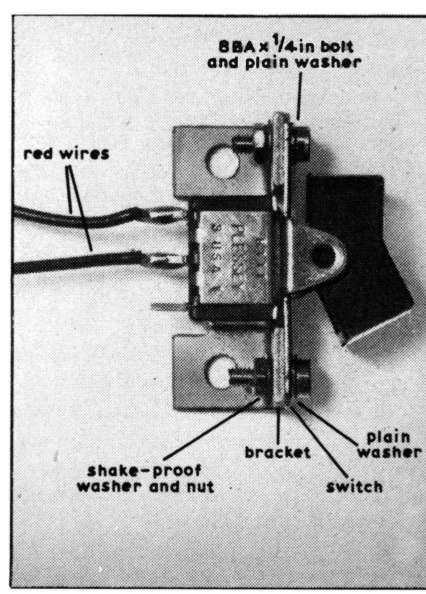
( ) Press fit the 21 miniature sockets into place and solder into position, making sure that the tops of the sockets are level with the top of the circuit board. Seventeen of the sockets (for the display sub-assembly) fit above the positions for the four d.i.l. i.cs. The remaining four are situated in the holes marked 1, 2, 3, and 4.

It will be found that all electronic component positions are marked with their reference number on the board.

( ) Fit resistor R_1, 220Ω, 0.5W.
Fit resistors R_2 to R_9, 47Ω, 0.25W.

Fig. 16. The 5V regulator and heat sink sub-assembly.

Fig. 17. Mains switch sub-assembly.



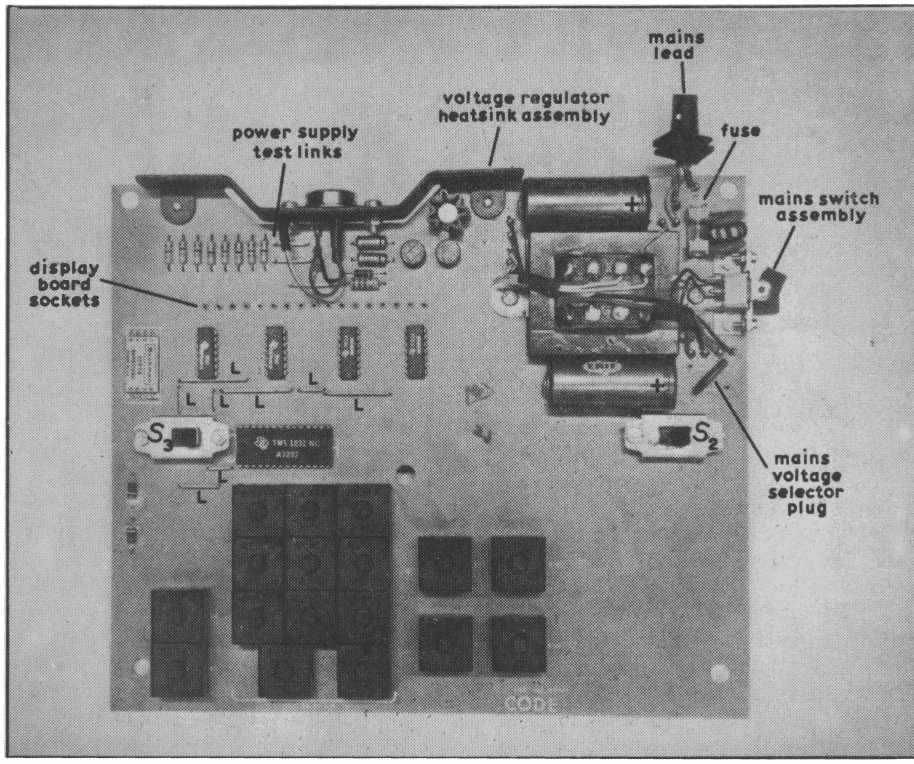


Fig. 18. Main printed circuit board showing the position of all components.

( ) Fit capacitors C_5 and C_6 (10μF, 16V). The printed circuit board has white lines to show the components' positions; the bisecting line indicates the positive end. The black line round the capacitor is the *negative* connection. The positive connection is at the end nearest R_9.

( ) Fit diodes. D_1 7.5V zener
D_2, D_3, IN4001
The white band indicates the positive end.

( ) Fit bridge rectifiers MR_1 and MR_2 (type W005). The '+' mark on the rectifier's body must line up with the '+' mark on the circuit board. (Ensure that the bridges are pushed down flush with the board.)

( ) Fit the 15V regulator IC_1 (TBA 625C). The pip on the TO-5 case must line up with the marking on the board. Make sure the bottom of the can is flat on the board.

( ) Press fit corrugated heat sink on to IC_1.

( ) Fit fuse holder into the two large holes to the left of the mounting position for C_1 and C_2.

( ) Cut, strip and tin the four wires from the toroidal coil L_1. The red wires go to the holes marked 'R' and black wires to the holes marked 'B'. The coil is mounted so that it stands upright and is flush to the board.

( ) Fit capacitors C_1 and C_2 (1.8nF marked 1800p) either side of L_1. Together C_1, C_2 and L_1 form a mains pulse interference suppressor.

( ) Fit the hybrid integrated circuit clock generator in the white package (9698 21280) so that pin 1 corresponds to the 1 marked on the board.

( ) Fit IC_3 and IC_4 (SN75491N) so that the 'horse shoe' indentation corresponds to the horse shoe marking on the board.

( ) Fit IC_5 and IC_6 (SN75492N). Each package has a horse shoe indentation which must be lined up with the board marking.

( ) Fit capacitors C_3 (2,200μF) and C_4 (1,500μF); the '+' marking on the components lining up with the '+' markings on the board.

( ) Fit the display brightness control switch S_3 (three-position slide) in the following manner: Push a 14mm ($\frac{9}{16}$in) 4.40 u.n.c. (unified coarse thread) screw through the circuit board from underneath and place a pillar, the switch and a wavy 4.40 washer on the screw in that order. Loosely secure with a nut. Repeat the procedure for the other switch mounting hole. Tighten up screws and then (*and only then*) solder the switch connections to the board.

( ) Fit S_2 (two-position slide) to the board in the same manner as S_3.

( ) Remove the tops of all the key switches by giving them a slight pull.
It will be noticed that the base of the key switches is formed from two snap-together parts which contain the magnet and reed switch assembly. These two parts of the switch are matched and must not be interchanged.
The shot-moulded key tops (with the numbers, letters etc,) are fully interchangeable.

( ) Fit all the key-switch bases to the board (they will only go in one way) and carefully align them both horizontally and vertically before soldering. Pieces of card and elastic bands may be of help here. Solder the switches in position.

If any switches have become misaligned melt the solder for that switch and 'juggle' it into position.

( ) Strip and tin the three wires from the 5V regulator and heat sink assembly and solder them to the circuit board pins as follows:
Red to pin B
Black to pin E
Yellow to pin C

( ) Identify the two 'Tapex' self tapping screws (when viewed from the thread end they have a very slightly triangular cross section). The screws are 4.40 u.n.c. and are 6mm ($\frac{1}{4}$in) long. Use these screws to secure the heat sink assembly to the main circuit board.

( ) Lay the mains transformer (T_1) in the oblong cut-out in the printed circuit board with the white wire to the rear. Bolt the transformer in position using two 6.32 u.n.c. 8mm ($\frac{5}{16}$in) long screws, 6.32 wavy washers and nuts. The nuts and washers should be on the underside of the board.

( ) Cut the remaining large sleeve in two. Place one half over the blue and yellow wires and the other half over the red, black, orange and brown wires. These sleeves are to keep the wires neatly in a bundle and are not for insulating purposes.

( ) Solder the transformer lead-out wires to the marked circuit board pins as follows (all the wires are tinned and are already cut to the correct length):

blue wires,	one to each pin BL
yellow wires,	one to each pin YW
red wire	to RD
black wire	to BLK
orange wire	to ORG
brown wire	to BRN
white wire	to W

( ) Bolt mains switch to board using two 4.40 u.n.c., 6mm ($\frac{1}{4}$in) long, screws, 4.40 wavy washers and nuts. Refer to Fig. 18. The nuts and washers should be on the underside of the board.

( ) Solder the two red wires from the mains switch assembly to the two pins marked $S1$ (one wire to each pin!).

( ) Read the warning notes at the beginning of this article regarding the calculator i.c. TMS1802NC.

( ) Fit IC_7 (TMS1802NC) to the printed circuit board after removing the conductive foam. If the i.c. has a horse shoe marking the device must be fitted so that this marking corresponds with the horse shoe marking on the board. That is, nearest to the switch S_3. The i.c. may, however, have a dot on the package indicating pin 1. If this is the case the package must be fitted with the end with the dot nearest to S_3.

If the pins on the i.c. do not line up with the holes in the circuit board bend the pins by pressing them on a flat, insulating, surface. Remember not to touch the pins with the fingers.

( ) Solder the mains lead to the main circuit board pins as follows (the leads are tinned and have already been cut to the correct length):

green/yellow to pin E
brown to pin L
blue to pin N

This completes the main circuit board assembly.

Display printed circuit board assembly (Fig. 19)

The display board involves some fairly intricate soldering. The constructor must therefore have a suitable soldering iron and should preferably be working in a quiet environment to assist concentration.

The display printed circuit board is double sided and has plated through holes. It comes equipped with 17 mounted pins which have been accurately set at 45° and spaced to match the 17 sockets in the main circuit board. The alignment of these pins should not be disturbed.

( ) Solder the mounted pins to the printed circuit track on side A of the display board taking great care to prevent solder running down the pins. If this happens the solder will have to be removed before the display board will plug into the main circuit board.

( ) Insert one indicator into position LD9 on side B of the board ensuring that the type number on the package is facing in the direction indicated on the board. All the pins on the packages are accurately preformed and the package should be pushed down as far as the bends on the leads. Hold the digit in place while turning the board over. *Solder the middle pin only*. The middle pin has only a copper pad to solder to but as the hole is plated through solder will flow down into the hole and around the lead.

If necessary the solder connection should be re-heated whilst gently manipulating the indicator until the package reaches its final position. (Hard down against the bends in the leads and square).

( ) This procedure is repeated for the other eight digits (LD8 to LD1) ensuring that the indicators are inserted with the type number in the right direction and that only the middle pin on each package is soldered, making sure that all the packages finally sit at the same height. This can be achieved by very carefully melting the solder round the centre pin (taking care not to overheat) and manipulating each individual indicator. All the indicators should be true and square in all three planes.

( ) Cut all the indicator leads off so they stand about 1.5mm ($\frac{1}{16}$in) proud of side A of the board.

( ) Solder all the remaining connections, taking them a row at a time and taking care not to miss any. Soldering must be carried out only on side A of the board. The other holes in the board do not need soldering as they are plated through.

( ) Examine the display printed circuit board, with a magnifying glass if available, for conductors bridged with solder and missed connections.

Power supply test

WARNING: WHENEVER THE MACHINE IS CONNECTED TO THE MAINS CERTAIN COMPONENTS AND CERTAIN CONDUCTORS ON THE PRINTED CIRCUIT BOARD ARE AT MAINS VOLTAGE. CARELESS HANDLING COULD RESULT IN A FATAL ACCIDENT. TAKE CARE.

( ) Place the main circuit board assembly in the lower case half, locating the raised lugs in the holes in the circuit board.

( ) Fit red 'plug links' for the appropriate mains supply as indicated on the main circuit board and insert a 50mA fuse in the fuse holder.

( ) Connect a suitable mains plug to the mains lead in the usual manner:

brown – live
blue – neutral
yellow/green – earth

( ) Plug the calculator into the mains socket and switch on the calculator.

( ) Measure the voltages present at the pins marked '5 volts', '+ volts' and '– volts' nearest to C_5 and C_6. The results should be as follows (use the case of the TO-3, 5V regulator as common):

5 volt pin	$5V \pm 0.25V$
+ volt pin	$+7.5V \pm 1V$
– volt pin	$-7.5 \pm 1V$

( ) Switch off and remove mains plug.

( ) If the voltage measurements were within the prescribed limits one can proceed with the construction. If they were not, locate and cure the trouble *before proceeding any further*.

( ) Solder in place three bare tinned copper wire links marked '5 volts', '+ volts' and '– volts'.

( ) Remove the printed circuit board from the lower case half and place it on a raised flat surface clearing the mains transformer protrusion.

( ) Push the key switch tops into position referring to Fig. 13.

( ) Place the constant slide switch top (S_2) into position with the 'K' marking to the right.

( ) Place the display brightness switch top (S_3) into position with the red section to the right.

( ) Plug the display printed circuit board into the 17 sockets in the main circuit board. A considerable amount of force is necessary so one must be very careful if nothing is to be broken.
(If it is necessary to remove the display board at any time carefully lever it upwards using a large screwdriver, taking care not to distort the pins).

( ) Place the main circuit board back into the lower case half as before.

Functional test

( ) Replace the mains plug, switch on, place K switch to right, and perform the tests detailed in Table 2.

If the calculator does not operate correctly examine all connections, referring to the circuit diagram (Fig. 20) and the calculator description given in the first article. If you are still unable to trace the fault complete the assembly procedure and, after carefully packing the calculator, return it to Advance Electronics for servicing.

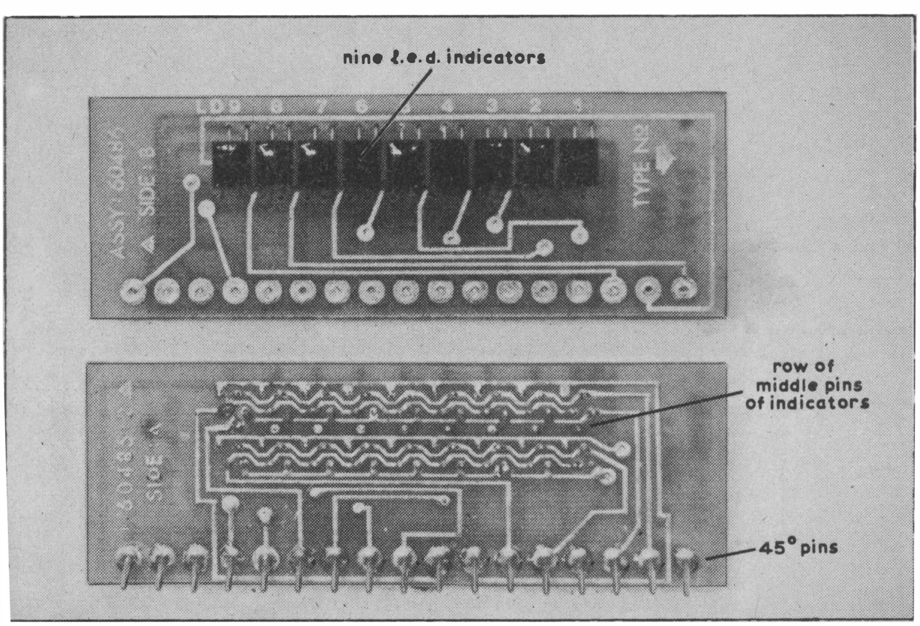


Fig. 19. Both sides of the indicator printed circuit board.

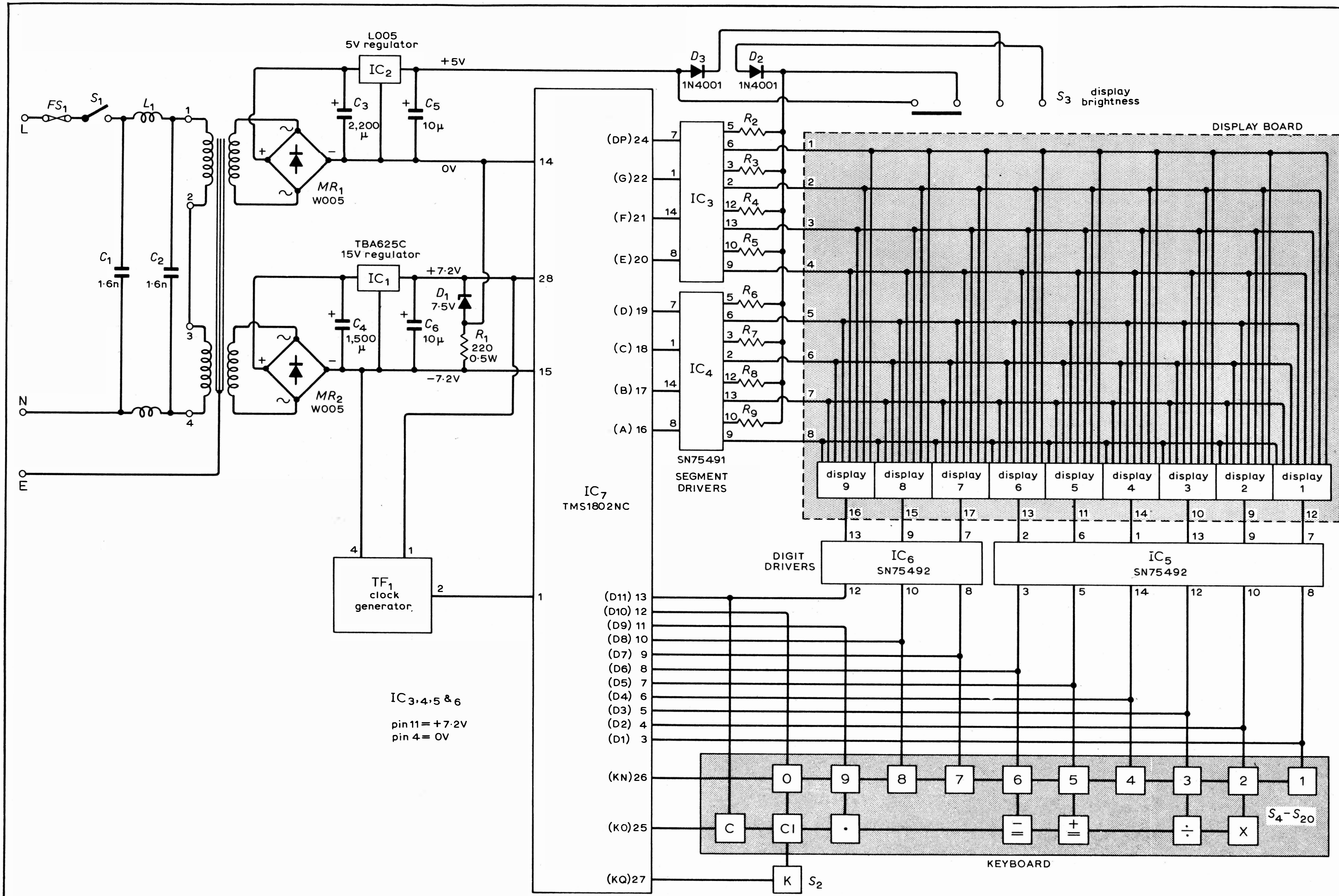


Fig. 20. Circuit diagram of the calculator.

Table 2

KEY OPERATION	DISPLAY READING
C	0.
1.2 3 4 5 6 7 9 0	C 1.2345679
Cl	0.
8 8 8 8 8 8 8 8	88888888.
X	88888888.
Black =	⊔ 790 12344.
'K' switch to the far left (constant in)	
C	0.
.1 2 3 4 5 6 7	0. 1234567
X	0. 1234567
1	1
Black =	0. 1234567
÷	0. 1234567
.1 2 3 4 5 6 7	0. 1234567
Red =	— 1

Cl: Clears the last number entered (should an error have been made) and resets the display register to 0.

K: Enables the calculator to store the command to multiply or divide by a number which does not vary for a series of calculations.

It will be remembered (Part 1) that the extreme left-hand indicator is used to indicate if the displayed number is negative or if some abnormal condition exists within the calculator. The symbols and their meanings are repeated in Table 3.

When an entry overflow is indicated calculations can continue but the symbol will remain illuminated until the machine is cleared.

Table 3

C	entry overflow
⊔	answer overflow
—	negative number
6	entry overflow, answer overflow and negative number

Final assembly

( ) Cut the mains cover (a piece of black card with two holes punched in it) in the centre of the two fold lines and fit to the upper and lower case halves as shown in Figs. 14 and 15 after folding along the fold lines.

( ) Fit the circuit board into the lower case half ensuring that the lugs fit into the holes at the corners of the circuit board. It is best to align the left hand front hole first.

( ) Push the moulding on the mains lead firmly into the slot at the rear of the case.

( ) Fit the disc with the red dot into the groove at the right hand side of the case. The slot in the disc fits over the mains switch and the red dot should be towards the front of the case.

( ) Fit the second disc in its groove at the left hand side of the case (spun finish outwards) with the peg towards the front.

( ) Fit the display shield (a piece of black card with a slot cut in it) over the indicators so that it rests on the indicator leads.

( ) Slide the Perspex magnifier over the indicators, making sure that the printed circuit board and the display shield fit in the slots in the magnifier.

( ) Place the top half of the case in position ensuring that the end discs and the slide switch tops fit into their grooves and slots.

( ) Secure the two case halves together with five 6.32 u.n.c., 12mm ($\frac{1}{2}$in) long screws fitted from underneath.

( ) Remove the thin protective film of plastic from both the aluminium key plate and the lower aluminium plate.

The calculator is now complete and if it has been carefully constructed should have a long and trouble free life. Note that a dust cover is provided to protect the machine when it is not being used.

Operating the calculator

Entering a number into the calculator is simply a matter of pressing the appropriate keys, as was seen during the test procedure. For instance, to enter 15.36 one presses key 1, then key 5, then the decimal point key followed by keys 3 and 6.

The operations which the various keys perform are set out below. Some of the explanations may not be clear at this stage but they will be clarified during the practical examples.

×: Stores the command to multiply and executes a possible preceding instruction.

÷: Stores the command to divide and executes a possible preceding instruction.

= (black): Performs addition. Enters the last number keyed into the calculator (which is indicated on the display) and performs a possible preceding instruction.

= (red): Performs subtraction. Enters the last number keyed into the calculator (which is indicated on the display) as a negative number and performs a possible preceding instruction.

C: Resets the whole calculator to 0.

If the symbol appears which indicates that the result of a calculation has exceeded the capacity of the machine the answer will be correct to the eight most significant digits and the decimal point must be shifted eight places to the right to obtain the correct answer.

Some worked examples follow and it is recommended that the reader tries these to familiarize himself with the machine.

During the examples a colon (:) will be used to indicate that keystrokes have to be made.

The instruction 5.1: means press key 5 followed by the decimal point key followed by the 1 key, in other words, enter 5.1. In the same manner the following instructions are to be interpreted as follows: ×: press multiply key; ÷: press divide key; B=: press black equals key; R=: press red equals key; → K: slide constant switch to the right; ← K: constant switch to the left; and C: press clear key. The number which will appear on the display is printed in square brackets [4159659] whenever the indicated number is significant.

General arithmetic examples

Example a. 15.3+27.9
C: 15.3: B=: 27.9: B=: [43.2]

Example b. 14.8−4.12
C: 14.8: B=: 4.12: R=: [10.68]

Example c. 15−7+8
C: 15: B=: 7: R=: 8: B=: [16]

Example d. 1.3923905 × 400
C: 1.3923905: ×: 400: B=: [556.9562]

Example e. −3 × 8
C: 3: R=: ×: 8: B=: [−24]

Example f. $22 \div 7$
C: 22: $\div$: 7: B= : [3.1428571]

Example g. $5 \times (-7) \div (-3)$
C: 5: $\times$: 7: R= : $\div$: 3: R= : [11.666666]

Example h. $\dfrac{4(5+7-3)}{2} - 3$

C: 5: B= : 7: B= : 3: R= : $\times$: 4: $\div$: 2: B= : 3: R= : [15]

Example i. Convert 17.1, 19.5, and 23 inches to millimetres. There are 25.4mm to the inch.
C: ← K: 25.4: $\times$:
The machine has now stored the instruction multiply by 25.4 in its constant register. Proceed as follows:

17.1: B= : [434.34] mm
19.5: B= : [495.3] mm
23: B= : [584.2] mm

Notice that there was no need to enter the instruction to multiply or 25.4 between each calculation, nor was there need to clear the machine.

Example j. Convert \$17.26, \$15.33 and 77c to pounds assuming that the exchange rate is \$2.55 to the pound.
C: ←K: 17.26: $\div$: 2.55: B= : [6.7686274] which would be rounded off to £6.77. The machine has now stored the instruction to $\div$ 2.55. Proceed as follows

15.33: B= : [6.0117647] (£)
.77: B= : [0.3019607] (£)

Example k. $7^4 \times 3$
C: ← K: 7: $\times$: 3: B= : B= : B= : B= : [7,203]

Example l. $46 \div 3^3$
C: ← K: 46: $\div$: 3: B= : B= : B= : [1.7037036]

Example m. Find 3^2, 3^3, 3^4, $3^5 \ldots 3^n$
C: ← K: 3: $\times$: B= : [9] = 3^2
B= : [27] = 3^3
B= : [81] = 3^4
B= : [243] = 3^5 etc.

Make sure the constant switch is in the right hand position before the next example.

Example n. Find the reciprocal of 0.000081 (= 1/0.000081).
There are two ways of doing this.
C: 1: $\div$: 0.000081: B= : [12345.679]
If 0.000081 is the result of an earlier calculation and is already held in the machine it is inconvenient to use the technique above to find the reciprocal as it would be necessary to clear the calculator and enter 1$\div$ and the number.
The calculator holds 0.000081 as the result of a previous calculation (to simulate this enter 0.000081 followed by B= :). To find the reciprocal proceed as follows:
← K: $\div$: B= : [1] (indicated) → K: B= : [12345.679]
To prove the result repeat the operation
← K: $\div$: B= : → K: B= : [0.000081]
This technique can be used to great advantage as will be seen in later examples.

Example o. Find the square root of 35. The method uses the well known formula:

$$= \frac{1}{2}\left(\frac{x}{n}+n\right)$$

where n is an approximation and x is the number the square root of which is required. A mental approximation can be tried on the calculator and 5.9 seems reasonable
C: 5.9: $\times$: B= : [34.81] = (5.9^2)
which is not far from 35.
To find $\sqrt{35}$ proceed as follows:
C: 5.9: B= : ← K: $\div$: B= : → K: 35: B= : 5.9: B= : $\div$: 2: B= : [5.9161015]
The result of this calculation (5.9161015) is used in place of 5.9 and the procedure is repeated. Because 5.9161015 is already in the machine the first three operations are omitted.
← K: $\div$: B= : → K: 35: B= : 5.9161015: B= : $\div$: 2: B= : [5.9160795]
The procedure is repeated with the new approximation:
← K: $\div$: B= : → K: 35: B= : 5.9160795: B= : $\div$: 2: B= : [5.9160795]
This is the same as the second approximation and the process is complete. To calculate the error, with the result still in the machine, all one need do is square 5.9160795:

$\times$: B= : [34.999996]
R= : 35: B= : [0.000004]

which represents the error.
In general the iteration process is continued until the square root is correct to the required number of decimal places.

Some typical examples in electronics

Example p. Find the resistance R of a circuit consisting of 3.9kΩ in parallel with 5.6kΩ using the formula:

$$R = \frac{3.9 \times 5.6}{3.9+5.6} \times 10^3$$

This can be solved by calculating the denominator and using the constant register to store $\div(3.9+5.6)$ while 3.9×5.6 is being found:
C: 3.9: B= : 5.6: B= : ← K: $\div$: B= : → K: 3.9: $\times$: 5.6: B= : $\times$: 1000: B= : [2298.9472]Ω

Example q. A tuned circuit is required which will resonate at 10.7MHz; calculate suitable values of L and C using the formula:

$$10.7 = \frac{159}{\sqrt{LC}}$$

where L is in μH and C is in pF.
$\sqrt{LC} = 159/10.7$
C: 159: $\div$: 10.7: B= : [14.859813] ($=\sqrt{LC}$)

$$\sqrt{LC} = 14.859813$$
$$\therefore \quad LC = (14.859813)^2$$

(14.859813 is already in the calculator)

$\times$: B= : [220.81404] (= LC)

If a value of 8μH is chosen for L:

$$C = 220.81404/8$$

(220.81404 is already in the calculator)
$\div$: 8: B= : [27.601755]
$\therefore \quad C = 27\text{pF}, L = 8\mu\text{H}.$

As an exercise, to prove the calculation, proceed as follows: (we have already established 14.859813 as being $\sqrt{LC}$)
C: 27.601755: $\times$: 8: $\div$: 14.859813: B= : ← K: $\div$: B= : → K: 159: B= : [10.7]

Example r. Assuming that the coil of the above example has a resistance of 5Ω calculate its dynamic resistance r_d using the formula:

$$r_d = (L/CR) \times 10^6$$

where L is in μH, R is in ohms and C is in pF

$$r_d = [8/(27 \times 5)] \times 10^6$$

C: 27: $\times$: 5: B= : ← K: $\div$: B= : → K: 8: B= : $\times$: 1000000: B= : [59,259.2]

$$r_d = 59{,}259.2\Omega$$

Example s. Find the Q of the coil in examples **q** and **r** using the formula:

$$Q = r_d/(2\pi f L)$$
f in MHz, L in μH

C: 2: $\times$: 3.1416: $\times$: 10.7: $\times$: 8: B= : ← K: $\div$: B= : → K: 59259.2: B= : [110.17958]

$$Q = 110$$

Example t. The 3dB bandwidth of the tuned circuit ($=f_0/Q$) can be calculated as follows:
C: 10.7: $\times$: 1000: $\div$: 110: B= : [97.272727]

3dB bandwidth = 97kHz

There are of course many other ways in which the calculator can be used but by now the reader should be able to discover them for himself.

V.H.F. Reception

Wireless World is collecting information for a survey on the reception of v.h.f./f.m. sound broadcasts and will be glad to hear of readers' experiences and opinions on this subject. The following topics would be of interest: design, performance and price of receivers; facilities on sets; dealers' experience in selling and installing sets; users' experience of buying sets and after-sales service; comparison of v.h.f./f.m. broadcast reception with that on medium and long waves; and interference effects from other stations (e.g. national vs. local), from man-made sources and natural sources.