OCTOBER 1975
75c*

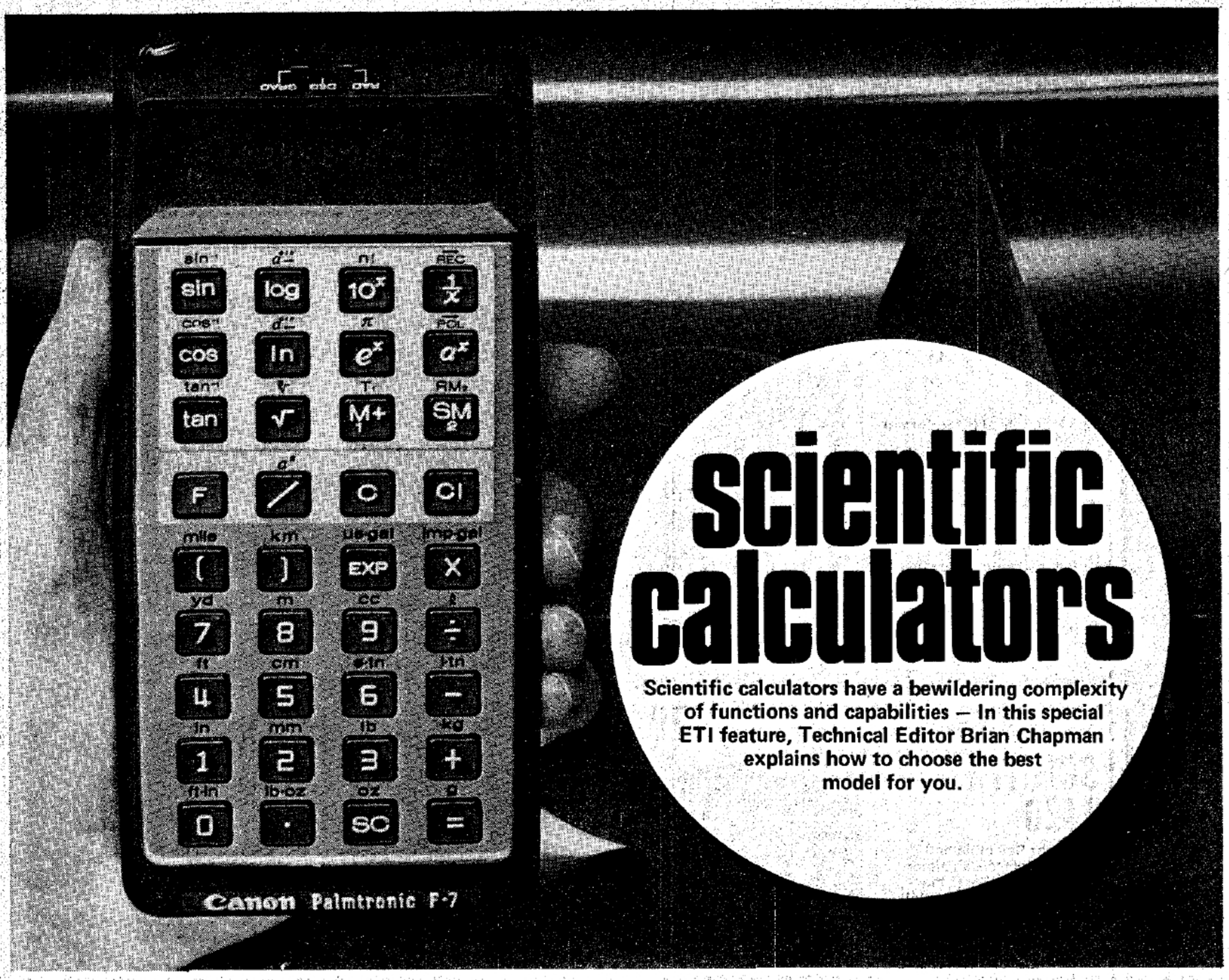
electronics TODAY

Registered for posting as a periodical — Category C. NZ 85c

OFF ON DEG RAD

LIFE ON MARS?

SCIENTIFIC CALCULATORS



scientific calculators

Scientific calculators have a bewildering complexity of functions and capabilities — In this special ETI feature, Technical Editor Brian Chapman explains how to choose the best model for you.

SINCE our first calculator survey published two years ago in the July 1973 issue of Electronics Today there has been an astonishing change in prices and capabilities of electronic calculators. At that time the cheapest four-function calculator in the survey was $67 with the average being around $120. Now, the cheapest four-function machine sells for $10! And the average price is around $30 for machines that include a memory.

The market is so large and the competition so fierce that many companies have dropped out of the calculator scene and it now seems to be that companies having their own integrated circuit manufacturing capabilities are dominating the market. This is exemplified by the entry of National Semiconductor into the field with their very competitively priced "Novus" range that extends from the cheapest four-function machine to several 100 step programme machines.

The price war seems to be largely over in the four-function category and has shifted to the scientific models. Prices are continuing to drop on these models and new models with ever greater capabilities are released almost continually. It seems that soon the price of machines having HP35 capability will fall to around $30, and fully programmable types (eg HP65) to around $150.

The size of the market may be gauged from the sales of the Sharp Corporation. In the 1974 financial year Sharp manufactured 14.9 million calculators for a claimed 40% share of the world market.

All in all the scientific calculator field is an interesting and exciting one. It has one disturbing aspect however. If you have bought a calculator 12 months ago it is not nice to know that the same calculator is now selling for from half to one quarter of what you paid for it.

SELECTING A CALCULATOR

To select a scientific calculator requires some careful thought. One must first decide what kind of problems must be handled and how much capability is really required. Fully programmable calculators are very nice indeed but cost a lot of money — do you really need the programme capability?

As an aid to selection the following sections describe the salient features of scientific calculators, and the survey chart provides details of most of the makes and models at present available on the Australian market.

ENTRY MODES

Algebraic:

Most people would be familiar with the algebraic-entry mode used on the majority of simple four-function calculators and on many scientific calculators. This problem entry method closely follows the manner in which equations are written. That is, the key sequence for multiplying two by three would be:—

[2] [x] [3] [=]

An alternative entry mode is used on an occasional simple calculator and on many scientific machines. This entry

mode is known as "Reverse Polish". The key sequence for the above problem is:—

[2] [ent] [3] [x]

The ENTER key causes the previously entered number to be transferred from the working register to a temporary storage register and instructs the calculator to treat the next digits keyed in as a new number entry, and not as additional digits of the first number. The command for the desired operation is then keyed in to complete the calculation.

At first sight it would appear that there is no advantage in using this latter procedure as, in the example given, there are exactly the same number of key presses required to solve the problem. Further it is an unfamiliar procedure to which one must become accustomed.

But suppose we had a slightly more difficult problem such as:

$$(3 + 7) \times (9 - 3)$$

To solve this problem we must perform the calculations within the brackets first. We therefore need to store the result of one bracketed calculation whilst we perform the other. The key sequence would therefore be:

[3] [x] [7] [=] [M+] [9] [–] [3] [X] [RM] [=]

Notice that we need a memory and a total of 11 key presses to solve the problem.

More advanced algebraic machines incorporate facilities to key in the parenthesis brackets. With such a machine the key sequence would be:

[3] [+] [7] [X] [(] [9] [–] [3] [)] [=]

An improvement as we now need only 10 keystrokes and do not need to use our memory.

Reverse Polish:

With machines that have Reverse Polish entry a three or four deep stack of registers is used to perform the working calculations. For example in the Hewlett Packard calculators there are four registers labelled X, Y, Z and T with the X register being the one that contains the displayed number. These working registers or "stack" as it is called are completely independent of the normal memory registers.

The key sequence for our problem when done on these machines would be:—

1	2	3	4	5	6	7	8	9
[3]	[ENT]	[7]	[+]	[9]	[ENT]	[3]	[–]	[X]

Note that now there are only nine key presses required and that the registers automatically shift contents up and down as the problem proceeds. The stack contents for the above key sequence would be as shown in the table.

	1	2	3	4	5	6	7	8	9
T									
Z						10	10		
Y		3	3		10	9	9	10	
X	3	3	7	10	9	9	3	6	60

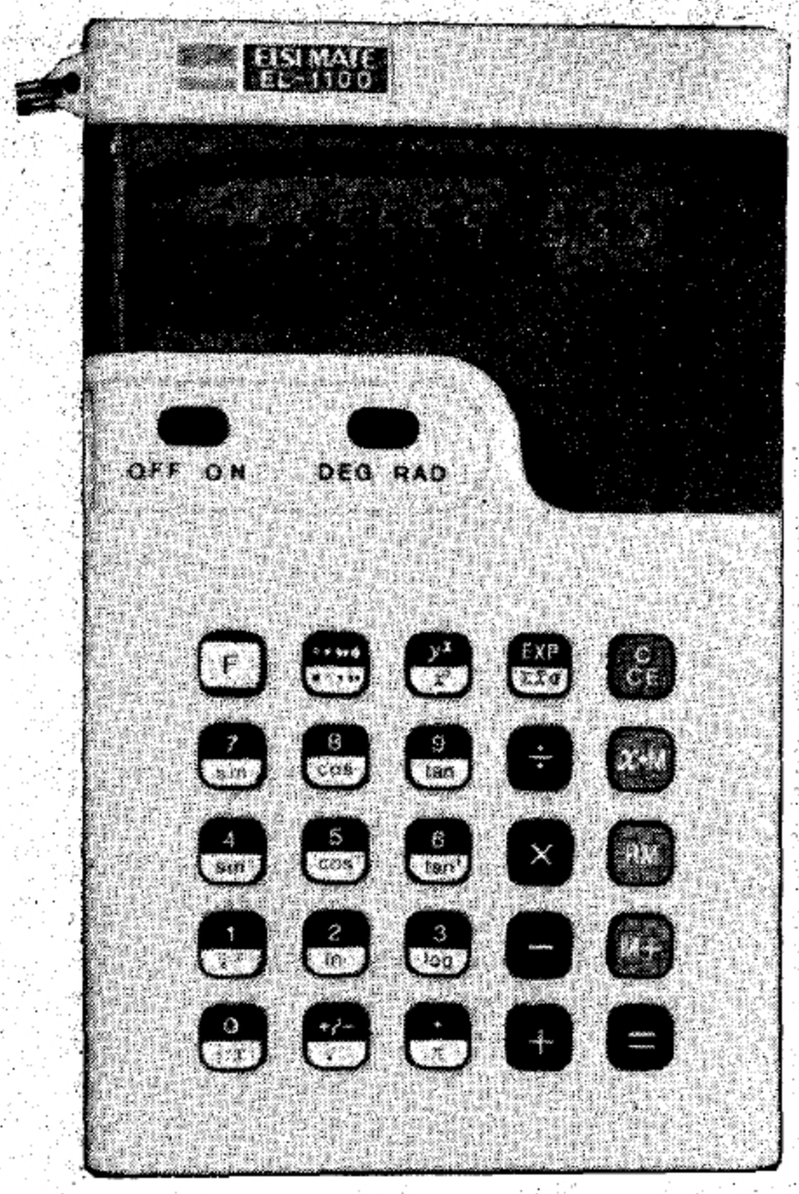
Reverse Polish notation is thus very economical in terms of key presses required, especially as problem difficulty increases. A four-high stack allows very complex problems, with several nested brackets, to be solved without the need to store data in the main memory. To solve a complex problem with a Reverse-Polish organised machine we start from the middle of the problem and work outwards.

This is not a real disadvantage as it is less confusing than to write the equation out with all the brackets required for a direct algebraic solution. Additionally in algebraic machines the single-key function commands (logs, trig functions, square root etc) follow the entered number just the same as in Reverse Polish machines, eg [3] [0] [sin] so algebraic entry mode is in fact inconsistent.

Reverse-Polish machines usually incorporate roll-down and possibly a roll-up key so that the contents of the stack may be reviewed at any time. We therefore recommend Reverse-Polish machines because the method facilitates the solving of complex problems with less chance of keying errors. Algebraic machines however, especially those with two levels of parenthesis, are just as powerful and may be preferred by some people.

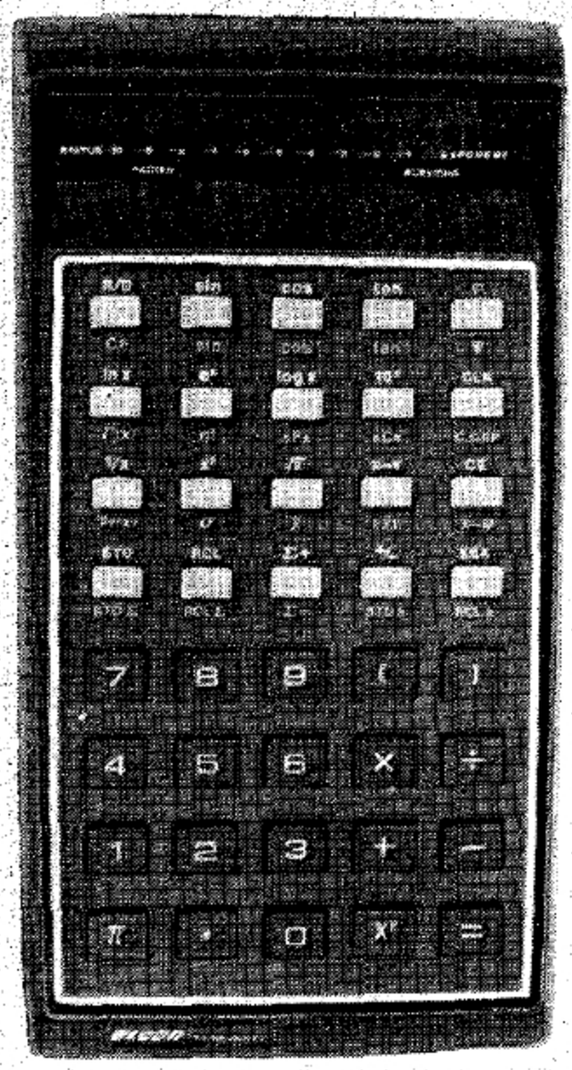
NOTATION

There are three methods of number notation used in calculators, standard fixed or floating point, scientific and engineering.



The Sharp EL 1100 has some unusual features. The exponent is displayed in a separate 2-digit display. The key with the unusual notation immediately to the right of the F key converts decimal degrees to degrees, minutes and seconds and vice versa.

This machine from Adler will perform most common business calculations.



The SC60 from Elcon incorporates a selection of statistical functions and has the ability to overflow the normal 10 -99 to 10 +99 range by a further 100 decades at each end.

scientific calculators

Standard Notation.

In standard notation the number is represented by an integer and decimal with a number of digits up to the maximum provided in the machine. The minimum number of digits required for useful calculations is 8 but some machines have 14 or more. Fixed point operation is very useful for financial calculations and is therefore essential on machines which incorporate business functions. With floating point operation the decimal point is automatically positioned such that maximum use is obtained from the available display digits. With both floating and fixed point operation the maximum range without overflow is from 1×10^{-7} to $9.9^{\cdot} \times 10^{7}$ a total of 15 decades. The lower limit is sometimes extended to 1×10^{-8} by eliminating the zero in front of the decimal point and the upper range may be extended by displaying the result of a computation that exceeds $9.9^{\cdot} \times 10^{7}$ with the decimal point shifted eight places to the left of its true position. When overflow occurs the machine is locked out and an overflow symbol generated. Calculation is therefore usually not possible on a result which has put the machine into the overflow condition.

Scientific Notation.

For most engineering and scientific applications an eight digit display is inadequate, for such machines are limited to the multiplication of two four-digit numbers. Whereas many constants and measured quantities require representation by more than eight digits. For example how do you enter Boltzmann's constant (1.38×10^{-23} joule) into an eight-digit machine? Scientific notation is a method of representing the number by means of a mantissa and a, typically, two-digit exponent. Thus Boltzmann's constant would be displayed as 1.38 −23 where the −23 represents the power of 10 by which the mantissa must be multiplied. All calculators having scientific notation are capable of automatically switching from standard to scientific notation when the number exceeds the standard capacity (or vice versa). Such machines have a key marked EE or EXP which allows numbers to be entered in scientific form. The number of digits in the mantissa varies from 5 to 12 digits depending on the machine.

Scientific notation can extend the range of a calculator from 15 to 200 decades — an enormous increase.

Engineering Notation.

The scientific method of notation is not ideal for practical engineering problems because physical units in the SI system are represented in a modified scientific notation where the exponents of 10 are always a multiple of three. For example a calculated capacitance value may appear in scientific notation as 1.28 −05 Farads, this needs interpretation as 12.8 microfarads. This is automatically done in engineering notation, the result would be expressed as 12.8 −06 thus expressing the quantity in the needed units.

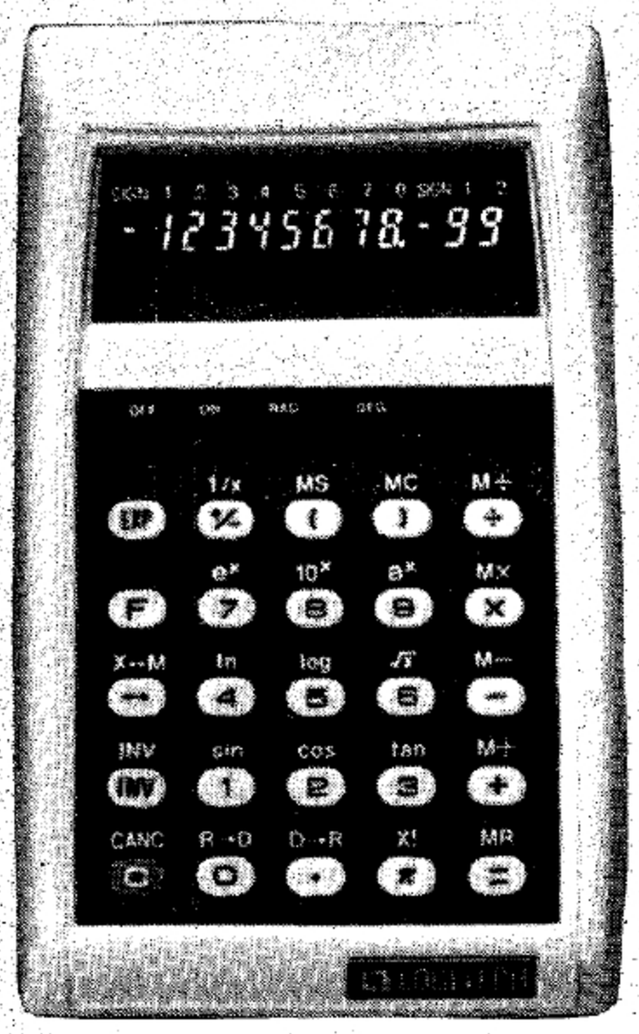
Only one of the calculators surveyed has this feature, the Hewlett Packard HP25. We venture to predict that this feature will be incorporated into most future designs.

PREPROGRAMMED FUNCTIONS

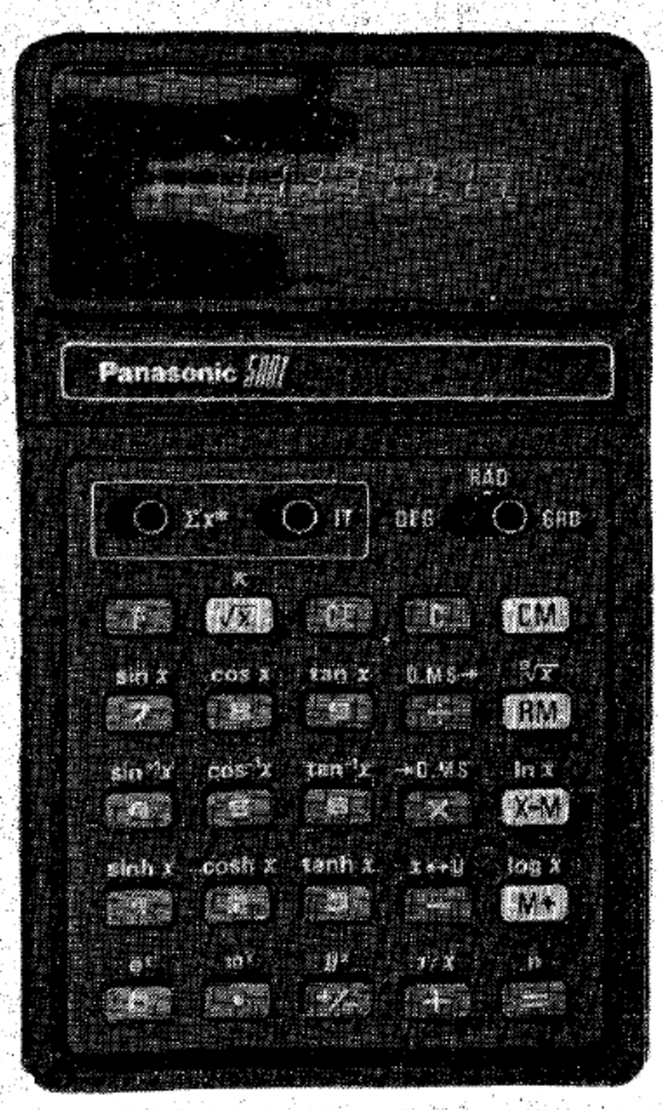
The number of pre-programmed functions incorporated into a machine depends firstly on the price of the machine and secondly on the primary applications for which it is designed.

The first additions to the basic four functions are usually 1/x, $\sqrt{x}$ and π for scientific applications and 1/x and % for business applications. It is also at this level that a memory is added. Such machines as these, although more advanced than basic four-function machines are not covered in this survey.

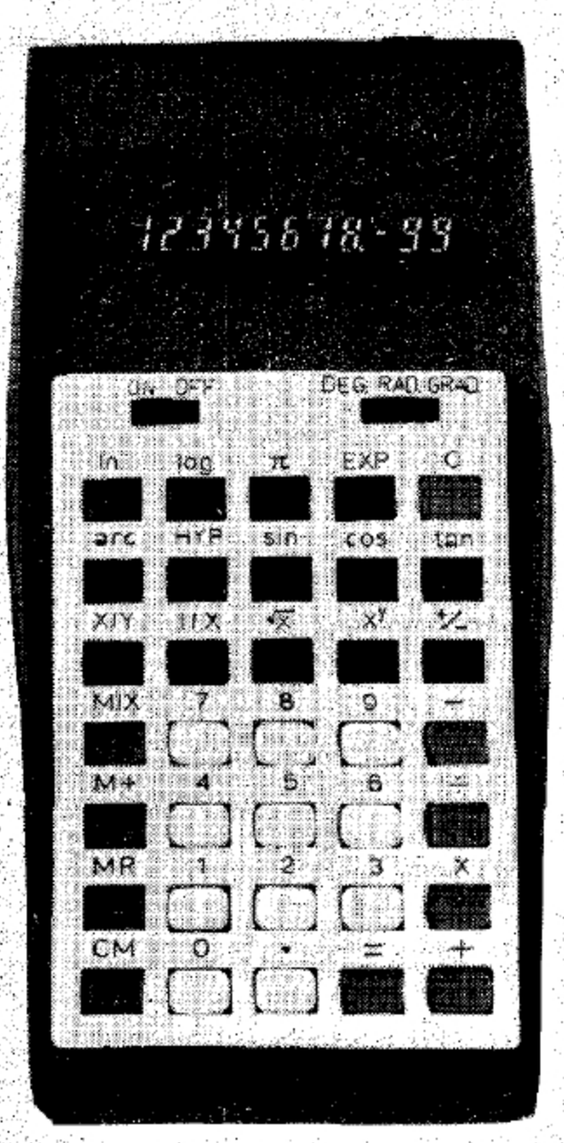
Machines of greater capability than



The Logitech 1233.S is an attractive looking machine that has far more power than is suggested by its price.



The Panasonic 5001 from National incorporates angular measure in grads, $3\sqrt{X}$ and sum of the squares.



The Qualitron 1419 is unusual in incorporating hyperbolic functions.

the above become even more dedicated to specific applications. The categories which seem to be most catered for are general purpose scientific, statistics, business and metric conversion.

In general-purpose scientific machines the functions that are generally added to those discussed above are trigonometric functions and their inverse, logarithmic functions both common and natural, e^x and sometimes 10^x and x^y. Additionally a switch is incorporated which allows operation in either degrees or radians.

Other functions that are added in more expensive machines are rectangular — to — polar conversion, decimal degress to degrees, minutes and seconds conversion and vice versa, extra memory registers, factorial X and, on a few machines, hyperbolic-trig functions and their inverse.

Statistical Machines.

There are a number of machines which have many standard statistical functions built into them. They may also incorporate a number of basic scientific functions.

Typical statistical functions are summation of x and y values, mean and standard deviation, sum of squares, square root of sum of squares and linear correlation of regression. Some advanced scientific models will also incorporate a few of these functions such as summation, mean and standard deviation.

Business Machines.

Those machines which are dedicated to business applications appear to have relatively few functions, when compared to other machines, but the relatively few keys can be used to solve dozens of different problems — everything from discounts and markup to interest rates, remaining principal on a mortgage, the future value of an annuity, or depreciation.

More advanced machines may also solve problems associated with statistics, bond prices and yields and, because these functions are based on calendar intervals, a calendar may be built into the machine. For example the HP80 incorporates a 200 year calendar (1900 to 2099) such that you can find the number of calendar days between two dates; the day of a week a date falls on; a future or past date given the number of days from a known date.

Metric Converters.

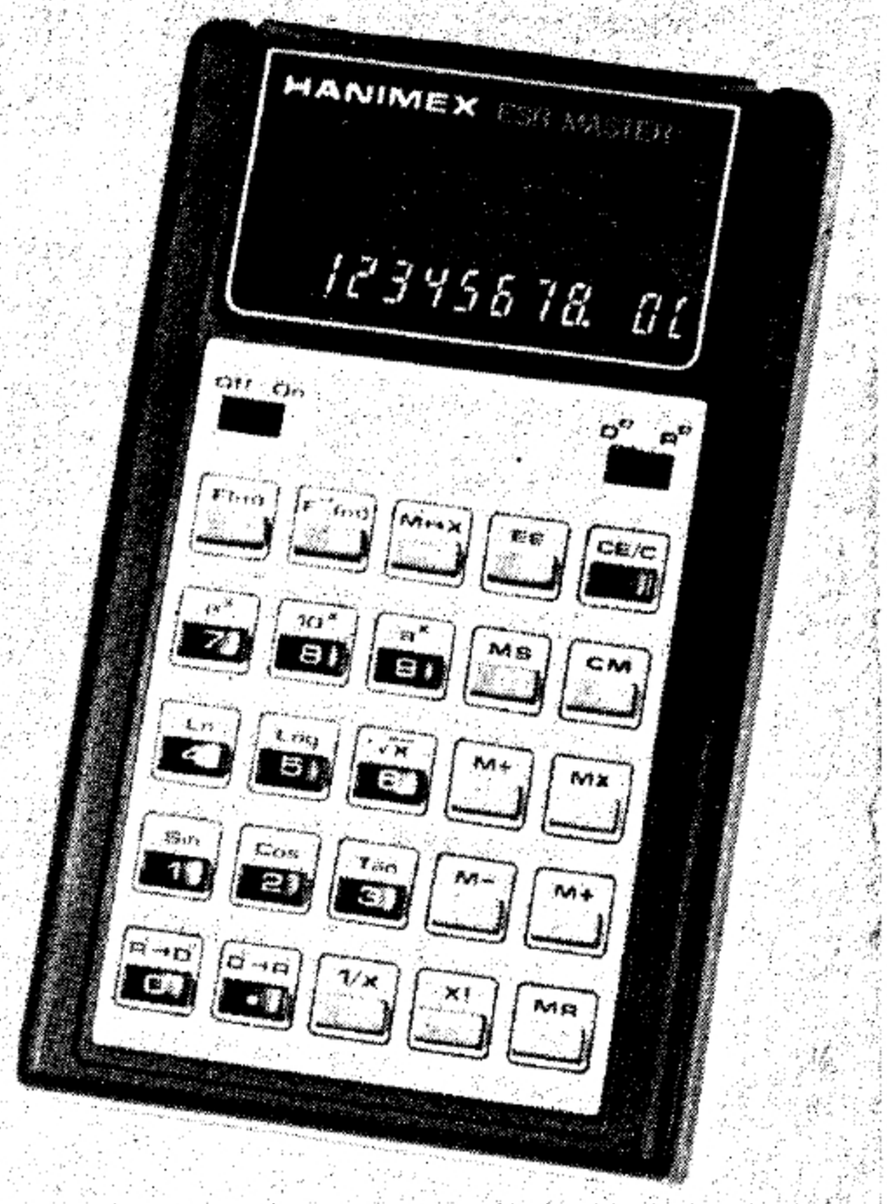
Whether machines devoted to metric conversions can be classified as scientific calculators is debatable but we thought they were worthy of inclusion because of their dedicated nature. Some general purpose scientific calculators have a number of metric conversions built in. There are a few machines available which can, convert any metric quantity to US or imperial and vice versa. It seems a pity that some calculators convert to US standards only and not to imperial, a serious drawback in non-US standard countries.

Perhaps the most outstanding conversion calculator is the Sharp EL8300 which has several unusual features. Apart from its 29 standard conversions from metric to and from imperial or US it has three registers available for storing other conversion factors and is capable of adding numbers expressed in integer and fraction form, eg, 1 7/8 may be added to 4 2/3 without first converting the fractions to decimals.

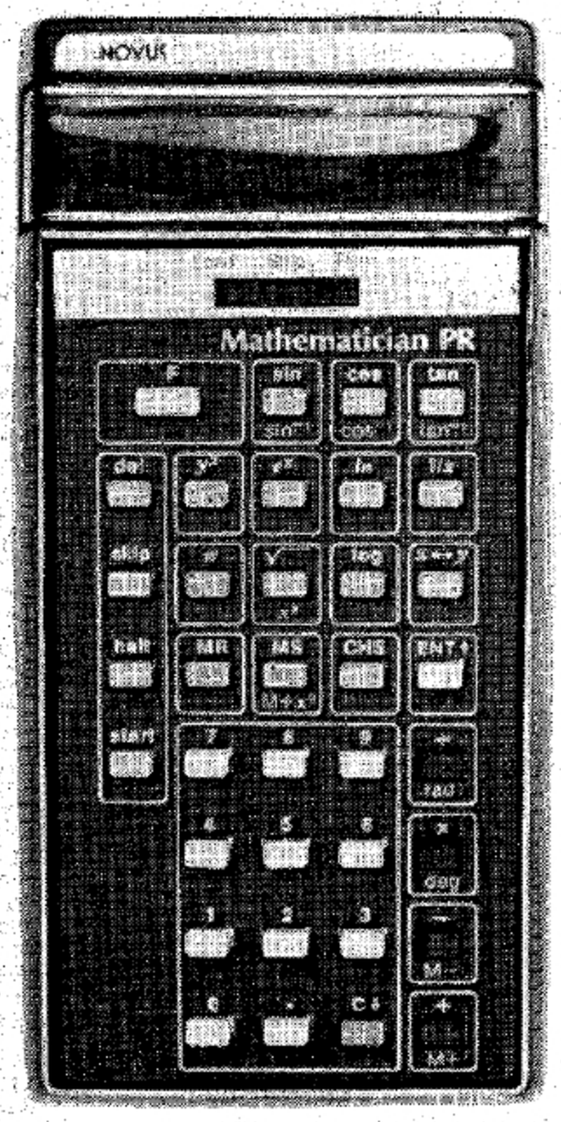
Advanced Scientific.

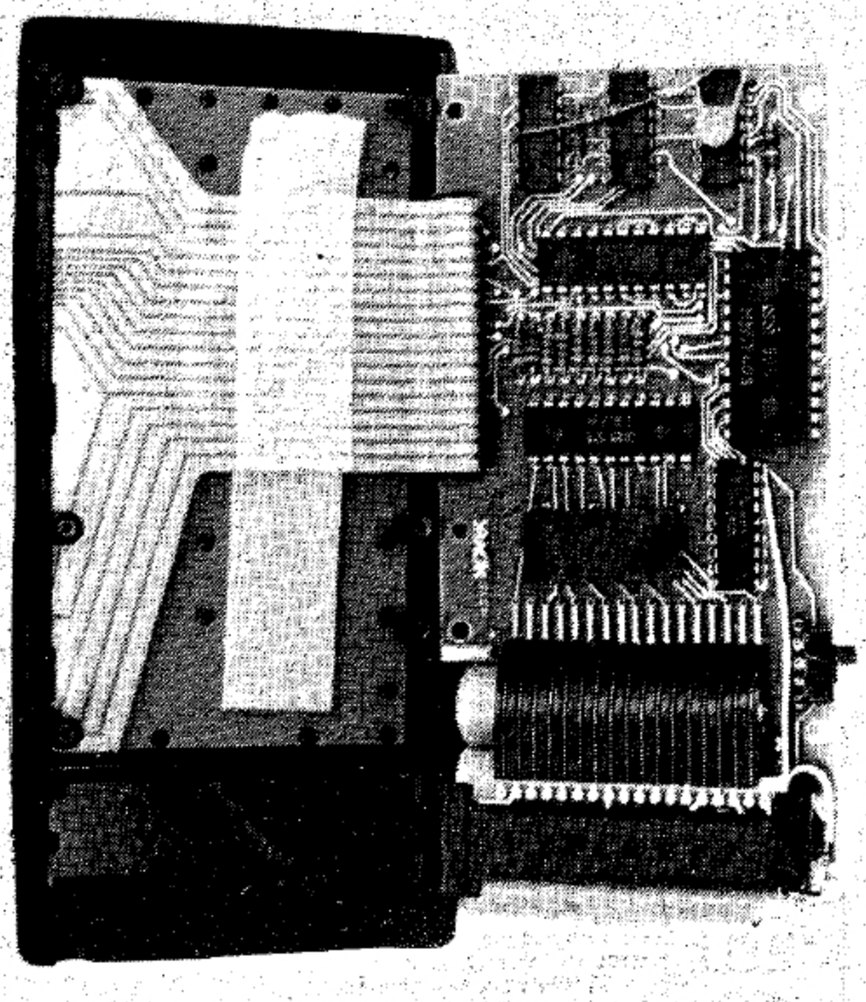
Calculators of an advanced scientific nature may have, in addition to the standard scientific functions, the most important functions from some of the other categories. For example the HP45 has, as well as standard functions, three metric conversions, three statistical functions and nine addressable memories. Further, programmable calculators can be organised to solve almost any specific problem.

Advanced calculators usually have to organise the keys to perform dual or even triple functions. This is done by incorporating function change keys. For example, the HP45 provides 48 functions and 9 memories with just 40 keys.



Top the Hanimex range, the ESR MASTER has an excellent selection of functions and a very flexible memory.





The Novus Mathematician PR has a 100 step programme and Reverse-Polish notation, although very sophisticated the internal view shows the constructional simplicity.

scientific calculators

The new HP25 from Hewlett Packard has a 49 step programme with editing and conditional branching. As with all Hewlett Packard calculators very comprehensive owner's and applications manuals are provided with the machine.

PROGRAMMING

With the aid of an advanced scientific calculator one can solve just about any problem that one might encounter. But, say you wanted to plot the response of a filter network versus frequency. The individual data points must all be calculated using the same basic formula — a laborious process even with an advanced calculator.

If a calculator incorporates a programme capability the problem need only be entered once. The problem may then be repetitively solved simply by inserting the data for each point and pressing the start key — the calculator does the rest.

Of course, as with everything, the power of the programmes fitted to scientific calculators varies considerably. The first thing that one notices is the number of programme steps available. On the calculators reviewed this varies from 49 to 300. However the effectiveness of the number of steps depends greatly on other programme features and on the available number of storage registers.

The simplest kind of programme capability is where the programme simply remembers the key stroke sequence used to solve the problem. Such a programme is fitted to the Sharp PC-1001. It is not possible to modify the programme in any way or to review the contents of the programme memory.

A step up from this is the programme as fitted to the Novus 4515. This is basically the same as that used in the Sharp except that a SKIP key has been provided which allows several small programmes to be stored within the 100 step programme memory. The Novus however has the disadvantage that it has only one storage register. Thus if more than one constant is required in a programme it must be written into the programme each time it is used (an eight digit constant will consume eight programme steps). The Sharp calculator on the other hand has eight storage registers thus the contents of any memory can be recalled with one or two programme steps.

The next stage of programme development is to incorporate programme editing. In the HP programmables, for example, when the machines are switched to programme mode, the display shows the line number and the key code for the programme step. Single-step, back step and delete keys allow the programme to be debugged without rewriting the whole thing. Pressing a further key

THE PROGRAMME SPECIFICATION OF THE HP65

These keyboard controls give you full programmability in a pocket calculator . . .

These keys take the HP-65 out of the realm of the calculator and into the sophisticated world of computer technology. They permit you to write, record, save and read back your programs. They also set in motion the HP-65's other powerful programming functions.

To write or run your program . . .

W/PRGM ▮▮▮▮▮▮▮▮▮▮ **RUN**

Set this switch to "WRITE PROGRAM" to enter or change any steps in the program memory and for recording programs, without altering any data stored in the four-register automatic memory or the addressable registers.

Set to "RUN" for all other operations.

To structure your program . . .

LBL This "LABEL" key enables you to indicate and identify a series of steps within your program. Up to 15 labels are available by pressing this key and any digit (0-9) or letter (A-E) key.

GTO This "GO TO" key, in conjunction with a digit key, sets off a search in the program memory for the label with the same digit. It can be used from the keyboard when editing, or as part of a program.

A B C D E

These User Definable keys are just what their name implies. They are letter labels for parts of your program which can be executed directly from the keyboard. Or, they can be used to call a sub-routine when used within a program.

RTN When this "RETURN" key is pressed, it enables you to start at the beginning of your program again. If this key is used as part of your stored program, it stops execution of your program and returns control to the keyboard for manual operation. When used as part of a label subroutine, it returns control to the calling program.

R/S When this "RUN/STOP" key is included in your stored program, it will halt execution of the program and return control to the keyboard for manual operation. When used from the keyboard, it can stop a running program or start a stopped program at the next step.

To include conditional functions in your program . . .

SF1 **SF2**

Like a computer, the HP-65 can take alternate computational paths based on the condition of the two flags. With the "SET FLAG 1" and "SET FLAG 2" keys, the flags can be set or cleared manually from the keyboard or automatically by an appropriate program step.

TF1 **TF2**

The condition of the flags can be tested automatically at any point in your program by using these "TEST FLAG 1" and "TEST FLAG 2" keys to include an appropriate test flag instruction. Your program will either advance sequentially or skip over the next steps, depending on the condition of the tested flag.

x≠y **x≤y** **x=y** **x>y**

These keys allow you to compare the values in the X and Y registers. If the test condition is not met, the program skips over the next two steps. If the test condition is met, the program continues with the next step. This allows the HP-65 to perform conditional branches based on the results of the test.

DSZ The "DECREMENT AND SKIP ON ZERO" key subtracts a "1" from the integer previously stored in addressable register 8, then advances your program depending on the value remaining in the register. If the value in register 8 is not equal to zero, the program advances to the next step. If it does equal zero, it skips the next two steps. "DSZ" allows you to loop through a portion of your program a predetermined number of times.

NOP If this "NO OPERATION" key is included in your stored program, it will advance the program to the following step. It is often used in conjunction with conditional-skip instructions.

To edit your program . . .

PRGM

Use this "PROGRAM" key to clear the entire 100-step program memory, so you can begin keying in a new or revised program you have developed.

DEL This "DELETE" key erases a single program step and automatically moves the remaining steps up one place in the program memory to fill the resulting gap. To insert the corrected step, just key it in and the following steps will move down automatically.

SST When the HP-65 is in the "WRITE PROGRAM" mode, this "SINGLE STEP" key lets you step through each program instruction in the program memory, as the display shows a number for each step. This number represents the location (row and column) of the key corresponding to that particular instruction. For example, "34" refers to the key in row 3, column 4—"RCL." (Exception: digit keys are represented by the numbers 00 to 09.)

If the "SST" key is used with the HP-65 in the "RUN" mode, you can execute a program one step at a time.

called "GO TO" (GTO) followed by a programme step number allows you to get to any particular step in the programme.

An important addition to the repertoire of programmable calculators is the ability to to make logical decisions. Such capability makes them akin to computers in that alternative paths can be taken within the programme conditional upon the results of a test. Other additions such as "decrement and skip if zero" and user definable keys can make the calculator extremely powerful even with a limited number of available programme steps.

STORED PROGRAMMES

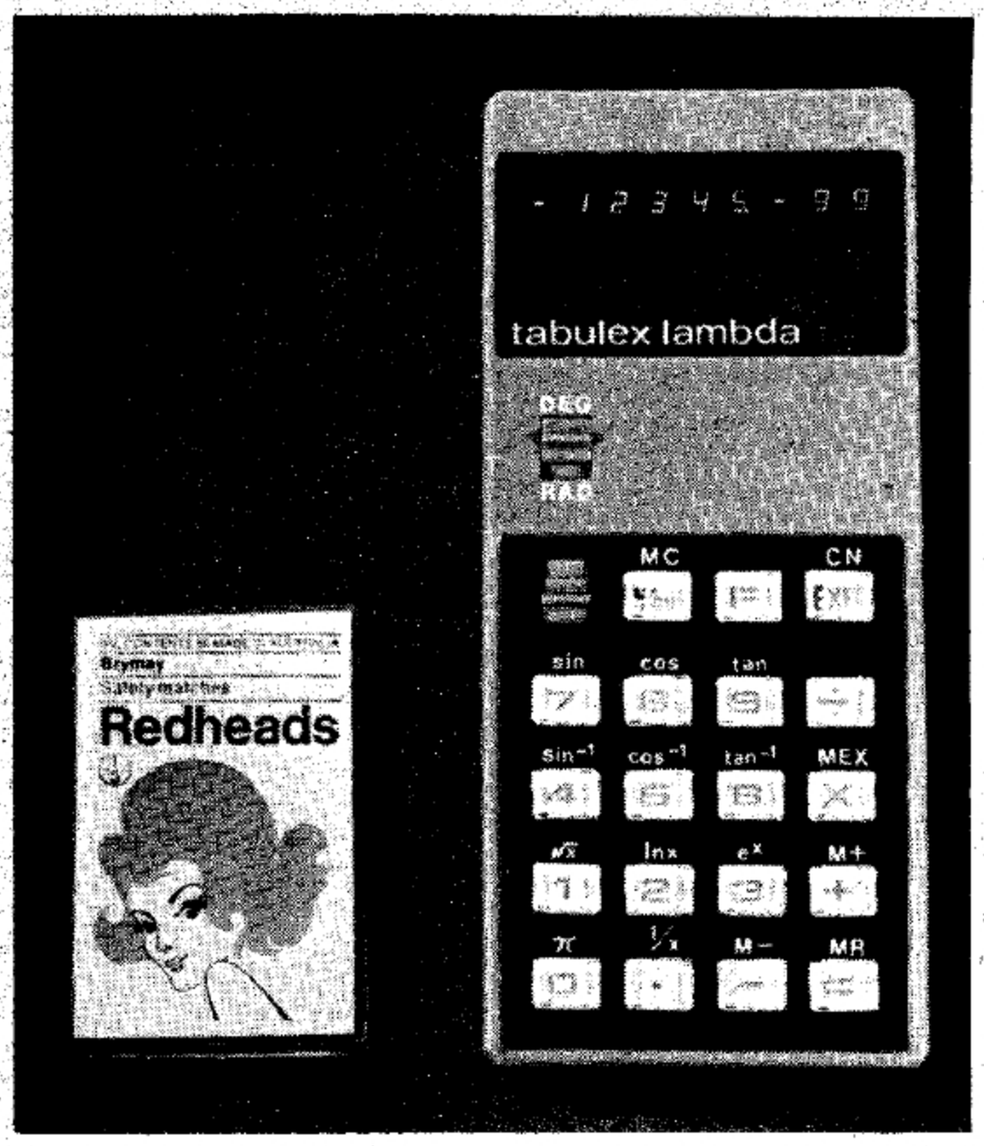
The ultimate in programmable calculators is one which has the ability to permanently store programmes for future use. There are three methods in use with portable scientific calculators. The HP65 stores its programmes on tiny magnetic cards, the card reader being built into the calculator. Pre-programmed cards are available for a variety of applications. Each card can store 100 programme steps.

The Compucorp 326 has a cassette recorder for programme storage and again pre-recorded cassettes are available for a variety of applications. Each cassette is capable of storing 14 blocks of data. Each block may contain the data for 12 data registers or 160 programme steps. The calculator has manual or programmable controls for writing or reading data registers or programmes onto or from the tape cassette.

Both the Compucorp and the HP65 are extremely well backed up with comprehensive operating instructions, sample problems and data on the pre-recorded programmes for each pack of programme cards or cassette.

The third method of programme storage is that used by Sharp in its PC1002. This calculator has interchangeable, programmable read-only memories, each being programmed for different applications. There are PROMs available programmed for statistics, business etc, or Sharp will programme the PROM to the customer's specification. When the PROM is interchanged the functions of the keys are changed, the new functions being indicated by a keyboard overlay card.

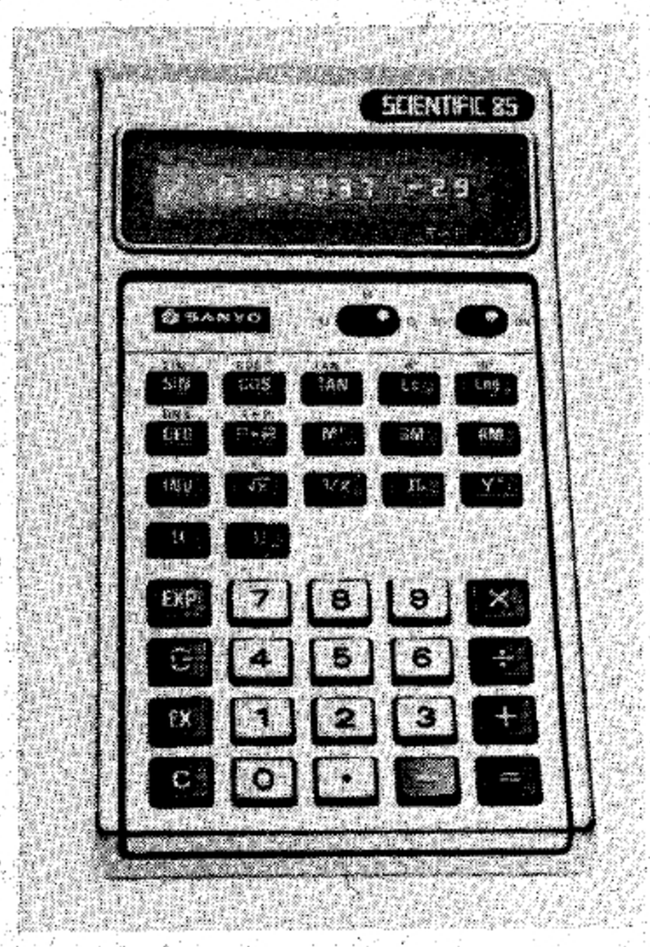
The Sharp system does not allow the user to store his own programmes and thus is less flexible. But it does extend the capabilities of an inexpensive programmable calculator considerably. Each pre-programmed PROM is available, we understand, for around $45.



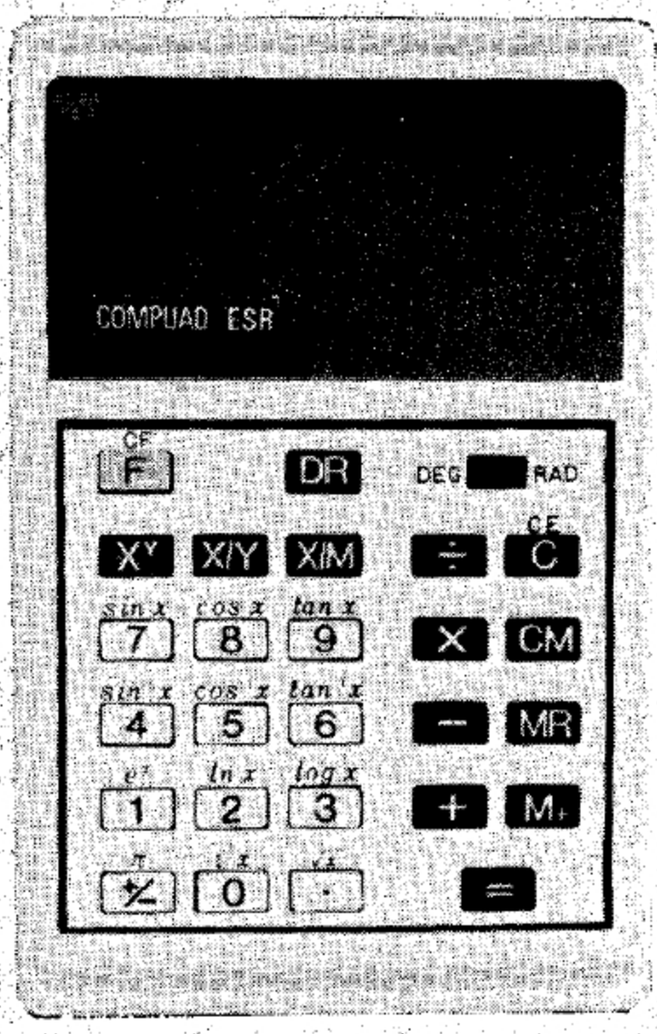
This calculator although of limited capability was the smallest in our survey and is inexpensive.

Many other machines are available with ever greater capability but these are desk-top models costing up to $3000 or more. They include machines with print-out, graph plotters and even machines with interactive programmes, using BASIC computer language, that tell you what to do next and advise you of any entry errors by means of an alphanumeric display. Such machines are beyond the scope of this article, but who knows how many of the sophisticated features of these machines will eventually appear in pocket and portable machines.

Comparison chart – pages 40-41.



ıe Sanyo Scientific 85 (CZ 0123)



The machine from Compuad, although not having scientific notation, is quite powerful for the price.

MANUFACTURER (Distributor)	MODEL	ORGANIZATION: RPN Logic	Algebraic logic	No of digits	SN No of digits	Exponent digits Engineering notation	Range (decades)	RPN Stack — No.	Addressable memories	Roll down stack	LAST x' register	Program steps	M◄►x	PREPROGRAMMED FUNCTIONS: %	1/x	x²	√x	yˣ	log x	ln x	eˣ	10ˣ	x!	π	/%	x◄►y	Trig	Hyperbolic Trig	Rectangular◄► Polar	Deg/Radians	Grads	Vector arithmetic	Metric Conv	No Statistics function	No Business functions	PROGRAMMING: Single Step	Editing	Run/Stop	Conditional Branching tests	Conditional Branching flags	Direct Branching	Decrement and skip if zero	User definable keys	Perm. Prog. Storage	Labels	GENERAL FEATURES: Timer	Printer	Battery saver feature	Battery operation	Charger	Mains adapter	Mains operation	PRICE $	
HORNET (Kitsets)	SR30		•	8					1				•		•		•	a^x	•	•	•			•		•			•																									39	
SHARP	EL1100		•	10	10	1	200		1				•		•	•	•	•	•	•	•			•		•			•				3																							100	Decimal to DMS conversion
	EL8104		•	8					1				•		•		•		•	•	•			•		•			•																										70	3 conversion factor memories, fractional calculation.
	EL8300		•	8									•	•										•									29																						80	Nautical/land US/IMPERIAL to metric converter
	PC1001		•	10	10	2	200		8			64	•				•	•	•	•	•			•		•	•		•																									•	295	Interchangeable PROMs available for business
	PC1002			10	10	2	200		8			300	•				•	•	•	•	•			•		•	•		•				*	*	*							*	*											•	395	statistics etc. also programmable to customer specification.
	PC1802		•	8					1				•		•		•		•	•	•			•		•			•																										70	
FORDS (Dick Smith)	SC85M		•	8					1				•		•		•	xY	•	•	•			•		•	•		•																										39*	
LLOYD'S	999		•	8					1				•		•		•	xY	•	•	•	•		•		•			•																										63	Key for $m + x^2$
(WHK)	333		•	8	5	2	200		1				•		•	•	•			•	•			•		•			•																										47	
COMMODORE (WHK)	F4146R		•	10	10	2	200		2				•	•	•	•		•						•	•									*																				71	full range of financial computations $x\sqrt{y}$
	SR414		•	10	10	2	200		2				•		•	•	•	•	•	•	•	•		•		•		•					2																				71	Parenthesis keys.
	SR8120D		•	8	8	2	200		2				•			•	•		•	•	•	•		•		•			•																										47	
	SR9120D		•	8	8	2	200		2				•		•	•	•	•	•	•	•	•		•		•			•				2																				53	Parenthesis keys. $x\sqrt{y}$
RICOH (J. Renwick)	1623		•	16					2					•			•															3	3																				265	
SANYO	CZ0111		•	8	8	2	200		1						•	•	•	•	•	•	•	•		•			•	•					1																				79*	grads, decimal degrees to DMS, radians grads to degrees.
	CZ0123		•	8	8	2	200		2						•	•	•	•	•	•	•	•	•	•		•	•																										99*	2 levels of parenthesis.
	CZ2171		•	10	10	2	200		1						•	•	•	•	•	•	•	•		•		•	•		•																										79*	2 levels of parenthesis, nicad batteries
	CZ8109		•	8					2					•			•								•																												62*	financial calculations, summations and averages, sell, cost margin trend
	CZ8125		•	8	5	2	200		1						•		•		•	•		•		•			•																										58*	
COMPUAD	ESR		•	3					1				•		•		•		•	•	•			•		•	•		•																										49	rad to deg, deg to rad.
ADLER	84F		•	8					4					•											•								2	*																				80	standard financial calculations
	88T		•	8					1				•		•		•		•	•	•			•		•			•																										80	
	108T		•	8	8	2	200		1				•		•		•	•	•	•	•	•	•	•		•			•																										119	
FARAD	310		•	8					4					•			•								•								2	*																				65*	Standard financial calculations.
	330		•	8	8	2			1				•		•		•	xY	•	•				•		•	•	•	•																										70*	
	808		•	8					1				•		•		•	xY	•	•	•			•		•			•																										55*	Rad to deg, deg to rad.
	1233.S		•	8	8	2			1				•		•		•	•	•	•	•	•	•	•			•																										75*	
TABULEX LAMBOA (FARAD)			•	8	5	2			1					•		•			•	•				•			•																										40*	
CANON	F2		•	8	8	2	200								•	•	•	•	•	•	•	•																																		AR	No inverse trig functions
	F5		•	8					1	•	•				•	•	•	•	•	•	•	•		•		•			•																										AR	F6,F7 dec deg — DMS, grads. 8 deep parenthesis. F5,6,7
	F6		•	8	8	2	200		2						•	•	•	•	•	•	•	•	•	•					•	•	•																										AR	interchangeable nicads or dry cell cassettes and charger
	F7		•	8	8	2	200		2						•	•	•	•	•	•	•	•	•	•					•	•	•	*																										AR	supplied. F7 full range of metric conversions, fractional arith.

MANUFACTURER (Distributor)	MODEL	RPN logic	Algebraic logic	No of digits	SN No of Digits	Exponent digits	Engineering notation	Range (decades)	RPN stack – No.	Addressable memories	Roll down stack	LAST x' register	Program steps	M←→x	%	1/x	x²	√x	yˣ	log x	ln x	eˣ	10ˣ	x!	π	/%	x←→y	Trig	Hyperbolic Trig	Rectangular←→Polar	Deg/Radians	Grads	Vector arithmetic	Metric Conv	No Statistics function	No Business functions	Single Step	Editing	Run/Stop	Conditional Branching tests	Conditional Branching flags	Direct Branching	Decrement and skip if zero	User definable keys	Perm. Prog. Storage	Labels	Timer	Printer	Battery saver feature	Battery operation	Charger	Mains adapter	Mains operation	PRICE $	
		ORGANIZATION												PREPROGRAMMED FUNCTIONS																							PROGRAMMING									GENERAL FEATURES										
HEWLETT PACKARD	HP21	•		10	8	2		200	4	1	•	•				•		•	•	•	•	•	•	•		•	•		•	•	•																						119*	
	HP25	•		10	8	2	•	200	4	8	•	•	49			•	•	•	•	•	•	•	•			•	•		•	•	•			4		•	•	•	8		•								•	•			179*	
	HP35	DISCONTINUED REPLACED BY HP21																																																			
	HP45	•		10	10	2		200	4	9	•	•			•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	3	3																•	•			225*	
	HP46	•		10	10	2		200	4	9	•	•			•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	3	3																•	•		•	630*	
	HP55	•		10	10	2		200	4	20	•	•	49		•	•	•	•	•	•	•	•	•	•		•	•	•	•	•	•	•	7	5	10	•	•	•	2		•					•			•	•			360*	
	HP65	•		10	10	2		200	4	9	•	•	100		•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•		5	17	•	•	•	4	2	•	•	5	•	15				•	•			760*	program cards available for most common problems.
	HP70	•		10	10	2		200	4	2	•				•											•	•							6															•	•			152*	
	HP80	•		7	10	2		200	4	1	•				•			•	•							•	•							4	10															•	•			268*	
	HP81	•		7	10	2		200	4	20	•				•			•	•	•						•	•							5	19														•			•		950*	
NOVUS (National Semi-conductor)	4510	•		8				16	5	1						•	•	•	•	•	•	•				•	•			•				1															•	•		A		60	
	4515	•		8				16	3	1			100			•	•	•	•	•	•	•				•	•			•				1		•	•	•											•	•				100	
	4520	•		8	8	2		200	4	1	•					•			•	•	•	•	•			•	•																					•	•				80	
	4525	•		8	8	2		200	4	1	•		100			•			•	•	•	•	•			•	•																					•	•				150	
	6010		•	8				16		1					•	•		•															20															•	•		A		60	US/metric converter
	6020		•	8				16		2					•	•		•									•	•							11															•	•		A		80	sum of digits depreciation.
	6025		•	8				16		2			100		•	•		•									•	•							11															•	•				136	
	6030		•	8				16		1					•	•	•	•																	9															•	•		A		86	
	6035		•	8				16		1			100		•	•	•	•																	9															•	•	•			136	
HANIMEX	VP8SR		•	8						1				•		•		•		•	•		•			•		•		•																				•		A		40	
	ESR100		•	8						1				•		•		•	x^y	•	•	•		•		•	•		•		•																				•		A		60	
	ESR1010SN		•	8	8	2				1				•		•		•		•	•			•		•		•		•																				•		A		70	
	ESR Master		•	8	8	2				1				•		•		•	•	•	•	•	•	•	•	•	•	•	•																				•		A		90	$D^0 \rightarrow R^0$, $R^0 \rightarrow D^0$. 2 levels of parenthesis.
PANASONIC (Haco)	JE5001U		•	8				15		1				•		•		•	•	•	•	•	•	•	•	•	•	•	•	•	•			1																•				70	DMS → → DMS, $\sqrt[3]{x}$, item counter
QUALITRON (Photo Import)	1438		•	8						2																							24																•	A			AR	Universal converter, land nautical, Imperial, US to metric
	1439		•	8						4				•		•									•								14																•	A			AR	item counter incorporated
	1445		•	8						1				•		•		•	x^y	•	•	•		•		•	•		•		•																				•	A			AR	
	1408		•	8						1						•		•															12																•	A			AR	Imperial to metric converter
	1448		•	8	5	2				1				•		•		•		•	•			•		•		•		•																				•	A			AR	
	1419		•	14	10	2				1				•		•		•	x^y	•	•	•		•		•	•	•		•																				•	A			AR	
	1420		•	14	10	2		200		1				•		•	•	•	x^y	•	•	•		•	•	•	•		•		•				14																•	A			AR	1 level of parenthesis.
KINGSPOINT ELCON (EMAIL) (EMDNA)	SC33		•	8	8	2		200		1						•	•	•	x^y	•	•	•	•			•		•																						•	•	•				42*	Two levels of parenthesis on 40, 44 and 60
	SC40		•	10	10	2		200		1						•	•	•	x^y	•	•	•	•		•	•		•																						•	•	•				70*	
	SC44		•	8	8	2		200		1						•	•	•	x^y	•	•	•	•	•	•	•		•							1																•	•	•				65*	over-flow and underflow possible to 10^{199}, argument limits permitting.
	SC60		•	10	10	2		200		2				•		•	•	•	x^y	•	•	•	•	•	•	•		•							9																•	•	•				115*	
CAS10 (Peacock Bros)	FX11		•	8														•	a^x	•	•	•		•		•																										•		A			no inverse trig.
	FX15		•	8	6	2		80		1						•	•	•	x^y	•	•	•		•		•																										•		A		86	sexagesimal to decimal conversion
COMPUCORP (Datanamics)	BETA 326		•	13	10	2		200		12		•	160	•		•	•	•	a^x	•	•	•	•	•	•		•		•	•	•	•	15	5		•	•	•	7		•		•	13					•	•			1067	Resting of parenthesis to four levels. Cassette recorder for program storage included in price. Pre-prog. cassettes avail.

Prices to nearest dollar asterisk indicates sales tax must be added.
AR – price available on request.