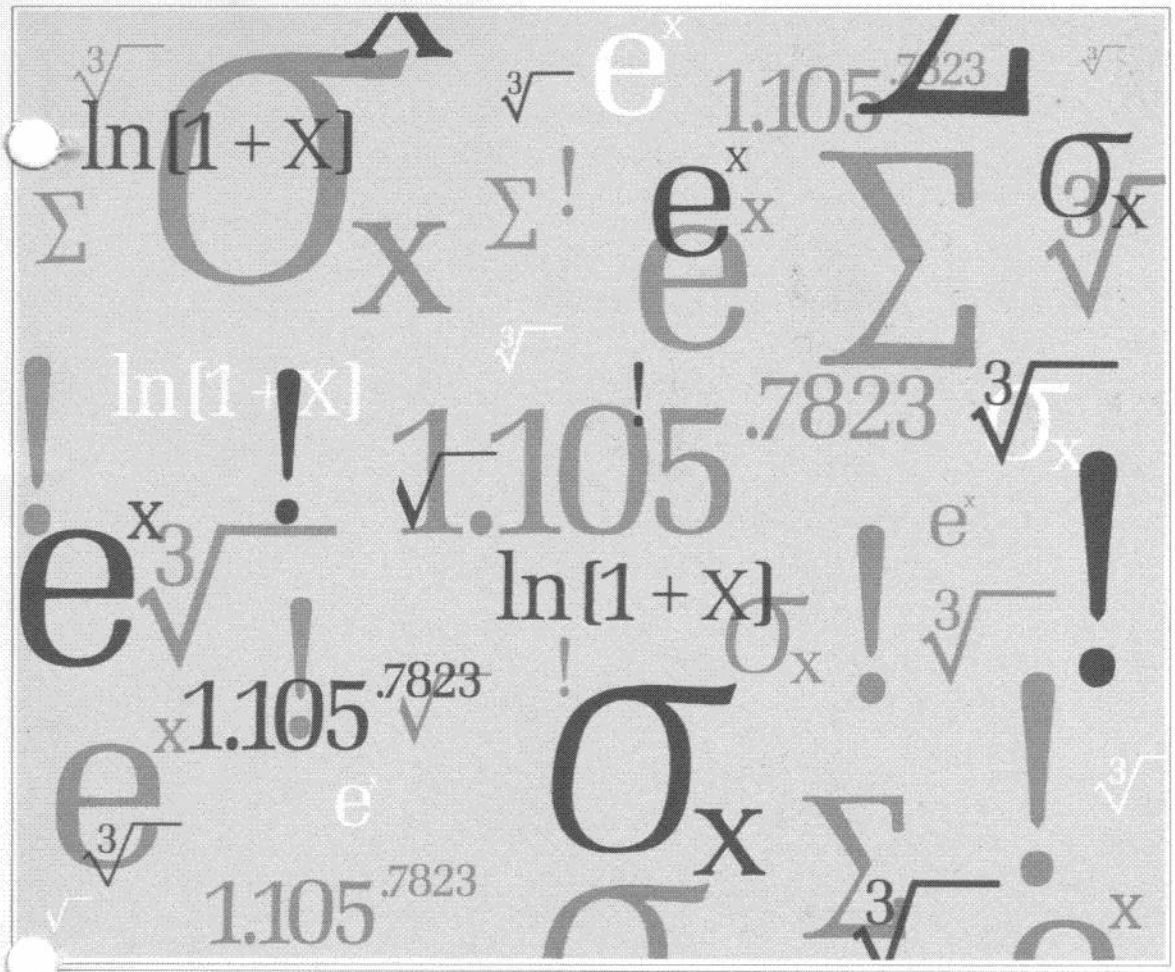
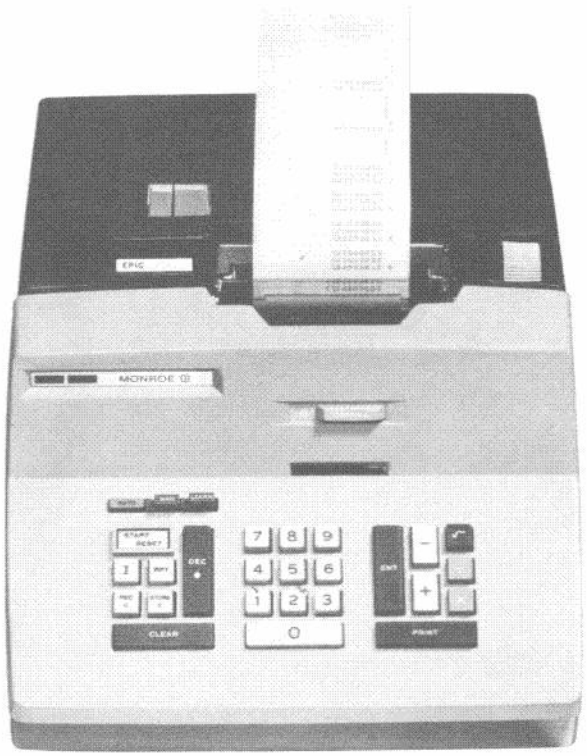


EPIC™ Operating Instructions

A DIVISION OF LITTON INDUSTRIES

MONROE

It's electronic . . . It prints . . . And it learns



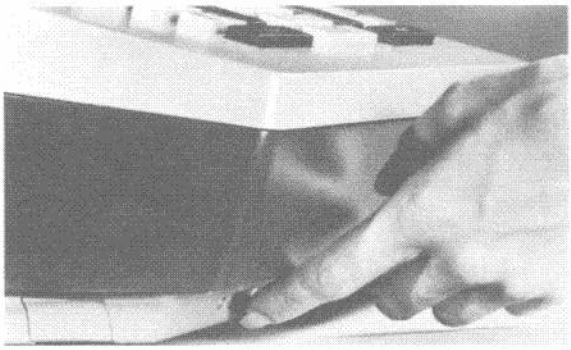
This booklet tells how to operate Monroe electronic programmable printing calculators, the EPIC 3000 and the EPIC 2000. The two calculators are identical except for the number of program steps. The EPIC 3000 has a 42 step programming capacity and the EPIC 2000 has a programming capacity of 14 steps.

The EPIC takes full advantage of electronic capability to eliminate repeated selection of control keys. As the operator does a computation the first time, the EPIC learns the sequence of entries and control keys. Thereafter, the same calculation can be done by listing numbers with an enter bar in the same way that they would be entered in a 10-key adding machine. At the same time a printed record is made of each number entered, each control key used, and any answer that the operator wants to see.

It is recommended that the operator go through the booklet and perform all the instructions on the calculator.

Contents

General Instructions



Setting Up the Calculator
Connect the EPIC to its computing unit by pushing in the connector with screws properly aligned and turning the screws.

Plug the computer unit into a 115 AC voltage outlet. Actually, the calculator will operate from 95 to 130 volts AC. If the outlet will not accept the 3-prong plug, use the adapter.

Starting the Calculator
Turn the switch to the right. The word EPIC lights. If the voltage is outside the above range, the red light will go on. Otherwise, the green light goes on. This green light is the READY light.

Depress START RESET. This key unlocks the keyboard and clears any information in the calculator: keyboard entry, any learned routine, and answers. The symbol ⊟ prints. If the AUTO key is down, the START RESET key will not depress. In this case, depress MANual then START RESET.

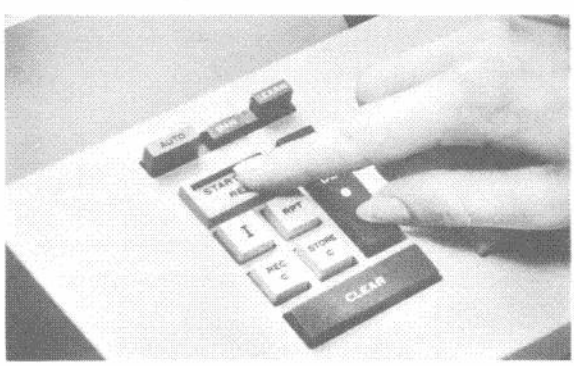
READY Light
The READY light blinks off during calculations and the keyboard locks momentarily. Since the EPIC calculates silently, the READY light comes on to indicate that the keyboard is prepared to accept input.

The READY light may be off as briefly as a two hundred fiftieth of a second while a number is being entered or it may be off for a few seconds while an entire sequence of multiplication, division, root, etc. is done.

Red Light
When the red light goes on it indicates that an improper operation has been performed. The following operations will turn on the red light:

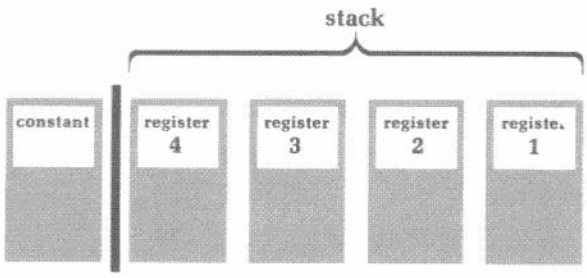
1 An arithmetic operation whose result exceeds the capacity of the calculator.
2 Dividing by zero.
3 Attempting to take the square root of a negative number.
4 Exceeding the number of program steps while in LEARN. This will be explained in detail later in the instructions.

When the red light is on keys cannot be depressed except MANual, LEARN, and START RESET. To continue, depress MANual then START RESET.



The Fundamentals of the EPIC

Register Action
The EPIC has five number holders called registers. Registers 1, 2, 3, 4 operate as a unit and are called a stack. The other register is independent of the stack and is called the constant register. They may be visualized for instruction purposes as follows:



How the Stack Works
As a number is set in the keyboard it enters the first register. At the same time the number in each register moves down one position. The contents of the fourth register clear out.

Arithmetic operations take place between numbers in registers 1 and 2 with the number in register 1 acting on the number in register 2; that is, register 1 adds to, subtracts from, multiplies by and divides into the number in register 2. The results of arithmetic operations move into the first register and numbers in registers 3 and 4 move ~~up one register~~ to registers 2 and 3 respectively.

How the Constant Register Works
Two control keys connect the constant register with register one of the stack. Depression of the STORE C key duplicates the number in register 1 in the constant register; the number in the constant register is cleared; the number in register 1 remains in register 1.

Depression of the REC C key duplicates the number in the constant register in register 1 and moves all other numbers down one register. The number in the constant register remains there.

Capacity
The EPIC has a 16 digit printout capacity of which either 4 or 8 digits are reserved for decimal places. A decimal selector is used by the operator to choose the number of decimal places.

If the operator selects the fourth decimal, the EPIC has a capacity of 999 billion plus. If larger decimal capacity is required, the operator can select the eighth decimal and still have a capacity of 99 million plus. The EPIC automatically takes care of decimal alignment; zeros will print on the tape behind the last significant digit. The EPIC automatically inserts zeros to the right of the last significant digit so that the number will print at a preselected decimal point.

If the operator sets numbers with more places either to the left or right of the decimal point than the capacity described above, the digital keys lock.

If an answer exceeds the whole number capacity, the red light goes on. Depress MANual then START RESET to continue.

If an answer exceeds the decimal capacity, the first 4 or 8 decimal places are retained and the remaining places are dropped.

Setting Numbers in the Keyboard
Numbers are set in the 10-key keyboard in the same order that they are written; the decimal point is entered by the decimal bar. Keyboard dials display the number set in the keyboard.

example: 1.25 is set as 1 DEC 25

How to Add, Subtract, Multiply, and Divide

The arithmetic operations of addition, subtraction, multiplication, and division take place between two numbers.

Set first number in 10-key keyboard
Depress ENTer bar
Set second number in 10-key keyboard
Depress + for addition
— for subtraction
× for multiplication
÷ for division
Depress PRINT to see answer.

example: addition

Set 2
Depress ENTer bar
Set 5
Depress + for addition +
Depress PRINT to see answer 7

example: multiplication

Set 2
Depress ENTer bar
Set 5
Depress × for multiplication ×
Depress PRINT to see answer 10

example: subtraction

Set 2
Depress ENTer bar
Set 5
Depress — for subtraction −
Depress PRINT to see answer −3

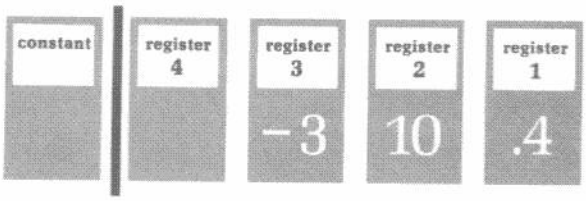
example: division

Set 2
Depress ENTer bar
Set 5
Depress ÷ for division ÷
Depress PRINT to see answer 0.4

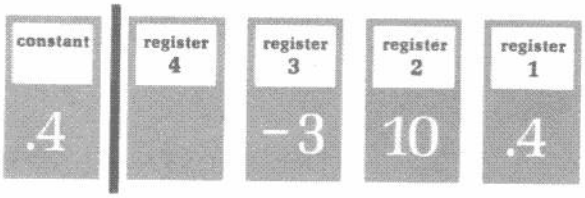
Utilization of Answers

The last three answers of the preceding calculations are in registers one, two, and three. These answers may be used in further calculations without re-entering them.

The following paragraphs define the function of the control keys and the examples illustrate how these control keys can use two previous answers or a previous answer and a keyboard entry in further calculations.

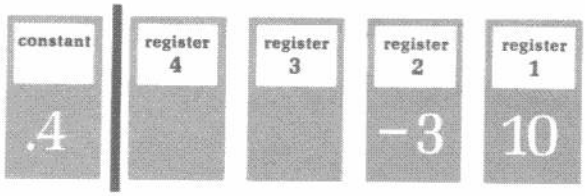


STORE C Key
This key changes the constant register number to the number in register 1. The number stays in register 1.
Depress STORE C



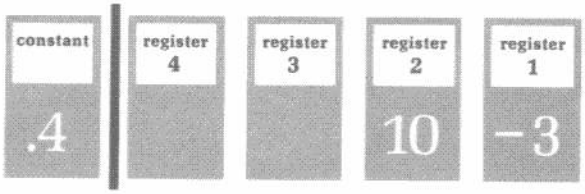
CLEAR Bar
This bar clears the number from register 1. All other numbers move up one register.

Depress CLEAR

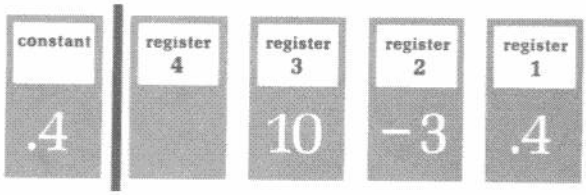


INTERCHANGE Key
This key interchanges the numbers in registers 1 and 2.

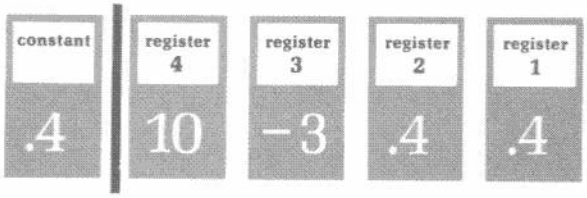
Depress I



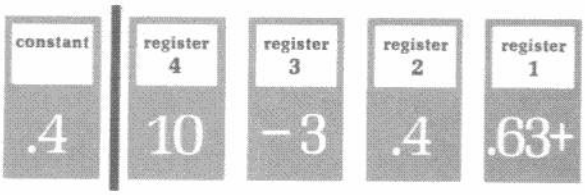
REC C Key
This key recalls the number in the constant register to the first register. Other numbers move down one register.
Depress REC C



REPEAT Key
This key duplicates in register 2 the number in register 1. All other numbers move down one register.
Depress RPT



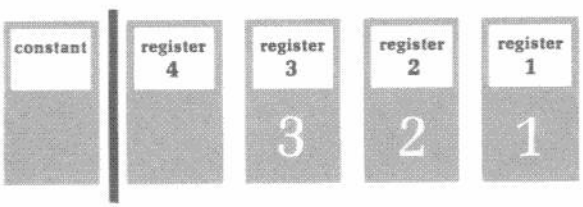
SQUARE ROOT Key
This key replaces the number in register 1 with its square root. The contents of all other registers remain the same.
Depress $\sqrt{}$



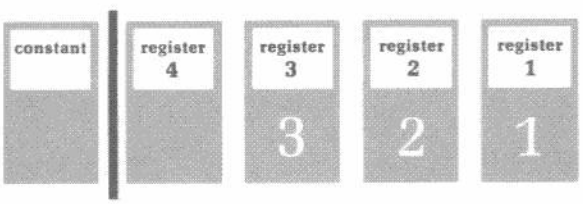
Examples Using the Numbers in the First Three Registers

By using the I, STORE C and CLEAR keys the numbers in the first three registers can be used with a keyboard entry or combined in a calculation with either of the other two. The diagrams below show how this is possible.

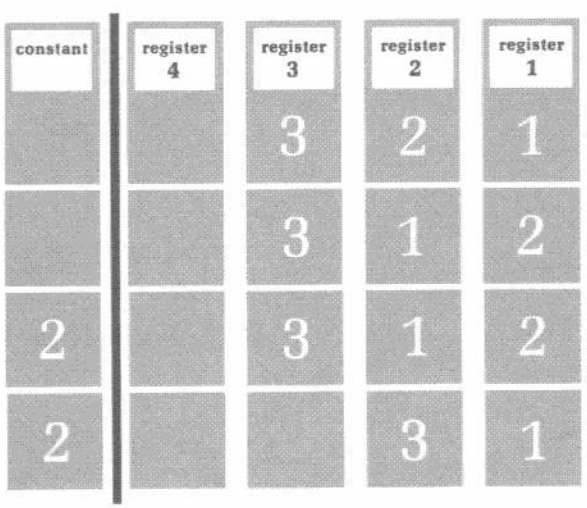
To use the number in register 1 with a keyboard entry just set the number and depress +, −, ×, or ÷



To use the number in register 1 with the number in register 2 simply depress the +, −, ×, or ÷.



To use the number in register 1 with the number in register 3

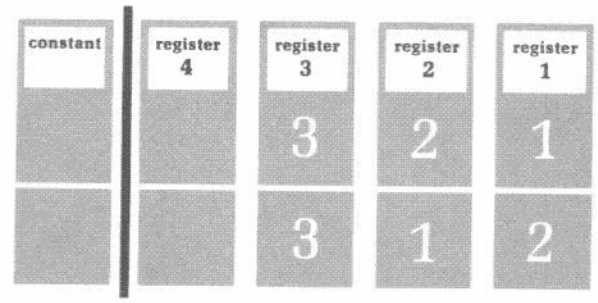


Depress I

Depress STORE C

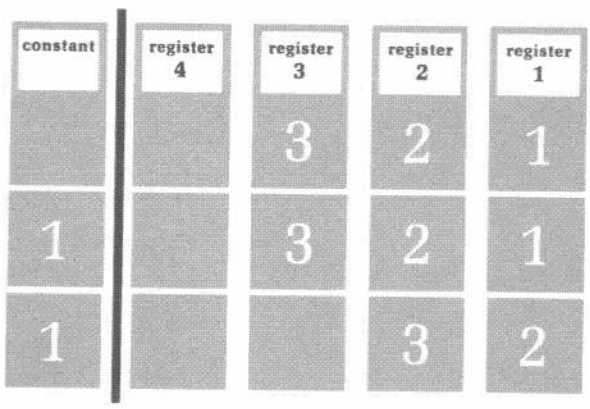
Depress CLEAR; then depress +, −, ×, or ÷

Examples Using the Numbers in the First Three Registers (cont.)



To use the number in register 2 with a keyboard entry:

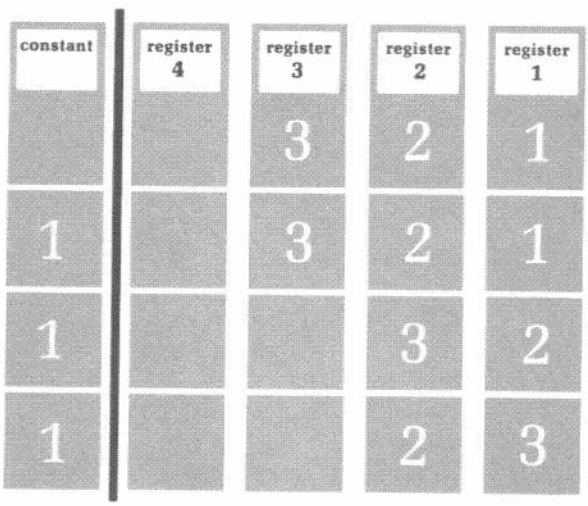
Depress I; then set number and depress +, −, ×, or ÷



To use the number in register 2 with the number in register 3:

Depress STORE C

Depress CLEAR; then depress +, −, ×, or ÷



To use the number in register 3 with a keyboard entry:

Depress STORE C

Depress CLEAR

Depress I; then set number and depress +, −, ×, or ÷

The EPIC Learns

For addition, subtraction, multiplication, division, or any combination of these arithmetic processes a calculator operator performs a sequence of keyboard entries and control key depressions. If the operator depresses the LEARN key and then does a calculation, the EPIC learns the sequence of keyboard entries and control key depressions.

How the EPIC Learns

For those operators who are interested in details of how the EPIC learns, here is what happens. Depressing the LEARN key erases the EPIC's electronic program memory and prepares it to make a record of the control keys that the operator depresses. The memory also marks any point in the sequence of control key depressions where keyboard entries are made. As a result, keyboard entries and control key depressions are memorized in the order that they were made, and the EPIC is automatically programmed to do the sequence.

How the Program Works

To use the program depress the AUTO key. Set the first number in the keyboard and depress ENTer; the second number, ENTer; the third number, ENTer, and so on. The program memory carries out all operations up to the next keyboard entry; then, the READY indicator lights to show that the operations are completed and the EPIC is ready for the next number. The program can be used as many times as required because the EPIC loops; that is, it repeats the program over and over again, going back to the first step after it finishes the last step. All keys except the digital keys, ENTer bar, CLEAR bar, and program keys are locked during AUTOmatic operation so the operator will not inadvertently depress a control key.

Not Limited to Program Only

The EPIC is not limited to programmed operation only; other calculations can be done in MANual. To leave automatic operation depress MANual when the READY indicator is on. Thus, the change from AUTOmatic to MANual is made when the calculator is waiting for a keyboard entry. If the operator depresses MANual at any other time, a calculation might be interrupted.

How to Re-enter Automatic Program

To continue the program depress the AUTO key. At this point the calculator assumes that the keyboard entry required by the program has been made and carries out all operations up to the next keyboard entry using the number in the first register as the entry. If the operator wishes to use a number other than the one in the first register, it should be set on the keyboard and the ENTer bar depressed before the AUTO key is depressed. In some cases the operator may want to enter several numbers.

Program Steps
Either forty-two or fourteen steps can be learned depending on whether the operator uses the EPIC 3000 or the EPIC 2000. A step consists of either setting a number on the keyboard or depressing a control key other than the ENTer bar; if the operator exceeds the number of steps the red light comes on and the keyboard locks. This locking protects the operator from inadvertently exceeding the learning capacity and, as a consequence, operating with an incomplete program in the automatic mode of operation.

Continuous Operation
If no entries are made during the LEARN process, the EPIC will receive no signal to stop and will therefore loop continuously through its program, performing the sequence of calculations on the numbers in the registers when LEARN was depressed and then on the numbers generated from the calculations. In this case, the READY light is always out. For an example of this type of operation, see the cube root routine on page 17.

In this type of program, too, the operator can leave AUTOmatic to do another calculation; but, since the READY light is always out, timing is different. The operator should depress MANual during a printout. If the operator depresses MANual at any other time, a calulation might be interrupted. To return to automatic depress AUTO. The EPIC continues the routine with the next step after the printout.

Tape Gives Complete Proof of Accuracy
The EPIC gives a complete and easy check on calculations. The operator need only check the printed tape to see that the LEARN sequence was properly performed and the correct entries were made in AUTOmatic. No other check is needed. When a problem is completed, there is complete confidence that the results are correct.

Automatic Addition of Products

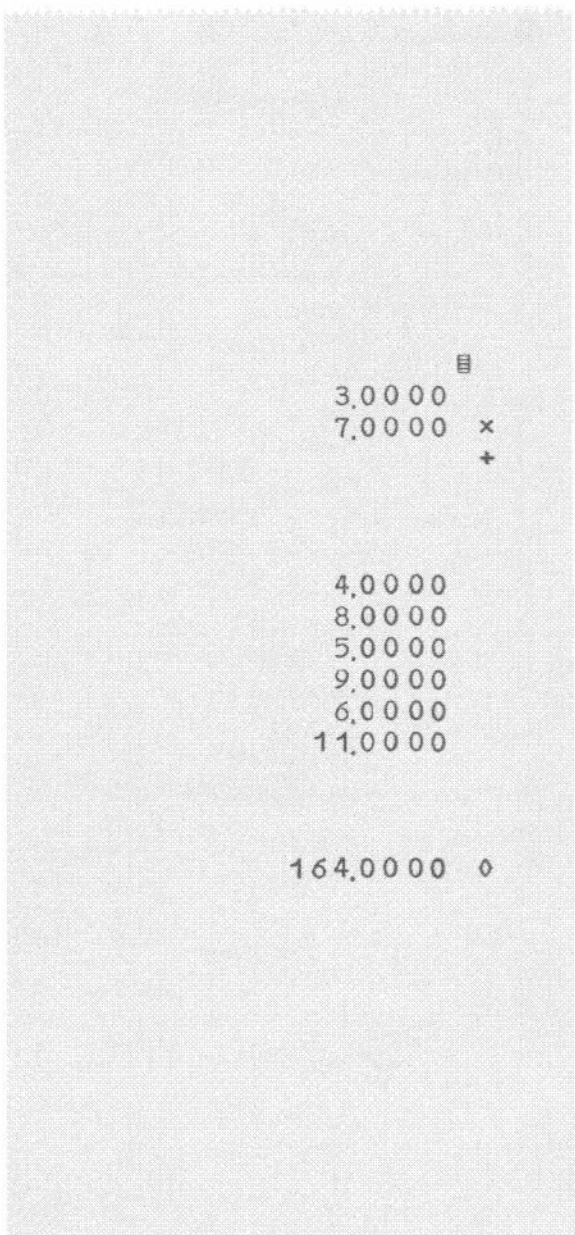
Since the last two answers are always available in the 1st and 2nd registers, a plus step programmed after each multiplication will add them thereby accumulating the answers.

example: $\Sigma xy = 164$

x	y
3	7
4	8
5	9
6	11

instructions:

Depress **START RESET**
Depress **LEARN**
Set **3**
Depress **ENT**
Set **7**
Depress × +
Depress **AUTO**
Set **4**
Depress **ENT**
Set **8**
Depress **ENT**
Continue in same way for remaining values
To print total depress **MAN**
PRINT
To begin new problem:
Depress **CLEAR**
Set **first x**
Depress **ENT**
Depress **AUTO**
Set **first y**
Depress **ENT**
Continue with the remaining values



Multiplying a Series of Numbers

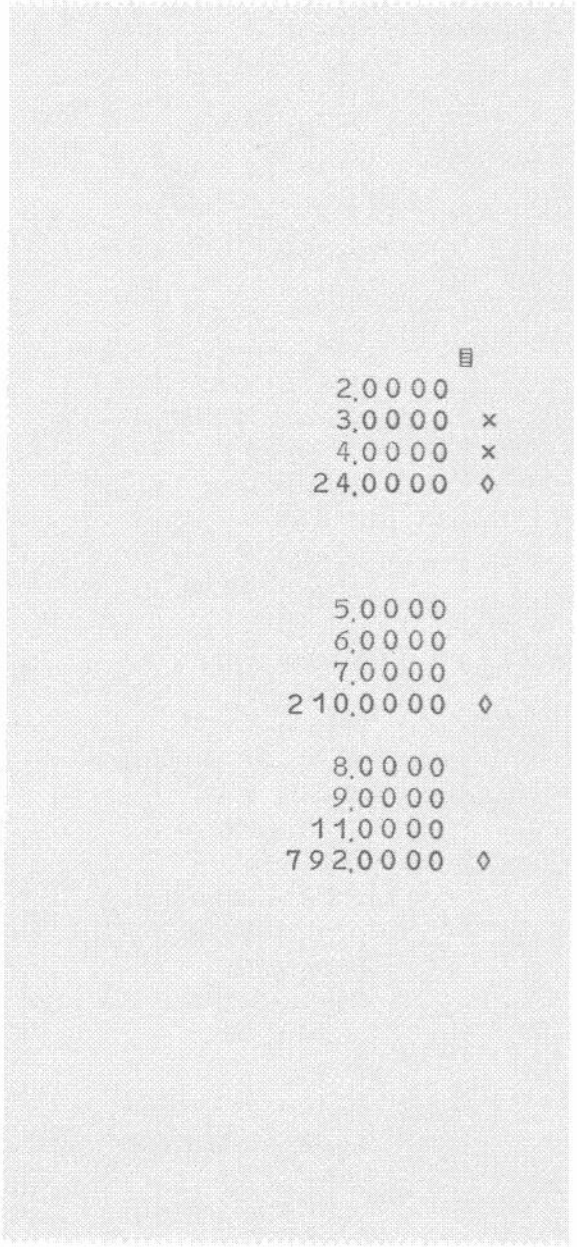
This is the special case of multiplying the last answer by another number. The answer to the first multiplication is immediately available for multiplication by another number.

example: $2 \times 3 \times 4 = 24$
$5 \times 6 \times 7 = 210$
$8 \times 9 \times 11 = 792$

instructions:

Decimal Selector at	**4**
Depress	**LEARN**
Set	**2**
Depress	**ENT**
Set	**3**
Depress	×
Set	**4**
Depress	×
	PRINT
Depress	**AUTO**
Set	**5**
Depress	**ENT**
Set	**6**
Depress	**ENT**
Set	**7**
Depress	**ENT**

Continue with remaining values



Raising a Number to a Power

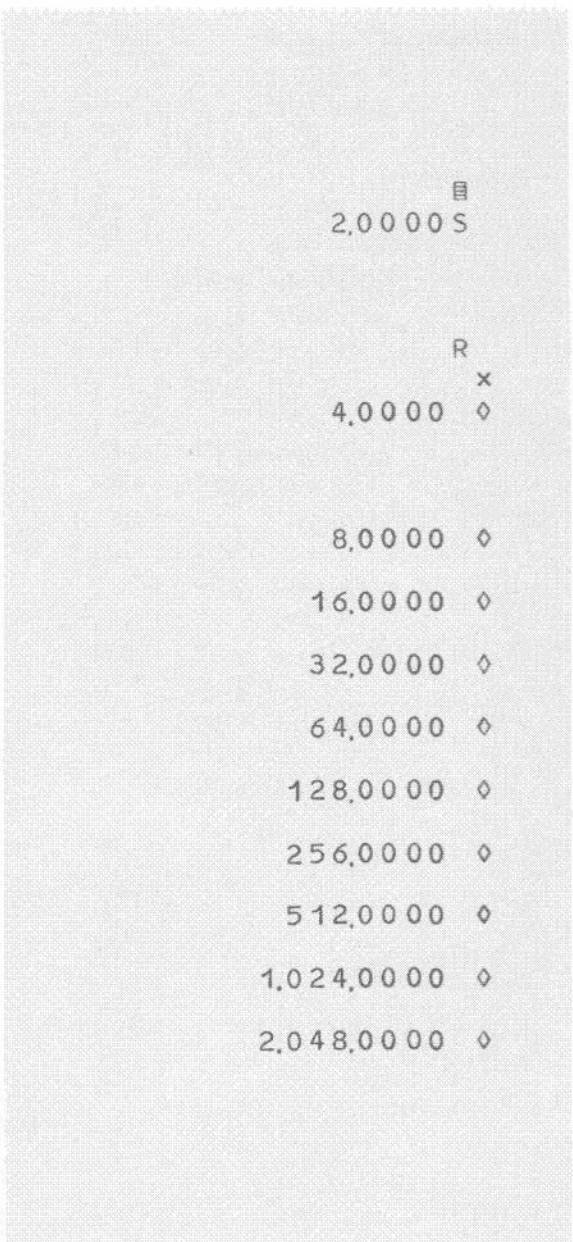
Multiplying a number by itself uses the same method as the example on the previous page except that the number is recalled from the constant register instead of being set on the keyboard. Since the program generates answers from information already in the registers, and no keyboard entries are required, the EPIC operates unattended.

example: X, X^2, X^3, X^4, X^5, etc.

instructions:

Depress **MAN**
Set **2**
Depress **STORE C**
Depress **LEARN**
Depress **REC C** ×
Depress **PRINT**
Depress **AUTO**

Stop EPIC at required power by depressing MANual during printout



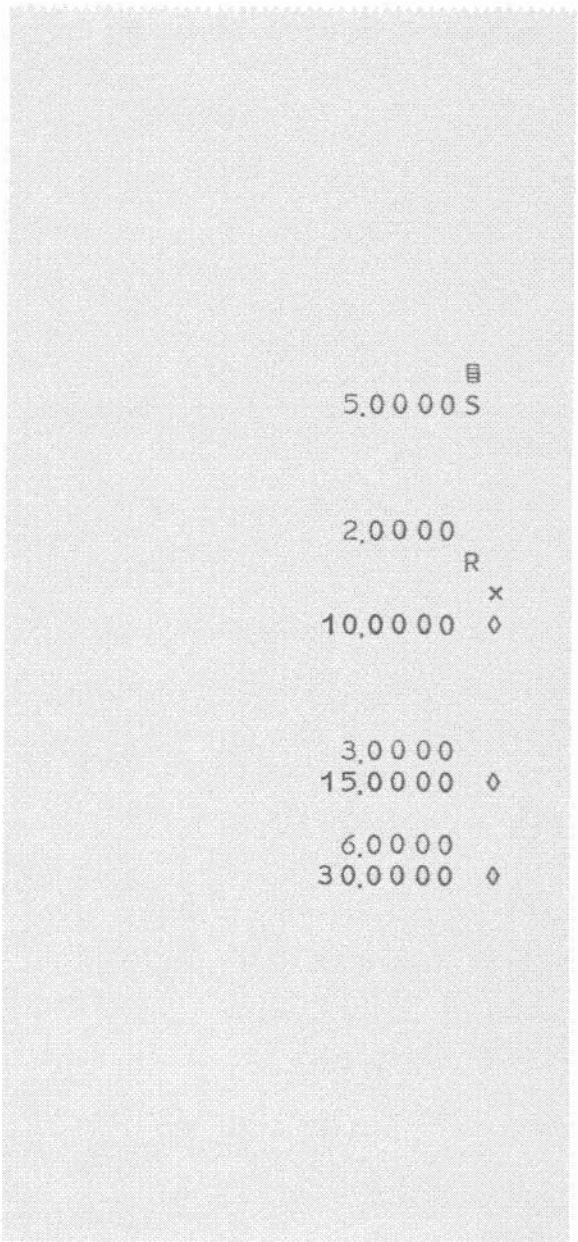
Multiplication by the Same Number

The constant is stored in the constant register and is recalled each time it is needed.

example: **5 × 2 = 10**
5 × 3 = 15
5 × 6 = 30

instructions:

Decimal Selector at	**4**
Depress	**MAN**
Set	**5**
Depress	**STORE C**
Depress	**LEARN**
Set	**2**
Depress	**ENT**
Depress	**REC C**
	×
	PRINT
Depress	**AUTO**
Set	**3**
Depress	**ENT**
Set	**6**
Depress	**ENT**



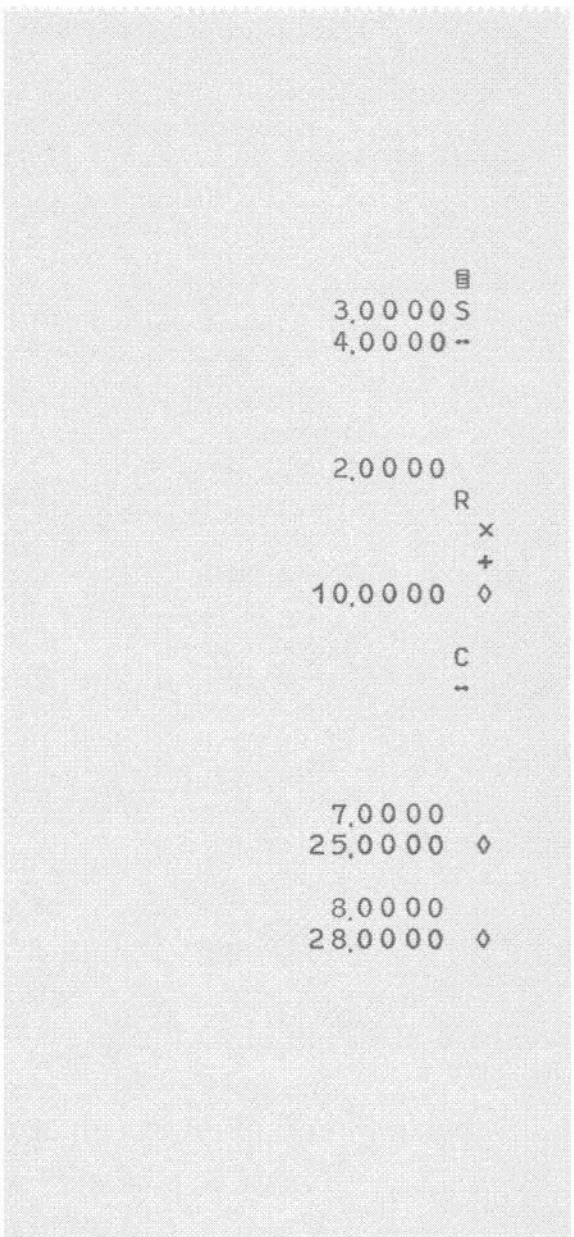
Two Constants

One constant is stored in the constant register and is recalled each time it is needed. The second constant is held in the stack and regenerated during each program cycle by depressing the repeat key.

example: $2 \times 3 + 4 = 10$
$7 \times 3 + 4 = 25$
$8 \times 3 + 4 = 28$

instructions:

Decimal Selector at	**4**	
Depress	**MAN**	
Set	**3**	
Depress	**STORE C**	Store first constant and put second constant in stack
Set	**4**	
Depress	**RPT**	
Depress	**LEARN**	
Set	**2**	
Depress	**ENT**	
	REC C	
	×	
	+	
	PRINT	
	CLEAR	
	RPT	
Depress	**AUTO**	
Set	**7**	
Depress	**ENT**	
Set	**8**	
Depress	**ENT**	



Distance Between Points

In this application the EPIC subtracts one X coordinate from the other and squares the difference. The same is done for the Y coordinates. The two results are added and a depression of the square root key finds D.

example: **evaluate** $D = \sqrt{(X_1 - X_2)^2 + (Y_1 - Y_2)^2}$

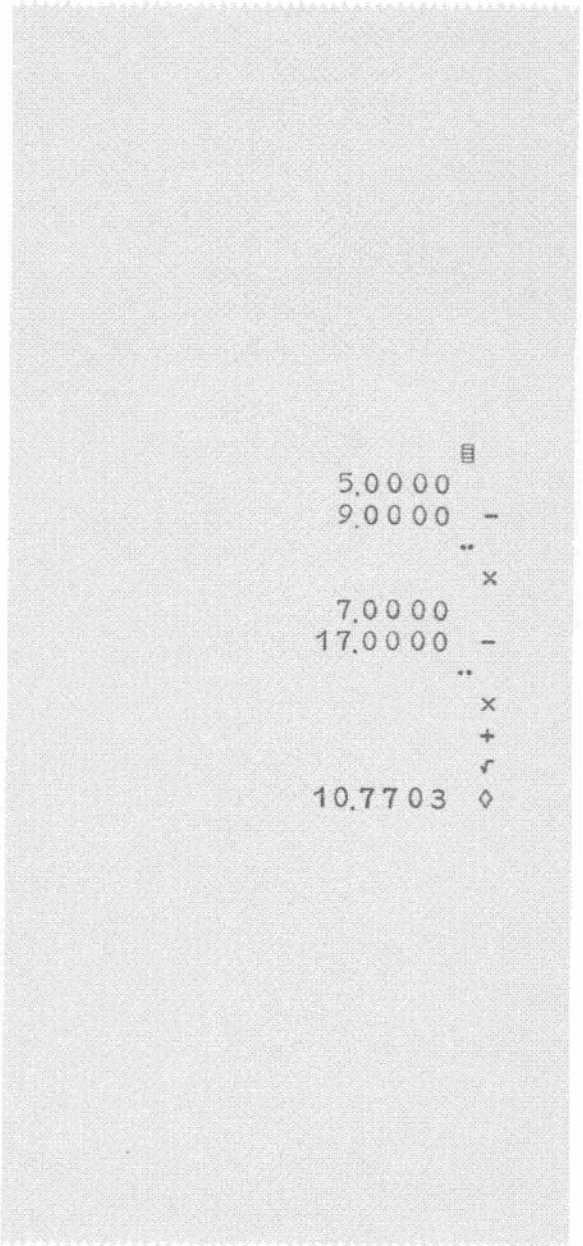
Find the distance between two points when
$X_1 = 5$, $Y_1 = 7$, $X_2 = 9$, $Y_2 = 17$
Distance = 10.7703

instructions:

Depress	**LEARN**
Set	**5**
Depress	**ENT**
Set	**9**
Depress	**−**
	RPT
	×
Set	**7**
Depress	**ENT**
Set	**17**
Depress	**−**
	RPT
	×
	+
	√
	PRINT
Depress	**AUTO**

For other distances,

Set	X_1
Depress	**ENT**
Set	X_2
Depress	**ENT**
Set	Y_1
Depress	**ENT**
Set	Y_2
Depress	**ENT**



Roots

Using the square root capability the EPIC can compute the cube root or 5th root of a number completely automatically. Since no keyboard entries are made in LEARN the EPIC operates unattended.

example 1: $\sqrt[3]{27} = 3$

instructions:

Decimal Selector at **4**
Depress **MAN**
Set **27**
Depress **STORE C**
Depress **LEARN**
Depress $\sqrt{\ }$
PRINT
REC C
I
÷
Depress **AUTO**

When printouts are the same, the closest approximation has been reached. Depress MANual when the answer is setting up in the keyboard dials.

For other Cube Roots: **Set number**
Depress **STORE C**
Depress **AUTO**

example 2: $\sqrt[5]{243} = 3$ (Tape not shown)

Depress **MAN**
Set **243**
Depress **STORE C**
Depress **LEARN**
Depress $\sqrt{\ }$
$\sqrt{\ }$
PRINT
REC C
I
÷
Depress **AUTO**

For other fifth roots: **Set number**
Depress **STORE C**
Depress **AUTO**

```
                  E
27.00005

                  √
5.1961  ◊

                  R
                  I
                  ÷

2.2795  ◊
3.4416  ◊
2.8009  ◊
3.1047  ◊
2.9489  ◊
3.0258  ◊
2.9871  ◊
3.0064  ◊
2.9967  ◊
3.0016  ◊
2.9991  ◊
3.0004  ◊
2.9997  ◊
3.0001  ◊
2.9999  ◊
3.0000  ◊
3.0000  ◊
```

Sine Power Series Expansion

The EPIC evaluates sin x by summing the terms of its Maclaurin power series. Each term of the series after the first can be obtained from the preceding term by a multiplication by $-x^2$ and a division by n+1 and then n+2 where n! is the denominator of the preceding term.

For example, $\frac{+x^5}{5!} = \left(\frac{-x^3}{3!}\right) \times \frac{-x^2}{4x5}$

As each term is computed, it is both stored and added to the sum of the previous terms.

example: sin 19° = 0.32556815

formula: $\sin x = \frac{x}{1!} - \frac{x^3}{3!} + \frac{x^5}{5!} - \frac{x^7}{7!} + \frac{x^9}{9!} - \cdots$

(x = angle expressed in radian measure)

instructions:

Decimal Selector at **8**
Depress **START RESET**
Depress **MAN**
Set **19** Convert angle to radians
Depress **ENT** using $x = \frac{\pi \times \text{angle}}{180}$
Set **3.14159265**
Depress **×**
Set **180**
Depress **÷**

Put x in the constant register; compute $-x^2$. Recall x into the first register; $-x^2$ moves into register two.

PRINT STORE C
RPT × −
REC C
LEARN

Set **1**
Depress **÷**
Set **1**
Depress **÷**
Depress **STORE C CLEAR**
I REC C + PRINT I
RPT REC C ×
Depress **AUTO**
Set **2**
Depress **ENT**
Set **3**
Depress **ENT**
ENTer 4, 5; 6, 7; 8, 9; etc. until printouts repeat

To start routine for other angles:

Depress **MAN**
Depress **CLEAR**
CLEAR CLEAR

Follow MAN portion of the program at left

Set **1**
Depress **ENT**
Depress **AUTO**
Set **1**
Depress **ENT**
ENTer 2, 3; 4, 5; 6, 7; 8, 9; etc. until printouts repeat

```
                    R
 19.000000000
  3.141592650  ×
180.000000000  ÷
  0.331612550  ◊

                  S
                  ↔
                    ×
                    −
                  R

  1.000000000  ÷
  1.000000000  ÷
                  S
                  C
                  I
                  R
                    +
  0.331612550  ◊

                  I
                  ↔
                  R
                    ×

  2.000000000
  3.000000000
  0.325534820  ◊

  4.000000000
  5.000000000
  0.325568230  ◊

  6.000000000
  7.000000000
  0.325568150  ◊

  8.000000000
  9.000000000
  0.325568150  ◊
```

Negative Numbers

Numbers with varying algebraic signs may be entered during automatic operation by programming a subtraction between the number and zero. In automatic operation, the algebraic sign determines the order of input of the number and zero. In the problem below, depressing the decimal bar automatically enters a zero.

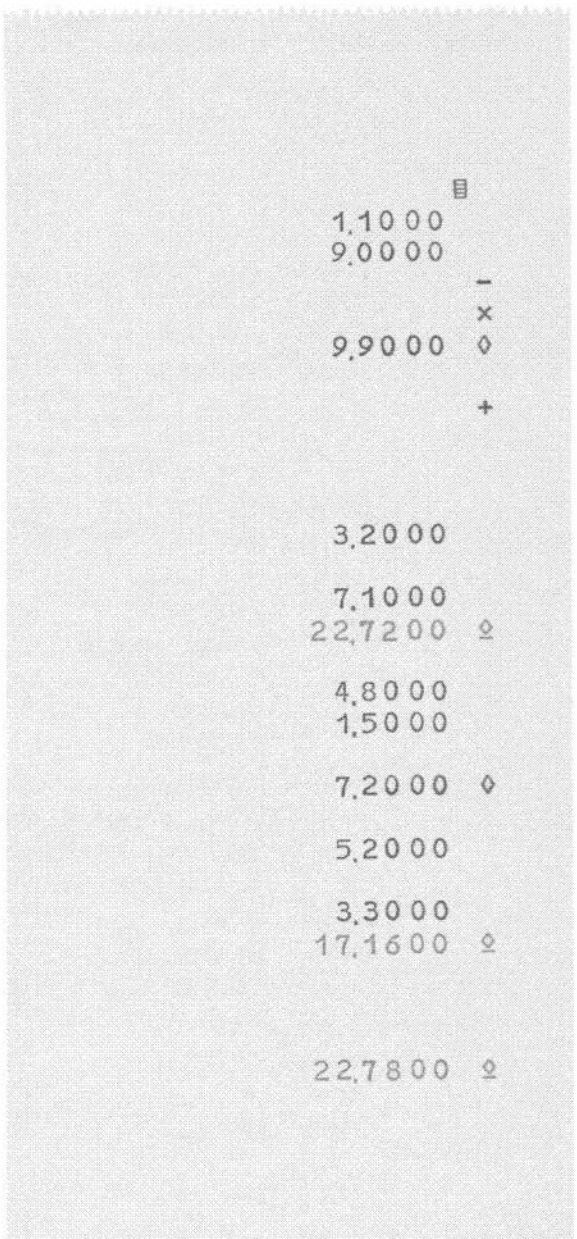
example:

x		y		
1.1	×	9.0	=	9.90
3.2	×	−7.1	=	−22.72
4.8	×	1.5	=	7.20
5.2	×	−3.3	=	−17.16
				−22.78

instructions:

	Depress	**START RESET**
	Depress	**LEARN**
	Set	**1 DEC • 1**
	Depress	**ENT**
If first Y is − exchange these steps.	Set	**9**
	Depress	**ENT**
	Depress	**DEC •**
	Depress	**−**
		×
		PRINT
		+
	Depress	**AUTO**
For the other problems:		**Enter x**
If y is positive		**Set y Depress ENT**
		Depress DEC • ENT
If y is negative		**Depress DEC • ENT**
		Set y Depress ENT
After listing all x's and y's	depress	**MAN and PRINT for grand total**

Sign of Y depends on whether Y is entered before or after DEC •



Any Root of a Number

The power series expansion for exp x and ln(1 + x) can be programmed for evaluation on the EPIC. Thus, using the relation $a^x = e^{x \ln a}$ roots of numbers are easily found.
The program for finding ln(1 + x) where x is between −1 and +1 and exp x (any x) is similar to that used for the sine power series expansion on page 18.

example: $(1.105)^{.7823} = 1.08124049$

$$\ln(1+x) = \frac{x}{1} - \frac{x^2}{2} + \frac{x^3}{3} - \frac{x^4}{4} + \frac{x^5}{5} - \cdots$$

instructions:

Decimal Selector at	**8**	
Find ln(1.105) =	**ln(1 + .105)**	
Depress	**MAN**	
Set	**x = .105**	Put x in first and constant registers.
Depress	**STORE C**	Put common ratio between numerators (x−) in third register.
	−	
	I	
	REC C	The second register (now zero) will hold the sum of the terms.
Depress	**LEARN**	
Set	**1**	
Depress	**÷ +**	
	PRINT	
	I RPT REC C	
	× STORE C	
	CLEAR	
	I REC C	
Depress	**AUTO**	
Now	**ENTer 2, 3, 4, 5, . . . until printouts are the same (at 8 in this example).**	
Depress	**MAN**	
Depress	**CLEAR**	
Depress	**PRINT**	
ln 1.105 is now in register one		
Set	**DEC • 7823**	
Depress	**×**	
Depress	**PRINT**	

```
                    ⊟
0.1 0 5 0 0 0 0 0 S
                    −
                  I
                  R

1.0 0 0 0 0 0 0 0  ÷
                   +
0.1 0 5 0 0 0 0 0  ◊

                  I
                  ••
                  R
                    ×
                  S
                  C
                  I
                  R

2.0 0 0 0 0 0 0 0
0.0 9 9 4 8 7 5 0  ◊

3.0 0 0 0 0 0 0 0
0.0 9 9 8 7 3 3 7  ◊

4.0 0 0 0 0 0 0 0
0.0 9 9 8 4 2 9 9  ◊

5.0 0 0 0 0 0 0 0
0.0 9 9 8 4 5 5 4  ◊

6.0 0 0 0 0 0 0 0
0.0 9 9 8 4 5 3 2  ◊

7.0 0 0 0 0 0 0 0
0.0 9 9 8 4 5 3 3  ◊

8.0 0 0 0 0 0 0 0
0.0 9 9 8 4 5 3 3  ◊

                  C
0.0 9 9 8 4 5 3 3  ◊

0.7 8 2 3 0 0 0 0  ×
0.0 7 8 1 0 9 0 0  ◊
```

Any Root of a Number (cont.)

Now find exp(.078109) as follows:

$$e^x = 1 + x + \frac{x^2}{2!} + \frac{x^3}{3!} + \frac{x^4}{4!} + \cdots$$

Set	**1**	Put 1 in 3rd register and .078109, (x ln a), in registers 1 and 2
Depress	**ENT**	
	I	
	RPT	
Depress	**LEARN**	
Set	**1**	
Depress	÷	
	STORE C	
	CLEAR	
	I	
	REC C	
	+	
	PRINT	
	I	
	RPT	
	REC C	
	×	
Depress	**AUTO**	
Now	**ENTer 2, 3, 4 ,5, . . .**	
	until printouts are the same	
	(at 6 in this example).	

The last printout is the required result.

```
 0.0 7 8 1 0 9 0 0   ◊

 1.0 0 0 0 0 0 0 0
                 I
                 ..
 1.0 0 0 0 0 0 0 0   ÷
                 S
                 C
                 I
                 R
                   +
 1.0 7 8 1 0 9 0 0   ◊

                 I
                 ..
                 R
                   ×

 2.0 0 0 0 0 0 0 0
 1.0 8 1 1 5 9 5 0   ◊

 3.0 0 0 0 0 0 0 0
 1.0 8 1 2 3 8 9 2   ◊

 4.0 0 0 0 0 0 0 0
 1.0 8 1 2 4 0 4 7   ◊

 5.0 0 0 0 0 0 0 0
 1.0 8 1 2 4 0 4 9   ◊

 6.0 0 0 0 0 0 0 0
 1.0 8 1 2 4 0 4 9   ◊
```

Standard Deviation: Σx, Σx^2, N

The EPIC 3000 can be programmed to find summation x, summation x^2, and to count the number of x values. These sums are then used to compute the standard deviation in manual operation.

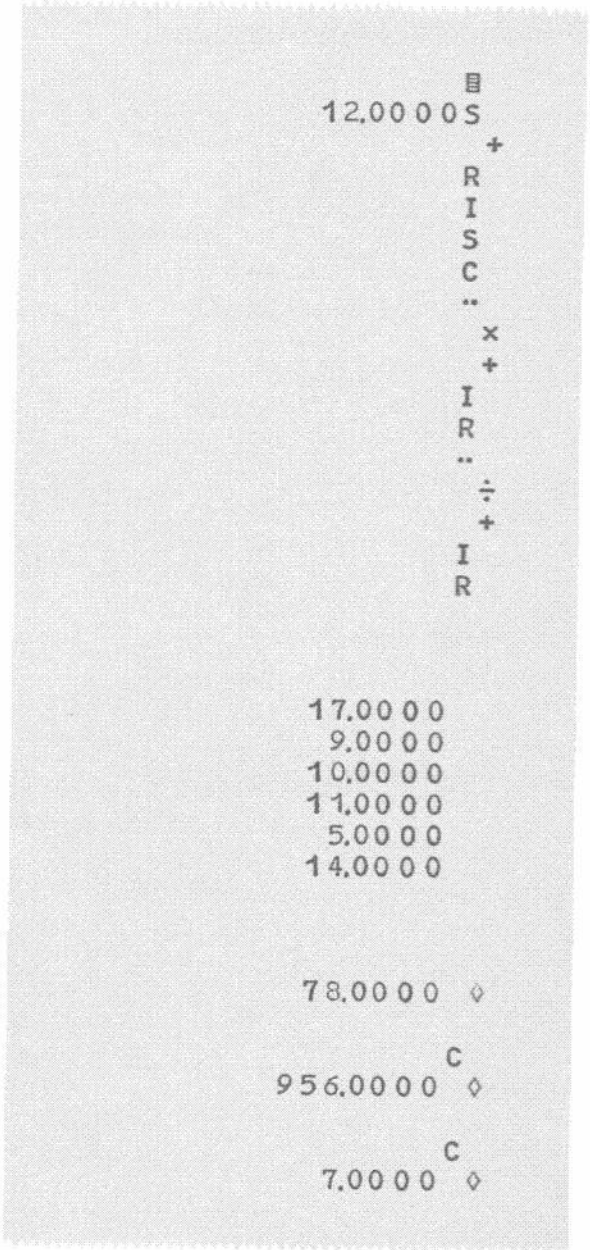
On this page the program for Σx, Σx^2 and N is given. The next page shows the program for finding the standard deviation by entering N, Σx^2, and Σx. If a number of standard deviation problems are to be done, it is suggested that all the summations be found first. Then, each set of summations can be used in the standard deviation program.

example: Find the standard deviation of the set of numbers (12, 17, 9, 10, 11, 5, 14)

instructions:

Decimal Selector at	**4**
Depress	**START RESET**
Depress	**LEARN**
Set	**12**
Depress	**STORE C + REC C I STORE C CLEAR RPT × + I REC C RPT ÷ + I REC C**
Depress	**AUTO**
Set	**17**
Depress	**ENT**
Set	**9**
Depress	**ENT**
Set	**10**
Depress	**ENT**
Set	**11**
Depress	**ENT**
Set	**5**
Depress	**ENT**
Set	**14**
Depress	**ENT**

To print the summations depress MANual, PRINT, CLEAR, PRINT, CLEAR, PRINT. The numbers printed will be Σx, Σx^2 and N in that order. To begin summations of next set of values, depress CLEAR and ENTer the first value of x. Then depress the AUTO key and enter the remaining values of x.



Standard Deviation (cont.)

Convert Σx, Σx^2 and N to standard deviation using the formula

$$\sigma = \sqrt{\frac{\Sigma x^2}{N} - \left(\frac{\Sigma x}{N}\right)^2}$$

example: Find standard deviation when
$N = 7$, $\Sigma x^2 = 956$, $\Sigma x = 78$

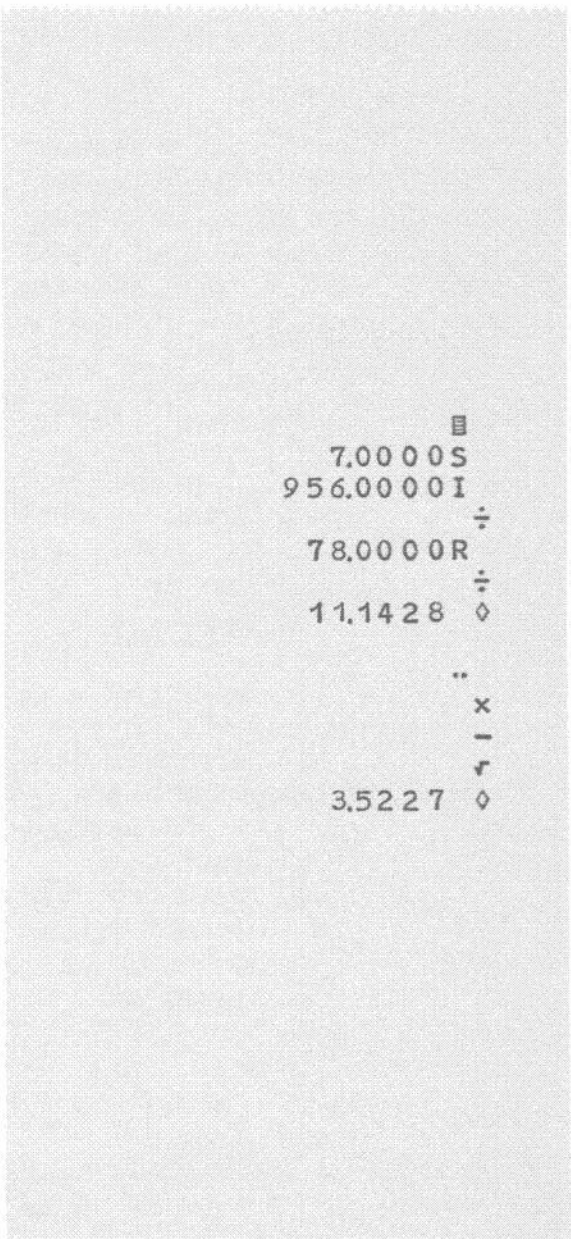
instructions:

Depress	**LEARN**
Set	**7**
Depress	**STORE C**
Set	**956**
Depress	**I**
	÷
Set	**78**
Depress	**REC C**
	÷
	PRINT $\bar{x} = 11.1428$
	RPT
	×
	−
	√
	PRINT $\sigma_x = 3.5227$
Depress	**AUTO**

To find other standard deviations:

Set	**N**
Depress	**ENT**
Set	**Σx^2**
Depress	**ENT**
Set	**Σx**
Depress	**ENT**

In this example, the Mean ($\bar{x}$) is printed.
This step can be omitted.



Linear Correlation Coefficient

The program used to find the summations for values of x in the Standard Deviation section can be used again to find summation y and summation y^2. It is only necessary to clear the registers and enter the first y value in MANual; then go into AUTOmatic to complete the calculations. A program for summation xy has been given on page 11. Assuming the necessary summations are known, the formula for the linear correlation coefficient can be programmed for evaluation.

example:

x	y
56.4	41.7
99.7	97.0
110.5	98.4
73.1	68.5
60.5	52.6
149.0	100.7

$\Sigma x^2 = 56{,}536.16$
$\Sigma y^2 = 38{,}429.95$
$\Sigma x = 549.20$
$\Sigma y = 458.90$
$\Sigma xy = 46{,}089.93$
$N = 6$

$$r = \frac{N\Sigma xy - \Sigma x \Sigma y}{\sqrt{N\Sigma x^2 - (\Sigma x)^2} \cdot \sqrt{N\Sigma y^2 - (\Sigma y)^2}} = .8941$$

instructions:

Depress **LEARN**
Set **6**
Depress **STORE C**
Set **56536 DEC 16**
Depress **×**
Set **38429 DEC 95**
Depress **REC C × I**
Set **549 DEC 2**
Depress **STORE C RPT ×**
− √ I REC C
Set **458 DEC 9**
Depress **STORE C × REC C I**
STORE C CLEAR
RPT × − √ ×
Set **46089 DEC 93**
Depress **ENT**
Set **6**
Depress **× REC C − I ÷ PRINT**
Depress **AUTO**

To find other linear correlations enter the summations in following order: **N Σx^2 Σy^2 Σx Σy Σxy N**

```
                    E
          6.0000 S
56,536.1600 ×
38,429.9500 R
                  ×
                  I
      549.2000 S
                  ..
                  ×
                  −
                  √
                  I
                  R
      458.9000 S
                  ×
                  R
                  I
                  S
                  C
                  ..
                  ×
                  −
                  √
                  ×
46,089.9300
          6.0000 ×
                  R
                  −
                  I
                  ÷
      0.8941 ◊
```

Linear Regression Curve

The formulas for the slope m and y-axis intercept b of the linear regression curve can be programmed for evaluation on the EPIC when the necessary sums are known. The summations are done the same way as described in the correlation section.

The printout of the value of m is delayed until end of program so that the answers are the last two printouts on the tape.

For other answers enter the summations in the following order:
N Σxy Σx Σy Σx^2 Σy Σx^2 Σx Σxy
To evaluate $y = mx + b$ use the program on page 15. Enter m with its proper sign. Depress STORE C key. Enter b with its proper sign. Depress RPT key.

example: $\Sigma x = 456$ $\Sigma x^2 = 35308$
$\Sigma y = 590$ $\Sigma y^2 = 61222$
$N = 6$ $\Sigma xy = 43401$

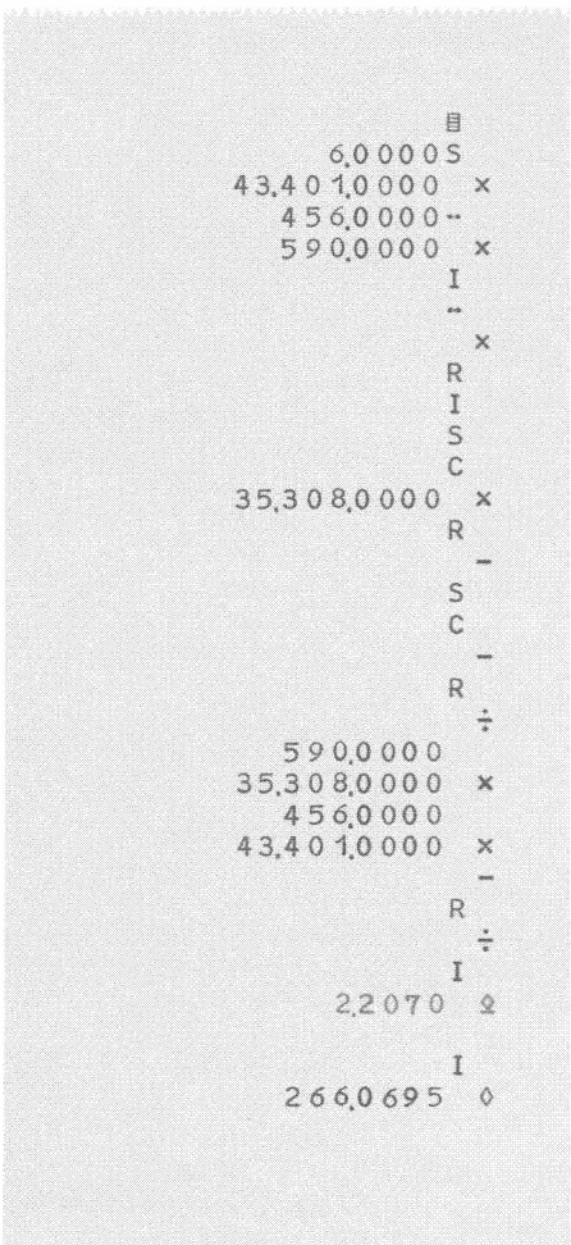
formulas:

$$m = \frac{N\Sigma xy - \Sigma x\Sigma y}{N\Sigma x^2 - (\Sigma x)^2} = -2.2070$$

$$b = \frac{\Sigma y\Sigma x^2 - \Sigma x\Sigma xy}{N\Sigma x^2 - (\Sigma x)^2} = 266.0695$$

instructions:

Decimal Selector at **4**
Depress **LEARN**
Set **6**
Depress **STORE C**
Set **43401**
Depress ×
Set **456**
Depress **RPT**
Set **590**
Depress ×
Depress **I RPT ×**
REC C I STORE C CLEAR
Set **35308**
Depress × **REC C** − **STORE C**
CLEAR − **REC C** ÷
Set **590**
Depress **ENT**
Set **35308**
Depress ×
Set **456**
Depress **ENT**
Set **43401**
Depress ×
Depress − **REC C** ÷ **I**
PRINT I PRINT
Depress **AUTO**



Chi Square

The Chi Square distribution can be computed from a contingency table without having to compute the theoretical frequency separately.

example:

				total
	11	98	41	150
	90	95	123	308
	112	37	85	234
total	213	230	249	692

formula: $\chi^2 = \Sigma \frac{(f_o - f_t)^2}{f_t}$

instructions:

Decimal Selector at **4**
Depress **MANual**
Set **692** Put N in storage
Depress **STORE C CLEAR**
Depress **LEARN**
Set **150**
Depress **ENT**
Set **213**
Depress **×**
REC C ÷ RPT
Set **11**
Depress **ENT I −**
RPT ×
I ÷ +
Depress **AUTO**

List remaining cells with their associated row and column totals.

Then depress **MAN and PRINT**
Chi Square = 122.0826

To begin another problem perform the following steps:

Depress **CLEAR**
Set **N**
Depress **STORE C**
CLEAR
Set **first row total and ENT**
Depress **AUTO**

```
                    692.00000S
                             C

                    150.00000
                    213.00000  ×
                             R
                             ÷
                            ..
                     11.00000
                             I
                             -
                            ..
                             ×
                             I
                             ÷
                             +

                    308.00000
                    213.00000
                     90.00000
                    234.00000
                    213.00000
                    112.00000
                    150.00000
                    230.00000
                     98.00000
                    308.00000
                    230.00000
                     95.00000
                    234.00000
                    230.00000
                     37.00000
                    150.00000
                    249.00000
                     41.00000
                    308.00000
                    249.00000
                    123.00000
                    234.00000
                    249.00000
                     85.00000

                    122.08826  ◊
```

Solution of the Quadratic Equation $ax^2 + bx + c = 0$

The real or imaginary roots of a quadratic equation in the form $ax^2 + bx + c = 0$ can be found on the EPIC 3000 by programming the quadratic formula $x = (-b \pm \sqrt{b^2 - 4ac}) \div 2a$
The EPIC prints five answers:

Discriminant
Real part of complex root
Imaginary part of complex root
Real root
Real root

If the discriminant is negative, the second and third printouts are the roots. If the discriminant is positive, the fourth and fifth printouts are the roots.

The algebraic sign of a, b, and c is handled by programming a subtraction between each of them and zero as previously described on page 19.

example 1: $3x^2 + 15x + 12 = 0 \quad x = -1, -4$

instructions:

Decimal Selector at	**4**
Depress	**LEARN**
Set	**15**
Depress	**ENT** Enter b; establish sign
Depress	**DEC •**
Depress	**—**
	RPT
Set	**3**
Depress	**ENT** Enter a; establish sign
Depress	**DEC •**
Depress	**—**
Depress	**RPT + STORE C**
	÷ I RPT ×
Set	**12**
Depress	**ENT**
Depress	**DEC •**
Depress	**—**
Depress	**REC C × RPT + —**
Depress	**PRINT** $(b^2 - 4ac)$
	RPT × √ √
	REC C ÷ STORE C
	CLEAR — RPT
	PRINT
	REC C PRINT
	+ PRINT
	CLEAR REC C — PRINT
Depress	**AUTO**

```
                  B
15.0000           -
                  ..
 3.0000           -
                  ..
                  +
                 S
                  ÷
                 I
                  ..
                  x
12.0000           -
                 R
                  x
                  ..
                  +
                  -
81.0000           ◊
                  ..
                  x
                  √
                  √
                 R
                  ÷
                 S
                 C
                  -
                  ..
 2.5000           ◊
                 R
 1.5000           ◊
                  +
 1.0000           ◊
                 C
                 R
                  -
 4.0000           ◊
```

Solution of the Quadratic Equation $ax^2 + bx + c = 0$ (cont.)

The EPIC 3000 is now programmed to find the roots of a quadratic equation. For another equation enter coefficients b, a, and c.

example 2: $2x^2 - 12x + 26 = 0$

$x = 3 \pm 2i$

instructions:

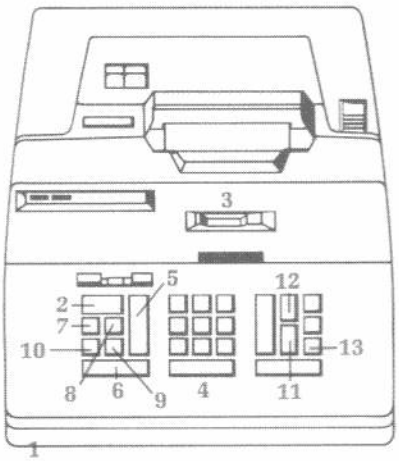
Depress $^{DEC}_{\bullet}$ **ENT**
Set **12**
Depress **ENT**
Set **2**
Depress **ENT** $^{DEC}_{\bullet}$ **ENT**
Set **26**
Depress **ENT** $^{DEC}_{\bullet}$ **ENT**

Depressing the $^{DEC}_{\bullet}$ bar automatically sets a zero in the keyboard

b
a
c

12.0000
2.0000
26.0000
64.0000 ◊
3.0000 ◊
2.0000 ◊
5.0000 ◊
1.0000 ◊

Control Keys and Their Use



On-Off Switch 1
The on-off switch is located under the front left-hand side of the EPIC. Move to the right for on and left for off.

START RESET Key ⊟ 2
The START RESET key clears the EPIC's registers of all numbers and erases any learned program. After the EPIC is turned on, depress the START RESET key.

Decimal Selector 3
The selector, located above the display dials, sets the decimal point at either 4 or 8.

10-Key Keyboard 4
Numbers set in the keyboard go immediately into register 1 and appear in the display dials. As the first digit is set the numbers in the stack move down one register. When either the whole number or decimal capacity is reached, the keyboard locks. All keyboard entries print with the symbol of the control key used.

DEC Bar 5
The decimal bar places the decimal point in the number.

CLEAR BAR C 6
The CLEAR bar clears the number in the keyboard dials. If there is no number in the keyboard dials, the CLEAR bar clears the number in register one. All other numbers move up one register. Refer to LEARN key for additional information.

I Key I 7
Interchanges the numbers in registers 1 and 2. All other registers remain unchanged.

RPT Key ·· 8
Repeats the number in register 1 by duplicating it in register 2. All other numbers move down one register.

STORE C Key S 9
Replaces the number in the constant register with the number in register 1. The number in register 1 remains there.

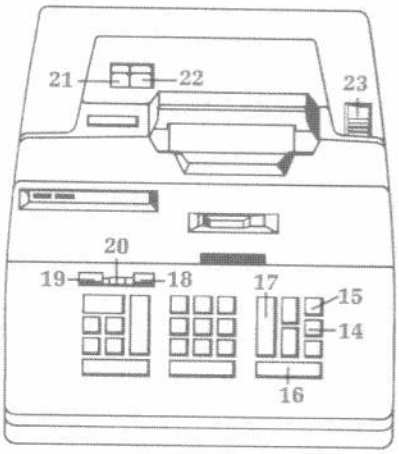
REC C Key R 10
Recalls the number in the constant register into register 1. All other numbers move down one register. The number in the constant register is still stored there.

+ Key + 11
Adds the numbers in registers 1 and 2. The result goes into register 1. All other numbers move up one register.

— Key – 12
Subtracts the number in register 1 from the number in register 2. The result goes into register 1. All other numbers move up one register.

× Key × 13
Multiplies the numbers in registers 1 and 2. The result goes into register 1. All other numbers move up one register.

Control Keys and Their Use



÷ Key ÷ 14
Divides the number in register 1 into the number in register 2. The result goes into register 1. All other numbers move up one register.

√ Key √ 15
Replaces the number in register 1 by its square root. The contents of the other registers remain unchanged.

PRINT BAR ◊ 16
Prints the number in register 1 on the tape. The number stays in register 1. This bar is locked when a number is in the keyboard dials.

ENT Bar 17
The ENTer bar moves the number in the keyboard dials to the selected decimal point, prints the number on the tape, and clears the number from the dials. The number remains in register 1.

LEARN Key 18
The LEARN key tells the EPIC's electronic memory to erase the program and to remember a new sequence of number entries and control key depressions. Only in one instance is a control key depression not remembered. If, during the LEARN sequence, the operator sets a wrong number and depresses CLEAR while the number is still in the keyboard, the EPIC remembers the fact that a number was set but does not remember the depression of the CLEAR bar. This arrangement permits the operator to correct the number and eliminates the need to redo the program.

AUTO Key 19
The AUTOmatic key tells the EPIC to put the program into effect, so that the calculator will select the proper control keys for the number entry or entries.

MAN Key 20
The MANual key permits the operator to use the calculator in a conventional way by selecting control keys. The program is not affected.

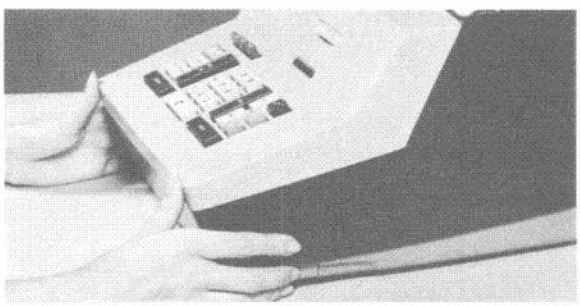
Space Control Lever 21
The left-hand lever on top of the EPIC can be set at double space or single space. Push lever back for double space.

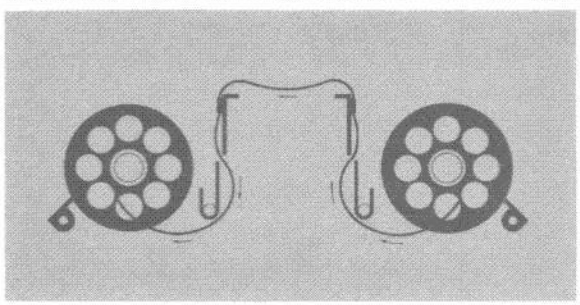
Platen Release 22
The right-hand lever on top of the EPIC releases the platen tear-off to permit adjustment of the paper. The mid-position holds the tearoff away from the platen to permit insertion of the paper tape. Push the platen release all the way back to release the paper from the roller; the platen release will not stay in this position unless held.

Platen Twirler 23
The wheel on the top right-hand side of the EPIC rotates the roller and moves the paper up or down.

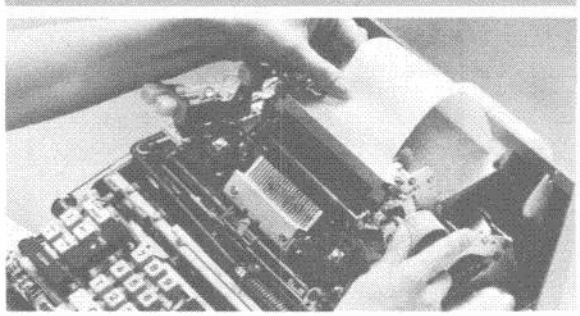
Changing the Ribbon and Paper Roll

Ribbon Change
Depress the buttons on each side of the calculator and remove case. Remove both spools. Discard one and use the other with the new spool. Thread the ribbon through the guide making sure the black half is at the top. Insert metal tip of ribbon in the slot in the spool and turn it flat so it fits in the space provided. Place spool in holder and close the case.

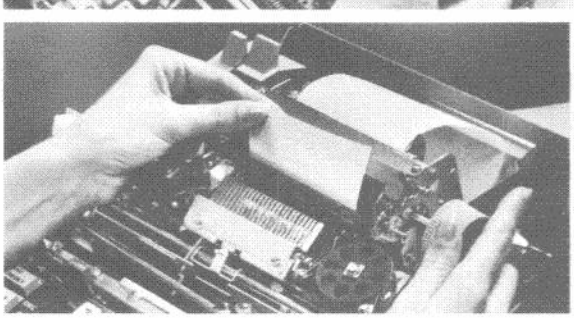




Paper Roll Change
Remove the case. Push the platen release lever to the rear in order to move the plastic tearoff away from the platen. Remove the old paper roll core. Place the new paper roll in the holder and feed the leading edge of the roll behind the platen.



Rotate the platen knob to feed the paper around the platen. Adjust paper while holding platen release lever all the way to the rear of the calculator. Pull platen release all the way forward to move the plastic tearoff flush against the platen. Replace the case.



A Concluding Note

To the Operator

Monroe is always ready to assist anyone in the operation of its machines to make sure they are being used in the most efficient manner possible. Additional information and personal instruction will be given by representatives of the nearest branch or local office.

To the Owner

Years of dependable service have been crafted into this sturdy machine. Like a car or any precision device, it should be given periodic check-ups and lubrication to assure its best operation and long life. Monroe International renders this service gratis for 90 days; thereafter, a nominal annual charge is made for a continuation of this preventive maintenance.

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