

SCIENTIFIC CALCULATOR

MODEL **EL-5103**

INSTRUCTION MANUAL

(ELECTRONIC CALCULATOR) LIMITED WARRANTY:

SHARP ELECTRONICS CORPORATION warrants this product to the original purchaser to be free from defective materials and workmanship. Under this warranty the product will be repaired or replaced, at our option, without charge for parts or labor, with the exception of batteries, when returned to a SHARP CONSUMER FACTORY SERVICE CENTER listed in the instruction booklet supplied with your unit.

This warranty does not apply to any appearance items nor to any product whose exterior has been damaged or defaced, nor to any product subjected to misuse, abnormal service or handling, nor to any products altered or repaired by other than a SHARP CONSUMER FACTORY SERVICE CENTER. This warranty does not apply to any product purchased outside the United States, its territories, or possessions.

The period of this warranty covers one (1) year on parts and one (1) year on labor from date of purchase.

This warranty entitles the original purchaser to have the warranted parts and labor rendered at no cost for the period of the warranty described above when the unit is carried or shipped, prepaid, to a SHARP CONSUMER FACTORY SERVICE CENTER together with proof of purchase.

THIS SHALL BE THE EXCLUSIVE WRITTEN WARRANTY OF THE ORIGINAL PURCHASER AND NEITHER THIS WARRANTY NOR ANY OTHER WARRANTY, EXPRESSED OR IMPLIED, SHALL EXTEND BEYOND THE PERIOD OF THE TIME LISTED ABOVE. IN NO EVENT SHALL SHARP BE LIABLE FOR CONSEQUENTIAL ECONOMIC DAMAGE OR CONSEQUENTIAL DAMAGE TO PROPERTY. SOME STATES DO NOT ALLOW A LIMITATION ON HOW LONG AN IMPLIED WARRANTY LASTS OR AN EXCLUSION OF CONSEQUENTIAL DAMAGE, SO THE ABOVE LIMITATION AND EXCLUSION MAY NOT APPLY TO YOU. IN ADDITION, THIS WARRANTY GIVES SPECIFIC LEGAL RIGHTS, AND YOU MAY HAVE OTHER RIGHTS WHICH VARY FROM STATE TO STATE.

If service of your calculator is required, use only an authorized SHARP Service Center.

Keep this manual for further reference.

All of the keys may become inoperative during the operation of the calculator due to a strong external noise and so on. In such a case, remove the batteries and install them again. Press the **OFF**, **ON**, **2ndF** and **CA/CL** keys in this order and check the display "0," or "—".

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OPERATIONAL NOTES

Thank you for your purchase of the SHARP scientific calculator, EL-5103.

Since the liquid crystal display is made of glass material, treat the calculator with care. Do not put the "EL-5103" in your back pocket as it may be damaged when you sit down.

To insure trouble-free operation of your SHARP calculator, we recommend the following:

1. The calculator should be kept in areas free from extreme temperature changes, moisture and dust.
2. During summer weather vehicles left in direct sun light are subject to high temperature build up.
Prolonged exposure to high temperature may cause damage to your calculator.
3. A soft, dry cloth should be used to clean the calculator. Do not use solvents or a wet cloth.
4. If the calculator will not be operated for an extended period of time, remove the batteries to avoid possible damage caused by battery leakage.

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INTRODUCTION

This manual will introduce you to the Sharp EL-5103 scientific calculator. The EL-5103 is a new and powerful computing instrument. It will provide you with formidable computing power in mathematical, scientific, engineering and business calculations.

The EL-5103 provides direct entry of calculations and formulas as written. You will see as you follow through this manual that the EL-5103 makes it unnecessary to learn a machine language. After keying in a formula, you will be able to visually edit, correct and test your inputs.

COMPUTATION MODE

Set the mode switch to "COMP".

When the symbol "FIX", "SCI" or "ENG" appears at the top of the display, press the **CL** key. And press the **FSE** key continuously until the above symbol disappears. In this case the floating decimal point system is set. (For the **FSE** key see "Display System and decimal places")

1. Addition, Subtraction & Playback

Key in the following:

$$12 \text{ [+] } 45.6 \text{ [-] } 32.1 \text{ [+] } 789 \text{ [-] } 741 \text{ [+] } 213$$

As you key in the "1" in 32.1+, you will note that 13th character "+" exceeds the 13 column capacity of the display owing to extra presence of the cursor. At this point, a unique feature called "rolling writer" becomes effective. As each additional step is entered, the display will roll to the left. The data rolled off the screen will be recorded up to 80 steps in the COMP MODE. An arrow ← will appear on the display indicating information now is stored in that direction.

Now press **=**

Your answer is 286.5

fraction. The full order of priorities is described in the supplementary below. The mathematical priorities can be re-ordered by using parenthesis.)

Supplementary - 1 priority level

The machine, provided with a function that judges the priority level of individual calculations, permits keys to be operated according to a given algebraic formula. The following shows the priority level of individual calculations.

- 1) (-)
- 2) Single-term function preceded by numerals
($x^2, x^{-1}, n!$, →DEG, →D.MS)
- 3) Two-term function preceded and followed by numerals
($\sqrt{y}, \sqrt[n]{y}$, →POL, →REC ...)
- 4) Multiplication cleared of "X" instruction located just before memory or π .
(Ex. $2\pi, 4A$)
- 5) Single-term function followed by numerals.
($\sqrt{\quad}, e^x, 10^x, \sqrt[n]{\quad}, \text{LN}, \text{LOG}, \text{SIN}, \text{COS}, \text{TAN}, \text{SIN}^{-1}, \text{COS}^{-1}, \text{TAN}^{-1}, \text{SINH}, \text{COSH}, \text{TANH}, \text{SINH}^{-1}, \text{COSH}^{-1}, \text{TANH}^{-1}$)
- 6) \times, \div

labeled "supplementary". The supplementary sections may be skipped without hampering your ability to operate the calculator. You may wish to return to the supplementary sections as your skill in operating the EL-5103 increases.

Name label

Write your name on the attached name label and stick it on the back of the calculator.

MODES

Note the mode switch on the lower right of your calculator. As you move the switch from one mode to another the name of the mode appears in the display. "AER" stands for Algebraic Expression Reserve; "COMP" for COMPUTations; and "STAT" for STATistical.

Now press **PB** (playback). You will get back in the display a portion of your original input to check and/or edit. Press **PB** again to obtain the remainder of your inputs. Editing will be explained in detail in a later section.

If you have placed material in the display and have not used the calculator for approximately ten minutes, the calculator will go into (APO) "Automatic Power Off" automatically to conserve battery life. Be simply turning the calculator on all of your last inputs will return to the display.

2. Multiplication, Division

a. Key in the following:

$$* \text{ [CL] } 841 \text{ [X] } 586 \text{ [÷] } .12 \text{ [=]}$$

Answer: 4106883.333

(* After play back operation in COMP mode press **=** or **CL** key.)

b. Key in the following:

$$2 \text{ [+] } 5 \text{ [X] } 3 \text{ [÷] } 4 \text{ [-] } 1 \text{ [=]}$$

Answer: 4.75

Note that the EL-5103 follows the priority of mathematics known as algebraic operating system. In other words multiplication and division will occur before addition and sub-

- Calculations have priority to others, when parenthesized.
- Provided that functions shown in item (5) above are successively designated in an algebraic formula, calculations are performed from the right to the left.

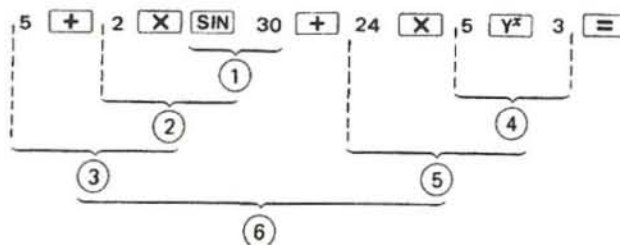
Ex. $e^x \text{ LN } \sqrt{120} \rightarrow e^x (\text{LN } (\sqrt{120}))$

The other functions are calculated from the left to the right.

Ex. $A \sqrt[n]{B} C Y^X D \rightarrow ((A \sqrt[n]{B}) C) Y^X D$

Order of calculations in a typical example:

Ex. $5 + 2 \times \sin 30 + 24 \times 5^3 =$



formula, some of the instructions or numerics included in the expression can't be treated directly.

Therefore, they are temporarily stored in the built-in buffers and the rest is treated in advance.

This calculator has a 16-stage function buffer (for calculation instruction) and 8-stage data buffer (for numerical data) in it. When the calculation exceeds 16-stage in function or 8-stage in data is performed, an error occurs.

Ex. 1 $1 + 2 \times (3 - 4 \div (7 \div 5 \sqrt{7 \times 6 Y^X} 3 =$

Functional buffer: 11-stage (including parentheses)
Data buffer: 8-stage

Ex. 2 $14 - 5 + 4 \times \text{SIN } 2 A Y^X (2 + 3 \div \text{LOG } 3 B \sqrt{48} =$

When the next "+" command arrives, "14-5" is calculated and the 11-stage (including parentheses) result is retained as "9".

Each memory is regarded as a numerical value.

Functional buffer: 11-stage (including parentheses)
Data buffer: 8-stage

a. Trigonometric functions

The angular mode is designated by the 2ndF DRG (---) key. As you press these keys the mode "DEG" "RAD" "GRAD" will appear at the top of the display. Put the angular mode at "DEG".

Key in the following:

$\text{SIN } 30 \text{ + } \text{COS } 40 \text{ =}$

Answer: 1.266044443

Put the angular mode at "RAD"

Key in: $\text{COS } .25 \text{ } \pi \text{ =}$

Answer: 0.707106781

b. Inverse Trigonometric Functions and Second Function

The yellow key in the upper left of the calculator marked "2nd F" must be used to designate the material appearing in brown above each key. When this key is pressed, the designation "2nd F" will appear in the upper part of the display. If you press this key in error, press it a second time and the "2nd F" designation will disappear.

Put the angular mode at "DEG"

Key in: $\text{2ndF} \text{ SIN}^{-1} .5 \text{ =}$

Answer: 30 (Remember to use the second function key to get the inverse)

Answer: 400

Calculate 3^3 and 3^4

Key in: $3 \text{ } Y^X 3 \text{ =}$

Answer: 27

Key in: $3 \text{ } Y^X 4 \text{ =}$

Answer: 81

e. Roots

Calculate: $\sqrt{25}$

Key in: $\text{2ndF} \sqrt{} 25 \text{ =}$

Answer: 5

Calculate: Cube root of 27

Key in: $\text{2ndF} \sqrt[3]{} 27 \text{ =}$

Answer: 3

Calculate fourth root of 81

Key in: $4 \text{ } \text{2ndF} \sqrt[4]{} 81 \text{ =}$

Answer: 3

f. Logarithmic Functions

Natural Logarithms: Key in: $\text{LN } 21 \text{ =}$

Answer: 3.044522438

When "x" comes "12 ÷ 4" is calculated, resulting in 3X.

When "-" comes, "3 + 2" is calculated, resulting in 5--.

Although "x" is omitted, the calculation is executed as if "x" were present.

Functional buffer: 16-stage (including parentheses)

Data buffer: 7-stage

End of Supplementary 1

When only the symbol "→" appears at the top of the display during calculation, do not continue making entries.

3. Scientific Functions

Scientific Calculations are performed in the same manner as basic computations. As you will note, in the following examples, scientific functions are used as you would normally read them.

Note Step: 1 step correspond to 1-digit display. However instructions such as SIN, SIN^{-1} , SINH^{-1} and LOG are processed as one-step.

Put the angular mode at "RAD"

Key in: $\text{2ndF} \text{COS}^{-1} (\text{---}) 1 \text{ =}$ (To enter a negative number, press the (---) key before numerals.)

Answer: 3.141592654 (Value of π)

In this Manual, we'll always show the key's second functions as follows;

$\text{2ndF} \text{INS} \rightarrow \text{2ndF} \text{INS}$

c. Hyperbolic and Inverse Hyperbolic functions

When using the hyperbolic and arc hyperbolic functions "HYP" will appear in the top of the display.

Key in: $\text{HYP} \text{SIN } 4 \text{ =}$

Answer: 27.2899172

Key in: $\text{2ndF} \text{ARCHYP} \text{SIN } 9 \text{ =}$

Answer: 2.893443986

d. Power Functions

Calculate: 20^2

Key in: $20 \text{ } X^2 \text{ =}$

g. Exponential Functions

Key in: $e^X 3.0445 \text{ =}$

Answer: 20.99952881 (21 as in item "f" above)

Key in: $\text{2ndF} 10^X 2.238 \text{ =}$

Answer: 172.9816359 (173 as in item "f" above)

h. Reciprocals

Calculate: $1/6 + 1/7$

Key in: $6 \text{ } X^{-1} \text{ + } 7 \text{ } X^{-1} \text{ =}$

Answer: 0.30952381

i. Factorial

Calculate: 69!

Key in: $69 \text{ } \text{2ndF} \text{ } \pi! \text{ =}$

Answer: 1.7112245E 98 (1.7112245×10^{98})

Note that the Error section deals with the calculation limits of the calculator.

j. Permutations

Calculate: ${}_5 P_3$

Key in: $5 \text{ } \text{2ndF} \text{ } \pi! \text{ } \div \text{ } (5 \text{ } - \text{ } 3 \text{ }) \text{ =}$

${}_n P_r = \frac{n!}{(n-r)!}$

5 cards in a deck of 52.

Key in: 52 $\frac{2ndF}{7!}$ \div () 5 $\frac{2ndF}{7!}$ () 52 $-$ 5 () $\frac{2ndF}{7!}$ $=$

Answer: 2598960

Supplementary 2 – effective digits

- In this calculator, all calculations are performed by using a numerical value whose mantissa is 12 digits or less. Calculation results are displayed after they are subjected to decimal system, but the calculator retains a numerical value whose mantissa is 12 digits. However, when a calculation results is used in the following calculation, the result displayed in accordance with the decimal system is used.
- When a numerical value is inputted as a mantissa, only its upper 10 digits are effective, but the number of inputted digits is retained. A numerical value smaller than 1 (or larger than -1) is also retained within 10 digits as much as possible.

Ex. 123456789876 \rightarrow equal to $1.234567898 \times 10^{11}$
 0.0000000001234 \rightarrow equal to 1.234×10^{-11}

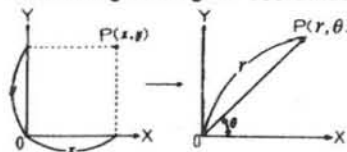
End of supplementary 2

Key in: $\frac{2ndF}{-D.MS}$ $=$

Answer 3: 0.022833333 or the average time is 2 minutes 28 seconds

m. Coordinate Conversion

Converting rectangular coordinates to polar ($x, y \rightarrow r, \theta$)



$$r = \sqrt{x^2 + y^2} \quad \text{DEG: } 0 \leq |\theta| \leq 180$$

$$\theta = \tan^{-1} \frac{y}{x} \quad \text{RAD: } 0 \leq |\theta| \leq \pi$$

$$\text{GRAD: } 0 \leq |\theta| \leq 200$$

Solve for $x = 6$ and $y = 4$ mode = DEG

Key in: 6 $\frac{2ndF}{POL}$ 4 $=$

Answer: 7.211102551 (r)

Key in: $\frac{RCL}{E}$ Answer: 33.69006753 (θ)

Note that the values of r and θ are stored in E.

Calculate the magnitude and direction (phase) in a vector $\vec{i} = 12 + j9$

Key in: 12 $\frac{2ndF}{POL}$ 9 $=$

Answer: 15 (r)

Key in: $\frac{RCL}{E}$ Answer: 36.86989765 (θ)

Key in: 300 $\frac{2ndF}{\div}$ $\frac{RCL}{A}$ $\frac{STO}{B}$

Answer: 5 Content of Memory B

Key in: $\frac{RCL}{A}$ $\frac{2ndF}{\div}$ $\frac{RCL}{B}$ $\frac{STO}{C}$

Answer: 12 Content of Memory C

Accessible memory M:

Before starting a calculation clear the memory by pressing $\frac{CL}{STO}$ $\frac{M}{M}$.

Key in: 12 $\frac{+}{+}$ 5 $\frac{M+}{M+}$

Answer: 17

To subtract key in: 2 $\frac{+}{+}$ 5 $\frac{2ndF}{M+}$ $\frac{M+}{M+}$

Answer to this equation: 7

Key in: 12 $\frac{X}{X}$ 2 $\frac{STO}{M}$ Answer: 24 (Also takes place of 10 in memory)

Key in: 8 $\frac{2ndF}{M+}$ 2 $\frac{M+}{M+}$

Answer: 4 $\frac{RCL}{M}$: 28

5. Formula Solution in the COMP MODE

To solve a formula using the memories as variables in the COMP MODE you must first place your values in the appropriate memories. Capacity is 80 program steps for

must be entered as integer and decimal respectively.

Convert $12^\circ 47' 52''$ to its decimal equivalent

Key in: 12.4752 $\frac{2ndF}{DEG}$ $=$

Answer: 12.79777778

When converting decimal degrees to the equivalent degrees/minutes/seconds, the answer is broken down: integer portion = degrees; 1st and 2nd decimal digits = minutes; 3rd and 4th digits = seconds; and the 5th through end decimal digits are decimal seconds.

Convert 24.7256 to its degree/minute/second equivalent

Key in: 24.7256 $\frac{2ndF}{-D.MS}$ $=$

Answer: 24.433216 or $24^\circ 43' 32''$

A horse has track times of 2 minutes 25 seconds, 2 minutes 38 seconds, and 2 minutes 22 seconds. What is the average running time?

Key in: .0225 $\frac{2ndF}{+}$.0238 $\frac{2ndF}{+}$.0222 $\frac{2ndF}{+}$ $=$

Answer 1: 0.123611111 (press $\frac{PB}{PB}$ if you wish to check your input)

Key in: $\frac{2ndF}{\div}$ 3 $=$

Answer 2: 0.041203704

Converting polar coordinates to rectangular ($r, \theta \rightarrow x, y$)

Solve for P ($14, \pi/3$), $r = 14$ $\theta = \pi/3$

Mode = RAD Key in 14 $\frac{2ndF}{REC}$ () $\frac{\pi}{3}$ $\frac{2ndF}{\div}$ 3 () $=$

Answer: 7 (X)

Key in: $\frac{RCL}{E}$ Answer: 12.12435565 (y)

4. Multiple data memories

The EL-5103 has 6 memories (A ~ E, M) for storing variables, constants or results. Independently accessible memory M has memory plus and memory minus ($\frac{2ndF}{M+}$) function.

By Memory Safe Guard, turning the calculator on and off will not affect the material stored in the memory.

Memory A ~ E:

To input a number into a memory press the value followed by $\frac{STO}{STO}$ and the memory letter. Addition or subtraction to a memory is not possible. To recall a value from a memory press $\frac{RCL}{RCL}$ and the appropriate memory letter. To clear a memory press $\frac{O}{O}$ $\frac{STO}{STO}$ and the memory letter.

Key in: 12 $\frac{X}{X}$ 5 $\frac{STO}{A}$

Answer: 60 Content of Memory A

playback. (Refer to "Direct Formula Entry" for a detailed discussion of steps.)

Key in: 1 $\frac{STO}{A}$, 2 $\frac{STO}{B}$, and 3 $\frac{STO}{C}$

Key in: $\frac{2ndF}{A}$ $\frac{+}{+}$ $\frac{2ndF}{B}$ $\frac{+}{+}$ $\frac{2ndF}{C}$ $=$

Answer: 6

Key in: $\frac{2ndF}{A}$ $\frac{X^2}{X^2}$ $\frac{+}{+}$ $\frac{2ndF}{B}$ $\frac{X^2}{X^2}$ $\frac{+}{+}$ $\frac{2ndF}{C}$ $\frac{X^2}{X^2}$ $=$

Answer: 14

Key in: (Mode = DEG) $\frac{SIN}{SIN}$ $\frac{2ndF}{A}$ $\frac{+}{+}$ $\frac{COS}{COS}$ $\frac{2ndF}{B}$ $\frac{+}{+}$ $\frac{TAN}{TAN}$ $\frac{2ndF}{C}$ $=$

Answer: 1.069251013

Use of memories in a formula

Each memory of this calculator has a storage capacity of 12 digits for mantissa and of 2 digits for exponent.

- In the entry of a formula, pushing the $\frac{2ndF}{A} \sim \frac{2ndF}{E}$, $\frac{2ndF}{M}$ recalls a numerical value stored in a designated memory and uses it when the inputted formula is executed for calculation.
- In the entry of a formula pushing a $\frac{RCL}{A} \sim \frac{RCL}{E}$, $\frac{RCL}{M}$ recalls a numerical value stored in the designated memory and writes it into the formula.

Although the calculation result is displayed at 10 digits, the calculator (memory A) retains a numerical value whose mantissa is 12 digits.

- (1) When the contents of the memory A is designated as variable with $\boxed{2ndF} \boxed{A}$:
 FIX mode, TAB = 2
 $2 \boxed{2ndF} \boxed{A} \boxed{X} \rightarrow 2AX _$ (For FIX mode and TAB see Display system and decimal places).
 $3 \boxed{=}$ $\rightarrow 8.00$

When memory A is directly designated, its capacity (mantissa = 12 digits, exponent = 2 digits) is used in full.

- (2) When the contents of the memory A is written with $\boxed{RCL} \boxed{A}$:

FIX mode, TAB = 2
 $2 \boxed{X} \boxed{RCL} \boxed{A} \boxed{X} \rightarrow 2 \times 1.33 x _$
 $3 \boxed{=}$ $\rightarrow 7.98$ \leftarrow A numerical value according to the setting -- FIX mode, TAB = 2 -- is entered into the formula.

Note: In the above calculation range, the calculation results or intermediate results are treated or displayed as 0 (zero), when their absolute values are below 1×10^{-99} .

• Scientific and special functions:

Functions	Dynamic range
SIN x COS x TAN x	DEG: $ x < 1 \times 10^{10}$
	RAD: $ x < \frac{\pi}{180} \times 10^{10}$
	GRAD: $ x < \frac{10}{9} \times 10^{10}$
	In TAN x, however, the following cases are excluded. DEG: $ x = 90 (2n - 1)$ RAD: $ x = \frac{\pi}{2} (2n - 1)$ $n = \text{integer}$ GRAD: $ x = 100 (2n - 1)$
SIN ⁻¹ x COS ⁻¹ x	$-1 \leq x \leq 1$

will be caused by a calculation or instruction beyond the capacity of the machine or by an ungrammatical formula. Correct "Grammar" is discussed in the following section. An error can be cleared by the \boxed{CL} or \boxed{PB} key.

Supplementary 3 – Error Conditions

- When the absolute value of a calculation result is 1×10^{100} or more.
- When a number is divided by 0 (zero). ($A \div 0$)
- When the absolute value of a result of memory calculation is 1×10^{100} or more.
- When a formula that exceeds the capacity of function (16-stage) or date (8-stage) buffer is used for calculation.
- For scientific functions an error occurs when the calculations exceed the following ranges:

CALCULATION RANGE

- The entry and four (4) arithmetic calculations:
 1st, 2nd operand: $\pm 1 \times 10^{-99} \sim \pm 9.999999999 \times 10^{99}$ and 0
 Calculation result: $1 \times 10^{-99} \sim 9.9999999 \times 10^{99}$,
 $-1 \times 10^{-99} \sim -9.999999 \times 10^{99}$ and 0

Functions	Dynamic range
TAN ⁻¹ x	$ x < 1 \times 10^{100}$
LN x LOG x	$1 \times 10^{-99} \leq x < 1 \times 10^{100}$
e ^x	$-1 \times 10^{100} < x \leq 230.2585092$
10 ^x	$-1 \times 10^{100} < x < 100$
Y ^x	$-1 \times 10^{100} < x \log y < 100$ $y \geq 0$ (Here, $Y^x = 0$ at $Y = 0$)
$\sqrt[x]{y}$	$-1 \times 10^{100} < \frac{1}{x} \log y < 100$ $y \geq 0, x \neq 0$
$\sqrt[3]{x}$	$ x < 1 \times 10^{100}$
SINH x COSH x TANH x	$-227.9559242 \leq x \leq 230.2585092$

Functions	Dynamic range
SINH ⁻¹ x	$ x < 1 \times 10^{50}$
COSH ⁻¹ x	$1 \leq x < 1 \times 10^{50}$
TANH ⁻¹ x	$ x < 1$
\sqrt{x}	$0 \leq x < 1 \times 10^{100}$
x ²	$ x < 1 \times 10^{50}$
x ⁻¹	$ x < 1 \times 10^{100}$ $x \neq 0$
n!	$0 \leq n \leq 69$ (n: integer)
→POL	$1 \times 10^{-50} < x < 1 \times 10^{50}$ $1 \times 10^{-50} < y < 1 \times 10^{50}$ (x: X factor, y: Y factor)
→REC	$ x < 1 \times 10^{100}$ y is in the same condition as x of SIN x.

Functions	Dynamic range
→DEG →D.MS	$ x < 1 \times 10^{100}$
Statistical calculation	Data CD $ x < 1 \times 10^{50}$ $ y < 1 \times 10^{50}$ $ \Sigma x < 1 \times 10^{100}$ $\Sigma x^2 < 1 \times 10^{100}$ $ \Sigma y < 1 \times 10^{100}$ $\Sigma y^2 < 1 \times 10^{100}$ $ \Sigma xy < 1 \times 10^{100}$ $ n < 1 \times 10^{100}$
	\bar{x}

SINH ⁻¹ x	x < 1 x 10
COSH ⁻¹ x	1 ≤ x < 1 x 10 ⁵⁰
TANH ⁻¹ x	x < 1
√x	0 ≤ x < 1 x 10 ¹⁰⁰
x ²	x < 1 x 10 ⁵⁰
x ⁻¹	x < 1 x 10 ¹⁰⁰ x ≠ 0
n!	0 ≤ n ≤ 69 (n: integer)
→POL	1 x 10 ⁻⁵⁰ < x < 1 x 10 ⁵⁰ 1 x 10 ⁻⁵⁰ < y < 1 x 10 ⁵⁰ (x: X factor, y: Y factor)
→REC	x < 1 x 10 ¹⁰⁰ y is in the same condition as x of SIN x. x: Magnitude y: Direction (phase)

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Functions		Dynamic range
Statistical calculation	sx	n ≠ 1 $0 \leq \frac{\sum x^2 - n\bar{x}^2}{n-1} < 1 \times 10^{100}$
	σx	n ≠ 0 $0 \leq \frac{\sum x^2 - n\bar{x}^2}{n} < 1 \times 10^{100}$
	r	n ≠ 0 $0 < (\sum x^2 - n\bar{x}^2) \cdot (\sum y^2 - n\bar{y}^2) < 1 \times 10^{100}$ $ \sum xy - \frac{\sum x \cdot \sum y}{n} < 1 \times 10^{100}$ $\left \frac{\sum xy - \frac{\sum x \cdot \sum y}{n}}{\sqrt{(\sum x^2 - n\bar{x}^2) \cdot (\sum y^2 - n\bar{y}^2)}} \right < 1 \times 10^{100}$

3

Functions		Dynamic range
Statistical calculation	x'	$\left \frac{y-a}{b} \right < 1 \times 10^{100}$

Note: As a rule, the error of functional calculations is less than ±1 at the lowest digit of a displayed numerical value (at the lowest digit of mantissa in the case of scientific notation system) within the above calculation range.

In the calculation of SINH x and TANH x, x is a singular point when it is 0 (zero). Near this point the error is accumulated, reducing the accuracy.

End of Supplementary 3 – Error Conditions

7. Grammer

Multiplication of one variable followed by another is automatic. Multiplication of a number before a variable is automatic. The π key may be used as a number.

Ex. Set EL-5103 at the floating decimal point system. Angular mode: DEG

Calculator interface showing various function keys like SIN, COS, TAN, etc.

→DEG →D.MS		x < 1 x 10 ¹⁰⁰
Statistical calculation	Data CD	x < 1 x 10 ⁵⁰ y < 1 x 10 ⁵⁰ Σx < 1 x 10 ¹⁰⁰ Σx ² < 1 x 10 ¹⁰⁰ Σy < 1 x 10 ¹⁰⁰ Σy ² < 1 x 10 ¹⁰⁰ Σxy < 1 x 10 ¹⁰⁰ n < 1 x 10 ¹⁰⁰
	\bar{x}	n ≠ 0

Functions		Dynamic range
Statistical calculation	\bar{y}	Same as \bar{x} , sx, σx
	sy	
	σy	
	b	n ≠ 0 $0 < \sum x^2 - n\bar{x}^2 < 1 \times 10^{100}$ $ \sum xy - \frac{\sum x \cdot \sum y}{n} < 1 \times 10^{100}$ $\left \frac{\sum xy - \frac{\sum x \cdot \sum y}{n}}{\sum x^2 - n\bar{x}^2} \right < 1 \times 10^{100}$
	a	a is the same condition as b, and $ \bar{y} - b\bar{x} < 1 \times 10^{100}$
y'	a + bx < 1 x 10 ¹⁰⁰	

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If the closing of a parenthesis occurs at the end of an expression, it is not necessary to include the second part of that parenthesis –

Calculate $4 \sin 30 + \frac{2 \cos 30}{\sqrt{2} \pi + \tan 30}$

Key in: 4 [SIN] 30 [=] 2 [COS] 30 [=] ([2ndF] [√] 2 [X] [π] [=])
[+] [TAN] 30 [=]

Answer: 2.345014014

Supplementary 4 – Grammatical Error Conditions

When any formula incapable of being calculated has been solved:

Example: (1) A2, π3, (4+5)6 ... Some calculation command is omitted at the place where it cannot be omitted.

(2) SIN², 10^{x-1}, 5y^x

COS+, Y^x=, x+, (x...

The calculation of x² needs to be calculated in advance in order to calculate, for example, SIN². However, no numerical value to be used is present.

a. Correction

Key in: 5 [+] 3 [X] 2 [-] [SIN] 30 [=] Angular mode: DEG

Answer: 10.5 Press [PB]

The cursor is flashing over the =. If you wish to change the multiplier from 2 to 4, press the [←] key 5 times until it covers the 2; now press 4; press [=] (if necessary to move the cursor back).

Answer: 16.5

To change SIN 30 to COS 45, move the cursor to over the SIN and press [COS] 45 and [=]

Answer: 16.29289322

b. Deletion

Key in: 12 [+] 45 [+] 78

To change the 45 to 5, press the cursor ([←]) key 5 times until it covers the 4 and press [2ndF] [DEL]. The 4 will disappear and all remaining material in the display will shift automatically to the left.

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1. Formula Entry I

In Section 5 of the discussion on the COMP Mode, entering a formula was demonstrated. However, if it was required to do other calculations in the COMP MODE the equation would be lost. To retain a formula so that we may use it over and over the AER Mode is used.

Put the calculator in the AER mode. Clear the display by pressing [2ndF] [CA] (above Red CL Key).

Formula: $A^2 + B^2$

Key in: [2ndF] [A] [X^2] [+] [2ndF] [B] [X^2]

To solve this equation move the mode switch to COMP. (Floating decimal point system)

Put in values: 2 [STO] A, 3 [STO] B

Press [COMP] Key

Answer: 13

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2. Formula Entry II Dialogic Form

The second procedure for formula entry involves placing an equation into the calculator as a function of the variables in the formula. The function key [f()=] is above the [COMP] key. Start with the [f()=] key, follow with the variables, close with the [f()=] key,

Solve 3 equations: $X^2 + Y^2 = 23$, $X + 45Y = \sqrt{X} - \ln Y$

Let $X = A$, $Y = B$

Mode: AER

Key in: a. [2ndF] [CA]

[f()=] display should read f (

b. [2ndF] [A] [2ndF] [B] [f()=] display should read f (AB) = in other words, a function of variables A and B

c. [2ndF] [A] [X^2] [+] [2ndF] [B] [X^2] [2ndF] [9] 23 [2ndF] [A] [+] 45 [2ndF] [B] [2ndF] [9] [2ndF] [sqrt] [2ndF] [A] [-] [LN] [2ndF] [B]

Note that as you enter the 2 in the second equation, the 13 character capacity of the display is exceeded. The rolling writer begins and as each additional entry is made an entry is rolled off to the left and stored. The left pointing arrow indicates informa-

Key in: ([π] [+] 4) 2 [=] Display indicates error. A multiplication sign must be placed between the) and 2. Press [PB] key. Move the cursor to over the 2. Press [2ndF] [INS]. An opening occurs on the display and all material following the insertion automatically shifts to the right.

Press [X] and [=]

Answer: 14.28318531

DIRECT FORMULA ENTRY (AER)

(ALGEBRAIC EXPRESSION RESERVE)

With AER a formula can be stored as an algebraic expression. The formula, even if complicated is entered as you would read it. The rolling writer dot matrix liquid crystal display makes it possible to enter up to 48 steps with no limit on characters.

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Replace the values: 4 [STO] A, 5 [STO] B

Press [COMP] Answer: 41

Solve the equation: $5 \times (X + 8) = 60$ for X

Mode: AER Key in: [2ndF] [CA]

Note that in the AER mode a comma is used to end an equation. The [2ndF] [9] (above [PB]) keys produce the comma in the AER mode. A series of equations using the same variables may be placed in the AER mode.

Key in: (let $X = A$) 5 ([2ndF] [A] [+] 8) , [2ndF] [A] , [2ndF] [A] [+] 1 [STO] [A] [2ndF] [9]

Move the switch to COMP MODE

Press the [COMP] key. Display: 60

And press the [COMP] key again. Answer, 4 is the value of A that we are seeking.

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Change to the COMP MODE (Floating decimal point system)

Press [COMP]; the display will read $A = ?$

The flashing ? asks you to place in a number

Put in 2

Press [COMP] and get $B = ?$

Put in 3

Note that in the AER mode two variables were used, therefore, the calculator will not ask for a value of C. If two variables such as C and D had been used, the calculator would have only asked for these.

Press [COMP] and get Answer: 13

Press [COMP] again and get Answer: 181

Press [COMP] again and get Answer: 0.315601274

Only three equations were placed in the AER Mode.

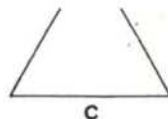
Press [COMP] again and get $A = ?$ again. New values may now be put in for A and B.

If you push [COMP] without entering a numeral, the previous value is retained.

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The basic equation is

$$C = \sqrt{A^2 + B^2 - 2AB \cos D}$$



Mode: AER

Note that since the entire equation falls under the square root sign parenthesis must be used.

Key in: $\boxed{2ndF} \boxed{CA} \boxed{f(=)} \boxed{2ndF} \boxed{A} \boxed{2ndF} \boxed{B} \boxed{2ndF} \boxed{D} \boxed{f(=)} \boxed{2ndF} \boxed{\sqrt{\quad}} \boxed{(} \boxed{2ndF} \boxed{A} \boxed{x^2} \boxed{+} \boxed{2ndF} \boxed{B} \boxed{x^2} \boxed{-} \boxed{2} \boxed{2ndF} \boxed{A} \boxed{2ndF} \boxed{B} \boxed{COS} \boxed{2ndF} \boxed{D}$

Change to COMP mode Angle Mode: DEG (Floating decimal point system)

Press \boxed{COMP} , Put in 3 for A

Press \boxed{COMP} , Put in 4 for B

Press \boxed{COMP} , Put in 60 for D

Press \boxed{COMP} , value of the third side is 3.605551275

Solve for angle of 45° instead of 60°

Mode: COMP (Floating decimal point system) Press \boxed{COMP} , A = ?

Key in: 100

Press \boxed{COMP} , Answer 1: 65

Press \boxed{COMP} , Answer 2: 63.05

Press \boxed{COMP} , Answer 3: 61.789

Press \boxed{COMP} , Answer 4: 110

Answer 4 is the original price of \$100 plus the increment of \$10. The next time COMP is pressed, A = ? is displayed. By-pass placing a value in for A each time as it has been changed automatically by equation 4. Answer 3 will now give the discounted price for a list of 110. Continued pressing of the \boxed{COMP} key will give the answer for each increment of 10 of the price. After putting the initial value of A in at 100, it is unnecessary to key in any other values.

Turn off the calculator. If you wish to use this equation, at a later date, "Memory Safe Guard" will protect the equation and it will be there at that time for reuse. All equations in the AER Mode and all information in memories in the COMP Mode are retained unless intentionally erased.

4. Business Applications

There are many business applications for which the EL-5103 is an ideal tool. This example also illustrates that the answer from one equation may be stored and used in another equation.

A series of discounts from the list price are offered. They are 35%, 3%, and 2%. Calculate the final price for a series of prices starting at \$100 and continuing at \$110, \$120, etc. 35% is equivalent to .65; 3% to .97; and 2% to .98. The initial price call (A)

Mode: AER

Key in: $\boxed{2ndF} \boxed{CA} \boxed{f(=)} \boxed{2ndF} \boxed{A} \boxed{f(=)} \boxed{.65} \boxed{2ndF} \boxed{A} \boxed{STO} \boxed{B} \boxed{2ndF} \boxed{9} \boxed{.97} \boxed{2ndF} \boxed{B} \boxed{STO} \boxed{C} \boxed{2ndF} \boxed{9} \boxed{.98} \boxed{2ndF} \boxed{C} \boxed{2ndF} \boxed{9} \boxed{2ndF} \boxed{A} \boxed{+} \boxed{10} \boxed{STO} \boxed{A}$

Supplementary 5 - Steps

Program Steps

The capacity of the EL-5103 for storing algebraic formulas is 48 steps.

If the 48th step is loaded with an instruction, the flickering cursor appears over that instruction. Inputting of further instructions only causes the instruction stored in the 48th step to be replaced by each new instruction.

Therefore, an algebraic formula must be composed of and stored within 48 steps.

Scientific functions are fully merged and therefore represent only one step each. For instance, SIN, COSH, $TANH^{-1}$, LOG, \sqrt{x} represent one step each.

Each numeral and the decimal point represent a step. Therefore, if a formula includes a constant with more than one numeral, it may be advisable to use a letter (i.e., A ~ E, M) to save steps.

The cursor may be used to count steps, as it will stop only once at a fully merged scientific function.

End of Supplementary - 5 steps

STATISTICAL MODE

Set the mode switch to STAT. The black items around the keys STO, RCL and M+ are now in effect. Pressing \boxed{Data} will clear the memories (A ~ E, M) so that they can be used for storing statistical results as described below. To clear previous statistical inputs and calculations, press $\boxed{2ndF}$ and \boxed{CA} . Intermediate results can be obtained and then additional data may be added.

Memory	Contents
A	Σy
B	Σy^2
C	Σx
D	Σx^2
E	Σxy
M	n

1. One-variable statistical calculation

Calculate the following statistics.

(1) n: Number of samples

(2) Σx : Total of samples

(3) Σx^2 : Sum of squares of samples

(4) \bar{x} : Mean value of samples $\bar{x} = \frac{\Sigma x}{n}$

(5) sx: Standard deviation with population parameter taken to be "n-1".

$$sx = \sqrt{\frac{\Sigma x^2 - n\bar{x}^2}{n-1}} \quad (\text{Used to estimate the standard deviation of population from the sample data extracted from that population.})$$

(6) σx : Standard deviation with population parameter taken to be "n".

$$\sigma x = \sqrt{\frac{\Sigma x^2 - n\bar{x}^2}{n}} \quad (\text{Used when all populations are taken to be sample data or when finding the standard deviation of population with sample taken to be a population.})$$

• Data for one-variable statistical calculations are inputted by the following opera-

(2) Data [X] Frequency [Data]

putted)
Data can be specified in the form of algebraic formula, but parenthesize the formula when using "+", "-", "x" or "/" instruction.

Ex. (5 + 4 x 3) [Data] Frequency of data 1
(SIN5 + LN2) x 5 [Data] Frequency of data 5

In the above example, if the formula is not parenthesized, 5+ and SIN5+ are neglected, and the same results are experienced as in key operation 4 x 3 [Data] and LN2 x 5 [Data].

2. Single Variable Statistics

Calculate standard deviation, mean, and variance (sx)² from the following data:

Value	35	45	55	65
Frequency	1	1	5	2

As each sample is entered the number of that sample will appear on the right hand side of the display.

statistics.

In Linear Regression there are three important values; r, a, and b. The correlation coefficient r shows the relationship between two variables for a particular sample. The value of r is between -1 and 1. If r equals -1 or 1, all points on the correlation diagram are on a line. The further the value of r is from -1 and 1, the less the points are massing about the line and the less reliable is the correlation. If r is more than 0, it shows a positive correlation (Y is in proportion to X) and if r is less than 0, it is a negative correlation (Y is inverse proportion to X).

The equation for the straight line is Y = a + bX. The point at which the line crosses the Y axis is a. The slope is b.

r Correlation coefficient

$$r = \frac{S_{xy}}{\sqrt{S_{xx} \cdot S_{yy}}}$$

a a = $\bar{y} - b\bar{x}$ Coefficient of linear regression equation

b b = $\frac{S_{xy}}{S_{xx}}$ Y = a + bX

$$\left(\begin{array}{l} S_{xx} = \sum x^2 - \frac{(\sum x)^2}{n} \\ S_{yy} = \sum y^2 - \frac{(\sum y)^2}{n} \\ S_{xy} = \sum xy - \frac{\sum x \cdot \sum y}{n} \end{array} \right)$$

Mode: STAT, Floating decimal point system

Student No.	Mark in Math.	Mark in English
n	X	Y
1	82	79
2	53	50
3	61	87
4	74	96
5	51	73
6	51	73

Key in:	Display
[2ndF] [CA] 82 [(x,y)] 79 [Data]	1
53 [(x,y)] 50 [Data]	2
61 [(x,y)] 87 [Data]	3
74 [(x,y)] 96 [Data]	4
51 [(x,y)] 73 x 2 [Data]	6 (Note: to input multiple identical samples proceed as indicated)
[2ndF] [r]	.571587901
[2ndF] [a]	34.26190476

35 [Data]	1
45 [Data]	2
55 x 5 [Data]	7
65 x 2 [Data]	9

Key in: Display:

Mean: [2ndF] [x̄] 53.88888889
Standard Deviation: [2ndF] [sx] 9.279607272
Variance: [x²] [=] 86.11111112
Correct Data (CD): The last entry above is an error and must be changed to 60 x 2.

Key in:	Display
65 [X] 2 [CD]	7
60 [X] 2 [Data]	9

Note: When you correct the mis-entry before pressing the [Data] key, use [CL] key.

3. Two-Variable Statistics and Linear Regression.

In addition to the same statistical functions for Y as for X in single-variable statistics, the sum of the products of samples $\sum XY$ is added in two-variable 4:

$$x' = \frac{y - a}{b} \quad \text{Estimated value (the value of } x \text{ is estimated from that of } y.)$$

$$y' = a + bx \quad \text{Estimated value (the value of } y \text{ is estimated from that of } x.)$$

• Data for two-variable statistic calculations are inputted by the following operations.

- (1) Data (x) [(x,y)] Data (y) [Data]
- (2) Data (x) [(x,y)] Data (y) [X] Frequency [Data]

Example: If we know a student's mark in mathematics, can we predict the mark in English?

The exam marks for six students chosen at random are given in the following table:

The value of r of .57 indicates that the correlation is marginal. The equation for the straight line for this data is Y = 34.26 + .68X.

If we had a student whose mark in mathematics was 90, based on this analysis, what mark would the student have in English?

90 [2ndF] [y'] 95.33333333

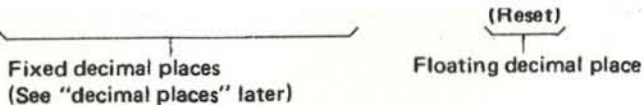
If we had a student whose mark in English was 80, based on this analysis, what mark would the student have in mathematics?

80 [2ndF] [x'] 67.40350877

DISPLAY SYSTEM AND DECIMAL PLACES

The EL-5103 has four types of display system and these display system can be selected with the [FSE] (FIX, SCI, ENG mode) key.

As you press the [FSE] key in the COMP or STAT mode, the mode symbol "FIX", "SCI", "ENG" or "Blank" will appear at the top of the display. Use the [FSE] key, when an answer is displayed or the calculator is cleared with [CL] key.



The designation of decimal system and decimal places is retained even when the calculator is turned off.

(1) FIX (FIXed decimal point system)

- Calculation results are displayed after they are subjected to decimal designation and rounding.
- When a calculation result is used for further calculations or formula the contents displayed will be used.

i0

- When a calculation result is used for further calculations or formula, the contents displayed will be used.

Ex. (CL) FSE Push the FSE key continuously until "SCI" is displayed.
 2ndF TAB 2 Decimal: 2
 (This means that the number of effective digit has been set at 3.)
 .3 ÷ 7 = → 4.29E-02
 + → 4.29E-02+ (The calculation result is of three effective digits and rounded off, being used in the next formula.)

(3) ENG (ENGINEERING notation)

- Every calculation result is displayed on the basis of scientific notation ($A \times 10^B$). At this time its mantissa is displayed according to a decimal designation (TAB) and its exponent is automatically set at a multiple of 3 (... -6, -3, 0, 3, 6, ...) to be displayed. Therefore, any display can be easily read in the unit of K (kilo- 10^3) or m (milli- 10^{-3}), etc. that is frequently used in the engineering field.

i2

Ex. (CL) PSE Turn off "FIX", "SCI", and "ENG".
 1 ÷ 3 = → 0.33333333
 X → 3.33333333E-01 X (Press the PB key)
 Displayed
 CL
 1 ÷ 5 Exp (-) 12 = → 2.E 11
 X → 2.E11.X -

Decimal Places

The 2ndF TAB keys are used to specify the number of decimal digits in the calculation result when the FIX, SCI or ENG mode is set. The number of places after the decimal point is specified by the numeral key (0 ~ 9) pressed after the 2ndF TAB keys. Carry over will be automatically rounded.

Use the 2ndF TAB keys when the calculation result is displayed or the calculator is cleared with the CL key.

possible ... a maximum of 9 digits.
 Ex. (CL) FSE Push the FSE key continuously until "FIX" is displayed.
 2ndF TAB 3 Pre-set the number of decimal places.
 5 ÷ 3 = → 1.667
 X → 1.667 X
 CL 5 ÷ 9 = → 0.556
 X → 5.556E-01 X

(2) SCI (SCIENTIFIC notation)

- Calculation results are displayed with scientific notation ($A \times 10^B$). Since the mantissa of the calculation result is displayed in accordance with a decimal designation, the number of effective digits can be easily designated. The next digit after the specified number of decimal places is automatically rounded off.

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(The next digit after the specified number of decimal places is automatically rounded off.)

Ex. (CL) FSE Push the FSE key continuously until "ENG" is displayed.
 2ndF TAB 2 Decimal: 2
 .3 ÷ 7 = → 42.86E-03 (42.86×10^{-3})
 X → 42.86E-03X (The calculation result is rounded off and used in the following formula.)

Floating decimal point system

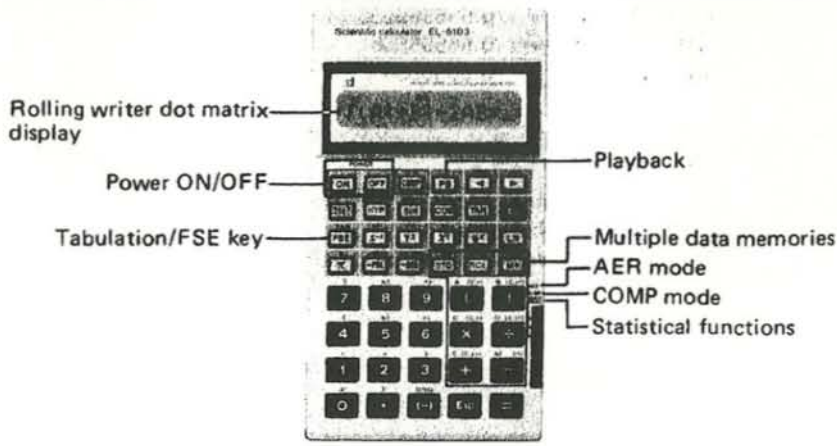
(4) When (1) through (3) is being cancelled:

- (when "FIX", "SCI" or "ENG" is not displayed)
- Calculation results are displayed in floating decimal point system. Calculation results, if they are out of the range $0.00000001 \leq |x| \leq 9999999999$ or are not zeroes, are displayed on the basis of scientific notation.
- When calculation results, when used in the following formula, are treated in such a way as to retain as many effective digits as possible — a maximum of 10 digits.

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Example: FIX mode
 2ndF TAB 9
 5 ÷ 9 = → 0.555555556
 2ndF TAB 8 → 0.55555556
 2ndF TAB 7 → 0.5555556
 ?
 2ndF TAB 1 → 0.6
 2ndF TAB 0 → 1.

- Note:
- A display, when it cannot occur on the basis of any decimal designation, can occur based on a possible system.
 - The designations of decimal places is retained even when the display system is changed.



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STAT: Statistical calculations mode
The statistical program will be activated.
This mode is operated completely independently of the AER mode.

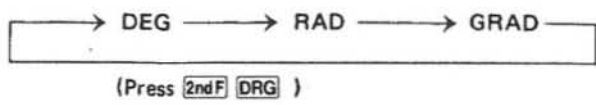
2nd function designation key

- Numeral and statistical calculations keys**
- \cdot \square \square \sim \square \square : Used to enter numbers.
 - \square \square \square : STAT mode (When the calculator is set at the statistical calculation mode.)
Used to obtain the estimated value of y .
 - \square \square \square : STAT mode
Used to obtain the estimated value of x .
 - \square \square \square : STAT mode
Used to obtain the correlation coefficient in two-variable statistical calculation.
 - \square \square \square : STAT mode
Used to obtain the constant a of the linear regression equation $y = a + bx$.

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Change sign and Degree/Radian/Grad selection key

- \square \square : Used to designate the negative number.
Ex. -2.4 \square \square 2.4
- \square \square \square : Used for calculation of trigonometric, inverse trigonometric and coordinate conversion. The \square \square \square keys change the angular mode.



Ex. DEG \rightarrow GRAD: Depress the \square \square \square keys twice.
"DEG" mode - Entries and answers are in decimal degrees.
"RAD" mode - Entries and answers are in radians.
"GRAD" mode - Entries and answers are in grads. ($100^g = 90^\circ = \frac{\pi}{2}$).

Exp Enter exponent key
Example: 1.234×10^{15}
Key in: 1.234 \square \square 15

- ON** Power on key
When this key is depressed, the calculator is turned on.
- Automatic Power-Off function (A.P.O.):**
This calculator is automatically turned off approximately 10 minutes after the last key operation to save your batteries.
- OFF** Power off key
When this key is depressed, the calculator is turned off.
- Mode switch**
- AER:** Algebraic Expression Reserve mode
This mode is used for placing algebraic formulas into the calculator. In this mode, a calculation can not be performed.
- COMP:** Compute mode
This mode permits the calculator to perform (except for statistical calculation) all standard calculations including four arithmetic calculations and scientific calculations and calculations that use algebraic formulas from the AER mode.

- \square \square \square : STAT mode
Used to obtain the coefficient b of the linear regression equation $y = a + bx$.
- \square \square \square : STAT mode
Used to obtain the mean value of data (Data: x)
- \square \square \square : STAT mode
Used to obtain the standard deviation (s_x) of the sample of data (x).
- \square \square \square : STAT mode
Used to obtain the standard deviation (σ_x) of the population of data (x).
- \square \square \square : STAT mode
Used to obtain the mean value of data (Data: y)
- \square \square \square : STAT mode
Used to obtain the standard deviation (s_y) of the sample of data (y).
- \square \square \square : STAT mode
Used to obtain the standard deviation (σ_y) of the population of data (y).

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- \square \square \square \square } Arithmetic calculation, memory and statistical calculation keys
- \square \square \square } : Pressed for addition, subtraction, multiplication and division.
- \square \square : COMP mode, STAT mode:
Performs the calculation.
AER mode:
Designates the execution instruction of the calculation.
- \square \square \square } : Used to designate the memories (\square \square \sim \square \square , \square \square)
Note: To designate the memory after pressing the \square \square or \square \square key, the \square \square is not needed.
- \square \square \square : STAT mode
Used to obtain the sum of data (Data: x)

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- 2ndF** $\Sigma(x,y)$: STAT mode
Used to obtain the sum of the products of data x and y in two-variable statistical calculation.
- 2ndF** $\Sigma(N)$: STAT mode
Used to obtain the number of samples entered.
- A** $\Sigma(y)$ **B** $\Sigma(y^2)$
() : Parenthesis, memory and statistical calculation keys.
- (** : Used to open parenthesis.
) : Used to close parenthesis.
- 2ndF** **A** : Used to designate the memories (**A** , **B**)
2ndF **B** : Note: To designate the memory after pressing the **STO** or **RCL** key, the **2ndF** is not needed.
- 2ndF** $\Sigma(y)$: STAT mode
Used to obtain the sum of data (Data: y)
- 2ndF** $\Sigma(y^2)$: STAT mode
Used to obtain the sum of squares of data (Data: y)

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- (x,y) : STAT mode
Used to distinguish data x and data y in the two-variable statical calculation.
Example: Refer to page 48.

CD
STO Store and statistical calculation key

- STO** : The EL-5103 has six memory register. To designate each memory, press the **STO** key followed by **A** ~ **E** , **M** (Ex. **STO** **A**)
AER mode:
Designates the instruction to store a number into the designated memory.
COMP mode:
Depression of the **STO** and **A** ~ **E** , **M** key clear a number in the designated memory and then stores a number being displayed or calculated result in the designated memory.

- CD** : STAT mode:
Used to correct the mis-entry of data.

$f()$ =
COMP Compute and variable designation key

- COMP** : Example: Refer to page 35.
 $f()$ = : AER mode:
Example Refer to page 36.

i4

INS
▶ Cursor step-up and insert key

- ▶** : Makes the cursor go right by one step. This key is effective only within the area where instructions are written.
- 2ndF** **INS** : Provides a blank necessary for insertion of an instruction in the step indicated by the cursor.
Pushing the **2ndF** and **INS** keys in this sequence shifts the contents of the display to the right. In the blank step appears the insert mark " \square ".
Example: Refer to page 33.

CA
CL Clear/clear all key

- CL** : AER mode:
Places the cursor in the first position in the algebraic expression reserve area.
COMP mode:
Clears the contents of the calculation registers. The contents of the memory and stored algebraic formulas are not affected. Clears the error condition.
STAT mode:
Clears the contents of the calculation registers. The entry data for the

- M+** : AER mode:
Instruction to add a result to the independently accessible memory (M).

COMP mode:
Used to add a calculated result to the contents of the independently accessible (M) memory.

- 2ndF** **M+** : AER mode:
Instruction to subtract a result from the independently accessible (M) memory.

Note: When the **2ndF** **M+** keys is pressed, the "M-" will be displayed.

COMP mode:
Used to subtract a result from the contents of the independently accessible (M) memory.

- Data** : STAT mode:
Used to enter data in one-variable or two-variable statistical calculations.

(x,y)
RCL Recall and statistical calculation key

- RCL** : Recall the contents of the designated memory. To designate each memory, depress **A** ~ **E** , **M** keys following the **RCL** key. (Ex. **RCL** **A**)_{6c}

PB Playback and comma key

- PB** : AER mode:
The display will show the equations previously entered when the playback key is pressed. If the equations total more than 13 characters, continued pressing of **PB** will bring forth each segment in the proper sequence.

COMP and STAT mode:
In the COMP mode pressing the playback key allows the user to check all of the inputs of the most recent calculations. In this mode, the playback features is in 13-step segments. In the STAT mode the user can check the last data entry.

- 2ndF** **,** : AER mode:
Inserts comma between formulas to distinguish them from each other when storing two or more formulas.

DEL
◀ Cursor step-down and delete key

- ◀** : Makes the cursor go left by one step. This key is effective only within the area where instructions are written.
- 2ndF** **DEL** : Deletes the symbol (instruction) stored in the step indicated by the cursor. (The cursor does not move.)

6!

- 2ndF** **CA** : AER mode:
Clears the algebraic expression reserve area of all contents.
COMP mode:
Clears the contents of the calculation registers. The contents of the memory and stored algebraic formula are not affected.
STAT mode:
Clears the entry data or calculated result of the statistical calculation. The stored algebraic formulas are retained.

ARC/HYP
HYP Hyperbolic/arc hyperbolic key

Example: Refer to page 13.

- SIN⁻¹** **COS⁻¹** **TAN⁻¹**
SIN **COS** **TAN** Trigonometric and inverse trigonometric functions keys
Example: Refer to page 12.

- 3√**
X⁻¹ Reciprocal and cube root key
Example: Refer to page 14 and 15.

- X²** Square and square root key
X² : Example: Refer to page 13.
2ndF **√** : Example: Refer to page 14.

Y^x and \sqrt{x} key

- Y^x : Raises a number to a power.
 $2^{nd}F \sqrt{x}$: Used to obtain x th root of a number.
 Example: Refer to page 14.

Natural/common antilogarithm key

Example: Refer to page 15.

Natural/common logarithm key

Example: Refer to page 14.

Pi and factorial key

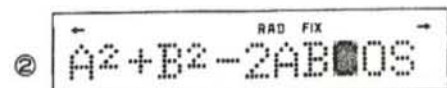
- π : Used to enter the constant π ($\pi \approx 3.141592654$).
 $2^{nd}F \Gamma!$: Used to calculate the factorial.
 $n! = n \cdot (n-1) \cdot (n-2) \cdot \dots \cdot 2 \cdot 1$

Rectangular coordinate \leftrightarrow polar coordinate conversion key

Example: Refer to page 18 and 19.

Degree/minute second \leftrightarrow Decimal degrees conversions key

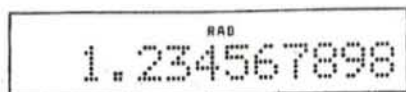
Example: Refer to page 17.



Cursor

When a numeral key or a key to specify a calculation instruction is pushed in the AER, COMP or STAT mode, the cursor indicates each time the step in which the instruction of the key to be pushed next will be written. If the step indicated by the cursor is filled with an instruction, a symbol of that step and all of dots contained in one-digit display of that step are alternately displayed as cursor display. The cursor can be freely shifted within the area where instructions are written by operating the \blacktriangleright and \blacktriangleleft keys.

2) Calculation result



- SCI** Scientific notation symbol
 This symbol indicates that calculation results are displayed on the basis of scientific notation.
- ENG** Engineering notation symbol
 This symbol indicates that calculation results are displayed on the basis of engineering notation.
- Er** Error symbol
 This symbol shows that an error has been detected.
- Appears, when there exists anything to be displayed to the left of the displayed contents of an algebraic formula.
- Appears, when there exists anything to be displayed to the right of the displayed contents of an algebraic formula.
 Appears also to indicate that the machine is in operation when it is executing a calculation.

FSE

$2^{nd}F$ TAB

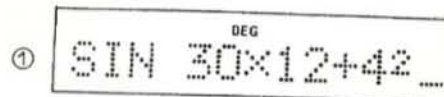
Example: Refer to page 49.

DISPLAY

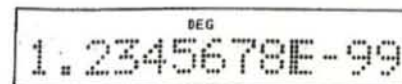
The EL-5103 has a 13-digit alpha-numeric dot matrix liquid crystal display.

1. Display format

1) Algebraic formulas/contents of the entry



Cursor (Indicating position of next entry).



Mantissa

Exponent

2. Symbols and indicator

- $2^{nd} F$** Second function designation symbol
 Appears when second function is set.
- HYP** Hyperbolic function symbol
 Appears when hyperbolic function is set.
- DEG** Angular symbols
DEG: Appears when degree mode is set.
RAD: Appears when radian mode is set.
GRAD: Appears when grad mode is set.
- FIX** Fixed decimal symbol
 This symbol indicates that calculation results are displayed on the basis of fixed decimal system.

SPECIFICATIONS

- Type:** Pocketable scientific calculator
- Number of internal calculation digits:** Mantissa 12 digits, Exponent 2 digits
- Calculation system:** According to algebraic formula (with priority judging function)
- Memory:** 6
- Display (Calculation result):** 10 digits full-floating or Mantissa 8 digits (7 digits in negative)/Exponent 2 digits
- Display system:** Fixed decimal system (FIX)
 Scientific notation (SCI)
 Engineering notation (ENG)
 Floating decimal point system
- Calculations:** Four arithmetic calculations, trigonometric and inverse

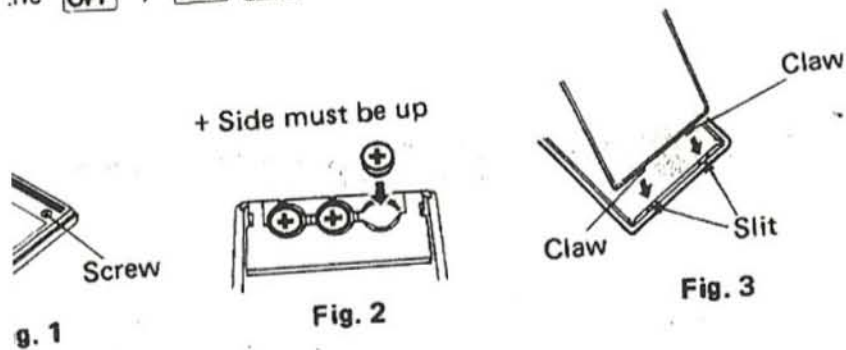
trigonometric functions, reciprocal, square and cube root, square and power, logarithmic and exponential, Xth root of Y ($\sqrt[x]{y}$), factorial, coordinate conversion, memory, and statistical calculations.

Capacity:
reserve:

80 steps
Capacity: 48 steps
Functions: Cursor step-up, step-down, insertion, deletion, playback.
13-digit Dot matrix liquid crystal display.
LSi etc.
4.5V $\ddot{=}$ (DC): Alkaline manganese battery x 3 or Silver oxide battery x 3
4.5V $\ddot{=}$ (DC): 0.0006W
Alkaline manganese battery (LR44)
Approx. 450 hours or Silver oxide battery (S15 or G-13)
Approx. 1,400 hours
Display 555555. at the ambient temperature: 20°C (68°F).

Slide the back cover into the slits of the calculator proper. (Fig. 3) in slightly while replacing the screws.

When the batteries are correctly installed "0." or "—" will be displayed. If nothing or a meaningless symbol, remove the batteries and install the OFF, ON, 2ndF and CA keys in this order and check the



Operating temperature:
Dimensions:

Weight:
Accessories:

The operating time slightly changes type of battery or the way of use.
0°C ~ 40°C (32°F ~ 104°F)
69(W) x 128(D) x 7.8(H)
2-23/32"(W) x 5-1/32"(D) x 5/16"(H)
Approx. 80g (0.18 lbs.)
Wallet, Alkaline manganese battery manual

BATTERY REPLACEMENT

Dimming of the display shows that the batteries should be replaced.

1. Turn off the calculator.
2. Remove the screws from the back cover with a small screw driver (Fig. 1).
3. Replace the batteries. (Fig. 2) (+ side must be up)

Battery: Alkaline manganese battery (Type LR-44) x 3 or Silver oxide battery (Type S-15 or G13) x 3
(Eveready model S76, Mallory model MS76, and Ray-O-V or equivalent should be used.)

- Note: When replacing the batteries, observe the following instructions to prevent failure of the set due to improper battery replacement.
- Always replace all 3 batteries at the same time.
 - Do not mix new batteries with used batteries.
 - Do not use different kinds of batteries together.
 - Wipe off the surface of the new batteries with dry cloth and batteries as shown in Fig. 2.

YOUR OWN APPLICATION

SERVICE CENTER ADDRESS

SHARP ELECTRONICS CORPORATION
SHARP CONSUMER FACTORY SERVICE CENTER
430 East Plainfield Road, Countryside, Ill. 60525 Phone: (312)242-0871