USER MANUAL FOR GRAPHICAL CALCULATOR

I. General Description

- Key matrix 3-3
- Display....4-4
- Operation modes....5-7
- Calculation priority sequence....8-8
- Number of stacks....9-9
- Number of input/output digits and calculation digits....9-9
- Overflow and errors....10-10
- Number of input characters....10-10
- Corrections....11-12

II. Manual Calculations....13-13

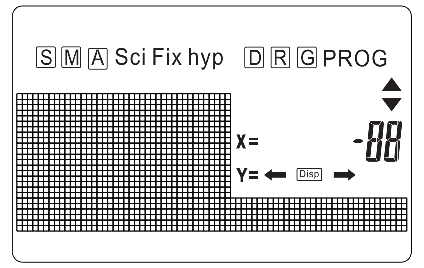
- Arithmetic operations & parenthesis calculations....13-13
- Percentage calculations 14-14
- Specifying the format of calculation results....15-15
  - Specifying the number of decimal places 15-16
  - Rounding the intermediate result....16-17
  - Specifying the number of significant digits 17-17
  - Shifting the decimal place 18-18
- Memory....18-18
  - Variable memory 18-20
  - Independent memories....20-22
- Special functions....23-23
  - Answer function 23-23
  - Omitting the multiplication sign 24-24
  - Continuous calculation function....24-25
  - Replay function 26-27
  - Error position display function....27-28
  - Multistatement function 28-29
- Scientific function....29-29
  - Trigonometric functions & inverse trigonometric functions....29-30
  - Logarithmic and exponential functions....30-31
  - Performing hyperbolic and inverse hyperbolic functions....31-31
  - Coordinate transformation....32-32
  - Other functions(√, x^2, x^{-1}, $x!$, $^3\sqrt{}$, Ran#)....32-33
  - Fractions....34-34

- Degree, Minute, Second calculation 34-34
- Binary, octal, decimal, hexadecimal calculations....35-36
  - Binary, octal, decimal, hexadecimal conversions 36-38
  - Negative expressions 39-39
  - Basic arithmetic operations using binary, octal, decimal, hexadecimal values....38-38
  - Logical operations 39-40
- Statistical calculations....40-40
  - Standard deviation....40-43
  - Regression calculation....44-54
- Numerical Integration....55-56
- Formula memory function....56-57
- Complex Number Calculation (Optional)....58-58
- Previous Calculation Recall....58-58

III. Graphs....59-60

- Built-in Function Graph....60-60
  - Overdrawing built-in function graphs....61-61
- User Generated Graphs....61-61
  - Specifying range parameters....61-65
  - Generation of Function Graphs....65-66
  - Generation of Parametric Graphs....66-67
  - Graph Overdraw....67-68
- Zoom Function....68-70
- Trace Function 70-72
- Draw Operations 72-73
  - Plot 73-75
  - Line 75-78
  - Tangent....78-78
  - Horizontal....78-79
  - Vertical....79-79
- Graph Scroll 80-80
- Single-Variable Statistical Graphs....80-82
- Paired-Variable Statistical Graphs.... 82-84
- Graph Learning....84-84
  - Graph Shift....84-86
  - Graph Change....86-87
- Graph Solving....87-89

◆ Display



S :- Indicates SHIFT key has been pressed.
A :- Indicates ALPHA key has been pressed.
M :- Indicates MODE key has been pressed.
DISP :- Indicates intermediate result is displayed.
D :- Indicates angular measurement in units of "Degrees".
R :- Indicates angular measurement in units of "Radians".
G :- Indicates angular measurement in units of "Gradients".
FIX :- Indicates specification of number of decimal places is being executed.
SCI :- Indicates specification of number of significant digits is being executed.
hyp :- Indicates hyp key has been pressed
***i*:-** Indicates the display of imaginary number.
←,→:-Indicates number of characters exceeds limitation of screen. Non-displayed characters can be viewed by "scrolling" right or left, as indicated by arrow(s).
®,™ :- Indicates the content in last calculation memory.
PROG :- Indicates the calculator is in programming mode.

◆ Operation modes

When using calculatorit is necessary to select the proper mode to meet your requirements. This can be done by pressing MODE to view the main menu and select the appropriate mode by moving the cursor to the right or the left.

Press MODE once to read the first page of the main menu.

MODE ?
COMP CMPLX

Press → to select the mode.

MODE ?
COMP CMPLX

As the icons "→" or "←" appear, one can press → or ← correspondingly to view the hidden menu.

MODE ?
SD REG BASE

After locating the desired mode, press = to confirm and leave the main menu.

As you press MODE again, you can move to the menu to select function graph or parametric graph.

MODE

GRAPH ?
FUNCT PARA

Or if you want to define the "degree" or "radian" or gradient", you can press MODE again during the display of "graph-selection" menu mentioned above.

Press MODE again.
(This sub-menu will be skipped in Base-N mode.)

ANGLE ?
DEG RAD GRA

Select the angular unit by pressing ← or → then followed by = .

Or if you want to define the answer display format, you can proceed to the following page by pressing MODE further.

(This sub-menu will be skipped in Base-N mode.)

FORMAT?
FIX SCI NORM

Press MODE once more to leave the menu.

_

Calculation modes

COMP mode : - general calculations, including function calculations can be executed.
COMPLEX mode:- calculations including complex numbers can be executed. "CMPLX" appears on the display.
SD mode:- standard deviation calculation can be executed. "SD" appears in the display.
REG mode:- regression calculations can be performed. "LR" appears in the display.
BASE-N mode:- binary, octal, decimal, hexadecimal conversion and calculations, as well as logical operations can be carried out. "BASE-N" appears on the display.

Note:- The five calculation modes listed above are totally independent, and cannot be used together.

Note:- The calculation mode last selected is retained in memory when the power is switched OFF.

Angular measurement modes

Deg mode:- specify measurement in "degrees". "D "symbol appears in display window.
Rad mode:- specify measurement in "radians". "R " symbol appears in display window.
Gra mode:- specify measurement in "grads". "G " symbol appears in display window.

With the exception of the BASE-N mode, these three angular measurement modes can be used in combination with the manual calculation modes.

Display modes

Fix mode:- specify number of decimal places. "FIX" symbol appears in display window.
Sci mode:- specify number of significant digits. "SCI" symbol appears in display window.
Norm mode:- cancels "Fix" and "Sci" specifications. This operation also changes the range of the exponent display. When the results exceed the following limits, exponent is to be displayed.

Norm 1 :- $10^{-2} > |x|$, or $|x| \geq 10^{10}$
Norm 2 :- $10^{-9} > |x|$, or $|x| \geq 10^{10}$

In combination with Fix, Sci or Norm mode, you can cause the exponent display for the number being displayed to change in multiples of 3 by pressing ENG .

* With the exception of the BASE-N mode, Fix, Sci and Norm modes can be used in combination with the manual calculations.
* Engineering display format is not available in Complex mode.
* The display mode last selected is retained in memory when the power is switched OFF.

◆ Calculation priority sequence

This calculator employs true algebraic logic to calculate the parts of a formula in the following order :-

1. Coordinate transformation / integration, Pol(x, y), Rec(r, θ), ∫dx
2. Type A functions :-
   These functions are those in which the value is entered and than the function key is pressed, such as x^2, x^{-1}, $x!$, ° ′ ″, Engineering symbols.
3. Power / root, x^y, $^x\sqrt{}$
4. Fractions, $a^b/_c$
5. Abbreviated multiplication format in front of π, memory or parenthesis, such as 2π, 5A, πR, etc.
6. Type B functions :-
   These functions are those in which the function key is pressed and then the value is entered such as √, $^3\sqrt{}$, log, ln, e^x, 10^x, sin, cos, tan, $\sin^{-1}$, $\cos^{-1}$, $\tan^{-1}$, sinh, cosh, tanh, $\sinh^{-1}$, $\cosh^{-1}$, $\tanh^{-1}$, Int, Frac, Abs, (-), (following in BASE-N mode only) d, H, b, o, Neg, Not.
7. Abbreviated multiplication format in front of Type B functions, such as, 2√3, A log2, etc.
8. ×, ÷
9. +, –
10. and (in BASE-N mode only)
11. or, xor, xnor (in BASE-N mode only)

* When functions with the same priority are used in series, execution is performed from right to left for :- $e^x\ln\sqrt{120} \rightarrow e^x\{\ln(\sqrt{120})\}$. Otherwise, execution is from left to right.
* Operations enclosed in parentheses are performed first.

◆ Number of stacks

There is a memory area known as a "stack" for the temporary storage of low priority numeric values and commands (functions, etc.). The numeric value stack has nine levels, while the command stack has 24. If a complex formula is employed that exceeds the stack space available, a stack error (Stk ERROR) message will appear on the display.

Calculations are performed in the order of the highest calculation priority first. Once a calculation is executed, it is cleared from the stack.

◆ Number of input/output digits and calculation digits

The allowable input/output range (number of digits) of this unit is 10 digits for a mantissa and 2 digits for the exponent. Calculations, however, are performed inernally with a range of 12 digits for a mantissa and 2 digits for an exponent.

Example $3 \times 10^5 \div 7 =$

3 EXP 5 ÷ 7 =	D 42857.14286
3 EXP 5 ÷ 7 – 42857	D 3E5÷7
=	D 0.14285714

Once a calculation is completed, the mantissa is rounded off to 10 digits and displayed.

Example $3 \times 10^5 \div 7 =$

3 EXP 5 ÷ 7 =	D 42857.14286
– 42857 =	D 0.14286

◆ Overflow and errors

If the operational range of the unit is exceeded, or incorrect inputs are made, an error message will appear on the display and subsequent operation will be impossible. This is carried out by the error check function. The following operations will result in errors :-

1. The answer, whether intermediate or final, or any value in memory exceeds the value of $\pm 9.999999999 \times 10^{99}$.
2. An attempt is made to perform function calculations that exceed the input range.
3. Improper operation during statistical calculations, e.g., attempting to obtain x or $x\sigma n$ without data input.
4. The capacity of the numeric value stack or the command stack is exceeded.
5. Input errors are made, e.g, 5 × × 3 =.

When error message appears, most keys will become inoperative. In this case, press the AC key to return to normal operation. You can also press the ← or → key to cause the cursor to show the position of the error.

The following error messages will be displayed for the operations listed above:-

case (1) to case (3)	Ma ERROR
case (4)	Stk ERROR
case (5)	Syn ERROR
case (6)	Range ERROR

Besides pressing AC when an error occurs, you can also press ON key to clear the error.

◆ Number of input characters

This calculator features a 79-step area for calculation execution. One function comprises one step. Each press of numeric or + , – , × and ÷ keys comprise one step. Though such operations as SHIFT x! (x^{-1} key) require two key operations, they actually comprise only one function, and, therefore, only one step. These steps can be confirmed using the cursor. With each press of the ← or → key, the cursor is moved one step.

Input characters are limited to 79 steps. Usually, the cursor is represented by a blinking " _ ".

When numeric values or calculation commands are input, they appear on the display from the left. Calculation results, however, are displayed from the right.

◆ Corrections

To make corrections in a formula that is being input, use the ← and → keys to move to the position of the error and press the correct keys.

Example To change an input of 122 to 123 :-

1 2 2	D 1 2 2 _
←	D 1 2 2
3	D 1 2 3 _

Example To change an input of cos60 to sin60 :-

COS 6 0	D cos 60 _
← ← ←	D cos 60
sin	D sin 60

If after making corrections, input of the formula is complete, the answer can be obtained by pressing = . If, however, more is to be added to the formula, advance the cursor using the → key to the end of the formula for input.

If an unnecessary character has been included in a formula, use the ← and → keys to move to the position of the error and press the DEL key. Each press of DEL will delete one command (one step).

Example To correct an input of 369 × × 2 to 369 × 2 :-

3 6 9 × × 2	D 3 6 9 × × 2 _
← ← DEL	D 3 6 9 × 2

If a character has been omitted from a formula, use the ← or → key to move to the position where the character should have been input, and press SHIFT followed by INS key. Each press of SHIFT INS will create a space for input of one command.

Example To correct an input of 2.36^2 to $\sin 2.36^2$:-

2 • 3 6 x^2	D 2.36^2 _
← ← ← ← ←	D 2.36^2
SHIFT INS	D □ $.36^2$
SIN	D sin □$.36^2$

When SHIFT INS are pressed, the space that is opened is displayed as " ". The function or value assigned to the next key you press will be inserted in the □ . To exit from the insertion mode, move the cursors, or press SHIFT INS , or press = .

Even after the = key has been pressed to calculate a result, it is possible to use this procedure for correction. Press the ← key to move the cursor to the place where the correction is to be made.

II. Manual Calculations

IIa. Arithmetic operations & Parenthesis calculations

- arithmetic operations are performed by pressing the keys in the same order as noted in the formula
- for negative values, press [(-)] before entering the value
- for mixed basic arithmetic operations, multiplication and division are given priority over addition and subtraction
- assuming that display mode Norm 1 is selected

Example	Operation	Display (lower)
23+4.5-53=-25.5	23 [+] 4.5 [–] 53 [=]	–25.5
56×(-12)÷(-2.5)=268.8	56 [×]-12 [÷]-2.5 [=]	268.8
12369×7532×74103= $6.903680613 \times 10^{12}$	12369[×] 7532 [×] 74103[=]	6.903680613^{12}
$(4.5\times10^{75})\times(-2.3\times10^{-79})$ = -1.035×10^{-3}	4.5[exp]75 [×] -2.3 [exp] - 79 [=]	-1.035^{-03}
$(2+3)\times10^2$=500	[( ] 2 [+] 3[ )][×] 1 [exp]2 [=]	500.
$(1\times10^5)\div7$=14285.71429	1[exp]5 [÷] 7 [=]	14285.71429
$(1\times10^5)\div7-14285$=0.7142857 please note that internal calculation is calculated in 12 digits for a mantissa and the result is displayed rounded off to 10 digits.	1[exp]5[÷]7 [–]14285 [=]	0.71428571
3 + 5 × 6 = 33	3 [+] 5 [×] 6 [=]	33.
7 × 8 – 4 × 5 = 36	7 [×] 8 [–] 4 [×] 5 [=]	36.
1 + 2 – 3 × 4 ÷ 5 + 6 = 6.6	1 [+] 2 [–] 3 [×] 4 [÷] 5 [+] 6 [=]	6.6
100 – (2+3) × 4 = 80	100 [–][( ] 2 [+] 3[ )] [×] 4 [=]	80.
2 + 3 × (4 + 5) = 29	2 [+] 3 [×] [(] 4 [+] 5 [=] Closed parentheses occurring immediately before operation of the [=] key may be omitted.	29.
(7 – 2) × (8 + 5) = 65	[( ] 7 [–] 2 [ )][( ] 8 [+] 5 [=] A multiplication sign [×] occurring immediately before an open parantheses can be omitted.	65.
10 – { 2 + 7 × (3 + 6)}= -55	10 [–][( ] 2 [+] 7 [( ] 3 [+] 6 [=]	-55.

IIb. Percentage calculations

- Percentage cannot be executed in Base-N mode or CMPLX mode.

Example	Operation	Display (Lower)
Percentage 26% of $15.00	15 [×] 26 [shift][%]	3.9
Premium 15% increase from $36.20	36.2 [×] 15 [shift][%][+]	41.63
Discount 4% discount from $47.50	47.5 [×] 4 [shift][%][–]	45.6
Ratio 75 is what % of 250 ?	75 [÷] 250 [shift][%]	30.
Rate of change 141 is an increase of what % from 120 ?	141 [–] 120 [shift][%]	17.5
Rate of change 240 is a decrease of what % from 300 ?	240 [–] 300 [shift][%]	-20.

IIc. Specifying the Format of Calculation Results

You can change the precision of calculation results by specifying the number of decimal places or the number of significant digits. You can also shift the decimal place of a displayed value three places to the left or right for one-touch conversions of metric weights and measures.

Upon power up reset, the display format is defaulted at Norm1. Each time you can press MODE to enter the menu and select the desired format in the sub-menu "Fix/Sci/Norm". When you choose "Norm", you can further select between Norm 1 or Norm 2 in the following window.

Norm 1~2?

Key in either 1 or 2 to specify Norm 1 or Norm 2 respectively.

Norm 1 :- all values less than 10^{-2} or greater than 10^9 are automatically expressed as exponents.
Norm 2 :- all values less than 10^{-9} or greater than 10^9 are automatically expressed as exponents.

Note: You cannot specify the display format (Fix, Sci) while the calculator is in Base-N mode.

◆ Specifying the Number of Decimal places

The calculator always performs calculations using a 10-digit mantissa and 2-digit exponent, and results are stored in memory as a 12-digit mantissa and 2-digit exponent no matter how many decimal places you specify. Intermediate results and final results are then automatically rounded off to the number of decimal places you have specified.
It should be noted that displayed results are rounded to the specified number of decimal places, but stored results are normally not rounded.

To specify the number of decimal places (Fix), select "FIX" in the sub-menu "Fix/Sci/Norm" and then you are asked to enter a value indicating the number of places (0 ~ 9) as below.

Fix 0~9?

At this time, you should be able to see "FIX" on the display. The number of decimal places specified will remain in effect until Norm1 or Norm2 is specified as described above or significant digits are specified by selecting "SCI" in the sub-menu "Fix/Sci/Norm".

Example	Operation	Display (Lower)
100 ÷ 6 = 16.66666666…	100 [÷] 6 [=]	16.66666667
specify 4 decimal places	[Mode][Mode][Mode] [Mode] [=] [4]	16.6667
cancel specification	[Mode][Mode][Mode] [Mode] [→][→][=][1]	16.66666667
200 ÷ 7 × 14 = 400	200 [÷] 7 [×] 14 [=]	400.
rounded to 3 decimal places	[Mode][Mode][Mode] [Mode] [=] [3]	400.000
	200 [÷] 7 [=] The intermediate result is automatically rounded to the specified three decimal places.	28.571
The stored 10-digit result (28.571421857) is used when you continue the calculation by simply pressing [×] or any other arithmetic function key.	[×]	Ans × _
	14 [=] (The final result is automatically rounded to the specified three decimal places.)	400.000
Cancel specification by specifying Norm 1 again.	[Mode][Mode][Mode] [Mode] [→][→][=][1]	400.

◆ Rounding the Intermediate Result

As the number of decimal places is specified, the intermediate result will be automatically rounded to the specified decimal places. However, the stored intermediate result is not rounded. In order to match the displayed value and the stored value, SHIFT RND can be input.

You can compare the final result obtained in the previous example with the final result of the following example.

Example	Operation	Display
200 ÷ 7 × 14 = 400	200 [÷] 7 [×] 14 [=]	400.
rounded to three decimal places	[Mode][Mode][Mode] [Mode] [=][3]	400.000
	200 [÷] 7 [=] (The intermediate result is automatically rounded to the specified three decimal places.)	28.571
round the stored intermediate result to the specified three decimal places	[Shift][RND]	28.571
	[×]	Ans×
	14[=]	399.994
Cancel specification by specifying Norm1 again.	[Mode][Mode][Mode] [Mode] [→][→][=][1]	399.994

◆ Specifying the Number of Significant Digits

This specification is used to automatically round intermediate results and final results to the number of digits you have specified.

As with the number of decimal places, displayed results are rounded to the specified number of digits, but stored results are normally not rounded.

To specify the number of significant digits (Sci.), select "SCI" in the sub-menu "Fix/Sci/Norm" and then you ar asked to enter a value indicating the number of significant digits (0~9) as below.

Sci 0~9?

(Note : "0" indicating 10 significant digits.)

Meanwhile, the "SCI" indicator will appear on the display.

Example	Operation	Display
100 ÷ 6 = 16.66666666…	100 [÷] 6 [=]	16.66666667
Specify 5 significant digits	[Mode][Mode][Mode] [Mode] [→][=][5]	1.6667^{01}
Cancel specification by specifying Norm 1 again.	[Mode][Mode][Mode] [Mode] [→][→][=][1]	16.66666667

◆ Shifting the Decimal Place

You can use the key ENG to shift the decimal point of the displayed value three places to the left or right. Each 3-place shift to the left is the same as dividing the value by 1000, and each shift to the right is the same as multiplying by 1000. This means that this function is useful when converting metric weights and measures to other metric units.

Example	Operation	Display
123m × 456 = 56088m = 56.088km	123 [×] 456 [=]	56088.
	[ENG]	56.088^{03}
78g × 0.96 = 74.88g = 0.07488kg	78 [×] 0.96 [=]	74.88
	[Shift][←ENG]	0.07488^{03}

IId. Memory

This calculator contains 9 standard memories. There are two basic types of memories, i.e., "variable" memories, which are accessed by using the STO and RCL keys in combination with the alphabets A, B, C, D, E, F, M, X and Y. The independent" memories, which are accessed by using the M+ , Shift M- and SHIFT RCL and M keys. The variable memory and independent memory utilize the same memory area.
Contents of both the variable and independent memories are protected even when the power is turned OFF.

◆ Variable memories

Up to 9 values can be retained in memory at the same time, and can be recalled when desired.

Example Input 123 into memory "A" :-

AC 123	1 2 3 _

STO A	A = 1 2 3.
AC	_
SHIFT RCL A	A = 1 2 3.

When formulas are input, the result of the formula's calculation is retained in memory.

Example Input the result of 123 × 456 into memory "B" :-

AC 123 × 456	1 2 3 × 4 5 6 _
STO B	B = 5 6 0 8 8.
AC	_
SHIFT RCL B	B = 5 6 0 8 8.

If a variable expression is entered, the expression is first calculated according to the values stored in the variable memories used in the expression. The result is then stored in the variable memory specified for the result.

Example Input the results of A×B into memory "C" :-

AC Alpha A × Alpha B	A × B _
STO C	C = 6 8 9 8 8 2 4.

AC	_
SHIFT RCL C	C = 6 8 9 8 8 2 4.

* Syn ERROR is generated when an attempt is made to input a substitution formula (such as C = A×B) or multistatements (such as A×B : C×D), and the existing memory contents are retained.

When input is made in a format such as "A=log 2", where the variable is equal to the formula, the results of the calculation are input into the specified memory.

Example Executing "A=log2" :-

AC Alpha A Alpha = log 2	A = log 2 _
=	0. 3 0 1 0 2 9 9 9 5
AC	_
SHIFT RCL A	A = 0. 3 0 1 0 2 9 9 9 5

Deleting memories

To delete all contents of variable memories, press Shift followed by Mcl = .

◆ Independent memories

Addition and subtraction (to and from sum) results can be stored directly in memory. Results can also be totalized in memory, making it easy to calculate sums. The icon "M" will be lighted as long as M is not empty.