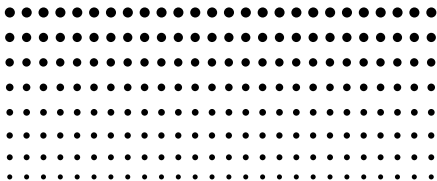




***fx-100MS***  
***fx-115MS*** (***fx-912MS***)  
***User's Guide 2***  
***(Additional Functions)***

■ **fx-912MS owners**

Please be sure to read the important notice of this manual.



**Important!**

Please keep your manual and all information handy for future reference.



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# Contents

<b>Before getting started...</b> .....	<b>2</b>
■ Modes .....	2
<b>Mathematical Expression Calculations and Editing Functions</b> .....	<b>3</b>
■ Replay Copy .....	3
■ CALC Memory .....	4
■ SOLVE Function .....	4
<b>Scientific Function Calculations</b> .....	<b>5</b>
■ Inputting Engineering Symbols .....	5
<b>Complex Number Calculations</b> .....	<b>7</b>
■ Absolute Value and Argument Calculation .....	8
■ Rectangular Form $\leftrightarrow$ Polar Form Display .....	8
■ Conjugate of a Complex Number .....	9
<b>Base-<math>n</math> Calculations</b> .....	<b>9</b>
<b>Statistical Calculations</b> .....	<b>11</b>
Normal Distribution .....	11
<b>Differential Calculations</b> .....	<b>12</b>
<b>Integration Calculations</b> .....	<b>13</b>
<b>Power Supply</b> .....	<b>14</b>
<b>Specifications</b> .....	<b>16</b>

See the “fx-95MS/fx-100MS/fx-115MS/fx-570MS/fx-991MS User’s Guide” for details about the following items.

Removing and Replacing the Calculator’s Cover/

Safety Precautions/ Handling Precautions/

Two-line Display/

Before getting started... (except for “Modes”)/

Basic Calculations/ Memory Calculations/

Scientific Function Calculations/ Equation Calculations/

Statistical Calculations/ Technical Information

# Before getting started...

## ■ Modes

Before starting a calculation, you must first enter the correct mode as indicated in the table below.

- The following table shows the modes and required operations for the fx-100MS and fx-115MS.

### fx-100MS and fx-115MS Modes

To perform this type of calculation:	Perform this key operation:	To enter this mode:
Basic arithmetic calculations		COMP
Complex number calculations		CMPLX
Standard deviation		SD
Regression calculations		REG
Base- <i>n</i> calculations		BASE
Solution of equations		EQN

- Pressing the key more than three times displays additional setup screens. Setup screens are described where they are actually used to change the calculator setup.
- In this manual, the name of the mode you need to enter in order to perform the calculations being described is indicated in the main title of each section.

**Example:**

**Complex Number  
Calculations**

### **Note!**

- To return the calculation mode and setup to the initial defaults shown below, press (Mode) .

Calculation Mode: COMP  
Angle Unit: Deg  
Exponential Display Format: Norm 1, Eng OFF  
Complex Number Display Format:  $a+bi$   
Fraction Display Format:  $a^b/c$   
Decimal Point Character: Dot

- Mode indicators appear in the upper part of the display, except for the BASE indicators, which appear in the exponent part of the display.
- Engineering symbols are automatically turned off while the calculator is the BASE Mode.
- You cannot make changes to the angle unit or other display format (Disp) settings while the calculator is in the BASE Mode.
- The COMP, CMPLX, SD, and REG modes can be used in combination with the angle unit settings.
- Be sure to check the current calculation mode (SD, REG, COMP, CMPLX) and angle unit setting (Deg, Rad, Gra) before beginning a calculation.

## Mathematical Expression Calculations and Editing Functions

**COMP**

Use the **MODE** key to enter the COMP Mode when you want to perform mathematical expression calculations or edit expressions.

COMP ..... **MODE** **1**

### ■ Replay Copy

Replay copy lets you recall multiple expressions from replay so they are connected as a multi-statement on the screen.

#### • Example:

Replay memory contents:

1 + 1  
 2 + 2  
 3 + 3  
 4 + 4  
 5 + 5  
 6 + 6

Multi-statement: 4 + 4:5 + 5:6 + 6

Use **▲** and **▼** to display the expression 4 + 4.

Press **SHIFT** **▲**(COPY).

- You can also edit expressions on the display and perform other multi-statement operations. For more details about using multi-statements, see “Multi-statements” in the separate “User’s Guide.”
- Only the expressions in replay memory starting from the currently displayed expression and continuing to the last expression are copied. Anything before the displayed expression is not copied.

## ■ CALC Memory

**COMP**   **CMPLX**

- CALC memory lets you temporarily store a mathematical expression that you need to perform a number of times using different values. Once you store an expression, you can recall it, input values for its variables, and calculate a result quickly and easily.
- You can store a single mathematical expression, with up to 79 steps. Note that CALC memory can be used in the COMP Mode and CMPLX Mode only.
- The variable input screen shows the values currently assigned to the variables.
- **Example:** Calculate the result for  $Y = X^2 + 3X - 12$  when  $X = 7$  (Result: **58**), and when  $X = 8$  (Result: **76**).

(Input the function.)

**ALPHA** **Y** **ALPHA** **=** **ALPHA** **X** **x<sup>2</sup>** **+** 3 **ALPHA** **X** **-** 12

(Store the expression.)

**CALC**

(Input 7 for X? prompt.)

7 **=**

(Input 8 for X? prompt.)

**CALC** 8 **=**

- Note that the expression you store is cleared whenever you start another operation, change to another mode, or turn off the calculator.

## ■ SOLVE Function

The SOLVE function lets you solve an expression using variable values you want, without the need to transform or simply the expression.

- **Example:** C is the time it would take for an object thrown straight up with initial velocity A to reach height B.

Use the formula below to calculate initial velocity A for a height of B = 14 meters and a time of C = 2 seconds. Gravitational acceleration is D = 9.8 m/s<sup>2</sup>.  
(Result: A = **16.8**)

$$B = AC - \frac{1}{2} DC^2$$

[ALPHA] [B] [ALPHA] [=] [ALPHA] [A] [X] [ALPHA] [C] [−]  
[ ( ] 1 [ ÷ ] 2 [ ) ] [X] [ALPHA] [D] [X] [ALPHA] [C] [x<sup>2</sup>]  
[SHIFT] [SOLVE]  
 (B?)      14 [=]  
 (A?)      [▼]  
 (C?)      2 [=]  
 (D?)      9 [.] 8 [=]  
           [▲] [▲]  
 (A?)      [SHIFT] [SOLVE]

- The SOLVE function finds approximations based on Newton's method, which means that error can occur. Certain expressions or initial values may result in error without convergence of results.
- If an expression does not include an equals sign (=), the SOLVE function produces a solution for expression = 0.

## Scientific Function Calculations COMP

Use the [MODE] key to enter the COMP Mode when you want to perform basic arithmetic calculations.

COMP ..... [MODE] [1]

### ■ Inputting Engineering Symbols

COMP
EQN
CMLPX

- Turning on engineering symbols makes it possible for you to use engineering symbols inside your calculations.

- To turn engineering symbols on and off, press the **MODE** key a number of times until you reach the setup screen shown below.

Disp  
1

- Press **1**. On the engineering symbol setting screen that appears, press the number key (**1** or **2**) that corresponds to the setting you want to use.

- 1**(Eng ON): Engineering symbols on (indicated by “Eng” on the display)
- 2**(Eng OFF): Engineering symbols off (no “Eng” indicator)

- The following are the nine symbols that can be used when engineering symbols are turned on.

To input this symbol:	Perform this key operation:	Unit
k (kilo)	<b>SHIFT</b> <b>k</b>	$10^3$
M (Mega)	<b>SHIFT</b> <b>M</b>	$10^6$
G (Giga)	<b>SHIFT</b> <b>G</b>	$10^9$
T (Tera)	<b>SHIFT</b> <b>T</b>	$10^{12}$
m (milli)	<b>SHIFT</b> <b>m</b>	$10^{-3}$
$\mu$ (micro)	<b>SHIFT</b> <b><math>\mu</math></b>	$10^{-6}$
n (nano)	<b>SHIFT</b> <b>n</b>	$10^{-9}$
p (pico)	<b>SHIFT</b> <b>p</b>	$10^{-12}$
f (femto)	<b>SHIFT</b> <b>f</b>	$10^{-15}$

- For displayed values, the calculator selects the engineering symbol that makes the numeric part of the value fall within the range of 1 to 1000.
- Engineering symbols cannot be used when inputting fractions.
- Example:**  $9 \div 10 = 0.9$  m (milli)

**MODE** ..... **1**(Disp) **1**

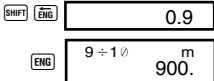
Eng  
0.

9  **$\div$**  10 **=**

$9 \div 10$  m  
900.

When engineering symbols are turned on, even standard (non-engineering) calculation results are displayed using engineering symbols.





## Complex Number Calculations

**CMPLX**

Use the **MODE** key to enter the CMPLX Mode when you want to perform calculations that include complex numbers.

CMPLX ..... **MODE** **2**

- The current angle unit setting (Deg, Rad, Gra) affects CMPLX Mode calculations. You can store an expression in CALC memory while in the CMPLX Mode.
- Note that you can use variables A, B, C, and M only in the CMPLX Mode. Variables D, E, F, X, and Y are used by the calculator, which frequently changes their values. You should not use these variables in your expressions.
- The indicator “R↔I” in the upper right corner of a calculation result display indicates a complex number result. Press **SHIFT** **Re←Im** to toggle the display between the real part and imaginary part of the result.
- You can use the replay function in the CMPLX Mode. Since complex numbers are stored in replay memory in the CMPLX Mode, however, more memory than normal is used up.
- **Example:**  $(2+3i)+(4+5i) = 6+8i$

(Real part 6)

2 **+** 3 **i** **+** 4 **+** 5 **i** **=**

(Imaginary part 8i)

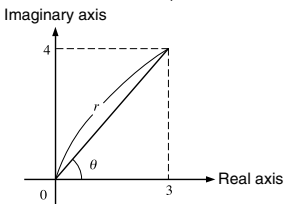
**SHIFT** **Re←Im**

## ■ Absolute Value and Argument Calculation

Supposing the imaginary number expressed by the rectangular form  $z = a + bi$  is represented as a point in the Gaussian plane, you can determine the absolute value ( $r$ ) and argument ( $\theta$ ) of the complex number. The polar form is  $r \angle \theta$ .

- **Example 1:** To determine the absolute value ( $r$ ) and argument ( $\theta$ ) of  $3+4i$  (Angle unit: Deg)

$$(r = 5, \theta = 53.13010235^\circ)$$



$$(r = 5)$$

$$\text{SHIFT} \text{Abs} ( 3 + 4 i ) =$$

$$(\theta = 53.13010235^\circ)$$

$$\text{SHIFT} \text{arg} ( 3 + 4 i ) =$$

- The complex number can also be input using the polar form  $r \angle \theta$ .

- **Example 2:**  $\sqrt{2} \angle 45 = 1 + i$   
(Angle unit: Deg)

$$\sqrt{\phantom{x}} 2 \text{SHIFT} \angle 45 =$$

$$\text{SHIFT} \text{Re--Im}$$

## ■ Rectangular Form $\leftrightarrow$ Polar Form Display

You can use the operation described below to convert a rectangular form complex number to its polar form, and a polar form complex number to its rectangular form. Press  $\text{SHIFT} \text{Re--Im}$  to toggle the display between the absolute value ( $r$ ) and argument ( $\theta$ ).

- **Example:**  $1 + i \leftrightarrow 1.414213562 \angle 45$

$$(\text{Angle unit: Deg}) \quad 1 + i \text{SHIFT} \rightarrow r \angle \theta = \text{SHIFT} \text{Re--Im}$$

$$\sqrt{\phantom{x}} 2 \text{SHIFT} \angle 45 \text{SHIFT} \rightarrow a+bi = \text{SHIFT} \text{Re--Im}$$

- You select rectangular form ( $a+bi$ ) or polar form ( $r\angle\theta$ ) for display of complex number calculation results.

**MODE** ... **1** (Disp) **▶**

**1** ( $a+bi$ ): Rectangular form

**2** ( $r\angle\theta$ ): Polar form (indicated by " $r\angle\theta$ " on the display)

## ■ Conjugate of a Complex Number

For any complex number  $z$  where  $z = a+bi$ , its conjugate ( $\bar{z}$ ) is  $\bar{z} = a-bi$ .

- Example:** To determine the conjugate of the complex number  $1.23 + 2.34i$  (Result:  $1.23 - 2.34i$ )

**SHIFT** **Conjg** ( **1** **•** **23** **+** **2** **•** **34** **i** **)** **=**  
**SHIFT** **Re-Im**

## Base- $n$ Calculations

**BASE**

Use the **MODE** key to enter the BASE Mode when you want to perform calculations using Base- $n$  values.

BASE ..... **MODE** **MODE** **3**

- In addition to decimal values, calculations can be performed using binary, octal and hexadecimal values.
- You can specify the default number system to be applied to all input and displayed values, and the number system for individual values as you input them.
- You cannot use scientific functions in binary, octal, decimal, and hexadecimal calculations. You cannot input values that include decimal part and an exponent.
- If you input a value that includes a decimal part, the unit automatically cuts off the decimal part.
- Negative binary, octal, and hexadecimal values are produced by taking the two's complement.

- You can use the following logical operators between values in Base- $n$  calculations: and (logical product), or (logical sum), xor (exclusive or), xnor (exclusive nor), Not (bitwise complement), and Neg (negation).
- The following are the allowable ranges for each of the available number systems.

Binary	$1000000000 \leq x \leq 1111111111$
	$0 \leq x \leq 0111111111$
Octal	$4000000000 \leq x \leq 7777777777$
	$0 \leq x \leq 3777777777$
Decimal	$-2147483648 \leq x \leq 2147483647$
Hexadecimal	$80000000 \leq x \leq \text{FFFFFFFF}$
	$0 \leq x \leq 7\text{FFFFFFF}$

- Example 1:** To perform the following calculation and produce a binary result:

$$10111_2 + 11010_2 = \mathbf{110001_2}$$

Binary mode:

**AC** **BIN**

$$10111 \mathbf{+} 11010 \mathbf{=}$$

- Example 2:** To perform the following calculation and produce an octal result:

$$7654_8 \div 12_{10} = \mathbf{516_8}$$

Octal mode:

**AC** **OCT**

**LOGIC** **LOGIC** **LOGIC** **4** (o) 7654 **÷**

**LOGIC** **LOGIC** **LOGIC** **1** (d) 12 **=**

- Example 3:** To perform the following calculation and produce a hexadecimal and a decimal result:

$$120_{16} \text{ or } 1101_2 = \mathbf{12d_{16}} = \mathbf{301_{10}}$$

Hexadecimal mode:

**AC** **HEX**

120 **LOGIC** **2** (or)

**LOGIC** **LOGIC** **LOGIC** **3** (b) 1101 **=**

Decimal mode:

**DEC**

- **Example 4:** To convert the value  $22_{10}$  to its binary, octal, and hexadecimal equivalents.

*( $10110_2, 26_8, 16_{16}$ )*

Binary mode: **AC** **BIN**

**LOGIC** **LOGIC** **LOGIC** **1** (d) 22 **=**

Octal mode: **OCT**

Hexadecimal mode: **HEX**

- **Example 5:** To convert the value  $513_{10}$  to its binary equivalent.

Binary mode: **AC** **BIN**

**LOGIC** **LOGIC** **LOGIC** **1** (d) 513 **=**

- You may not be able to convert a value from a number system whose calculation range is greater than the calculation range of the resulting number system.
- The message “Math ERROR” indicates that the result has too many digits (overflow).

## Statistical Calculations

**SD**

**REG**

### Normal Distribution

**SD**

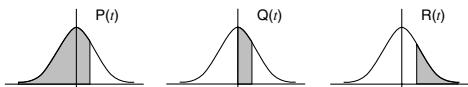
Use the **MODE** key to enter the SD Mode when you want to perform a calculation involving normal distribution.

SD ..... **MODE** **MODE** **1**

- Press **SHIFT** **DISTR**, which produces the screen shown below.

P(	Q(	R(	→t
1	2	3	4

- Input a value from **[1]** to **[4]** to select the probability distribution calculation you want to perform.



- **Example:** To determine the normalized variate ( $\rightarrow t$ ) for  $x = 53$  and normal probability distribution  $P(t)$  for the following data: 55, 54, 51, 55, 53, 53, 54, 52

( $\rightarrow t = -0.284747398$ ,  $P(t) = 0.38974$ )

55 **[DT]** 54 **[DT]** 51 **[DT]** 55 **[DT]**  
 53 **[DT]** **[DT]** 54 **[DT]** 52 **[DT]**  
 53 **[SHIFT]** **[DISTR]** **[4]** ( $\rightarrow t$ ) **[=]**  
**[SHIFT]** **[DISTR]** **[1]** ( $P()$ ) **[(-)]** 0.28 **[)]** **[=]**

## Differential Calculations

**COMP**

The procedure described below obtains the derivative of a function.

Use the **[MODE]** key to enter the COMP Mode when you want to perform a calculation involving differentials.

COMP ..... **[MODE]** **[1]**

- Three inputs are required for the differential expression: the function of variable  $x$ , the point ( $a$ ) at which the differential coefficient is calculated, and the change in  $x$  ( $\Delta x$ ).

**[SHIFT]** **[d/dx]** expression **[,]**  $a$  **[,]**  $\Delta x$  **[)]**

- **Example:** To determine the derivative at point  $x = 2$  for the function  $y = 3x^2 - 5x + 2$ , when the increase or decrease in  $x$  is  $\Delta x = 2 \times 10^{-4}$  (Result: **7**)

**[SHIFT]** **[d/dx]** 3 **[ALPHA]** **[X]** **[X<sup>2</sup>]** **[+/-]** 5 **[ALPHA]** **[X]** **[+]** 2 **[,]** 2 **[,]**  
 2 **[EXP]** **[(-)]** 4 **[)]** **[=]**

- You can omit input of  $\Delta x$ , if you want. The calculator automatically substitutes an appropriate value for  $\Delta x$  if you do not input one.
- Discontinuous points and extreme changes in the value of  $x$  can cause inaccurate results and errors.

## Integration Calculations

COMP

The procedure described below obtains the definite integral of a function.

Use the  $\boxed{\text{MODE}}$  key to enter the COMP Mode when you want to perform integration calculations.

COMP .....  $\boxed{\text{MODE}}$   $\boxed{1}$

- The following four inputs are required for integration calculations: a function with the variable  $x$ ;  $a$  and  $b$ , which define the integration range of the definite integral; and  $n$ , which is the number of partitions (equivalent to  $N = 2^n$ ) for integration using Simpson's rule.

$\boxed{\int dx}$  expression  $\boxed{,}$   $a$   $\boxed{,}$   $b$   $\boxed{,}$   $n$   $\boxed{)}$

- **Example:**  $\int_1^5 (2x^2 + 3x + 8) dx = 150.6666667$   
(Number of partitions  $n = 6$ )

$\boxed{\int dx}$   $\boxed{2}$   $\boxed{\text{ALPHA}}$   $\boxed{\text{X}}$   $\boxed{x^2}$   $\boxed{+}$   $\boxed{3}$   $\boxed{\text{ALPHA}}$   $\boxed{\text{X}}$   $\boxed{+}$

$\boxed{8}$   $\boxed{,}$   $\boxed{1}$   $\boxed{,}$   $\boxed{5}$   $\boxed{,}$   $\boxed{6}$   $\boxed{)}$   $\boxed{=}$

### Note!

- You can specify an integer in the range of 1 to 9 as the number of partitions, or you can skip input of the number of partitions entirely, if you want.
- Internal integration calculations may take considerable time to complete.
- Display contents are cleared while an integration calculation is being performed internally.

# Power Supply

The type of battery you should use depends on the model number of your calculator.

## fx-115MS

The TWO WAY POWER system actually has two power supplies: a solar cell and a G13 Type (LR44) button battery. Normally, calculators equipped with a solar cell alone can operate only when relatively bright light is present. The TWO WAY POWER system, however, lets you continue to use the calculator as long as there is enough light to read the display.

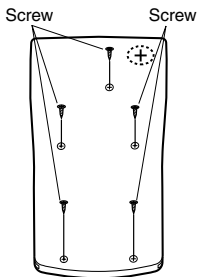
### • Replacing the Battery

Either of the following symptoms indicates battery power is low, and that the battery should be replaced.

- Display figures are dim and difficult to read in areas where there is little light available.
- Nothing appears on the display when you press the **ON** key.

### • To replace the battery

- ① Remove the five screws that hold the back cover in place and then remove the back cover.
- ② Remove the old battery.
- ③ Wipe off the sides of new battery with a dry, soft cloth. Load it into the unit with the positive  $\oplus$  side facing up (so you can see it).
- ④ Replace the back cover and secure it in place with the five screws.
- ⑤ Press **ON** to turn power on. Be sure not to skip this step.





## fx-100MS

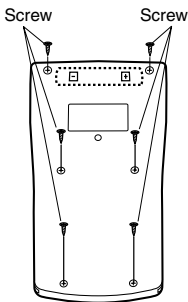
This calculator is powered by a single AA-size battery.

### • Replacing the Battery

Dim figures on the display of the calculator indicate that battery power is low. Continued use of the calculator when the battery is low can result in improper operation. Replace the battery as soon as possible when display figures become dim.

### • To replace the battery

- ① Press **SHIFT** **OFF** to turn power off.
- ② Remove the six screws that hold the back cover in place and then remove the back cover.
- ③ Remove the old battery.
- ④ Load a new battery into the unit with its positive  $\oplus$  and negative  $\ominus$  ends facing correctly.
- ⑤ Replace the back cover and secure it in place with the six screws.
- ⑥ Press **ON** to turn power on.



### Auto Power Off

Calculator power automatically turns off if you do not perform any operation for about six minutes. When this happens, press **ON** to turn power back on.

# Specifications

## Power Supply:

**fx-100MS:** Single AA-size battery (R6P(SUM-3))

**fx-115MS:** Solar cell and a single G13 Type button battery (LR44)

## Battery Life:

**fx-100MS:** Approximately 17,000 hours continuous display of flashing cursor.

Approximately 2 years when left with power turned off.

**fx-115MS:** Approximately 3 years (1 hour use per day).

## Dimensions:

**fx-100MS:** 20.0 (H) × 78 (W) × 155 (D) mm  
1<sup>3</sup>/<sub>16</sub>" (H) × 3<sup>1</sup>/<sub>16</sub>" (W) × 6<sup>1</sup>/<sub>8</sub>" (D)

**fx-115MS:** 12.7 (H) × 78 (W) × 154.5 (D) mm  
1/2" (H) × 3<sup>1</sup>/<sub>16</sub>" (W) × 6<sup>1</sup>/<sub>16</sub>" (D)

## Weight:

**fx-100MS:** 133 g (4.7 oz) including battery

**fx-115MS:** 105 g (3.7 oz) including battery

**Power Consumption:** 0.0002 W

**Operating Temperature:** 0°C to 40°C (32°F to 104°F)

## Important notice for fx-912MS owners

The names fx-912MS (Japan domestic model name) and fx-115MS (international model name) apply to the same model. Owners of the fx-912MS should refer to the description of fx-115MS.

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