Chapter 1
Getting started

This chapter provides basic information about the operation of your calculator. It is designed to familiarize you with the basic operations and settings before you perform a calculation.

Basic Operations

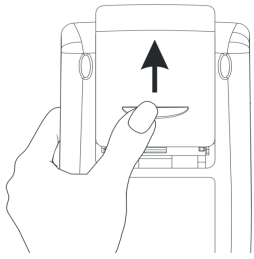
The following sections are designed to get you acquainted with the hardware of your calculator.

Batteries

The calculator uses 4 AAA (LR03) batteries as main power and a CR2032 lithium battery for memory backup.
Before using the calculator, please install the batteries according to the following procedure.

To install the main batteries

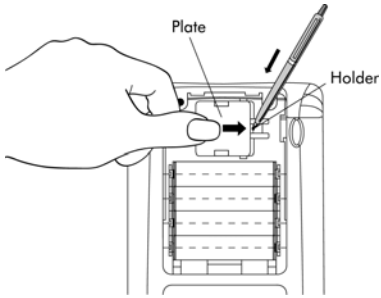
a. **Make sure the calculator is OFF.** Slide up the battery compartment cover as illustrated.



b. Insert 4 new AAA (LR03) batteries into the main compartment. Make sure each battery is inserted in the indicated direction.

To install the backup battery

a. **Make sure the calculator is OFF.** Press down the holder. Push the plate to the shown direction and lift it.



b. Insert a new CR2032 lithium battery. Make sure its positive (+) side is facing up.

c. Replace the plate and push it to the original place.

After installing the batteries, press [ON] to turn the power on.

Warning: When the low battery icon is displayed, you need to replace the batteries as soon as possible. However, avoid removing the backup battery and main batteries at the same time to avoid data lost.

Turning the calculator on and off

The [ON] key is located at the lower left corner of the keyboard. Press it once to turn your calculator on. To turn the calculator off, press the right-shift key [↱] (first key in the second row from the bottom of the keyboard), followed by the [ON] key. Notice that the [ON] key has a OFF label printed in the upper right corner as a reminder of the OFF command.

Adjusting the display contrast

You can adjust the display contrast by holding the [ON] key while pressing the [+] or [−] keys. The [ON](hold) [+] key combination produces a darker display. The [ON](hold) [−] key combination produces a lighter display

Contents of the calculator's display

Turn your calculator on once more. The display should look as indicated below.

At the top of the display you will have two lines of information that describe the settings of the calculator. The first line shows the characters:

RAD XYZ HEX R= 'X'

For details on the meaning of these symbols see Chapter 2.
The second line shows the characters: { HOME } indicating that the HOME directory is the current file directory in the calculator's memory. In Chapter 2 you will learn that you can save data in your calculator by storing them in files or variables. Variables can be organized into directories and sub-directories. Eventually, you may create a branching tree of file directories, similar to those in a computer hard drive. You can then navigate through the file directory tree to select any directory of interest. As you navigate through the file directory the second line of the display will change to reflect the proper file directory and sub-directory.

At the bottom of the display you will find a number of labels, namely,

EDIT VIEW RCL STO PURGE CLEAR

associated with the six *soft menu keys*, F1 through F6:

F1 F2 F3 F4 F5 F6

The six labels displayed in the lower part of the screen will change depending on which menu is displayed. But F1 will always be associated with the first displayed label, F2 with the second displayed label, and so on.

Menus

The six labels associated with the keys F1 through F6 form part of a menu of functions. Since the calculator has only six soft menu keys, it only display 6 labels at any point in time. However, a menu can have more than six entries.

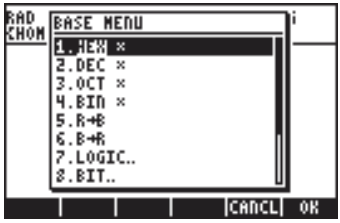
Each group of 6 entries is called a Menu page. The current menu, known as the TOOL menu (see below), has eight entries arranged in two pages. The next page, containing the next two entries of the menu is available by pressing the NXT (NeXT menu) key. This key is the third key from the left in the third row of keys in the keyboard. Press NXT once more to return to the main TOOL menu, or press the TOOL key (third key in second row of keys from the top of the keyboard).

The TOOL menu is described in detain in the next section. At this point we will illustrate some properties of menus that you will find useful while using your calculator.

SOFT menus vs. CHOOSE boxes

Menus, or SOFT menus, associate labels in the lower part of the screen with the six soft menu keys (F1 through F6). By pressing the appropriate soft menu key, the function shown in the associated label gets activated. For example, with the TOOL menu active, pressing the CLEAR key (F6) activates function CLEAR, which erases (clears up) the contents of the screen. To see this function in action, type a number, say 1 2 3 ENTER, and then press the F6 key.

SOFT menus are typically used to select from among a number of related functions. However, SOFT menus are not the only way to access collections of related functions in the calculator. The alternative way will be referred to as CHOOSE boxes. To see an example of a choose box, activate the TOOL menu (press TOOL), and then press the keystroke combination → BASE (associated with the 3 key). This will provide the following CHOOSE box:



This CHOOSE box is labeled BASE MENU and provides a list of numbered functions, from 1. HEX x to 6. B→R. This display will constitute the first page of this CHOOSE box menu showing six menu functions. You can navigate through the menu by using the up and down arrow keys, ▲▼, located in the upper right side of the keyboard, right under the F5 and F6 soft menu keys. To activate any given function, first, highlight the function name by using the up and down arrow keys, ▲▼, or by pressing the number corresponding to the function in the CHOOSE box. After the function name is selected, press the OK soft menu key (F6). Thus, if you wanted to use function R→B (Real to Binary), you could press 6 F6.

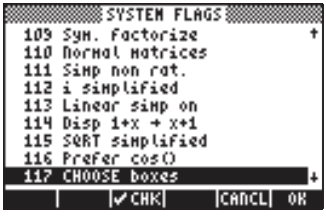
If you want to move to the top of the current menu page in a CHOOSE box, use ←▲. To move to the bottom of the current page, use ←▼. To move to the top of the entire menu, use →▲. To move to the bottom of the entire menu, use →▼.

Selecting SOFT menus or CHOOSE boxes

You can select the format in which your menus will be displayed by changing a setting in the calculator system flags (A system flag is a calculator variable that controls a certain calculator operation or mode. For more information about flags, see Chapter 24). System flag 117 can be set to produce either SOFT menus or CHOOSE boxes. To access this flag use:

MODE MORE ▲ ← ▲ ▼

Your calculator will show the following screen, highlighting the line starting with the number 117:



By default, the line will look as shown above. The highlighted line (117 CHOOSE boxes) indicates that CHOOSE boxes are the current menu display setting. If you prefer to use SOFT menu keys, press the ✓CHK soft menu key (F3), followed by OK (F6). Press OK (F6) once more to return to normal calculator display.

If you now press [→] [BASE], instead of the CHOOSE box that you saw earlier, the display will now show six soft menu labels as the first page of the STACK menu:

To navigate through the functions of this menu, press the [NXT] key to move to the next page, or [←] [PREV] (associated with the [NXT] key) to move to the previous page. The following figures show the different pages of the BASE menu accessed by pressing the [NXT] key twice:

Pressing the [NXT] key once more will takes us back to the first menu page.

Note: With the SOFT menu setting for system flag 117, the keystroke combination [→] (hold) [▼], will show a list of the functions in the current soft menu. For example, for the two first pages in the BASE menu, you will get:

To revert to the CHOOSE boxes setting, use:

[MODE] ▲ [←] ▲ [▼] ☑ CHOOSE boxes OK.

Notes:
1. The TOOL menu, obtained by pressing [TOOL], will always produce a SOFT menu.
2. Most of the examples in this User's Manual are shown using both SOFT menus and CHOOSE boxes. Programming applications (Chapters 21 and 22) use exclusively SOFT menus.
3. Additional information on SOFT menus vs. CHOOSE boxes is presented in Chapter 2 o f this guide.

The TOOL menu

The soft menu keys for the menu currently displayed, known as the TOOL menu, are associated with operations related to manipulation of variables (see pages for more information on variables):

EDIT (F1) EDIT the contents of a variable (see Chapter 2 and Appendix L for more information on editing)

VIEW (F2) VIEW the contents of a variable

RCL (F3) ReCaLl the contents of a variable

STO (F4) STOre the contents of a variable

PURGE (F5) PURGE a variable

CLEAR (F6) CLEAR the display or stack

The calculator has only six soft menu keys, and can only display 6 labels at any point in time. However, a menu can have more than six entries. Each group of 6 entries is called a Menu page. The TOOL menu has eight entries arranged in two pages. The next page, containing the next two entries of the menu are available by pressing the NXT (NeXT menu) key. This key is the third key from the left in the third row of keys in the keyboard.

In this case, only the first two soft menu keys have commands associated with them. These commands are:

CASCMD (F1) CASCMD: CAS CoMmanD, used to launch a command from the CAS by selecting from a list

HELP (F2) HELP facility describing the commands available

Pressing the NXT key will show the original TOOL menu. Another way to recover the TOOL menu is to press the TOOL key (third key from the left in the second row of keys from the top of the keyboard).

Setting time and date

The calculator has an internal real time clock. This clock can be continuously displayed on the screen and be used for alarms as well as running scheduled tasks. This section will show not only how to set time and date, but also the basics of using CHOOSE boxes and entering data in a dialog box. Dialog boxes on your calculator are similar to a computer dialog box.

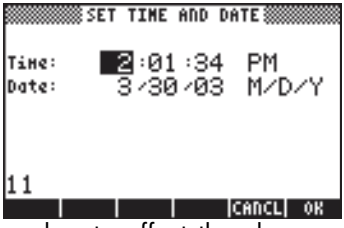
To set time and date we use the TIME choose box available as an alternative function for the 9 key. By combining the right-shift button, ↱, with the

9 key the TIME choose box is activated. This operation can also be represented as ↱ TIME. The TIME choose box is shown in the figure below:

As indicated above, the TIME menu provides four different options, numbered 1 through 4. Of interest to us as this point is option *3. Set time, date...* Using the down arrow key, ▼, highlight this option and press the OK soft menu key. The following *input form* (see Appendix 1-A) for adjusting time and date is shown:

Setting the time of the day

Using the number keys, 1 2 3 4 5 6 7 8 9 0, start by adjusting the hour of the day. Suppose that we change the hour to 11, by pressing 1 1 as the hour field in the SET TIME AND DATE input form is highlighted. This results in the number *11* being entered in the lower line of the input form:



Press the OK soft menu key to effect the change. The value of *11* is now shown in the hour field, and the minute field is automatically highlighted:

Let's change the minute field to 25, by pressing: 2 5 OK. The seconds field is now highlighted. Suppose that you want to change the seconds field to 45, use: 4 5 OK

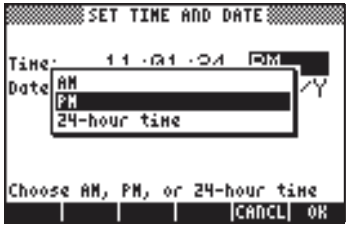
The time format field is now highlighted. To change this field from its current setting you can either press the +/- key (the second key from the left in the fifth row of keys from the bottom of the keyboard), or press the CHOOS soft menu key (F2).

- If using the +/- key, the setting in the time format field will change to either of the following options:

    - AM : indicates that displayed time is AM time
    - PM : indicates that displayed time is PM time
    - 24-hr : indicates that that the time displayed uses a 24 hour format where18:00, for example, represents 6pm

  The last selected option will become the set option for the time format by using this procedure.

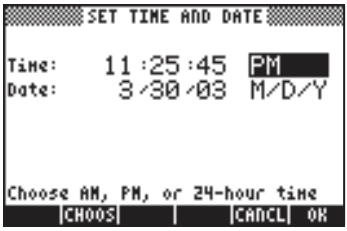
- If using the CHOOS soft menu key, the following options are available.



  Use the up and down arrow keys, ▲ ▼, to select among these three options (AM, PM, 24-hour time). Press the OK soft menu key to make the selection.

Setting the date

After setting the time format option, the SET TIME AND DATE input form will look as follows:



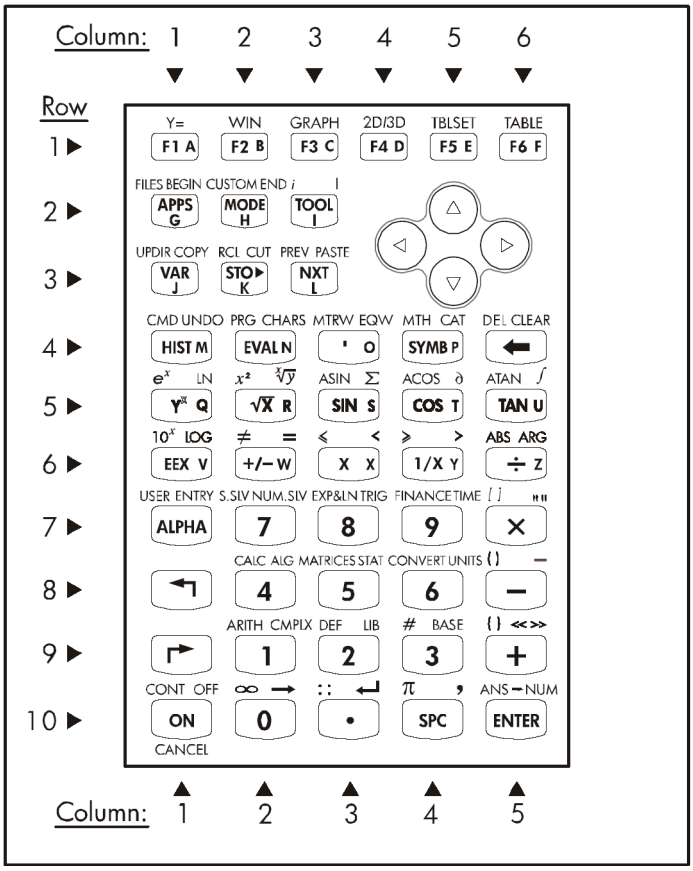
To set the date, first set the date format. The default format is M/D/Y (month/day/year). To modify this format, press the down arrow key. This will highlight the date format as shown below:

Use the CHOOS soft menu key to see the options for the date format:

Highlight your choice by using the up and down arrow keys, ▲ ▼, and press the OK soft menu key to make the selection.

Introducing the calculator's keyboard

The figure below shows a diagram of the calculator's keyboard with the numbering of its rows and columns.



The figure shows 10 rows of keys combined with 3, 5, or 6 columns. Row 1 has 6 keys, rows 2 and 3 have 3 keys each, and rows 4 through 10 have 5 keys each. There are 4 arrow keys located on the right-hand side of the keyboard in the space occupied by rows 2 and 3.

Each key has three, four, or five functions. The main key function correspond to the most prominent label in the key. Also, the left-shift key, *key (8,1)*, the right-

shift key, *key (9,1)*, and the ALPHA key, *key (7,1)*, can be combined with some of the other keys to activate the alternative functions shown in the keyboard. For example, the SYMB key, *key(4,4)*, has the following six functions associated with it:

SYMB	Main function, to activate the SYMBolic menu
↰ MTH	Left-shift function, to activate the MTH (Math) menu
↱ CAT	Right-shift function, to activate the CATalog function
ALPHA P	ALPHA function, to enter the upper-case letter P
ALPHA ↰ P	ALPHA-Left-Shift function, to enter the lower-case letter p
ALPHA ↱ P	ALPHA-Right-Shift function, to enter the symbol P

Of the six functions associated with the key only the first four are shown in the keyboard itself. This is the way that the key looks in the keyboard:

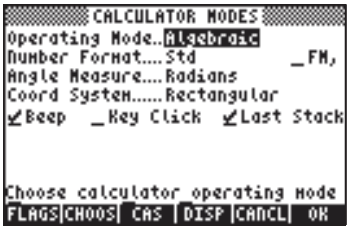
Notice that the color and the position of the labels in the key, namely, **SYMB**, *MTH*, *CAT* and **P**, indicate which is the main function (**SYMB**), and which of the other three functions is associated with the left-shift ↰ (*MTH*), right-shift ↱ (*CAT*) , and ALPHA (**P**) keys.

For detailed information on the calculator keyboard operation referee to Appendix B .

Selecting calculator modes

This section assumes that you are now at least partially familiar with the use of choose and dialog boxes (if you are not, please refer to Chapter 2).

Press the MODE button (second key from the left on the second row of keys from the top) to show the following *CALCULATOR MODES* input form:



Press the OK soft menu key to return to normal display. Examples of selecting different calculator modes are shown next.

Operating Mode

The calculator offers two operating modes: the *Algebraic* mode, and the *Reverse Polish Notation* (*RPN*) mode. The default mode is the Algebraic mode (as indicated in the figure above), however, users of earlier HP calculators may be more familiar with the RPN mode.

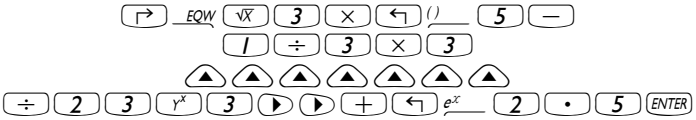
To select an operating mode, first open the CALCULATOR MODES input form by pressing the MODE button. The *Operating Mode* field will be highlighted. Select the *Algebraic* or *RPN* operating mode by either using the +/- key (second from left in the fifth row from the keyboard bottom), or pressing the CHOOS soft menu key. If using the latter approach, use up and down arrow keys, ▲ ▼, to select the mode, and press the OK soft menu key to complete the operation.

To illustrate the difference between these two operating modes we will calculate the following expression in both modes:

$$\sqrt{\frac{3\cdot\left(5-\frac{1}{3\cdot 3}\right)}{23^3}+e^{2.5}}$$

To enter this expression in the calculator we will first use the *equation writer*, [→] [EQW]. Please identify the following keys in the keyboard, besides the numeric keypad keys:

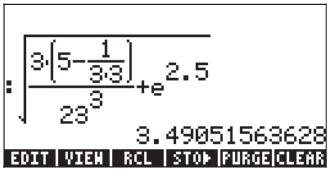
The equation writer is a display mode in which you can build mathematical expressions using explicit mathematical notation including fractions, derivatives, integrals, roots, etc. To use the equation writer for writing the expression shown above, use the following keystrokes:



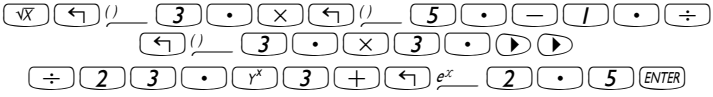
After pressing [ENTER] the calculator displays the expression:

```
√ (3*(5-1/(3*3))/23^3+EXP(2.5))
```

Pressing [ENTER] again will provide the following value. Accept Approx. mode on, if asked, by pressing [OK]. [**Note**: The integer values used above, e.g., 3, 5, 1, represent exact values. The EXP(2.5), however, cannot be expressed as an exact value, therefore, a switch to Approx mode is required]:



You could also type the expression directly into the display without using the equation writer, as follows:



to obtain the same result.

Change the operating mode to RPN by first pressing the MODE button. Select the *RPN* operating mode by either using the +/- key, or pressing the soft menu key. Press the soft menu key to complete the operation. The display, for the RPN mode looks as follows:

Notice that the display shows several levels of output labeled, from bottom to top, as 1, 2, 3, etc. This is referred to as the *stack* of the calculator. The different levels are referred to as the *stack levels*, i.e., stack level 1, stack level 2, etc.

In RPN mode, instead of writing an operation such as 3 + 2 by pressing 3 + 2 ENTER, we write the operands first , in the proper order, and then the operator, i.e., 3 ENTER 2 +. As you enter the operands, they occupy different stack levels. Entering 3 ENTER puts the number 3 in stack level 1. Next, entering 2 pushes the 3 upwards to occupy stack level 2. Finally, by pressing +, we are telling the calculator to apply the operator, or program, + to the objects occupying levels 1 and 2. The result, 5, is then placed in level 1.

Let's try some other simple operations before trying the more complicated expression used earlier for the algebraic operating mode:

123/32	1 2 3 ENTER 3 2 ÷
4^2	4 ENTER 2 y^x
$\sqrt[3]{27}$	2 7 ENTER 3 ↱ $\sqrt[x]{y}$

Notice the position of the y and the x in the last two operations. The base in the exponential operation is y (stack level 2) while the exponent is x (stack level 1) before the key y^x is pressed. Similarly, in the cubic root operation, y (stack level 2) is the quantity under the root sign, and x (stack level 1) is the root.

Try the following exercise involving 3 factors: $(5 + 3) \times 2$

5 ENTER 3 +	Calculates (5 + 3) first.
2 ×	Completes the calculation.

Let's try now the expression proposed earlier:

$$\sqrt{\frac{3\cdot\left(5-\frac{1}{3\cdot 3}\right)}{23^3}+e^{2.5}}$$

[3] [•] [ENTER] Enter 3 in level 1

[5] [•] [ENTER] Enter 5 in level 1, 3 moves to y

[3] [•] [ENTER] Enter 3 in level 1, 5 moves to level 2, 3 to level 3

[3] [•] [×] Place 3 and multiply, 9 appears in level 1

[1/x] 1/(3×3), last value in lev. 1; 5 in level 2; 3 in level 3

[−] 5 - 1/(3×3) , occupies level 1 now; 3 in level 2

[×] 3× (5 - 1/(3×3)), occupies level 1 now.

[2] [3] [•] [ENTER] Enter 23 in level 1, 14.66666 moves to level 2.

[3] [•] [y^x] Enter 3, calculate 23^3 into level 1. 14.666 in lev. 2.

[÷] (3× (5-1/(3×3)))/23^3 into level 1

[2] [•] [5] Enter 2.5 level 1

[↰] [e^x] $e^{2.5}$, goes into level 1, level 2 shows previous value.

[+] (3× (5 - 1/(3×3)))/23^3 + $e^{2.5}$ = 12.18369, into lev. 1.

[√x] √((3× (5 - 1/(3×3)))/23^3 + $e^{2.5}$) = 3.4905156, into 1.

Although RPN requires a little bit more thought than the algebraic (ALG) mode, there are multiple advantages in using RPN. For example, in RPN mode you can see the equation unfolding step by step. This is extremely useful to detect a possible input error. Also, as you become more efficient in this mode and learn more of the tricks, you will be able to calculate expression faster and will much less keystrokes. Consider, for example the calculation of (4×6 - 5)/(1+4×6 - 5). In RPN mode you can write:

[4] [ENTER] [6] [×] [5] [−] [ENTER] [1] [+] [÷]

obviously, even In RPN mode, you can enter an expression in the same order as the algebraic mode by using the Equation writer. For example,

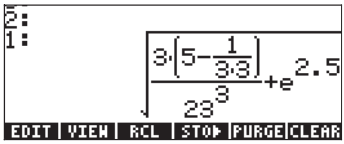
[↱] [EQW] [√x] [3] [•] [×] [↰] [( )] [5] [•] [−]

[1] [÷] [3] [•] [×] [3] [•]

[▲] [▲] [▲] [▲] [▲] [▲] [▲]

[÷] [2] [3] [•] [y^x] [3] [▶] [▶] [+] [↰] [e^x] [2] [•] [5] [ENTER]

The resulting expression is shown in stack level 1 as follows:



Notice how the expression is placed in stack level 1 after pressing ENTER. Pressing the EVAL key at this point will evaluate the numerical value of that expression Note: In RPN mode, pressing ENTER when there is no command line will execute the DUP function which copies the contents of stack level 1 of the stack onto level 2 (and pushes all the other stack levels one level up). This is extremely useful as showed in the previous example.

To select between the ALG vs. RPN operating mode, you can also set/clear system flag 95 through the following keystroke sequence:

MODE ▼ 9 ▼ ▼ ▼ ▼ ✓ ENTER

Alternatively, you can use one of the following shortcuts:

- In ALG mode,
  CF(-95) selects RPN mode

- In RPN mode,
  95 +/- ENTER SF selects ALG mode

For more information on calculator's system flags see Chapter 2.

Number Format and decimal dot or comma

Changing the number format allows you to customize the way real numbers are displayed by the calculator. You will find this feature extremely useful in operations with powers of tens or to limit the number of decimals in a result.

To select a number format, first open the CALCULATOR MODES input form by pressing the MODE button. Then, use the down arrow key, ▼, to select the option *Number format*. The default value is *Std*, or *Standard* format. In the standard format, the calculator will show floating-point numbers with the maximum precision allowed by the calculator (12 significant digits). To learn

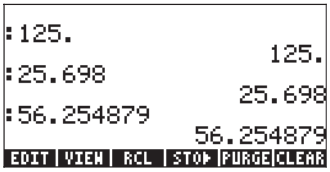
more about reals, see Chapter 2. To illustrate this and other number formats try the following exercises:

- **Standard format**:

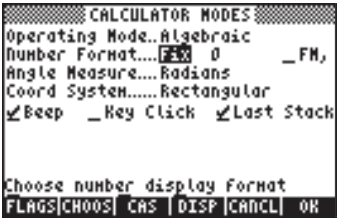
  This mode is the most used mode as it shows numbers in the most familiar notation.

  Press the ▓▓▓ soft menu key, with the *Number format* set to *Std*, to return to the calculator display. Enter the number 123.4567890123456. Notice that this number has 16 significant figures. Press the ENTER key. The number is rounded to the maximum 12 significant figures, and is displayed as follows:

  In the standard format of decimal display, integer numbers are shown with no decimal zeros whatsoever. Numbers with different decimal figures will be adjusted in the display so that only those decimal figures that are necessary will be shown. More examples of numbers in standard format are shown next:



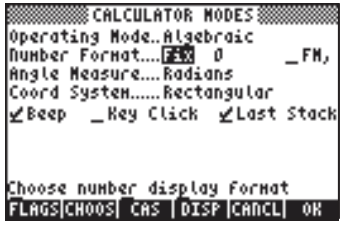
- **Fixed format with no decimals**: Press the MODE button. Next, use the down arrow key, ▼, to select the option *Number format*. Press the ▓CHOOS soft menu key, and select the option *Fixed* with the arrow down key ▼.



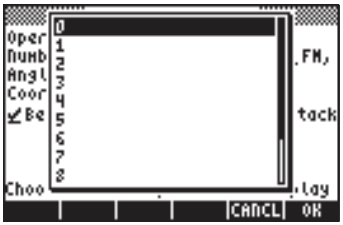
Notice that the Number Format mode is set to *Fix* followed by a zero (*0*). This number indicates the number of decimals to be shown after the decimal point in the calculator's display. Press the [OK] soft menu key to return to the calculator display. The number now is shown as:

This setting will force all results to be rounded to the closest integer (0 digit displayed after the comma). However, the number is still stored by the calculator with its full 12 significant digit precision. As we change the number of decimals to be displayed, you will see the additional digits being shown again.

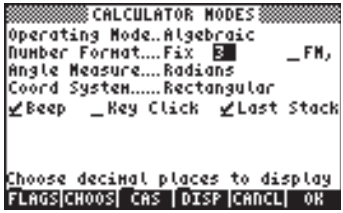
- **Fixed format with decimals**:
  This mode is mainly used when working with limited precision. For example, if you are doing financial calculation, using a FIX 2 mode is convenient as it can easily represent monetary units to a 1/100 precision. Press the [MODE] button. Next, use the down arrow key, ▼, to select the option *Number format*. Press the [CHOOS] soft menu key, and select the option *Fixed* with the arrow down key ▼.



Press the right arrow key, ▶, to highlight the zero in front of the option *Fix*. Press the [CHOOS] soft menu key and, using the up and down arrow keys, ▲▼, select, say, 3 decimals.



Press the OK soft menu key to complete the selection:



Press the OK soft menu key return to the calculator display. The number now is shown as:

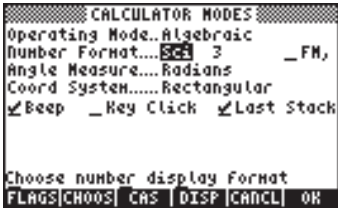
Notice how the number is rounded, not truncated. Thus, the number 123.4567890123456, for this setting, is displayed as 123.457, and not as 123.456 because the digit after 6 is > 5

- **Scientific format**

  The scientific format is mainly used when solving problems in the physical sciences where numbers are usually represented as a number with limited precision multiplied by a power of ten.

  To set this format, start by pressing the MODE button. Next, use the down arrow key, ▼, to select the option *Number format*. Press the CHOOS soft menu key and select the option *Scientific* with the arrow down key ▼. Keep the number 3 in front of the *Sci*. (This number can be changed in the

same fashion that we changed the *Fixed* number of decimals in the example above).



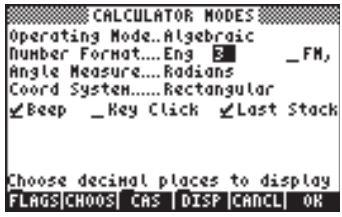
Press the OK soft menu key return to the calculator display. The number now is shown as:

This result, 1.23E2, is the calculator's version of powers-of-ten notation, i.e., 1.235×10^2. In this, so-called, scientific notation, the number *3* in front of the *Sci* number format (shown earlier) represents the number of significant figures after the decimal point. Scientific notation always includes one integer figure as shown above. For this case, therefore, the number of significant figures is four.

- **Engineering format**

  The engineering format is very similar to the scientific format, except that the powers of ten are multiples of three.

  To set this format, start by pressing the MODE button. Next, use the down arrow key, ▼, to select the option *Number format*. Press the CHOOS soft menu key and select the option *Engineering* with the arrow down key ▼. Keep the number 3 in front of the *Eng*. (This number can be changed in the same fashion that we changed the *Fixed* number of decimals in an earlier example).



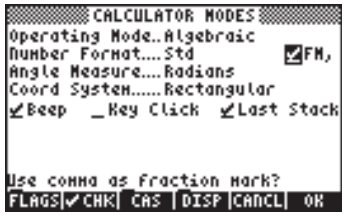
Press the OK soft menu key return to the calculator display. The number now is shown as:

Because this number has three figures in the integer part, it is shown with four significative figures and a zero power of ten, while using the Engineering format. For example, the number 0.00256, will be shown as:

- **Decimal comma vs. decimal point**

  Decimal points in floating-point numbers can be replaced by commas, if the user is more familiar with such notation. To replace decimal points for commas, change the *FM* option in the CALCULATOR MODES input form to commas, as follows (Notice that we have changed the *Number Format* to *Std*):

- Press the MODE button. Next, use the down arrow key, ▼, once, and the right arrow key, ▶, highlighting the option *__FM,*. To select commas, press the ✓ soft menu key. The input form will look as follows:



- Press the soft menu key return to the calculator display. The number 123.456789012, entered earlier, now is shown as:

Angle Measure

Trigonometric functions, for example, require arguments representing plane angles. The calculator provides three different *Angle Measure* modes for working with angles, namely:

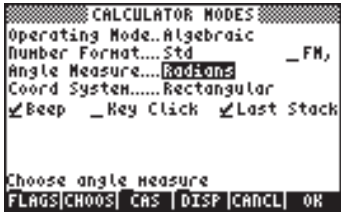
- *Degrees*: There are *360* degrees (*360°*) in a complete circumference, or *90* degrees (*90°*) in a right angle. This representation is mainly used when doing basic geometry, mechanical or structural engineering, and surveying.
- *Radians*: There are 2π radians ($2\pi^r$) in a complete circumference, or $\pi/2$ radians ($\pi/2^r$) in a right angle. This notation is mainly used when solving mathematics and physics problems. This is the default mode of the calculator.
- *Grades*: There are *400* grades (*400 g*) in a complete circumference, or *100* grades (*100 g*) in a right angle. This notation is similar to the degree mode, and was introduced in order to "simplify" the degree notation but is seldom used now.

The angle measure affects the trig functions like SIN, COS, TAN and associated functions.

To change the angle measure mode, use the following procedure:

- Press the MODE button. Next, use the down arrow key, ▼, twice. Select the *Angle Measure* mode by either using the +/- key (second from left in the fifth row from the keyboard bottom), or pressing the soft menu

key. If using the latter approach, use up and down arrow keys, ▲ ▼, to select the preferred mode, and press the soft menu key to complete the operation. For example, in the following screen, the Radians mode is selected:



Coordinate System

The coordinate system selection affects the way vectors and complex numbers are displayed and entered. To learn more about complex numbers and vectors, see Chapters 4 and 9, respectively.

Two- and three-dimensional vector components and complex numbers can be represented in any of 3 coordinate systems: The Cartesian (2 dimensional) or Rectangular (3 dimensional), Cylindrical (3 dimensional) or Polar (2 dimensional), and Spherical (only 3 dimensional). In a Cartesian or Rectangular coordinate system a point P will have three linear coordinates (x,y,z) measured from the origin along each of three mutually perpendicular axes (in 2 d mode, z is assumed to be 0). In a Cylindrical or Polar coordinate system the coordinates of a point are given by (r,θ,z), where r is a radial distance measured from the origin on the xy plane, θ is the angle that the radial distance r forms with the positive x axis -- measured as positive in a counterclockwise direction --, and z is the same as the z coordinate in a Cartesian system (in 2 d mode, z is assumed to be 0). The Rectangular and Polar systems are related by the following quantities:

$$x = r \cdot \cos(\theta) \qquad r = \sqrt{x^2 + y^2}$$

$$y = r \cdot \sin(\theta) \qquad \theta = \tan^{-1}\left(\frac{y}{x}\right)$$

$$z = z$$

In a Spherical coordinate system the coordinates of a point are given by (ρ,θ,ϕ) where ρ is a radial distance measured from the origin of a Cartesian system, θ is an angle representing the angle formed by the projection of the linear distance ρ onto the xy axis (same as θ in Polar coordinates), and ϕ is the angle

from the positive *z* axis to the radial distance ρ. The Rectangular and Spherical coordinate systems are related by the following quantities:

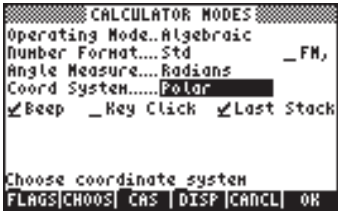
$$x = \rho \cdot \sin(\phi) \cdot \cos(\theta) \qquad \rho = \sqrt{x^2 + y^2 + z^2}$$

$$y = \rho \cdot \sin(\phi) \cdot \sin(\theta) \qquad \theta = \tan^{-1}\left(\frac{y}{x}\right)$$

$$z = \rho \cdot \cos(\phi) \qquad \phi = \tan^{-1}\left(\frac{\sqrt{x^2 + y^2}}{z}\right)$$

To change the coordinate system in your calculator, follow these steps:

- Press the MODE button. Next, use the down arrow key, ▼, three times. Select the *Angle Measure* mode by either using the +/- key (second from left in the fifth row from the keyboard bottom), or pressing the CHOOS soft menu key. If using the latter approach, use up and down arrow keys, ▲ ▼, to select the preferred mode, and press the OK soft menu key to complete the operation. For example, in the following screen, the Polar coordinate mode is selected:



Beep, Key Click, and Last Stack

The last line of the CALCULATOR MODES input form include the options:

_Beep _Key Click _Last Stack

By choosing the check mark next to each of these options, the corresponding option is activated. These options are described next:

_Beep : When selected, , the calculator beeper is active. This operation mainly applies to error messages, but also some user functions like BEEP.

_Key Click : When selected, each keystroke produces a "click" sound.

_*Last Stack*: Keeps the contents of the last stack entry for use with the functions UNDO and ANS (see Chapter 2).

The _*Beep* option can be useful to advise the user about errors. You may want to deselect this option if using your calculator in a classroom or library.
The _*Key Click* option can be useful as an audible way to check that each keystroke was entered as intended.
The _*Last Stack* option is very useful to recover the last operation in case we need it for a new calculation.

To select, or deselect, any of these three options, first press the MODE button. Next,

- Use the down arrow key, ▼, four times to select the _*Last Stack* option. Use the ☑ soft menu key to change the selection.
- Press the left arrow key ◀ to select the _*Key Click* option. Use the ☑ soft menu key to change the selection.
- Press the left arrow key ◀ to select the _*Beep* option. Use the ☑ soft menu key to change the selection.

Press the OK soft menu key to complete the operation.

Selecting CAS settings

CAS stands for *C*omputer *A*lgebraic *S*ystem. This is the mathematical core of the calculator where the symbolic mathematical operations and functions are programmed and performed. The CAS offers a number of settings can be adjusted according to the type of operation of interest. These are:

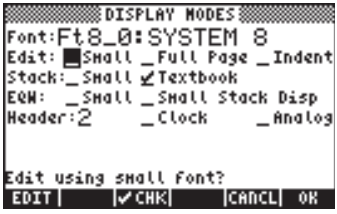
- The default independent variable
- Numeric vs. symbolic mode
- Approximate vs. Exact mode
- Verbose vs. Non-verbose mode
- Step-by-step mode for operations
- Increasing power format for polynomials
- Rigorous mode
- Simplification of non-rational expressions

Details on the selection of CAS settings are presented in Appendix C.

Selecting Display modes

The calculator display can be customized to your preference by selecting different display modes. To see the optional display settings use the following:

- First, press the MODE button to activate the CALCULATOR MODES input form. Within the CALCULATOR MODES input form, press the DISP soft menu key to display the DISPLAY MODES input form.

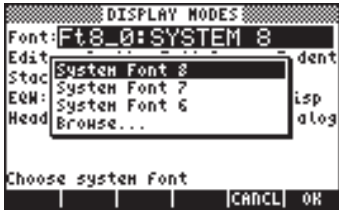


- To navigate through the many options in the DISPLAY MODES input form, use the arrow keys: ◀ ▶ ▼ ▲.
- To select or deselect any of the settings shown above, that require a check mark, select the underline before the option of interest, and toggle the ✓CHK soft menu key until the right setting is achieved. When an option is selected, a check mark will be shown in the underline (e.g., the *Textbook* option in the *Stack:* line above). Unselected options will show no check mark in the underline preceding the option of interest (e.g., the *_Small, _Full page,* and *_Indent* options in the *Edit:* line above).
- To select the Font for the display, highlight the field in front of the *Font:* option in the DISPLAY MODES input form, and use the CHOOS soft menu key.
- After having selected and unselected all the options that you want in the DISPLAY MODES input form, press the OK soft menu key. This will take you back to the CALCULATOR MODES input form. To return to normal calculator display at this point, press the OK soft menu key once more.

Selecting the display font

Changing the font display allows you to have the calculator look and feel changed to your own liking. By using a 6-pixel font, for example, you can display up to 9 stack levels! Follow these instructions to select your display font: First, press the MODE button to activate the CALCULATOR MODES input form. Within the CALCULATOR MODES input form, press the DISP soft menu key to display the DISPLAY MODES input form. The *Font:* field is highlighted, and the option *Ft8_0:system 8* is selected. This is the default value of the display font.

Pressing the [FONT] soft menu key will provide a list of available system fonts, as shown below:



The options available are three standard *System Fonts* (sizes *8, 7,* and *6*) and a *Browse..* option. The latter will let you browse the calculator memory for additional fonts that you may have created (see Chapter 23) or downloaded into the calculator.

Practice changing the display fonts to sizes *7* and *6*. Press the OK soft menu key to effect the selection. When done with a font selection, press the [OK] soft menu key to go back to the CALCULATOR MODES input form. To return to normal calculator display at this point, press the [OK] soft menu key once more and see how the stack display change to accommodate the different font.

Selecting properties of the line editor

First, press the [MODE] button to activate the CALCULATOR MODES input form. Within the CALCULATOR MODES input form, press the [DISP] soft menu key to display the DISPLAY MODES input form. Press the down arrow key, [▼], once, to get to the *Edit* line. This line shows three properties that can be modified. When these properties are selected (checked) the following effects are activated:

_Small	Changes font size to small
_Full page	Allows to place the cursor after the end of the line
_Indent	Auto intend cursor when entering a carriage return

Detailed instructions on the use of the line editor are presented in Chapter 2 in this guide.

Selecting properties of the Stack

First, press the [MODE] button to activate the CALCULATOR MODES input form. Within the CALCULATOR MODES input form, press the [DISP] soft menu key to

display the DISPLAY MODES input form. Press the down arrow key, ▼, twice, to get to the *Stack* line. This line shows two properties that can be modified. When these properties are selected (checked) the following effects are activated:

_Small Changes font size to small. This maximized the amount of information displayed on the screen. Note, this selection overrides the font selection for the stack display.

_Textbook Display mathematical expressions in graphical mathematical notation

To illustrate these settings, either in algebraic or RPN mode, use the equation writer to type the following definite integral:

[↱] EQW [↱] ∫ 0 ▶ [↰] ∞ ▶ [↰] e^x +/- X ▶ X ENTER

In Algebraic mode, the following screen shows the result of these keystrokes with neither *_Small* nor *_Textbook* are selected:

With the *_Small* option selected only, the display looks as shown below:

With the *_Textbook* option selected (default value), regardless of whether the *_Small* option is selected or not, the display shows the following result:

Selecting properties of the equation writer (EQW)

First, press the MODE button to activate the CALCULATOR MODES input form. Within the CALCULATOR MODES input form, press the DISP soft menu key to display the DISPLAY MODES input form. Press the down arrow key, ▼, three

times, to get to the *EQW* (Equation Writer) line. This line shows two properties that can be modified. When these properties are selected (checked) the following effects are activated:

_Small Changes font size to small while using the equation editor

_Small Stack Disp Shows small font in the stack for textbook style display

Detailed instructions on the use of the equation editor (EQW) are presented elsewhere in this manual.

For the example of the integral $\int_0^{\infty} e^{-X} dX$, presented above, selecting the *_Small Stack Disp* in the *EQW* line of the DISPLAY MODES input form produces the following display:

Selecting the size of the header

First, press the MODE button to activate the CALCULATOR MODES input form. Within the CALCULATOR MODES input form, press the DISP soft menu key to display the DISPLAY MODES input form. Press the down arrow key, ▼, four times, to get to the *Header* line. The value *2* is assigned to the *Header* field by default. This means that the top part of the display will contain two lines, one showing the current settings of the calculator, and a second one showing the current sub directory within the calculator's memory (These lines were described earlier in the manual). The user can select to change this setting to *1* or *0* to reduce the number of header lines in the display.

Selecting the clock display

First, press the MODE button to activate the CALCULATOR MODES input form. Within the CALCULATOR MODES input form, press the DISP soft menu key to display the DISPLAY MODES input form. Press the down arrow key, ▼, four times, to get to the *Header* line. The *Header* field will be highlighted. Use the

right arrow key (▶) to select the underline in front of the options *_Clock* or *_Analog*. Toggle the ✓ soft menu key until the desired setting is achieved. If the *_Clock* option is selected, the time of the day and date will be shown in the upper right corner of the display. If the *_Analog* option is also selected, an analog clock, rather than a digital clock, will be shown in the upper right corner of the display. If the *_Clock* option is not selected, or the header is not present, or too small, the date and time of day will not be shown in the display.