Chapter 2
Introducing the calculator

In this chapter we present a number of basic operations of the calculator including the use of the Equation Writer and the manipulation of data objects in the calculator. Study the examples in this chapter to get a good grasp of the capabilities of the calculator for future applications.

Calculator objects

Any number, expression, character, variable, etc., that can be created and manipulated in the calculator is referred to as an object. Some of the most useful type of objects are listed below.

Real. These object represents a number, positive or negative, with 12 significant digits and an exponent ranging from -499 to +499. example of reals are: 1., -5., 56.41564 1.5E45, -555.74E-95

When entering a real number, you can use the EEX key to enter the exponent and the +/- key to change the sign of the exponent or mantissa.

Note that real must be entered with a decimal point, even if the number does not have a fractional part. Otherwise the number is taken as an integer number, which is a different calculator objects. Reals behave as you would expect a number to when used in a mathematical operation.

Integers. These objects represent integer numbers (numbers without fractional part) and do not have limits (except the memory of the calculator). Example of integers are: 1, 564654112, -4131654673546467654654 87. Note how these numbers do not have a decimal point.

Due to their storage format, integer numbers are always maintain full precision in their calculation. For example, an operation such as 30/14, with integer numbers, will return 15/7 and not 2.142…. To force a real (or floating-point) result, use function →NUM (→ →NUM).

Integers are used frequently in CAS-based functions as they are designed to keep full precision in their operation.
If the approximate mode (APPROX) is selected in the CAS (see Appendix C), integers will be automatically converted to reals. If you are not planning to use

the CAS, it might be a good idea to switch directly into approximate mode. Refer to Appendix C for more details.

Mixing integers and reals together or mistaking an integer for a real is a common occurrence. The calculator will detect such mixing of objects and ask you if you want to switch to approximate mode.

Complex numbers, are an extension of real numbers that include the unit imaginary number, $i^2 = -1$. A complex number, e.g., *3 + 2i*, is written as *(3, 2)* in the calculator.

Complex numbers can be displayed in either Cartesian or polar mode depending on the setting selected. Note that complex numbers are always stored in Cartesian mode and that only the display is affected. This allows the calculator to keep as much precision as possible during calculations.

Most mathematics functions work on complex numbers. There is no need to use a special "complex +" function to add complex numbers, you can use the same [+] function that on reals or integers.

Vector and matrix operations utilize objects of type 3, **real arrays**, and, if needed, type 4, **complex arrays**. Objects type 2, **strings**, are simply lines of text (enclosed between quotes) produced with the alphanumeric keyboard.

A **list** is just a collection of objects enclosed between curly brackets and separated by spaces in RPN mode (the space key is labeled [SPC]), or by commas in algebraic mode. Lists, objects of type 5, can be very useful when processing collections of numbers. For example, the columns of a table can be entered as lists. If preferred, a table can be entered as a matrix or array.

Objects type 8 are *programs in User RPL language*. These are simply sets of instructions enclosed between the symbols << >>.

Associated with programs are objects types 6 and 7, **Global** and **Local Names**, respectively. These names, or variables, are used to store any type of objects. The concept of global or local names is related to the scope or reach of the variable in a given program.
An **algebraic object**, or simply, an **algebraic** (object of type 9), is a valid algebraic expression enclosed within quotation or tick marks.

Binary integers, objects of type 10, are used in some computer science applications.

Graphics objects, objects of type 11, store graphics produced by the calculator.

Tagged objects, objects of type 12, are used in the output of many programs to identify results. For example, in the tagged object: Mean: 23.2, the word Mean: is the tag used to identify the number 23.2 as the mean of a sample, for example.

Unit objects, objects of type 13, are numerical values with a physical unit attached to them.

Directories, objects of type 15, are memory locations used to organize your variables in a similar fashion as folders are used in a personal computer.

Libraries, objects of type 16, are programs residing in memory ports that are accessible within any directory (or sub-directory) in your calculator. They resemble *built-in functions*, objects of type 18, and *built-in commands*, objects of type 19, in the way they are used.

Editing expressions on the screen

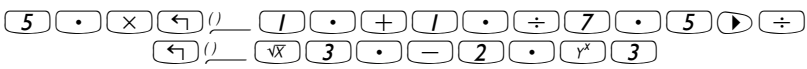
In this section we present examples of expression editing directly into the calculator display (algebraic history or RPN stack).

Creating arithmetic expressions

For this example, we select the Algebraic operating mode and select a *Fix* format with 3 decimals for the display. We are going to enter the arithmetic expression:

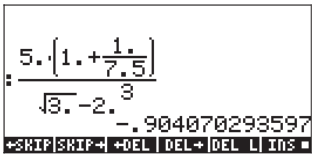
$$5.0 \cdot \frac{1.0 + \frac{1.0}{7.5}}{\sqrt{3.0} - 2.0^3}$$

To enter this expression use the following keystrokes:



The resulting expression is: 5.*(1.+1./7.5)/(√3.-2.^3).

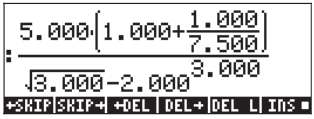
Press ENTER to get the expression in the display as follows:



Notice that, if your CAS is set to EXACT (see Appendix C) and you enter your expression using integer numbers for integer values, the result is a symbolic quantity, e.g.,

5 × ↰ (/) 1 + 1 ÷ 7 • 5 ▶ ÷
↰ (/) √x 3 − 2 y^x 3

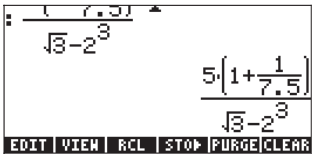
Before producing a result, you will be asked to change to Approximate mode. Accept the change to get the following result (shown in Fix decimal mode with three decimal places – see Chapter 1):



In this case, when the expression is entered directly into the stack. As soon as you press ENTER, the calculator will attempt to calculate a value for the expression. If the expression is entered between quotes, however, the calculator will reproduce the expression as entered. In the following example, we enter the same expression as above, but using quotes. For this case we set the operating mode to Algebraic, the CAS mode to Exact (deselect *_Approx*), and the display setting to *Textbook*. The keystrokes to enter the expression are the following:

' 5 × ↰ (/) 1 + 1 ÷ 7 • 5 ▶ ÷
↰ (/) √x 3 − 2 y^x 3 ENTER

The result will be shown as follows:



To evaluate the expression we can use the EVAL function, as follows:

EVAL ↰ ANS ENTER

As in the previous example, you will be asked to approve changing the CAS setting to *Approx*. Once this is done, you will get the same result as before.

An alternative way to evaluate the expression entered earlier between quotes is by using the option ↱ →NUM. To recover the expression from the existing stack, use the following keystrokes: ◀ ◀ ↱ →NUM

We will now enter the expression used above when the calculator is set to the RPN operating mode. We also set the CAS to *Exact* and the display to *Textbook*. The keystrokes to enter the expression between quotes are the same used earlier, i.e.,

' 5 × ↰ ( ) 1 + 1 ÷ 7 • 5 ▶ ÷
↰ ( ) √x 3 − 2 y^x 3 ENTER

Resulting in the output

Press ENTER once more to keep two copies of the expression available in the stack for evaluation. We first evaluate the expression using the function *EVAL*, and next using the function *→NUM*.

Here are the steps explained in detail: First, evaluate the expression using function EVAL. The resulting expression is semi-symbolic in the sense that there are floating-point components to the result, as well as a √3. Next, we switch stack locations and evaluate using function →NUM:

▶ Exchange stack levels 1 and 2 (the SWAP command)

↱ →NUM Evaluate using function →NUM

This latter result is purely numerical, so that the two results in the stack, although representing the same expression, seem different. To verify that they are not, we subtract the two values and evaluate this difference using function EVAL:

(−) Subtract level 1 from level 2

(EVAL) Evaluate using function EVAL

The result is zero (0.).

Note: Avoid mixing integer and real data to avoid conflicts in the calculations. For many physical science and engineering applications, including numerical solution of equation, statistics applications, etc., the APPROX mode (see Appendix C) works better. For mathematical applications, e.g., calculus, vector analysis, algebra, etc., the EXACT mode is preferred. Become acquainted with operations in both modes and learn how to switch from one to the other for different types of operations (see Appendix C).

Editing arithmetic expressions

Suppose that we entered the following expression, between quotes, with the calculator in RPN mode and the CAS set to EXACT:

rather than the intended expression: $5.\frac{1+\frac{1}{7.5}}{\sqrt{3}-2^3}$. The incorrect expression was entered by using:

' 5 × ↰ ( ) 1 + 1 ÷ 1 • 7 5 ▶ ÷
↰ ( ) √x 5 − 2 y^x 3 ENTER

To enter the line editor use ↰ ▼. The display now looks as follows:

The editing cursor is shown as a blinking left arrow over the first character in the line to be edited. Since the editing in this case consists of removing some characters and replacing them with others, we will use the right and left arrow keys, ◀ ▶, to move the cursor to the appropriate place for editing, and the delete key, ⌫, to eliminate characters.

The following keystrokes will complete the editing for this case:

- Press the right arrow key, ▶, until the cursor is immediately to the right of the decimal point in the term *1.75*
- Press the delete key, ⌫, twice to erase the characters *1.*
- Press the right arrow key, ▶, once, to move the cursor to the right of the *7*
- Type a decimal point with .
- Press the right arrow key, ▶, until the cursor is immediately to the right of the *√5*
- Press the delete key, ⌫, once to erase the Character *5*
- Type a *3* with 3
- Press ENTER to return to the stack

The edited expression is now available in the stack.

Editing of a line of input when the calculator is in Algebraic operating mode is exactly the same as in the RPN mode. You can repeat this example in Algebraic mode to verify this assertion.

Creating algebraic expressions

Algebraic expressions include not only numbers, but also variable names. As an example, we will enter the following algebraic expression:

$$\frac{2L\sqrt{1+\frac{x}{R}}}{R+y}+2\frac{L}{b}$$

We set the calculator operating mode to Algebraic, the CAS to *Exact*, and the display to *Textbook*. To enter this algebraic expression we use the following keystrokes:

'2 × ALPHA L × √x ◀ ( ) 1 + ALPHA ◀ X ÷ ALPHA R ▶ ÷
◀ ( ) ALPHA R + ALPHA ◀ Y ▶ + 2 × ALPHA L ÷ ALPHA ◀ B

Press ENTER to get the following result:

Entering this expression when the calculator is set in the RPN mode is exactly the same as this Algebraic mode exercise.

Editing algebraic expressions

Editing of an algebraic expression with the line editor is very similar to that of an arithmetic expression (see exercise above). Suppose that we want to modify the expression entered above to read

$$\frac{2L\sqrt{1+\frac{x^2}{R}}}{R+x}+2\sqrt{\frac{L}{b}}$$

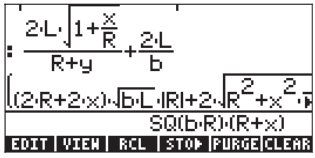
To edit this algebraic expression using the line editor use ◀ ▼. This activates the line editor, showing the expression to be edited as follows:

The editing cursor is shown as a blinking left arrow over the first character in the line to be edited. As in an earlier exercise on line editing, we will use the right and left arrow keys, ◀ ▶, to move the cursor to the appropriate place for editing, and the delete key, ⌫, to eliminate characters.

The following keystrokes will complete the editing for this case:

- Press the right arrow key, ▶, until the cursor is to the right of the *x*
- Type [y^x] [2] to enter the power 2 for the *x*
- Press the right arrow key, ▶, until the cursor is to the right of the *y*
- Press the delete key, ◀, once to erase the characters *y*.
- Type [ALPHA] [←] [X] to enter an *x*
- Press the right arrow key, ▶, 4 times to move the cursor to the right of the *
- Type [√x] to enter a square root symbol
- Type [←] [( )] to enter a set of parentheses (they come in pairs)
- Press the right arrow key, ▶, once, and the delete key, ◀, once, to delete the right parenthesis of the set inserted above
- Press the right arrow key, ▶, 4 times to move the cursor to the right of the *b*
- Type [←] [( )] to enter a second set of parentheses
- Press the delete key, ◀, once, to delete the left parenthesis of the set inserted above.
- Press [ENTER] to return to normal calculator display.

The result is shown next:

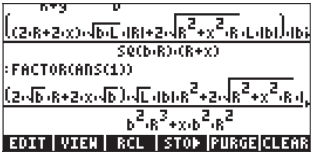


Notice that the expression has been expanded to include terms such as |R|, the absolute value, and SQ(b·R), the square of b·R. To see if we can simplify this result, use FACTOR(ANS(1)) in ALG mode:

- Press [←] [▼] to activate the line editor once more. The result is now:

- Pressing ENTER once more to return to normal display.

To see the entire expression in the screen, we can change the option *_Small Stack Disp* in the *DISPLAY MODES* input form (see Chapter 1). After effecting this change, the display will look as follows:



Note: To use Greek letters and other characters in algebraic expressions use the CHARS menu. This menu is activated by the keystroke combination ↱ CHARS. Details are presented in Appendix D.

Using the Equation Writer (EQW) to create expressions

The equation writer is an extremely powerful tool that not only let you enter or see an equation, but also allows you to modify and work/apply functions on all or part of the equation. The equation writer (EQW), therefore, allows you to perform complex mathematical operations, directly, or in a step-by-step mode, as you would do on paper when solving, for example, calculus problems.

The Equation Writer is launched by pressing the keystroke combination ↱ ↱ EQW (the third key in the fourth row from the top in the keyboard). The resulting screen is the following:

The six soft menu keys for the Equation Writer activate the following functions:

EDIT: lets the user edit an entry in the line editor (see examples above)
SELB: highlights expression and adds a graphics cursor to it
SIZE: if selected (selection shown by the character in the label) the font used in the writer is the system font 8 (the largest font available)
EVAL: lets you evaluate, symbolically or numerically, an expression highlighted in the equation writer screen (similar to → EVAL)
FACTO: lets you factor an expression highlighted in the equation writer screen (if factoring is possible)
SIMP: lets you simplify an expression highlighted in the equation writer screen (as much as it can be simplified according to the algebraic rules of the CAS)

If you press the NXT key, two more soft menu options show up as shown below:

The six soft menu keys for the Equation Writer activate the following functions:

CMDS: allows access to the collection of CAS commands listed in alphabetical order. This is useful to insert CAS commands in an expression available in the Equation Writer.
HELP: activates the calculator's CAS help facility to provide information and examples of CAS commands.
Some examples for the use of the Equation Writer are shown below.

Creating arithmetic expressions

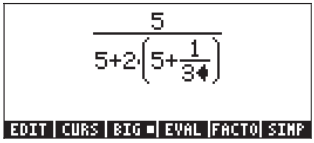
Entering arithmetic expressions in the Equation Writer is very similar to entering an arithmetic expression in the stack enclosed in quotes. The main difference is that in the Equation Writer the expressions produced are written in "textbook" style instead of a line-entry style. Thus, when a division sign (i.e., ÷) is entered in the Equation Writer, a fraction is generated and the cursor placed in the numerator. To move to the denominator you must use the down arrow key. For example, try the following keystrokes in the Equation Writer screen:
5 ÷ 5 + 2

The result is the expression

The cursor is shown as a left-facing key. The cursor indicates the current edition location. Typing a character, function name, or operation will enter the corresponding character or characters in the cursor location. For example, for the cursor in the location indicated above, type now:

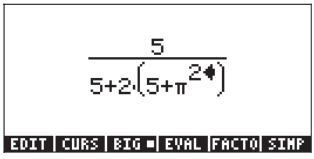
[×] [←] [(] [5] [+] [1] [÷] [3]

The edited expression looks as follows:



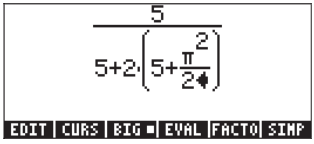
Suppose that you want to replace the quantity between parentheses in the denominator (i.e., 5+1/3) with (5+π^2/2). First, we use the delete key ([◄]) delete the current 1/3 expression, and then we replace that fraction with π^2/2, as follows: [◄] [◄] [◄] [←] [π] [y^x] [2]

When we hit this point the screen looks as follows:



In order to insert the denominator *2* in the expression, we need to highlight the entire π^2 expression. We do this by pressing the right arrow key ([►]) once. At that point, we enter the following keystrokes: [÷] [2]

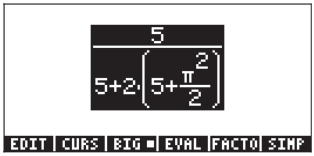
The expression now looks as follows:



Suppose that now you want to add the fraction 1/3 to this entire expression, i.e., you want to enter the expression:

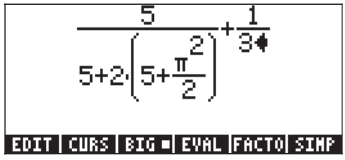
$$\frac{5}{5+2\cdot(5+\frac{\pi^2}{2})}+\frac{1}{3}$$

First, we need to highlight the entire first term by using either the right arrow (▶) or the upper arrow (▲) keys, repeatedly, until the entire expression is highlighted, i.e., seven times, producing:

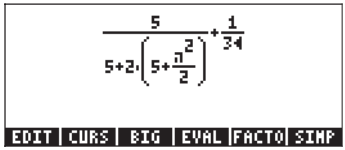


NOTE: Alternatively, from the original position of the cursor (to the right of the 2 in the denominator of $\pi^2/2$), we can use the keystroke combination [↱] [▲], interpreted as ([↱] [▲]).

Once the expression is highlighted as shown above, type [+] [1] [÷] [3] to add the fraction 1/3. Resulting in:



Showing the expression in smaller-size
To show the expression in a smaller-size font (which could be useful if the expression is long and convoluted), simply press the soft menu key. For this case, the screen looks as follows:

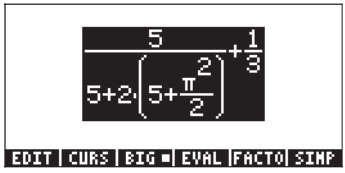


To recover the larger-font display, press the soft menu key once more.

Evaluating the expression
To evaluate the expression (or parts of the expression) within the Equation Writer, highlight the part that you want to evaluate and press the soft menu key.

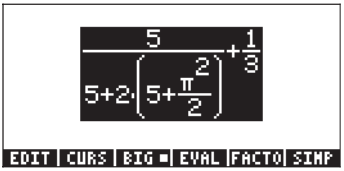
For example, to evaluate the entire expression in this exercise, first, highlight the entire expression, by pressing ↑ ▲. Then, press the soft menu key. If your calculator is set to Exact CAS mode (i.e., the *_Approx* CAS mode is not checked), then you will get the following symbolic result:

If you want to recover the unevaluated expression at this time, use the function UNDO, i.e., ↑ UNDO (the first key in the third row of keys from the top of the keyboard). The recovered expression is shown highlighted as before:



If you want a floating-point (numerical) evaluation, use the →*NUM* function (i.e., ↑ →NUM). The result is as follows:

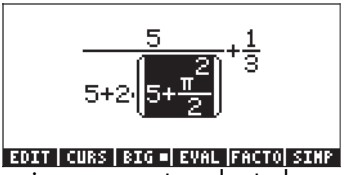
Use the function UNDO (↑ UNDO) once more to recover the original expression:



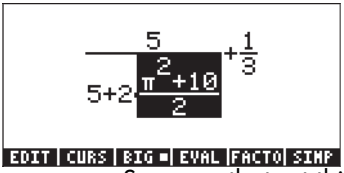
Evaluating a sub-expression

Suppose that you want to evaluate only the expression in parentheses in the denominator of the first fraction in the expression above. You have to use the arrow keys to select that particular sub-expression. Here is a way to do it:

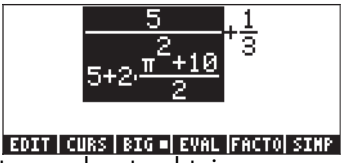
▼ Highlights only the first fraction
▼ Highlights the numerator of the first fraction
▶ Highlights denominator of the first fraction
▼ Highlights first term in denominator of first fraction
▶ Highlights second term in denominator of first fraction
▼ Highlights first factor in second term in denominator of first fraction
▶ Highlights expression in parentheses in denominator of first fraction



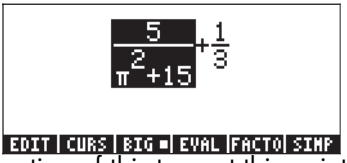
Since this is the sub-expression we want evaluated, we can now press the EVAL soft menu key, resulting in:



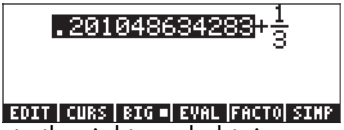
A symbolic evaluation once more. Suppose that, at this point, we want to evaluate the left-hand side fraction only. Press the upper arrow key (▲) three times to select that fraction, resulting in:



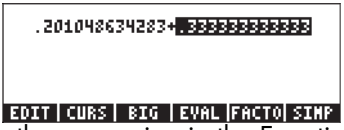
Then, press the EXPAN soft menu key to obtain:



Let's try a numerical evaluation of this term at this point. Use ↱ →NUM to obtain:



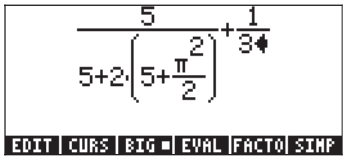
Let's highlight the fraction to the right, and obtain a numerical evaluation of that term too, and show the sum of these two decimal values in small-font format by using: ▶ ↱ →NUM F3 , we get:



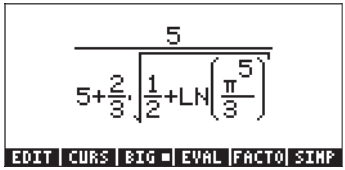
To highlight and evaluate the expression in the Equation Writer we use: ▲ F4 , resulting in:

Editing arithmetic expressions

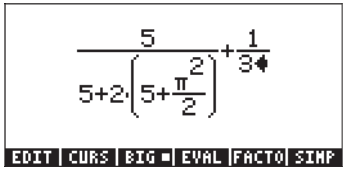
We will show some of the editing features in the Equation Writer as an exercise. We start by entering the following expression used in the previous exercises:



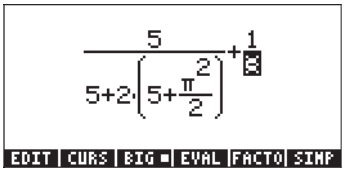
And will use the editing features of the Equation Editor to transform it into the following expression:



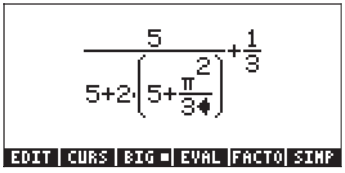
In the previous exercises we used the arrow keys to highlight sub-expressions for evaluation. In this case, we will use them to trigger a special editing cursor. After you have finished entering the original expression, the typing cursor (a left-pointing arrow) will be located to the right of the 3 in the denominator of the second fraction as shown here:



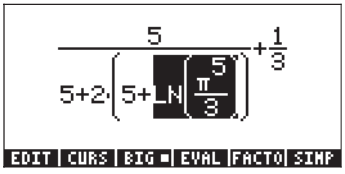
Press the down arrow key (▼) to trigger the clear editing cursor. The screen now looks like this:



By using the left arrow key (◀) you can move the cursor in the general left direction, but stopping at each individual component of the expression. For example, suppose that we will first will transform the expression $\pi^2/2$ into the expression $LN(\pi^5/3)$. With the clear cursor active, as shown above, press the left-arrow key (◀) twice to highlight the *2* in the denominator of $\pi^2/2$. Next, press the delete key (⌫) once to change the cursor into the insertion cursor. Press ⌫ once more to delete the 2, and then 3 to enter a 3. At this point, the screen looks as follows:



Next, press the down arrow key (▼) to trigger the clear editing cursor highlighting the 3 in the denominator of $\pi^2/3$. Press the left arrow key (◀) once to highlight the exponent 2 in the expression $\pi^2/3$. Next, press the delete key (⌫) once to change the cursor into the insertion cursor. Press ⌫ once more to delete the 2, and then 5 to enter a 5. Press the upper arrow key (▲) three times to highlight the expression $\pi^5/3$. Then, type ↱ LN to apply the *LN* function to this expression. The screen now looks like this:

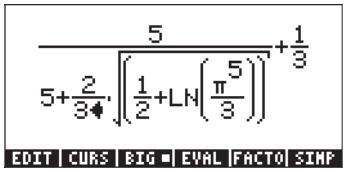


Next, we'll change the 5 within the parentheses to a ½ by using these keystrokes: ◀ ⌫ ⌫ 1 ÷ 2

Next, we highlight the entire expression in parentheses an insert the square root symbol by using: ▲ ▲ ▲ ▲ √x

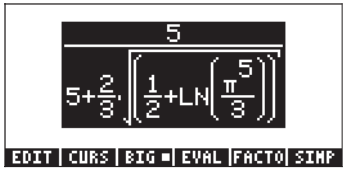
Next, we'll convert the 2 in front of the parentheses in the denominator into a 2/3 by using: ◀ ◀ ◀ 2 ÷ 3

At this point the expression looks as follows:



The final step is to remove the 1/3 in the right-hand side of the expression. This is accomplished by using: ▲ ▲ ▲ ▲ ▲ ▶ ◀ ◀ ◀ ◀ ◀

The final version will be:



In summary, to edit an expression in the Equation Writer you should use the arrow keys (◀ ▶ ▲ ▼) to highlight expression to which functions will be applied (e.g., the *LN* and square root cases in the expression above). Use the down arrow key (▼) in any location, repeatedly, to trigger the clear editing cursor. In this mode, use the left or right arrow keys (◀ ▶) to move from term to term in an expression. When you reach a point that you need to edit, use the delete key (◀) to trigger the insertion cursor and proceed with the edition of the expression.

Creating algebraic expressions

An algebraic expression is very similar to an arithmetic expression, except that English and Greek letters may be included. The process of creating an algebraic expression, therefore, follows the same idea as that of creating an arithmetic expression, except that use of the alphabetic keyboard is included.

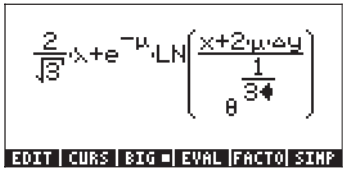
To illustrate the use of the Equation Writer to enter an algebraic equation we will use the following example. Suppose that we want to enter the expression:

$$\frac{2}{\sqrt{3}}\lambda + e^{-\mu}\cdot LN\left(\frac{x+2\mu\cdot\Delta y}{\theta^{1/3}}\right)$$

Use the following keystrokes:

2 ÷ √x 3 ▶ ▶ × ALPHA → N + ← e^x +/- ALPHA → M
▶ ▶ × → LN ALPHA ← X + 2 × ALPHA → M × ALPHA → C
ALPHA ← Y ▲ ▲ ▲ ÷ ALPHA → T y^x 1 ÷ 3

This results in the output:



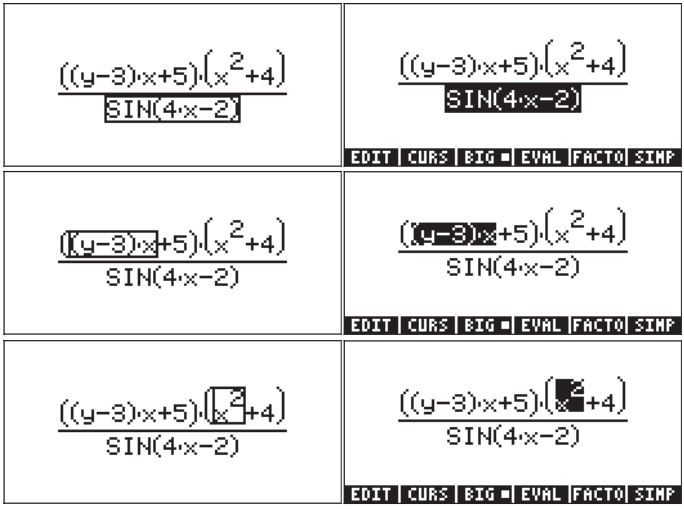
In this example we used several lower-case English letters, e.g., x (ALPHA ← X), several Greek letters, e.g., λ (ALPHA → N), and even a combination of Greek and English letters, namely, Δy (ALPHA → C ALPHA ← Y). Keep in mind that to enter a lower-case English letter, you need to use the combination: ALPHA ← followed by the letter you want to enter. Also, you can always copy special characters by using the CHARS menu (→ CHARS) if you don't want to memorize the keystroke combination that produces it. A listing of commonly used ALPHA → keystroke combinations was listed in an earlier section.

The expression tree

The expression tree is a diagram showing how the Equation Writer interprets an expression. See Appendix E for a detailed example.

The CURS function

The CURS function (▦) in the Equation Writer menu (the F2 key) converts the display into a graphical display and produces a graphical cursor that can be controlled with the arrow keys (◀ ▶ ▲ ▼) for selecting sub-expressions. The sub-expression selected with ▦ will be shown framed in the graphics display. After selecting a sub-expression you can press ENTER to show the selected sub-expression highlighted in the Equation writer. The following figures show different sub-expressions selected with and the corresponding Equation Writer screen after pressing ENTER.

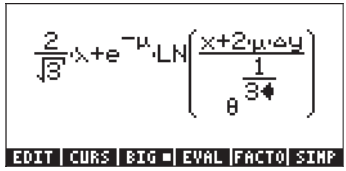


Editing algebraic expressions

The editing of algebraic equations follows the same rules as the editing of algebraic equations. Namely:

- Use the arrow keys (◀ ▶ ▲ ▼) to highlight expressions
- Use the down arrow key (▼), repeatedly, to trigger the clear editing cursor . In this mode, use the left or right arrow keys (◀ ▶) to move from term to term in an expression.
- At an editing point, use the delete key (⌫) to trigger the insertion cursor and proceed with the edition of the expression.

To see the clear editing cursor in action, let's start with the algebraic expression that we entered in the exercise above:

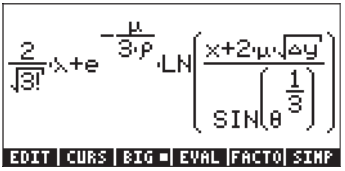


Press the down arrow key, ▼, at its current location to trigger the clear editing cursor. The 3 in the exponent of θ will be highlighted. Use the left arrow key, ◀, to move from element to element in the expression. The order of selection of the clear editing cursor in this example is the following (press the left arrow key, ◀, repeatedly):

1. The 1 in the 1/3 exponent

2. θ
3. Δy
4. μ
5. 2
6. x
7. μ in the exponential function
8. λ
9. 3 in the √3 term
10. the 2 in the 2/√3 fraction

At any point we can change the clear editing cursor into the insertion cursor by pressing the delete key (⌫). Let's use these two cursors (the clear editing cursor and the insertion cursor) to change the current expression into the following:



If you followed the exercise immediately above, you should have the clear editing cursor on the number *2* in the first factor in the expression. Follow these keystrokes to edit the expression:

▶ ALPHA ↱ 2 Enters the factorial for the 3 in the square root (entering the factorial changes the cursor to the selection cursor)

▼ ▼ ▶ ▶ Selects the μ in the exponential function

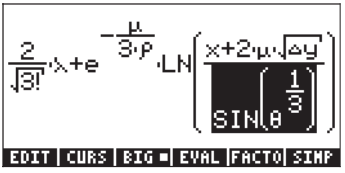
÷ 3 × ALPHA ↱ F Modifies exponential function argument

▶ ▶ ▶ ▶ Selects Δy

√x Places a square root symbol on Δy (this operation also changes the cursor to the selection cursor)

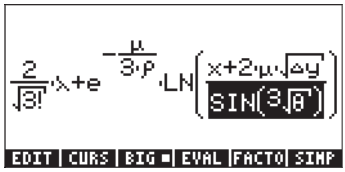
▼ ▼ ▶ ▲ ▲ SIN Select $\theta^{1/3}$ and enter the SIN function

The resulting screen is the following:

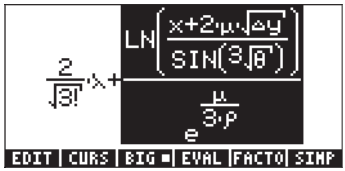


Evaluating a sub-expression

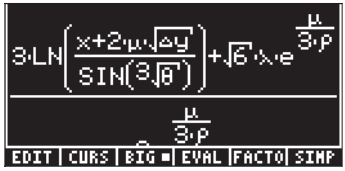
Since we already have the sub-expression $SIN\left(\theta^{1/3}\right)$ highlighted, let's press the EVAL soft menu key to evaluate this sub-expression. The result is:



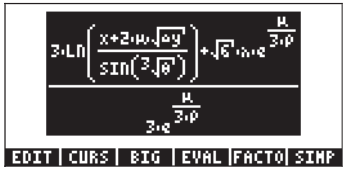
Some algebraic expressions cannot be simplified anymore. Try the following keystrokes: ▲ F4 . You will notice that nothing happens, other than the highlighting of the entire argument of the *LN* function. This is because this expression cannot be evaluated (or simplified) any more according to the CAS rules. Trying the keystrokes: ▲ F4 again does not produce any changes on the expression. Another sequence of ▲ F4 keystrokes, however, modifies the expression as follows:



One more application of the ▲ F4 keystrokes produces more changes:



This expression does not fit in the Equation Writer screen. We can see the entire expression by using a smaller-size font. Press the BIG soft menu key to get:

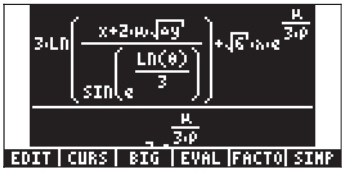


Even with the larger-size font, it is possible to navigate through the entire expression by using the clear editing cursor. Try the following keystroke sequence: F3 ▼ ▼ ▼ ▼, to set the clear editing cursor atop the factor

3 in the first term of the numerator. Then, press the right arrow key, ▶, to navigate through the expression.

Simplifying an expression

Press the BIG soft menu key to get the screen to look as in the previous figure (see above). Now, press the SIMP soft menu key, to see if it is possible to simplify this expression as it is shown in the Equation Writer. The result is the following screen:



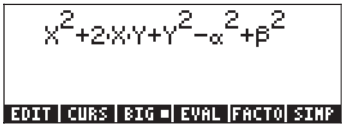
This screen shows the argument of the SIN function, namely, $\sqrt[3]{\theta}$, transformed into $e^{\frac{LN(\theta)}{3}}$. This may not seem like a simplification, but it is in the sense that the cubic root function has been replaced by the inverse functions exp-LN.

Factoring an expression

In this exercise we will try factoring a polynomial expression. To continue the previous exercise, press the ENTER key. Then, launch the Equation Writer again by pressing the ↱ EQW key. Type the equation:

X Y^x 2 ▶ + 2 × X × ALPHA Y + ALPHA Y Y^x 2 ▶ −
ALPHA ↱ A Y^x 2 ▶ ▶ + ALPHA ↱ B Y^x 2

resulting in

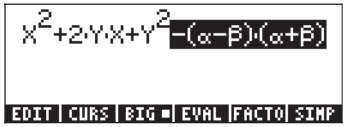


Let's select the first 3 terms in the expression and attempt a factoring of this sub-expression: ↱ ▲ ▼ ↱ ▶ ↱ ▶ . This produces:

Now, press the BIG soft menu key, to get

Press ↱ UNDO to recover the original expression. Next, enter the following keystrokes: ▼▼▼▶▶▶▶▶▶▶▶▲▲▲↱▶ to select the last two terms in the expression, i.e.,

press the FACTO soft menu key, to get



Press ↱ UNDO to recover the original expression. Now, let's select the entire expression by pressing the upper arrow key (▲) once. And press the FACTO soft menu key, to get

Press ↱ UNDO to recover the original expression.

Note: Pressing the EVAL or the SIMP soft menu keys, while the entire original expression is selected, produces the following simplification of the expression:

Using the CMDS menu key

With the original polynomial expression used in the previous exercise still selected, press the NXT key to show the CMDS and TAYLR soft menu keys. These two commands belong to the second part of the soft menu available with the Equation Writer. Let's try this example as an application of the CMDS soft menu key: Press the CMDS soft menu key to get the list of CAS commands:

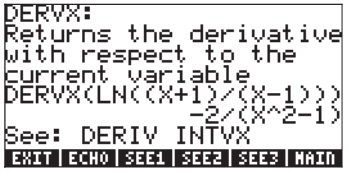
Next, select the command DERVX (the derivative with respect to the variable X, the current CAS independent variable) by using: ALPHA D ▼ ▼ ▼ . Command DERVX will now be selected:

Press the OK soft menu key to get:

Next, press the NXT key to recover the original Equation Writer menu, and press the EVAL soft menu key to evaluate this derivative. The result is:

Using the HELP menu

Press the NXT key to show the ◀ and ▶ soft menu keys. Press the ▶ soft menu key to get the list of CAS commands. Then, press ALPHA D ▼ ▼ ▼ to select the command DERVX. Press the OK soft menu key to get information on the command DERVX:



Detailed explanation on the use of the help facility for the CAS is presented in Chapter 1. To return to the Equation Writer, press the soft menu key. Press the ENTER key to exit the Equation Writer.

Using the editing functions BEGIN, END, COPY, CUT and PASTE

To facilitate editing, whether with the Equation Writer or on the stack, the calculator provides five editing functions, BEGIN, END, COPY, CUT and PASTE, activated by combining the right-shift key (↱) with keys (2,1), (2,2), (3,1), (3,2), and (3,3), respectively. These keys are located in the leftmost part of rows 2 and 3. The action of these editing functions are as follows:

BEGIN: marks the beginning of a string of characters for editing

END: marks the ending of a string of characters for editing

COPY: copies the string of characters selected by BEGIN and END

CUT: cuts the string of characters selected by BEGIN and END

PASTE: pastes a string of characters, previously copied or cut, into the current cursor position

To see and example, lets start the Equation Writer and enter the following expression (used in an earlier exercise):

2 ÷ √x 3 ▶ ▶ × ALPHA ↱ M + ↰ e^x +/- ALPHA ↱ M
▶ ▶ × ↱ LN ALPHA ↰ X + 2 × ALPHA ↱ M × ALPHA ↱ C
ALPHA ↰ Y ▲ ▲ ▲ ÷ ALPHA ↱ T y^x 1 ÷ 3

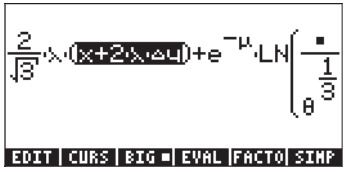
The original expression is the following:

$$\frac{2}{\sqrt{3}}\lambda + e^{-\mu \cdot LN\left(\frac{x+2\cdot\lambda\cdot\Delta y}{\theta^{\frac{1}{3}}}\right)}$$

EDIT | CURS | BIG ■ | EVAL | FACTO | SIMP

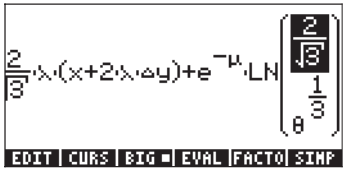
We want to remove the sub-expression $x+2\cdot\lambda\cdot\Delta y$ from the argument of the *LN* function, and move it to the right of the λ in the first term. Here is one possibility: ▼ ◀ ◀ ◀ ▲ ▲ ▲ ↱ CUT ◀ ◀ ▲ × ↱ PASTE

The modified expression looks as follows:



Next, we'll copy the fraction *2/√3* from the leftmost factor in the expression, and place it in the numerator of the argument for the LN function. Try the following keystrokes:

The resulting screen is as follows:



The functions BEGIN and END are not necessary when operating in the Equation Writer, since we can select strings of characters by using the arrow keys. Functions BEGIN and END are more useful when editing an expression with the line editor. For example, let's select the expression *x+2·λ·Δy* from this expression, but using the line editor within the Equation Writer, as follows:

The line editor screen will look like this (quotes shown only if calculator in RPN mode):

To select the sub-expression of interest, use:

The screen shows the required sub-expression highlighted:

We can now copy this expression and place it in the denominator of the LN argument, as follows: ↱ COPY ▶ ▶ … (27 times) … ▶

◀ ◀ … (9 times) … ◀ ↱ PASTE

The line editor now looks like this:

Pressing ENTER shows the expression in the Equation Writer (in small-font format, press the soft menu key):

Press ENTER to exit the Equation Writer.

Creating and editing summations, derivatives, and integrals

Summations, derivatives, and integrals are commonly used for calculus, probability and statistics applications. In this section we show some examples of such operations created with the equation writer. Use ALG mode.

Summations

We will use the Equation Writer to enter the following summation:

$$\sum_{k=1}^{\infty} \frac{1}{k^2}$$

Press ↱ EQW to activate the Equation Writer. Then press ↱ Σ to enter the summation sign. Notice that the sign, when entered into the Equation Writer screen, provides input locations for the index of the summation as well as for the quantity being summed. To fill these input locations, use the following keystrokes:

ALPHA ↰ K ▶ 1 ▶ ↰ ∞ ▶ 1 ÷ ALPHA ↰ K y^x 2

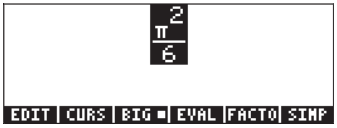
The resulting screen is:

To see the corresponding expression in the line editor, press ↑ ▲ and the F1 soft menu key, to show:

This expression shows the general form of a summation typed directly in the stack or line editor:

Σ(*index = starting_value, ending_value, summation expression*)

Press ENTER to return to the Equation Writer. The resulting screen shows the value of the summation,



To recover the unevaluated summation use ↑ UNDO . To evaluate the summation again, you can use the F4 soft menu key. This shows again that

$$\sum_{k=1}^{\infty}\frac{1}{k^2}=\frac{\pi^2}{6}.$$

You can use the Equation Writer to prove that

$$\sum_{k=1}^{\infty}\frac{1}{k}=+\infty\,.$$

This summation (representing an infinite series) is said to diverge.
Double summations are also possible, for example:

Derivatives

We will use the Equation Writer to enter the following derivative:

$$\frac{d}{dt}(\alpha\cdot t^2+\beta\cdot t+\delta)$$

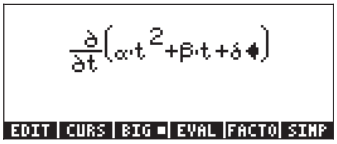
Press ↑ EQW to activate the Equation Writer. Then press ↑ ∂ to enter the (partial) derivative sign. Notice that the sign, when entered into the Equation Writer screen, provides input locations for the expression being differentiated

and the variable of differentiation. To fill these input locations, use the following keystrokes:

ALPHA ◀ T ▶ ALPHA ▶ A × ALPHA ◀ T y^x 2

▶ ▶ + ALPHA ▶ B × ALPHA ◀ T + ALPHA ▶ D

The resulting screen is the following:



To see the corresponding expression in the line editor, press ▶ ▲ and the F1 soft menu key, to show:

This indicates that the general expression for a derivative in the line editor or in the stack is: ∂*variable*(*function of variables*)

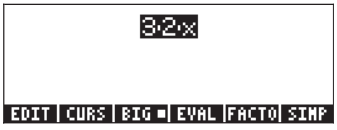
Press ENTER to return to the Equation Writer. The resulting screen is not the derivative we entered, however, but its symbolic value, namely,

To recover the derivative expression use ▶ UNDO . To evaluate the derivative again, you can use the F4 soft menu key. This shows again that

$$\frac{d}{dt}(\alpha \cdot t^2 - \beta \cdot t + \delta) = 2\alpha \cdot t + \beta \, .$$

Second order derivatives are possible, for example:

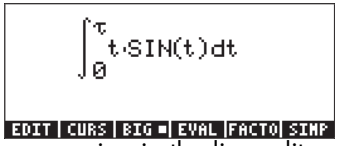
which evaluates to:



Note: The notation $\frac{\partial}{\partial x}(\ )$ is proper of partial derivatives. The proper notation for total derivatives (i.e., derivatives of one variable) is $\frac{d}{dx}(\ )$. The calculator, however, does not distinguish between partial and total derivatives.

Definite integrals

We will use the Equation Writer to enter the following definite integral: $\int_0^{\tau} t \cdot \sin(t) \cdot dt$. Press ↱ EQW to activate the Equation Writer. Then press ↱ ∫ to enter the integral sign. Notice that the sign, when entered into the Equation Writer screen, provides input locations for the limits of integration, the integrand, and the variable of integration. To fill these input locations, use the following keystrokes: 0 ▶ ALPHA ↱ U ▶ ALPHA ↰ T × SIN ALPHA ↰ T ▶ ALPHA ↰ T. The resulting screen is the following:



To see the corresponding expression in the line editor, press ▲ ▲ and the F1 soft menu key, to show:

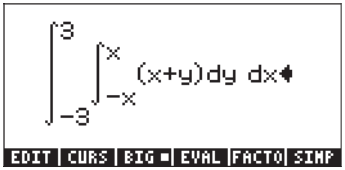
This indicates that the general expression for a derivative in the line editor or in the stack is: ∫(*lower_limit, upper_limit,integrand,variable_of_integration*)

Press ENTER to return to the Equation Writer. The resulting screen is not the definite integral we entered, however, but its symbolic value, namely,

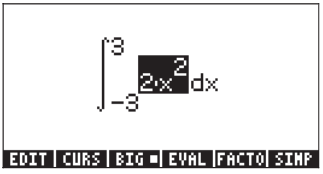
To recover the derivative expression use ↱ UNDO. To evaluate the derivative again, you can use the F4 soft menu key. This shows again that

$$\int_0^{\tau} t \cdot \sin(t) \cdot dt = \sin(\tau) - \tau \cdot \cos(\tau)$$

Double integrals are also possible. For example,



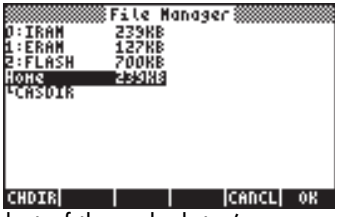
which evaluates to 36. Partial evaluation is possible, for example:



This integral evaluates to 36.

Organizing data in the calculator

You can organize data in your calculator by storing variables in a directory tree. To understand the calculator's memory, we first take a look at the file directory. Press the keystroke combination ↰ FILES (first key in second row of keys from the top of the keyboard) to get the calculator's File Manager screen:



This screen gives a snapshot of the calculator's memory and of the directory tree. The screen shows that the calculator has three memory ports (or memory partitions), port *0:IRAM, port 1:ERAM,* and *port 2:FLASH* . Memory ports are used to store third party application or libraries, as well as for backups. The size of the three different ports is also indicated. The fourth and subsequent lines in this screen show the calculator's directory tree. The top directory (currently highlighted) is the *Home* directory, and it has predefined into it a sub-directory called *CASDIR*. The *File Manager* screen has three functions associated with the soft-menu keys:

CHDIR: Change to selected directory

CANCL: Cancel action

OK: Approve a selection

For example, to change directory to the CASDIR, press the down-arrow key, ▼, and press CHDIR. This action closes the *File Manager* window and returns us to normal calculator display. You will notice that the second line from the top in the display now starts with the characters { HOME CASDIR } indicating that the current directory is CASDIR within the HOME directory.

Functions for manipulation of variables

This screen includes 20 commands associated with the soft menu keys that can be used to create, edit, and manipulate variables. The first six functions are the following:

EDIT To edit a highlighted variable
COPY To copy a highlighted variable
MOVE To move a highlighted variable
RCL To recall the contents of a highlighted variable
EVAL To evaluate a highlighted variable
TREE To see the directory tree where the variable is contained

If you press the NXT key, the next set of functions is made available:

PURGE To purge, or delete, a variable
RENAM To rename a variable
NEW To create a new variable
ORDER To order a set of variables in the directory
SEND To send a variable to another calculator or computer
RECV To receive a variable from another calculator or computer

If you press the NXT key, the third set of functions is made available:

HALT To return to the stack temporarily
VIEW To see contents of a variable
EDBIN To edit contents of a binary variable (similar to EDIT)
HOME To show the directory containing the variable in the header
LIBS Provides a list of variable names and description
SORT To sort variables according to a sorting criteria

If you press the NXT key, the last set of functions is made available:

XSEND To send variable with X-modem protocol
CHDIR To change directory

To move between the different soft menu commands, you can use not only the NEXT key (NXT), but also the PREV key (↰ PREV).

The user is invited to try these functions on his or her own. Their applications are straightforward.

The HOME directory

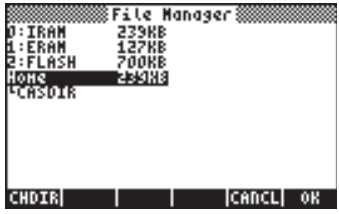
The HOME directory, as pointed out earlier, is the base directory for memory operation for the calculator. To get to the HOME directory, you can press the UPDIR function (↰ UPDIR) -- repeat as needed -- until the ‹HOME› spec is shown in the second line of the display header. Alternatively, you can use ↰ (hold) UPDIR, press ENTER if in the algebraic mode. For this example, the HOME directory contains nothing but the CASDIR. Pressing VAR will show the variables in the soft menu keys:

Subdirectories

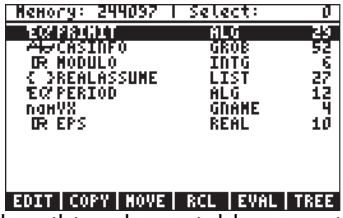
To store your data in a well organized directory tree you may want to create subdirectories under the HOME directory, and more subdirectories within subdirectories, in a hierarchy of directories similar to folders in modern computers. The subdirectories will be given names that may reflect the contents of each subdirectory, or any arbitrary name that you can think of.

The CASDIR sub-directory

The CASDIR sub-directory contains a number of variables needed by the proper operation of the CAS (Computer Algebraic System, see appendix C). To see the contents of the directory, we can use the keystroke combination: ↰ FILES which opens the *File Manager* once more:



This time the CASDIR is highlighted in the screen. To see the contents of the directory press the soft menu key or (ENTER), to get the following screen:



The screen shows a table describing the variables contained in the CASDIR directory. These are variables pre-defined in the calculator memory that establish certain parameters for CAS operation (see appendix C). The table above contains 4 columns:

- The first column indicate the type of variable (e.g., 'EQ' means an equation-type variable, |R indicates a real-value variable, { } means a list, *nam* means 'a global name', and the symbol represents a graphic variable.
- The second column represents the name of the variables, i.e., *PRIMIT, CASINFO, MODULO, REALASSUME, PERIOD, VX,* and *EPS*.
- Column number 3 shows another specification for the variable type, e.g., *ALG* means an algebraic expression, *GROB* stands for *graphics object, INTG* means an integer numeric variable, *LIST* means a list of data, GNAME means a *global name*, and *REAL* means a real (or floating-point) numeric variable.
- The fourth and last column represents the size, in bytes, of the variable truncated, without decimals (i.e., nibbles). Thus, for example, variable PERIOD takes 12.5 bytes, while variable REALASSUME takes 27.5 bytes (1 byte = 8 bits, 1 bit is the smallest unit of memory in computers and calculators).

CASDIR Variables in the stack

Pressing the (ON) key closes the previous screen and returns us to normal calculator display. By default, we get back the TOOL menu:

We can see the variables contained in the current directory, CASDIR, by pressing the (VAR) key (first key in the second row from the top of the keyboard). This produces the following screen:

Pressing the NXT key shows one more variable stored in this directory:

- To see the contents of the variable EPS, for example, use ▶ EPS. This shows the value of EPS to be `.0000000001`
- To see the value of a numerical variable, we need to press only the soft menu key for the variable. For example, pressing EPS followed by ENTER, shows the same value of the variable in the stack, if the calculator is set to *Algebraic*. If the calculator is set to *RPN* mode, you need only press the soft menu key for ENTER.
- To see the full name of a variable, press the tickmark key first, ', and then the soft menu key corresponding to the variable. For example, for the variable listed in the stack as PERIO, we use: ' PERIO, which produces as output the string: `'PERIOD'`. This procedure applies to both the *Algebraic* and *RPN* calculator operating modes.

Variables in CASDIR

The default variables contained in the CASDIR directory are the following:

PRIMIT	Latest primitive (anti-derivative) calculated, not a default variable, but one created by a previous exercise
CASINFO	a graph that provides CAS information
MODULO	Modulo for modular arithmetic (default = 13)
REALASSUME	List of variable names assumed as real values
PERIOD	Period for trigonometric functions (default = 2π)
VX	Name of default independent variable (default = X)
EPS	Value of small increment (epsilon), (default = 10^{-10})

These variables are used for the operation of the CAS.

Typing directory and variable names

To name subdirectories, and sometimes, variables, you will have to type strings of letters at once, which may or may not be combined with numbers. Rather than pressing the ALPHA, ALPHA ◀, or ALPHA ▶ key combinations to type each letter, you can hold down the ALPHA key and enter the various letter. You can also

lock the alphabetic keyboard temporarily and enter a full name before unlocking it again. The following combinations of keystrokes will lock the alphabetic keyboard:

[ALPHA] [ALPHA] locks the alphabetic keyboard in upper case. When locked in this fashion, pressing the [↰] before a letter key produces a lower case letter, while pressing the [↱] key before a letter key produces a special character. If the alphabetic keyboard is already locked in upper case, to lock it in lower case, type, [↰] [ALPHA]

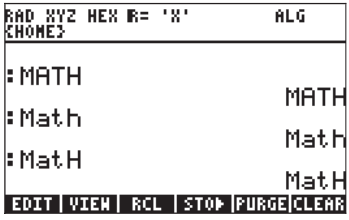
[ALPHA] [ALPHA] [↰] [ALPHA] locks the alphabetic keyboard in lower case. When locked in this fashion, pressing the [↰] before a letter key produces an upper case letter. To unlock lower case, press [↰] [ALPHA]

To unlock the upper-case locked keyboard, press [ALPHA]

Let's try some exercises typing directory/variable names in the stack. Assuming that the calculator is in the Algebraic mode of operation (although the instructions work as well in RPN mode), try the following keystroke sequences. With these commands we will be typing the words 'MATH', 'Math', and 'MatH'

[ALPHA] [ALPHA] [M] [A] [T] [H] [ENTER]
[ALPHA] [ALPHA] [M] [↰] [A] [↰] [T] [↰] [H] [ENTER]
[ALPHA] [ALPHA] [M] [↰] [ALPHA] [A] [T] [↰] [H] [ENTER]

The calculator display will show the following (left-hand side is Algebraic mode, right-hand side is RPN mode):



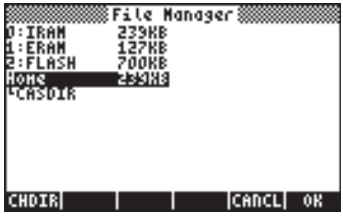
Note: if system flag 60 is set, you can lock the alphabetical keyboard by just pressing [ALPHA]. See Chapter 1 for more information on system flags.

Creating subdirectories

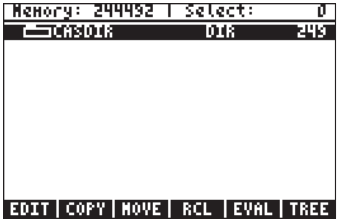
Subdirectories can be created by using the FILES environment or by using the command CRDIR. The two approaches for creating sub-directories are presented next.

Using the FILES menu

Regardless of the mode of operation of the calculator (Algebraic or RPN), we can create a directory tree, based on the HOME directory, by using the functions activated in the FILES menu. Press (↰) FILES to activate the FILES menu. If the HOME directory is not already highlighted in the screen, i.e.,



use the up and down arrow keys (▲ ▼) to highlight it. Then, press the OK soft menu key. The screen may look like this:



showing that only one object exists currently in the HOME directory, namely, the CASDIR sub-directory. Let's create another sub-directory called MANS (for MANualS) where we will store variables developed as exercises in this manual. To create this sub-directory first enter: (NXT) NEW . This will produce the following input form:

The *Object* input field, the first input field in the form, is highlighted by default. This input field can hold the contents of a new variable that is being created. Since we have no contents for the new sub-directory at this point, we simply skip this input field by pressing the down-arrow key, ▼, once. The *Name* input field is now highlighted:

This is where we enter the name of the new sub-directory (or variable, as the case may be), as follows: ALPHA ALPHA M A N S ENTER

The cursor moves to the *_Directory* check field. Press the ☑ soft menu key to specify that you are creating a directory, and press OK to exit the input form. The variable listing for the HOME directory will be shown in the screen as follows:

The screen indicates that there is a new directory (MANS) within the HOME directory.

Next, we will create a sub-directory named INTRO (for INTROduction), within MANS, to hold variables created as exercise in subsequent sections of this chapter. Press the ON key to return to normal calculator display (the TOOLS menu will be shown). Then, press VAR to show the HOME directory contents in the soft menu key labels. The display may look like this (if you have created other variables in the HOME directory they will show in the soft menu key labels too):

To move into the MANS directory, press the corresponding soft menu key (F1 in this case), and ENTER if in algebraic mode. The directory tree will be shown in the second line of the display as {HOME MANS}. However, there will be no labels associated with the soft menu keys, as shown below, because there are no variables defined within this directory.

Let's create the sub-directory INTRO by using:

← FILES [soft menu] NXT [soft menu] ▼ ALPHA ALPHA I N T R O ENTER [soft menu] [soft menu]

Press the ON key, followed by the VAR key, to see the contents of the MANS directory as follows:

Press the [soft menu] soft menu key to move into the INTRO sub-directory. This will show an empty sub-directory. Later on, we will do some exercises in creating variables.

Using the command CRDIR

The command CRDIR can be used to create directories. This command is available through the command catalog key (the → CAT key, second key in fourth row of keys from the top of the keyboard), through the programming menus (the ← PRG key, same key as the → CAT key), or by simply typing it.

- Through the catalog key

  Press → CAT ALPHA C. Use the up and down arrow keys (▲ ▼) to locate the CRDIR command. Press the [soft menu] soft menu key to activate the command.

- Through the programming menus

  Press ← PRG . This will produce the following pull-down menu for programming:

Use the down arrow key (▼) to select the option *2. MEMORY…* , or just press 2. Then, press OK. This will produce the following pull-down menu:

Use the down arrow key (▼) to select the *5. DIRECTORY* option, or just press 5. Then, press OK. This will produce the following pull-down menu:

Use the down arrow key (▼) to select the *5. CRDIR* option, and press OK.

Command CRDIR in Algebraic mode

Once you have selected the CRDIR through one of the means shown above, the command will be available in your stack as follows:

At this point, you need to type a directory name, say *chap1* :

ALPHA ALPHA ← ALPHA C H A P 1 ALPHA ENTER

The name of the new directory will be shown in the soft menu keys, e.g.,

Command CRDIR in RPN mode

To use the CRDIR in RPN mode you need to have the name of the directory already available in the stack before accessing the command. For example:

ALPHA ALPHA ← ALPHA C H A P 2 ALPHA ENTER

Then access the CRDIR command by either of the means shown above, e.g., through the → CAT key:

Press the soft menu key to activate the command, to create the sub-directory:

Moving among subdirectories

To move down the directory tree, you need to press the soft menu key corresponding to the sub-directory you want to move to. The list of variables in a sub-directory can be produced by pressing the VAR (VARiables) key. To move up in the directory tree, use the function UPDIR, i.e., enter ← UPDIR .

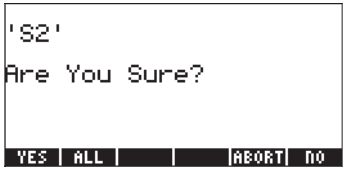
Alternatively, you can use the FILES menu, i.e., press ← FILES . Use the up and down arrow keys (▲ ▼) to select the sub-directory you want to move to, and then press the (CHange DIRectory) or F1 soft menu key. This will show the contents of the sub-directory you moved to in the soft menu key labels.

Deleting subdirectories

To delete a sub-directory, use one of the following procedures:

Using the FILES menu

Press the ← FILES key to trigger the FILES menu. Select the directory containing the sub-directory you want to delete, and press the if needed. This will close the FILES menu and display the contents of the directory you selected. In this case you will need to press ENTER. Press the soft menu key to list the contents of the directory in the screen. Select the sub-directory (or variable) that you want to delete. Press NXT . A screen similar to the following will be shown:

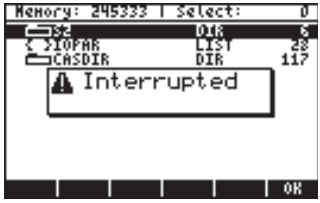


The 'S2' string in this form is the name of the sub-directory that is being deleted.

The soft menu keys provide the following options:

YES Proceed with deleting the sub-directory (or variable)
ALL Proceed with deleting all sub-directories (or variables)
ABORT Do not delete sub-directory (or variable) from a list
NO Do not delete sub-directory (or variable)

After selecting one of these four commands, you will be returned to the screen listing the contents of the sub-directory. The ABORT command, however, will show an error message:



and you will have to press OK, before returning to the variable listing.

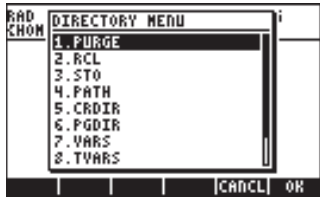
Using the command PGDIR

The command PGDIR can be used to purge directories. Like the command CRDIR, the PGDIR command is available through the ↱ CAT or through the ↰ PRG key, or it can simply be typed in.

- Through the catalog key
  Press ↱ CAT (ALPHA) (ALPHA) P G. This should highlight the PGDIR command. Press the OK soft menu key to activate the command.
- Through the programming menus
  Press ↰ PRG. This will produce the following pull-down menu for programming:

Use the down arrow key (▼) to select the option *2. MEMORY…* Then, press OK. This will produce the following pull-down menu:

Use the down arrow key (▼) to select the *5. DIRECTORY* option. Then, press OK. This will produce the following pull-down menu:



Use the down arrow key (▼) to select the *6. PGDIR* option, and press OK.

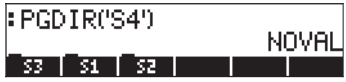
Command PGDIR in Algebraic mode

Once you have selected the PGDIR through one of the means shown above, the command will be available in your stack as follows:

At this point, you need to type the name of an existing directory, say *S4* :

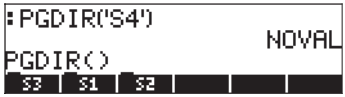
ALPHA S 4 ENTER

As a result, sub-directory S4 is deleted:

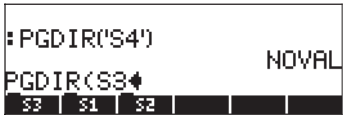


Instead of typing the name of the directory, you can simply press the corresponding soft menu key at the listing of the PGDIR( ) command, e.g.,

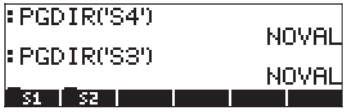
Press OK, to get:



Then, press ▶ to enter 'S3' as the argument to PGDIR.



Press ENTER to delete the sub-directory:



Command PGDIR in RPN mode

To use the PGDIR in RPN mode you need to have the name of the directory, between quotes, already available in the stack before accessing the command. For example: ' ALPHA S 2 ENTER

Then access the PGDIR command by either of the means shown above, e.g., through the ↱ CAT key:

Press the OK soft menu key to activate the command and delete the sub-directory:

Using the PURGE command from the TOOL menu
The TOOL menu is available by pressing the TOOL key (Algebraic and RPN modes shown):

The PURGE command is available by pressing the PURGE soft menu key. In the following examples we want to delete sub-directory *S1*:

- Algebraic mode: Enter PURGE VAR ▼ ENTER
- RPN mode: Enter VAR ' ▼ ENTER TOOL PURGE VAR

Variables

Variables are like files on a computer hard drive. One variable can store one object (numerical values, algebraic expressions, lists, vectors, matrices, programs, etc). Even sub-directories can be through of as variables (in fact, in the calculator, a subdirectory is also a type of calculator object).

Variables are referred to by their names, which can be any combination of alphabetic and numerical characters, starting with a letter (either English or Greek). Some non-alphabetic characters, such as the arrow (→) can be used in a variable name, if combined with an alphabetical character. Thus, '→A' is a valid variable name, but '→' is not. Valid examples of variable names are: 'A', 'B', 'a', 'b', 'α', 'β', 'A1', 'AB12', '→A12','Vel','Z0','z1', etc.

A variable can not have the same name than a function of the calculator. You can not have a SIN variable for example as there is a SIN command in the calculator. The reserved calculator variable names are the following: ALRMDAT, CST, EQ, EXPR, IERR, IOPAR, MAXR, MINR, PICT, PPAR, PRTPAR, VPAR, ZPAR, der_, e, i, n1,n2, …, s1, s2, …, ΣDAT, ΣPAR, π, ∞

Variables can be organized into sub-directories.

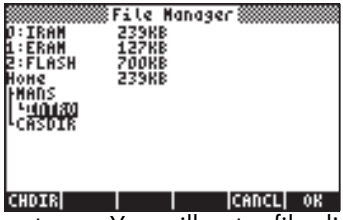
Creating variables

To create a variable, we can use the FILES menu, along the lines of the examples shown above for creating a sub-directory. For example, within the sub-directory {HOME MANS INTRO}, created in an earlier example, we want to store the following variables with the values shown:

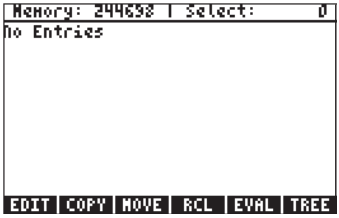
Name	*Contents*	*Type*
A	12.5	real
α	-0.25	real
A12	3×10^5	real
Q	'r/(m+r)'	algebraic
R	[3,2,1]	vector
z1	3+5i	complex
p1	<< → r 'π*r^2' >>	program

Using the FILES menu

We will use the FILES menu to enter the variable A. We assume that we are in the sub-directory {HOME MANS INTRO}. To get to this sub-directory, use the following: ◀ FILES and select the INTRO sub-directory as shown in this screen:



Press OK to enter the directory. You will get a files listing with no entries (the INTRO sub-directory is empty at this point)



Press the NXT key to move to the next set of soft menu keys, and press the NEW soft menu key. This will produce the NEW VARIABLE input form:

To enter variable A (see table above), we first enter its contents, namely, the number 12.5, and then its name, A, as follows: 1 2 . 5 ▼ ALPHA A ▼. Resulting in the following screen:

Press ▼ once more to create the variable. The new variable is shown in the following variable listing:

The listing indicates a real variable (|R), whose name is A, and that occupies 10.5 bytes of memory. To see the contents of the variable in this screen, press NXT VIEW.

- Press the GRAPH soft menu key to see the contents in a graphical format.

- Press the TEXT soft menu key to see the contents in text format.
- Press ▼ to return to the variable list
- Press ON once more to return to normal display. Variable A should now be featured in the soft menu key labels:

Using the STO▶ command

A simpler way to create a variable is by using the STO command (i.e., the STO▶ key). We provide examples in both the Algebraic and RPN modes, by creating the remaining of the variables suggested above, namely:

Name	*Contents*	*Type*
α	-0.25	real
A12	3×10^5	real
Q	'r/(m+r)'	algebraic
R	[3,2,1]	vector
z1	3+5i	complex
p1	<< → r 'π*r^2' >>	program

- **Algebraic mode**

  Use the following keystrokes to store the value of –0.25 into variable α: 0 . 2 5 +/- STO▶ ALPHA → A. AT this point, the screen will look as follows:

  This expression means that the value –0.25 is being stored into α (the symbol ▶ suggests the operation). Press ENTER to create the variable. The variable is now shown in the soft menu key labels when you press VAR:

  The following are the keystrokes required to enter the remaining variables:

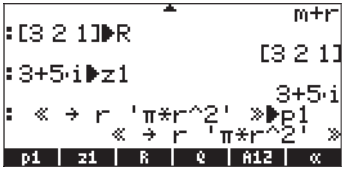
  A12: 3 EEX 5 STO▶ ALPHA A 1 2 ENTER

  Q: ALPHA ← R ÷ ← ( )

  ALPHA ← M + ALPHA ← R ▶ ▶ STO▶ ALPHA Q ENTER

  R: ← [ ] 3 → , 2 → , 1 ▶ STO▶ ALPHA R ENTER

z1: 3 + 5 × ← i ___ STO▸ ALPHA ← Z 1 ENTER (if needed, accept change to Complex mode)
p1: → « » → ⟶ ALPHA ← R ' ← π ___ ×
ALPHA ← R y^x 2 ▸ ▸ ▸ STO▸ ALPHA ← P 1 ENTER.
The screen, at this point, will look as follows:



You will see six of the seven variables listed at the bottom of the screen: *p1, z1, R, Q, A12, α.*

- **RPN mode**

Use the following keystrokes to store the value of –0.25 into variable α: . 2 5 +/- ENTER ' ALPHA → A ENTER. At this point, the screen will look as follows:

With –0.25 on the level 2 of the stack and 'α' on the level 1 of the stack, you can use the STO▸ key to create the variable. The variable is now shown in the soft menu key labels when you press VAR:

To enter the value 3×10^5 into A12, we can use a shorter version of the procedure: 3 EEX 5 ' ALPHA A 1 2 ENTER STO▸
Here is a way to enter the contents of Q:
Q: ALPHA ← R ÷ ← () ___
ALPHA ← M + ALPHA ← R ▸ ▸ ' ALPHA Q ENTER STO▸
To enter the value of R, we can use an even shorter version of the procedure:
R: ← [] ___ 3 SPC 2 SPC 1 ▸ ' ALPHA R STO▸
Notice that to separate the elements of a vector in RPN mode we can use the space key (SPC), rather than the comma (→ ___,) used above in Algebraic mode.

z1: ' 3 + 5 × ↰ i ' ALPHA ↰ Z 1 STO▸ (if needed, accept change to Complex mode)
p1: ↱ « » ↱ → ALPHA ↰ R ' ↰ π × ALPHA ↰ R y^x 2 ▸ ▸ ▸ ' ALPHA ↰ P 1 ▸ ENTER STO▸.
The screen, at this point, will look as follows:

You will see six of the seven variables listed at the bottom of the screen: *p1, z1, R, Q, A12, α.*

Checking variables contents

As an exercise on peeking into the contents of variables we will use the seven variables entered in the exercise above. We showed how to use the FILES menu to view the contents of a variable in an earlier exercise when we created the variable A. In this section we will show a simple way to look into the contents of a variable.

Pressing the soft menu key label for the variable

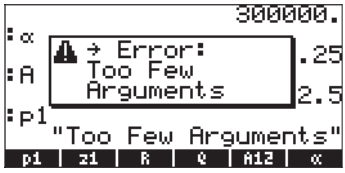
This procedure will show the contents of a variable as long as the variable contains a numerical value or an algebraic value, or an array. For example, for the variables listed above, press the following keys to see the contents of the variables:

Algebraic mode

Type these keystrokes: VAR ▮▮ ENTER ▮▮ ENTER ▮▮ ENTER. At this point, the screen looks as follows:

Next, type these keystrokes: ▮▮ ENTER ▮▮ ENTER NXT ▮▮ ENTER. At this point, the screen looks as follows:

Pressing the soft menu key corresponding to *p1* will provide an error message (try NXT [illegible] ENTER):

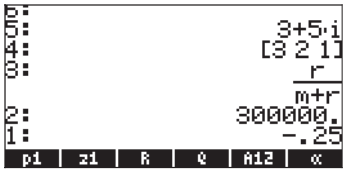


Note: By pressing [illegible] ENTER we are trying to activate (run) the *p1* program. However, this program expects a numerical input. Try the following exercise: ON [illegible] ← ( ) 5 ENTER. The result is:

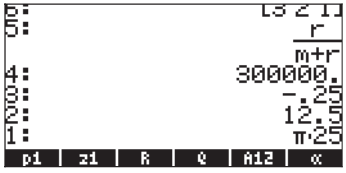
The program has the following structure: << → r 'π*r^2' >>
The « » symbols indicate a program in User RPL language. The characters → r indicate that an input, to be referred to as *r*, is to be provided to the program. The action from the program is to take that value of *r* and evaluate the algebraic 'π*r^2'. In the example shown above, *r* took the value of 5, and thus the value of $\pi r^2 = \pi \cdot 25$ is returned. This program, therefore, calculates the area of a circle given its radius *r*.

RPN mode
In RPN mode, you only need to press the corresponding soft menu key label to get the contents of a numerical or algebraic variable. For the case under consideration, we can try peeking into the variables *z1*, *R*, *Q*, *A12*, α, and *A*, created above, as follows: VAR [illegible]

At this point, the screen looks like this:



To see the contents of A, use: NXT A.
To run program *p1* with r = 5, use: NXT 5 p1.



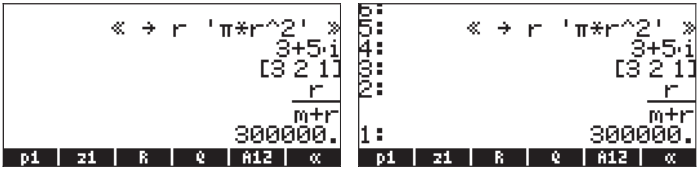
Notice that to run the program in RPN mode, you only need to enter the input (5) and press the corresponding soft menu key. (In algebraic mode, you need to place parentheses to enter the argument).

Using the right-shift key ↱ followed by soft menu key labels
In Algebraic mode, you can display the content of a variable by pressing VAR ↱ and then the corresponding soft menu key. Try the following examples:

VAR ↱ p1 ↱ z1 ↱ R ↱ Q ↱ A12

Note: In RPN mode, you don't need to press ↱ (just VAR and then the corresponding soft menu key).

This produces the following screen (Algebraic mode in the left, RPN in the right)



Notice that this time the contents of program *p1* are listed in the screen. To see the remaining variables in this directory, press NXT:

Listing the contents of all variables in the screen
Use the keystroke combination ↱ ▼ to list the contents of all variables in the screen. For example:

Press ON to return to normal calculator display.

Replacing the contents of variables

Replacing the contents of a variable can be thought of as storing a different value in the same variable name. Thus, the examples for creating variables shown above can be used to illustrate the replacement of a variable's content.

Using the STO▶ command
Using as illustration the six variables, *p1, z1, R, Q, A12, a,* and *A*, created earlier, we will proceed to change the contents of variable *A12* (currently a numerical variable) with the algebraic expression 'β/2', using the STO▶ command. First, using the Algebraic operating mode:

' ALPHA ↱ B ÷ 2 ▶ STO▶ VAR ENTER

Check the new contents of variable *A12* by using ↱ VAR.

Using the RPN operating mode:

' ALPHA ↱ B ÷ 2 ENTER ' VAR ENTER STO▶

or, in a simplified way,

' ALPHA ↱ B ÷ 2 ▶ ' VAR STO▶

Using the left-shift ↰ key followed by the variable's soft menu key (RPN)
This is a very simple way to change the contents of a variable, but it only works in the RPN mode. The procedure consists in typing the new contents of the variable and entering them into the stack, and then pressing the left-shift key

followed by the variable's soft menu key. For example, in RPN, if we want to change the contents of variable *z1* to '*a+b·i* ', use:

' ALPHA ← A + ALPHA ← B × ← i ENTER

This will place the algebraic expression '*a+b·i* ' in level *1:* in the stack. To enter this result into variable *z1*, use: VAR ← [z1]

To check the new contents of *z1*, use: → [z1]

An equivalent way to do this in Algebraic mode is the following:

ALPHA ← A + ALPHA ← B × ← i ENTER STO [z1] ENTER

To check the new contents of *z1*, use: → [z1]

Using the ANS(1) variable (Algebraic mode)

In Algebraic mode one can use the ANS(1) variable to replace the contents of a variable. For example, the procedure for changing the contents of *z1* to '*a+bi*' is the following: ← ANS STO [z1] ENTER . To check the new contents of *z1*, use: → [z1]

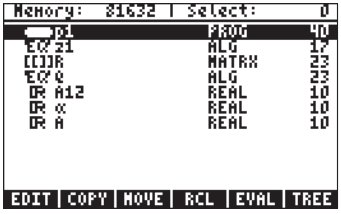
Copying variables

The following exercises show different ways of copying variables from one sub-directory to another.

Using the FILES menu

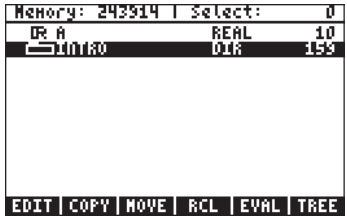
To copy a variable from one directory to another you can use the FILES menu. For example, within the sub-directory {HOME MANS INTRO}, we have variables *p1, z1, R, Q, A12, α,* and *A*. Suppose that we want to copy variable *A* and place a copy in sub-directory {HOME MANS}. Also, we will copy variable *R* and place a copy in the HOME directory. Here is how to do it:

Press ← FILES [FILE] to produce the following list of variables:

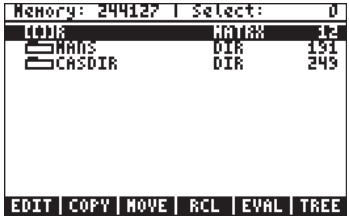


Use the down-arrow key ▼ to select variable *A* (the last in the list), then press [COPY]. The calculator will respond with a screen labeled PICK DESTINATION:

Use the up arrow key (▲) to select the sub-directory MANS and press OK. If you now press ← UPDIR, the screen will show the contents of sub-directory MANS (notice that variable A is shown in this list, as expected):



Press ON INTRO ENTER (Algebraic mode), or ON INTRO (RPN mode) to return to the INTRO directory. Press ← FILES OK to produce the list of variables in {HOME MANS INTRO}. Use the down arrow key (▼) to select variable *R*, then press EDIT. Use the up arrow key (▲) to select the HOME directory, and press OK. If you now press ← UPDIR, twice, the screen will show the contents of the HOME directory, including a copy of variable *R*:



Using the history in Algebraic mode

Here is a way to use the history (stack) to copy a variable from one directory to another with the calculator set to the Algebraic mode. Suppose that we are within the sub-directory {HOME MANS INTRO}, and want to copy the contents of variable *z1* to sub-directory {HOME MANS}. Use the following procedure: → ' Z1 STO▶ ' Z1 ENTER This simply stores the contents of *z1* into itself (no change effected on *z1*). Next, use ← UPDIR ENTER to move to the {HOME MANS} sub-directory. The calculator screen will look like this:

Next, use the delete key three times, to remove the last three lines in the display: ◀ ◀ ◀. At this point, the stack is ready to execute the command ANS(1)▶z1. Press ENTER to execute this command. Then, use → VAR, to verify the contents of the variable.

Using the stack in RPN mode

To demonstrate the use of the stack in RPN mode to copy a variable from one sub-directory to another, we assume you are within sub-directory {HOME MANS INTRO}, and that we will copy the contents of variable *z1* into the HOME directory. Use the following procedure: → VAR ENTER ' VAR ENTER

This procedure lists the contents and the name of the variable in the stack. The calculator screen will look like this:

Now, use ← UPDIR ← UPDIR to move to the HOME directory, and press STO▶ to complete the operation. Use → VAR, to verify the contents of the variable.

Copying two or more variables using the stack in Algebraic mode

The following is an exercise to demonstrate how to copy two or more variables using the stack when the calculator is in Algebraic mode. Suppose, once more, that we are within sub-directory {HOME MANS INTRO} and that we want to copy the variables *R* and *Q* into sub-directory {HOME MANS}. The keystrokes necessary to complete this operation are shown following:

→ R STO▶ Q ENTER

→ Q STO▶ R ENTER

← UPDIR ENTER

◀ ◀ ◀ ENTER

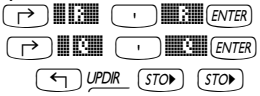
◀ ◀ ◀ ◀ ENTER

To verify the contents of the variables, use → R and → Q.

This procedure can be generalized to the copying of three or more variables.

Copying two or more variables using the stack in RPN mode

The following is an exercise to demonstrate how to copy two or more variables using the stack when the calculator is in RPN mode. We assume, again, that we are within sub-directory {HOME MANS INTRO} and that we want to copy the variables *R* and *Q* into sub-directory {HOME MANS}. The keystrokes necessary to complete this operation are shown following:



To verify the contents of the variables, use and .

This procedure can be generalized to the copying of three or more variables.

Reordering variables in a directory

In this section we illustrate the use of the ORDER command to reorder the variables in a directory. We assume we start within the sub-directory {HOME MANS} containing the variables, *A12, R, Q, z1, A,* and the sub-directory *INTRO*, as shown below. (Copy A12 from INTRO into MANS).

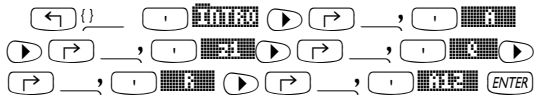
Algebraic mode

In this case, we have the calculator set to Algebraic mode. Suppose that we want to change the order of the variables to *INTRO, A, z1, Q, R, A12*. Proceed as follows to activate the ORDER function:

PRG	Select MEMORY from the programming menu
	Select DIRECTORY from the MEMORY menu
	Select ORDER from the DIRECTORY menu

The screen will show the following input line:

Next, we'll list the new order of the variables by using their names typed between quotes:



The screen now shows the new ordering of the variables:

RPN mode

In RPN mode, the list of re-ordered variables is listed in the stack before applying the command ORDER. Suppose that we start from the same situation as above, but in RPN mode, i.e.,

The reordered list is created by using:

Then, enter the command ORDER, as done before, i.e.,

PRG Select MEMORY from the programming menu

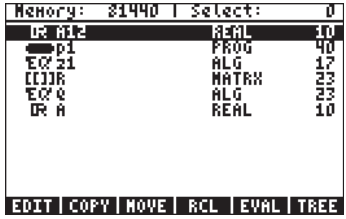
Select DIRECTORY from the MEMORY menu

Select ORDER from the DIRECTORY menu

The result is the following screen:

Moving variables using the FILES menu

To move a variable from one directory to another you can use the FILES menu. For example, within the sub-directory {HOME MANS INTRO}, we have variables *p1, z1, R, Q, A12, α,* and *A*. Suppose that we want to move variable *A12* to sub-directory {HOME MANS}. Here is how to do it: Press FILES to show a variable list. Use the down-arrow key ▼ to select variable *A12*, then press MOVE. The calculator will respond with a PICK DESTINATION screen. Use the up arrow key ▲ to select the sub-directory MANS and press OK. The screen will now show the contents of sub-directory {HOME MANS INTRO}:



Notice that variable A12 is no longer there. If you now press ↰ UPDIR, the screen will show the contents of sub-directory MANS, including variable *A12*:

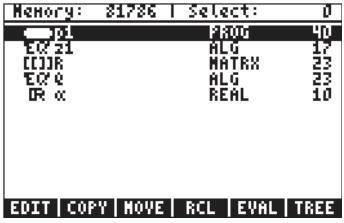
Note: You can use the stack to move a variable by combining copying with deleting a variable. Procedures for deleting variables are demonstrated in the next section.

Deleting variables

Variables can be deleted using function PURGE. This function can be accessed directly by using the TOOLS menu (TOOL), or by using the FILES menu ↰ FILES PURGE.

Using the FILES command

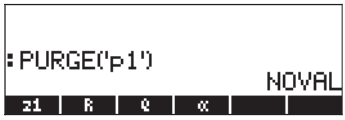
The FILES command can be used to purge one variable at a time. To delete a variable from a given directory you can use the FILES menu. For example, within the sub-directory {HOME MANS INTRO}, we have variables *p1, z1, R, Q, α,* and *A* left. Suppose that we delete variable *A*. Here is how to do it: Press ↰ FILES PURGE to produce the variable list. Use the down-arrow key ▼ to select variable *A* (the last in the list), then press NXT PURGE YES. The screen will now show the contents of sub-directory INTRO without variable A.



Using function PURGE in the stack in Algebraic mode

We start again at subdirectory {HOME MANS INTRO} containing now only variables *p1, z1, Q, R,* and *α*. We will use command PURGE to delete

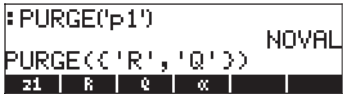
variable *p1*. Press TOOL PURGE VAR ENTER. The screen will now show variable *p1* removed:



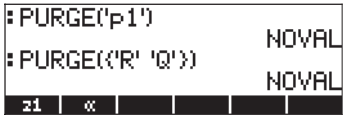
You can use the PURGE command to erase more than one variable by placing their names in a list in the argument of PURGE. For example, if now we wanted to purge variables *R* and *Q*, simultaneously, we can try the following exercise. Press :

TOOL PURGE ← {} ' VAR ▶ → , ' VAR

At this point, the screen will show the following command ready to be executed:



To finish deleting the variables, press ENTER. The screen will now show the remaining variables:



Using function PURGE in the stack in RPN mode

We start again at subdirectory {HOME MANS INTRO} containing variables *p1, z1, Q, R,* and *α*. We will use command PURGE to delete variable *p1*. Press ' PURGE ENTER TOOL PURGE. The screen will now show variable *p1* removed:

To delete two variables simultaneously, say variables *R* and *Q*, first create a list (in RPN mode, the elements of the list need not be separated by commas as in Algebraic mode): VAR ← {} ' ▶ ' ENTER. Then, press TOOL PURGE use to purge the variables.

UNDO and CMD functions

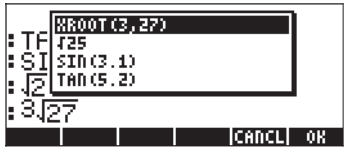
Functions UNDO and CMD are useful for recovering recent commands, or to revert an operation if a mistake was made. These functions are associated with

the HIST key: UNDO results from the keystroke sequence [→] [UNDO], while CMD results from the keystroke sequence [←] [CMD].

To illustrate the use of UNDO, try the following exercise in algebraic (ALG) mode: [5] [×] [4] [÷] [3] [ENTER]. The UNDO command ([→] [UNDO]) will simply erase the result. The same exercise in RPN mode, will follow these keystrokes: [5] [ENTER] [4] [ENTER] [×] [3] [ENTER] [÷]. Using [→] [UNDO] at this point will undo the most recent operation (20/3), leaving the original terms back in the stack:

To illustrate the use of CMD, let's enter the following entries in ALG mode. Press [ENTER] after each entry.

Next, use the CMD function ([←] [CMD]) to show the four most recent commands entered by the user, i.e.,



You can use the up and down arrow keys ([▲] [▼]) to navigate through these commands and highlight any of them that you want to entry anew. Once you have selected the command to enter, press [OK].

The CMD function operates in the same fashion when the calculator is in RPN mode, except that the list of commands only shows numbers or algebraics. It does not show functions entered. For example, try the following exercise in RPN mode:

[5] [ENTER] [2] [ENTER] [3] [÷] [×] [SIN]

['] [SIN] [5] [×] [2] [ENTER].

Pressing [←] [CMD] produces the following selection box:

As you can see, the numbers 3, 2, and 5, used in the first calculation above, are listed in the selection box, as well as the algebraic 'SIN(5x2)', but not the SIN function entered previous to the algebraic.

Flags

A flag is a Boolean value, that can be set or cleared (true or false), that specifies a given setting of the calculator or an option in a program. Flags in the calculator are identified by numbers. There are 256 flags, numbered from -128 to 128. Positive flags are called user flags and are available for programming purposes by the user. Flags represented by negative numbers are called system flags and affect the way the calculator operates.

To see the current system flag setting press the MODE button, and then the FLAGS soft menu key (i.e., F1). You will get a screen labeled *SYSTEM FLAGS* listing flag numbers and the corresponding setting.

(**Note**: In this screen, as only system flags are present, only the absolute value of the flag number Is displayed). A flag is said to be *set* if you see a check mark (✓) in front of the flag number. Otherwise, the flag is *not set* or *cleared*. To change the status of a system flag press the ✓CHK soft menu key while the flag you want to change is highlighted, or use the +/- key. You can use the up and down arrow keys (▲ ▼) to move about the list of system flags. Although there are 128 system flags, not all of them are used, and some of them are used for internal system control. System flags that are not accessible to the user are not visible in this screen. A complete list of flags is presented in Chapter 24.

Example of flag setting: general solutions vs. principal value

For example, the default value for system flag 01 is *General solutions*. What this means is that, if an equation has multiple solutions, all the solutions will be returned by the calculator, most likely in a list. By pressing the ☑ soft menu key you can change system flag 01 to *Principal value*. This setting will force the calculator to provide a single value known as the principal value of the solution.

To see this at work, first set system flag 01 (i.e., select *Principal Value*). Press OK twice to return to normal calculator display. We will try solving a quadratic equation solution, say, $t^2+5t+6 = 0$, with command QUAD.

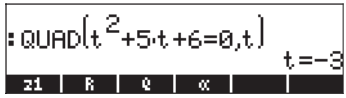
Algebraic mode

Use the following keystroke sequence: ↱ CAT (ALPHA) Q (use the up and down arrow keys, ▲ ▼ , to select command QUAD) , press OK .

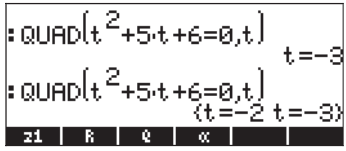
To enter the equation as the first argument of function QUAD, use the following keystrokes:

↱ EQW (ALPHA) ↰ T Y^x 2 ▶ + 5 × (ALPHA) ↰ T + 6 ▲ ▲
↱ = 0 (ENTER)
↱ , (ALPHA) ↰ T (ENTER)

The result is:



Now, change the setting of flag 1 to *General solutions*: MODE ☑ OK OK . And try the solution again: ▲ ▲ ENTER ENTER . The solution now includes two values:



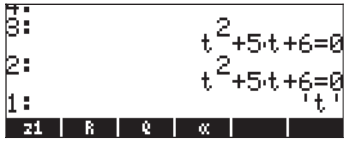
RPN mode

First set system flag 01 (i.e., *Principal Value*). Press OK twice to return to normal calculator display. Then, type the quadratic equation as follows:

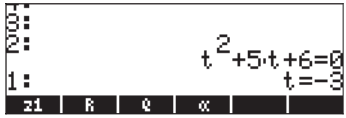
↱ EQW (ALPHA) ↰ T Y^x 2 ▶ + 5 × (ALPHA) ↰ T + 6 ▲ ▲
↱ = 0 (ENTER)

ENTER (keeping a second copy in the RPN stack)

' ALPHA ← T ENTER



Use the following keystroke sequence to enter the QUAD command: → CAT ALPHA Q (use the up and down arrow keys, ▲▼ , to select command QUAD) , press OK . The screen shows the principal solution:



Now, change the setting of flag 01 to *General solutions*: MODE FLAGS ▼ CHOOS OK OK. And try the solution again: ◀ ' ALPHA ← T ENTER → CAT ALPHA Q (use the up and down arrow keys, ▲▼ , to select command QUAD) , press OK . The screen now shows the two solutions:

Other flags of interest

Bring up once more the current flag setting by pressing the MODE button, and then the FLAGS soft menu key. Make sure to clear system flag 01, which was left set from the previous exercise. Use the up and down arrow keys (▲▼) to move about the system flag list.

Some flags of interest and their preferred value for the purpose of the exercises that follow in this manual are:

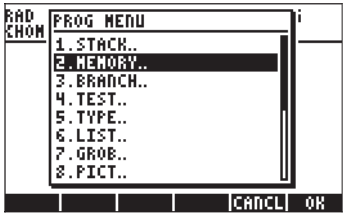
02 Constant → symb:	Constant values (e.g., π) are kept as symbols
03 Function → symb:	Functions are not automatically evaluated, instead they are loaded as symbolic expressions.
*27 'X+Y*i' → (X,Y):*	Complex numbers are represented as ordered pairs
60 [α][α] locks:	The sequence ALPHA ALPHA locks the alphabetic keyboard

Press OK twice to return to normal calculator display.

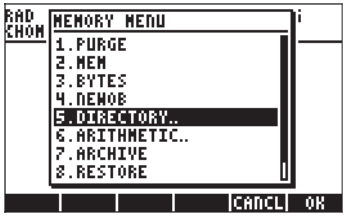
CHOOSE boxes vs. Soft MENU

In some of the exercises presented in this chapter we have seen menu lists of commands displayed in the screen. These menu lists are referred to as *CHOOSE boxes*. For example, to use the ORDER command to reorder variables in a directory, we use, in algebraic mode:

[←] [PRG] [▼] Show PROG menu list and select MEMORY



[OK] [▼][▼][▼][▼] Show the MEMORY menu list and select DIRECTORY



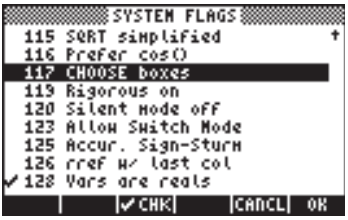
[OK] [▲][▲] Show the DIRECTORY menu list and select ORDER

[OK] activate the ORDER command

There is an alternative way to access these menus as *soft MENU* keys, by setting flag *117*. To set this flag try the following:

[MODE] [FLAG] [▲][▲][▲][▲][▲][▲][▲]

The screen shows flag 117 not set (*CHOOSE boxes*), as shown here:



Press the ✓CHK soft menu key to set flag 117 to *soft MENU*. The screen will reflect that change:

Press OK twice to return to normal calculator display.

Now, we'll try to find the ORDER command using similar keystrokes to those used above, i.e., we start with ◀ PRG .

Notice that instead of a menu list, we get soft menu labels with the different options in the PROG menu, i.e.,

Press F2 to select the MEMORY soft menu (MEM). The display now shows:

Press F5 to select the DIRECTORY soft menu (DIR)

The ORDER command is not shown in this screen. To find it we use the NXT key to find it:

To activate the ORDER command we press the F3 (ORDER) soft menu key. Although not applied to a specific example, this exercise shows the two options for menus in the calculator (CHOOSE boxes and soft MENUs).

Note: most of the examples in this user guide assume that the current setting of flag 117 is its default setting (that is, *not* set). If you have set the flag but want to strictly follow the examples in this guide, you should clear the flag before continuing.

Selected CHOOSE boxes

Some menus will only produce CHOOSE boxes, e.g.,

- The APPS (APPlicationS menu), activated with the APPS key, first key in the second row of keys from the top of the keyboard:

- The CAT (CATalog menu), activated with the ↱ CAT key, second key in the fourth row of keys from the top of the keyboard:

- The HELP menu, activated with TOOL NXT ⌨

- The CMDS (CoMmanDS) menu, activated within the Equation Writer, i.e., ↱ EQW NXT CMDS