SCIENTIFIC CALCULATOR
FOR THE PALM HANDHELD COMPUTER

MODEL
SC-123PU

INSTRUCTION MANUAL

INTRODUCTION

With the program SC-123PU you get a powerful and freely available scientific calculator for the Palm platform. Apart from scientific functions it also offers a full set of logical operations and conversions between different numeric systems. Additionally the calculator offers a units mode for easy conversions between different units including currencies, as well as calculations with mixed units. The program is designed in a way, that it simulates the visual and operational aspects of a true calculator, such that the user will be immediately familiar with its interface.

CONTENTS

1. BACKGROUND

The calculator program SC-123PU can be executed on all devices equipped with the Palm Operating System version 2.0 or higher.

The calculator program automatically adapts to single and multi color devices. The high resolution displays of SONY Clié devices and devices equipped with Palm Operating System version 5 or higher are also automatically detected and supported. If the device offers a dynamic input area, then the input area can be hidden so the calcluator can use the bigger display size.

The calculator SC-123PU is shipped in four different languages: English, german, french and esperanto. Only menu items and dialog boxes have been translated; key and and esperanto. Only menu items and dialog boxes have been translated; key and display labeling is identical in all versions. To select the desired language, you have to install the proper program module. Since the name of the program module is the same for all languages, you can only have one language version installed at the same time.

Installation of the SC-123PU on the Palm Device

The calculator program SC-123PU has to be installed on your Palm device. If you don't know how to install additional applications on your Palm device, please refer to the instruction manual which is shipped with your Palm device.

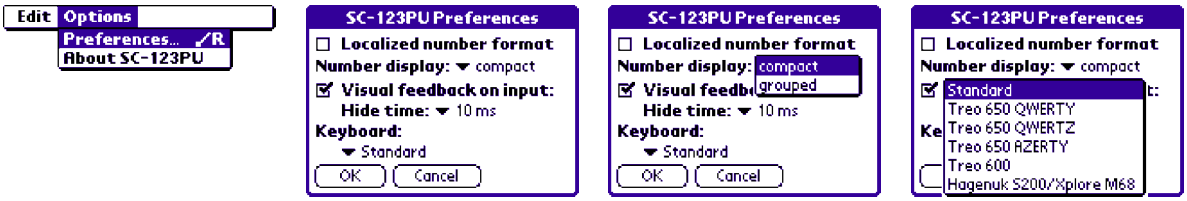
If there is already an SC-103PC or SC-103PU calculator program installed on the palm device when you install the SC-123PU, then the settings, memory contents and user defined units from the SC-103PU or SC-103PC will be transferred into the SC-123PU automatically when it is started for the first time. If both SC-103PC and SC-103PU are installed, then the data from the SC-103PU will be transferred.

Installation Procedure:

1. Select one of the available language versions of the SC-123PU. You find the various language versions in the subdirectories english, deutsch, french and esperanto. Install file `SC-123PU.prc` from the selected subdirectory on your Palm device as usual.
2. Now you should find an application called SC-123PU in the category "unfiled". If you select the corresponding symbol, the SC-123PU will be displayed.

Preferences

To display the preferences window, select the menu item "**Preferences...**", which is located in the "**Options**" menu.



Format of Number Display

You can specify how the calculator should display the numbers. If you select "Localized number format", then seperator characters for numbers are used according to the global system preferences. Otherwise, the decimal point is always displayed as a period and spaces are used to separate groups of three digits. Separator characters for groups of three digits will, however, only be used if you select "grouped" number display mode. In "compact" mode digits are displayed with equal spacing. Number settings only have effect in SCIENTIFIC and UNITS mode, the appearance of numbers in LOGIC mode can not be changed.

NOTE: All examples shown in these operating instructions assume that the "Localized number format" is not active and that the compact number display is selected. If you use other settings, then numbers displayed on your device may appear in a different format.

Flickering of the Display

You can control the flickering effect of the displayed numbers while pressing an operator key like [+]. You can enable and disable the flickering and additionally you can specify the amount of time the display will be hidden to cause the flickering effect.

The flickering of the display serves as a visual feedback to show you that the calculator has accepted your input. In addition, the pressed key will be highlighted but this effect is often not noticable during fast input because of the delay time of the usually used liquid crystal displays.

The flickering effect of the display can be made stronger or softer. If a greater hide time is selected, the display will be hidden for a longer time and the flickering effect will be stronger. Select a value according to your personal taste.
Note: If the flickering effect is enabled, then the display will be dark as long as you press a key. If you release the key before the selected hide time is reached, then the display will stay dark at least until the selected hide time is over. Not all keys, e.g. number keys, result in a flickering effect of the display because some result in a visual display change anyway and also to simply prevent a too nervous display.

Keyboard

It is possible to select from one of six keyboard mappings. This controls how digits and signs entered using a keyboard or Graffiti® are mapped to the keys of the calculator.

With the options "**Treo 650 QWERTY**", "**Treo 650 QWERTZ**", "**Treo 650 AZERTY**" or "**Treo 600**" enabled, the operation of the SC-123PU using the keyboard of the Treo smartphone will be simplified. The calculator then uses some special key-operation mappings which eliminate the need to enter numbers and operators using the option key. They can then be entered directly. The "**Treo 650 QWERTY**" setting is for Treo devices with a standard QWERTY keybord layout, the "**Treo 650 QWERTZ**" setting for Treo devices with a german QWERTZ keybord layout and the "**Treo 650 AZERTY**" setting for Treo devices with a french AZERTY keybord layout.
For Treo 600 devices the selection "**Treo 600**" has to be used so that the digit "0" can be entered using the Alt key.

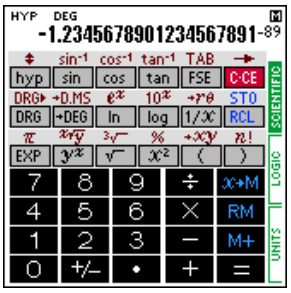
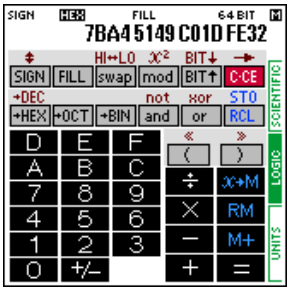
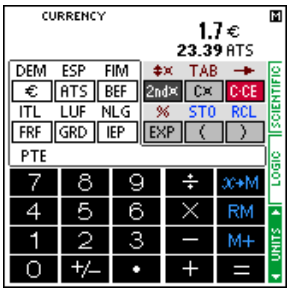
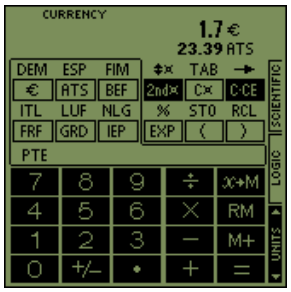
For the Hagenuk S200, which is technically identical to the Xplore M68 use the setting "**Hagenuk S200/Xplore M68**" so that the basic arithmetic operations can be entered using the five way navigation stick.

On devices other than the listed smartphones this option should be set to "**Standard**".

For further information about the key bindings with the different settings, see chapter "**Entering using a Keyboard or Graffiti®**".

2. OPERATING MODES

The calculator SC-123PU offers three general operating modes for different tasks. To select the desired operating mode there are the three vertically arranged fields at the right border of the display which are labeled SCIENTIFIC, LOGIC and UNITS. To select the desired operating mode, tip on the corresponding field with the stylus. The field indicating the currently selected mode is shown in a dark background color.

	On color devices	On B/W devices
SCIENTIFIC mode		
LOGIC mode		
UNITS mode		

In SCIENTIFIC mode, the SC-123PU acts like a scientific calculator with 20 digits. In LOGIC mode, conversions between four different numeric systems are possible and basic arithmetic calculations and boolean operations can be performed. In UNITS mode, conversions between different units including currencies and mixed unit calculations can be performed.

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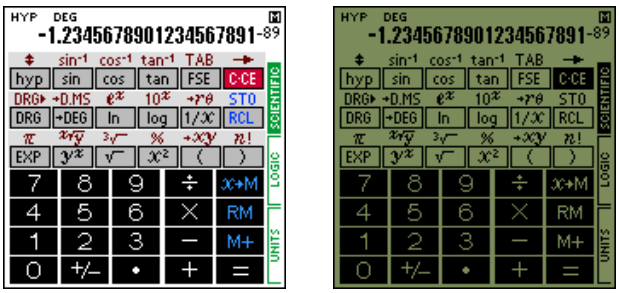
3. SCIENTIFIC MODE

The Palm handheld can be used like a calculator with 20 digits. For that purpose the program SC-123PU has to be switched into SCIENTIFIC mode. You can activate the SCIENTIFIC mode by tapping on the corresponding field at the right border.

This is how the calculator in SCIENTIFIC mode looks like:

On color devices **On B/W devices**



Calculations

Now we will perform some simple calculations. Press the following keys and look at the display:

Input	Display
123	123.
[+]	123.
654	654.
[=]	777.

Did you get the right result? If not, press the [C·CE] key and try the same calculation again.
Next, the value of pi (π) should be recalled. The symbol "π" is located above the key [EXP]. Press the symbol.

Input	Display
[π]	3.1415926535897932385

The Display now shows the value of π.
Now 10^4 should be calculated. For this operation the function 10^x will be used.

Input	Display
4 [10^x]	10000.

Following the most important keys will be outlined:

* [C·CE] (Clear) (red or dark key)

If this key is pressed immediately after input of numerical data or after a recall of the memory contents, this data will be cleared. In any other case, pressing the [C·CE] key clears the operator and/or the numerical data which have been entered. The content of the memory will not be cleared by pressing the [C·CE] key.

Input	Display
123 [+] 456	456.
[C·CE]	0.
789 [=]	912. (123 + 789 = 912)
6 [×] 2 [+]	12.
[C·CE]	0.
6 [÷] 2 [+]	3.
5 [=]	8.

The [C·CE] key can also be used to clear an error condition.

Input	Display
5 [÷] 0 [=]	Error Symbol E 0.

C·CE	0.

* FSE (Display mode switch)

With this key you can switch the display mode for the result of a calculation from floating point system (normal mode) to fixed point system (FIX), scientific notation (SCI), engineering notation (ENG) or vice versa.

Input	Dispay
23 × 1000 =	23000. (Normal)
FSE	FIX 23000.000 (FIX)
FSE	SCI 2.300 04 (SCI)
FSE	ENG 23.000 03 (ENG)

* TAB (specifies the number of decimal digits)

In comibation with a number key, this key can be used to specify the number of decimal digits (digits after the decimal point). Press the clear key C·CE so that "0." is displayed. Press the key FSE, then "0.000" (FIX mode) appeares on the display.

1. Specification of 2 decimal digits.

Input	Display
TAB 2	FIX 0.00
5 ÷ 8 =	FIX 0.63

2. Specification of 5 decimal digits.

Input	Display
TAB 5	FIX 0.62500

In combination with the • key this key can be used to specify that all available decimal digits after the decimal point should be displayed in scientific (SCI) and engineering (ENG) notation. When fixed point format (FIX) is active TAB • switches back to floating point system.

* DRG (specifies the angular mode)

This key is used to specify the angular mode for numerical data for trigonometric functions, inverse trigonometrc functions and coordinate transformations.

Input	Display
	(Degree)

DEG

RAD

DRG (Radian)

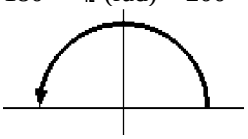
GRAD

DRG (Grad)

DEG

DRG (Degree)

180° = π (rad) = 200g



DEG: Degree [°]
RAD: Radian [rad]
GRAD: Grad [g]

* DRG▸ (transforms between angular modes)

This key is used for transformations between angular modes and simultaneously specifies the angular mode for numerical data for trigonometric functions, inverse trigonometrc functions and coordinate transformations.

Input	Dispay	
180	DEG 180.	(Degree)
DRG▸	RAD 3.14159265358979323 85	(Radian)
DRG▸	GRAD 200.	(Grad)
DRG▸	DEG 180.	(Degree)

* 0 to 9, ·DEC, EXP and +/–

EXP: Used to enter numbers in exponential notation. The exponent will be displayed superscript with smaller digits. (At some places where no superscript digits can be displayed, the exponent will be shown after the letter "E", for example -1.23E-05 for $-1{,}23\times10^{-5}$.)

Input	Display
C·CE 4 EXP 3	$4.^{03}$ (4×10^{3})
=	4000.
+/–	-4000.

+/–: Used to enter negative numbers (or to inverse the sign from negative to positive).

Input	Display
1.23 +/–	-1.23
EXP 5 +/–	-1.23^{-05} (-1.23×10^{-5})
=	-0.0000123
+/–	0.0000123

* ← (Backspace)

With this key the last entered digit can be deleted.

Input	Display	
125	125.	
[→]	12.	
3	123.	
[+] 478	478.	
[→]	47.	
[→]	4.	
56	456.	
[=]	579.	(123 + 456 = 579)
1.456 [EXP] 19	1.456^{19}	
[→]	1.456^{01}	
2	1.456^{12}	
[÷] 1000 [=]	1456000000.	(1.456×10^{12} / 1000 = 1456000000)

Basic Usage

1. Addition and Subtraction

Input: 12 [+] 45.6 [−] 32.1 [+] 789 [−] 741 [+] 213 [=]
Result: 286.5

2. Multiplication and Division

a. *Input:* 841 [×] 586 [÷] 12 [=]
Result: 41068.833333333333333
b. *Input:* 427 [+] 54 [×] 32 [÷] 7 [−] 39 [×] 2 [=]
Result: 595.85714285714285714

Note that multiplication and division have priority over addition and subtraction. Internally, the calculator first calculates the multiplication and division.

Multiplication with a constant:
The value entered first acts as a constant.
Input: 3 [×] 5 [=] *Result:* 15
Input: 10 [=] *Result:* 30

Division with a constant:
The value entered after the division sign acts as a constant.
Input: 15 [÷] 3 [=] *Result:* 5
Input: 30 [=] *Result:* 10

Note:
Depending on the priority, the calculator puts some calculations in pending state. In case of chain calculations, the last calculation instruction, taking into account the priority rules, and the relevant numeric value are retained and can be used for further calculations or as constants, respectively.

a + b × c =	+ bc	(Constant addition)
a × b ÷ c =	÷ c	(Constant division)
a ÷ b × c =	a/b ×	(Constant multiplication)
a × b - c =	- c	(Constant subtraction)

3. Memory Calculations

The independently accessible memory can be maintained with the three keys [x→M], [RM] and [M+]. Before starting a calculation clear the memory by pressing [C·CE] and [x→M].
If a value other than zero is stored in memory "M" is displayed.

Input: 12 [+] 5 [M+]

Result: 17

For subtraction enter: 2 [+] 5 [=] [+/–] [M+]

Result of this equation: -7

Enter [RM] to recall memory contents: 10 will be displayed.

Input: 12 [×] 2 [=] [x→M]

Result: 24 (replaces 10 in memory)

Input: 6 [÷] 2 [M+]

Result: 3

[RM]: 27

To subtract a value from memory contents, the keys [+/–] and [M+] can be pressed.

In addition to the memory which can be modified with the [x→M] key, there are 10 memory slots available which can be modified with [STO] [0] to [STO] [9].
To read the contents of these memories you have to press the keys [RCL] [0] to [RCL] [9] just like [RM] for the independently accessible memory.

Scientific Calculations

To calculate trigonometric and inverse trigonometric equations and for coordinate transformations the angular mode has to be assigned. The assignment of the angular mode DEG, RAD or GRAD happens by pressing the [DRG] key.

1. Trigonometric Functions

Exercise: sin 30° + cos 40°

Angular mode to DEG

Input: 30 [sin] + 40 [cos] [=] *Result:* 1.2660444431189780352

Exercise: cos 0.25π

Angular mode to RAD

Input: 0.25 [×] [π] [=] [cos] *Result:* 0.7071067811865475244

2. Inverse Trigonometric Functions

Exercise: $\sin^{-1} 0.5$

Angular mode to DEG

Input: 0.5 [sin⁻¹] *Result:* 30

Exercise: $\cos^{-1} -1$

Angular mode to RAD

Input: 1 [+/–] [cos⁻¹] To input a negative number, press the [+/–] key after entering the number.

Result: 3.1415926535897932385 (Value of π)

The results of inverse trigonometric functions are only valid between the following ranges:

$\theta = \sin^{-1} x, \theta = \tan^{-1} x$	$\theta = \cos^{-1} x$
DEG: -90 <= θ <= 90 [°]	DEG: 0 <= θ <= 180 [°]
RAD: -π/2 <= θ <= π/2 [rad]	RAD: 0 <= θ <= π [rad]
GRAD: -100 <= θ <= 100 [g]	GRAD: 0 <= θ <= 200 [g]

3. Hyperbolic- and Inverse Hyperbolic Functions

Exercise: sinh 4

Input: 4 [hyp] [sin] *Result:* 27.289917197127752449

Exercise: $\sinh^{-1} 9$

Input: 9 [hyp] [sin⁻¹] *Result:* 2.8934439858858713781

4. Power Functions

Exercise: 20^2
Input: 20 [x²] *Result:* 400
Exercise: 3^3 and 3^4
Input: 3 [yˣ] 3 [=] *Result:* 27
Input: 3 [yˣ] 4 [=] *Result:* 81

5. Roots

Exercise: Square root of 25
Input: 25 [√] *Result:* 5
Exercise: Cube root of 27
Input: 27 [³√] *Result:* 3
Exercise: Fourth root of 81
Input: 81 [ˣ√y] 4 [=] *Result:* 3

6. Logarithmic Functions

Exercise: ln 21, log 173
Natural Logarithms
Input: 21 [ln] *Result:* 3.0445224377234229965
Common Logarithms
Input: 173 [log] *Result:* 2.2380461031287954146

7. Exponential Functions

Exercise: $e^{3.0445}$
Input: 3.0445 [eˣ] *Result:* 20.995928813094317577 (see ln 21)
Exercise: $10^{2.238}$
Input: 2.238 [10ˣ] *Result:* 172.98163592151015219 (see log 173)

8. Reciprocals

Exercise: 1/6 + 1/7
Input: 6 [1/x] [+] 7 [1/x] [=] *Result:* 0.3095238095238095238

9. Factorial

Exercise: 69!
Input: 69 [n!]
Result: $1.7112245242814131137^{98}$ (= $1.7112245242814131137\times10^{98}$)

On calculating the factorial it is easily possible to overflow the calculation limits of the SC-123PU which results in the error indication "E". The section Calculation Range discusses the calculation limits of the calculator.

Exercise: ${}_8P_3 = 8!/(8-3)!$
Input: 8 [n!] [÷] [(] 8 [−] 3 [)] [n!] [=]
Result: 336

10. Percent calculations

Exercise: 45% of 2780 (2.780 × 45/100)
Input: 2780 [×] 45 [%] [=] *Result:* 1251
Exercise: 200 - 200 × 30/100
Input: 200 [−] 30 [%] [=] *Result:* 140

11. Angle/Time conversions

To convert an angle or time (°, ', ", or hours, minutes, seconds) to its decimal equivalent the degrees have to be given as integer portion and the minutes and seconds as decimal digits.

Exercise: Transformation of 12°47'52" to its decimal equivalent
Input: 12.4752 [→DEG] *Result:* 12.797777777777777778

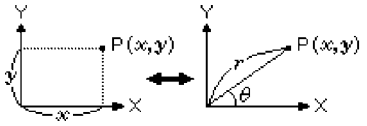
When converting decimal degrees to the equivalent degrees/minutes/seconds, the answer is broken down:
integer portion = degrees; 1st and 2nd decimal digits = minutes; 3rd and 4th digits = seconds; and 5th through end decimal digits are decimal seconds.

Exercise: Conversion of the decimal angle 24.7256 to its degree/minute/second equivalent
Input: 24.7256 [→D.MS] *Result:* 24.433216 or 24°43'32"

A horse has leap times of 2 minutes 25 seconds, 2 minutes 38 seconds and 2 minutes 22 seconds. What is the average running time?
Input: 0.0225 [→DEG] [+] 0.0238 [→DEG] [+] 0.0222 [→DEG] [=]
Result 1: 0.1236111111111111111
Input: [÷] 3 [=]
Result 2: 0.0412037037037037037
Input: [→D.MS]
Result 3: 0.0228333333333333333
or the average time is 2 minutes 28 seconds.

12. Coordinate Conversion

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



$r = \sqrt{x^2 + y^2}$
$\theta = \tan^{-1}\frac{y}{x}$

DEG: $0 <= |\theta| <= 180$
RAD: $0 <= |\theta| <= \pi$
GRAD: $0 <= |\theta| <= 200$

Convert rectangular coordinates $x = 6$ and $y = 4$ to polar coordinates.
Angular mode: DEG
Input: 6 [↕] 4 [→rθ] *Result:* 7.2111025509279785862 (r)
Input: [↕] *Result:* 33.690067525979786914 (θ)

Calculate the magnitude and direction (phase) in a vector i = 12 + j9
Input: 12 [↕] 9 [→rθ] *Result:* 15 (r)
Input: [↕] *Result:* 36.869897645844021297 (θ)

Converting polar coordinates to rectangular ($r, \theta \rightarrow x, y$).
Solve for P(14, π/3), r = 14, $\theta = \pi/3$
Angular mode: RAD
Input: [π] [÷] 3 [=] [↕] 14 [↕] [→xy]
Result: 6.9999999999999999994 (x)
Input: [↕]
Result: 12.124355652982141055 (y)

Hint:
In the above example $\theta = \pi/3$ is entered first and is replaced by $r = 14$ by pushing the [↕] key after entering r.

Usage of the Parenthesis Keys

Usage of the parenthesis keys [(] and [)] is required if series of calculations are combined together and the priority of operations has to be changed.
After pressing the [(] key, "( )" is displayed in the top of the display.
Calculations between parenthesis have priority over all other calculations. The parentheses can be nested more than once. First the calculations between the innermost parenthesis will be made.

Exercise: 12 + 42 ÷ (8 - 6)
Input: 12 [+] 42 [÷] [(] 8 [−] 6 [)] [=]
Result: 33
Exercise: 126 ÷ {(3 + 4) × (3 - 1)}
Input: 126 [÷] [(] [(] 3 [+] 4 [)] [×] [(] 3 [−] 1 [)] [)] [=]
Result: 9

Hint:
It is not neccessary to close the parenthesis immediately before the [=] key (or [M+] key).

Decimal Digits

The number of decimal digits in a calculation result can be specified; to do this use the [TAB] key in combination with the keys [0] to [9]. In this case, the display has to be switched to fixed point (FIX), scientific notation (SCI) or engineering notation (ENG).

[TAB] [0] → No decimal digits.
(The number will be rounded to the next integer number.)
[TAB] [1] → One decimal digit.
(The number will be rounded to the first decimal digit.)
[TAB] [9] → Nine decimal digits.
(The number will be rounded to the 9th decimal digit.)

To clear the TAB setting (switching to variable number of decimal digits after the decimal point) use [TAB] [•] in scientific or engineering notation. When [TAB] [•] is pressed when the fixed point system is active (FIX), then the calculator switches back to the floating point system.

Example:
[TAB] 9
0.5 [÷] 9 [=] → 0.055555556 (FIX mode)
(The number is rounded to the 9th place after the decimal point.)
[FSE] → 5.555555556^{-02} (SCI mode)
(The mantissa is rounded to the 9th place after the decimal point.)
[TAB] [•] → $5.5555555555555555556^{-02}$ (SCI mode)
(All available digits after the decimal point are displayed.)
[TAB] [3] → 5.556^{-02} (SCI mode)
(The mantissa is rounded to the third place after decimal digit.)
[FSE] → 55.556^{-03} (ENG mode)
[FSE] → 0.0555555555555555556

Priority Levels of Operations

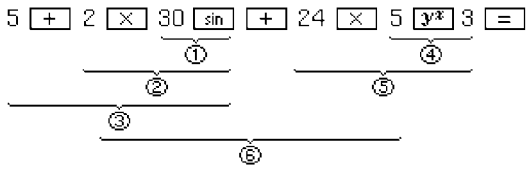
The program is provided with a function that judges the priority level of individual calculations; thus, you can enter your calculations in the same order as in a given mathematical formula. The following table shows the priority level of individual calculations.

Priority Levels of Operations

1. Functions as sin, x^2 or %

2. y^x, $\sqrt[x]{y}$
3. ×, ÷
4. +, -
5. =, M+
(Calculations which are given the same priority level are executed sequentially.)

Example:
Key operation and sequence of calculation in 5 + 2 × sin 30 + 24 × 5^3 =

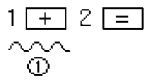


The numbers ① - ⑥ show the sequence of the calculations.
When calculations with higher priority are executed, those with lower priority must be saved in the meantime. The program is equipped with additional memories for such pending operations.
As these memories are also used for calculations with parentheses, calculations can be performed according to a given mathematical formula unless parentheses and pending operations exceed 30 levels in total.

- Functions with only one variable (x^2, $1/x$, $n!$, →DEG, →D.MS, etc.) are calculated immediately after key operation without being retained.

Calculations without Parentheses

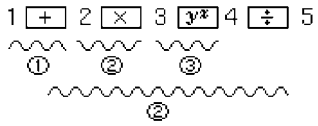
Example:



Pending of 1 level

Pending of 2 levels

Pending of 3 levels



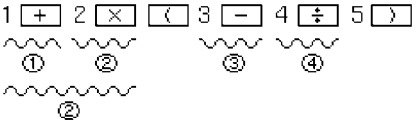
By pressing the y^x key, 3 pending levels are reached. After pressing the ÷ key the calculations "y^x" will be performed with highest priority and "×" with the same priority. Thus, after pressing the ÷ key, two pending levels remain.

Calculations with Parenthesis

Example:

i) 

4 numbers and operations stay pending.

ii) 

After pressing the) key first the calculation between parentheses 3 - 4 ÷ 5 will be performed; 2 calculations stay pending.

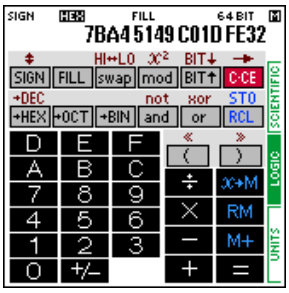
4. LOGIC MODE

Computer engineers and programmers are in need of simple conversions between various numeric systems as well as for calculations with boolean logic. With the calculator SC-123PU this problem is solved by providing the LOGIC mode. The LOGIC mode can be selected by tapping on the corresponding field at the right border.

Note:
You should first read the sections "**Calculations**" and "**Basic Usage**" in the chapter "**3. SCIENTIFIC MODE**", to get familiar with the operation of the calculator and its basic functions before you use the LOGIC mode.

This is how the calculator looks in LOGIC mode (hexadecimal notation selected):

On color devices **On B/W devices**



The calculator can operate with integer values up to a bit width of 64 bits in four different numeric systems.

Conversion Between Different Numeric Systems

→HEX To convert a number to its hexadecimal equivalent; at the same time the calculator will be switched to hexadecimal notation HEX. (HEX is shown in the displayed.)

→DEC To convert a number to its decimal equivalent; at the same time the calculator will be switched to decimal notation DEC. (DEC is shown in the display.)

→OCT To convert a number to its octal equivalent; at the same time the calculator will be switched to octal notation OCT. (OCT is shown in the display.)

→BIN To convert a nubmer to its binary equivalent; at the same time the calculator will be switched to binary notation BIN. (BIN is shown in the display.)

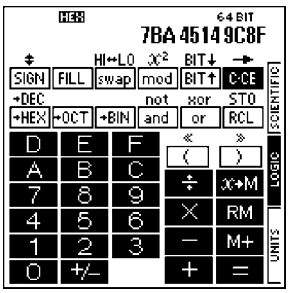
Exercise:
Conversion from decimal 30 to hexadecimal notation:
Press →DEC key if calculator is not currently in decimal notation (DEC is displayed).

Input	Display
30 →HEX	1E

Exercise:
Further conversion of hexadecimal 1E to binary format:

Input	Display
→BIN	11110

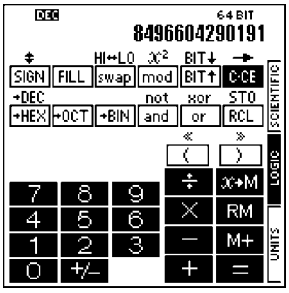
The Hexadecimal Notation



The hexadecimal notation system is mainly used in computer programming. The base for a hexadecimal number is 16; hexadecimal numbers consist of the digits 0 to 9 and the major letters A to F, which stand for the numbers 10 to 15 in the decimal system.

Keys for the letters A to F will be shown as soon as the calculator is in hexadecimal notation. The symbol HEX means, that numerical values on the display are shown in hexadecimal notation and that basic integer arithmetic and boolean operations can be performed.

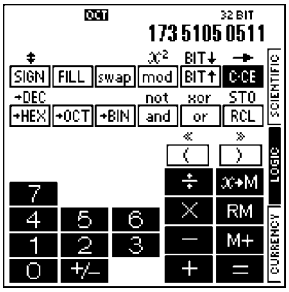
The Decimal Notation



In LOGIC mode even in decimal notation only integer values with a bit width of a maximum of 64 bits can be handled.

In decimal notation only the keys for the digits 0 to 9 are shown. The symbol DEC means, that numerical values on the display are shown in decimal notation and that basic integer arithmetic and boolean operations can be performed.

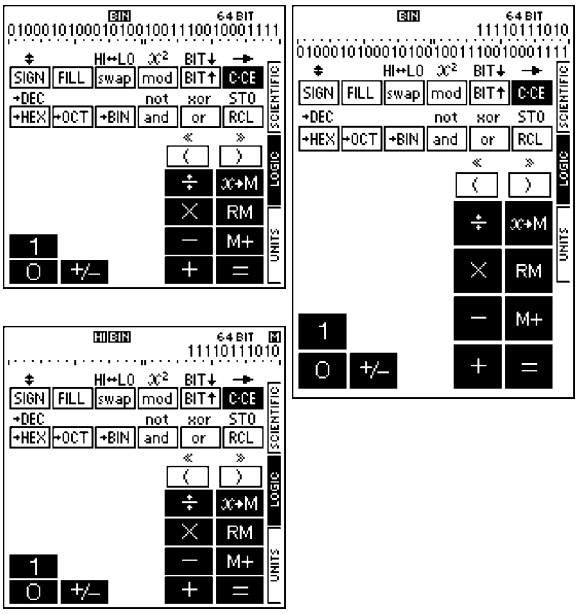
The Octal Notation



The base for a octal number is 8; octal numbers consist of the digits 0 to 7.

In octal notation only the keys for the digits 0 to 7 are shown. The symbol **OCT** means, that numerical values on the display are shown in octal notation and that basic integer arithmetic and boolean operations can be performed.

The Binary Notation



The binary notation system is mainly used in computer programming. The base for a binary number is 2; binary numbers consist of the digits 0 and 1.

In binary notation only the keys for the digits 0 and 1 are shown. A smaller font is used so that 32 positions can be displayed in one row. Additionally, a ruler is shown below the digits to support the identification of nibbles, bytes and words.

To see all 64 positions of a 64 bit wide number the display can be switched to show the higher longword or the lower longword using the HI↔LO key. Note: If the device supports a dynamic input area, and the input area is hidden, so the calculator has more display space, then the calculator will show a 64 Bit number in two lines. The first line shows the higher longword and the second line the lower longword. The key HI↔LO then has no function.

The symbol **HI** indicates, that the higher longword of a 64 bit number will be shown.

The symbol **BIN** means that numerical values on the display are shown in binary notation and that basic integer arithmetic and boolean operations can be performed.

Direct Bit Manipulation

In the binary notation system a digit can be swapped from 0 to 1 and vice versa by tapping on the digit position. If an empty area is tapped then the digit 1 will be set there. With this functionality it is possible to directly modify the bits of a value.

Selecting the Bit Width, Number Display and Sign Mode

The calculator can be switched to bit widths of 8, 16 and 32 bits which are commonly used in the computer industry. With the BIT↑ key the next higher and with the BIT↓ key the next lower bit width is selected. The currently selected bit width is shown in the display.

With the FILL key you can switch leading zeros on and off. Press the FILL key once to show numbers with leading zeros filled to the selcted bit width (**FILL** will be shown in the display). Press the FILL key once more to switch back to normal number display. If **FILL** is activated then leading zeros can be entered during input.

Example:
Settings: **SIGN**, **HEX** notation, **16 BIT**

Input	Display

1AB [=]	1AB	HEX 16 BIT
[FILL]	01AB	HEX FILL 16 BIT
[BIT↑]	0000 01AB	HEX FILL 32 BIT

Input	Display	
000AB8	00 0AB8	HEX FILL 32 BIT
[×]	0000 0AB8	HEX FILL 32 BIT
456 [=]	002E 79D0	HEX FILL 32 BIT
[FILL]	2E 79D0	HEX 32 BIT

With the [SIGN] key, the calculator can be switched between signed and unsigned mode. In the display the symbol SIGN appears if the signed mode is active.

Signs are only shown in HEX, DEC and OCT notations. In the BIN notation only the bits are shown, always without a sign.

With the [+/–] key the sign of a number can be changed. If the sign of a positive number is changed, the 2's complement of the number is calculated. In signed mode the number will then be shown as negative number in unsigned mode as 2's complement.

Example:
Settings: SIGN, HEX notation, 16 BIT

Input	Display	
180 [+/–]	-180	SIGN HEX 16 BIT
[SIGN]	FE80	HEX 16 BIT
[→BIN]	1111111010000000	BIN 16 BIT

Number Range

The selected bit width in combination with the sign mode has influence on the number range which can be handled. In contrast to the SCIENTIFIC mode, too big or too small numbers do not lead to an error condition in LOGIC mode but to an overflow.

Bit Width	Num. Sys.	Sign Mode	Number Range
8 BIT	HEX		0 ~ FF
8 BIT	HEX	SIGN	-80 ~ 7F
8 BIT	DEC		0 ~ 255
8 BIT	DEC	SIGN	-128 ~ 127
8 BIT	OCT		0 ~ 377
8 BIT	OCT	SIGN	-200 ~ 177
8 BIT	BIN		0 ~ 11111111
8 BIT	BIN	SIGN	0 ~ 11111111
16 BIT	HEX		0 ~ FFFF
16 BIT	HEX	SIGN	-8000 ~ 7FFF
16 BIT	DEC		0 ~ 65535
16 BIT	DEC	SIGN	-32768 ~ 32767
16 BIT	OCT		0 ~ 17 7777
16 BIT	OCT	SIGN	-10 0000 ~ 7 7777
16 BIT	BIN		0 ~ 1111111111111111
16 BIT	BIN	SIGN	0 ~ 1111111111111111
32 BIT	HEX		0 ~ FFFF FFFF
32 BIT	HEX	SIGN	-8000 0000 ~ 7FFF FFFF
32 BIT	DEC		0 ~ 4294967295
32 BIT	DEC	SIGN	-2147483648 ~ 2147483647
32 BIT	OCT		0 ~ 377 7777 7777
32 BIT	OCT	SIGN	-200 0000 0000 ~ 177 7777 7777

32 BIT	BIN		0 ~ 11111111111111111111111111111111
32 BIT	BIN	SIGN	0 ~ 11111111111111111111111111111111
64 BIT	HEX		0 ~ FFFF FFFF FFFF FFFF
64 BIT	HEX	SIGN	-8000 0000 0000 0000 ~ 7FFF FFFF FFFF FFFF
64 BIT	DEC		0 ~ 18446744073709551615
64 BIT	DEC	SIGN	-9223372036854775808 ~ 9223372036854775807
64 BIT	OCT		0 ~ 377 7777 7777
64 BIT	OCT	SIGN	-10 0000 0000 0000 0000 0000 ~ 7 7777 7777 7777 7777 7777
64 BIT	BIN		0 ~ 11111111111111111111111111111111 11111111111111111111111111111111
64 BIT	BIN	SIGN	0 ~ 11111111111111111111111111111111 11111111111111111111111111111111

Exercise:
Solve of 250 + 15 with unsigned 8 bit arithmetic (overflow calculation):

Press the [→DEC] key to select decimal notation (DEC is shown in the display).
Press the [BIT↓] until 8 BIT is shown in display.
With the [SIGN] key select unsigned mode (symbol SIGN cleared in display).

Input	Display
250 [+] 15 [=]	9 DEC 8 BIT

Exercise:
Display the result of the last calculation in binary notation:

Input	Display
[→BIN]	1001 BIN 8 BIT

Basic Arithmetic Calculations

The arithmetic operations addition, subtraction, multiplication and division can be used like in SCIENTIFIC mode. But only integer values can be handled.

Calculating with Numbers in LOGIC Mode

Exercise:
Addition of two hexadecimal numbers
A4 + BA =

Input	Display
[C CE] [→HEX]	0 HEX 16 BIT
A4 [+] BA [=]	15E HEX 16 BIT

Exercise:
4 × 4 =

Input	Display
[C CE] [→HEX]	0 HEX 16 BIT
4 [x²]	10 HEX 16 BIT

Exercise:
32 bit multiplication of the octal number 73 with the binary number 110 and display of the result as a decimal number
73 oct × 110 bin =
Press [BIT↑] until 32 BIT is shown in display

Input	Display
[C CE] [→OCT]	0 OCT 32 BIT
73 [×] [→BIN]	111011 BIN 32 BIT
110 [=]	101100010 BIN 32 BIT
[→DEC]	354 DEC 32 BIT

Exercise:
(12 + D) × B =

Input	Display
C·CE →HEX	0 HEX 32 BIT
(12 + D) × B =	155 HEX 32 BIT

Exercise:
43A - 3CB =
+) A38 - 2FB =
---
total

Input	Display
C·CE X→M	0. HEX 32 BIT
43A − 3CB M+	6F HEX 32 BIT
A38 − 2FB M+	73D HEX 32 BIT
RM	7AC HEX 32 BIT

The following hints have to be noted:

- Calculations in LOGIC mode do not take into account fractions.
- The result of a division will always be shown as an integer value. If a fraction results during a calculation the fractional part is cut and only the integer part will be displayed.

Examples:
Input: E ÷ 3 = *Result:* 4 HEX 32 BIT
Input: B ÷ 3 × 2 = *Result:* 6 HEX 32 BIT

With the modulo operation the remainder of a division can be computed.
Input: E mod 3 = *Result:* 2 HEX 32 BIT

By pressing the +/− key it is possible to calculate the complement of a number in a simple way.
Settings: Unsigned mode (symbol SIGN is not shown, HEX notation, 32 BIT
Input: AB +/− *Result:* FFFF FF55 HEX 32 BIT

Boolean Algebra

The operators of the boolean algebra AND, OR, XOR (exclusive or) and NOT can be used. In a logical operation two numbers will be transformed to binary representation (2's complement) and the logical relation will then be evaluated for every bit pair.

The following section will shown the results of the logical operators for these bit evaluations:

AND

X	Y	X AND Y
1	1	1
1	0	0
0	1	0
0	0	0

OR

X	Y	X OR Y
1	1	1
1	0	1
0	1	1
0	0	0

XOR

X	Y	X XOR Y
1	1	0
1	0	1
0	1	1
0	0	0

NOT

X	NOT X
1	0
0	1

After every bit pair has been assigned the corresponding result (a 1 or a 0) according to the above table, the resulting binary number will be converted back to the selected numeric system. This number is the result of the logical operation.

Example:

With the settings SIGN, DEC notation, 8 BIT, please perform the following calculations:

41 AND 27 →
gives
9

41 = 101001
27 = 011011 AND
← 001001

Input: 41 [and] 27 [=] *Result:* 9 SIGN DEC 8 BIT

41 OR 27 →
gives
59

41 = 101001
27 = 011011 OR
← 111011

Input: 41 [or] 27 [=] *Result:* 59 SIGN DEC 8 BIT

41 XOR 27 →
gives
50

41 = 101001
27 = 011011 XOR
← 110010

Input: 41 [xor] 27 [=] *Result:* 50 SIGN DEC 8 BIT

NOT 3 →
gives
-4 (2's complement)

3 = 00000011 NOT
← 11111100

Input: 3 [not] *Result:* -4 SIGN DEC 8 BIT

NOT *x* can generaly be computed with the equation NOT *x* = -(*x* + 1).

Bit Shift Operations

With the keys [«] and [»] it is possible to perform bit shift operations. Thereby the value will be transformed to binary representation and the single bits will be shiftet to the left or the right by the given amount. The result will be transformed back to the selected numeric system which yields the result of the operation.

Bit Shift Right

During the bit shift right operation the single bits of a value will be shiftet to the right by the given amount of positions. This is equivalent to a division by the power of 2.

Example:
Calculation of 80 » 3 is equivalent to $80/2^3$:

	decimal	**binary**
before shifting	80	01010000
after shifting	10	00001010

Input: 80 [»] 3 Display: 10 DEC

In signed mode (SIGN) an arithmetical shift right will be performed whereas in unsigned mode a logical shift right is executed. Arithmetical shift means that the sign of a number is retained; logical shift right always results in a cleared sign bit, treating all bits equal.

Example:
Arithmetic shift right of decimal -120 about one position (is equivalent to a division by two) and display of the result as binary number:
Settings: SIGN, 8 BIT

Input:	Result:	
[C·CE] [•DEC]	0	SIGN DEC 8 BIT
120 [+/–]	-120	SIGN DEC 8 BIT
[•BIN]	10001000	SIGN BIN 8 BIT
[»] 1 [=]	11000100	SIGN BIN 8 BIT
[•DEC]	-60	SIGN DEC 8 BIT

Logical shift right of the result from the previous calculation by 2 positions and display of the resulting value in binary notation.

Input:	Result:	
[SIGN]	196	DEC 8 BIT
[»] 2 [=]	49	DEC 8 BIT

→BIN 110001 BIN 8 BIT

Bit Shift Left

During the bit shift left operation the single bits of a value will be shiftet the given amount of positions to the left. This is equivalent to a multiplication with the power of 2.

Example:
Calculation of 3 « 2 is equivalent to 3×2^2:

	decimal	**binary**
before shifting	3	0000 0011
after shifting	12	0000 1100

Input:	Display:
3 « 2	12 DEC

Swapping Bytes and Nibbles

With the swap key the bytes of a 16 bit, 32 bit or 64 bit number will be swapped. This allows conversions from"little-endian" to "big-endian" format and vice versa.

Example:
Settings: Unsigned mode (symbol SIGN is not shown), HEX notation, 64 BIT

Input	Display
1234567890ABCDEF	1234 5678 90AB CDEF HEX 64 BIT
swap	EFCD AB90 7856 3412 HEX 64 BIT
BIT↓	7856 3412 HEX 32 BIT
swap	1234 5678 HEX 32 BIT
BIT↓	5678 HEX 16 BIT
swap	7856 HEX 16 BIT

In 8 bit notation the nibbles will be swapped:

Example:
Settings: Unsigned mode (symbol SIGN is not shown), HEX notation, 8 BIT

Input	Display
AB	AB HEX 8 BIT
swap	BA HEX 8 BIT

Parenthesis and Priority Levels of Operations

During the processing of complex expressions the calculator follows a set of predefined priorities which determine the sequence in which the operators have to be applied. In LOGIC mode, the same rules for priority of operators and parenthesis are valid as described in SCIENTIFIC mode in section "**Priority Levels of Operations**" but the additional boolean operators have to be taken into account:

Priority Levels of Operations

1. Functions like not or x^2
2. ×, ÷, mod
3. +, -
4. «, »
5. and
6. xor
7. or
8. =, M+

(Calculations which are on the same priority level are executed in sequence.)

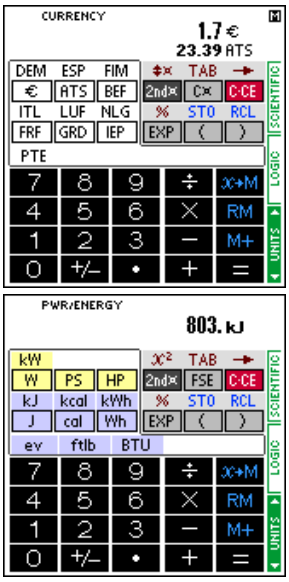
5. UNITS MODE

The UNITS mode offers easy conversions between different units and calculations with mixed units. The conversion factors and unit symbols can be freely defined by the user. The calculator is shipped with 84 physical units, 16 SI prefixes, the 12 Euro related national currencies and the Euro predefined. Each unit or currency is assigned to a key. The UNITS mode can be selected by tapping on the corresponding field at the right border.

Note:
You should first read the sections "**Calculations**" and "**Basic Usage**" in the chapter "**3. SCIENTIFIC MODE**", to get familiar with the operation of the calculator and its basic functions before you use the UNITS mode.

This is how the calculator looks like in UNITS mode:

On color devices



On B/W devices

Predefined Units

The UNITS Mode offers 10 unit sets each with 17 unit keys. Nine of the unit sets are predefined by default. The first unit set is predefined with currency units and the remaining with physical units.
The following table shows all predefined unit sets and their units:

Unit Set	Unit	Unit Symbol	Category	Factor	Offset
CURRENCY	**Euro**	**€***	Currency	**1**	0
	Austrian Schilling	ATS		13.7603	
	Belgian Franc	BEF		40.3399	
	German Mark	DEM		1.95583	
	Spanish Peseta	ESP		166.386	
	Finnish Markka	FIM		5.94573	
	French Franc	FRF		6.55957	
	Greek Drachma	GRD		340.75	
	Irish Punt	IEP		0.787564	
	Italian Lira	ITL		1936.27	
	Luxembourg Franc	LUF		40.3399	
	Dutch Guilder	NLG		2.20371	
	Portuguese Escudo	PTE		200.482	
LENGTH	micrometre	µm	Length	1×10^{6}	0

	millimetre	mm		1000	
	centimetre	cm		100	
	decimetre	dm		10	
	metre	**m**		**1**	
	kilometre	km		1×10^{-3}	
	mil	mil		$1/2.54\times10^{-5}$	
	inch	in		$1/2.54\times10^{-2}$	
	foot	ft		$1/3.048\times10^{-1}$	
	yard	yd		$1/9.144\times10^{-1}$	
	mile (international)	mi		1/1609.344	
	mile (nautical)	nmi		1/1852.0	
	astronomical unit	au		$6.684587153547039139\times10^{-12}$	
AREA	square millimetre	mm²	Area	1×10^{6}	0
	square centimetre	cm²		1×10^{4}	
	square metre	**m²**		**1**	
	are	a		1×10^{-2}	
	hectare	ha		1×10^{-4}	
	square kilometre	km²		1×10^{-6}	
	square inch	in²		$1/6.4516\times10^{-4}$	
	square foot (international)	ft²		$1/9.290304\times10^{-2}$	
	square yard	yd²		$1/8.3612736\times10^{-1}$	
	Joch (Austria)	Joch		1.0/5754.642	
	acre (Morgen)	acre		1/4046.85644642784	
	square mile (international)	mi²		$1/1609.344^2$	
VOLUME	cubic centimetre	cm³	Volume	1×10^{3}	0
	litre	**l**		**1**	
	cubic metre	m³		1×10^{-3}	
	teaspoon (US)	tsp		0.264172052358148×768	
	tablespoon (US)	tbsp		0.264172052358148×256	
	cubic inch	in³		0.264172052358148×231	
	fluid ounce (US)	oz		0.264172052358148×128	
	cup	cu		0.264172052358148×16	
	pint, liquid (US)	pt		0.264172052358148×8	
	quart, liquid (US)	qt		0.264172052358148×4	
	gallon, liquid (US)	gal		0.264172052358148	
	cubic foot	ft³		0.0353146667214886	
MASS (Masse und Temperatur)	milligram	mg	Mass	1×10^{6}	0
	carat	ct		5×10^{3}	
	gram	g		1×10^{3}	
	kilogram	**kg**		**1**	
	metric ton	t		1×10^{-33}	
	grain	gr		7000×(35.2739616/16)	
	ounce (avoirdupois)	oz		35.2739616	
	ounce (troy)	ozt		32.15074625	

	pound (troy)	lbt		32.15074625/12	
	pound (avoirdupois)	lb		35.2739616/16	
	short ton (US, 2000lb)	tn		35.2739616/(16×2000)	
	long ton (UK, 2240lb)	l.tn		35.2739616/(16×2240)	
PWR/ENERGY (Power and Energy)	**watt**	**W**	Power	**1**	0
	kilowatt	kW		1×10^{-3}	
	Pferdestärken	PS		1.359619307×10^{-3}	
	horsepower	HP		1.341021859×10^{-3}	
	joule	**J**	Energy	**1**	0
	kilojoule	J		1×10^{-3}	
	calorie	cal		1/4.1868	
	kilocalorie	kcal		1/4186.8	
	watt hour	Wh		1/3600	
	kilowatt hour	kWh		1/3600000	
	electron volt	ev		$1/1.60217733\times10^{-19}$	
	foot pound weight	ftlb		1/1.355818	
	british thermal unit	BTU		1/1.05505585262e+03	
TEMP/PRESS (Temperatur und Druck)	**kelvin**	**K**	Temperature	**1**	273.15
	degree Fahrenheit	°F		1.8	32
	degree Celsius	°C		1	0
	degree Réamur	°r		0.8	0
	pascal	PA	Pressure	1×10^{5}	0
	bar	**bar**		**1**	
	atmosphere standard	atm		1/1.01325	
	atmosphere technical	at		1.0197162	
	millimetre of mercury (Torr)	mmHg		750.06158	
	pound per square inch	psi		14.50377439	
	inch of mercury	inHg		29.529983	
	foot of water	ftW		33.4560927	
SPEED/TIME	**metre per second**	**m/s**	Velocity	**1**	0
	kilometre per hour	km/h		3.6	
	knot	knot		1.9438445	
	mile per hour	mi/h		1/0.44704	
	foot per second	ft/s		1/0.3048	
	second	s	Time	86400	0
	minute	min		1440	
	hour	h		24	
	day	**day**		**1**	
	year (365 days)	year		1/365	
SI PREFIX	atto	a	SI Prefix	1×10^{18}	0
	femto	f		1×10^{15}	
	pico	p		1×10^{12}	
	nano	n		1×10^{9}	
	micro	µ		1×10^{6}	
	milli	m		1×10^{3}	

	zenti	c		1×10^{2}	
	deci	d		1×10^{1}	
	Basis	**base**		**1**	
	deka	da		1×10^{-1}	
	hekto	h		1×10^{-2}	
	kilo	k		1×10^{-3}	
	mega	M		1×10^{-6}	
	giga	G		1×10^{-9}	
	tera	T		1×10^{-12}	
	peta	P		1×10^{-15}	
	exa	E		1×10^{18}	

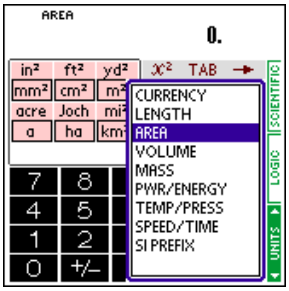
* On devices which are not equipped with a Euro symbol (€), that is, devices with a PalmOS version less than 3.3, EUR will be displayed instead of the Euro symbol.

Notes:

- Only units of the same category can be converted into each other. On color devices each category is assigned a color for easy recognition.
- A unit is converted into another unit, using the factors and offsets. For each category there is a unit with the factor 1 (shown in boldface). This unit is called the base unit of the category, and all other units of the same category are related to it.
- The calculator uses the following equation to convert a value from one unit to another unit:
  $value_2 = (value_1 - offset_1) / factor_1 \times factor_2 + offset_2$

Selecting the Unit Set

If the units mode is selected from scientific or logic mode by pressing the field labeled UNITS on the right border, then the recently used unit set will be selected.



In units mode the field labeled UNITS is provided with two arrows, one pointing up an one pointing down. By pressing this arrows the next or previous unit set can be selected.

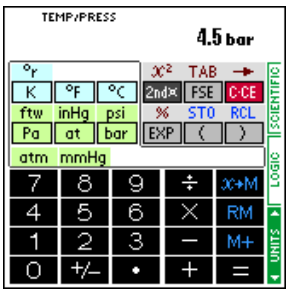
If in units mode the UNITS label itself is pressed, a selection list with all available unit sets is displayed and the desired unit set can be directly selected.

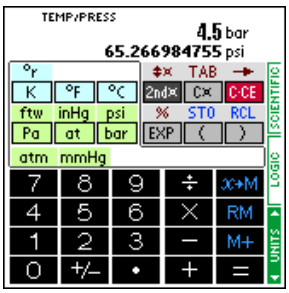
Different View Modes of the Units Mode

In unit mode for each unit set a "one line" or "two lines" view mode can be selected independently. By default the "two lines" view mode is selected for the first unit set which holds the currency units. All other unit sets use the "one line" view mode by default.

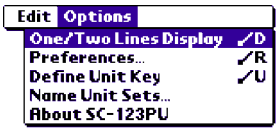
The same unit set shown in the two possible view modes:

One line view mode **Two lines view mode**





Switching Between The Two View Modes



With the menu item "**One/Two Lines Display**" in the "**Options**" menu the calculator can be toggled between "one line" and "two lines" view mode.

Alternate ways to change the view mode:

- To switch from "two lines" into "one line" view mode: Press [2nd] [C*]. This clears the unit of the second line.
- To switch from "one line" view mode to "two lines" view mode: Press the key [2nd] followed by a units key. This specifies the unit for the second line.

One Line View Mode

The "one line" view mode of the UNITS mode can be seen as extension to the SCIENTIFIC mode where unit conversions can be performed. The actual value will be simply convertet without permanently assigning it to a unit. For this reason, opposite to the "two lines" view mode there are no restrictions in the calculations which can be performed.

Following the most important keys will be outlined:

* Unit keys [in], [mm], [°C] etc.

With the unit keys a displayed number can be convertet from one unit to another. The key area with the unit keys is surrounded by a thin line. For conversion two unit keys have to be pressed in sequence. The shown number will be converted from the first into the second unit. A conversion can only be performed between units of the same category.

Example:
Conversion from 12.5 inch to millimetre.

- Select the unit set LENGTH after pressing the UNITS filed in the right border.

Input	Display
12.5	12.5
[in]	12.5 **in**
[mm]	317.5

Result: 12.5 inch are 317.5 mm

How many feet and inches are in 1.75 m?

Input	Display	
1.75 [m]	1.75 **m**	
[ft]	5.74146981627296	*Result 1:* 5 feet
[−] 5 [=] [ft]	0.74146981627296 **ft**	
[in]	8.89763779527559	*Result 2:* 8.9 inch

Result: 1.75 m are 5 feet and 8.9 inch.

* [2nd] (switching into "two lines" view mode)

With the key [2nd] and a following unit key the calculator can be switched from "one line" view mode to "two lines" view mode. For the second display line the pressed unit will be selected. For the first display line a unit compatible to the unit of the second line will be used. If in "one line" view mode a unit ist currently specified then this unit will also be used for the first display line in "two lines" view mode if it is compatible with the one selected for the second line.

Example:
Conversion of 3.8, 14.6 und 26.6 square metres to the corresponding square yards by using the "two lines" view mode and thereafter switching back to "one line" view mode.

- Select the unit set AREA after pressing the field UNITS at the right border.

Input	Display
[C·CE]	0.
3.8	3.8
[m²]	3.8 **m²**
[2nd] [yd²]	3.8 m² 4.5447621759441 yd²
[C·CE]	0. m² 0. yd²
14.6	14.6 m² 17.4614546759957 yd²
[C·CE]	0. m² 0. yd²
26.6	26.6 m² 31.8133352316087 yd²
[2nd] [C]	26.6

Two Lines View Mode

The "two lines" view mode is especially usefull for fast and easy conversion between two units. In the display two lines will be shown. User inputs are displayed in the first line. In the second line the entered or calculated value can instantly be viewed in a different unit. The numbers displayed in the two lines always represent the same value but in different units.

Following the most important keys will be outlined:

* Unit keys [€], [ATS] etc.

With the unit keys the unit of the number in the first display line can be selected. The key area with the unit keys is surrounded by a thin line. By pressing the [DEM] key for example the currency DEM will be assigned as unit to the value oft the first line in the display. During input of a number the unit can be assigned at any time without effecting the numerical value.

* [2nd] (specify second line)

With the [2nd] key you specify the second display line. The consecutively pressed key will the be related to the second display line instead of the first display line. So by pressing of [2nd] [ATS] the currency unit ATS will be assigned to the second line. If the unit of the second line will be changed then the numerical value of the second line will also be changed because the value of the first line will be converted to the new unit of the second line.

Example:
How many Euro (€), are 123.5 Austrian Schilling (ATS).

- Select the currency ATS for the first line by pressing the [ATS] key.
- Select the currency Euro for the second line by pressing [2nd] [€].

Input	Display
123.5	123.5 ATS 8.98 €

Showing the 123.5 ATS of the last example in BEF:

Input	Display
2nd BEF	123.5 ATS
	362.05 BEF

To start a new conversion, press the C·CE key first to clear the display and start a new input.

Input	Display
C·CE	0. ATS
	0.00 BEF
527.9	527.9 ATS
	1547.60 BEF
2nd €	527.9 ATS
	38.36 €

* ⇕× (exchange units)

With this key the units of the first line and the second line can be exchanged. Only the units will be new assigned. The values will not be exchanged.

Example:
Conversions between various currencies.

Input	Display
C·CE DEM 2nd ATS	0. DEM
	0.00 ATS
12.6	12.6 DEM
	88.65 ATS
⇕×	12.6 ATS
	1.79 DEM
C·CE	0. ATS
	0.00 DEM
100	100. ATS
	14.21 DEM

* C× (clear unit assignment)

If the C× key is pressed, the unit assignment for the first display line will be removed. So the number in the first display line has no unit. Simultaneously the second display line will be hidden ("---" will be shown) because a value without a unit can not be converted to a number with a unit.

By pressing of 2nd C×, the calculator will be switched into "one line" view mode.

* TAB (specifies the number of decimal digits)

In combination with a number key, this key can be used to specify the number of decimal digits (digits after the decimal point). In combination with the 2nd× key, the number of decimal digits for the second display line can be specified.

To remove the fixed number of digits after the decimal point and switch back to floating point mode press TAB • .

Note: The number of decimal digits can not be set during input of a number only after a calculation or after pressing the C·CE key.

1. Specification of 3 decimal digits for the first line.

Input	Display
C·CE	0. ATS
	0.00 DEM

TAB 3	0.000 ATS 0.00 DEM
5 ÷ 8 =	0.625 ATS 0.09 DEM

2. Specification of 5 decimal digits for the second line.

Input	Display
2nd TAB 5	0.625 ATS 0.08883 DEM

3. Floating point display for the second line.

Input	Display
2nd TAB •	0.625 ATS 0.08883481828157 DEM

Calculations with Mixed Units

In "two lines" view mode of the UNITS mode the basic operations plus percent calculations can be performed as shown in SCIENTIFIC mode. However, units will be taken into account. So it is possible to perform calculations with mixed units.

Example:
Calculate 120 ATS + 20.5 DEM and show the result in DEM and Euro.

Input	Display
C CE ATS 2nd €	0. ATS 0.00 €
120	120. ATS 8.72 €
+	120. **ATS** 8.72 €
20.5	20.5 ATS 1.49 €
DEM	20.5 DEM 10.48 €
=	37.556285110063 **DEM** 19.20 €

The result of calculations with units is displayed in the unit of the second operand, if one has been assigned. Otherwise, the unit of the first operand will be used for the result. Not all unit combinations are valid in calculations. The following table shows combinations of operations and their result units:

Unit of operand 1	Operation	Unit of operand 2	Unit of result
A	+	B	B
A		none	(illegal op.)
none		B	(illegal op.)
none		none	none
A	-	B	B
A		none	(illegal op.)
none		B	(illegal op.)
none		none	none
A	×	B	(illegal op.)
A		none	A
none		B	B

none		none	none
A	÷	B	none
A		none	A
none		B	(illegal op.)
none		none	none

By trying to apply a illegal calculation, the calculator will be set into an error condition and the symbol "E" will be displayed. The error condition can be cleared by pressing the [C·CE] key.

On multiplications and divisions the calculator selects no unit for the second operand by default. But a unit can be assigned to the second operand explicitely.

Example:

Input	Display
[C·CE] [ATS] [2nd] [€]	0. ATS 0.00 €
1000	1000. ATS 72.67 €
[÷]	1000. **ATS** 72.67 €
2	2.
[=]	500. **ATS** 36.34 €

Input	Display
[C·CE]	0. ATS 0.00 €
1000	1000. ATS 72.67 €
[÷]	1000. **ATS** 72.67 €
20	20.
[DEM]	20. DEM 10.23 €
[=]	7.10678546252625 ---

After pressing an operator key ([+], [÷] etc.) or the keys [=] resp. [M+] the unit assigned to the value in the first line of the display will be shown in bold face. This indicates, that the unit is dedicated to the value. Pressing a unit key in this situation yields to a conversion of the value to the new unit and not the simple assignment of a new unit to the value.

Parenthesis and Priority Levels of Operations

During the processing of complex expressions the calculator follows a set of predefined priorities which determine the sequence in which the operators have to be applied. In UNITS mode, the same rules for priority of operators and parenthesis are valid as described in SCIENTIFIC mode in section "**Priority Levels of Operations**".

Usage of the Memories

The usage of the memories in UNITS mode is basically the same as in SCIENTIFIC mode. With [X→M] a value will be stored in the independently accessible memory and with [M+] a value can be added to the current memory contents. Note that units are ignored when values are added to memory. No unit conversion is performed. The memory contents can be retrieved with the [RM] key like usual.

In addition to the independently accessible memory, 10 memory slots are available as in SCIENTIFIC mode which can be accessed with [STO] resp. [RCL] followed by a digit key.

In "two lines" view mode normally the value in the first display line will be stored in the memory. However, by using the [2nd] key the value of the second display line can be stored. Press one of the following key sequences: [2nd] [X→M], [2nd]

[M+] for independently accessible memory or [2nd] [STO] followed by a digit key to store the value of the second line in one of the 10 memory slots.

Combining UNITS and SCIENTIFIC modes

During input of a calculation the calculator can be switched between UNITS and SCIENTIFIC mode at any time without loosing the pending operations an entered digits. Especially the "one line" view mode can be used in combination with the SCIENTIFIC mode.

Example:
How much feet and inch is the diagonal *c* of a rectangle with the side length of *a* = 30 feet, 5 inch and *b* = 13 feet, 8 inch.
Formula: $c = \mathrm{sqrt}(a^2 + b^2)$

- Select unit set LENGTH after pressing the field UNITS at the right border.

Input	Display	
[C CE] [(] [(]	0.	
30 [+]	30.	
5 [in]	5. **in**	
[ft]	0.41666666666666	
[)]	30.4166666666666	
[x^2]	925.173611111111	
[+]	925.173611111111	
[(]	0.	
13 [+]	13.	
8 [in]	8. **in**	
[ft]	0.66666666666666	
[)]	13.6666666666666	
[)]	938.840277777777	
Switch into SCIENTIFIC mode.		
[√‾]	30.640500612388463027	*Result:* 30 feet
[−] 30		
[=]	0.640500612388463027	
Switch into UNITS mode (LENGTH).		
[ft] [in]	7.68600734866155	*Result:* 7.686 inch

Result: 30 feet, 7.686 inch

Defining Units

It is always possible to add new units to the already predefined units. Further it is possible to change or delete the predefined units.

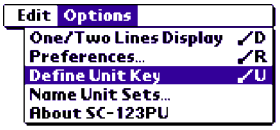
The calculator uses the following forumula to convert from $unit_1$ to $unit_2$:

$value_2 = (value_1 - offset_1) / factor_1 \times factor_2 + offset_2$

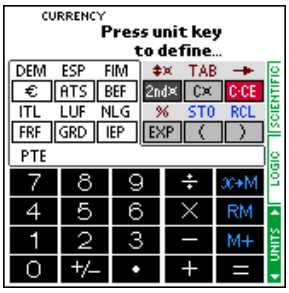
If a unit should be defined *factor* and *offset* relating to the other units of the same category have to be specified. In most cases for each category a base unit with a *factor* of 1 is defined. The *offset* is needed, if the units have different base points which is the case for example with the temerature units °C, °F and K:

	Factor	**Offset**
°C	1.	0
°F	1.8	32
K	1.	273.15

Unit Definition Form



With the unit definition form a new unit can be defined, an existing unit can be modified or deleted. With the menu item "**Define Unit Key...**" in the "**Options**" menu you switch into the unit definition mode.



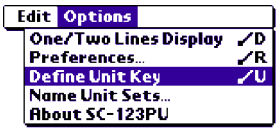
Here, the unit key to be defined can be selected by pressing the key. All unit keys are located in the bordered region. An undefined and therefore unlabeled unit key can also be selected to define its unit.

After selecting the unit key, the unit definition form appears. There the parameters of the unit can be changed and entered. With the key "Delete.." in the form, a unit definition can be erased.

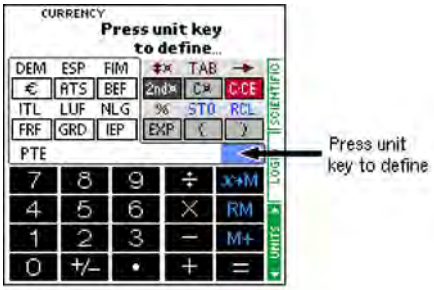
To define a unit, a unit symbol consisting of up to four charachters must be entered, which will be used as label for the unit key. The unit has to be assigned to one of the 15 categories. Only units of the same category can be converted into each other. Also, the conversion factor and offset related to the base unit has to be specified. The base unit is displayed if one exists. The calculator recognizes the base unit of a categoy by its conversion factor of 1.

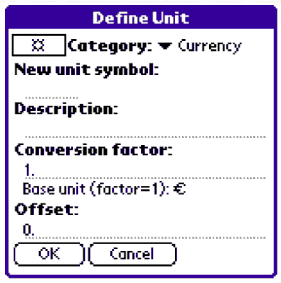
Note: An alternative way to open the unit definition form for a unit key is to press the unit key for a period of at least 2 seconds and then releasing the key.

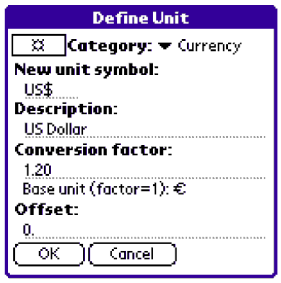
Example:
The currency US dollar should be added to the already defined currencies. The unit key above the x→M key should be used. The conversion factor should be 1.20.



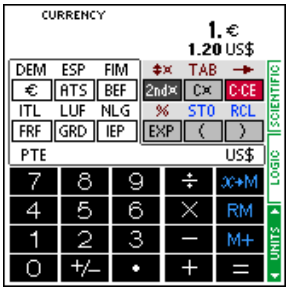
In the menu "**Options**" select the menu item "**Define Unit Key...**" and then press the unit key you want to define.







The unit definition form appears where the currency symbol US$ can be entered under "**New unit symbol**". Optionally a descriptive text can be entered under "**Description**". It has no further function. For "**Conversion factor**" 1.20 should be entered. Currency units do not need any offset so we leave this field with value 0. For the "**Category**", "Currency" has to be selected, so that the new currency unit can be convertet to the already defined currencies. By pressing "OK" the unit definition form will be closed and the unit is defined.

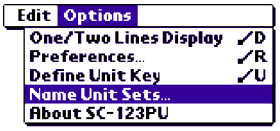


The new unit is defined. It can be used:

Input	Display
€ 2nd US$	0. € 0.00 US$
1	1. € 1.20 US$
C·CE DEM	0. DEM

	0.00 US$
64.55	64.55 DEM
	39.60 US$

Defining Unit Sets



Already existing unit sets can be renamed an new units sets can be defined. Further unit sets can be hidden. For this the unit set definition form has to be opened via the menu item "**Name Unit Sets...**" in the "**Options**" menu.

Here the names of the unit sets can be entered. There are 10 unit sets available. By default nine of them are predefined according the following table:

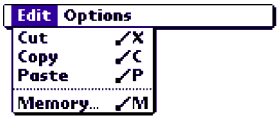
Name of the unit set	Description
CURRENCY	Currency units
LENGTH	Length units
AREA	Area units
VOLUME	Volume units
MASS	Mass (Weight) units
PWR/ENERGY	Power and Energy (Work) units
TEMP/PRESS	Temperature and pressure units
SPEED/TIME	Speed (velocity) and time units
SI PREFIX	SI prefixes

For every unit set it can be selected if it should be visible or not. Invisible unit sets can not be used. Unit sets without a name can not be made visible.

6. INPUTS

Usually, the digits and operators will be entered by pressing the displayed keys. But all digits and some operators can also be entered using the Graffiti® region of the Palm device or pasted from the clipboard. Values can also be copied to the clipboard. Further it is possible to directly modify the contents of the memories in a special form.

Direct Manipulation of the Memories

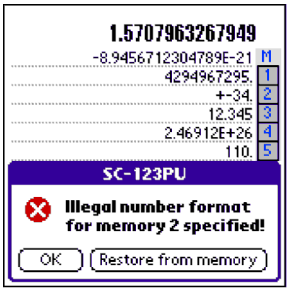


A memory manipulation form can be opened via the menu item "**Memory...**" in the "**Edit** " menu. In this form the contents of all memories can be seen simultaneously and they can also be modified.

In the first line the actual display value is displayed. In the following line the contents of the independently accessible memory (M) is shown, followed by the 10 memories (1 to 9 and 0) which are assigned to the number keys.
The actual display value can be stored in the independently accessible memory by pressing the key x<>M and can be restored using the key RM.
In addition to the independently accessible memory there are 10 memory slots available which can be modified with STO 0 to STO 9. To read the contents of these memories you have to press the keys RCL 0 to RCL 9.
The memory contents can also be changed directly using Graffiti®.

Note: The numbers in the memory manipulation form will be shown in floating point format or in scientific format. Scientific format will be automatically chosen if the number could not be displayed in floating point format with all of its decimal places. Therefore the number format in the memory manipulation form can be different from the one in the display of the calculator. For memory contents an exponent will be shown after the letter "E" and has also to be entered this way. The positive sign for an exponent can be omitted during input.

By pressing "OK" the memory form will be closed and all entered values will be written to the memories.



By pressing RM resp. RCL followed by a digit key or when selecting "OK", the entered values will be written back to the memories. But first it will be checked if the entered data is a valid value. If no valid value is entered an error requester will be displayed. It can be closed by pressing "OK" to correct the invalid input by hand. But if "Restore from memory" will be pressed, the last memory contents will be restored and the input will be lost.

In the shown example a wrong input is done for memory location 2.

Entering using a Keyboard or Graffiti®

Following there is a table containing the keys, which have been assigned a symbol. So the operation associated with this key can be performed by entering the related symbol using a keyboard or Graffiti®.

SCIENTIFIC and UNITS Mode		LOGIC Mode	
Key:	**Symbol:**	**Key:**	**Symbol:**
0 to 9	"0" to "9"	0 to 9	"0" to "9"
.	".", ","	A to F	"a" to "f", "A" to "F"
+/–	"_"	+/–	"_"
C·CE	"C", " " (space)	C·CE	" " (space)
←	Backspace	←	Backspace
÷	"/", "÷", ":"	÷	"/", "÷", ":"
×	"*"	×	"*"
–	"-"	–	"-"
+	"+"	+	"+"
=	"=", Enter	=	"=", Enter
(	"(", "[", "{"	(	"(", "[", "{"
)	")", "]", "}"	)	")", "]", "}"
%	"%"	and	"&"
EXP	"e", "E", "#"	not	"n", "N", "~"
y^x	"^" (only SCIENTIFIC)	or	"o", "O", "|"
n!	"!" (only SCIENTIFIC)	xor	"x", "X", "^"
		mod	"m", "M", "%"
		«	"l", "L", "<"
		»	"r", "R", ">"

The above described mappings are valid when the "**Keyboard**" option in the preferences window is set to "**Standard**" (default). When one of the Treo key mappings are selected in the preferences, then the following assignments are valid:

Treo 650 QWERTY keyboard or Treo 600 keyboard:

Treo input:	**SCIENTIFIC and UNITS modes:**	**LOGIC mode:**
"q", "Q"	÷	÷
"w", "W"	+	+
"e"	1	1
"E"	1	E
"r", "R"	2	2
"t", "T"	3	3
"y"	(	(
"Y"	(	«
"u"	)	)

"U"	)	»
"i", "I"	+/–	+/–
"o", "O"	y^x (only SCIENTIFIC)	or
"p", "P"	C·CE	C·CE
"a"	no operation	and
"A"	no operation	A
"s", "S"	–	–
"d"	4	4
"D"	4	D
"f"	5	5
"F"	5	F
"g", "G"	6	6
"h", "H"	x^2	x^2
"j", "J"	n! (only SCIENTIFIC)	not
"k", "K"	÷	÷
"l", "L"	√ (only SCIENTIFIC)	no operation
Backspace	→	→
"z", "Z"	X	X
"x"	7	7
"X"	7	xor
"c"	8	8
"C"	8	C
"v", "V"	9	9
"b", "B"	EXP	B
"n", "N"	no operation	not
"m", "M"	no operation	mod
"."	•	HI↔LO
Enter	=	=
"0"	0	0
" " (space)	=	=

"**Treo 600**" has to be selected on Treo 600 devices to allow the input of the digit "0" via the Alt key.

Treo QWERTZ keyboard:

Treo input:	**SCIENTIFIC and UNITS modes:**	**LOGIC mode:**
"q", "Q"	÷	÷
"w", "W"	+	+
"e"	1	1
"E"	1	E
"r", "R"	2	2
"t", "T"	3	3
"z"	(	(
"u"	)	)
"U"	)	»
"i", "I"	+/–	+/–
"o", "O"	y^x (only SCIENTIFIC)	or
"p", "P"	C·CE	C·CE
"a"	no operation	and
"A"	no operation	A
"s", "S"	–	–
"d"	4	4

"D"	4	D
"f"	5	5
"F"	5	F
"g", "G"	6	6
"h", "H"	x^2	x^2
"j", "J"	$n!$ (only SCIENTIFIC)	not
"k", "K"	÷	÷
"l", "L"	$\sqrt{}$ (only SCIENTIFIC)	no operation
Backspace	←	←
"y", "Y"	×	×
"Z"	(	«
"x"	7	7
"X"	7	Hor
"c"	8	8
"C"	8	C
"v", "V"	9	9
"b", "B"	EXP	B
"n", "N"	no operation	not
"m", "M"	no operation	mod
"."	•	HI↔LO
Enter	=	=
"0"	0	0
" " (space)	=	=

Treo AZERTY keyboard:

Treo input:	SCIENTIFIC and UNITS modes:	LOGIC mode:
"a"	÷	÷
"A"	÷	and
"z", "Z"	+	+
"e"	1	1
"E"	1	E
"r", "R"	2	2
"t", "T"	3	3
"y"	(	(
"Y"	(	«
"u"	)	)
"U"	)	»
"i", "I"	+/–	+/–
"o", "O"	y^x (only SCIENTIFIC)	or
"p", "P"	C·CE	C·CE
"q", "Q"	no operation	and
"s", "S"	–	–
"d"	4	4
"D"	4	D
"f"	5	5
"F"	5	F
"g", "G"	6	6
"h", "H"	x^2	x^2
"j", "J"	$n!$ (only SCIENTIFIC)	not
"k", "K"	÷	÷
"l", "L"	$\sqrt{}$ (only SCIENTIFIC)	no operation

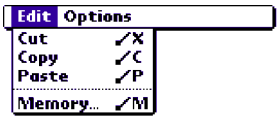
"m", "M"	no operation	mod
"w", "W"	×	×
"x"	7	7
"X"	7	Hor
"c"	8	8
"C"	8	C
"v", "V"	9	9
"b", "B"	EXP	B
"n", "N"	no operation	not
"."	•	HI↔LO
Backspace	→	→
Enter	=	=
"0"	0	0
" " (space)	=	=

Hagenuk S200/Xplore M68 keyboard:

When "**Hagenuk S200/Xplore M68**" is selected in the keyboard settings, then the following key bindings are valid:

Hagenuk S200, Xplore M68 input:	**SCIENTIFIC and UNITS mode:**	**LOGIC mode:**
Stick to the left	−	−
Stick to the right	+	+
Stick up	×	×
Stick down	÷	÷
Pressing the stick	+/−	+/−
"C"	C·CE	C·CE
"0" to "9"	0 to 9	0 to 9
"*"	•	HI↔LO
"#"	=	=

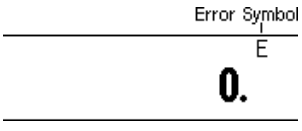
Data Exchange with the Clipboard



With the menu items in the menu "Edit", the value currently shown on the display can be cut or copied to the clipboard or a value in the clipboard can be pasted to the SC-123PU.

7. ERRORS

While in an error condition the display shows the symbol "E":



An error will be raised from a calculation or command which exceeds the capacity of the program. An error can be cleared by pressing the C·CE key.

Error Conditions

1. If the absolute value of a calculation result is greater than 1×10^{99} (not in LOGIC mode).
2. If a number is divided by 0 (zero) (e.g. 5 ÷ 0 =)

3. If in CURRENCY mode a illegal calculation was entered.
4. If the absolute value of a result of memory calculation is greater than 1×10^{99} (not in LOGIC mode).
5. If the pending operation inclusive open parentheses exceeds 30 levels.
6. For scientific functions an error occurs if the calculations exceed the following ranges:

Calculation Range

Numerical calculations:
For calculations with *x*, the value of *x* has to be in the given ranges:

$-1\times10^{100} < x <= -1\times10^{-99}$ for a negative *x*
$10^{-99} <= x < 10^{100}$ for a positive *x*
$x = 0$

The displayed value for *x* will be limited by the number of displayable positions.

Functions:

Function	Range of *x*
sin *x* cos *x* tan *x*	DEG: $\|x\| < 1\times10^{20}$ RAD: $\|x\| < (\pi/180)\times10^{20}$ GRAD: $\|x\| < (10/9)\times10^{20}$ Further only for tan *x*: (*n* = integer) DEG: $\|x\| \neq 90(2n-1)$ RAD: $\|x\| \neq (\pi/2)(2n-1)$ GRAD: $\|x\| \neq 100(2n-1)$
$\sin^{-1}x$ $\cos^{-1}x$	$-1 <= x <= 1$
$\tan^{-1}x$	$\|x\| < 1\times10^{100}$
sinh *x* cosh *x* tanh x	$-227.95592420641052271 <= x <= 230.25850929940456840$
$\sinh^{-1}x$	$\|x\| < 1\times10^{50}$
$\cosh^{-1}x$	$1 <= x < 1\times10^{50}$
$\tanh^{-1}x$	$\|x\| < 1$
ln *x* log *x*	$1\times10^{-99} <= x < 1\times10^{100}$
e^x	$-1\times10^{100} < x <= 230.25850929940456840$
10^x	$-1\times10^{100} < x < 100$
$\sqrt[3]{x}$	$\|x\| < 1\times10^{100}$
$1/x$	$\|x\| < 1\times10^{100}$; $x \neq 0$
x^2	$\|x\| < 1\times10^{50}$
$\sqrt{x}$	$0 <= x < 1\times10^{100}$
n!	$0 <= n <= 69$ (*n* = ganzzahlig)
DMS→DEG DEG→DMS	$\|x\| < 1\times10^{100}$
y^x ($y^x=10^{x \log y}$)	if $y > 0$, $-1\times10^{100} < x \log y < 100$ if $y = 0$, $x > 0$ if $y < 0$, *x* = integer or if $1/x$ = non integer ($x \neq 0$) and $-1\times10^{100} < x \log \|y\| < 100$
$\sqrt[x]{y}$ ($\sqrt[x]{y}=10^{1/x \log y}$)	if $y > 0$, $-1\times10^{100} < 1/x \log y < 100$; $x \neq 0$ if $y = 0$, $x > 0$

	if $y < 0$, x or $1/x$ have to be integer and not zero, and $-1\times10^{100} < 1/x \log \lvert y\rvert < 100$	
$x, y \rightarrow r, \theta$	$(x^2+y^2) < 1\times10^{100}$	$r = \sqrt{x^2+y^2}$
	$y/x < 1\times10^{100}$	$\theta = \tan^{-1}(y/x)$
$r, \theta \rightarrow x, y$	$r < 1\times10^{100}$	$x = r \cos\theta$
	$\lvert r \sin\theta\rvert < 1\times10^{100}$	$y = r \sin\theta$
	$\lvert r \cos\theta\rvert < 1\times10^{100}$	