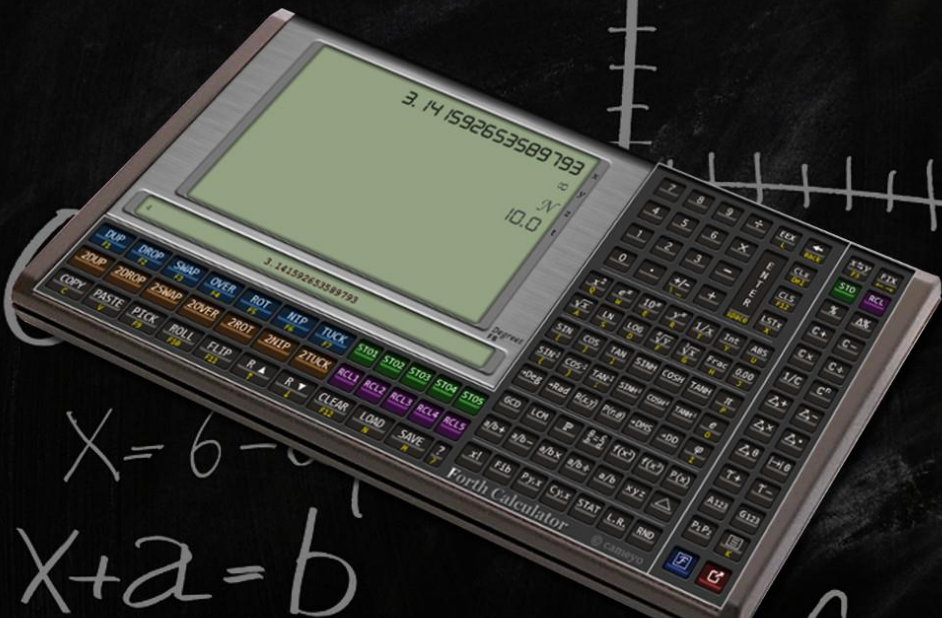
Forth Calculator Manual



FORTH CALCULATOR MANUAL

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Fast Fibonacci algorithms (fibo.pde)

https://www.nayuki.io/page/fast-fibonacci-algorithms

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The Handbook of Essential Mathematics
Compilation and Explanations: John C. Sparks
Editors: Donald D. Gregory and Vincent R. Miller
Public Edition

Forth Calculator Manual
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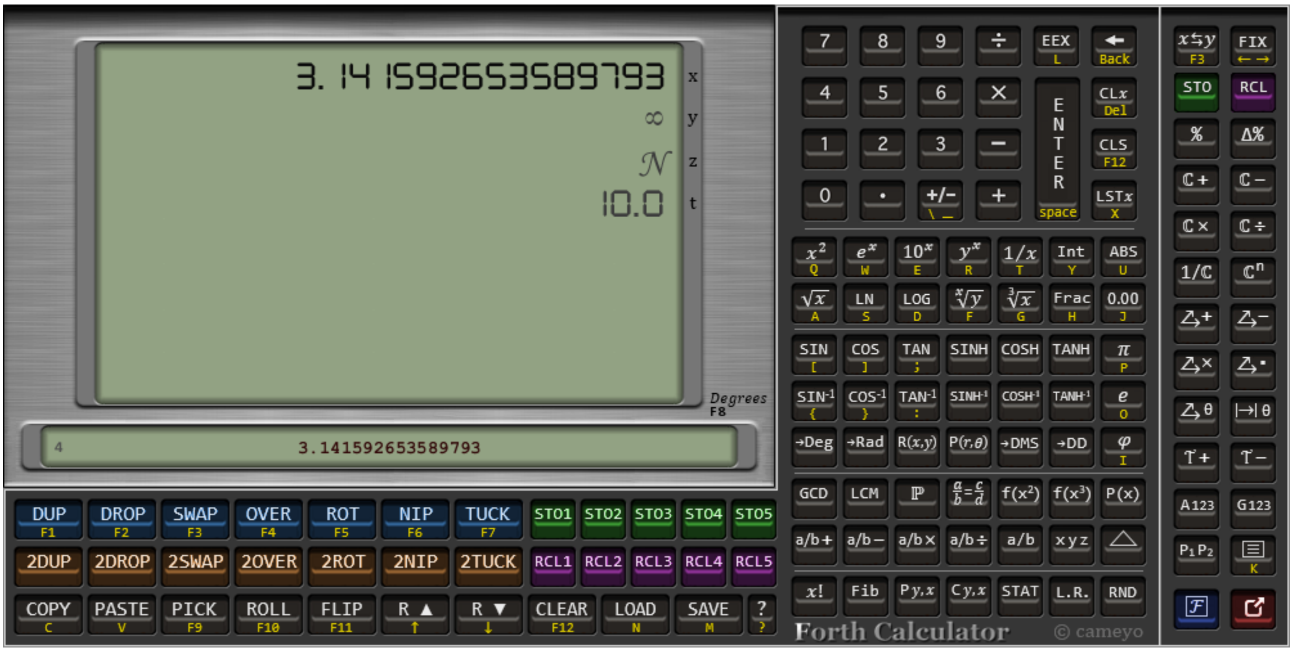
Introduction

Forth Calculator is a scientific calculator that uses RPN (Reverse Polish Notation) with an enhanced battery management with control of the Forth language.
It was developed with the intention of satisfying the needs of students and includes over 75 functions that relate to different branches of mathematics (algebra, geometry, statistics, trigonometry, combinatorics).
This manual describes the features and operation of the calculator.

You can find the latest version of the web at the program:https://github.com/cameyo42/ForthCalc
The program works with Windows, Mac OSX and Linux and is distributed in the source version: to use it in your computer you have to compile it (see Appendix C).

Note: In this manual, the numbers are displayed in international notation,
the point. "" represents the decimal separator and the comma "," it is the thousands separator.

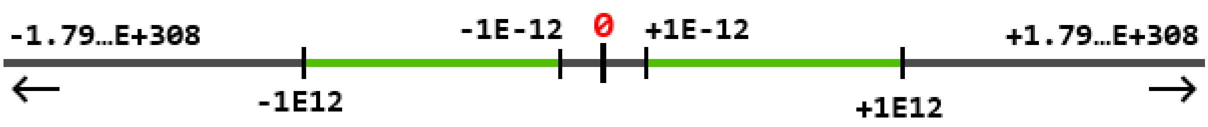
Chapter 1 - General Features



The calculator works with a stack of 4096 cells.
Each cell can contain a number.
The display shows the first 8 cells of the stack.
The range of numbers that can be used by the calculator ranges approximately from:
-1.79769313486231570E + 308 + 308 + 1.79769313486231570E (15 significant digits).
They also managed special numbers like Infinity (and NaN - Not a Number (∞) $\mathcal{N}$).
In the upper display the eight numbers at the top of the stack are displayed, with the first four values marked by the letters x, y, z, and t.
The lower display shows:

a) the number which is located on top of the stack in the real representation, or a notification message relating to the last performed operation (at the center)
b) the number of stack elements (left)

In the lower right next to the main display are the unit of measure used in trigonometric calculations (degrees or radians). Clicking on it it changes the unit of measurement.
The numbers between [-1e12, 1E12 +] and not from [1E-12, + 1E12] are shown in decimal notation; outside this range the numbers are displayed in exponential notation.



(rappresentazione non in scala)

The numbers that fall in the green zone are displayed as decimal numbers, others are displayed as numbers with exponent.
With decimal notation we can choose how many digits to display the decimal part of the numbers: zero to nine (in this case, the displayed number is rounded off the real number). We can also

choose to have the real representation of the number (the one used by the system during the calculation).
The calculator has 5 memory registers for storing numbers from the user.

Note: To view the shortcut keys, press the TAB key.

Note: To enable / disable the audible feedback of the keys, press the "="

Chapter 2 - Using and data visualization

The following figure shows the part of the calculator dedicated insertion and to change the numbers:

All numbers are entered in the register X (the one on top of the stack).

The table lists all the keys' functions (and their shortcuts) available to insert and edit a number in X-register:

KEY	FUNCTION	DESCRIPTION
0	**Insert digits (0..9)**	Inserts a digit in the X-register
•	**Decimal (. or,)**	Inserts the decimal separator
+/−	**Change sign (\ o _)**	Changes the sign of the register number X
EEX	**Numbers with exponent**	It allows you to enter numbers with exponent (Eg. X)$12.3E12 = 12.310^{12}$
←	**Back (Backspace)**	Delete the last digit entered
CLx	**X Clear (Del)**	Resets the value of the register X
CLS	**Clear Stack**	Delete all the data from the stack and resets the register X
LSTx	**Last X (x)**	Inserts in the X-register the previous value
ENTER	**ENTER or Enter (Enter or Space)**	Inserts the value of X in the stack (in the Y-register). The X register value remains unchanged. This button is used to separate the insertion of the numbers in the stack. In the manual, the ENTER key is represented by: ENTER

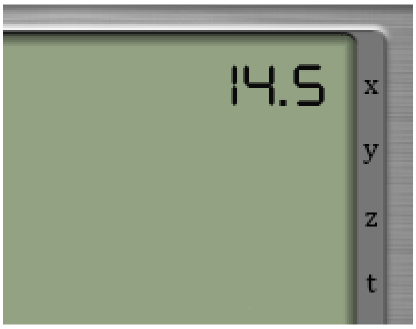
Note: The button FIX It allows you to specify the number of digits to display after the decimal point.

Note: To delete all the values of the stack press CLEAR.

Enter a number

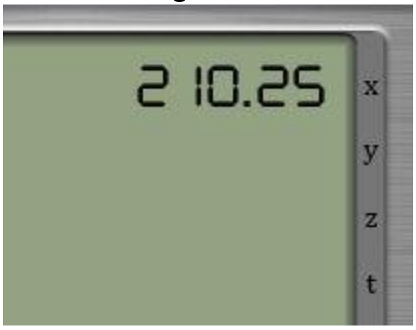
We insert the number in register X. 14.5

Press the keys:



At this point we can apply a function to that number.
Eleviamolo squared by pressing the button:

Now the X register contains the result.



Note: When we type a wrong digit can delete it by pressing the button .

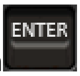
Insertion of two numbers

We insert the numbers 24:50 (one in the register X and the other in the Y-register) and calculate their sum.

to press 

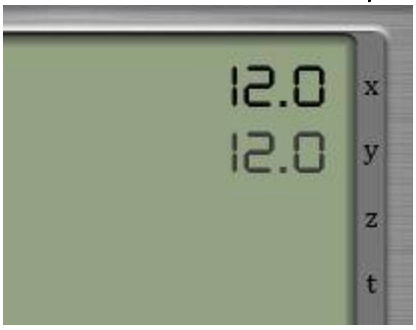
to reset the register X.

Press the keys:

Then press the button 

to "push" the value of the X-register in the register Y.

In RPN notation "ENTER" key is used to separate numbers to be entered.

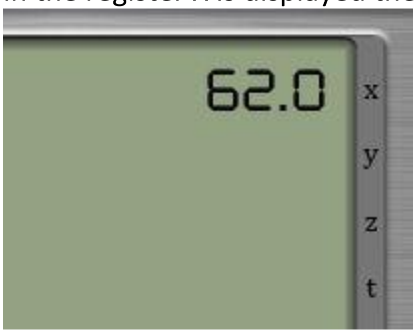


Enter the second number (which will be in the X-register):

Now we can apply a function to these two numbers (for example, the sum):

The values that we had in the X and Y registers have been "consumed" by the operation of addition:

in the register X is displayed the result of the operation, while the Y register is empty:



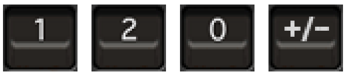
Inserting a negative number

We put the number -102.

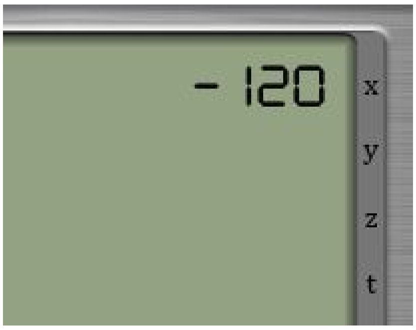
to press 

to reset the register X.

To enter a "-" (not the subtraction) must first enter at least one digit, after we put the sign when we want, here are two equivalent entries:



or



Note: Enter the number and then the sign.

Enter a number in exponential format

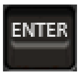
Suppose you want to enter the number x:3510^{12}

to press 

to reset the register X.

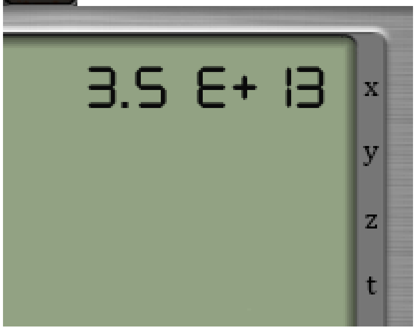
Enter the number 35:

Press the ENTER key:



Enter the number 12:

Press the button EEX:



Note: x$3510^{12} = 3.5\ \mathrm{E} + 13$

Note: In this way it is also possible to insert large numbers to decimal numbers (eg. X)$2210^{1.5}$

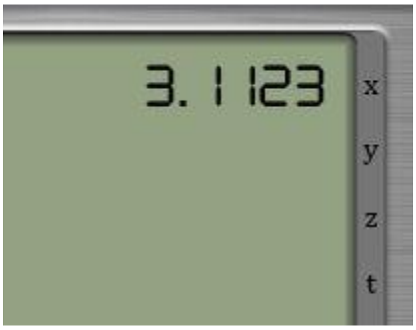
Setting the number of digits displayed

In the previous example we have found a number that is displayed with all the decimal digits (this is the actual number used by the calculator when performing operations).
We can choose how many digits we want to display after the decimal point (0 to 9).
We write the number 3.112293344556 (which has 12 digits after the decimal point) and then press ENTER:

Suppose you want to display the number to four decimal places after the decimal point, in this case, press the button 

then the key 

to get the following result:



The number is rounded and shown with four digits.

Note: The number is always worth 695.7010852370432, only changed his view.
Note: The new display is applied to all the numbers of the stack.

To view the actual number must use the value -1:
to press 

then the key 

to change the sign, press the key 

.

Note: The button 

It is located at the top right of the calculator.

Note: Pressing the keyboard keys ← (left arrow) and → (right arrow), you can automatically change the number of digits displayed after the decimal point.

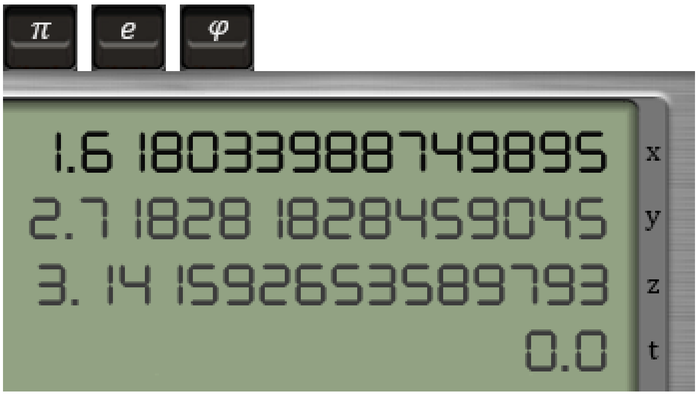
Chart Display Formats

Value	Format	data Type
-2	00,00,00	times
-1	Real number	Numbers

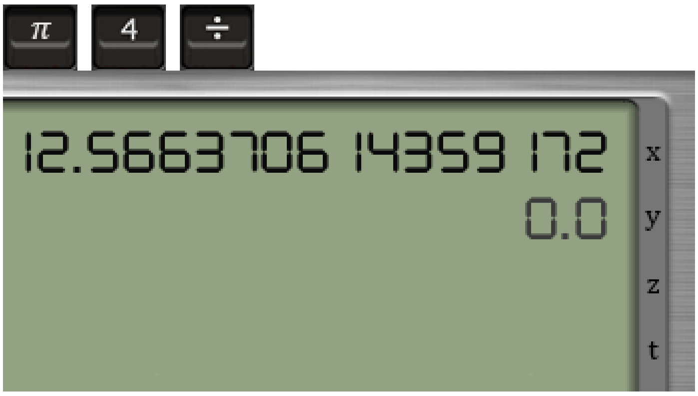
0..9	0..9 decimal	Numbers

Inserting, and $\boldsymbol{\pi e \varphi}$

To enter the constants Pi Greek or Euler's number or rapposto Aureo $\pi e \varphi$ simply press the corresponding button:



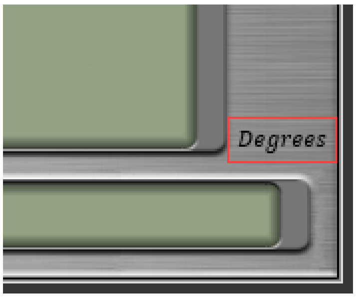
We calculate $\boldsymbol{\pi/4}$:

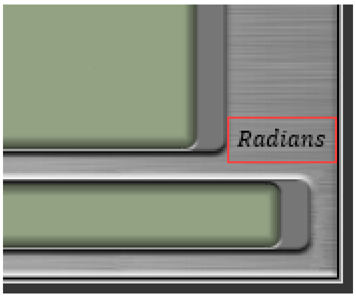


Note: After pressing one of three buttons NOT to press ENTER to enter another number.

trigonometric Choice of the unit for calculations (degrees or radians)

To change the trigonometric unit for inputting numbers to trigonometric calculations (by degrees in radians or vice versa), just click the relevant indicator on the display:



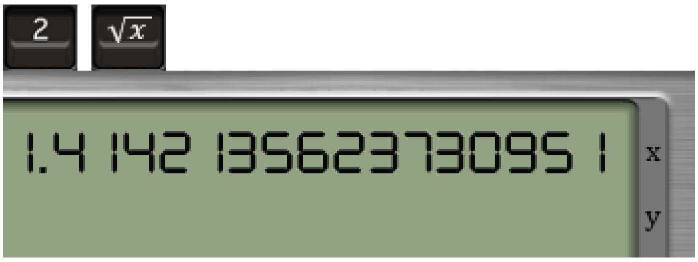


shortcut key: F8.

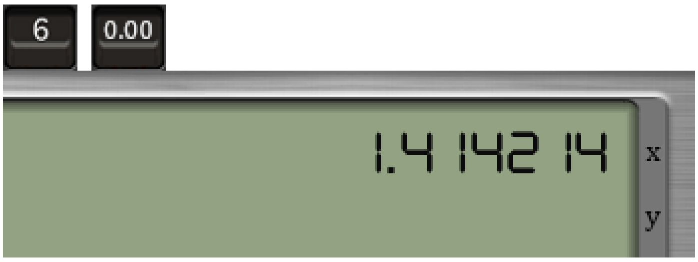
Rounding a Number

This function rounds the number in the X register with N decimal digits. The value of N is entered by the user.

Suppose we want to calculate with 6 decimal places:√2



Now to round up to 6 decimal places, simply press:



Note: This function changes the value of the number (not displayed).

Chapter 3 - Introduction to the use of the RPN

In this chapter we will see how the RPN notation (post-fix notation) and its key features.
Unlike the algebraic notation (in-fix notation) the RPN system can perform calculations without the use of parentheses.

Basic principles

- The number or numbers required for an operation (a function) must be entered before pressing the function button to apply: first the numbers, then the operator.
- The numbers needed to perform the operation must be separated by the ENTER key (except for the last number entered).
- The application of each operation / function eliminates from the data stack used and places the result in the top of the stack (one or more numbers).
- The result of each operation can be used in subsequent operations without pressing the ENTER key (the insertion of a new number automatically pushes the previous result in the stack)

The parameters of a function

One of the fundamental concepts is that the parameters of a function, this is the number of values required to apply a certain function. For example, to apply the square root function we need a single parameter: the value of a number; instead to apply the function LCM (Least Common Multiple), which calculates the least common multiple, we need at least two values.
Note: the application of a function performs different actions:

a) calculates the result of the function
b) eliminates from the stack the values used for the calculation
c) It fits into X cell (or multiple cells) the result value

Let's see some example cases:

1) Function applied to a value

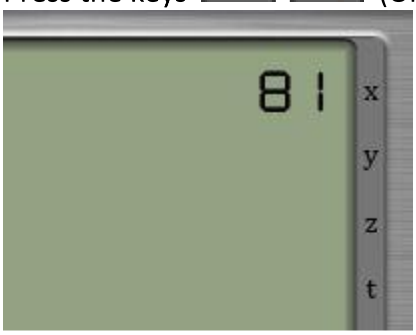
<u>Calculate the cube root of 81</u>

to press 

to reset the register X.

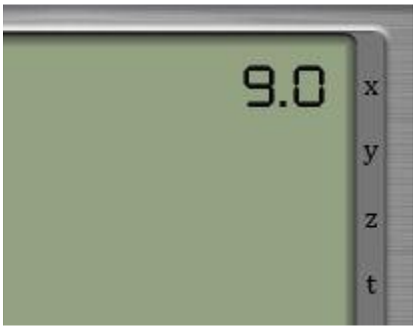
Press the keys 

(Only parameter):



Press the button 

:

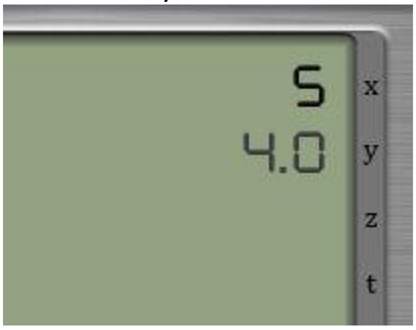


2) Function applied to two values

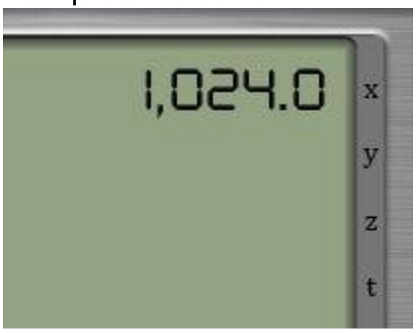
To calculate 4^5

to press CLx to reset the register X.

Press the keys 4 ENTER and then 5



Now press the button y^x



3) Function applied to multiple values

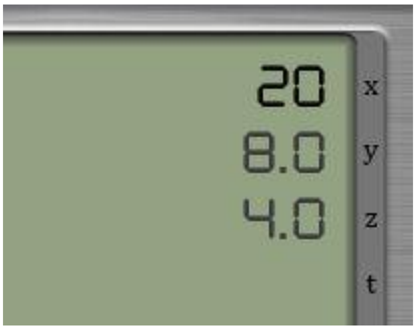
Calculate the greatest common divisor of the numbers 3, 8 and 12.

The function GCD (Greatest Common Divisor) calculates the greatest common divisor and is applied to all the values of the stack.

to press CLEAR to eliminate all the values of the stack and reset the register X.

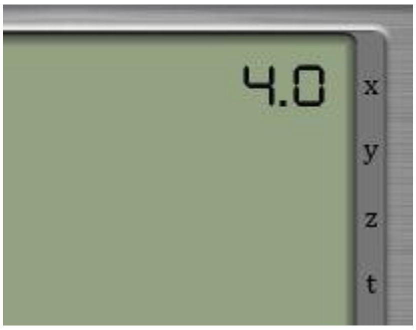
Press the keys 4 ENTER 8 ENTER 2 0:

Note: The utime entered value is not followed by the "ENTER" key as it is already in the cell X of the stack.



Finally press 

:



Functions that return more than one value

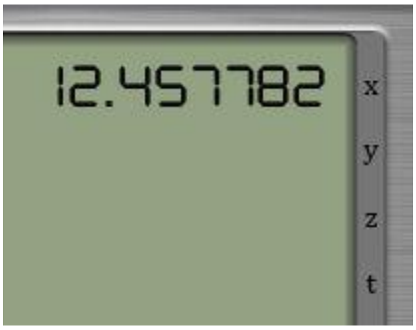
So far we have seen functions that return a single value, but there are also functions that have more than one value as a result. For example, the function → DMS (Degrees, Minutes, Seconds) converts a coordinate expressed in decimal degrees a coordinated expressed in degrees, minutes, seconds (The inverse function is → DD). So in this case, three values are returned: the degrees, minutes and seconds; these values are stored in an orderly manner in the cells at the top of the stack: the degrees in the cell X, minutes and seconds in the Y cell in the cell Z.
Here's an example:
Convert the decimal coordinate 12.457782 in degrees minutes seconds

to press 

to reset the X-register

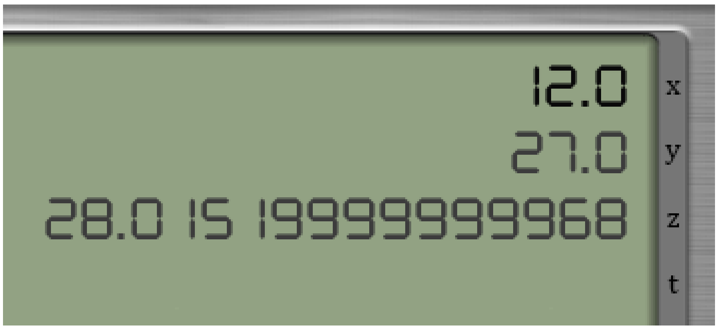
Press the keys 

:



Press the button 

:



The result is 12 ° 27 '28.01519999999968' '(approximate 12 ° 27' 28.0152 ").
As you can see the data are stored in sequence starting from the cell on top of the stack (X): grades in the cell X, minutes and seconds in the Y cell in the cell Z.

We see to complete the reverse operation:
Convert the coordinate 77 ° 42 '32' 'in decimal degrees

to press 

to reset the register X.

Press the keys 

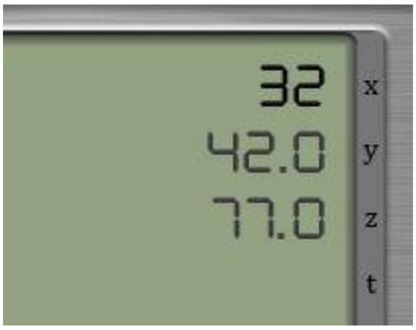
to enter the degrees.

Press the keys 

to enter the minutes.

Press the keys 

to enter the seconds.



Finally press 

.

Quesa time we have only one result (s Decimal Degrees) located nalla cell X.

The advantages of RPN

- The RPN logic system allows to evaluate virtually any expression without use and remember the brackets or restructure operations.
- RPN solves the problems in the same way that you learn early math with paper and pencil.
- RPN helps solve problems incrementally, a little at a time. Never work with more than two numbers at once.
- RPN shows continuous and immediate feedback. It can all intermediate responses of each operation used because the calculator performs each function immediately after pressing the function key.
- RPN makes it easy recovery of errors, it is possible to restore the logic of the operations because the calcolatorice performs operations in sequence.
- RPN allows you to reuse the numbers without typing again. This results in a great time saver when working with expressions or chained calculations.
- RPN is a more logical input method. Once used RPN, algebraic system will seem primitive.

RPN Reference Card

Calculations with a number:

1) Enter the number,
2) Press the function key to apply.

EXAMPLE	KEYS	RESULT
$\sqrt{2}$	2 $\sqrt{x}$	1.41422135623730951
22^2	2 2 x^2	484.0

Calculations with two numbers:

1) Enter the first number,
2) Press ENTER (to separate the first from the second number)
3) Enter the second number (do not press ENTER)
4) Press the function key to apply.

EXAMPLE	KEYS	RESULT
$(12 + 3)$	1 2 ENTER 3 +	15.0
$(14 * 2)$	1 4 ENTER 2 ×	28.0

A series of additions and subtractions or multiplications:

1) Enter the first number,
2) Press ENTER
3) Enter the second number
4) Press the function key to apply
5) Repeat 3) and 4) for all other numbers

EXAMPLE	KEYS	RESULT
$(1 + 3 + 2 + 4)$	1 ENTER 3 + 2 + 4 +	15.0
$(14 * 2 * 3)$	1 4 ENTER 2 × 3 ×	28.0

Calculations concatenated (one level of parentheses)

Calculate the values as you would with pen and paper.

EXAMPLE	KEYS	RESULT
$(1 + 3) - (4 * 2)$	1 ENTER 3 + 4 ENTER 2 × −	-4
$(4 * 2) + (2 * 3)$	4 ENTER 2 × 2 ENTER × 3 +	14.0

Calculations concatenated (with multiple levels of brackets)

Calculate the values starting from the most nested parenthesis level.

EXAMPLE	KEYS	RESULT
$2 * (3 + (4 * 2))$	4 ENTER 2 × 3 + − 2 ×	10.0

$1 + (2 * (3 + 4))$	3 ENTER 4 + 2 × 1 +	15.0

Calculations concatenated with a non-commutative operations (with multiple levels of parenthesis)
Some functions are not commutative, for example $(-, \div, y^x)(2 - 3) \neq (3 - 2)$.

In this case we can use the button SWAP to exchange the places of the registers X and Y values

EXAMPLE	KEYS	RESULT
$2 * (6 \div (2 * 3))$	2 ENTER 3 × 6 SWAP ÷ 2 ×	2.0
$1 + (2 - (3 + 4))$	3 ENTER 4 + 2 SWAP − 1 +	-4.0

Note: The shortcut key for SWAP is F3.

Using Memories (STO and RCL)
Although the battery is able to support a virtually unlimited sequence of operations, in some cases it may be convenient to use the memory cells (five) available to the user.
The STO1 buttons, STO2, STO3, STO4 STO5 and store the current value of the cell X, while the corresponding keys RCL1, RCL2, RCL3, RCL4 RCL5 and restore cell X in the stored value.
To calculate .$[(2^4 + 3^2) * (4^3 - 5^2)] - [(3^2) * (2 + 4^2)]$
We calculate and store in STO1, then calculate finally recall the stored value with RLC1 and do the subtraction.$[(3^2) * (2 + 4^2)][(2^4 + 3^2) * (4^3 - 5^2)]$

3 x^2 4 x^2 2 + × STO1

$[(3^2) * (2 + 4^2)] = 162$

2 ENTER 4 y^x 3 x^2 + 4 ENTER 3 y^x 5 x^2 − ×

$[(2^4 + 3^2) * (4^3 - 5^2)] = 975$

RCL1 − $= 813$

nested Expressions

When we calculate the expressions with nested parentheses typically it is convenient to begin the calculations with the more internal and work outward. Consider the following expression:

$$[2 * [3 + 5 * (6 + 7)]$$

Setting out from the inner we can proceed as follows:$(6 + 7)$

6 ENTER 7 + 5 × 3 + 2 × $= 136$

If we start from the left and proceed to the right we have to write:

2 ENTER 3 ENTER 5 ENTER 6 ENTER 7 + × + × $= 136$

So starting with the more internal they have the following advantages:

1) It is easier to keep track of what you are doing
2) It should be a smaller number of keys to solve the entire expression

In special cases it is more convenient and intuitive to operate from left to right.
For example, to calculate we can do this in two different ways:4^{3^2}
First we start with the more internal and continue outwards3^2

3 ENTER 2 y^x 4 SWAP y^x $= 262{,}144.0$

In the second method we calculate from left to right

4 ENTER 3 y^x 2 y^x $= 262{,}144.0$

As you can see the second method does not need to exchange items with the SWAP button.

Chapter 4 - Examples on the calculation of expressions

+ - ÷ ×

This section presents the classic examples to evaluate expressions.
Try it yourself to solve them.
Note: solutions have been tested with this calculator.

Example 1

+ - ÷ ×

$$\sqrt{\frac{\mathbf{8.33 \times (4 - 5.2) \div [(8.33 - 7.46) \times 0.32]}}{\mathbf{4.3 \times (3.15 - 2.75) - (1.71) \times (2.01)}}}$$

KEYS	DISPLAY	COMMENT
4 ENTER	4	
5.2 -	1.2	Result 4 - 5.2
8:33 ×	-9996	(4 result - 5.2) × 8:33
LSTx	8:33	Call the number displayed before the last operation
7:46 -	0.87	from 8:33 to 7:46 Result
0:32 ×	0.2784	Outcome (8:33 to 7:46) × 0:32
÷	-35.90517241	Outcome -9996 ÷ 0.2784, the numerator of the division.
3:15 ENTER	3:15	
2.75 -	0.4	Result of 3.15 - 2.75
4.3 ×	1.72	Result of 4.3 × (3.15 - 2.75)
1.71 ENTER	1.71	
1.2 ×	3.4371	Result of 1.71 × 1.2
-	-1.7171	Result of 1.72 - 3.4371, the denominator of the division.
÷	20.910356074	
$\sqrt{x}$	4.572784280	Final results

This example can be found in the book HP-11C Owner's Handbook (1981).

Example 2

\+ - ÷ ×

$$\frac{(\mathbf{3}+\mathbf{1})\times(\mathbf{4}+\mathbf{3})+(\mathbf{2}+\mathbf{6})\times(\mathbf{4}+\mathbf{6})}{(\mathbf{2}+\mathbf{3})\times(\mathbf{2}+\mathbf{1})+(\mathbf{3}+\mathbf{5})\times(\mathbf{4}+\mathbf{2})}$$

KEYS	DISPLAY	COMMENT
3 ENTER 1 +	4	Let's start with the first expression of the numerator
4 ENTER 3 +	7	
×	28	outcome $(3+1)\times(4+3)$
ENTER 6 + 2	8	
4 ENTER 6 +	10	
×	80	outcome $(2+6)\times(4+6)$
+	108	The numerator: 28 + 80
2 ENTER 3 +	5	
2 ENTER 1 +	3	
×	15	outcome $(2+3)\times(2+1)$
ENTER 3 5 +	8	
4 ENTER 2 +	6	
×	48	outcome $(3+5)\times(4+2)$
+	63	The denominator: 15 + 48
÷	1.714285714	108/63 Final Result

Example 3

+ - ÷ ×

$$\frac{(\mathbf{3}^{\frac{2}{7}} + \mathbf{4}^{\frac{4}{9}})}{(\mathbf{7}^{\frac{1}{4}} + \mathbf{8}^{\frac{3}{5}})}$$

KEYS	DISPLAY	COMMENT
3 ENTER		We start from the numerator
7 ÷ 2 ENTER		$2/7$
y^x	1.368738	$\mathbf{3}^{\frac{2}{7}}$
4 ENTER		
4 ENTER 9 ÷		$4/9$
y^x	1.851749	$\mathbf{4}^{\frac{4}{9}}$
+	3.220488	$\mathbf{3}^{\frac{2}{7}} + \mathbf{4}^{\frac{4}{9}}$
7 ENTER		
ENTER 1 ÷ 4		$1/4$
y^x	1.626577	$\mathbf{7}^{\frac{1}{4}}$
8 ENTER		
3 5 ENTER ÷		$3/5$
y^x	3.482202	$\mathbf{8}^{\frac{3}{5}}$
+	5.108779	$\mathbf{7}^{\frac{1}{4}} + \mathbf{8}^{\frac{3}{5}}$
÷	0.630383	Final results

Chapter 5 - The calculator in action

In this chapter we will see how to use the calculator to automatically solve some mathematical problems.
All scientific calculators possess basic functions which allow to carry out normal arithmetic / trigonometry and advanced features that vary from model to model. This calculator has some features that automatically solve various mathematical problems.
The explanations of the various functions contain the parameters of the function (input data) and the function result (one or more values) with a variable number of decimal places.

Coordinate Conversion from Decimal Degrees to Degrees, Minutes, Seconds

Convert 13.561245 in degrees, minutes, seconds

Parameters of the function	the Function Key	Result	Logs	Unknown
13.561245	→DMS	13.000000	X	degrees
		33.000000	Y	minutes
		40.482000	Z	seconds

Coordinate Conversion from Degrees, Minutes, Seconds to Decimal Degrees

Convert 12 ° 45 '22' 'in decimal degrees

Parameters of the function	the Function Key	Result	Logs
12 ENTER	→DD	12.756111	X
45 ENTER			Y
22			Z

Converting to Rectangular Coordinates in Polar Coordinates

Convert x = 10, y = 30 in polar coordinates

Parameters of the function	the Function Key	Result	Logs	Unknown
10 ENTER	P(r,θ)	31.622777	X	x
30		33.000000	Y	y
		40.48200	Z	

Convert Polar to Rectangular Coordinates Coordinates

Convert r = 56 and θ = 27 in rectangular coordinates

Parameters of the function	the Function Key	Result	Logs
56 ENTER	R(x,y)	49.896365	X
27		25.423468	Y

Calculating the Greatest Common Divisor

Calculate the greatest common divisor of the numbers 40, 24, 88

Parameters of the function	the Function Key	Result	Logs
40 ENTER	GCD	8.000000	X
24 ENTER			
88			

Note: The GCD calculates the greatest common divisor of all the numbers of the stack

Calculation of the minimum common multiple

Calculate the least common multiple of the numbers 40, 24, 88

Parameters of the function	the Function Key	Result	Logs
12 ENTER	LCM	168.000000	X
8 ENTER			
14			

Note: The LCM calculates the least common multiple of all the numbers of the stack

Factoring in prime numbers

Factoring the number 130

Parameters of the function	the Function Key	Result	Logs
130 ENTER	Fact	13.0000	X
		5.0000	Y
		2.0000	Z

calculating Proportions

Calculate the missing value in the proportion: 26: 4 = x: 32

Note: The missing value is inserted as 0 (zero).

Parameters of the function	the Function Key	Result	Logs
26 ENTER	$\frac{a}{b}=\frac{c}{d}$	32.0000	X
4 ENTER		208.0000	Y
0 ENTER		4.0000	Z
32		26.0000	T

of Second Degree Equations Resolution (re, im)

Solve the equation $-3x^2 + 2x - 2 = 0$

Parameters of the function	the Function Key	Result	Logs	Unknown
-3 ENTER	$f(x^2)$	0.333333	X	Re (x1)
2 ENTER		0.745356	Y	Im (x1)
-2		0.333333	Z	Re (x2)
		-0.745356	T	Im (x2)

Equations of third degree Resolution (re, im)

Solve the equation $3x^3 - 2x^2 + 4x - 3 = 0$

Parameters of the function	the Function Key	Result	Logs	Unknown
3 ENTER	$f(x^3)$	0.726373	X	Re (x1)
-2 ENTER		0.000000	Y	Im (x1)
4		-0.029853	Z	Re (x2)
-3		1.172950	T	Im (x2)
		-0.029853		Re (x3)
		-1.172950		Im (x3)

polynomials Rating

Evaluate the polynomial at the point$3x^2 - 4x - 6x = 5$

Parameters of the function	the Function Key	Result	Logs
3 ENTER	P(x)	49.0000	X
-4 ENTER			Y
-6 ENTER			Z
2 ENTER (polynomial)			T
5			

Note: Any missing terms of the polynomial must be entered as zero.

Resolution of Linear Systems (2x2, ..., 5x5)

Solve the linear system:

$x + 2y = 1$

$2x - 3y = -2$

Parameters of the function	the Function Key	Result	Logs	Unknown
1 ENTER	xyz	-0.142857	X	x
2 ENTER		0.571429	Y	y
1 ENTER				
2 ENTER				
-3 ENTER				
-2 ENTER				
2 (num. Equations)				

Note: Any missing terms of the equations are entered as zero.

Solve the linear system:

$x\ +\ 2y - z = 1$

$2x - 3y + 2z = -2$

$-3x + y - 3z = 1$

Parameters of the function	**the Function Key**	**Result**	**Logs**	**Unknown**
1 ENTER		-0.142857	X	x
2 ENTER		0.571429	Y	y
-1 ENTER		0.000000	Z	z
1 ENTER				
2 ENTER				
-3 ENTER				
2 ENTER				
-2 ENTER				
-3 ENTER				
1 ENTER				
-3 ENTER				
1 ENTER				
3 (num. Equations)				

Solve the linear system:

$x + y + z - 4t + 2w = 1$
$2x - 3y - 3z + t + w = -2$
$3x + 2y - z + 4t - 2w = 6$
$2x - y + 3z - 2t + 4w = 6$
$-x - y - z - t - w = -5$

Parameters of the function	the Function Key	Result	Logs	Unknown
1 ENTER		1.0000	X	x
1 ENTER		1.0000	Y	y
1 ENTER		1.0000	Z	z
-4 ENTER		1.0000	T	t
2 ENTER		1.0000		w
1 ENTER				
2 ENTER				
-3 ENTER				
-3 ENTER				
1 ENTER				
1 ENTER				
-2 ENTER				
3 ENTER				
2 ENTER				
-1 ENTER				
4 ENTER				
-2 ENTER				
6 ENTER				
2 ENTER				
-1 ENTER				
3 ENTER				
-2 ENTER				
4 ENTER				
6 ENTER				
-1 ENTER				
-1 ENTER				
-1 ENTER				
-1 ENTER				
-1 ENTER				
-5 ENTER				
5 (num. Equations)				

Calculation of Fractions

Sum the two fractions and $5/67/12$

Parameters of the function	the Function Key	Result	Logs
5 ENTER	a/b+	17.0000 (num)	X
6 ENTER		12.0000 (den)	Y
7 ENTER			Z
12 ENTER			T

Note: The resulting fraction is automatically simplified

Divide the two fractions and $5/67/12$

Parameters of the function	the Function Key	Result	Logs
5 ENTER	a/b÷	10.0000 (num)	X
6 ENTER		7.0000 (den)	Y
7 ENTER			Z
12 ENTER			T

Number Convert to Decimal Fraction

Convert the decimal to a fraction generating1.14

Parameters of the function	the Function Key	Result	Logs
1:14 ENTER	a/b	57.0000 (num)	X
0 (period length)		50.0000 (den)	Y

Convert the decimal to a fraction generating$1.1\overline{4}$

Parameters of the function	the Function Key	Result	Logs
1:14 ENTER	a/b	103.0000 (num)	X
1 (period length)		90.0000 (den)	Y

Convert the decimal to a fraction generating$1.01\overline{42}$

Parameters of the function	the Function Key	Result	Logs
1.0142 ENTER	a/b	3347.0000 (num)	X
2 (period length)		3300.0000 (den)	Y

the number Factorial Calculation

Calculate the factorial of 10

Parameters of the function	the Function Key	Result	Logs
10	x!	3,628,800.0	X

Calculate the factorial of 200

Parameters of the function	the Function Key	Result	Logs
200	x!	∞	X

Result:788657867364790503552363213932185062295135977687173263294742533244359449963403342920304284011984623904177212138919638830257642790242637105061926624952829931113462857270763317237396988943922445621451664240254033291864131227428294853277524242407573903240321257405579568660226031904170324062351700858796178922222789623703897374720000000000000000000000000000000000000000000000000

Note: The factorial function fact save a file <number> .txt file in the data folder (where the program) with the value of factorial was installed.

Note: If the value of the saved file contains the actual value.∞

the Fibonacci number calculation

Calculate the Fibonacci number of 10

Parameters of the function	the Function Key	Result	Logs
10	Fib	55.0	X

Calculate the Fibonacci number 1500

Parameters of the function	the Function Key	Result	Logs
1500	Fib	∞	X

Result:
1355112566856310195163693686714840837778601071241849724213354315322148731087352875061225935403571726530037377881434732025769925708235655004534991410292424959599748398222869928752724193181132509509964244762124220020925443992019696046532143849830534589337893258539338153909354947929619480083814599618712258335489800

Note: The factorial function saves fibo file <number> .txt file in the data folder (where the program) with the value of factorial was installed.

Note: If the result of a value, the saved file contains the actual value.∞

Statistical Parametric a Series

Calculate the statistical parameters of the series: $21, 23, 37, 23, 38, 2, 10$

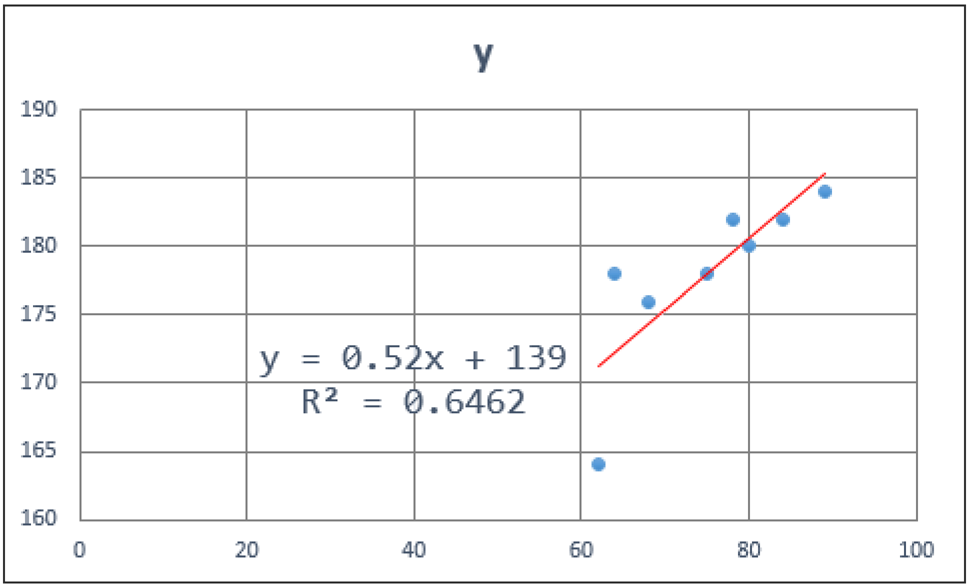
Parameters of the function	the Function Key	Result	Logs	Unknown
10 ENTER		7.0	X	N° values
2 ENTER		154.0	Y	Sum
38 ENTER		2.0	Z	Minimum
23 ENTER	STAT	38.0	T	Maximum
37 ENTER		22.0		Average
23 ENTER		23.0		Median
21		171.3333		Variance
		13.0894		Std Dev

Linear Regression

Given a number of pairs of data Linear Regression function calculates (with the method of least squares) the coefficients $N(x_i, y_i)q$ is of the interpolation line and the coefficient of determination.$my = m * x + qR^2$

Example:

x	y
62	164
64	178
68	176
75	178
78	182
80	180
84	182
89	184



Parameters of the function	the Function Key	Result	Logs	Unknown
62 164 ENTER ENTER		139.0	X	q
64 178 ENTER ENTER		00:52	Y	m
68 176 ENTER ENTER		0.6462	Z	R2
75 178 ENTER ENTER	L.R.			
78 182 ENTER ENTER				
80 180 ENTER ENTER				
84 182 ENTER ENTER				
89 184 ENTER ENTER				

Permutations

Calculate the number of groups with x elements selected from elements y (with a different sort)
Number of option to choose an ordered set of r (x) properties to a total of (y) objects
Pr (n, r) = n! / (N-r)! NPr (n, r) = n! / (N-r)!
Example
There are 3 people (A, B and C) and two chairs. How many different ways can sit the two people?
Solution: different ways $\{AB, BA, AC, CA, BC, CB\} = 6(poich\grave{e}\ AB \neq BA, AC \neq CA\ e\ BC \neq CB)$
$nPr(n,r) = n!/(n-r)! = 3!/(3-2)! = 6$

Parameters of the function	the Function Key	Result	Logs
3 ENTER		6.0000	X
2			

Combinations

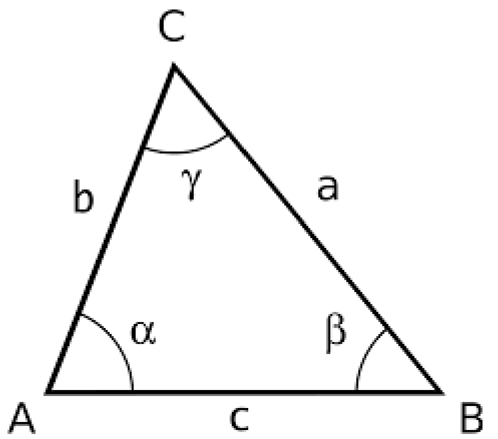
Calculate the number of groups with x elements selected from elements y (independent law)
Number of dii possibility to choose an unordered set of r (x) elements selected from a total of n (y) elements.
There are 3 people (A, B and C) and two chairs. How many different ways can choose the people to be seated?
Solution: different ways $\{AB, AC, BC\} = 3(poich\grave{e}\ AB = BA, AC = CA\ e\ BC = CB)$
$nCr(n,r) = n!/r!\,(n-r)! = 3!/2!\,(3-2)! = 3$

Parameters of the function	the Function Key	Result	Logs
3 ENTER		3.0000	X
2			

Triangle Resolution

This function finds the solution of the triangle in the five cases:

1) Side Side Side - LLL
2) Side Side Angle - LLA
3) Side Angle Side - LAL
4) Angle Side Angle - ALA
5) Angle Angle Side - AAL



(Image from Wikipedia)

The parameters of the triangle should be placed in the following order: $\boldsymbol{a}, \boldsymbol{b}, \boldsymbol{c}, \boldsymbol{\alpha}, \boldsymbol{\beta}, \boldsymbol{\gamma}$.
Note: The missing parameters are entered with the number zero.

Determine the unknown elements of a triangle that has $c = 125m, \beta = 80$ e $\alpha = 70$.

Parameters of the function	the Function Key	Result	Logs	Variable
0 ENTER		234.9232	X	to
0 ENTER		246.2019	Y	b
125 ENTER		125.0000	Z	c
70 ENTER		70.0000	T	α
80 ENTER		80.0000		β
0		30.0000		γ

Determine the unknown elements of a triangle that has $b = 121m, c = 76m$ e $\beta = 70$.

Parameters of the function	the Function Key	Result	Logs	Variable
0 ENTER		123.6699	X	to
121 ENTER		121.0000	Y	b
76 ENTER		76.0000	Z	c
0 ENTER		73.8274	T	α
70 ENTER		70.0000		β
0		36.1726		γ

Determine the unknown elements of a triangle that has $a = 695, b = 453m$ e $\beta = 39$.

Parameters of the function	**the Function Key**	**Result**	**Logs**	**Variable**
695 ENTER		695.0000	X	to
453 ENTER		453.0000	Y	b
0 ENTER		658.0561	Z	c
0 ENTER		74.9090	T	α
39 ENTER		39.0000		β
0		66.0910		γ
		695.0000		a1
		453.0000		b1
		422.1767		c1
		105.0910		α1
		39.0000		β1
		35.9090		γ1

In this case there are two solutions. To view all the results need to slide the stack upwards with the R key ↑.

Determine the unknown elements of a triangle that has $a = 18, b = 36m$ e $\alpha = 45$.

Parameters of the function	**the Function Key**	**Result**	**Logs**	**Variable**
18 ENTER		0.0000	X	γ
36 ENTER		0.0000	Y	β
0 ENTER		45.0000	Z	α
45 ENTER		0.0000	T	c
0 ENTER		36.0000		b
0		18.0000		to

In this case there are no solutions and data remain unchanged.

Calculations with Complex Numbers

The arithmetic mean of complex numbers comprises the addition, subtraction, division, multiplication, the inverse and power.

The numbers are entered in the natural order:.$(a\ +\ ib)\ e\ (c\ + id)$

Addition of two complex numbers

We calculate $(2 + 3i)\ +\ (4 + 5i)$

Parameters of the function	the Function Key	Result	Logs	Variable
2 ENTER	ℂ+	6.0	X	Re1
3 ENTER		8.0	Y	Im1
4 ENTER				
5				

Division of two complex numbers

We calculate $(4 + 3i)\ /\ (3 - 2i)$

Parameters of the function	the Function Key	Result	Logs	Variable
4 ENTER	ℂ÷	1.307692307692	X	Re1
3 ENTER		0.461538461538	Y	Im1
3 ENTER				
-2				

The solution applies $1.\overline{307692} + i0.\overline{461538}$.

We can use the function to calculate the fraction Generating generating fractions:

Parameters of the function	the Function Key	Result	Logs	Variable
1.307692 ENTER	a/b	6	X	Numerator
6 (length of the period)		13	Y	Denominator

Parameters of the function	the Function Key	Result	Logs	Variable
1.0461538 ENTER	a/b	17	X	Numerator
6 (length of the period)		13	Y	Denominator

So the result of the division is:.$\frac{6}{13} + i\,\frac{17}{13}$

Inverse of a complex number

We calculate the inverse of $(3 - i4)$

Parameters of the function	the Function Key	Result	Logs	Variable
3 ENTER	1/ℂ	00:12	X	Re1
-4		-0.16	Y	Im1

The result is true. (Try to calculate the generating fractions).$0.12 + i016 = \frac{3}{25} + i\,\frac{4}{25}$

Power of a complex number

We calculate $(2 - i4)^3$

Parameters of the function	the Function Key	Result	Logs	Variable
2 ENTER		-88	X	Re1
-4		16	Y	Im1
3				

Calculations with vectors

The operations available on three-dimensional vectors (3D) are: addition, subtraction, the vector product (cross-product), the scalar product (dot-product), the angle between two vectors, the magnitude and the direction of a vector.
The numbers are entered in the natural order:.$x1, y1, z1$ e $x2, y2, z2$
To calculate the two-dimensional vectors we set to zero the coordinate values.z

Addition of two vectors

We calculate $v1 = (4,10,2) + v2 = (4, -8, -3)$

Parameters of the function	the Function Key	Result	Logs	Variable
4 ENTER		8.0	X	x
10 ENTER		2.0	Y	y
2 ENTER		-1	Z	z
4 ENTER				
-8 ENTER				
-3				

vector product of two vectors

We calculate $v1 = (4,10,2) \times v2 = (4, -8, -3)$

Parameters of the function	the Function Key	Result	Logs	Variable
4 ENTER		-14	X	x
10 ENTER		20	Y	y
2 ENTER		-72	Z	z
4 ENTER				
-8 ENTER				
-3				

Scalar product of two vectors

We calculate $v1 = (4,10,2) \times v2 = (4, -8, -3)$

Parameters of the function	the Function Key	Result	Logs	Variable
4 ENTER		-70	X	Climb
10 ENTER			Y	
2 ENTER				
4 ENTER				
-8 ENTER				
-3				

The angle between two vectors

We calculate the angle between the vectors $v1 = (4,10,2)$ e $v2 = (4,-8,-3)$

Parameters of the function	**the Function Key**	**Result**	**Logs**	**Variable**
4 ENTER		132.6368	X	Angle
10 ENTER				
2 ENTER				
4 ENTER				
-8 ENTER				
-3				

Magnitude and direction of a vector

We calculate the magnitufine and the direction of the vector $v = (4,-8,-3)$

Parameters of the function	**the Function Key**	**Result**	**Logs**	**Variable**
4 ENTER		9.4340	X	Magnitude
-8 ENTER		-63.4349	Y	Direction
-3				

Addition and Subtraction of time

We can add and subtract numbers representing the time with the format hhmmss (hours minutes seconds).
To view this format you must set up a new view of the numbers as follows:

Now we can enter numbers that represent the times:

Time	Inserting	Display
45 hours 23 min 56 sec	452356 ENTER	45,23,56
12 hours 3 min 56 sec	120356 ENTER	12,03,56
0 h 23 min 0 sec	2300 ENTER	23,00
0 hours 0 min 42 sec	42 ENTER	42
1 hour 0 min 5 sec	10005 ENTER	1,00,05

We calculate $6\ ore\ 54\ min\ 59\ sec\ +\ 1\ ora\ 5\ min\ 1\ sec\ =\ 8\ ore\ 0\ min\ 0\ sec$

Parameters of the function	the Function Key	Result	Logs	Variable
65459 ENTER		8,00,00	X	Sum
10501 ENTER				

We calculate $2\ ore\ 2\ min\ 2\ sec -\ 1\ ora\ 2\ min\ 3\ sec\ =\ 59\ min\ 59\ sec$

Parameters of the function	the Function Key	Result	Logs	Variable
20202 ENTER		59.59	X	Difference
10203 ENTER				

Note: When you do not operate with the times we may want to change the display format of numbers.

Numerical Sequence Generation

Functions A123 is G123 allow to generate sequences of arithmetic and geometric numbers.
The number of arithmetic formula is: $\boldsymbol{x_n = x_0 + distanza * (n-1)}$
Example
A sequence of numbers that starts with a number contains$x_0 = 1 distanza = 3 n = 5$
1,4,7,10,13

Parameters of the function	the Function Key	Result	Logs
1 ENTER	A123	13.0	X
3 ENTER		10.0	Y
5		7.0	Z
		4.0	T
		1.0	

The formula for the geometric series is: $\boldsymbol{x_n = x_0 * rapporto * (n-1)}$
Example
A sequence of numbers that starts with a containing numbers$x_0 = 1 rapporto = 2 n = 5$
1,2,4,8,16

Parameters of the function	the Function Key	Result	Logs
1 ENTER	G123	16.0	X
2 ENTER		8.0	Y
5		4.0	Z
		2.0	T
		1.0	

Note: You can reverse the order of the numbers in the stack with the key FLIP.

Distance, slope and the straight line passing through two points

Given two points, and this function calculates the distance between the two points, and the slope and the coefficients of the straight line that passes through the data points.$P_1 = (x_1, y_1) P_2 = (x_2, y_2) mq y = m * x + q$
Example: and $P_1 = (2,3) P_2 = (7,9)$

Parameters of the function	the Function Key	Result	Logs	Variable
2 ENTER	P1 P2	7.8102	X	Distance
3 ENTER		50.1944	Y	Slope
7 ENTER		1.2	Z	m
9		0.6	T	q

Chapter 6 - Memories

The calculator has five (5) memory for storing numbers.

Pressing one of the following keys 

is stored on the corresponding memory (1..5) the value of the register X.

Pressing one of the following keys 

It is loaded into the X-register the value stored in the corresponding memory (1..5).

Pressing 

They are stored in the memories 1..5 the first five values of the stack.

Pressing 

are inserted into the stack the values stored in memories 1..5.

NoteThe values recorded in the memories are lost when you exit the program.

Chapter 7 - Advanced techniques for the management of the stack

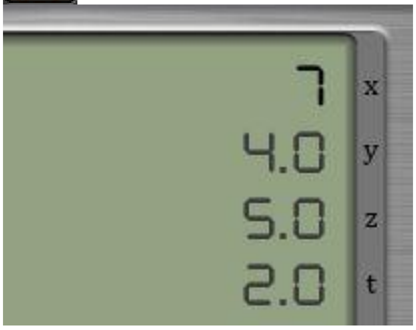
The Forth commands allow the creation of practical and fast calculation techniques. Let us analyze some examples to understand and use these features. It should be a bit of exercise to exploit these functions.

NoteBefore performing each example you may want to reset the battery with the key CLEAR or CLS.

Copy and Paste of the stack values

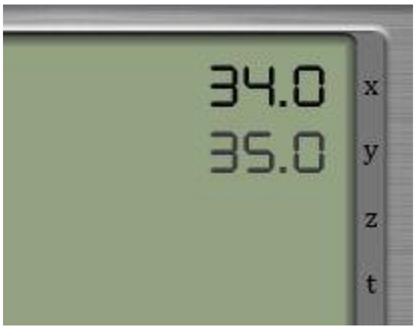
The values in the stack can be copied and then pasted temporarily in memory when we consider it appropriate. The copied Vallori remain in memory until the calculator is not closed.
This function is useful when we want to apply more functions to the same numbers, for example suppose that we need to calculate the sum and multiplication between two fractions 2/5 and 4/7
We insert the numbers in the stack:

2 ENTER
5 ENTER
4 ENTER
7



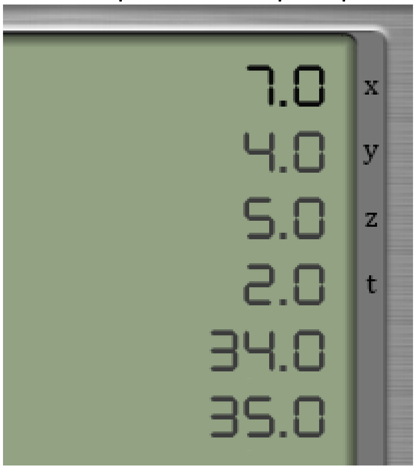
Before you do this we press the button COPY to copy the data into memory.

Then we press the button a/b+ to calculate the sum of the two fractions

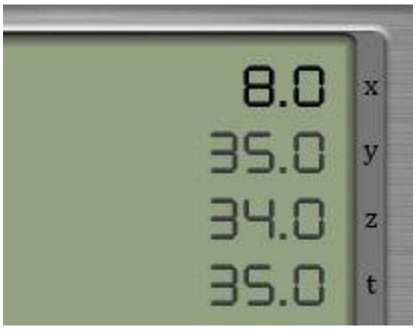


The sum worth fraction 34/35.

Now we paste the copied precededemente values with the key:



We press the button to calculate the multiplication between the two fractions:

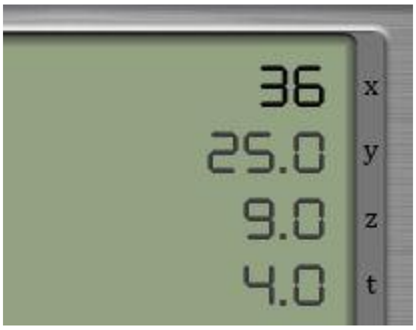


The fraction result of the multiplication is worth 8/35.
Note that we still display the result of the previous operation (34/35).

Application of a function to more elements of the stack

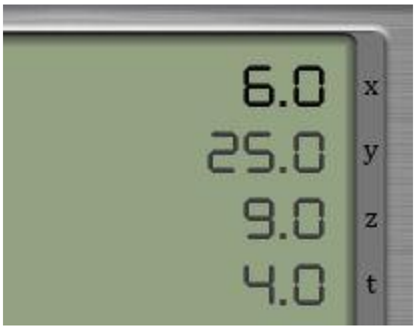
Suppose we want to calculate the square root of different numbers (eg. 4, 9, 25, 36).
There are several ways to do this, but in this case we will use functions that allow you to rotate the stack (forward or reverse).

Before we delete the data in the stack with the key  Then we put all of our data in the stack:



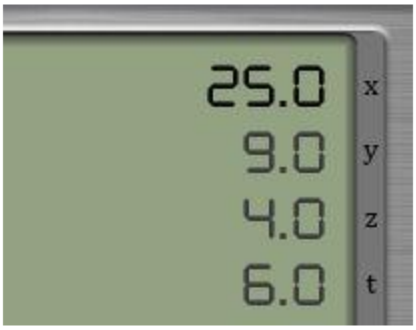
Now we calculate the root of the value which is located in the cell X (36) by pressing the button 

and we get the value 6:



Now we press the button 

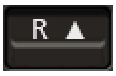
to rotate the stack upwards:



As you can see all the numbers have moved upwards true: the number 25 is led to the top of the stack, while the number 6 has been inserted into the bottom of the stack (+1 rotation of the stack).

Now we can calculate the root of 25 (X cell) with the key 

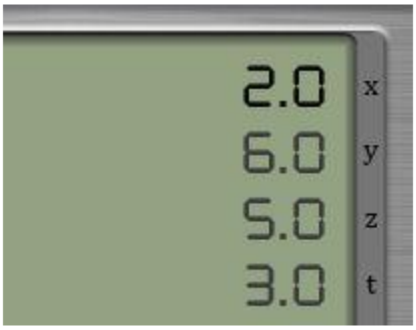
.
To complete all the steps you need to type the following keys:



(Moves the number 9 in the top of the stack and then calculates the square root)


(Moves the number 4 in the top of the stack and then calculates the square root)

The end result should be the following:

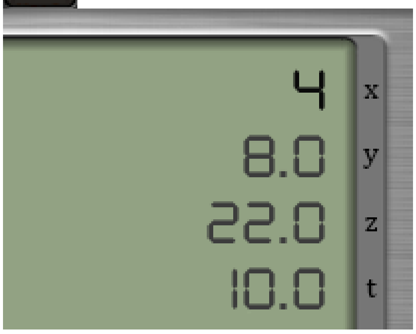


Note: The keys that rotate the stack R ▼ is R ▲ They can be activated even with the shortcut keys ↓ (down arrow) and ↑ (arrow).

Saving and loading of the stack data

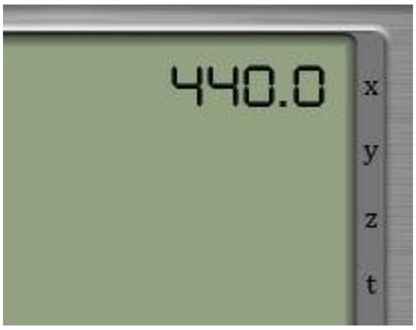
Data copied using the key COPY remain in memory as long as the calculator is on and are no longer available for a new program start.
The SAVE and LOAD functions allow to save on disk the values of the stack and retrieve them also in the subsequent sessions of use of the calculator.
Suppose we want to calculate the least common multiple and the greatest common divisor of a series of numbers (10, 22, 8, 4).

Before we delete the values of the stack with the key CLEAR Then press the following keys to enter information in the stack:



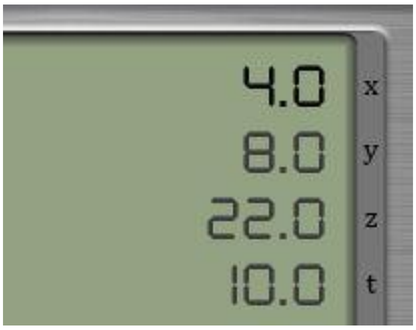
Before performing any procedure we save the data with the key SAVE. In this way the values in the stack are saved on disk in two identical files ("stack.txt" and "stack-yyyy-mm-dd-hh-mm-ss.txt").

Now we calculate the mcm by pressing the button LCM:



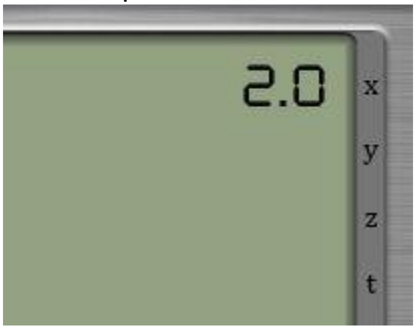
To calculate the MCD load the previously saved values with the key 

.
Note: They are loaded onto the stack data in the "stack.txt" file.



Then we press the button 

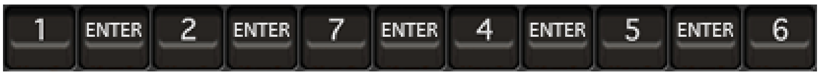
:



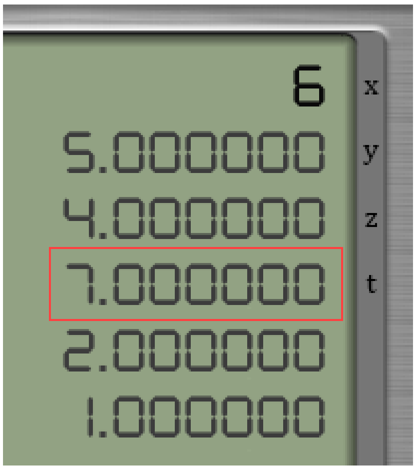
Note: Unlike the copy operation (which keeps all the data already present in the stack), when we upload the data on the stack from an external file, all values present in the stack are deleted before the load operation.

Changing the battery numbers

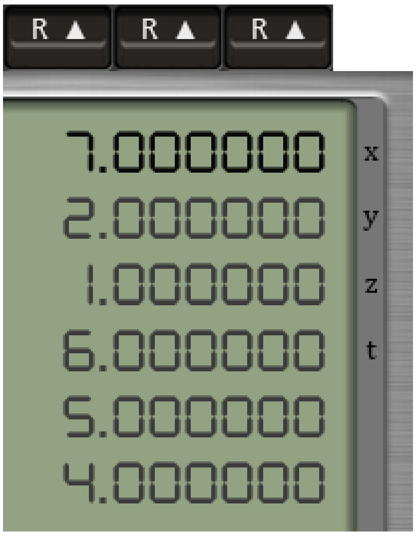
After entering a few numbers in the stack we realize that we have entered a wrong number: let's see how we can enter the correct number.
Suppose you want to enter the numbers 1,2,3,4,5 and 6:



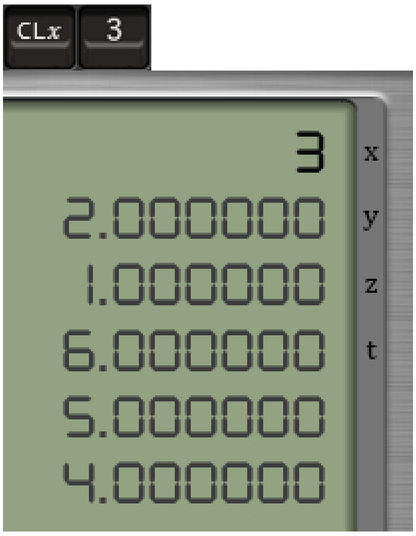
Then we realize that he had mistakenly entered the number 7 instead of the number 3:



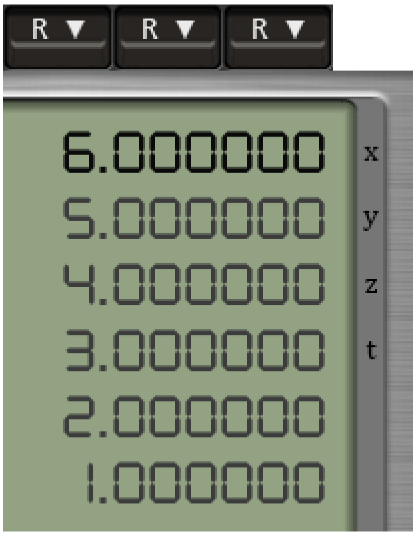
To enter the correct number we must first bring the number 7 in the register X.
To do this it is necessary to rotate the stack upwards of three positions three times by pressing the R key ↑:



CLx Now we press the button to reset the X register and then enter the number 3:



At this point it is necessary to restore the order of the stack by pressing three times the key R ↓:

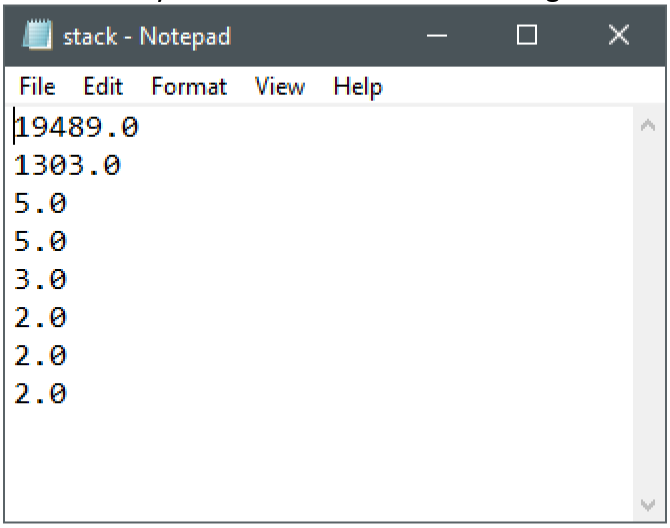


Correction done!

Observation:
The effective use of Forth commands for the management of the stack occurs only after much exercise.

Changing stack.txt file with a text editor

The button  opens the 'stack.txt' file with the default editor of your system.
This is a very effective method for entering data in the stack because it allows to use a text editor.



You can edit numbers, save the file and then load the stack with the button 
.

Note: Enter only a number to each row. If you enter non-numeric characters you get unexpected results.

Chapter 8 - The controls Forth

Standard features

With the available Forth commands can change the stack of numbers depending on our needs. Below the standard controls and their operation are listed.

BUTTON	COMMAND	NOTATION PILA
DUP	DUP	(X - xx)
Duplicate cell in the top of the stack X.		
Duplicate the top cell x.		
DROP	DROP	(X -)
It removes from the stack at the top of the cell X.		
Remove the top from the x cell stack.		
SWAP	SWAP	(X1 x2 - x1 x2)
Swap the two cells on top of the stack.		
Exchange the top two of the cell stack.		
OVER	OVER	(X1 x2 - x1 x1 x2)
Copy the second cell x1 at the top of the stack		
Place a copy of x1 second cell on top of the stack.		
ROT	ROT	(X1 x2 x3 - x2 x3 x1)
Rotate the three cells at the top of the stack. Move the third cell x1 at the top of the stack.		
Rotate the top three cell stack. Move the third cell x1 on top of the stack.		
NIP	NIP	(X1 x2 - x2)
Delete the second cell of the stack.		
Remove the second cell of the stack.		
TUCK	TUCK	(X1 x2 - x1 x2 x2)
Copy the first cell under the second cell of the stack.		
Copy the first (top) cell below the second cell of the stack.		
2DUP	2DUP	(X1 x2 - x1 x1 x2 x2)
Duplicate the pair of x1 x2 cells on top of the stack		
Duplicate the top two cell pair x1 x2.		
2DROP	2DROP	(X1 x3 x4 x2 - x1 x2 x3 x4 x1 x2)
Removes the pair of cells from the stack x1 x2		
Remove cell pair x1 x2 from the stack.		
2SWAP	2SWAP	(X1 x2 x3 x4 - x3 x4 x1 x2)
Swap the two pairs of cells on top of the stack.		
Exchange the top two cell pairs.		
2OVER	2Over	(X1 x3 x4 x2 - x1 x2 x3 x4 x1 x2)

Copy the pair of cells x1 x2 at the top of the stack.		
Copy the cell pair x1 x2 on top of the stack.		
2ROT	**2ROT**	**(X1 x2 x3 x4 x5 x6 - x3 x4 x2 x5 x6 x1)**
Rotate the three pairs of cells on top of the list. Move the third pair of cells on top of the stack.		
Rotate the top three cell pairs. Move the third cell pair x1 x2 on top of the stack.		
2NIP	**2NIP**	**(X1 x2 x3 x4 - x3 x4)**
Removes the second pair of cells from the stack.		
Remove the second cell pair x1 x2 from the stack.		
2TUCK	**2TUCK**	**(X1 x2 x3 x4 - x3 x4 x1 x2 x3 x4)**
Copy the pair of cells on top of the list x3 x4 below the second pair of cells.		
Copy the top cell pair x3 x4 below the second cell pair.		

Note: For more information consult the book "Starting Forth" by Leo Brodie.

Special functions

In addition to the standard commands the calculator provides additional provisions functions that operate on the stack.

BUTTON	FUNCTION	DESCRIPTION
COPY	**COPY**	Copy in memory the elements of the stack
PASTE	**PASTE**	Paste in the stack elements in memory
PICK	**PICK**	Copy top of the stack in the N-th element
ROLL	**ROLL**	Rotate the stack of N elements
FLIP	**FLIP**	Reverses the order of the stack
R ▲	**R UP**	Rotate the stack upward (+1)
R ▼	**R DOWN**	Rotate the stack downward (-1)
CLEAR	**CLEAR**	Delete all data from the stack (0.0 in the X-register)
LOAD	**LOAD**	Load stack from file 'stack.txt'
LOAD	**SAVE**	Save the stack in the file 'stack.txt'

Chapter 9 - List of Mathematical Functions

KEY	FUNCTION	DESCRIPTION
x^2	**Elevating squared**	Calculates the log of the square number X
$\sqrt{x}$	**Square root**	Calculate the square root of the number of the register X
e^x	**Natural Antilogarithm.**	It maximizes the number and the power of the number of the register X
LN	**Natural logarithm**	Calculates the natural logarithm of the number of the register X
10^x	**ten power**	It maximizes the number 10 to the power of the number of the register X
LOG	**Logarithm base 10**	Calculates the base 10 logarithm of the number of the register X
y^x	**Exponentiation**	It raises the number in the Y-register the power of the number of the register X.
$\sqrt{x}$	**Root**	Calculates the X-th root of the register number Y.
$1/x$	**Reciprocal**	Calculates the reciprocal of the number of the register X
$\sqrt[3]{x}$	**Cubic root**	Calculates the cube root of the number of the register X
%	**Percentage**	Calculates the X% value of the register number Y
Δ%	**Delta percent**	Calculate the percentage change in the number of the register Y with respect to that of the X-register
Int	**Full Part**	Calculates the integer portion of the number of the register X
Frac	**Fractional Part**	Calculates the fractional portion of the number of the register X
ABS	**Absolute value**	Calculates the absolute value of the register number X
0.00	**Rounds number**	Rounds the number of the register X to N decimal digits
SIN	**Otherwise**	Calculates the log of the number breast X
COS	**Cosine**	Calculates the cosine of the number of the register X
TAN	**Tangent**	Calculates the tangent of the number of the register X
π	**PI Greek**	Inserts in the X-register the value of Pi Greek
e	**Number of Euler**	Inserts in the X-register the value of the Euler's number
φ	**rapposto Aureo**	Wrap in X-register the value of the Golden Ratio

SINH	**hyperbolic sine**	Calculates the hyperbolic sine of the number of the register X
COSH	**hyperbolic cosine**	Calculates the hyperbolic cosine of the number of the register X
TANH	**Tangent Hyperbolic**	Calculates the hyperbolic tangent of the number of the register X
SIN^{-1}	**arcoseno**	Calculates the acrcoseno the register number X
COS^{-1}	**cosine**	Calculates the arc cosine of the number of the register X
TAN^{-1}	**arctangent**	Calculates the arc tangent of the number of the register X
$SINH^{-1}$	**inverse hyperbolic sine**	Calculates the hyperbolic arc sine of the number of the register X
$COSH^{-1}$	**inverse hyperbolic cosine**	Calculates the inverse hyperbolic cosine of the number of the register X
$TANH^{-1}$	**hyperbolic arc tangent**	Calculates the arc tangent of the number of the register X
→Deg	**Convert radians to degrees**	Converts Degrees register number X
→Rad	**Convert Degrees to Radians**	Converts Radians the register number X
$R(x,y)$	**Convert to Rectangular Coordinates Spherical Coordinates**	Converts by coordinates (r, θ) To coordinates (x, y)
$P(r,\theta)$	**Converting to Rectangular Coordinates a Spherical Coordinates**	Converts from coordinates (x, y) coordinates (r, θ)
→DD	**Conversion from Degrees-First-Seconds in Decimal Degrees**	It converts from Degree-First-Seconds in Decimal Degrees
→DMS	**Conversion from Decimal Degrees to Degree-First-Seconds**	It converts from Decimal Degrees to Degree-First-Seconds
GCD	**Greatest Common Divisor**	Calculates the GCD of all the numbers of the stack
LCM	**Least common multiple**	Include the MCM of all the numbers of the stack
$\mathbb{P}$	**Factoring**	Decomposes into prime numbers in the register number X
$\frac{a}{b}=\frac{c}{d}$	**Solving Proportions**	It solves a ratio of numbers
$f(x^2)$	**Resolution of second-degree equations**	It solves a quadratic equation (real and complex roots)
$f(x^3)$	**Resolution of third-degree equations**	It solves a third degree equation (real and complex roots)
P(x)	**polynomial Rating**	It calculates the value of a polynomial
a/b+	**Fraction Sum**	Calculates the sum of two fractions
a/b−	**Subtracting fractions**	Calculates subtracting two fractions

a/b×	**Multiplication of fractions**	Calculates the multiplication between two fractions
a/b÷	**Division of Fractions**	Calculates the division between two fractions
a/b	**Generating Fraction**	It converts from decimal to fraction
xyz	**Solution Linear Systems**	It solves linear systems (from 2x2 to 5x5)
△	**Triangle Solution**	It solves the three elements data triangle (sides and angles)
$x!$	**Factorial**	Calculates the factorial of the number of the register X
Fib	**Fibonacci**	It calculates the number of the register X Fibonacci number
Py,x	**Permutations**	Calculate the number of groups with y elements selected from elements x (with different ordering)
Cy,x	**Combinations**	Calculate the number of groups with y elements selected from elements x (independent law)
STAT	**Statistical Parameters**	Include some statistical parameters of all the numbers of the stack (Number values, Sum, Min, Max, Mean, Median, Variance, Std Deviation)
L.R.	**Linear Regression**	Calculate the coefficients of the straight line interpolating $y = m * x + q$ all the data of the stack
RND	**random number**	Generate a random number in the register X
ℂ+	**addition complexes**	Calculates the addition of two complex numbers
ℂ−	**Subtraction Complex**	Calculates the subtraction of two complex numbers
ℂ×	**Multiplication Complex**	Calculate the multiplication of two complex numbers
ℂ÷	**Complex Division**	Calculates the division of two complex numbers
1/ℂ	**Inverse Complex**	Calculates the inverse of a complex number
$ℂ^n$	**Power Complex**	Calculates the power of a complex number
+	**addition Vectors**	Sum of two 2D vectors
−	**Subtracting Vectors**	Subtract two 2D vectors
×	**Vector Product (cross)**	2D vector product of two vectors
·	**Product Scalar (dot)**	Product scalre two 2D vectors
θ	**Angle between Vectors**	Angle between two 2D vectors
|→| θ	**Magnitude and Direction**	Magnitude and direction of a 2D vector

T+	**addition time**	Calculates the addition of two times (hh, mm, ss)
T−	**Subtract times**	Compute the subtraction of two times (hh, mm, ss)
A123	**Arithmetic Sequence**	It generates an arithmetic sequence of numbers
G123	**Geometric Sequence**	Generate a sequence of numbers geomtrica
$P_1 P_2$	**Two points**	It calculates the distance between two points, the slope, and the straight line passing through the points.$mqy = m * x + q$
Degrees Radians	**Measuring trigonometric calculations Unit**	Set degrees or radians for trigonometric calculations

Special keys

	Edit files 'stack.txt'	Opens the 'stack.txt' file with the default editor
$\mathcal{F}$	**Opening Formulas**	Opens "The Handbook of Essential Mathematics" file
	Go out	Close the program

APPENDIX

Appendix A: RPN notation (Wikipedia)

The Reverse Polish Notation (English reverse polish notation or just RPN) is a syntax used for mathematical formulas. It was invented by Australian Hamblin, philosopher and computer expert, and was named by analogy with the Polish notation, invented by Lukasiewicz.
With the RPN is possible to carry out any type of operation, with the advantage of eliminating the problems due to the parentheses and the precedence of operators (before the division, then the addition etc.). Some scientific RPN calculators use as it prevents the record interim results during operation.
In Reverse Polish Notation, also called notation postfix in contrast with the normal notation infix, before inserting the operands, and then the operators: an example of RPN is 3 2 + which is equivalent to the classical 3 + 2, or 10 2 ÷ which provides 5 .
When using the RPN becomes account of owning a stack (stack) on which slowly accumulate operands: the first is the stacks 3, then the 2. An operator picks up instead from the top of the stack all operands it needs, do this, and will re-deposited the result. The lower element is to be considered always the left operand. If the complete expression is correct, at the end of all the operations on the stack you will have only one element, the end result.
This stack allows, as already said, to avoid the use of parentheses to prioritize the operations, just plug in the left part of the formula to all addresses of the outermost parenthesization operations, at the center of the most elementary operations, to the right all the operators of combinations of the results of the central operations with operands already present. There are in fact conversion algorithms is the infix that postfix than vice versa. As you can see, the RPN is easily implemented on computers.
An example:
5 + (10 * 2) → 5 10 2 * +
Before the multiplication are present on the stack 5, 10, 2. The "*" retrieves the first two elements (10, 2) multiplies them and modifies the stack so that it contains 5, 20. The operation "+" and adds 5 20, now present in the stack, replacing them with the result: 25.
Other more complex examples:
((10 * 2) + (4-5)) ÷ 2 → 10 * 2 4 5 - 2 to +
(7 ÷ 3) ÷ ((1 - 4) * 2) + 1 → 1 ÷ 7 3 1 4 - 2 * + or ÷ 7 ÷ 3 1 4 - 2 * ÷ 1 +
Reverse Polish Notation was inspired by Polish Notation, where operators are placed before the operand (ie: 1 + 2 instead of 1 + 2), but the former is more easily implemented in an electronic or software so.
Most pocket calculators using RPN instead of classical algebraic notation (with parentheses, and infix notation) has been produced by Hewlett Packard, which still continues to produce models based on RPN (HP-32S).

Appendix B: The Handbook of Essential Mathematics

Pressing  It opens the book "The Handbook of Essential Mathematics" in PDF format.

The Handbook of Essential Mathematics
Formulas, Processes, and Tables
Plus Applications in Personal Finance
Compilation and Explanations: John C. Sparks
Editors: Donald D. Gregory and Vincent R. Miller

The Handbook of Essential Mathematics contains three major sections. Section I, "Formulas", contains most of the mathematical formulas that a person would expect to encounter through the second year of college, regardless of major. In addition, there are formulas rarely seen in such compilations, included as a mathematical treat for the inquisitive. Section I also includes select mathematical processes, such as the process for solving a linear equation in one unknown, with a supporting examples. Section II, "Tables" Both includes 'pure math' tables and physical-science tables, useful in a variety of disciples ranging from physics to nursing. As in Section I, some tables are included just to nurture curiosity in a spirit of fun. In Sections I and II, each formula and table is enumerated for easy referral. Section III,

Note: The book is in the public domain.

Appendix C: Compiling the program

Note: *The explanations for the Windows operating system, but the operations to be carried out in a Mac OS X or Linux are similar.*

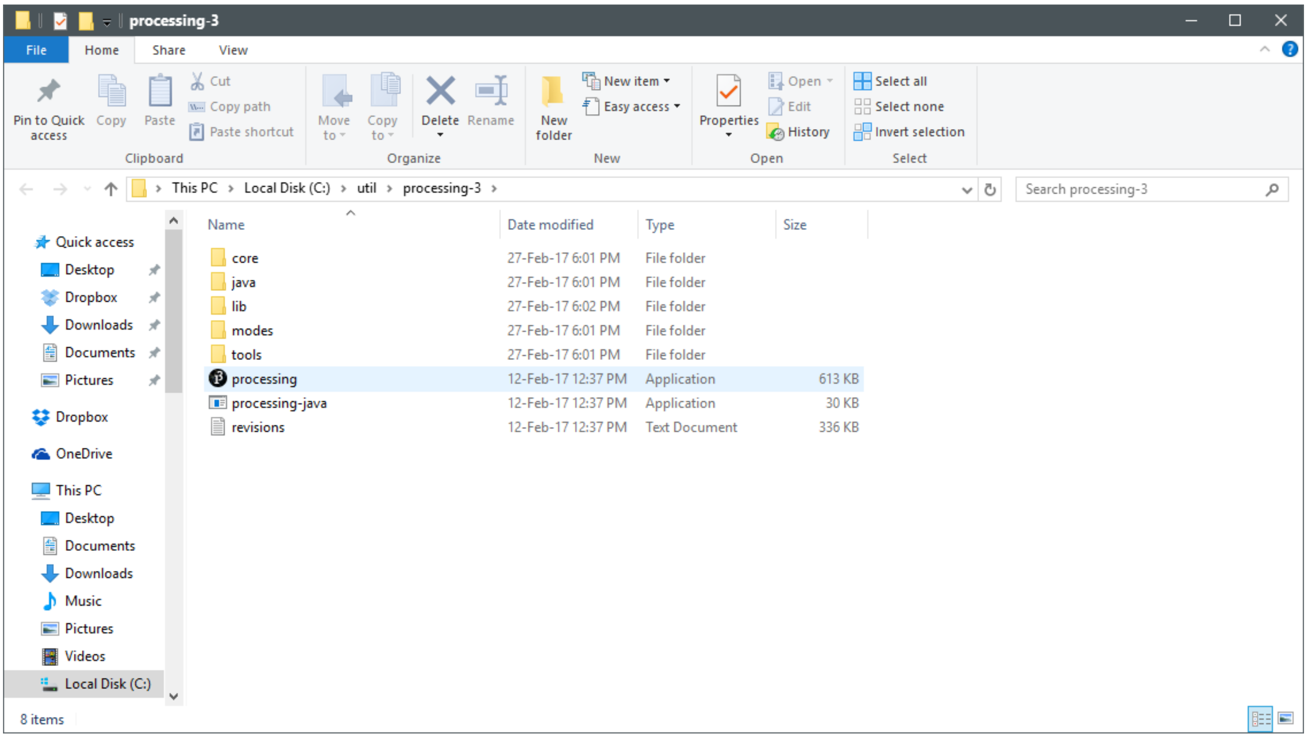
This program is distributed and comprehensive sources must be compiled for use in your system. Here are the steps to take to create and install the executable program.

First you need to download and install the Processing program at the following address:
https://processing.org/download/

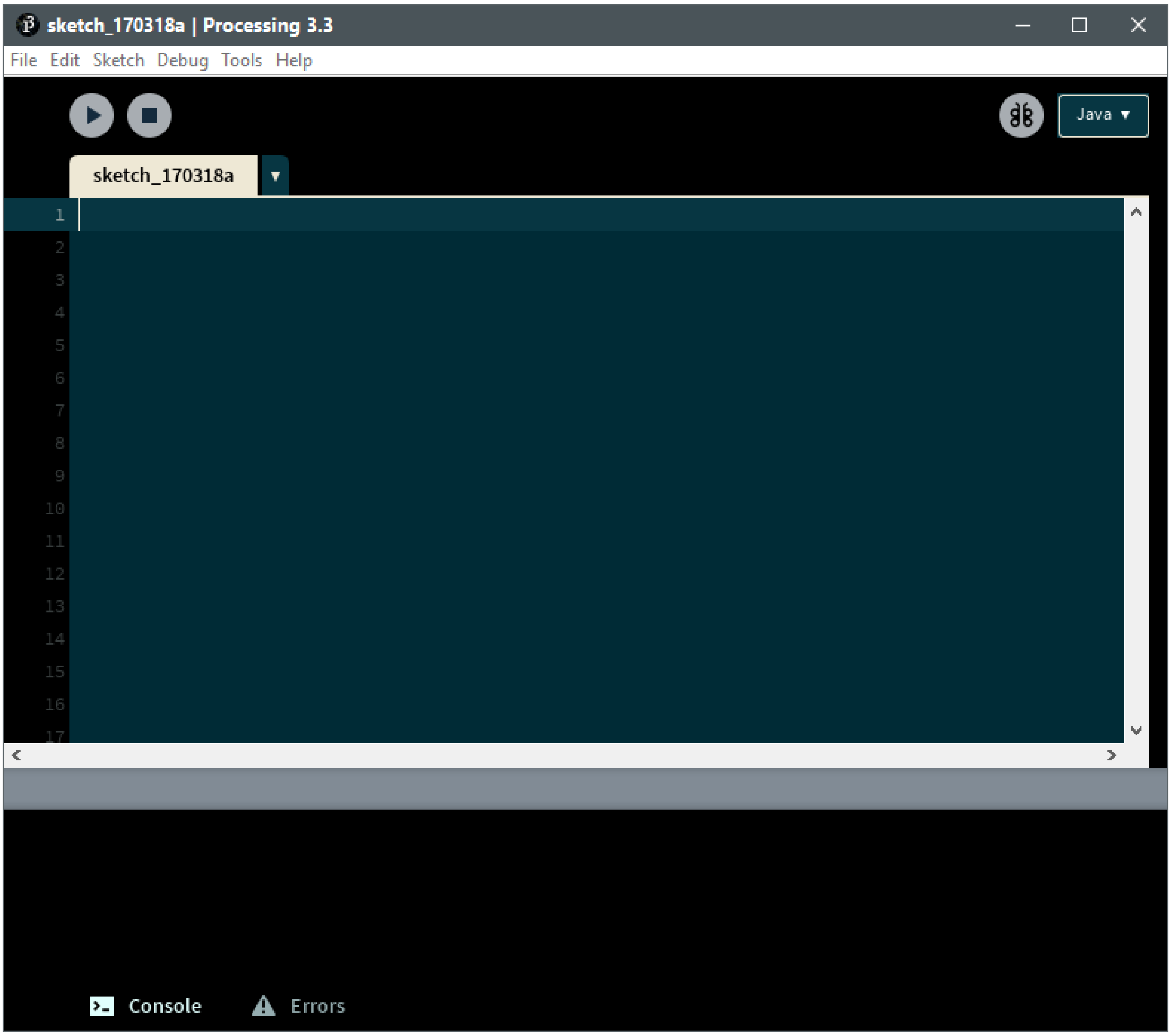
Installation is easy: just unzip the .zip file in the folder of your choice (eg C: \ util \ processing-3 \).

Then ForthCalc.zip download the program from the following link:
https://github.com/cameyo42/ForthCalc
and unzip it to another folder (for example c: \ util \ ForthCalc \).

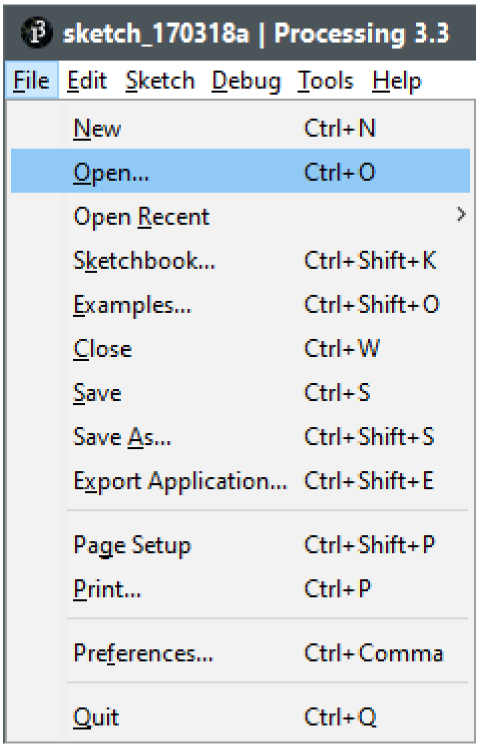
Now you need to run the Processing program (double click on the selected file in the figure):



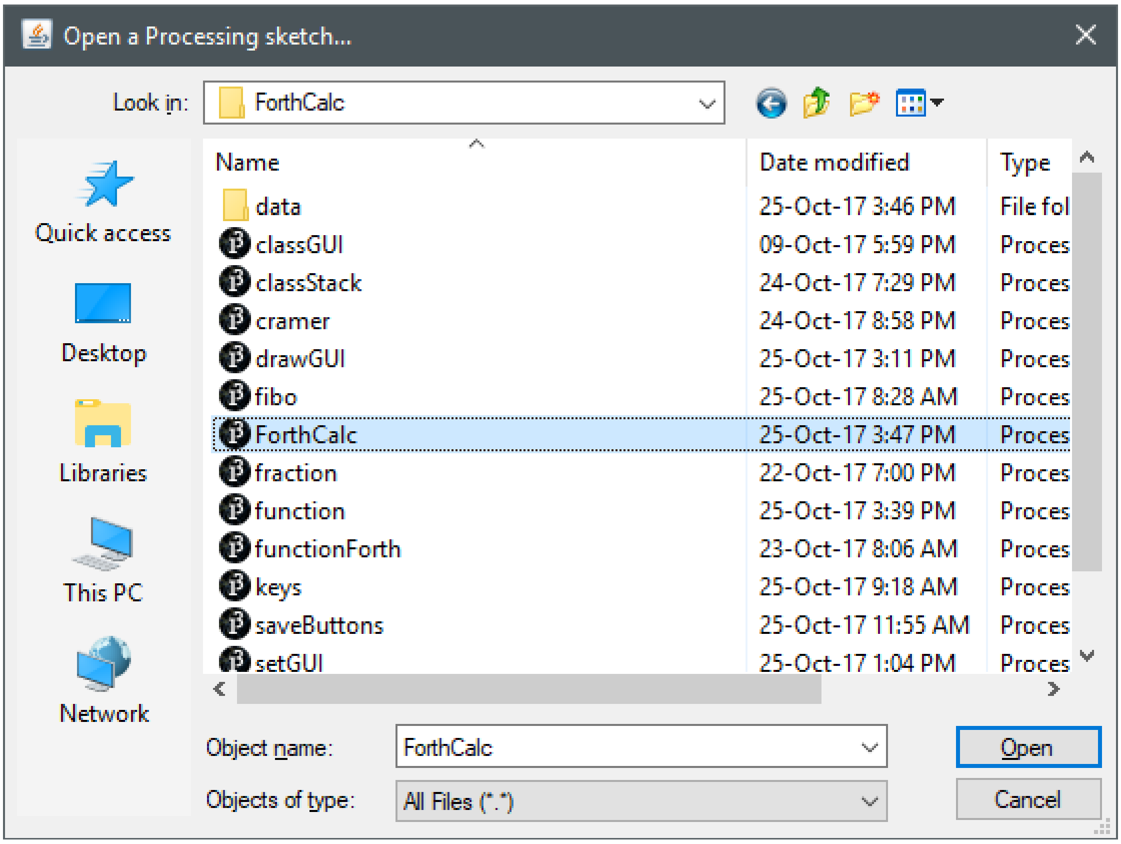
This opens the following window:



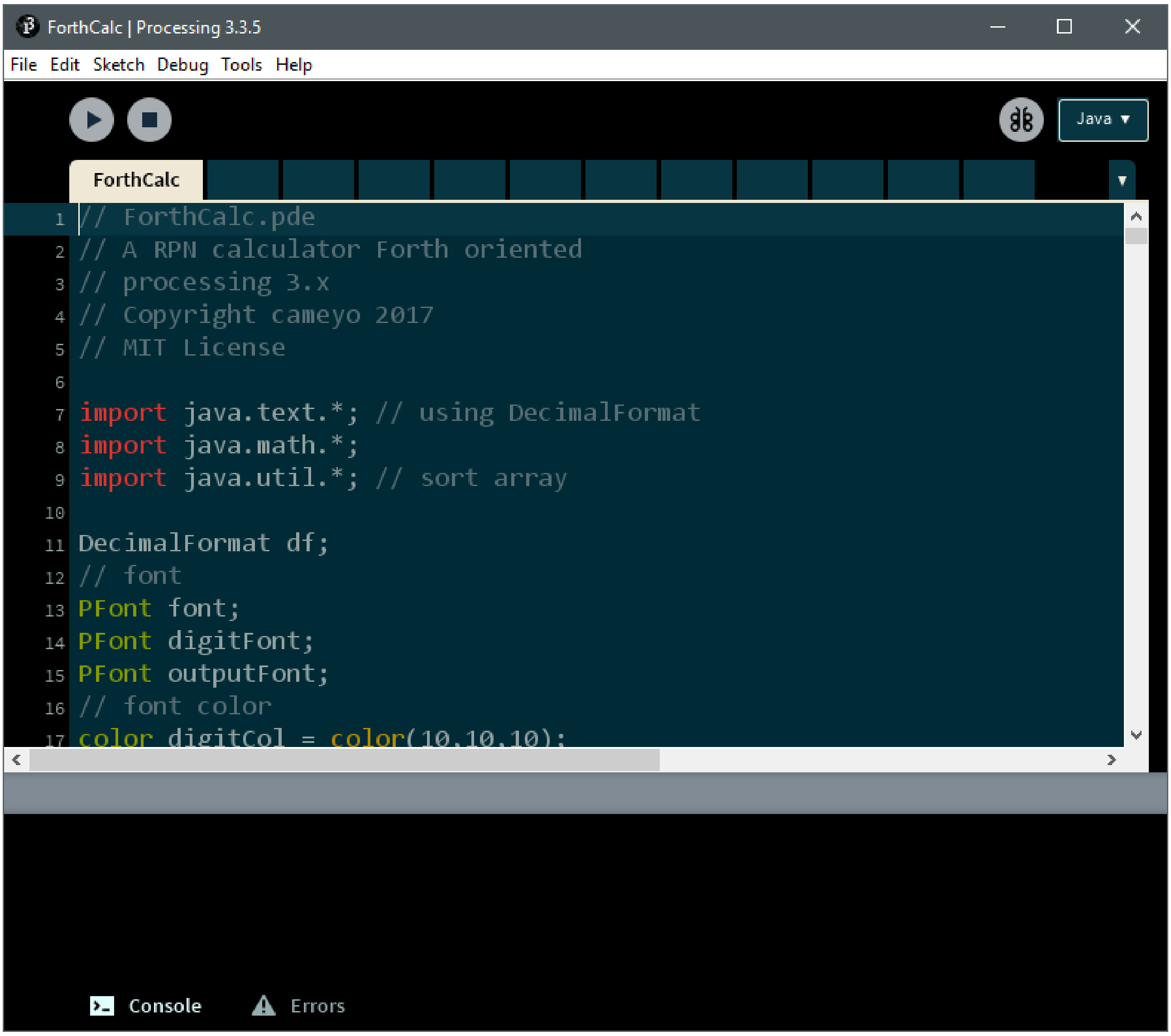
Select the command "Open .." from the "File" menu:



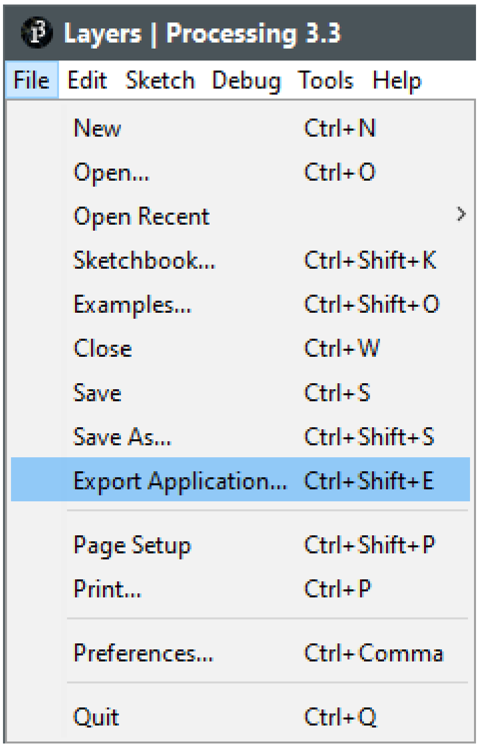
And ForthCalc.pde open the file (located in the folder where you scompattano the program):



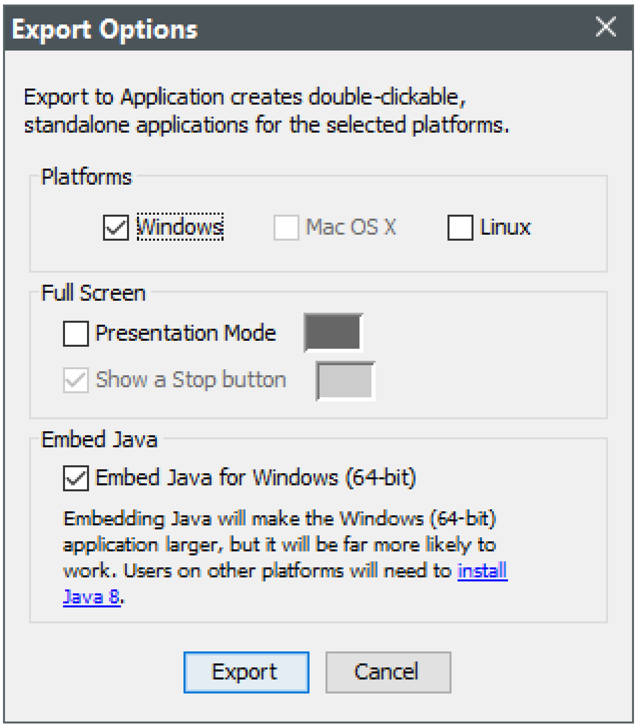
The following window appears:



Now to compile the selected program menu File -> Export Application:

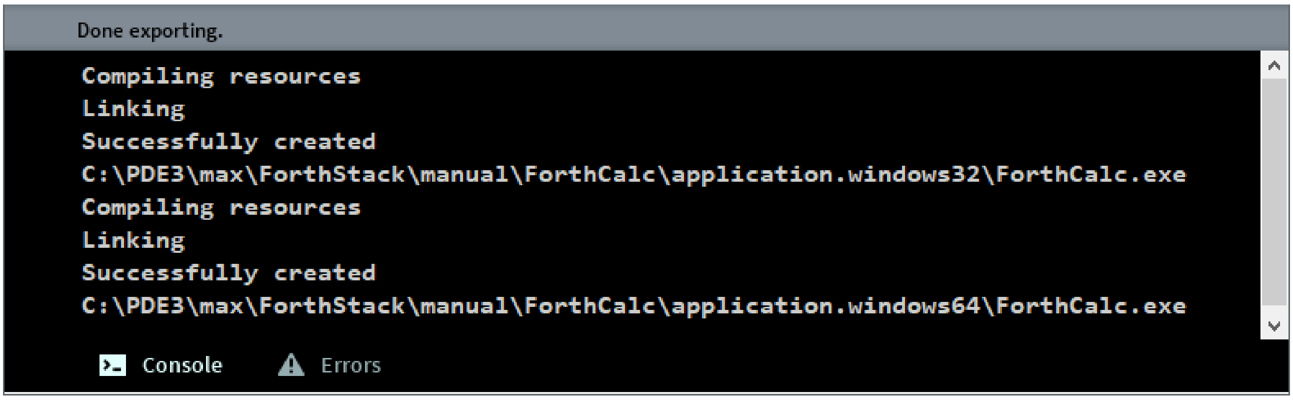


This window appears:

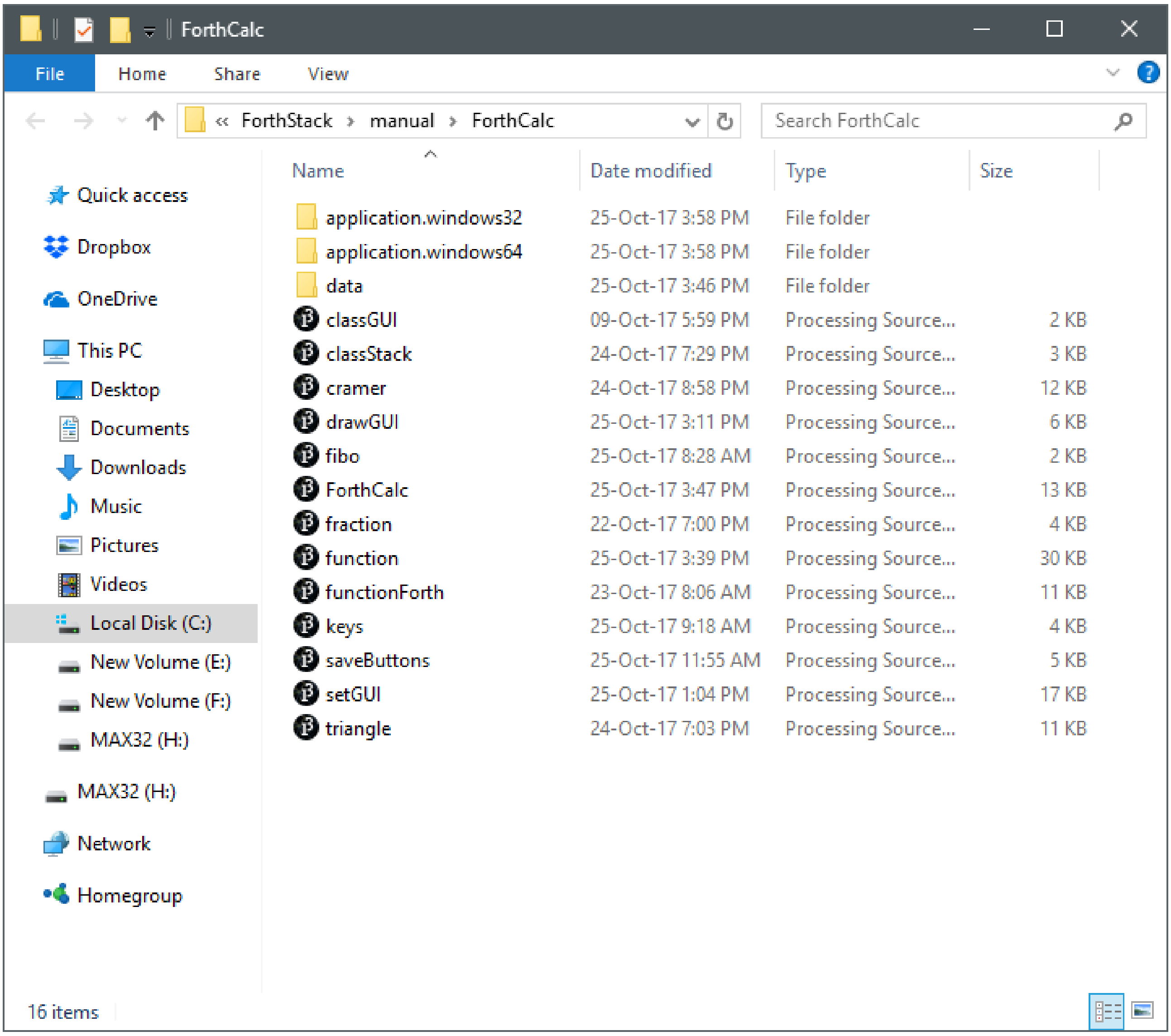


1) Select your system (Windows, Mac OS X or Linux).
2) Do not select "Presentation Mode".
3) Select "Embed Java ..."
4) Finally press the "Export" button.

After a few seconds, if all goes as planned, you should see the following message:



It also opens a Device Manager window that displays the location of the newly compiled program:



Inside the application.windows32 and application.windows64 folders are the programs (ForthCalc.exe) for version 32 and 64 bits respectively.

You can rename these folders and move them where you want.

Then create on your desktop (desktop) ForthCalc.exe a link to the program and you can start ... calculate.