

# User's Manual

**FUNGRAPH**

Version 1.9.2

## Mathematical software Graphs of functions in 2D

Windows XP® - Windows Vista® - Windows 7® - Windows 8® - Windows 10®



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## Introduction

FUGP is a Windows application to calculate 2D graphs of mathematical functions.

Please, read this manual carefully in order to learn all the capabilities of the application.

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To register the software, please see the option "REGISTER APPLICATION" in the help menu of the software.

After paying the registry fee you will receive by email the REGISTRATION KEY of the software. Once registered the software, it will be able to use the options that were disabled until that moment.

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You cannot use the same REGISTRATION KEY for multiple computers.

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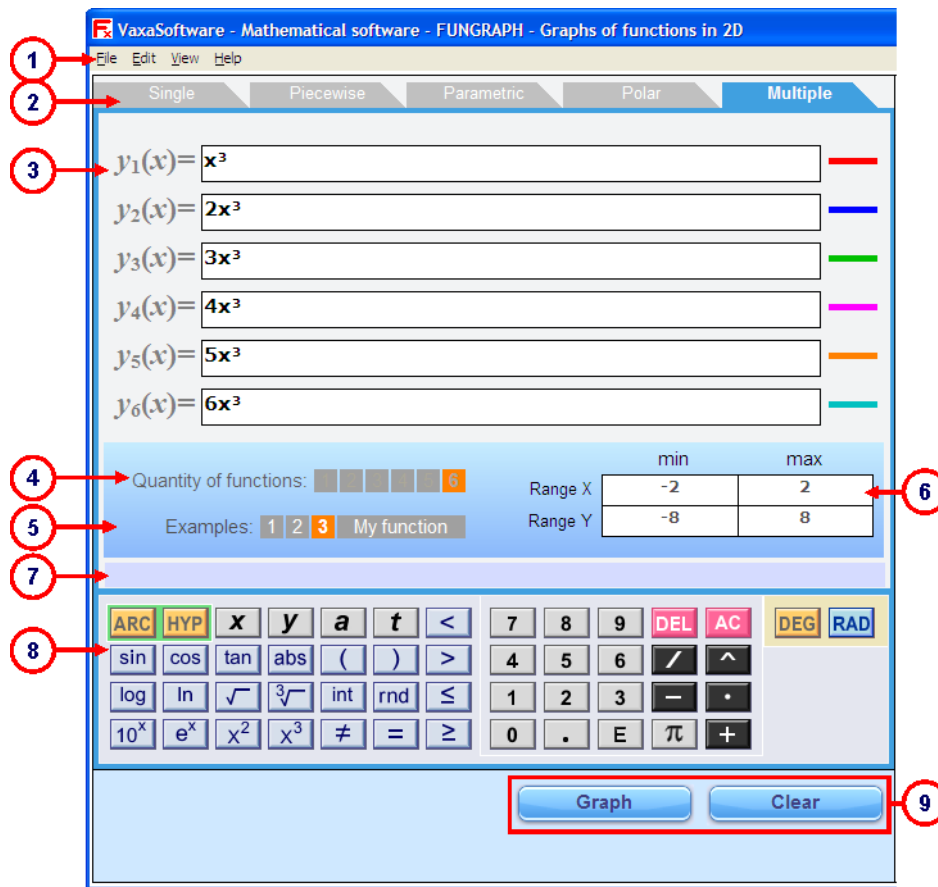
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## Main window: Left panel



**Fig. 1**  
Main window. Left panel

### ( 1 ) Menu bar

It contains the menus *File*, *Edit*, *View* and *Help*.

#### File menu

##### **Graph**

Calculate graph of current function.

##### **Print...**

Open the Print window to print the current function and its graph.

##### **Exit**

Close the application.

#### Edit menu

##### **Copy graph**

Copy current graph into clipboard.

## View menu

### Full screen graph

#### Single function

Show the single function input panel.

#### Piecewise function

Show the piecewise function input panel.

#### Parametric function

Show the parametric function input panel.

#### Polar function

Show the polar function input panel.

#### Multiple functions

Show the multiple functions input panel.

## Help menu

### User's manual (PDF document)...

Show this manual.

### Application registration...

Show the registration form window to register the application.

### Disabled functions in the unregistered version

Show the list of disabled functions when the application is not registered.

### Home page ([www.vaxasoftware.com](http://www.vaxasoftware.com))...

Connect to VaxaSoftware home page.

An active Internet connection and a browser are required.

### About...

Show the Splash window with the version and description of the application.

## (2) Type of function buttons

Allow select 5 types of functions.

### Single button

Show the single function input panel.

### Piecewise button

Show the piecewise function input panel.

### Parametric button

Show the parametric function input panel.

### Polar button

Show the polar function input panel.

### Multiple button

Show the multiple function input panel.

## (3) Function input boxes

Allow input functions.

#### (4) Quantity of parts/functions buttons

Allow select the quantity of parts or functions. This option is only available for *piecewise* and *multiple* function types.

#### (5) Example selection and *My function* buttons

Allow select an example function

To go back to the current user function you have to press the *My function* button.

#### (6) Range of variables input boxes

Allow input the range for variables  $x, y, t, a$ .

#### (7) Messages output box

Shows errors and messages from the virtual keyboard.

#### (8) Virtual keyboard

Allows edit mathematical expressions to input functions.

##### Direct input functions:

| Symbol | Description                 |
|--------|-----------------------------|
| sin    | Sine                        |
| cos    | Cosine                      |
| tan    | Tangent                     |
| abs    | Absolute value              |
| int    | Integer part                |
| rnd    | Random number within [0, 1) |
| $x^2$  | Square                      |

| Symbol            | Description           |
|-------------------|-----------------------|
| log               | Decimal logarithm     |
| ln                | Napierian logarithm   |
| $\sqrt{\quad}$    | Square root           |
| $\sqrt[3]{\quad}$ | Cube root             |
| $10^x$            | Decimal antilogarithm |
| $e^x$             | Exponential           |
| $x^3$             | Cube                  |

##### Trigonometric and hyperbolic functions

Press ARC and/or HYP keys and then SIN, COS or TAN keys to get the following functions:

| Symbol | Description |
|--------|-------------|
| arcsin | Arc sine    |
| arccos | Arc cosine  |
| arctan | Arc tangent |

| Symbol  | Description            |
|---------|------------------------|
| sinh    | Hyperbolic sine        |
| cosh    | Hyperbolic cosine      |
| tanh    | Hyperbolic tangent     |
| argsinh | Hyperbolic arg sine    |
| argcosh | Hyperbolic arg cosine  |
| argtanh | Hyperbolic arg tangent |

## Operator keys

| Symbol | Description    |
|--------|----------------|
| +      | Addition       |
| ·      | Multiplication |
| ^      | Power          |

| Symbol | Description |
|--------|-------------|
| -      | Subtraction |
| /      | Division    |

| Symbol | Description           |
|--------|-----------------------|
| =      | Equal to              |
| ≤      | Less than or equal to |
| <      | Less than             |

| Symbol | Description              |
|--------|--------------------------|
| ≠      | Not equal to             |
| ≥      | Greater than or equal to |
| >      | Greater than             |

## Other keys

| Symbol            | Description             |
|-------------------|-------------------------|
| <b>DEG</b>        | Angular mode is degrees |
| <b>RAD</b>        | Angular mode is radians |
| ( , )             | Parentheses             |
| <b>0123456789</b> | Numeric values          |
| .                 | Decimal point           |

| Symbol            | Description               |
|-------------------|---------------------------|
| <b>DEL</b>        | Delete left character     |
| <b>AC</b>         | Clear current input line  |
| <b>x, y, a, t</b> | Variables x, y, a, t      |
| <b>E</b>          | Scientific notation input |
| $\pi$             | Pi constant               |

## Decimal separator

This application uses decimal point  as decimal separator.

## Scientific notation

The scientific notation is used to show very big or very small numbers.

A scientific notation number has a mantissa and a power of 10.

To enter scientific notation numbers we use letter E to input the exponent of 10.

Examples:

$5.67 \times 10^{89}$  is entered as 5.67 E 89

$1.23 \times 10^{-34}$  is entered as 1.23 E-34

## Angular units: deg, rad

For trigonometric functions the angular unit for output and input can be selected from 2 formats: degrees and radians.

The angular unit is selected with the following keys:

**DEG** key: Degrees ( $^{\circ}$ ).                      1 right angle =  $90^{\circ}$  (90 degrees).

**RAD** key: Radians (rad).                      1 right angle =  $\pi/2$  rad.

The current angular unit key is shown in blue color.

## Priority sequence

Expressions are calculated from left to right.

However this application determines automatically the calculation sequence according to rules of algebra.

Example:

To calculate  $3 + 4 \cdot 7^2$ , the sequence is:

- 1)  $7^2 \rightarrow 49$
- 2)  $4 \cdot 49 \rightarrow 196$
- 3)  $3 + 196 \rightarrow 199$  (result)

Priority list of operators and functions:

| Priority level | Operators and functions                  |
|----------------|--|
| 6              | ( ) Parentheses                          |
| 5              | Scientific functions: sin, cos, log, ... |
| 4              | ^  |
| 3              | Implicit multiplication                  |
| 2              | · /                                      |
| 1              | + -                                      |

## Implicit multiplication

In many expressions, we can omit the multiplication operator sign  $\cdot$  in order to improve legibility.

This application assumes implicit multiplication in the following 3 cases:

- 1) A numeric value before a variable, function or left-parenthesis.

Examples:

| Input line expression | Internal calculation    |
|-----------------------|-------------------------|
| 25 a                  | $25 \cdot a$            |
| 7 $\pi$               | $7 \cdot \pi$           |
| 4 sin 30              | $4 \cdot \sin 30$       |
| 2 (4+5)               | $2 \cdot (4+5)$         |
| sin 30 cos 50         | $\sin 30 \cdot \cos 50$ |

- 2) A right-parenthesis before a number, variable, function or left-parenthesis.

Examples:

| Input line expression | Internal calculation |
|-----------------------|----------------------|
| (1+2) 7               | $(1+2) \cdot 7$      |
| (1+2) a               | $(1+2) \cdot a$      |
| (1+2) cos 5           | $(1+2) \cdot \cos 5$ |
| (1+2) (3+4)           | $(1+2) \cdot (3+4)$  |



3) A variable before another variable, a function or left-parenthesis.

Examples:

| Input line expression | Internal calculation |
|-----------------------|----------------------|
| ab                    | $a \cdot b$          |
| a log 5               | $a \cdot \log 5$     |
| a(2+4)                | $a \cdot (2+4)$      |

◆ **Note**

Implicit multiplication has greater priority than division:

So, expression:  $1 / 2\pi$  is calculated as  $1 / (2 \cdot \pi) = 0.159154943091895$

◆ **WARNING**

Implicit multiplication has less priority than functions:

So, the expression  $\sin 2x$  is calculated as  $(\sin 2) \cdot x$  and not as  $\sin (2 \cdot x)$ .

**Implicit power**

In many expressions, we can omit the power operator sign  $^{\wedge}$  in order to improve legibility.

This application assumes implicit power in the following case:

A variable before a number.

Examples:

| Input line expression   | Internal calculation |
|-------------------------|----------------------|
| a2                      | $a^2$                |
| a5                      | $a^5$                |
| t <sup>2</sup> + 5t + 6 | $t^2 + 5t + 6$       |

◆ **WARNING**

We cannot use implicit power with pi constant ( $\pi$ ) or e constant.

When pi constant is followed by a numeric value an implicit multiplication is assumed instead of implicit power:

So,  $\pi 100$  is calculated as  $\pi \cdot 100$  (and not  $\pi^100$ ).

About e constant:

$5e7$  is calculated as a scientific notation value  $5 \cdot 10^7$  (and not  $5 \cdot e^7$ )

**Power of functions with exponent previous to its argument (PFEP)**

In textbooks the power of a function is shown with exponent previous to its argument:

Example:  $\sin^2 30 = (\sin 30)^2$ .

In this application we can also enter expressions in this format:

| <b>DEG</b>      |             | Internal calculation |
|-----------------|-------------|----------------------|
| $\sin^2 30$     | 0.25        | $(\sin 30)^2$        |
| $\log^3 100$    | 8           | $(\log 100)^3$       |
| $\sin^{(4)} 30$ | 0.0625      | $(\sin 30)^4$        |
| $\sin^{(9)} 30$ | 0.001953125 | $(\sin 30)^9$        |

◆ **WARNING**

- 1) Exponent must be an integer positive number between 2 and 9.
- 2) If we use the power operator  $\boxed{\wedge}$ , the exponent must be in parentheses.  
Squares and cubes can be entered using  $\boxed{x^2}$  and  $\boxed{x^3}$  keys but without parentheses.

| Wrong                 | Description of error            | Right                               |
|-----------------------|---------------------------------|-------------------------------------|
| $\cos \wedge (12) 30$ | Exponent isn't between 2 and 9  | $(\cos 30) \wedge 12$               |
| $\cos \wedge 2 30$    | Exponent must be in parentheses | $\cos^2 30$ or $\cos \wedge (2) 30$ |

#### Autosaving the user functions

The user functions are saved when application is closed. When application is opened later, the user functions will be available again.

#### (9) Graph and Clear buttons

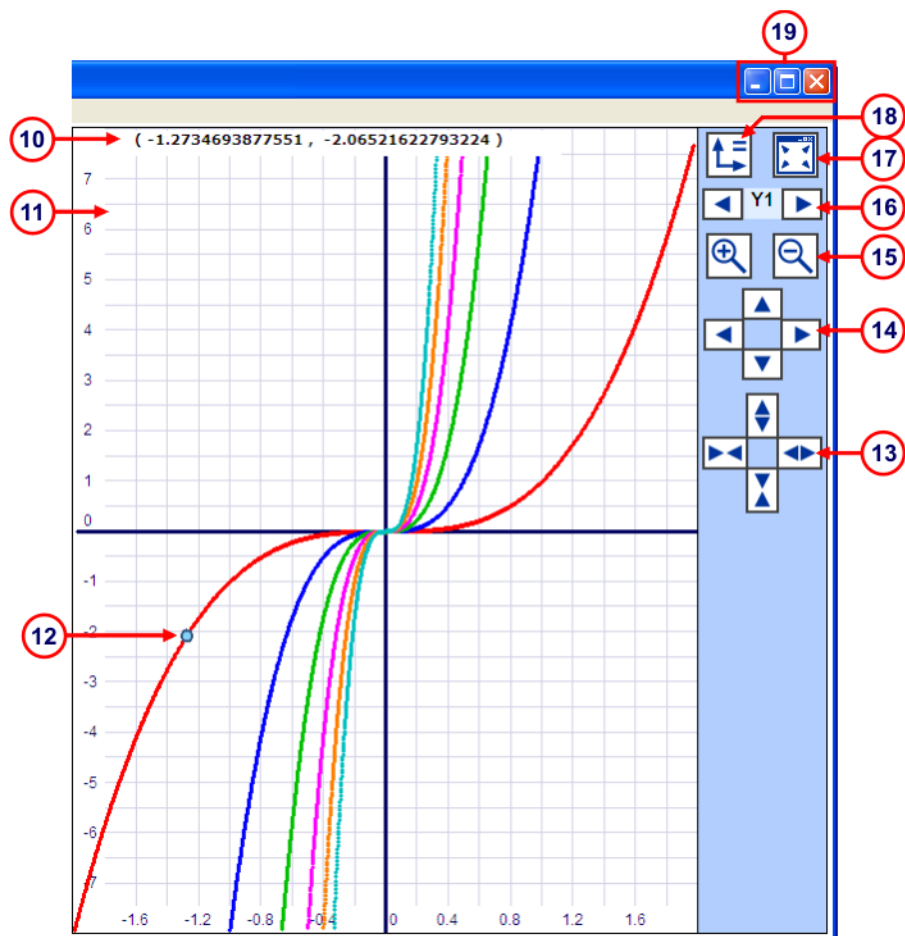
**Graph** button

Shows the graph of the current function.

**Clear** button

Clears the current function and its graph.

## Main window: *Right panel*



**Fig. 2**  
Main window. Right panel

### (10) Cursor coordinates

Shows (x, y) coordinates of the cursor. Cursor is shown as a blue circle. Cursor motion is simultaneous with mouse motion.

#### ◆ Note

Cursor coordinates is not shown for *Parametric* or *Polar* functions.

### (11) Graphic area

Shows the graphic of the function.

Normally the graphic of the function is shown in red color.

However *Piecewise* and *Multiple* functions are shown with several colors.

We can click the right button of mouse to show a contextual menu. Then we can choose the next menus:

*Zoom in*  
*Zoom out*  
*Isometric scales X:Y*  
*Copy coordinates*  
*Copy graph*  
*Full screen graph / normal window graph.*

We can click and drag in order to move the graphic.

## (12) Cursor

This cursor is shown as a blue circle. Cursor motion is simultaneous with mouse motion. The cursor is shown over the graphic according to the current function.

### ◆ Note

Cursor is not shown for *Parametric* or *Polar* functions.

## (13) X, Y zoom buttons

Set zoom for X-axis and Y-axis separately.

## (14) Scroll buttons

Move the graphic towards up, down, left and right.

## (15) Zoom buttons

Allow us zoom in / zoom out.

## (16) Select function buttons

Allow us select a function for *multiple* functions graphs

## (17) Full screen graph button

Shows the current graph in full screen.

## (18) Isometric scales button

Sets the scales of axes X:Y as 1:1.

## ( 19 ) Window control buttons

These are the classic buttons of the windows of MS-Windows ®.

### **Minimize** button

Minimizes the application to an icon on the desktop.

### **Maximize / Restore** button

Maximizes / restores the application's window size.

### **Close** button

Closes the application. Also we can press Alt + F4 keys on our keyboard.

## Range for entry values

|  |   |
|--|---|
| General range for entry and results values     | $\pm 2.4703282292062327 \times 10^{-324} \sim \pm 1.797693134862315807 \times 10^{308}$ and 0<br>0 is assumed for values within $\pm 2.470328229206232721 \times 10^{-324}$ |
| sin $x$  | (Degrees: DEG) $ x  \leq 5.284602884791370710 \times 10^{20}$   |
| cos $x$  | (Radians: RAD) $ x  \leq 9.2233719 \times 10^{18}$  |
| tan $x$  | (Degrees: DEG) $ x  \neq (2n+1) \cdot 90$<br>(Radians: RAD) $ x  \neq (2n+1) \cdot \pi/2$   |
| arcsin $x$ , arccos $x$                        | $ x  \leq 1$  |
| sinh $x$ , cosh $x$ , tanh $x$                 | $ x  \leq 709.78271289338402$   |
| argsinh $x$                                    | $ x  \leq 1.34078079299425 \times 10^{154}$   |
| argcosh $x$                                    | $1 \leq x \leq 1.34078079299425 \times 10^{154}$  |
| argtanh  | $ x  < 1$   |
| arctan $x$ , $\sqrt[3]{x}$ , abs $x$ , int $x$ | $ x  \leq 1.79769313486231580778 \times 10^{308}$   |
| $x^2$  | $ x  \leq 1.34078079299425 \times 10^{154}$   |
| $x^3$  | $ x  \leq 5.64380309412236 \times 10^{102}$   |
| $x^y$  | $x \leq 1.79769313486231580778 \times 10^{308}$<br>if $y$ is not integer then $x \geq 0$ , if $y = 0$ then $x \neq 0$   |
| $\sqrt{x}$ , ln $x$ , log $x$                  | $0 \leq x \leq 1.79769313486231580778 \times 10^{308}$ , $x \neq 0$ for ln $x$ and log $x$  |
| exp $x$  | $-1.79769313486231580778 \times 10^{308} \leq x \leq 709.78271289338402$  |

## Shortcut keys

### Main window

|                   |   |
|-------------------|---|
| <b>Alt + F4</b>   | Exit  |
| <b>Ctrl + F</b>   | Calculate current graph                                     |
| <b>Ctrl + F4</b>  | Exit  |
| <b>Ctrl + P</b>   | Print current function and its graph                        |
| <b>ESC</b>        | Cancel full screen graph and go back to normal window graph |
| <b>F1</b>         | Help: Show User's Manual (PDF document...)                  |
| <b>F5</b>         | Calculate current graph                                     |
| <b>Shift + F1</b> | Show <i>about window</i>                                    |

## Specifications

|  |   |
|--|---|
| <b>Reference</b>                       | <b>FUGP</b>   |
| <b>Description</b>                     | <b>FUNGRAPH</b> is a Windows application to calculate 2D graphs of mathematical functions.  |
| <b>License</b>                         | Trialware   |
| <b>Internal precision</b>              | As a rule, precision is $\pm 1$ in the 16th digit.  |
| <b>General range of calculation</b>    | From $\pm 2.47032822920 \times 10^{-324}$ to $\pm 1.79769313486 \times 10^{308}$ and 0 is assumed for values within $\pm 2.47032822920 \times 10^{-324}$  |
| <b>Levels of parentheses</b>           | <b>28 levels</b>  |
| <b>Types of function graphs</b>        | <b>5 main types of graphs:</b> <ul style="list-style-type: none"> <li>- <i>Single function</i></li> <li>- <i>Piecewise function</i></li> <li>- <i>Parametric function</i></li> <li>- <i>Polar function</i></li> <li>- <i>Multiple function</i></li> </ul> |
| <b>Scientific functions and others</b> | <b>27 Scientific functions and others</b><br>sin, cos, tan, arcsin, arccos, arctan,<br>sinh, cosh, tanh, arsinh, argcosh, argtanh,<br>log, ln, $\sqrt{x}$ , $\sqrt[3]{x}$ , $x^2$ , $x^3$ , $10^x$ , exp, int, abs, rnd, $\pi$ , E, Arc, Hyp,             |
| <b>Operators</b>                       | <b>6 Operators</b><br>( + ) Addition,                      ( - ) Subtraction,                      ( $\cdot$ ) Multiplication,<br>( / ) Division,                      ( ^ ) Power,                      ( ) Implicit multiplication                      |
| <b>Angular units</b>                   | <b>2 angular units:</b> Degrees (DEG) and radians (RAD).  |

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