



Option analytics module

User's manual

Version 3.0



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You may email your comments on this Manual to: quiksupport@argatech.com



1. About the Program

This manual contains the description of the Module functions which are available from the main menu by selecting the Strategy menu item. Before using new program functions for the first time read the operating manual carefully to prevent the possible errors occurred.

The program is intended for analyzing the strategies on the derivatives market and allows envisioning the possible scenarios and comparing them to others strategies.

1.1 Module functions

The Module allows to:

- Use the standard strategy templates for the analysis;
- Create new strategies, save and download them;
- Present volatility in the chart and create the chart templates.

1.2 Before starting

Option analytics module is an additional QUIK Workstation component.

This Module is a paid program. The possibility of using it is provided by the broker individually.

The **stratvolat.dll** file which is required for Module operation must be copied to the directory where the QUIK Workstation program files are installed, for example: C:\Program Files\QUIK.

Before copying the stratvolat.dll file exit the QUIK Workstation program.

1.3 Program operation

The Module functions are available from the main menu of the QUIK Workstation program. The Strategy item appears in the main menu after installation of the Module. It contains:

- Create strategy. For the detailed information see [Section 2](#).
- Create volatility chart. For the detailed information see [Section 3](#).



2. Option Analyst

menu **Strategy / Create strategy**

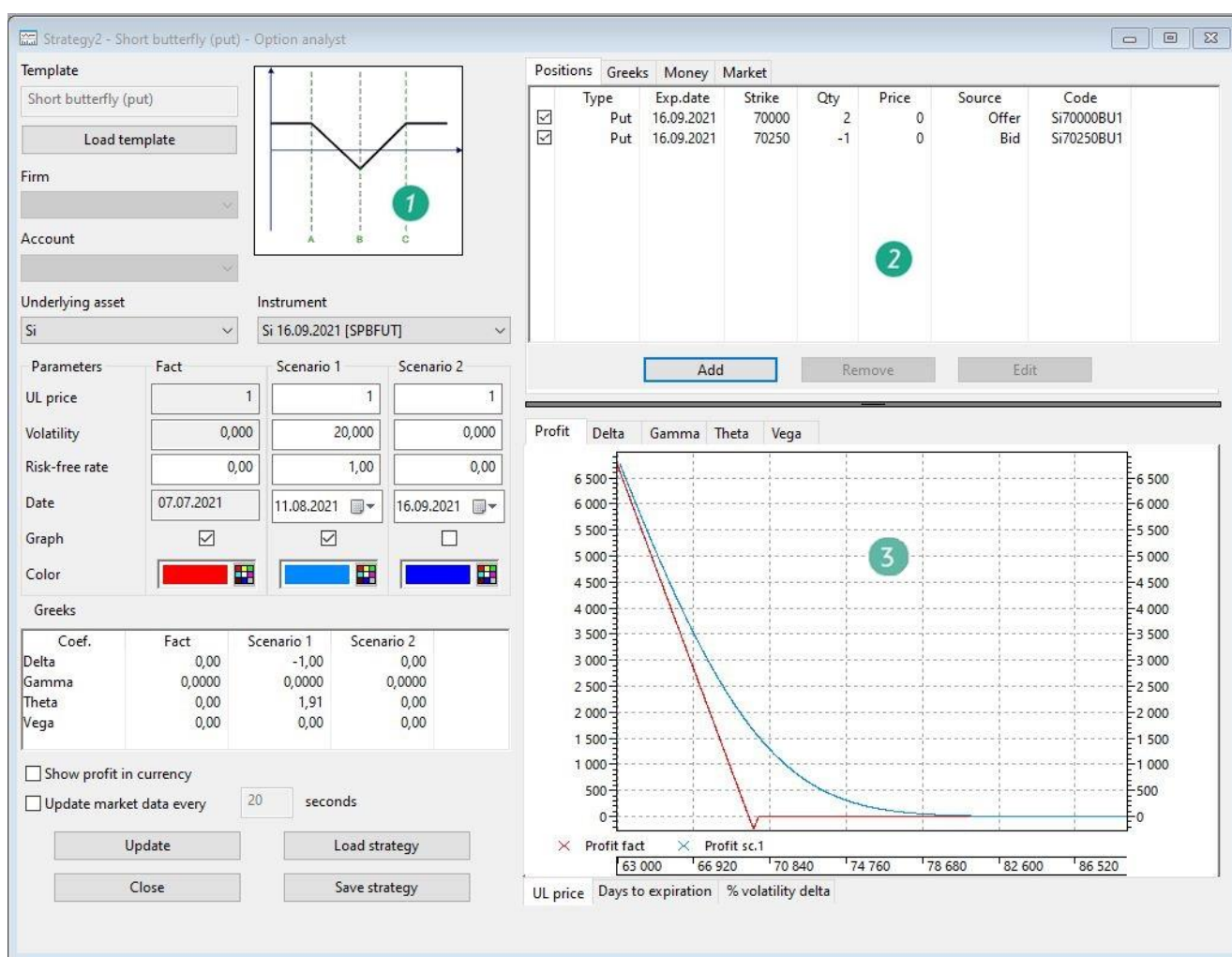
2.1 Purpose

Option analyst is intended for analyzing the strategies for simultaneous opening the positions with one-series options and an underlying asset, for calculation of all the required indicators for the aggregate position and using the functionality of standard options calculator.

There is a possibility of graphical analysis of complex option position focused on its profitability depending on the price of underlying asset, number of days till expiration or volatility. Changing the model parameters – volatility, the date of calculations – one can get the different scenarios of situation development.

There is a possibility of loading a definite strategy using a template, and then filling it by parameters of selected instruments and their current market indicators.

2.2 Window view



Window title shows the name of saved strategy and the selected template. If a strategy was not saved, strategy name is a next serial number (increasing with each opened window), for example 'Strategy 16 – Short butterfly (put) – Option analyst'.

The Option analyst dialog contains 3 sections:

1. Parameters panel is intended for loading a template and entering the scenarios of situation development.
2. Strategy input panel is intended for entering the positions for which the calculation will be made.
3. Charts window is intended for graphical display of the strategy entry results.

2.2.1 Parameters panel

The parameters panel is intended for creation and saving strategies, underlying asset and scenario selection.

Strategy20 - Current position - Option analyst

Template
Current position
Load template

Firm
SPBFUT389

Account
389_001

Underlying asset
MIX

Security
MIX 15.09.2015 [SPBFUT]

Parameters	Fact	Scenario 1	Scenario 2
UL price	167650	167650	167650
Volatility	0,000	0,000	0,000
Risk-free rate	0,00	0,00	0,00
Date	18.03.2015	16.06.2015	15.09.2015
Graph	☒	☐	☐
Color	■	■	■

Greeks	Coef.	Fact	Scenario 1	Scenario 2
Delta		-10,00	-10,00	-10,00
Gamma		0,0000	0,0000	0,0000
Theta		0,00	0,00	0,00
Vega		0,00	0,00	0,00

☐ Show profit in currency
☒ Update market data every 20 seconds

Update Load strategy
 Close Save strategy

The following settings are available on the panel:

1. **Template** is a text field displaying the name of a selected strategy template.
2. **Load template** button opens the dialog with the list of available template. When the user selects a template the strategy is downloaded and the Strategy window (which is located on the right) is refreshed.



3. **Firm** is the list of available identifiers of companies where the user has account positions. The parameter is available only for 'Current position' template.
4. **Account** is the list of available trading accounts available for selected company. The parameter is available only for 'Current position' template.
5. **Underlying asset** is intended for selection of an underlying asset for the analysis of the strategy which includes the derivatives contracts for this asset.
6. **Security** is the list of securities codes the [positions](#) are displayed for. The string includes: underlying asset code, date of filling the futures contract for the selected asset and code class in which the selected instrument is found. If selecting 'All' (by default) full list of positions for the selected underlying asset is loaded.
7. The fields for entering the initial data to be used for the parameters of scenarios calculation are below. The scenarios section is represented as a table consisting of columns and rows.

Column	Purpose
Fact	Parameters of the actual position to be transmitted from the trading system as absolute values
Scenario 1	Is set up by the user as offsets to compare with the actual position
Scenario 2	Is set up by the user as offsets to compare with the actual position

Row	Purpose
UL price	The price of underlying asset. The last trade price is displayed in the field. If there weren't any trades during the current session then the settlement price is displayed. If the Update market data every ... seconds parameter is enabled then the value of UL price field in the 'Fact', 'Scenario 1' and 'Scenario 2' columns is updated. If the user edited manually values of 'Scenario 1' and 'Scenario 2' columns, the changed price is not more updated. It is highlighted in color, recorded when saving the strategy to file and restored when running. A price value on the charts of the dependence of profit, delta, gamma, theta, vega on the price of underlying asset is displayed as a marker highlighted in a color that corresponds to the color of the graph. This marker is a vertical segment whose abscissas of the points are equal to the current price of an underlying asset
Volatility	Value of changing relative to the base volatility of options, in points. In the Effective volatility field, the value is filled in from last instrument in the strategy instrument list
Risk-free rate	Risk-free rate for options on shares. By default risk-free rate is zero.
Date	The date as of which the settlements of profit and coefficients for the chosen strategy are made. The graph of the dependence of profit on the days till expiration is built starting from this date. The graph values can vary till the closest date (included) of expiration of the contracts in the



Row	Purpose
	strategy. By default value in field Date of Scenario 1 and 2 changes automatically to expiry date of the latest contract with changes in instruments that compose a strategy, mark Positions in strategy entering panel.
Graph	Enables / disables the display of the current scenario on the graph
Color	Line color for the current scenario

8. The **Greeks table** (at the bottom of the screen) contains calculated values of the corresponding coefficients.
9. The **Show profit in currency** checkbox enables the display of profit values in currency, otherwise in contract price items.
10. The **Update market data every ... seconds** checkbox enables the update of market data that allows to monitor the changes in the asset portfolio during the trading session. The renewal interval is set up in seconds.

The buy of additional options won't lead to the change of the portfolio in the Option analytics module except when a user uploads his position again or when a user clicks the Update button or if he enables the Update market data every ... seconds parameter.

When the user clicks the Update button or if the Update market data every... seconds parameter is disabled, the following occurs:

- Check of the information for an instrument which is selected in the Underlying asset field is made. If the server does not have this instrument then the form is cleared and the update process is stopped.
- Check of the information for the instruments which are selected in the Code field of the Positions tab is made. If at least one of the instruments doesn't exist in the lists then all rows with option trades on the Positions tab are deleted and the corresponding changes occur on the other tabs.
- Update of the data in the Price field on Parameters panel and in the Price fields on the Positions tab in accordance with the selected source is made.
- Update of initial margin data on the Money tab and update of market data on the Market tab is made.
- Check and if necessary an update settlement dates in the scenarios for which the following condition must be fulfilled are made: a settlement date doesn't exceed the minimum date of expiration on the Positions tab.
- Recalculation of all the calculated fields in the form.
- Rebuilding the graphs in the graphical windows.



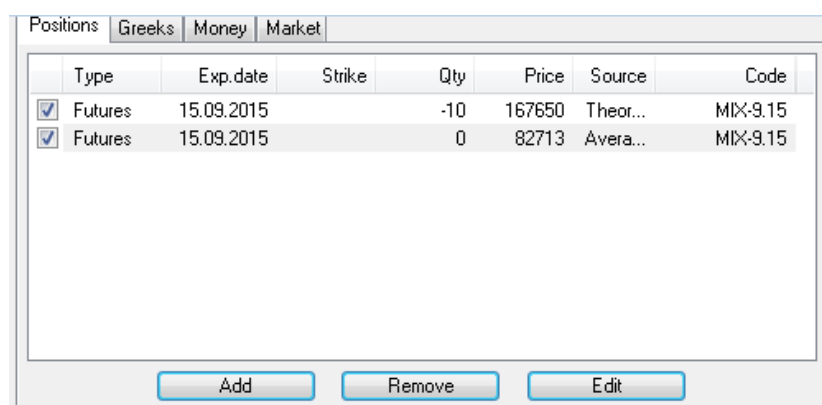
When a user clicks the Save strategy button the strategy is saved in the .str file. The dialog for loading the previously saved strategy file is opened by clicking the Load strategy button. Click the Close button to close the window of the Option analytics module.

2.2.2 Strategy entry panel

The strategy entry panel contains the Positions, Greeks, Money and Market tables which are located in one window on different tabs.

The Positions tab contains the list of strategy instruments. After the strategy template is chosen the Module automatically selects the contracts to be used in a strategy. The list can be corrected if necessary. The strategy can be saved in the file to be used in future.

When modeling the strategy one can include/exclude certain type of contract (without deleting it from the strategy). If the check in row of contract is not set this contract is not used in calculating parameters of the strategy and in building graphs.



Type	Exp.date	Strike	Qty	Price	Source	Code
☒ Futures	15.09.2015		-10	167650	Theor...	MIX-9.15
☒ Futures	15.09.2015		0	82713	Avera...	MIX-9.15

Buttons: Add, Remove, Edit

When modeling a strategy in Positions tag added and factual contracts are also displayed (is real position is loaded in edited):

- Red color of background means that the contract is added when modeling but doesn't exist in factual position.
- Red color of the text means that the client has a position for this contract but when modeling the price or quantity is changed. In the case of quantity change the value of factual and added quantity is displayed in appropriate column.
- Blue color of background means that contracts are in factual position of client's account but were deleted when modeling. If the added contract that was not in factual position is deleted it will disappear from the list. Deleted contracts don't participate in calculations.

To return to edition of underlying factual position load the template Current position and select appropriate underlying asset.

1. The following parameters are displayed on the Positions tab:



Column	Purpose
*Type	Type of futures contract. Valid values: Call, Put and Futures
Exp. date	Date of contract expiration
Strike	Price of contract expiration
Qty	Contracts quantity which is used for of strategy parameters calculation. For a short position the value is negative; for a long position the value is positive
Price	Contract price
Source	The value of this parameter determines the data source for the Price field. Valid values: Theor. price, Last price, Bid, Offer and Average (average price between the bid and offer prices). If the field has value '-----', then the price is entered manually. In this case the price field is not updated by clicking Update on the parameters panel
Code	Short code of the instrument

* – type 'Spot' is available only for spot-market instruments.

To add a new position to the table click Add. To change parameters of the selected position click Edit. The instrument code is added automatically. To delete the selected position from the list click Delete. Use checkboxes to enable and disable positions without deleting them.

2. The following parameters are displayed on the Greeks tab:

Column	Purpose
Code	Short code of the instrument
Volatility	Volatility value received from the trading system
Theor. price	Theoretical price value received from the trading system
Delta (%)	Calculated value of Delta coefficient. See Annex for Formulas
Gamma	Calculated value of Gamma coefficient. See Annex for Formulas
Theta	Calculated value of Theta coefficient. See Annex for Formulas



Column	Purpose
Vega	Calculated value of Vega coefficient. See Annex for Formulas

3. The following parameters are displayed on the Money tab:

Column	Purpose
Code	Short code of the instrument
Qty	Number of instrument units in the trade
Price	Price of the trade
Cash flow	For the options: the trade value (in monetary terms) is equal to the product of the Price, Qty field values (taking into account the sign) and the lot size. For the strategy is the sum of values by rows
Max profit	Maximum profit that can be achieved by transaction execution. The field can have a numeric value or "unlimited" (the profit is not limited). If the strategy is not above zero or does not fall below, value of the parameter is zero
Max loss	Maximum loss that can be achieved by transaction execution. The field can have a numeric value or "unlimited" (the profit is not limited). If the strategy is not above zero or does not fall below, value of the parameter is zero
Max GO	The initial margin for an instrument (without privileges). The value of the portfolio initial margin which is calculated for the strategy is displayed in the Strategy row in the Max GO field. It is calculated only if Module of unified money position is available on QUIK server

4. The parameters which are displayed on the Market tab are imported from the FORTS market:

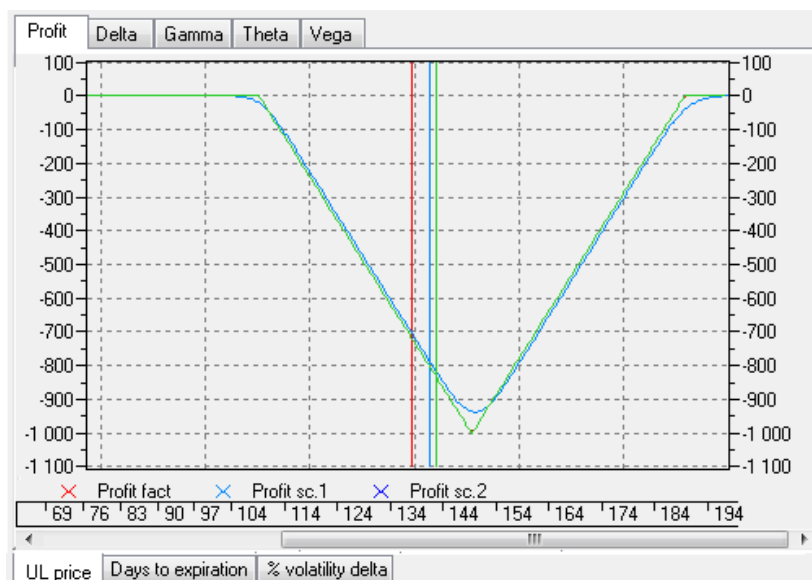
Column	Purpose
Code	Short code of the instrument
Last price	Price of the last trade
Ask	Bid price
Bid	Offer price
Trades	Trades quantity for an instrument by the end of current trading session
Contracts	Daily turnover (in pieces)



Column	Purpose
Open positions	Quantity of open positions for an instrument

2.2.3 Graphics window

The graphs which are built on the basis of entered values are displayed in the graphics window:



1. **Profit** is a forecast value of profit on derivative contracts.
2. **Delta, Gamma, Theta** and **Vega** are the values of corresponding sensitivity coefficients.

The following values are plotted on the horizontal scale:

1. **UL price** is a price of underlying asset.
2. **Days to expiration** are number of days till the expiration date of the option in the strategy.
3. **% volatility delta** is the change of volatility (in percent).

To switch the values on the horizontal scale, click on the headers below the graph window.

Vertical line on the graph determines the price of the underlying asset.

Information about location of the cursor is displayed in the plotting area if appropriate functions are enabled on panel Coordinates of cursor of the QUIK Workstation (for more information see sub-section 4.2.9 of User's manual for QUIK Workstation, Section 4: Working with graphs).

If the Build set of receiving instruments and parameters: according to settings for open user tables option button in the settings of the QUIK Workstation program (see Settings menu item, Program / Data receiving sections) is enabled then the following parameters will be added to the list of automatically requested data from the server: volatility (for the options), last price, bid, offer, theoretical price (for the options), settlement price.



2.3 Strategy templates

2.3.1 Using the strategy templates

The program contains the strategy templates for estimation and forecasting the future situations. Using these templates allows calculating possible profits and losses depending on the situation at the market.

The following changes are made during the upload of the strategy template:

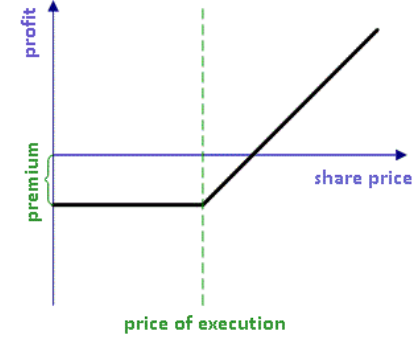
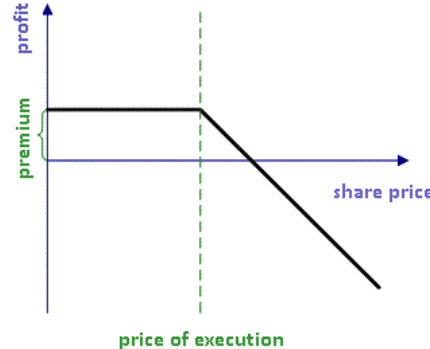
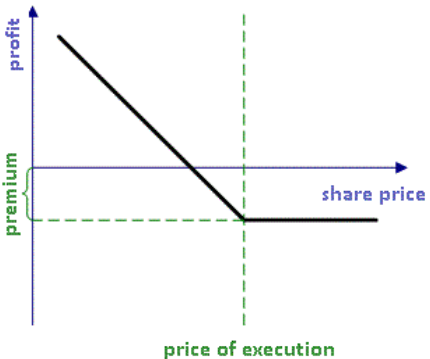
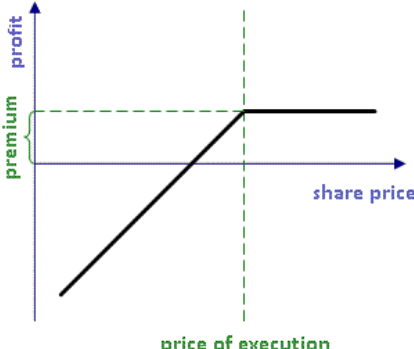
1. All rows are deleted from all tabs.
2. The option trades are added to the Positions tab accordingly to the strategy template.
3. The settlement dates in the scenarios for which the following condition have to be fulfilled are checked and (if necessary) corrected: the settlement date should not exceed the minimum expiration date which is specified on the Positions tab.
4. The rows with corresponding parameters are added to the Greeks, Money, Market tabs.

The following values are set up by default in the template:

Value	Note
Date of expiration of the option	The nearest date of the option expiration for current underlying asset
If the strike must not exceed the price of underlying asset	The maximum value of strikes from available values that doesn't exceed the price of underlying asset. If it doesn't exist then the minimum strike is selected. For example: When the price of underlying asset is 19855 then the value equal to 19500 will be selected among available strikes of 19000, 19500 and 20000 values
If the strike must be more than the price of underlying asset	The minimum value of strikes from available values that exceed the price of underlying asset. If it doesn't exist then the maximum strike is selected. For example: When the price of underlying asset is 19855 then the value equal to 20000 will be selected among available strikes of 19000, 19500 and 20000 values



2.3.2 Standard strategy templates

Strategy	Purpose	Strategy chart
Long call	The strategy is used if the price of underlying asset and its volatility are expected to rise. The profit is not limited; the loss is limited by the premium paid for the option	 The chart shows profit on the vertical axis and share price on the horizontal axis. A horizontal line at the premium level represents the loss until the share price reaches the price of execution (indicated by a vertical dashed line). After this point, the profit increases linearly with the share price.
Short call	The strategy is used if the price of underlying asset and its volatility are expected to decrease. The profit is limited by the premium paid for the option; the loss is not limited	 The chart shows profit on the vertical axis and share price on the horizontal axis. A horizontal line at the premium level represents the profit until the share price reaches the price of execution (indicated by a vertical dashed line). After this point, the profit decreases linearly as the share price increases.
Long put	The strategy is used if the price of underlying asset is expected to decrease and its volatility is expected to rise. The profit is not limited; the loss is limited by the premium paid for the option	 The chart shows profit on the vertical axis and share price on the horizontal axis. A downward-sloping line represents the profit until the share price reaches the price of execution (indicated by a vertical dashed line). After this point, the profit is constant at the premium level.
Short put	The strategy is used if the price of underlying asset is expected to rise and its volatility is expected to decrease. The profit is limited by the premium paid for the option; the loss is not limited	 The chart shows profit on the vertical axis and share price on the horizontal axis. An upward-sloping line represents the profit until the share price reaches the price of execution (indicated by a vertical dashed line). After this point, the profit is constant at the premium level.



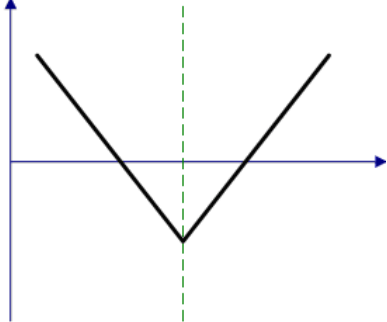
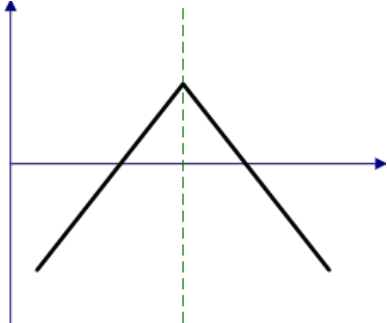
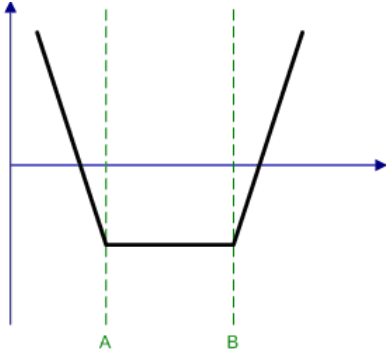
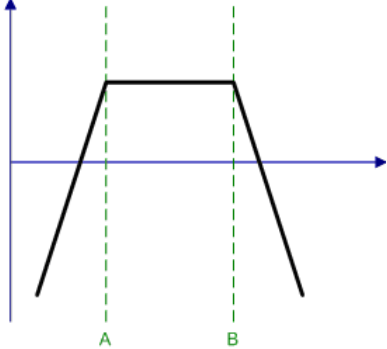
Strategy	Purpose	Strategy chart
Bull call spread	The strategy is used if the price of underlying asset is expected to moderately rise. The profit is: $s(B) - s(A) - p(A) + p(B)$; the loss is: $p(A) - p(B)$, where s – strike, p – option price, A and B – points of buy/sell of the options	
Bull put spread	The strategy is used if the price of underlying asset is expected to moderately rise. The profit is: $s(B) - s(A) - p(B) + p(A)$; the loss is: $p(B) - p(A)$, where s – strike, p – option price, A and B – points of buy/sell of the options	
Bear call spread	The strategy is used if the price of underlying asset is expected to moderately decrease. The profit is: $p(A) - p(B)$; the loss is: $s(B) - s(A) - p(A) + p(B)$, where s – strike, p – option price, A and B – points of buy/sell of the options	
Bear put spread	The strategy is used if the price of underlying asset is expected to moderately decrease. The profit is: $s(B) - s(A) - p(B) + p(A)$, the loss is: $p(B) - p(A)$, where s – strike, p – option price, A and B – points of buy/sell of the options	



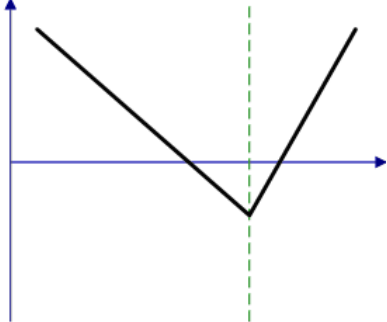
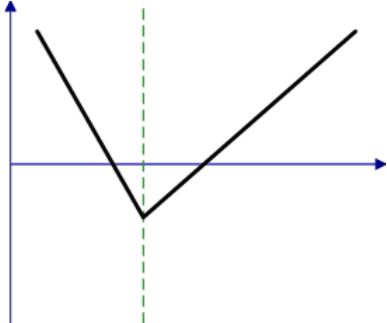
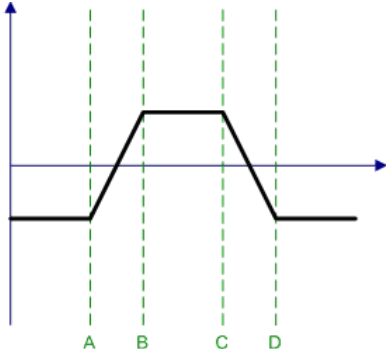
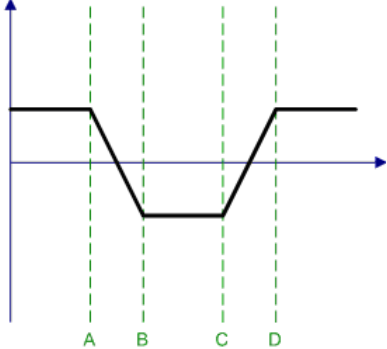
Strategy	Purpose	Strategy chart
Call ratio backspread	The strategy is used if the price of underlying asset is expected to change and the volatility is expected to rise. This strategy allows: - receiving the profit if the price of underlying asset rises; - receiving small profit if the price decreases; - limiting losses if the price remains unchanged. The profit is not limited in case of significant growth of the price of underlying asset. The loss is limited by the price paid for the bought options	
Put ratio backspread	The strategy is used if the price of underlying asset is expected to change and the volatility is expected to rise. This strategy allows: - receiving the profit if the price of underlying asset decreases; - receiving small profit if the price rises; - limiting losses if the price remains unchanged. The profit is not limited in case of significant fall of the price of underlying asset. The loss is limited by the price paid for the bought options	
Long butterfly (call)	The strategy is used if the price of underlying asset is not expected to change and the volatility is expected to decrease. This strategy allows receiving small profit if the prices are not changed and limits the losses when an underlying asset moves significantly. The profit is maximum if price of underlying asset is in point B for the moment of options expiration. The losses are limited by the spread between the premiums paid for 2 options B and the premiums paid for the options A and C	
Short butterfly (call)	The strategy is used if the price of underlying asset is expected to change and the volatility is expected to rise. This strategy allows receiving limited profit if the prices of underlying asset are changed and limits the losses when the price deviates insignificantly. The profit is maximum if the price of underlying asset is less than A and more than C at the moment of the options expiration. The losses are limited by the spread between the premiums paid for 2 options B and the premiums paid for the options A and C	

Strategy	Purpose	Strategy chart
Long butterfly (put)	The strategy is used if the price of underlying asset is not expected to change and the volatility is expected to decrease. This strategy allows receiving small profit if the prices are not changed and limits the losses when an underlying asset moves significantly. The profit is maximum if the price of underlying asset is at the point B at the moment of the options expiration. The losses are limited by the spread between the sum of premiums paid for the options A and C and the sum of premiums paid for two options B	
Short butterfly (put)	The strategy is used if the price of underlying asset is expected to change and the volatility is expected to rise. This strategy allows receiving limited profit if the prices of underlying asset are changed and limits the losses when the price deviates insignificantly. The profit is maximum if the price of underlying asset is less than A and more than C at the moment of the options expiration. The losses are limited by the spread between the premiums paid for 2 options B and the premiums paid for the options A and C	
Call ratio spread	The strategy is used if the price of underlying asset is not expected to change and the volatility is expected to decrease. This strategy allows receiving small profit if the prices are not changed and limits the losses when the price of underlying asset decreases but does not limits the losses when the price rises	
Put ratio spread	The strategy is used if the price of underlying asset is not expected to change and the volatility is expected to decrease. This strategy allows receiving small profit if the prices are not changed and limits the losses when the price of underlying asset rises but does not limits the losses when the price decreases	



Strategy	Purpose	Strategy chart
Long straddle	The strategy is used if the price of underlying asset is expected to change up or down and the volatility is expected to rise	
Short straddle	The strategy is used if the price of underlying asset is not expected to change and the volatility is expected to decrease	
Long strangle	The strategy is used if the price of underlying asset is not expected to change and the volatility is expected to rise	
Short strangle	The strategy is used if the price of underlying asset is not expected to change and the volatility is expected to decrease	



Strategy	Purpose	Strategy chart
Strap	The strategy is used if the price of underlying asset is more likely to rise than to decrease	
Strip	The strategy is used if the price of underlying asset is more likely to decrease than to rise	
Long condor	The strategy is used if the price of underlying asset is not expected to change and the volatility is expected to decrease. This strategy allows receiving small profit if the prices are not changed and limits the losses when the price of underlying asset moves significantly	
Short condor	The strategy is used if the price of underlying asset is expected to change and the volatility is expected to rise. This strategy allows receiving small profit if the prices of underlying asset are changed and limits the losses when the price deviates insignificantly	



3. Volatility Chart

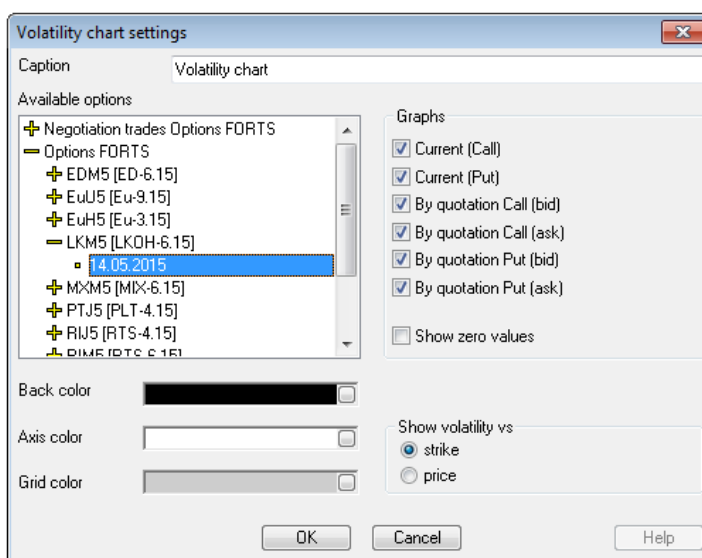
menu **Strategy / Create volatility chart**

3.1 Purpose

The volatility chart displays the values spread of option volatility depending on the strikes values.

The analysis of volatility allows reacting rapidly to the asymmetries of options prices and gives an opportunity to monitor the data simultaneously for all strikes on the same scale as the options prices are expressed in volatility values. The values spread diagramming of the option volatility with a specified date of execution depending on the strike is used as the comparative analysis instrument.

3.2 Volatility chart settings



The following parameters are available:

1. Caption – to change the text of the window's caption.
2. Available options – to select the options to be displayed on the chart.
3. Back color – to select the back color of the chart.
4. Axis color – to select a color of the chart's axes.
5. Grid color – to select the grid color.
6. * Graphs – price values used to build graph lines:
 - Current (Call) – current volatility for buy option;
 - Current (Put) – current volatility for sell option;
 - By quotation Call (bid) – volatility for sell quotes (bid);

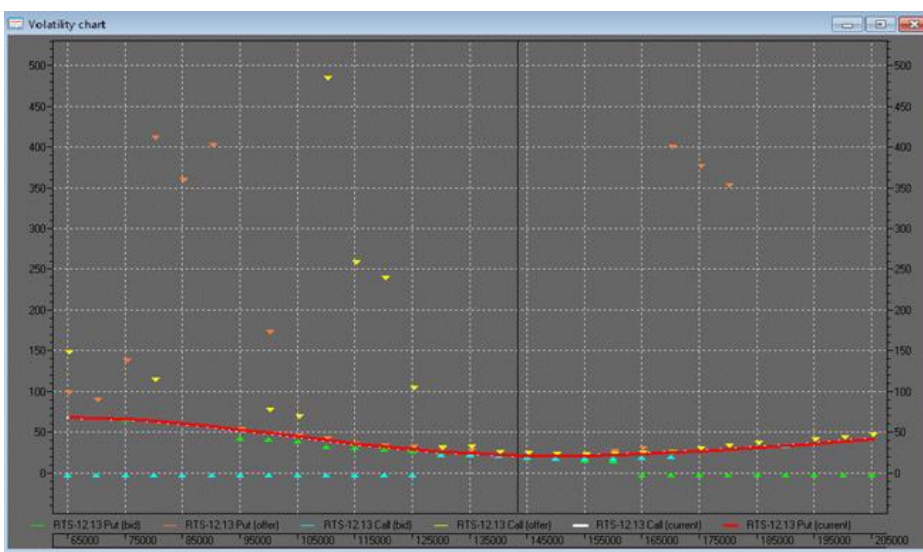


- By quotation Call (ask)» – volatility for buy quotes (ask);
 - By quotation Put (bid) – volatility for buy quotes (bid);
 - By quotation Put (ask) – volatility for buy quotes (ask);
7. Show zero values – to show the points with zero values. If the checkbox is disabled then these points are not displayed on the graph.
8. Show volatility vs – to select the way of the calculation of volatility changes:
- strike – in percentage of strike size;
 - *price – in percentage of price value.

Building graphs of current volatility and dependence on price is available only for FORTS options.

3.3 Window view

Window represents a chart whose horizontal scale is intended for the indication of strike values and a vertical one for the indication of volatility values which are expressed in percent. The price of underlying asset is indicated by a vertical line.



The quote charts are displayed as triangular marks whose vertices are directed:

- upward for volatility calculated for best offer price;
- downward for volatility calculated for best bid price.

When a user points to a mark the pop-up message with the values of volatility, bid and offer prices, last price of the trade and the theoretical price for this point appears.



3.4 Functions available from the context menu

Two context menus can be opened from the Volatility chart window. The first menu applies to the graphs line, the second one applies to the plot area.

The functions of the context menu which applies to the charts line:

- Edit graph – to open a graph editing window (for more information see [3.2](#)).
- Delete graph – to delete a graph from the chart.

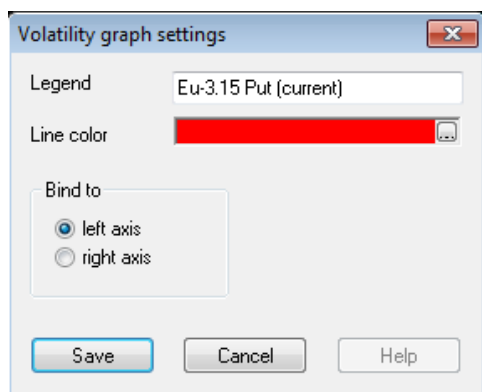
The functions of the context menu which apply to the plot area:

- Edit chart – to open a chart editing window.
- Edit graph – to edit the selected graph settings (see [3.5](#)).
- Delete graph – to delete a selected graph of the chart.
- Make a template – save the graph settings as a template.
- Templates – open the window of templates edition.
- Select graphs settings – apply selected settings template to the given graph.

For more information about working with graph templates see [3.6](#).

3.5 Volatility graph settings

The settings of graph's appearance are available in the Volatility graph settings dialog which can be opened from the context menu of the Volatility chart window.



The parameters are:

1. Legend – to change the graph's legend.
2. Line color – to select a color of graph's line.
3. Bind to – to select the axis for scaling the graphs values.



3.6 Working with graph templates

The template represents the configuration of the graph's window which is saved under the specified name. This template can be applied to the existing windows and used to quickly set up the new graph.

1. To view the list of templates use the Templates menu item of the graph's context menu.
 - Setup the template as a template selected by default. Select the required window configuration in the list of available templates and click Make default. Then the name of template becomes available in the Template by default section.
 - Rename the template. Select the required template and click Rename. In the opened dialog enter new name and click Enter.
 - Delete the template. Click Delete to delete the selected template.
 - Apply the template to several windows. To change the settings of all graphs accordingly to the selected template click Apply to all windows; to apply the template to the windows of the current tab click Apply to all on the bookmark.
2. New template creation.
 - Set up new quotes graph's window as new template or select one of existing templates.
 - Select the Make template menu item from the context menu of the graph.
 - To update the template select its name and click Save in the opened window.
 - To create a new template click Save into new. Enter new name and click OK in the opened dialog.
 - Click Close.
3. Template application. To make the settings for the graph using a template select the Select graph settings from templates / <Template's name> context menu item.

4. Annex. Formulas

1. Theoretical option price (Black – Scholes Model):

$$V_{call} = SN(d_1) - Ke^{-rT}N(d_2), V_{put} = N(-d_2)Ke^{-rT} - SN(-d_1)$$

$$d_1 = \frac{\left[\ln\left(\frac{S}{K}\right) + \left(r + \frac{\sigma^2}{2}\right)T \right]}{\sigma\sqrt{T}}, d_2 = d_1 - \sigma\sqrt{T},$$

Where,



V_{call} – theoretical option price (“Call”);

V_{put} – theoretical option price (“Put”);

S – current price of underlying asset;

T – time till expiration;

K – option’s strike;

r – risk-free interest rate;

N – normal distribution function;

e – base of the natural logarithm (2.71828).

2. Delta

$$\Delta_{call} = N(d_1)$$

$$\Delta_{put} = N(d_1) - 1$$

3. Gamma

$$\gamma_{call} = \frac{N'(d_1)}{S\sigma\sqrt{T}}$$

$$\gamma_{put} = \frac{N'(d_1)}{S\sigma\sqrt{T}}$$

4. Theta

$$\tau_{call} = -\frac{SN'(d_1)\sigma}{2\sqrt{T}} - rKe^{-rT}N(d_2)$$

$$\tau_{put} = -\frac{SN'(d_1)\sigma}{2\sqrt{T}} + rKe^{-rT}(1 - N(d_2))$$

5. Vega

$$v_{call} = S\sqrt{T}N'(d_1)$$

$$v_{put} = S\sqrt{T}N'(d_1)$$

