VELA

Realized Volatility Calculator (beta)

User Guide

May 2021

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Introduction

The goal of this document is to serve as a manual and walk the user through the features of the Realized Volatility Calculator. This document should serve as a guide for training any new user.

The purpose of the Realized Volatility Calculator Realized Volatility Calculator is to display the calculated realized volatility (based on minute, hourly and daily VWAP statistical variance) for a pre-configured set of instruments.

This guide attempts to capture the typical user's workflow along with everything that user needs to get up and running. This includes configuration settings, how jobs interact with one another, a walkthrough of the different GUIs and what to expect in them.

Configuration and Setup

The Realized Volatilty Calculator consists of four elements (all contained within an uploadable jar bundle called *bundle.RealisedVolFutures.jar*).

- **FuturesRealisedVolAlgo job** – Stores and retrieves trade data and performs VWAP and variance calculations. Saves to DB at end of day and sends to frontend GUI.
- **ClearRealisedVolDB job**– Utility job to clear DB
- **JobControl job**- Starts and stops FuturesRealisedVolAlgo at predefined times (default local server time: 08:25 to 15:20)
- **RealVolWidget** – Display GUI

In order to install the job please upload the aforementioned bundle.

Fig 1 – Select bundle to upload

The JobControl job will automatically start with the above default configs.

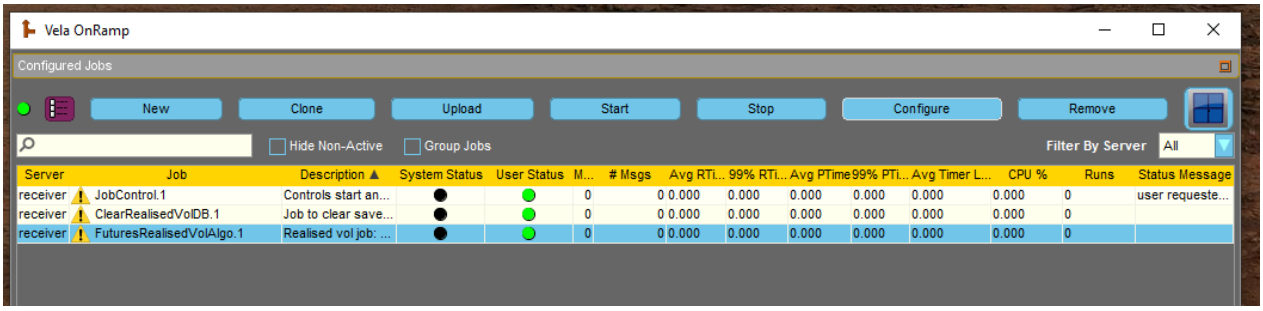


Fig 2 – Job instances created

Job Scheduler (JobControl)

The *JobControl* scheduler job automatically starts. However, if the user wishes to change the start/stop times of *FuturesRealisedVolAlgo.* They must stop *JobControl* job, select '*Configure'*, change the times as seen below and restart *JobControl*.

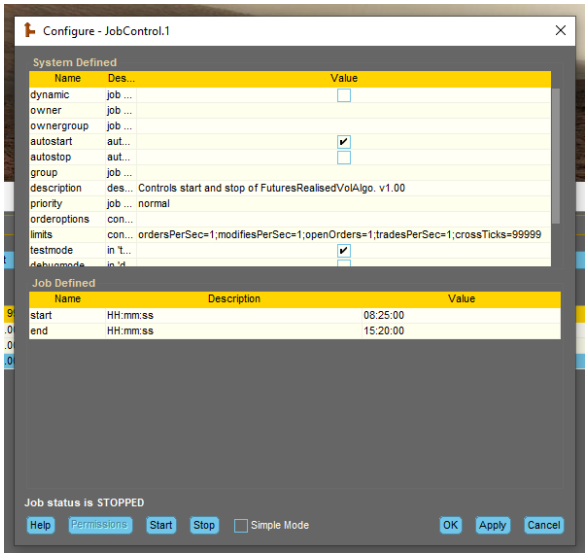


Fig 3 – JobControl (FuturesRealisedVolAlgo scheduler) config

FuturesRealisedVolAlgo configuration

Before running the main calculation algo (FuturesRealsedVolAlgo) certain configurations must be set. These only need to be set once only at the deployment stage. **See Calculations and Underlying Mechanics section for more information.**

- **timer** – this is set to 60000 and must not be changed
- **instruments** – select the instrument set you are interested in using the onramp instrument chooser. Double click the value field to alter this. Default is set to ES futures.
- **num points** – The user can chose how many data points the variance is calculated over. This is initially set at 20 but can be set to a maximum of 59.
- **num days** – Defines the number of days of records to be held in the DB. Obviously this sets the upper limit of the number of data points that daily realised vol can be calculated over.

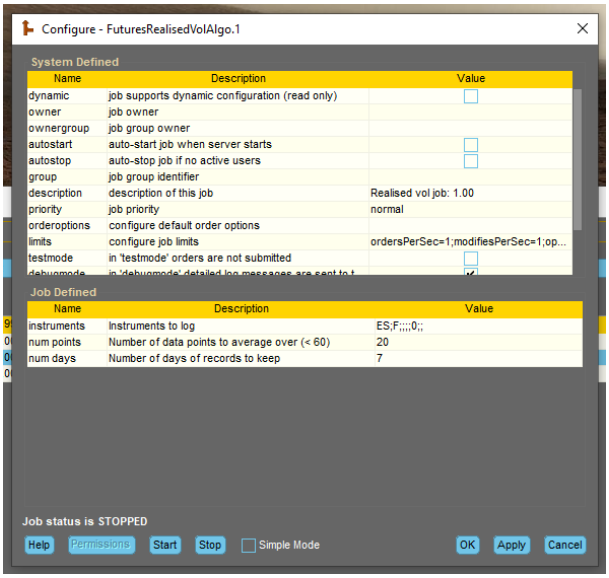


Fig 4 – FuturesRealisedVolAlgo configuration

Clear DB utility

VWAP values (which provide the fundamental data points in calculating variance and hence realized volatility) are persisted within a server based database. We provide a way to clear this if eg. the user wishes to remove all instruments, encounters any issues or simply to reset values. Simply click the Reset check box in the 'Configure' option for *ClearRealisedVolDB* and run the job.

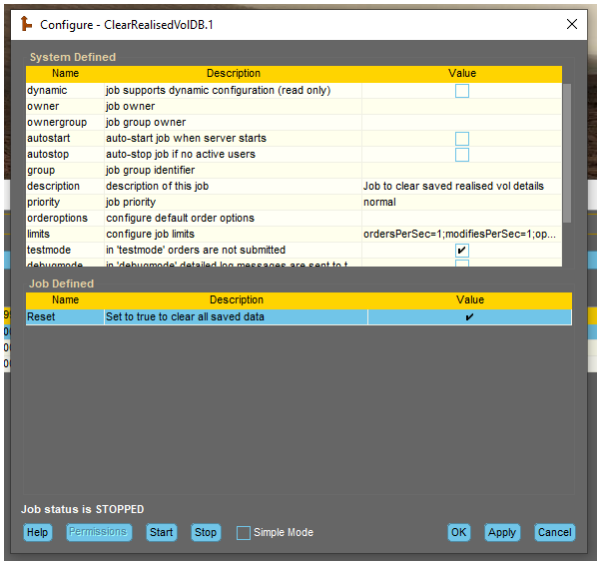


Fig 5 – Clearing the database

GUI Definitions

After uploading the GUI, in the frontend, you may be asked to update any widgets. Simply click yes. In order to display with the widget click the far right Freeway icon and select *RealVolWidget*.

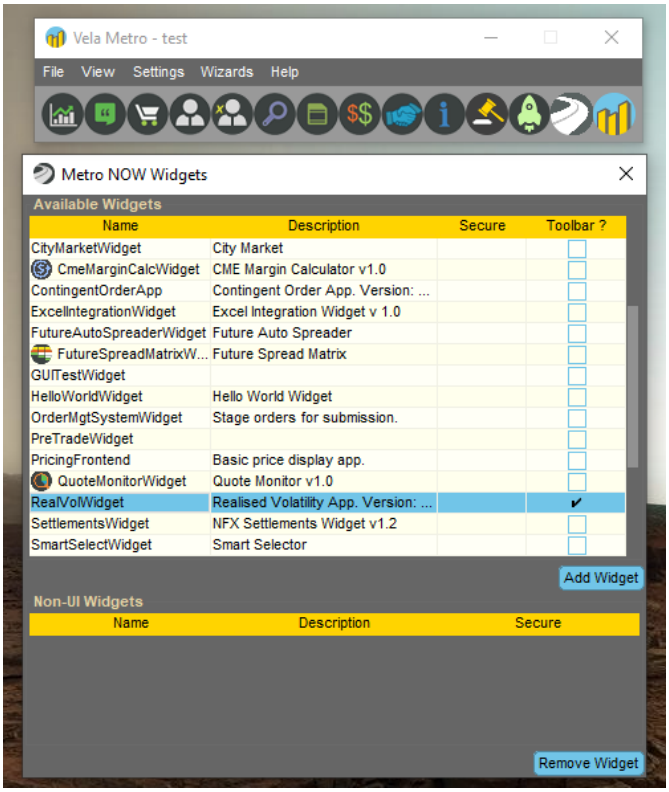
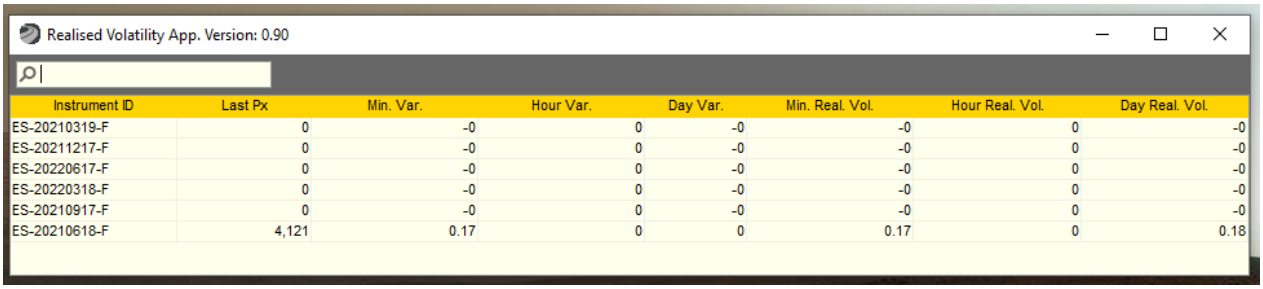


Fig 6 – Display widget in front end client

All being well (and if the backend job is running) you should see something like this. Instruments may vary depending on user choice:



Instrument ID	Last Px	Min. Var.	Hour Var.	Day Var.	Min. Real. Vol.	Hour Real. Vol.	Day Real. Vol.
ES-20210319-F	0	-0	0	-0	-0	0	-0
ES-20211217-F	0	-0	0	-0	-0	0	-0
ES-20220617-F	0	-0	0	-0	-0	0	-0
ES-20220318-F	0	-0	0	-0	-0	0	-0
ES-20210917-F	0	-0	0	-0	-0	0	-0
ES-20210618-F	4,121	0.17	0	0	0.17	0	0.18

Fig 7 – Realized Volatility App. GUI

We define the following fields:

Label	Description
InstrumentID	Metro Instrument identifier
LastPx	Last trade price contributing to VWAP
Min. Var.	Variance in VWAP captured in 1 minute time bins (available number data points set in *num points*)
Hour Var.	Variance in VWAP captured in over 60 minutes time bins (available number data points set in *num points*)
Day Var.	Variance in VWAP captured in over a complete job cycle (daily) available number data points set in *num days*)
Min. Real. Vol.	Minute realized volatility value calculated using Min. Var. value.
Hour Real. Vol.	Hourly realized volatility value calculated using Hour Var. value.
Day Real. Vol.	Daily realized volatility value calculated using Day Var. value.

Calculations and underlying mechanics

VWAP calculations

The algo captures trades in fundamental one minute intervals (timer=60000). These values are then used to infer hourly and daily VWAP values.

Each minute the VWAP is calculated using the standard definition:

$$VWAP_{min} = {\sum p_i q_i}\Big/{\sum q_i}$$

p_i: trade price
q_i: trade quantity

With the summation being taken over a one minute period.

The hourly VWAP ($VWAP_{hour}$) is calculated from the last 60 $VWAP_{min}$ data points and is updated every minute:

$$VWAP_{hour} = \sum VWAP_{min} Q_{min}$$

With Q_{min} as the total trade quantity in that minute associated with $VWAP_{min}$:

$$Q_{min} = \sum q_i$$

A rolling array of stored $VWAP_{hour}$ values of ('num points' size) is used to calculate the variance.

The daily VWAP $(VWAP_{daily})$ is simply the weighted $VWAP_{min}$ over the entire running cycle of the job (daily):

$$VWAP_{daily} = \sum VWAP_{min} Q_{min}$$

With the summation over all $VWAP_{min}$ for that day. This is calculated at the end of the day and the value obtained is used in the next day calculations.

Variance calculations

Variance (S^2) values are calculated from data set size of 'num points'. These are rolling arrays updated every minute. Eg if this is set to 10 then variance S^2_{min} is calculated using the last 10 $VWAP_{min}$ points, similarly S^2_{hour} is calculated using the last 10 $VWAP_{hour}$ values. S^2_{daily} uses only the number of days available (default 7). Using the following definitions for variance (see reference section):

$$S^2 = \sum ln \frac{VWAP_i}{VWAP_{i+1}}$$

S^2_{min} is calculated using VWAPs measured over minute intervals, S^2_{hour} is calculated using VWAPs measured over hour intervals and S^2_{day} using the total daily VWAP obtained through out the whole day.

An important point is that the summations will only be over data points available. If the job starts and there are no hour values or day values then expect zeros. (NaNs are handled in code and are represented by zero). For testing, please allow the algo to run over a sustained period of time.

Realized Volatility calculations

We employ the following definition to obtain the Real. Vol.:

$$Real.Vol._{min} = 100 * \left(\frac{S^2_{min} * 256}{n * T_{min}}\right)^{1/2}$$

$$Real.Vol._{hour} = 100 * \left(\frac{S^2_{hour} * 256}{n * T_{hour}}\right)^{1/2}$$

$$Real.Vol._{day} = 100 * \left(\frac{S^2_{day} * 256}{d * T_{day}}\right)^{1/2}$$

With time factors set as:

T_{min} = 1/(24*60)
T_{hour} = 1/24
T_{day} = 1
n = rolling average number eg. 10
d = number of days for which daily VWAP variance calculation is done eg. 7

Reference

Realized vol formulae taken from here: https://www.realvol.com/VolFormula.htm