cfbenchmarks
a kraken company

Token Market Price Benchmarks

Methodology Guide

Version:

1.0

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1 Version History

Version	Version Date	Changes to Previous
1.0	02 Feb 2026	Initial Draft

2 Overview

The Token Market Price Benchmarks have been specifically designed to serve as a transparent and representative indicator of the instantaneous price of a digital asset for the purposes of calculating margining requirements for futures trading and other financial instruments. No further applications of the Token Market Price Benchmarks have been taken into consideration in its design.

This document covers the methodology for calculating the Token Market Price Benchmarks. A summary of specifications is provided in Section 7.

Underlying Economic Reality

The Token Market Price Benchmarks are intended to measure the underlying economic reality of the exchange of the base asset for the quote asset or crypto assets that seek to represent the value of the quote asset "***quote proxy assets***" - such as "stablecoins" and vice versa. This is accomplished by the use of order input data from markets that facilitate the trading of the base asset for the quote asset or quote proxy assets.

3 Definitions

Quote Proxy Asset: a digital asset that is a fully reserve backed digital token, commonly referred to as a "stablecoin", that seeks to peg its value to that of the quote asset, where the stablecoin issuer operates a 1:1 redemption facility that is accessible to all Quote Proxy Asset holders.

Quote Proxy Asset List:

Name	**Ticker Symbol**
USD Coin	**USDC**
Tether USD	**USDT**

API: Application programming interface.

Calculation Time: Any time as of which a Token Market Price Benchmarks is published.

Contributed Exchange: A cryptocurrency trading venue approved by CF Oversight Function to serve as pricing source for the calculation of a Token Market Price Benchmarks.

Relevant Pair: The cryptocurrency versus cryptocurrency or legal tender pair referenced by a Token Market Price Benchmarks, as defined in Section 6.

Relevant Order Book: The universe of the currently unmatched limit orders to buy or sell a unit of cryptocurrency versus cryptocurrency or legal tender on a Contributed Exchange in the Relevant Pair, aggregated by price, that is reported through its API to the Calculation Agent.

Retrieval Time: The time, as given by the server clock of the Calculation Agent, which the Relevant Order Book of a Contributed Exchange corresponds to. When obtained from a request/response API such as a REST API, this would be the time of the request made by the Calculation Agent through the API of the Contributed Exchange. When obtained from a real time feed such as a Websocket API, this would be the most recent time as of which the Calculation Agent has a valid Order Book from an unbroken connection.

4 Methodology and Rules

4.1 Qualitative Description

The Token Market Price Benchmarks are calculated in real time based on the Relevant Order Books of all Contributed Exchanges. An order book is a list of buy and sell orders with associated limit prices and sizes that have not yet been matched due to lack of supply or demand to trade at that price. It therefore informs about the price at which a trader can buy or sell a certain amount of cryptocurrency as of now. In line with existing cryptocurrency market practises, the "order size" refers to the aggregated sizes of all orders at the same price, the price/sizes tuples of buy orders ("bids") descend by price and the price/size tuples of sell orders ("asks") ascend by price.

Calculation steps are as follows:

1. At the Effective Time, the Relevant Order Book of each Contributed Exchange is added to a joint list of order books.
2. The joint list of order books is aggregated into one consolidated order book. If the size of a bid or ask order price level exceeds the order size cap, it enters the consolidated order book with a size equal to the order size cap.
3. The cumulative bid price-volume curve, ask price-volume curve, mid price-volume curve and mid spread-volume curve are calculated from the consolidated order book at a granularity equal to the spacing parameter.
    a. The bid price-volume curve maps transaction volume to the marginal price per cryptocurrency unit a seller is required to accept in order to sell this volume to the consolidated order book.
    b. The ask price-volume curve maps a transaction volume to the marginal price per cryptocurrency unit a buyer is required to pay in order to purchase this volume from the consolidated order book.
    c. The mid price-volume curve represents the average of the bid price-volume curve and the ask price-volume curve.
    d. The mid spread-volume curve represents the percentage deviation of the ask price-volume curve from the mid price-volume curve.
4. The utilized depth is calculated as the maximum cumulative volume for which the mid spread-volume curve does not exceed a certain percentage deviation from the mid price. If this volume is less than the spacing parameter, the utilized depth is set to the spacing parameter.
5. The mid price-volume curve is weighted by the normalized probability density of the exponential distribution up to the utilized depth.
6. The Token Market Price Benchmarks is then given by the sum of the weighted mid price-volume curve obtained in the previous step.

4.2 Mathematical Representation

The following table shows the symbols used in the mathematical representation of the Token Market Price Benchmarks.

Symbol	Name	Description	Type
$\boldsymbol{T}$	Effective time	The time at which a Token Market Price Benchmark is calculated	Parameter, see Section 6
$\boldsymbol{C_T}$	Order size cap	The size above which any excess size of a bid or ask order price level is discarded	Internal variable, see Section 4.3
$\boldsymbol{D}$	Deviation from mid	The maximum percentage deviation of a limit order price level from the mid price-volume curve, until which that limit order price level is used for the calculation of a Token Market Price Benchmark	Parameter, see Section 6
$\boldsymbol{\lambda}$	Lambda	A parameter that determines the shape of the probability density function of the exponential distribution	Parameter, see Section 6
$\boldsymbol{s}$	Spacing	The spacing granularity of a price-volume curve	Parameter, see Section 6
$\boldsymbol{v}$	Volume	The independent variable of a price-volume curve	Internal variable
$\boldsymbol{A_T}$	Ask orders	The ask order price levels of the consolidated order book as of the effective time, ordered ascending by price	Input
$\boldsymbol{a_{T,i}}$ with $\boldsymbol{a_{T,i}} = \left(\boldsymbol{ap_{T,i}}, \boldsymbol{a\dot{s}_{T,i}}\right)$, $\boldsymbol{a_{T,i}} \boldsymbol{\epsilon} \boldsymbol{A_T}, \boldsymbol{a\dot{s}_{T,i}} = \left\{\boldsymbol{as_{T,i}}, \boldsymbol{C_T}\right\}$	Ask order	The ith price/size ask order pair of the consolidated order book	Input

$\boldsymbol{B_T}$	Bid orders	The bid order price levels of the consolidated order book as of the effective time, ordered descending by price	Input
$\boldsymbol{b_{T,i}}$ with $\boldsymbol{b_{T,i}} = \left(\boldsymbol{bp_{T,i}}, \boldsymbol{b\dot{s}_{T,i}}\right), \boldsymbol{b_{T,i}} \boldsymbol{\epsilon} \boldsymbol{B}, \boldsymbol{b\dot{s}_T}$ $\left\{\boldsymbol{bs_{T,i}}, \boldsymbol{C_T}\right\}$	Bid order	The ith price/size bid order pair of the consolidated order book	Input
$\boldsymbol{NF}$	Normalization factor	A parameter chosen such that $\frac{1}{NF}\sum_{v\in\{s,2s,\cdots,\underline{v}_T\}} \lambda e^{-\lambda v} =$ 1	Output
$\boldsymbol{CCRTI_T}$	CCRTI	The Token Market Price Benchmarks at time T	Output

Using the above notation, we define the ask price-volume curve, $askPV_T$, the bid price-volume curve, $bidPV_T$, the mid price-volume curve, $midPV_T$, and the mid spread-volume curve, $midSV_T$, in each case as of the effective time T, as:

$$\boldsymbol{a^{\Sigma}_{T,i}} = \sum_{\boldsymbol{j=1}}^{\boldsymbol{i}} \boldsymbol{a\dot{s}_{T,j}}$$	**Eq. 1a**
$$\boldsymbol{b^{\Sigma}_{T,i}} = \sum_{\boldsymbol{j=1}}^{\boldsymbol{i}} \boldsymbol{b\dot{s}_{T,j}}$$	**Eq. 1b**
$$\boldsymbol{p} = \boldsymbol{min}\left(\left\lfloor\frac{\boldsymbol{1}}{\boldsymbol{s}}\boldsymbol{mi}\left(\boldsymbol{a^{\Sigma}_{T,|A_T|}}, \boldsymbol{b^{\Sigma}_{T,|B_T|}}\right)\right\rfloor, \boldsymbol{50000}\right)$$	**Eq. 1c**
$$\boldsymbol{V} = \{\boldsymbol{1} \leq \boldsymbol{n} \leq \boldsymbol{p}\}$$	**Eq. 1d**
$$\boldsymbol{askPV_T}(\boldsymbol{v}): \boldsymbol{v} \in \boldsymbol{V} = \{\boldsymbol{ap_{T,1}}\ \boldsymbol{if}\ \boldsymbol{v} \leq \boldsymbol{a^{\Sigma}_{T,1}}\ \boldsymbol{ap_{T,2}}\ \boldsymbol{if}\ \boldsymbol{a^{\Sigma}_{T,1}} < \boldsymbol{v} \leq \boldsymbol{a^{\Sigma}_{T,2}}\ \ldots\ \boldsymbol{ap_{T,|A_T|-1}}\ \boldsymbol{if}\ \boldsymbol{a^{\Sigma}_{T,|A_T|-2}} < \boldsymbol{v} \leq \boldsymbol{a^{\Sigma}_{T,|A_T|-1}}\ \boldsymbol{ap_{T,|A_T|}}\ \boldsymbol{otherwise}$$	**Eq. 1e**
$$\boldsymbol{bidPV_T}(\boldsymbol{v}): \boldsymbol{v} \in \boldsymbol{V} = \{\boldsymbol{bp_{T,1}}\ \boldsymbol{if}\ \boldsymbol{v} \leq \boldsymbol{b^{\Sigma}_{T,1}}\ \boldsymbol{bp_{T,2}}\ \boldsymbol{if}\ \boldsymbol{b^{\Sigma}_{T,1}} < \boldsymbol{v} \leq \boldsymbol{b^{\Sigma}_{T,2}}\ \ldots\ \boldsymbol{bp_{T,|B_T|-1}}\ \boldsymbol{if}\ \boldsymbol{b^{\Sigma}_{T,|B_T|-2}} < \boldsymbol{v} \leq \boldsymbol{b^{\Sigma}_{T,|B_T|-1}}\ \boldsymbol{bp_{T,|B_T|}}\ \boldsymbol{otherwise}$$	**Eq. 1f**
$$\boldsymbol{midPV_T}(\boldsymbol{v}): \boldsymbol{v} \in \boldsymbol{V} = \frac{\boldsymbol{askPV_T}(\boldsymbol{v}) + \boldsymbol{bidPV_T}(\boldsymbol{v})}{\boldsymbol{2}}$$	**Eq. 1g**
$$\boldsymbol{midSV_T}(\boldsymbol{v}): \boldsymbol{v} \in \boldsymbol{V} = \frac{\boldsymbol{askPV_T}(\boldsymbol{v})}{\boldsymbol{midPV_T}(\boldsymbol{v})} - \boldsymbol{1}$$	**Eq. 1h**

The utilized depth, $\underline{v}_T$, is calculated as:

$\underline{v}_T = max(v \text{ where } midSV_T(v) \leq D \text{ and } midSV_T(v+s) > D, s)$	Eq. 2

The Token Market Price Benchmarks as of the effective time T, $CCRTI_T$, is then given by:

$CCRTI_T = \sum_{v \in \{s, 2s, \cdots, \underline{v}_T\}} midPV_T(v) \frac{1}{NF} \lambda e^{-\lambda v}$	Eq. 3

4.3 Dynamic Order Size Cap

Unless specified as a fixed value in Section 6, the order size cap is calculated from the uncapped consolidated order book. The following symbols are used in the calculation of the order size cap:

Symbol	Name	Description
ac_T	Ask sample size	The number of samples used for ask-side sizes
bc_T	Bid sample size	The number of samples used for bid-side sizes
$S_T = \{s_{T,1}, s_{T,2}, \cdots s_{T,n_T}\}$	Size sample set	The consolidated set of sizes, ordered by ascending size
k	Trimming / winsorizing size	The number of samples to trim or winsorize from S_T
$\underline{s}$	Trimmed mean	The trimmed mean of the sample set S_T
$S'_T = \{s'_{T,1}, s_{,T,2}, \cdots s'_{T,n_T}\}$	Winsorized sample set	The winsorized sample set of S_T
$\underline{s}'$	Winsorized mean	The mean of the winsorized sample set S'_T
σ	Winsorized sample standard deviation	The sample standard deviation of the winsorized sample set S'_T

Using the above notation, the dynamic order size cap is derived as follows:

$$ac_T = \left(ap_{T,i} \leq 1.05ap_{T,1}\}, (\lvert A_T \rvert, 50)\right)$$	Eq. 4a
$$bc_T = \left(bp_{T,i} \geq 0.95bp_{T,1}\}, (\lvert B_T \rvert, 50)\right)$$	Eq. 4b
$$S_T = \left[bs_{T,1}, bs_{T,2}, \cdots, bs_{T,bc_T}\right] \cup \left[as_{T,1}, as_{T,2}, \cdots, as_{T,ac_T}\right] S_T = \left[s_{T,1}, s_{T,2}, \cdots, s_{T,n_T}\right] where\ s_{T,1} \leq s_{T,2} \leq \cdots \leq s_{T,n_T}$$	Eq. 4c
$$k = \lfloor 0.01n_T \rfloor$$	Eq. 4d
$$\underline{s} = \frac{1}{n_T - 2k} \sum_{i=k+1}^{n_T-k} s_{T,i}$$	Eq. 4e
$$s'_{T,i} = s_{T,k+1}\ if\ i \leq k$$ $$s'_{T,i} = s_{T,n-k}\ if\ i > n-k$$ $$s'_{T,i} = s_{T,i}\ otherwise$$	Eq. 4f
$$\underline{s'} = \frac{1}{n_T} \sum_{i=1}^{n_T} s'_{T,i}$$	Eq. 4g
$$\sigma = \sqrt{\frac{1}{n_T - 1} \sum_{i=1}^{n_T} (s'_{T,i} - \underline{s'})^2}$$	Eq. 4h

The order size cap as of the effective time T, C_T, is then given by:

$$C_T = \underline{s} + 5\sigma$$	Eq. 5

5 Contingency Calculation Rules

5.1 Delayed Data

Delayed data is treated according to the following rules:

1. If the Retrieval Time of the Relevant Order Book of a Contributed Exchange is at least 30 seconds older than the Calculation Time, the Contributed Exchange is disregarded in the calculation of the Token Market Price Benchmarks for that Calculation Time.

If the Retrieval Times of the Relevant Order Books of all Contributed Exchanges are each at least 30 seconds older than the Calculation Time, a Token Market Price Benchmarks calculation failure occurs for that Calculation Time (see Section 5.5).

5.2 Erroneous Data

5.2.1 Erroneous Books

All Relevant Order Books are subject to an automated screening for erroneous data according to the following rules:

1. If the format of a Relevant Order Book deviates from the expected format such that it cannot be parsed, it is flagged as erroneous.

2. If the Relevant Order Book contains no bid orders or no ask orders, it is flagged as erroneous.

3. If the Relevant Order Book crosses, it is flagged as erroneous.

Relevant Order Books flagged as erroneous for a given Calculation Time are disregarded in the calculation of the Token Market Price Benchmarks for that Calculation Time.

If the Relevant Order Books of all Contributed Exchanges are flagged as erroneous for a given Calculation Time, a Token Market Price Benchmarks calculation failure occurs for that Calculation Time (see Section 5.5).

5.2.2 Erroneous Prices

All Relevant Order Books are subject to an automated filtering process according to the following rule.

1. If a Relevant Order Book contains any entries with a non-numeric or non-positive limit price or size then any such entries are flagged as erroneous.

All entries in a Relevant Order Book which are flagged as erroneous for a given Calculation Time are disregarded in the calculation of the Token Market Price Benchmarks for that Calculation Time.

5.3 Potentially Erroneous Data

All Relevant Order Books are subject to an automated screening for potentially erroneous data according to the following rules:

1. For each Contributed Exchange individually, the current mid price is calculated as the average of the highest bid price and the lowest ask price of the Relevant Order Book.

2. For each Contributed Exchange, the absolute percentage deviation of the mid price, as calculated in the previous step, from the median of the mid prices of all Contributed Exchanges is calculated.

3. If for any Contributed Exchange the absolute percentage deviation, as calculated in the previous step, exceeds the Potentially Erroneous Data Parameter for the respective Token Market Price Benchmarks represented in the Token Market Price Benchmarks Parameters (section 6) then the Relevant Order Book of that Contributed Exchange for the affected the Token Market Price Benchmarks is flagged as potentially erroneous.

4. 4. Upon an orderbook of a Contributed Exchange having been disregarded in the calculation as described in the previous step, its orderbook shall continue to be disregarded from the calculation of the affected index until the absolute deviation of the mid-price of its orderbook as calculated in step 2 is less than 50% of the Potentially Erroneous Data Parameter. At this point it shall be re-instated to the calculation for that Calculation Time and all subsequent Calculation Times unless it is removed from the calculation for any of the reasons as described in section 5.

Relevant Order Books flagged as potentially erroneous for a given Calculation Time are disregarded in the calculation of the Token Market Price Benchmarks for that Calculation Time. The occurrence of any such flag is reported to the Oversight Function.

If the Relevant Order Books of all Contributed Exchanges are flagged as potentially erroneous for a given Calculation Time, a Token Market Price Benchmarks Calculation Failure occurs for that Calculation Time (see Section 5.5).

5.4 Expert Judgement

The Administrator does not utilise expert judgment in the day to day calculation of the Token Market Price Benchmarks. In extraordinary circumstances Expert Judgement may be exercised by the Administrator in accordance with its codified policies and processes which are available upon request.

5.5 Calculation Failure

If a Token Market Price Benchmarks cannot be calculated for a given Calculation Time, for instance because:

- the Retrieval Times of the Relevant Order Books of all Contributed Exchanges are each at least 30 seconds older than the Calculation Time, or
- all Relevant Order Books are flagged as erroneous or potentially erroneous (see Section 5.2); or
- any other reason or circumstance that prevents the orderly calculation of a Token Market Price Benchmarks,

then the Token Market Price Benchmarks for that Calculation Time is not published. The occurrence of any Token Market Price Benchmarks calculation failure is reported to CF management and persistent failure will lead to a review of the methodology.

6 Crypto Price Benchmarks Parameters

6.1 Constants

Effective Time (T)	Approximately every second of each day for the entire year including weekends and holidays.
Lambda (λ)	$\frac{1}{0.3\underline{v}_T}$

6.2 Crypto Price Benchmarks Parameters

The following **file** summarizes the parameters for the currently supported Token Market Price Benchmarks.

7 Crypto Price Benchmarks Specifications

The following tables summarize the specifications for the currently supported CF Crypto Price Benchmarks:

Administrator	CF Benchmarks Ltd
Calculation Agent	CF Benchmarks Ltd
Calculation Methodology	Real time aggregation of order book data of Contributing Exchanges
Dissemination Time	Approximately every second of each day for the entire year including weekends and holidays.

The following **file** summarizes the specifications for the currently supported Token Market Price Benchmarks.

8 Methodology Review and Changes

This methodology is subject to internal review by the Administrator and the Oversight Function at least annually.

Any changes to this methodology are overseen by the Oversight Function, and in accordance with UK BMR Article 13.

All material changes to the methodology shall only be implemented after a consultation process with users and relevant stakeholders that shall be conducted according to the Administrator's policies and overseen by the Oversight Function.

Should the Administrator deem it necessary to cease providing any of the Token Market Price Benchmarks it shall only do so after a consultation process with users and relevant stakeholders that shall be conducted according to the Administrator's policies and overseen by the Oversight Function.

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