

# Guide to the Calculation of the FTSE DAR Digital Asset Prices and FTSE DAR Reference Prices

In Association with Digital Asset Research

v1.6



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## Section 1

# Introduction

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## 1. Introduction

- 1.1 This document sets out the methodology for the calculation of the FTSE DAR Digital Asset Prices, the FTSE DAR Reference Prices, and FTSE DAR Real-Time Prices. This document should be read in conjunction with the Guide to the Vetting of Digital Assets and Digital Asset Exchanges document which is available at [www.lseg.com/en/ftse-russell/](http://www.lseg.com/en/ftse-russell/).
- 1.1.1 A digital asset is a Cryptographically Secured Digital Instrument for which the issuance, transfer and ownership is recorded on a data structure commonly referred to as a Blockchain.
- 1.2 FTSE Russell**
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- 1.4 No liability whether as a result of negligence or otherwise is accepted by FTSE Russell (or any person concerned with the preparation or publication of this Guide to Calculation) for any losses, damages, claims and expenses suffered by any person as a result of:
- any reliance on this Guide to Calculation, and/or
  - any errors or inaccuracies in this Guide to Calculation, and/or
  - any non-application or misapplication of the policies or procedures described in this Guide to Calculation.

## Section 2

# Management responsibilities

## 2. Management responsibilities

### 2.1 FTSE International Limited (FTSE)<sup>1</sup>

- 2.1.1 FTSE is responsible for the calculation, production and operation of the FTSE DAR Reference Prices.
- 2.1.2 FTSE is the administrator of the FTSE DAR Reference Prices – Benchmark Assets.
- 2.1.3 FTSE will:
  - maintain records of the prices of all digital assets for which FTSE DAR Digital Asset Prices and FTSE DAR Reference Prices are calculated;
  - make changes to the digital assets for which FTSE DAR Digital Asset Prices and FTSE DAR Reference Prices are calculated in accordance with the Guide to the Vetting of Digital Assets and Digital Asset Exchanges;
  - publish changes to the digital assets for which FTSE DAR Digital Asset Prices and FTSE DAR Reference Prices are calculated resulting from their ongoing maintenance and in accordance to the Guide to the Vetting of Digital Asset and Digital Asset Exchanges;
  - disseminate the prices.

### 2.2 Digital Asset Research

- 2.2.1 Digital Asset Research (DAR) is the calculation agent for the FTSE DAR Digital Asset Prices. DAR assesses the quality of pricing data, qualifies pricing sources, and supplies FTSE Russell with price feeds.
- 2.2.2 DAR is an independent, privately-owned research firm and data provider which partners with FTSE Russell in research into and providing data on digital assets.
- 2.2.3 DAR is responsible for the ongoing vetting of digital assets and of the Exchanges of digital assets as set out in the Guide to the Vetting of Digital Assets and Digital Asset Exchanges. DAR collects and validates the data it obtains as Principal to ensure both digital assets and Exchanges of digital assets pass a strict set of rules.

### 2.3 Amendments to this Guide to Calculation

- 2.3.1 This Guide to Calculation shall be subject to regular review by FTSE Russell to ensure that it continues to best reflect the aims of the FTSE DAR Digital Asset Prices and FTSE DAR Reference Prices. The feedback from these reviews will be considered by the FTSE Russell Index Governance Board before approval is granted for any change to the methodology.

<sup>1</sup> The term administrator is used in this document in the same sense as it is defined in [Regulation \(EU\) 2016/1011 of the European Parliament and of the Council of 8 June 2016 on indices used as benchmarks in financial instruments and financial contracts or to measure the performance of investment funds](#) (the European Benchmark Regulation).

## Section 3

# FTSE DAR digital asset prices

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## 3. FTSE DAR digital asset prices

### 3.1 Overview

- 3.1.1 The FTSE DAR Digital Asset Prices are calculated by DAR and are used in the calculation of the FTSE DAR Reference Prices. The FTSE DAR Digital Asset Prices are calculated in US Dollars (USD).
- 3.1.2 Digital assets are quoted as a trading pair. Transaction data, which is the input to the FTSE DAR Digital Asset Prices, can be between fiat currency and a digital asset or a digital asset to digital asset, including Stablecoins.
- 3.1.3 As part of the FTSE DAR Digital Asset Price calculation, each digital asset price is converted into US Dollars using one or more of the following conversions, in the following order:
  - a. The digital asset to USD transaction;
  - b. The digital asset to an eligible fiat currency, which are Great British Pound (GBP), Euro (EUR) or Japanese Yen (JPY), then the fiat currency to USD;
  - c. The digital asset to an eligible Stablecoin, which are Tether (USDT) or USD Coin (USDC), then the Stablecoin to USD;
  - d. The digital asset to eligible digital asset, which are Bitcoin (BTC) or Ethereum (ETH), then the digital asset to USD.
- 3.1.4 Executed transactions from Eligible Exchanges, as set out in the Guide to the Vetting of Digital Asset and Digital Asset Exchanges, are used in the calculation of the FTSE DAR Digital Asset Prices. Price quotes are not used.
- 3.1.5 Prices are calculated net of any transaction costs.

### 3.2 Time Windows

- 3.2.1 There are several steps in the calculation of the FTSE DAR Digital Asset Price, which use the following three-time intervals of executed digital asset price and volume data from each Eligible Exchange.
  - 1. 15-Minute Price Window – consists of the most recent 15 minutes of executed price and volume data sourced from Eligible Exchanges. This window is the basis of price and volume data used in the conversion rates for eligible Digital Assets and Stablecoins.
  - 2. 10-Minute Price Window – consists of the most recent 10 minutes of executed price and volume data sourced from Eligible Exchanges. This window forms the basis of the data set for which the outlier tests are applied.
  - 3. 15-Second Price Window – consists of the most recent 15 seconds of executed price and volume data sourced from Eligible Exchanges. This window is the basis of the FTSE DAR Digital Asset Price.

### **3.3 Conversion VWAPs**

3.3.1 As an initial step in the calculation of the FTSE DAR Digital Asset Price, all transactions with non-USD quote currencies are converted to USD.

1. Fiat currency conversion: if the transaction pair includes an Eligible Fiat currency, foreign exchange rates from Alpha Vantage or Polygon.io are used in the conversion. Foreign exchange rates are updated each minute and trades are converted to USD using the most recent foreign exchange rate that is prior to the time of the executed transaction.
2. Stablecoin conversion: if the transaction pair includes an Eligible Stablecoin, the transaction is converted as follows:
  - a. The previous 15 minutes of transactions for each USD – Stablecoin pair are aggregated.
  - b. A Volume-Weighted Average Price (VWAP) for the Stablecoin is calculated for each Eligible Exchange on which the Stablecoin trades; this is referred to as the “Local Conversion Rate”.
  - c. A VWAP for the Stablecoin is calculated for all Eligible Exchanges on which the Stablecoin trades; this is referred to as the “Global Conversion Rate”.
  - d. A USD price is calculated for each trade with an eligible Stablecoin pair.
    - i. If the exchange on which the trade was executed has a Local Conversion Rate, this rate is used in the calculation.
    - ii. If the exchange on which the trade was executed does not have a Local Conversion Rate, the Global Conversion Rate is used in the calculation.
3. Digital Asset conversion: if the transaction pair is an Eligible Digital Asset, then the transaction is converted as follows:
  - a. The previous 15 minutes of transactions for each Digital Asset – Eligible Fiat pair are aggregated.
  - b. A VWAP for the Digital Asset is calculated for each Eligible Exchange on which the Digital Asset trades; this is referred to as the Local Conversion Rate.
  - c. A VWAP for the Digital Asset is calculated for all Eligible Exchanges on which the Digital Asset trades; this is referred to as the Global Conversion Rate.
  - d. A USD price is calculated for each trade with an Eligible Digital Asset pair.
    - i. If the exchange on which the trade was made has a Local Conversion Rate, then this rate is used in the calculation.
    - ii. If the exchange on which the trade was made does not have a Local Conversion Rate, the Global Conversion Rate is used in the calculation.

### **3.4 New Digital Assets**

3.4.1 A FTSE DAR Digital Asset Price will be calculated for new digital assets after 60 minutes of executed transactions are observed on Eligible Exchanges. The conversion of the VWAP will follow Rule 3.3.

### **3.5 Trade Outlier Filtration**

3.5.1 After the conversion to USD and prior to calculation the FTSE DAR Digital Asset Price, executed trades are filtered for each Eligible Exchange and trade volume level to identify and remove outliers.

1. Duplicate Trades
  - a. Duplicate trades are removed.

## 2. Exchange-Level Outlier Filtering

- All executed trades for a given digital asset from the most recent 10-minute window are aggregated.
- Using the aggregated trade data, a VWAP for the digital asset is calculated for each exchange on which the digital asset trades.
- Using the set of exchange VWAP values for the digital asset, a mean VWAP value and standard deviation values are calculated.
- Trades from any exchange with a VWAP value for the digital asset that is not within 1.5 standard deviations of the mean are excluded from the FTSE DAR Digital Asset Price calculation.

## 3. Trade-Level Outlier Filtering

- All trades for a given digital asset from the most recent 10-minute window are aggregated.
- Using the aggregated trade data, a mean price and standard deviations value is calculated for each digital asset.
- Any trade with a price that is not within 2.5 standard deviations of the mean is excluded from the FTSE DAR Digital Asset Price calculation.
- The remaining trades are known as Eligible Trades.

### 3.6 Calculation

3.6.1 The calculation of the FTSE DAR Digital Asset Price consists of the previous steps to derive the Eligible Trades of each digital asset's price and volume data from each Eligible Exchange.

- Calculate a 15 second VWAP in USD for each digital asset across all Eligible Exchanges. This is the FTSE DAR Digital Asset Price.
- If no trades have been executed in the most recent 15 seconds, the previous FTSE DAR Digital Asset Price is used. If there is no previously available FTSE DAR Digital Asset Price the Initialisation VWAP is used.
- The process is repeated every 15 seconds.

3.6.2 The FTSE DAR Digital Asset Price is the volume weighted average USD price of a digital asset from all Eligible Exchanges:

$$FTSE\ DAR\ Digital\ Asset\ Price_i = \frac{\sum_x (Volume_{x,i} \cdot Price\ in\ USD_{x,i})}{\sum_x Volume_{x,i}}$$

where  $Volume_{x,i}$  is the volume of the digital asset i traded on exchange x in units of the digital asset and  $Price\ in\ USD_{x,i}$  is the price in USD digital asset i traded on exchange x

## Section 4

# FTSE DAR reference prices

## 4. FTSE DAR reference prices

4.1 The FTSE DAR Reference Prices are calculated on an hourly basis for all digital assets that a FTSE DAR Digital Asset Price is calculated.

4.1.1 Three types of prices are produced:

- (1) **FTSE DAR Reference Prices – Benchmark Assets** are calculated from executed prices sourced entirely from vetted exchanges as outlined in the Guide to the Vetting of Digital Assets and Digital Asset Exchanges. The FTSE DAR Reference Prices - Benchmark Assets can be used in the European Union (as “use” is set out in article 3(1)(7) of the EU Benchmark Regulation and the Council of 8 June 2016 on indices used as benchmarks in financial instruments and financial contracts or to measure the performance of investment funds in the European Union) (the “EU BMR”).
- (2) **FTSE DAR Reference Prices – Non-Benchmark Assets** are calculated from executed prices not sourced entirely from vetted exchanges as set out in the Guide to the Vetting of Digital Assets and Digital Asset Exchanges. The FTSE DAR Reference Prices - Non-Benchmark Assets are not EU BMR compliant and are not to be used in the European Union (as “use” is set out in article 3(1)(7) of the EU Benchmark Regulation and the Council of 8 June 2016 on indices used as benchmarks in financial instruments and financial contracts or to measure the performance of investment funds in the European Union) (the “EU BMR”) and accordingly, the EU BMR does not apply to the FTSE DAR Reference Prices – Non-Benchmark Assets. Consequently, supervised entities (as “supervised entities” is set out in article 3(1)(17) of the EU BMR) within the European Union are not permitted to use the FTSE DAR Reference Prices – Non-Benchmark Assets as benchmarks as set out in article 3(1)(7) of the EU BMR.
- (3) **FTSE DAR Reference Prices – Benchmark Assets Hourly** are calculated from executed prices sourced entirely from vetted exchanges as outlined in the Guide to the Vetting of Digital Assets and Digital Asset Exchanges. The FTSE DAR Reference Prices - Benchmark Assets Hourly can be used in the European Union (as “use” is set out in article 3(1)(7) of the EU Benchmark Regulation and the Council of 8 June 2016 on indices used as benchmarks in financial instruments and financial contracts or to measure the performance of investment funds in the European Union) (the “EU BMR”).

4.1.2 The FTSE DAR Reference Price is determined as the volume weighted average of the FTSE DAR Digital Asset Price over the 15-minute period before the fixing time. For example, the fix at 4.00 p.m. would take all prices published every 15 seconds in the observation window from 3.45 p.m. to 4.00 p.m. inclusive (61 observations):

$$FTSE\ DAR\ Reference\ Price = \frac{\sum_{t=1}^{61} w_t \times FTSE\ DAR\ Digital\ Asset\ Price_t \times Volume_t}{\sum_{t=1}^{61} w_t \times Volume_t}$$

Where **FTSE DAR Digital Asset Price<sub>t</sub>** is the price of the digital asset at time, **t** and **Volume<sub>t</sub>** is the volume traded in the digital asset in the 15 second period over which the **FTSE DAR Digital Asset Price<sub>t</sub>** is determined. The integer **t** corresponds to the observation, counting down from **t = 61** at the start of the observation period to **t = 1** at the fixing time.



The weights,  $w_t = \frac{w'_t}{\sum w'_t}$ , where the un-normalised weights  $w'_t = \left\{\frac{1}{61}, \frac{1}{60}, \dots, \frac{1}{2}, 1\right\}$  are inversely proportional to the time  $t$ .

- 4.1.3 The FTSE DAR Reference Price Hourly is determined as the average of the FTSE DAR Digital Asset Price over the 60-minute period before the fixing time. For example, the fix at 4.00 p.m. would take all prices published every 15 seconds in the observation window from 3.00:15 p.m. to 4.00:00 p.m. (240 observations):

$$FTSE\ DAR\ Reference\ Price\ Hourly = \frac{\sum_{t=1}^n FTSE\ DAR\ Digital\ Asset\ Price_t}{n}$$

Where  $n = 240$ , **FTSE DAR Digital Asset Price<sub>t</sub>** is the price of the digital asset at time,  $t$  is determined. The integer  $t$  is one time unit with 15 seconds duration and corresponds to the observation, counting down from  $t = 240$  at the start of the observation period to  $t = 1$  and is initialised 15 seconds past the previous reference hour.

## Section 5

# FTSE DAR real time prices

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## 5. FTSE DAR real-time prices

### 5.1 Overview

- 5.1.1 Section 5 describes the method by which FTSE DAR real-time prices are derived.
- 5.1.2 The FTSE DAR real-time prices are calculated by DAR using the methodology outlined below, with FTSE Russell responsible for governance and oversight.
- 5.1.3 The FTSE DAR real time price is a 400-millisecond real-time price, hereafter called 400ms price. The price is calculated in real-time using a transaction-based price. The 400ms price will be used to calculate the FTSE DAR real-time indices.
- 5.1.4 FTSE DAR Real-Time Prices are calculated from executed prices sourced entirely from vetted exchanges as outlined in the Guide to the Vetting of Digital Assets and Digital Asset Exchanges. The FTSE DAR Real-Time Prices can be used in the European Union (as “use” is set out in article 3(1)(7) of the EU Benchmark Regulation and the Council of 8 June 2016 on indices used as benchmarks in financial instruments and financial contracts or to measure the performance of investment funds in the European Union) (the “EU BMR”).

### 5.2 FTSE DAR real-time prices methodology

- 5.2.1 Exchange Transaction Filtering
  - 5.2.1.1 All executed trades for a given digital asset from the most recent 3-minute window are aggregated.
  - 5.2.1.2 Using the aggregated trade data, a volume weighted average price (VWAP) for the digital asset is calculated for each exchange on which the digital asset trades.
  - 5.2.1.3 Using the set of exchange VWAP values for the digital asset, a median VWAP value and standard derivation values are calculated.
  - 5.2.1.4 Trades from any exchange with a VWAP value for the digital asset that is not within 2.5 standard deviations of the median are excluded.
- 5.2.2 Trade-Level Outlier Filtering
  - 5.2.2.1 All trades for a given digital asset from the most recent 3-minute window are gathered.
  - 5.2.2.2 Using the gathered trade data, time volume and weighted average price (TVWAP) and standard deviations value is calculated for each digital asset.
  - 5.2.2.3 Any trade with a price that is not within 2.5 standard deviations of the TVWAP is excluded.
  - 5.2.2.4 The remaining trades are known as Eligible Trades.

## 5.2.3 Calculation Parameters

5.2.3.1 *Duration* – The lookback cycle is observed to be 450 price observation periods. Each observation period is 400 milliseconds.

5.2.3.2 *Lookback Period Unit (LPU)* – The lookback cycle is split into durations of 2.5 price observation periods, with each duration hence called Lookback Period Unit (LPU).

5.2.3.1 *Time Weight* – The time weight of each LPU is calculated as:

$$TW_i = \frac{1}{i}$$

where,

$i$  = 1... $n$ , is the time position of LPU

$n$  = is the number of LPUs in an observation cycle

5.2.3.1 Normalised *Time Weight* – The normalised time weight of each LPU is calculated as:

$$NTW = \frac{TW}{\sum_{i=1}^n TW_i}$$

where,

$i$  = 1... $n$ , is the time position of LPU

$n$  = is the number of LPUs in an observation cycle

$TW$  = is the time weight per LPU

5.2.3.2 *Volume Weight* – The Volume Weight of each transaction is calculated as:

$$VW = \frac{TV}{\sum_{i=1}^n TV_i}$$

where,

$i$  = 1... $n$ , is the time position of LPU

$n$  = the number of transactions

$TV$  = the traded volume

5.2.3.3 *Cumulative Time Weight* – The transactions under each LPU are huddled together to apply the time weight in distinct tranches of the LPU. The Cumulative Weight of each transaction is calculated as:

$$CW = NTW \times VW \times 10000$$

where,

$NTW$  = is the normalized time weight per LPU

$VW$  = is the volume weight per LPU

5.2.3.4 Normalised *Cumulative Weight* – The Volume Weight of each transaction is calculated as:

$$NCW = \frac{CW}{\sum_{i=1}^n CW_i}$$

where,

$i$  = 1... $n$ , is the time position of LPU

$n$  = the number of transactions

$CW$  = cumulative weight per transaction

5.2.3.5 *Lookback Price* – The Lookback Price of each transaction is calculated as:

$$LP = \sum_{i=1}^n NCW_i \times TP_i$$

where,

$i$  = 1... $n$ , is the time position of LPU

$n$  = the number of transactions

$TP$  = transaction price

5.2.3.6 *Asset Transaction Filtering* – The asset derivation is derived at 2.5 standard deviations of the Lookback price.

5.2.3.7 *Price Volume Curve* – A Price Volume Curve is constructed using transactions sourced in one observation period and ordering by the traded volume.

$$PV = \max_p TV \rightarrow \min_p TV$$

where,

$TV$  = trading volume price cluster

5.2.3.8 *Mean Volume* – The mean volume is calculated from the traded volume.

$$MTV = \frac{\sum_{i=1}^n TV_i}{n}$$

where,

$TV$  = traded volume

$n$  = the number of transactions

5.2.3.9 *Lambda* – is calculated as

$$\lambda = \frac{MTV}{\sum_{i=1}^n TV_i}$$

where,

$TV$  = the traded volume

$MTV$  = the mean traded volume in the observation period.

5.2.3.10 *Volume Weight* – volume weight is calculated as

$$VW = \frac{TV}{\sum_{i=1}^n TV_i}$$

where,

$n$  = the number of transactions

$TV$  = the traded volume

5.2.3.11 *Spacing* – the transaction spacing is calculated as

$$S = \frac{\max(VW_i(1..n))}{VW}$$

where,

$n$  = the number of transactions

$VW$  = the traded volume

5.2.3.12 *Volume Density* – volume density is computed as

$$VD = \lambda \times e^{(-1 \times \lambda \times S)}$$

where,

$\lambda$  = lambda factor

$S$  = spacing

5.2.3.13 *Volume Density Weight* – Volume density weight is calculated as

$$VDW = \frac{VD}{\sum_{i=1}^n VD_i}$$

where,

$n$  = the number of observations in the PV curve

$VD$  = volume density

5.2.3.14 *400ms price* – The unit transaction weighted 400ms price is calculated as

$$400ms = \sum_{i=1}^n VDW_i \times EP_i$$

where,

$VDW$  = volume density weight

$EP$  = clustered executed price in the PV curve.

## Appendix A

# Further information

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A Glossary of Terms used in FTSE Russell's Ground Rule documents can be found using the following link:

[Glossary - Digital Assets.pdf](#)

Further information on the FTSE DAR Digital Asset Prices and the FTSE DAR Reference Prices is available from FTSE Russell.

For contact details please visit the FTSE Russell website or contact FTSE Russell client services at [info@ftserussell.com](mailto:info@ftserussell.com).

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