



DIGITAL  
ASSET  
RESEARCH

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# **DAR Close Price and Hourly Price Methodology**

v1.5

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# 1. Overview

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The DAR Close Price is a time-weighted average price (TWAP) derived from eligible, non-outlier trades that occur within a 30-minute window prior to the specified close time. DAR 15-Second Intraday Price values are used when calculating the DAR Close Price.

The DAR Hourly Price is calculated using an identical methodology to the DAR Close Price where the Close Time and Close Time Window are replaced with values relevant to the hour for which the price is calculated.

This methodology provides a glossary of key definitions and details on price tiers, trade outlier filtration, and the close price calculation.

## 2. Key Definitions

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Term	Definition
Asset	The digital asset that is being priced
Close Time	The time at which the pricing period closes; the DAR Close Price is calculated with 4 p.m. as its Close Time
Close Time Window	The 30-minute period directly before the Close Time
DAR Close Price	The value of an Asset, as derived from eligible pairs across Eligible Exchanges using the calculation described in this document
DAR 15-Second Intraday Price	The value of an Asset as of a specific time at the end of an Intraday Time Window, as derived from eligible pairs across Eligible Exchanges using the calculation described in this document  Prices are calculated for each of the following intervals within a given minute: 0:00, 0:15, 0:30, 0:45.
Eligible Exchanges	The exchanges from which pricing data is sourced when valuing the asset; eligible exchanges are determined based on an asset's price tier
Eligible Trades	The trades that remain after trade-level outlier filtering and are considered during price calculation



Intraday Time Window	The 15-second period directly before the DAR 15-Second Intraday Price is calculated
Price Tier	A tier rating for the price based on DAR's Exchange Vetting process; see <a href="#">Price Tiers</a>
Quote Currency	The digital or fiat currency in which the asset is being valued. Digital asset quote currencies include BTC and ETH; stablecoin quote currencies include USDC and USDT; and fiat quote currencies include USD, GBP, EUR, and JPY.
Vetted Exchanges	Digital Asset Exchanges that have passed all of DAR's quantitative and qualitative criteria. These are the most trustworthy exchanges that are not known to report inflated volumes and have robust policies and practices in place to prevent manipulative behavior by customers. See the <a href="#">DAR Exchange Vetting Methodology</a> for additional details.
Watchlist Exchanges	Digital Asset Exchanges that have passed only DAR's preliminary vetting, which includes data science testing and some qualitative diligence. These exchanges are not known to report inflated volumes or have manipulated transactions but may not have institutional policies and practices in place in order to prevent future manipulation and pass full vetting. See the <a href="#">DAR Exchange Vetting Methodology</a> for additional details.
$i$	The $i$ -th trade, where $i$ is a variable that represents any trade in the sequence of trades being considered in the calculation, i.e. the 4th trade or the 5th trade
$V_i$	Volume of the $i$ -th trade
$P_i$	Price of the $i$ -th trade
$VWAP$	Volume-Weighted Average Price, calculated as follows: $VWAP = \frac{\sum_i V_i \times P_i}{\sum_i V_i}$



## 3. Price Tiers

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A price's tier level is determined by the number of Vetted Exchanges and Watchlist Exchanges on which it is present and other price correlation factors.

Tier	Requirements
Tier 1	<ul style="list-style-type: none"><li>• Asset must be present on a minimum of 2 Vetted Exchanges</li><li>• The asset's price correlation between Vetted Exchanges and Watchlist Exchanges must be greater than 0.5</li></ul>
Tier 2	<ul style="list-style-type: none"><li>• Asset must be present on a combination of at least 2 Vetted Exchanges and Watchlist Exchanges</li></ul>
Tier 3	<ul style="list-style-type: none"><li>• Asset is present on 1 or fewer Vetted Exchanges and Watchlist Exchanges<ul style="list-style-type: none"><li>◦ Prices calculated for Tier 3 assets include trades from exchanges that are not Vetted Exchanges or Watchlist Exchanges</li></ul></li></ul>

## 4. Conversion to USD

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As an initial step in DAR Intraday Price calculation, all trades with non-USD quote currencies are converted to USD.

### 4.1 Fiat Conversion

If the Quote Currency for a trade is EUR, GBP, or JPY, then FX rates from Alpha Vantage or Polygon.io are used for the conversion.

FX rates are updated each minute and trades are converted to USD using the most recent conversion rate that is prior to the time of the trade.

### 4.2 Stablecoin Conversion

If the Quote Currency for a trade is USDC or USDT, then the trade is converted as follows:

- The previous 10 minutes of trades for each USD-stablecoin pair are collected.
- A VWAP for the stablecoin is calculated for each Eligible Exchange on which the stablecoin trades; this is referred to as the Local Conversion Rate.



- 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.
- A USD price is calculated for each trade with a stablecoin Quote Currency.
  - If the exchange on which the trade was made has a Local Conversion Rate, then this rate is used in the calculation.
  - If the exchange on which the trade was made does not have a Local Conversion Rate, then the Global Conversion Rate is used in the calculation.

## 4.3 Digital Asset Conversion

If the Quote Currency for a trade is BTC or ETH, then the trade is converted as follows:

- The previous 10 minutes of trades for each BTC-fiat and ETH-fiat pair are collected.
- A VWAP for the digital asset Quote Currency is calculated for each Eligible Exchange on which the digital asset trades; this is referred to as the Local Conversion Rate.
- A VWAP for the digital asset Quote Currency is calculated for all Eligible Exchanges on which the digital asset trades; this is referred to as the Global Conversion Rate.
- A USD price is calculated for each trade with a digital asset Quote Currency.
  - If the exchange on which the trade was made has a Local Conversion Rate, then this rate is used in the calculation.
  - If the exchange on which the trade was made does not have a Local Conversion Rate, then the Global Conversion Rate is used in the calculation.

## 5. Trade Outlier Filtration

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After conversion to USD and prior to calculating the DAR Intraday Price, trades are filtered at the exchange level and trade level to identify and remove outliers.

### 5.1 Exchange-Level Outlier Filtering

Trades are initially filtered at the exchange level using the following process:

- All trades for a given asset from within the 15-second Intraday Time Window are collected from Eligible Exchanges to form the data set.
- Using the data set, a VWAP for the asset is calculated for each Eligible Exchange on which the asset trades.
- Using the set of exchange VWAP values for the asset, a mean VWAP value and standard deviation values are calculated.
- Any exchange with a VWAP value for the asset that is not within 1.5 standard deviations of the mean will have its trades excluded from the DAR 15-Second Intraday Price calculation.



## 5.2 Trade-Level Outlier Filtering

Trades are then filtered at the trade level using the following process:

- All trades for a given asset that from within the most recent 10-minute period are collected from Eligible Exchanges to form the data set.
- Using the data set, calculate the mean price and standard deviation values for each asset.
- Any trade that has a price that is not within 2.5 standard deviations of the mean is excluded from the DAR 15-Second Intraday Price calculation.
- The final data set of remaining trades is known as Eligible Trades.

## 6. DAR Close Price Calculation

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The DAR Close Price is a time-weighted average price (TWAP) of the Asset as derived from trades within the Close Time Window and is calculated as follows:

1. Aggregate all trades for a single Asset on all Eligible Exchanges that were made during the 30-minute Close Time Window.
2. Convert [non-USD Quote Currencies to USD](#).
3. Remove outlier trades using the [Trade Outlier Filtration](#) process to determine Eligible Trades.
4. Derive DAR 15-Second Intraday Price values for each Intraday Time Window that falls within the Close Time Window by calculating a VWAP of all Eligible Trades (non-outlier trades).
  - a. If no DAR 15-Second Intraday Price values can be calculated during the Close Time Window because of a lack of Eligible Trades, the Close Time Window is iteratively extended back in 30-minute increments until a minimum of one Intraday Price is calculated in a given period.
5. Derive the DAR Close Price by calculating a volume-weighted, time-weighted average of the DAR Intraday Price during the Close Time Window.
  - a. The close at 4:00 p.m. will take all DAR Intraday Prices in the observation window from 3:30 p.m. to 4:00 p.m. inclusive (121 observations):

$$DAR\ Close\ Price = \frac{\sum_{t=1}^{121} w_t \times (DAR\ Intraday\ Price)_t \times (Volume)_t}{\sum_{t=1}^{121} w_t \times (Volume)_t}$$



Where, “(DAR Intraday Price)<sub>t</sub>” is the DAR Intraday 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 DAR Intraday Price is determined. The integer “t” corresponds to the observation, counting down from t = 121 at the start of the observation period to t = 1 at the close time.

- b. The time weights, “w<sub>t</sub>”, used to calculate the DAR Close Price are calculated in the following way:

$$w_t = \frac{w'_t}{\sum_{t=1}^{121} w'_t}$$

Where the un-normalized weights  $w'_t \in \left\{ \frac{1}{121}, \frac{1}{120}, \dots, \frac{1}{t}, \dots, \frac{1}{2}, 1 \right\}$  are inversely proportional to the time “t”.

**NOTE:** A DAR Hourly Price is calculated using an identical methodology where the Close Time and Close Time Window are replaced with values relevant to the hour for which the price is calculated. *Example:* A DAR Hourly Price for 1 p.m. would use 1 p.m. as its Close Time and 12:30 p.m.-1:00 p.m. as its Close Time Window.

## Appendix: Changelog

Substantive changes to the DAR Close Price and Hourly Price Methodology are tracked below.

Version	Change	Description
1.2	Principal Market Price added	Details on the calculation of the DAR Principal Market Price were added to the methodology
1.3	Asset Tier changed to Price Tier	The <i>Asset Tier</i> section was renamed to <i>Price Tier</i> to clarify that tiering occurs at the price level; the <i>Key Definitions</i> section was updated to reflect this change
1.4	Additional FX rate source added	Polygon.io was added as a source for FX rate data
1.5	Methodology title updated to include Hourly Price	The methodology’s title was changed to “DAR Close Price and Hourly Price Methodology”
1.5	DAR Intraday Price updated to DAR 15-Second Intraday Price	References to DAR Intraday Price were changed to DAR 15-Second Intraday Price to clarify which intraday granularity is used under this methodology





1.5	DAR Hourly Price information added to <i>Overview</i> section	The <i>Overview</i> section was updated to include additional information on the DAR Hourly Price
1.5	Principal Market Price information removed	Principal Market Price calculation information was removed and is now detailed in a separate methodology



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