Alpha Trading Signals & Multi-Factor Trading Strategy Project Schematics

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Alpha 1: Recency of Price/Volatility Peak

$$x_t = \begin{cases} \text{stddev}(r_t, 20), & r_t < 0 \\ \text{close}_t, & \text{otherwise} \end{cases}$$

$$\text{Alpha}_1(t) = \text{rank}\left(\arg \max_{s \in [t-4,t]} \left[\text{sign}(x_s) \cdot |x_s|^2 \right] \right) - 0.5$$

1. Definitions

Let the universe on day t be $\mathcal{I}_t$, with $N = |\mathcal{I}_t|$. For each stock $i \in \mathcal{I}_t$ define:

$$r_{i,t} = \frac{P_{i,t} - P_{i,t-1}}{P_{i,t-1}} \tag{1}$$

$$\text{(daily simple return)}, \tag{2}$$

$$\sigma_{i,t} = \sqrt{\frac{1}{19} \sum_{s=t-19}^{t} \left(r_{i,s} - \bar{r}_{i,t} \right)^2}, \tag{3}$$

$$quad\bar{r}_{i,t} = \tfrac{1}{20} \sum_{s=t-19}^{t} r_{i,s} \qquad \text{(20-day realized vol)}. \tag{4}$$

$$x_{i,t} = \begin{cases} \sigma_{i,t}, & r_{i,t} < 0, \\ P_{i,t}, & r_{i,t} \geq 0. \end{cases} \qquad \big(x_{i,t} \geq 0\big). \tag{5}$$

2. Recency index

Square to amplify extremes:

$$u_{i,t} = \big(x_{i,t}\big)^2.$$

Over the trailing 5-day window $[t-4, \ldots, t]$, define

$$k_{i,t} = \underset{0 \le j < 5}{\arg\max}\, u_{i,\,t-4+j}, \quad k_{i,t} \in \{0, 1, 2, 3, 4\},$$

so that $k_{i,t} = 4$ if today's $u_{i,t}$ is the largest.

3. Cross-sectional percentile rank

$$\mathrm{rank}_{\mathrm{pct}}(k_{i,t}) = \frac{\big|\{\, j \in \mathcal{I}_t : k_{j,t} \le k_{i,t} \}\big| - 1}{N - 1} \ \in [0, 1].$$

4. Alpha 1 signal

$$\boxed{\alpha_{i,t} = \mathrm{rank}_{\mathrm{pct}}(k_{i,t}) \ - \ 0.5 \ \in [-0.5,\, +0.5].}$$

5. Operator summary

Operator	Meaning
$\arg\max_{0 \le j < 5}\ u_{t-4+j}$	position of the max over the last 5 days (0=oldest, 4=most recent)
$\mathrm{rank}_{\mathrm{pct}}(\cdot)$	cross-sectional percentile rank on $[0, 1]$

6. Worked Example

Below is a simple illustration with five stocks. The k column represents how recently the peak value of x^2 occurred (4 means today, 0 means four days ago). The percentile rank is computed across all k values for that day. Then, $\alpha = \mathrm{rank} - 0.5$ gives the final trading signal.

Trading Logic:

Long the one(s) with the highest alpha(s)!

Stock	k (Days Ago)	Interpretation	Percentile Rank	$\alpha = \mathrm{rank} - 0.5$
A	2	Middle of the window (3 days ago)	0.50	0.00
B	4	Most recent (today)	1.00	0.50
C	1	4 days ago	0.25	-0.25
D	3	Yesterday	0.75	0.25
E	0	Oldest in window	0.00	-0.50

Alpha 7: Volume-Triggered Momentum Reversal Alpha

Formula:

$$\text{Alpha}_7(t) = \begin{cases} -\text{ts\_rank}\left(|\Delta\text{close}_t^{(7)}|, 60\right) \cdot \text{sign}(\Delta\text{close}_t^{(7)}), & \text{if volume}_t > \text{adv}_{20}(t) \\ -1, & \text{otherwise} \end{cases}$$

Where:

- $\Delta\text{close}_t^{(7)} = \text{close}_t - \text{close}_{t-7}$ is the 7-day price change.
- $\text{ts\_rank}(x, 60)$ is the time-series rank of x over the past 60 days.
- $\text{sign}(x)$ is the sign function: $+1$ if $x > 0$, -1 if $x < 0$.
- $\text{adv}_{20}(t)$ is the 20-day average dollar volume.

Interpretation:

- If today's volume is greater than the 20-day average:
  - The alpha measures how extreme the 7-day move is (via ts_rank of absolute 7-day return).
  - It then applies a sign — negative if the stock rose, positive if it fell.
- If volume is low → assign a default negative signal: -1.
- High Alpha 7 values occur when the stock fell sharply over 7 days on **unusually high volume** — a typical **mean-reversion setup**.

Trading Logic:

- Evaluate Alpha 7 at the end of day t.
- If Alpha 7 is in the top-k ranked values across the stock universe:
  - Submit a buy order for day $t + 1$.
- Hold the position for one day, or clear when Alpha 7 drops below a chosen threshold or reverses sign.

Example: Volume-Confirmed Oversold Signal
Assume:

- $\text{close}_{t-7} = 105, \quad \text{close}_t = 95 \quad \Rightarrow \Delta\text{close}^{(7)} = -10 The 60-days\_rank of — \Delta\text{close}^{(7)}| =$ 10 is 0.95
- Today's volume is twice the 20-day average

Then:

$$\text{Alpha}_7(t) = -\text{ts\_rank}(10, 60) \cdot \text{sign}(-10) = -0.95 \cdot (-1) = +0.95$$

Interpretation: The stock had a large drop on high volume and ranks near the most extreme 7-day declines in the past 3 months. **→ Strong long signal for mean-reversion entry at $t + 1$.**

Alpha 9: Price-Based Hybrid Strategy

Formula:

$$\text{Alpha}_9(t) = \begin{cases} \Delta\text{close}_t, & \text{if ts\_min}(\Delta\text{close}, 5) > 0 \\ \Delta\text{close}_t, & \text{if ts\_max}(\Delta\text{close}, 5) < 0 \\ -\Delta\text{close}_t, & \text{otherwise} \end{cases}$$

Where:

- $\Delta\text{close}_t = \text{close}_t - \text{close}_{t-1}$ is the 1-day price change.
- $\text{ts\_min}(\Delta\text{close}, 5)$ is the minimum 1-day return over the last 5 days.
- $\text{ts\_max}(\Delta\text{close}, 5)$ is the maximum 1-day return over the last 5 days.

Interpretation:

- If Δclose has been positive for 5 days, Alpha follows up momentum.
- If Δclose has been negative for 5 days, Alpha still follows down momentum.
- If the sign is mixed, Alpha takes a contrarian (mean-reverting) stance.

Example 1: Strong Downward Momentum

Day	Close Price	Δclose
$t-5$	100	
$t-4$	98	-2
$t-3$	97	-1
$t-2$	95	-2
$t-1$	94	-1
t	93	$\mathbf{-1}$

$$\text{ts\_max}(\Delta\text{close}, 5) = -1 < 0 \quad \Rightarrow \text{Alpha}_9(t) = -1$$

Example 2: Mixed Returns Reversion

Day	Close Price	Δclose
$t-5$	100	
$t-4$	101	$+1$
$t-3$	100	-1
$t-2$	101	$+1$
$t-1$	100	-1
t	99	$\mathbf{-1}$

$$\text{ts\_min} = -1 < 0, \quad \text{ts\_max} = +1 > 0 \quad \Rightarrow \text{Alpha}_9(t) = +1$$

Trading Logic:

- Evaluate Alpha 9 signal at the end of day t.

- If the signal > threshold (e.g., top-k ranked positive signals among all stocks):
  - Place a buy order for day $t+1$.
- Hold the stock for one day (i.e., sell at the end of day $t+1$), or until an opposing signal is observed.

Alpha 24: Long-Term Low Reversion with Flat Trend Filter

Formula:

$$\text{Alpha}_{24}(t) = \begin{cases} -\left(\text{close}_t - \text{ts\_min}(\text{close}, 100)\right), & \text{if } \frac{\Delta_{100}\left(\frac{1}{100}\sum_{i=0}^{99}\text{close}_{t-i}\right)}{\text{close}_{t-100}} \leq 0.05 \\ -\Delta\text{close}_t^{(3)}, & \text{otherwise} \end{cases}$$

Where:

- $\Delta_{100}(x) = x_t - x_{t-100}$ is the 100-day difference of x.
- $\sum_{i=0}^{99}\text{close}_{t-i}$ is the 100-day cumulative close price.
- $\text{ts\_min}(\text{close}, 100)$ is the lowest closing price in the past 100 days.
- $\Delta\text{close}_t^{(3)} = \text{close}_t - \text{close}_{t-3}$ is the 3-day price change.

Interpretation:

- If the 100-day moving average changed less than 5
  - The stock is considered to be in a flat trend.
  - Alpha 24 returns the negative distance from its 100-day low.
- Otherwise:
  - Use the negative 3-day return to favor recent losers.

Trading Logic:

- At the end of day t, compute the 100-day MA drift and Alpha 24.
- If Alpha 24 is among the most negative (e.g., top-k ranked), signal long for day $t+1$.
- Exit after one day or when rebound is confirmed by other filters.

Example: Flat Trend Near Historical Low
Assume:

- $\text{MA}_{100}(t) = 92, \quad \text{MA}_{100}(t-100) = 91$

- $\text{close}_{t-100} = 100$
- So: $\frac{92-91}{100} = 0.01 < 0.05 \Rightarrow$ Flat trend condition met
- $\text{ts\_min}(\text{close}, 100) = 90, \quad \text{close}_t = 91$
- Then: $\text{Alpha}_{24}(t) = -(91 - 90) = -1$

Interpretation: Stock is in a flat long-term regime and close to its 100-day low. $\rightarrow$ **Good candidate for mean-reversion entry.**

Alpha 43: Volume-Weighted Reversal Alpha

Formula:

$$\text{Alpha}_{43}(t) = \text{ts\_rank}\left(\frac{\text{volume}_t}{\text{adv}_{20}(t)},\ 20\right) \cdot \text{ts\_rank}\left(-\Delta\text{close}_t^{(7)},\ 8\right)$$

Where:

- $\Delta\text{close}_t^{(7)} = \text{close}_t - \text{close}_{t-7}$ is the 7-day price change.
- $\text{adv}_{20}(t)$ is the 20-day average daily trading volume.
- $\text{ts\_rank}(x,\ N)$ ranks the value of x within the past N days.
- The negative sign on $\Delta\text{close}^{(7)}$ ensures larger recent drops rank higher.

Interpretation:

- The first component captures whether today's volume is high relative to recent history.
- The second component rewards recent large price drops over 7 days.
- High Alpha 43 values occur when a stock has:
  - Dropped significantly in the last 7 days, and
  - Experienced unusually large volume today
- This is a classic signature of a **liquid panic sell-off**, often followed by a short-term rebound.

Trading Logic:

- Compute Alpha 43 at the end of day t.
- If Alpha 43 is in the top-k across the universe:
  - Submit a long order for day $t + 1$.
- Exit after one day or when other exit conditions (e.g., Alpha 9 turning negative) are triggered.

Example: Sharp Drop on Abnormal Volume
Assume:

- $\text{close}_{t-7} = 108, \quad \text{close}_t = 98 \Rightarrow \Delta\text{close}^{(7)} = -10$
- $\text{ts\_rank}(-\Delta\text{close}^{(7)}, 8) = 0.90$
- $\text{volume}_t = 1.5 \times \text{adv}_{20}(t)$
- $\text{ts\_rank}(\text{volume}/\text{adv}_{20}, 20) = 0.85$

Then:

$$\text{Alpha}_{43}(t) = 0.85 \cdot 0.90 = 0.765$$

Interpretation: The stock experienced a **large 7-day drop with a volume spike** → indicates a strong **mean-reversion signal**. → **Long entry for day $t + 1$.**

Alpha 52: Bounce Distance with Long-Term Confirmation

Formula:

$$\text{Alpha}_{52}(t) = [-\text{ts\_min}(\text{low}, 5)_t + \text{delay}(\text{ts\_min}(\text{low}, 5), 5)_t] \cdot \text{rank}\left(\frac{\sum_{i=1}^{240} r_{t-i} - \sum_{i=1}^{20} r_{t-i}}{220}\right) \cdot \text{ts\_rank}(\text{volume}, 5)$$

Where:

- low_t is the low price of the stock on day t
- $\text{ts\_min}(\text{low}, 5)$ is the minimum low over the last 5 days
- $\text{delay}(x, 5)_t = x_{t-5}$ is the 5-day lag of the time series
- $r_t = \log\left(\frac{\text{close}_t}{\text{close}_{t-1}}\right)$ is the daily log return
- The return ratio compares the **long-term return (240-day)** minus **short-term return (20-day)**, normalized over 220 days
- $\text{rank}(x)$ is cross-sectional rank among all stocks at time t
- $\text{ts\_rank}(\text{volume}, 5)$ is the time-series rank of current volume over the last 5 days

Interpretation:

- The first term measures the **rebound distance** from the 5-day low — stocks that are bouncing upward will score higher.
- The second term selects stocks with **strong long-term momentum** relative to recent weakness.

- The third term ensures that there's **active trading interest** via volume.
- Together, Alpha 52 captures stocks that are:
  - Emerging from a recent low (bounce)
  - In long-term uptrend
  - Trading on high volume

Trading Logic:

- Compute Alpha 52 at the end of day t
- If Alpha 52 is **positive and increasing**, use it as:
  - A confirmation to delay exit (if price is rebounding)
  - A secondary filter to verify reversal strength
- Could be combined with exit logic from Alpha 9 for smoother liquidation timing

Example: Stock Rebounding After a Drop
Assume:

- $\text{ts\_min}(\text{low}, 5)_t = 92, \quad \text{ts\_min}(\text{low}, 5)_{t-5} = 88$
- Long-term return component: $\frac{\sum_{i=1}^{240} r_{t-i} - \sum_{i=1}^{20} r_{t-i}}{220} = 0.10$
- Cross-sectional rank of return term = 0.70
- $\text{ts\_rank}(\text{volume}, 5) = 0.80$

Then:

$$\text{Alpha}_{52}(t) = (92 - 88) \cdot 0.70 \cdot 0.80 = 4 \cdot 0.70 \cdot 0.80 = 2.24$$

Interpretation: The stock has bounced significantly from its recent low, has **strong long-term trend**, and is trading on **high volume**. $\rightarrow$ **Potential confirmation to hold or delay exit.**

Composite Alpha Strategy for 5-Day Mean-Reversion with Alpha 52 Integration

1. Core Setup

We define the 5-day log return:

$$R_5(t) = \log\left(\frac{\text{close}_t}{\text{close}_{t-5}}\right)$$

This forms the core trigger condition of the strategy: identifying stocks that have significantly declined in 5 days.

Let:

$$A_i(t, s) \quad \text{denote the output of Alpha } i \text{ at time } t \text{ for stock } s$$

The selected entry alphas are:

- A_1: Volatility burst and recent extremum detection.
- A_7: 7-day return polarity under volume spike.
- A_{24}: Price proximity to 100-day low under flat trend.
- A_{43}: 7-day drawdown $\times$ high volume.

Exit alpha:

- A_9: Price-based hybrid signal indicating whether the stock is still in reversion mode or has reversed.
- A_{52}: Recent bounce distance $\times$ long-term trend confirmation $\times$ volume.

2. Normalization of Alphas

Each alpha signal has a different natural range, which may distort the composite score if not normalized. We apply one of the following normalization methods for each $A_i(t, s)$:

- **Z-score normalization (cross-sectional):**

$$\tilde{A}_i(t, s) = \frac{A_i(t, s) - \mu_i(t)}{\sigma_i(t)}$$

  where $\mu_i(t)$ and $\sigma_i(t)$ are the mean and standard deviation of A_i across all stocks on day t.

- **Rank normalization (preferred for stability):**

$$\tilde{A}_i(t, s) = \frac{\text{rank}_s(A_i(t, s))}{N}$$

  where N is the number of stocks, and ranks are scaled to the $[0, 1]$ interval.

- **Hybrid Normalization in Practice - Custom scaling (Alpha 24, 52):**

  In implementation, we adopt a hybrid method:

  – First, we apply *custom squeezing* to specific alphas with extreme or asymmetric distributions:

$$\tilde{A}_{24}^{\text{squeezed}}(t, s) = \frac{-A_{24}(t, s)}{1 + |A_{24}(t, s)|}, \quad \tilde{A}_{52}^{\text{squeezed}}(t, s) = 1 + \frac{1}{1 + e^{-A_{52}(t,s)}}$$

– Then, we apply cross-sectional Z-score normalization to all alphas (including the squeezed versions):

$$\tilde{A}_i(t,s) = \frac{A_i^{(\text{raw or squeezed})}(t,s) - \mu_i(t)}{\sigma_i(t)} \quad \text{with clipping to } [-3,3]$$

This two-step hybrid normalization ensures consistency in scale while preserving essential nonlinear structure in skewed signals like Alpha 24 and 52.

3. Entry Signal Construction

We construct the entry score as a product of two modules:

$$S^{(1)}_{\text{entry}}(t,s) = \frac{\tilde{A}_1(t,s) + \tilde{A}_7(t,s) + \tilde{A}_{43}(t,s)}{3} \quad \text{(Normalized panic intensity)}$$
$$S^{(2)}_{\text{entry}}(t,s) = \tilde{A}_{24}(t,s) \quad \text{(Bounded oversold score)}$$

$$S_{\text{entry}}(t,s) = S^{(1)}_{\text{entry}}(t,s) \cdot S^{(2)}_{\text{entry}}(t,s)$$

Alternative Methods for Combining Normalized Alphas

While multiplication is a natural way to enforce joint agreement across multiple alphas, it can overly penalize the final score when even one component is weak. Alternative aggregation techniques include:

- **Geometric Mean (Soft Conjunction):**

$$S_{\text{entry}}(t,s) = \left(\prod_{i=1}^{k} \tilde{A}_i(t,s) \right)^{1/k}$$

This reduces the impact of extremely small values while still requiring agreement across all components.

- **Weighted Sum (Linear Blend):**

$$S_{\text{entry}}(t,s) = \sum_{i=1}^{k} w_i \cdot \tilde{A}_i(t,s)$$

where weights w_i can be calibrated based on predictive power, signal stability, or cross-validation. This method allows for soft inclusion of weaker but still useful signals.

- **Hybrid Combination (Soft gating):**

$$S_{\text{entry}}(t,s) = \left(\sum_{i=1}^{k} w_i \cdot \tilde{A}_i(t,s) \right) \cdot \mathbf{1}_{\left\{ \min_i \tilde{A}_i(t,s) > \varepsilon \right\}}$$

This filters out entries where any component falls below a minimum quality threshold ε.

These alternatives offer greater flexibility in capturing complex signals while avoiding the brittleness of strict multiplicative scoring.

4. Entry Condition

The stock s is selected for long entry if:

$$\text{ENTRY}(t, s) = \mathbf{1}_{\{R_5(t,s)<\tau\}} \cdot \mathbf{1}_{\{S_{\text{entry}}(t,s)>\theta\}}$$

Where:

- $\tau < 0$ is the 5-day log return threshold (e.g., $\tau = -0.05$)
- θ is the threshold for the entry score, typically top-k or a cross-sectional percentile

5. Exit Condition

The primary exit alpha is $A_9(t, s)$, defined as:

$$A_9(t,s) = \begin{cases} \Delta\text{close}_t, & \text{if ts\_min}(\Delta\text{close}, 5) > 0 \\ \Delta\text{close}_t, & \text{if ts\_max}(\Delta\text{close}, 5) < 0 \\ -\Delta\text{close}_t, & \text{otherwise} \end{cases}$$

Interpretation:

- $A_9(t, s) < 0$ signals that price rose today in a mixed regime — likely bounce complete $\rightarrow$ exit

We define the exit rule:

$$\text{EXIT}(t, s) = \mathbf{1}_{\{A_9(t,s)<0\}} \cdot \mathbf{1}_{\{A_{52}(t,s)<\gamma\}}$$

6. Backtest Process

Let $t = 0, 1, \ldots, T$ index trading days and $i \in \mathcal{I}_t$ the tradable universe on day t. Denote

$$P_{i,t}^{\text{open}},\ P_{i,t-1}^{\text{close}},\ P_{i,t}^{\text{close}}$$

the opening, prior-close and closing prices. Define positions $Q_{i,t}$ (shares), cash C_t, and

$$\text{NAV}_t \ = \ C_t \ + \ \sum_{i \in \mathcal{I}_t} Q_{i,t}\, P_{i,t}^{\text{close}},$$

with $\text{NAV}_0 = C_0 = V_0$.

Tradeability filter:

$$\text{tradable}_{i,t} = \mathbf{1}\Big\{P_{i,t}^{\text{open}} \le (1+\Delta_i)\,P_{i,t-1}^{\text{close}},\quad P_{i,t}^{\text{open}} \ge (1-\Delta_i)\,P_{i,t-1}^{\text{close}},\quad \text{not halted}\Big\},$$

where

$$\Delta_i = \begin{cases} 0.19, & \text{if the 3-digit prefix of } i \in \{300, 301, 688, 689\}, \\ 0.097, & \text{otherwise.} \end{cases}$$

Exit step: For each i,

$$\text{Exit}_{i,t} = \mathbf{1}\{\tilde{A}_{9,i}(t) < 0\} \ \wedge\ \mathbf{1}\{\tilde{A}_{52,i}(t) < \theta_{\text{exit}}(t)\}.$$

Sell all shares of i at $P_{i,t}^{\text{open}}$ if $\text{Exit}_{i,t} = 1$ and $\text{tradable}_{i,t} = 1$. Cash updates include commissions c_{comm}, impact η_{imp}, and stamp duty s_{stamp}.

Entry step: Define

$$\text{Entry}_{i,t} = \mathbf{1}\{R_{5,i}(t) < \tau\} \ \wedge\ \mathbf{1}\{S_{\text{entry},i}(t) > \theta_{\text{entry}}(t)\},$$

and candidate set $\mathcal{S}_t = \{i : \text{Entry}_{i,t} = 1,\ Q_{i,t-1} = 0,\ \text{tradable}_{i,t} = 1\}$. Let $|\mathcal{S}_t| = n_t$. Rank each $i \in \mathcal{S}_t$ by $S_{\text{entry},i}(t)$ to get $\text{rank}_{i,t} \in \{1, \dots, n_t\}$, and weights

$$w_{i,t} = \frac{n_t - \text{rank}_{i,t} + 1}{\sum_{j \in \mathcal{S}_t}(n_t - \text{rank}_{j,t} + 1)}.$$

With total buying budget $B_t = C_t'/(1 + c_{\text{comm}} + \eta_{\text{imp}})$, buy

$$Q_{i,t}^{\text{buy}} = \frac{w_{i,t}\,B_t}{P_{i,t}^{\text{open}}},\quad C_t = C_t' - \sum_{i \in \mathcal{S}_t} Q_{i,t}^{\text{buy}}\,P_{i,t}^{\text{open}}\big[1 + (c_{\text{comm}} + \eta_{\text{imp}})\big],$$

and update positions $Q_{i,t} = Q_{i,t}^{(0)} + Q_{i,t}^{\text{buy}}$.

Note: All purchases are executed in units of 100 shares. The quantity $Q_{i,t}^{\text{buy}}$ is therefore rounded down to the nearest multiple of 100 before execution.

Performance metrics:

$$\text{PnL}_t = \text{NAV}_t - \text{NAV}_{t-1},\quad r_t = \frac{\text{NAV}_t}{\text{NAV}_{t-1}} - 1,$$

$$\text{AnnRet} = \Big(\tfrac{\text{NAV}_T}{V_0}\Big)^{\frac{244}{T}} - 1,\quad \text{AnnVol} = \sigma(r_t)\sqrt{244},\quad \text{Sharpe} = \frac{E[\,r_t - rf/244\,]}{\sigma(r_t)}\sqrt{244},$$

$$\text{MaxDD} = \max_t \frac{\max_{u \le t}\text{NAV}_u - \text{NAV}_t}{\max_{u \le t}\text{NAV}_u}.$$

7. Summary

- The strategy targets high-probability short-term bounces after steep 5-day drops.
- Entry requires extreme volatility or panic (Alpha 1, 7, 43), structural oversold condition (Alpha 24).
- Alphas are normalized via rank or custom scaling to ensure balance in the final score.
- Exit is determined by Alpha 9's price reversion logic, optionally confirmed with Alpha 52.
- The strategy is T+1 executable and long-only, tailored for the Chinese A-share market.

8. Interpretation of Mathematical Operators

- **Addition** $(+)$: Combines orthogonal panic indicators into an average signal.
- **Multiplication** $(\times)$: Enforces alignment across different signal dimensions.
- **Division** $(\div)$: Used to normalize and compress signal magnitude.
- **Sigmoid**: Smooths and bounds extreme values (used for Alpha 52).