PSEDYS | TECHNICAL REFERENCE MANUAL V3.0

MACD — Technical Reference Manual v1.0

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PSEDYS | Complete Edition

Formula · Components · Lag · Whipsaws · Zero Line · Signal Cross · Histogram · Divergence · MTF · macd_cross feature · Bot vs TradingView

CONTENTS

1. What is MACD? Definition, Components, MACD vs Simple MA
2. Calculation Formula — Complete
   - 2.1 Component 1 — MACD Line
   - 2.2 Component 2 — Signal Line
   - 2.3 Component 3 — Histogram
   - 2.4 Standard Parameters 12/26/9 and Their Derivation
   - 2.5 Complete Numeric Example — MACD 12/26/9
   - 2.6 Warm-up, Cold Start, and Limitations
   - 2.7 MACD Variants (Fast, Slow, with SMA, Wilder)
3. MACD Lag — Quantified on Each Component
4. Sensitivity to Whipsaws — MACD Line Behavior
5. Zero Line — Significance, Usage, Filters
6. Signal Line Crossover — Trading Signals
   - 6.1 Bullish and Bearish Crossover
   - 6.2 Filters for False Crossover
7. MACD Histogram — Advanced Analysis
   - 7.1 Momentum and Trend Strength
   - 7.2 Histogram Reversal — Early Entry
   - 7.3 Flat vs Expanding Histogram
8. MACD Divergence from Price
   - 8.1 Classic Bearish and Bullish Divergence
   - 8.2 Hidden Divergence
   - 8.3 MACD Divergence Validation
9. Slope MACD Line — Formula and Calibration
10. Multi-Timeframe Analysis (MTF) — Complete and Partial Scenarios
11. MACD in Sideways Market
12. PSEDYS — `macd_cross` as a Feature in Scoring Model
13. Bot vs TradingView Validation

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14. Practical Exercises with Complete Answers

15. Cheat Sheet — Quick Summary

1. What is MACD? Definition, Components, MACD vs Simple MA

MACD (Moving Average Convergence Divergence) is a **momentum indicator** derived from the difference between two EMAs with different periods. Unlike EMA/SMA which directly track the price, MACD **measures the relative speed** between a fast trend and a slow one — specifically, how much the fast EMA has diverged from the slow EMA.

MACD is composed of **three distinct elements**, each with a different role:

Component	Standard Color	What it Measures
MACD Line	Blue / White	Difference between EMA12 and EMA26 — trend speed
Signal Line	Orange / Red	EMA9 applied to MACD Line — smoothing of MACD
Histogram	Green/Red (bars)	MACD Line − Signal Line — momentum acceleration

MACD vs Simple MA — fundamental difference:

Feature	EMA/SMA	MACD
Type	Price-following indicator	Momentum indicator
Values	Absolute (prices)	Relative (price differences)
Zero Reference	None	Zero = EMA12 = EMA26 (equilibrium)
Oscillation	Does not oscillate — follows price	Oscillates around zero
Main Signal	Price vs MA, MA crossover	Zero cross, signal cross, divergence
Lag	(N-1)/2 bars	12.5 bars (MACD) + 4.0 bars (Signal)
Ideal for	Trend direction, dynamic S/R	Timing entry, trend strength, divergences

Note: MACD does not confirm trend direction (EMA 200 4H does) — it confirms the MOMENTUM and SPEED of the trend. A bullish MACD in a macro bearish context (price below EMA 200 4H) is not a Long signal.

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2. Complete Calculation Formula

2.1 Component 1 — MACD Line

```
MACD_Line = EMA(Close, fast) − EMA(Close, slow)
          = EMA(Close, 12)  − EMA(Close, 26)    [standard parameters]
```

Both EMAs are calculated using the standard formula `K = 2/(N+1)` :

```
K_fast = 2 / (12 + 1) = 2/13 = 0.153846 (15.38%)
K_slow = 2 / (26 + 1) = 2/27 = 0.074074 (7.41%)
```

The MACD Line is **positive** when EMA12 > EMA26 (bullish trend, fast above slow).
The MACD Line is **negative** when EMA12 < EMA26 (bearish trend, fast below slow).
MACD Line = **zero** exactly when EMA12 = EMA26 (trend transition or equilibrium).

2.2 Component 2 — Signal Line

The Signal Line is a **9-period EMA applied to the MACD Line** (not directly on price):

```
Signal_Line = EMA(MACD_Line, 9)
K_signal = 2 / (9 + 1) = 2/10 = 0.200000 (20.00%)

Recursive formula:
Current_Signal = Previous_Signal + K_signal × (Current_MACD − Previous_Signal)
```

The Signal Line **smooths** the MACD Line — it removes noise and produces less frequent but more reliable signals. Since it is an EMA of the MACD Line, it is always slower than the MACD Line.

Seed Signal Line (first value):
Identical to the seed of any EMA — first Signal value = SMA of the first 9 MACD Line values:

```
Signal_seed = mean(MACD_Line[bars 26..34]) / 9
```

2.3 Component 3 — Histogram

```
Histogram = MACD_Line − Signal_Line
```

The Histogram is positive when MACD Line > Signal Line (active bullish momentum).
The Histogram is negative when MACD Line < Signal Line (active bearish momentum).
Histogram = 0 exactly at the Signal crossover — it is the visual equivalent of the crossover.

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The Histogram is not a separate indicator — it is the visualization of the distance between MACD and Signal. However, its amplitude and direction communicate **momentum acceleration**.

2.4 Standard Parameters 12/26/9 and Their Derivation

The 12/26/9 parameters were established by Gerald Appel in the 1970s on stock data with 5-day/week sessions:
- **EMA 12** = ~2.4 trading weeks → fast trend (intraday/weekly)
- **EMA 26** = ~5.2 weeks → slow trend (monthly)
- **EMA 9** for Signal = ~1.8 weeks → signal smoothing

Calculated Multipliers:

Component	N	Formula K	Exact Value	Current Weight
EMA fast	12	2/13	0.153846	15.38%
EMA slow	26	2/27	0.074074	7.41%
EMA signal	9	2/10	0.200000	20.00%

Critical Note: The 12/26/9 parameters are optimized for **stock markets with 5-day/week sessions**. On crypto (24/7/365), the same parameters are acceptable on **hourly and daily charts**, but on **minute** timeframes (1M, 5M), the temporal equivalent is much shorter. PSEDYS uses the standard 12/26/9 parameters on **all timeframes** for consistency and comparability with external platforms.

2.5 Complete Numeric Example — MACD 12/26/9

Input Data (60 bars with realistic trend — up / retracement / up):

Bars 1–25: EMA12 and EMA26 are constructed. The first MACD Line value appears at bar 26.
Bars 26–34: MACD Line available, Signal Line accumulates for seed.
Bar 34: **Signal Line seed** = arithmetic mean of MACD Line[bars 26..34].
Bars 35+: Signal Line calculated recursively; Histogram available.

Complete Table — Key Bars (from bar 26 to 50):

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Bar	Close Price	EMA 12	EMA 26	MACD Line	Signal	Histogram
26	101.62	102.346	101.922	**+0.4244**	N/A	N/A
27	100.58	102.074	101.822	+0.2521	N/A	N/A
28	99.54	101.684	101.653	+0.0313	N/A	N/A
29	99.78	101.391	101.514	−0.1230	N/A	N/A
30	99.61	101.117	101.373	−0.2560	N/A	N/A
31	99.78	100.912	101.255	−0.3437	N/A	N/A
32	99.82	100.744	101.149	−0.4053	N/A	N/A
33	99.53	100.557	101.029	−0.4721	N/A	N/A
34	99.99	100.470	100.952	−0.4824	**−0.1527** [SEED]	**−0.3296**
35	99.43	100.310	100.839	−0.5296	−0.2281	−0.3015
36	100.12	100.281	100.786	−0.5055	−0.2836	−0.2219
37	101.32	100.440	100.826	−0.3851	−0.3039	−0.0812
38	**102.13**	100.700	100.922	**−0.2218**	**−0.2875**	**+0.0657 ← BULLISH CROSS**
39	**103.38**	101.113	101.104	**+0.0084**	−0.2283	+0.2367 ← **ZERO LINE CROSS**
40	104.12	101.575	101.328	+0.2477	−0.1331	+0.3808
41	105.09	102.116	101.606	+0.5097	−0.0046	+0.5142
42	104.87	102.540	101.848	+0.6916	+0.1347	+0.5569
43	**104.98**	102.915	102.080	+0.8351	+0.2748	**+0.5603 ← HIST PEAK**
44	105.20	103.267	102.311	+0.9555	+0.4109	+0.5446
45	105.05	103.541	102.514	+1.0270	+0.5341	+0.4928
46	105.16	103.790	102.710	+1.0800	+0.6433	+0.4367
47	105.05	103.984	102.883	+1.1005	+0.7347	+0.3658
48	105.25	104.179	103.059	+1.1200	+0.8118	+0.3082
49	106.09	104.473	103.283	+1.1895	+0.8873	+0.3022
50	106.45	104.777	103.518	+1.2591	+0.9617	+0.2974

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Verify Signal seed (bar 34):

```
MACD[bars 26..34] = +0.4244, +0.2521, +0.0313, −0.1230, −0.2560, −0.3437, −0.4053, −0.4721, −0.48
Sum = −1.3747
Seed = −1.3747 / 9 = −0.1527  ✓
```

Verify Signal bar 35:

```
Signal_35 = −0.1527 + 0.20 × (−0.5296 − (−0.1527))
          = −0.1527 + 0.20 × (−0.3769)
          = −0.1527 − 0.0754
          = −0.2281  ✓
```

Signal sequence from the table:
1. **Bar 34**: First Signal value — Histogram = −0.3296 (active bearish momentum)
2. **Bar 38**: **Bullish Signal Cross** — MACD (−0.2218) surpasses Signal (−0.2875) → Histogram turns positive (+0.0657). Both are still negative (below zero line) — bullish momentum signal, NOT bullish trend!
3. **Bar 39**: **Zero Line Bullish Cross** — MACD moves into positive territory (+0.0084). EMA12 surpasses EMA26 → confirms bullish trend
4. **Bar 43**: **Histogram Peak** (+0.5603) → maximum bullish momentum. From bar 44, histogram decreases → momentum slows (does not mean end of trend, means trend continues but slower)

2.6 Warm-up, Cold Start, and Limitations

Bars required at start:

Component	First valid value	Rationale
EMA 12	Bar 12	Seed = SMA(12)
EMA 26	Bar 26	Seed = SMA(26)
MACD Line	Bar 26	Requires both EMAs
Signal Line seed	Bar 34	SMA of first 9 MACD values
Signal Line recursive	Bar 35	First value calculated with EMA formula
Histogram	Bar 34	First value simultaneous with Signal seed

```
Absolute minimum bars:     35 bars (first Signal value)
Recommended warm-up:       61 bars (2×26 + 9) — more stable EMA seed
Practical for production: 100 bars minimum — safe buffer
```

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Cold Start — compound seed issue:

MACD has **three cascading seeds**, each propagating an initial error:
1. EMA 12 seed = SMA(12) → seed error if data is insufficient
2. EMA 26 seed = SMA(26) → seed error
3. Signal seed = SMA(9 MACD values) → error propagated from both EMAs

At a restart with only 35 bars, all three seeds are sub-optimal. The difference compared to MACD calculated with 400+ bars can be **0.1%–0.5%** of the asset's price — negligible on individual bars, but can shift crossovers by 1–3 bars compared to TradingView.

Correct cold start procedure:

```
# At startup:
# 1. Download at least 100 bars (recommended 200) from GM API
# 2. Calculate EMA12, EMA26 from bar 1 with recursive formula
# 3. Calculate MACD Line from bar 26 onwards
# 4. Calculate Signal from bar 34 onwards (SMA seed → recursive)
# 5. First 35 bars → invalidated (no signal)
# 6. Bars 35–61 → possible signal but with reduced accuracy
# 7. From bar 61+ → full accuracy signal
```

2.7 MACD Variants

Common alternative parameters:

Variant	Fast/Slow/Signal	K_fast	K_slow	Warm-up	Usage
Standard	**12/26/9**	**15.38%**	**7.41%**	**35 bars**	Universal — PSEDYS default
Fast scalp	5/13/5	33.33%	14.29%	18 bars	Crypto scalp, small TF
Slow swing	19/39/9	10.00%	5.00%	48 bars	Swing trading 4H/1D
Institutional	12/26/9 on 1D/1W	15.38%	7.41%	35 bars daily	Funds, macro

Variant with SMA Signal (rare):
Some implementations replace EMA9 for the Signal Line with **SMA9**. Result: smoother Signal Line, rarer but slower crossovers. TradingView default = EMA (standard) — if the bot uses SMA for signal, crossovers will be shifted compared to TradingView.

Variant with Wilder's RMA:
Not standardly used for MACD. Wilder's formula (K=1/N) produces a much slower MACD. Avoid if the goal is alignment with TradingView.

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3. MACD Lag — Quantified for Each Component

MACD is a derived indicator — its lag is the sum of the lags of its components.

3.1 Lag per Component

```
Lag EMA12       = (12 − 1) / 2 = 5.5 bars
Lag EMA26       = (26 − 1) / 2 = 12.5 bars
Lag MACD Line   = dominated by EMA26 ≈ 12.5 bars  (the slowest component determines)
Lag Signal Line = Lag MACD + Lag EMA9 = 12.5 + 4.0 = 16.5 bars
```

3.2 Order of Reaction to a New Trend (from Fast to Slow)

```
Temporal order of confirmation:
1. Histogram changes direction     → bar 0 (immediate) — earliest
2. MACD Line changes direction     → bar 1–3 → later
3. Signal Line crossover (MACD×Signal) → bar 3–8 → standard entry
4. Zero Line cross (MACD>0)        → bar 5–15 → macro confirmation
5. EMA 20 cross EMA 50 on price    → bar 8–20 → latest

→ The earlier the signal, the more false signals
→ The slower the signal, the later but more secure the entry
```

PSEDYS Practice: Use type 3 signals (Signal crossover on 5M) filtered with type 4 or 5 signals on higher timeframes.

3.3 Implication of Lag for Entry

Signal crossover at bar N means the trend started ~16 bars ago on that TF. On 5M → the trend started ~80 minutes ago. On 15M → ~4 hours ago. MACD is not an anticipatory entry indicator — it is a tool for confirming existing trends.

---

4. Sensitivity to Spikes — MACD Line Behavior

4.1 How MACD Line Reacts to a Spike

MACD Line = EMA12 − EMA26. Both EMAs react to a spike, but with different intensities:

```
EMA12 jumps by: K_fast × spike = 15.38% of the spike amplitude
EMA26 jumps by: K_slow × spike = 7.41%  of the spike amplitude

MACD Line jumps by: (K_fast − K_slow) × spike = (15.38% − 7.41%) × spike = 7.97% of the spike
```

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Numeric Example — spike of +1,000 USD on BTC:

```
EMA12 jumps by: 0.1538 × 1,000 = +153.85 USD
EMA26 jumps by: 0.0741 × 1,000 = +74.07  USD
MACD Line jumps by: 153.85 − 74.07 = +79.78 USD (7.98% of spike)
```

4.2 MACD Line vs Direct EMA at Spike

Indicator	Reaction to spike +1,000 USD
EMA 12 direct	+153.85 (15.38%)
EMA 26 direct	+74.07 (7.41%)
MACD Line	**+79.78 (7.98%)**
Signal Line (EMA9 on MACD)	+79.78 × 0.20 = +15.96 (1.60%)
Histogram	+79.78 − 15.96 = +63.82 (6.38%)

Important Observation: The spike causes the MACD Line to jump sharply, but the Signal Line (slower, K=0.20 from MACD) absorbs more of the shock. The histogram expands massively at the spike → false signal of strong momentum.

4.3 MACD Recovery After Spike

Like its component EMAs, MACD does not have a ghost effect (specific to SMA). The spike fades gradually as the effect in EMA12 and EMA26 decays. However:

```
EMA12 (K=0.1538) attenuates the spike faster than EMA26 (K=0.0741)
→ Immediately after the spike, MACD moves in the direction of the spike
→ As the spike attenuates, EMA12 decreases faster than EMA26
→ MACD can overshoot in the opposite direction in the bars immediately after the spike
```

Recommended Filter for Spike on MACD:

```
spike_bar = (high - low) > 3 * atr14
if spike_bar or spike_bar_previous_1 or spike_bar_previous_2:
    invalidate_macd_signal = True  # Ignore 3 bars after spike
```

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5. Zero Line — Significance, Usage, Filters

5.1 What Zero Line Means

Zero Line is the horizontal line at the value 0 of MACD. It represents the point where **EMA12 = EMA26** — the equilibrium moment of the two moving averages.

```
MACD > 0 (above Zero Line): EMA12 > EMA26
→ Bullish trend — fast speed is greater than slow speed
→ LONG bias

MACD < 0 (below Zero Line): EMA12 < EMA26
→ Bearish trend — fast speed is less than slow speed
→ SHORT bias

MACD = 0 (Zero Line): EMA12 = EMA26
→ Transition point or temporary equilibrium
```

5.2 Zero Line Cross — Major Trend Signal

Bullish Zero Cross: MACD moves from negative to positive (EMA12 surpasses EMA26 from below). The MACD equivalent of a Golden Cross on prices, but faster.

Bearish Zero Cross: MACD moves from positive to negative. The MACD equivalent of a Death Cross, but faster.

Strength of Zero Cross vs Signal Cross:

Signal	Meaning	Frequency	Precision
Signal Cross	Momentum changes	Frequent	Medium
Zero Cross	**Trend changes**	**Rare**	**High**
Zero Cross + Signal confirmed	Both aligned	Very rare	Very high

5.3 Zero Line as Trend Filter

Zero Line can be used as a macro filter on a higher TF, similar to EMA 200:

```
MACD 4H > 0 → EMA12 4H > EMA26 4H → LONG bias on small TFs
MACD 4H < 0 → EMA12 4H < EMA26 4H → SHORT bias on small TFs

PSEDYS Rule:
→ On 4H, MACD > 0 → execute ONLY Long signals on 5M/15M
→ On 4H, MACD < 0 → execute ONLY Short signals on 5M/15M
→ Exception: setup with strong divergence and confirmed volume
```

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5.4 Filters for False Zero Cross

A false Zero Cross occurs when MACD oscillates repeatedly around 0 without a real trend:

```
Filter 1 — MACD Magnitude at cross:
|MACD| > threshold_zero at the crossover moment (not enough to be > 0)
Recommended threshold on 5M: |MACD| > 0.05% of price (equivalent slope)

Filter 2 — ADX at cross:
ADX > 18 on 5M / ADX > 20 on 15M confirms the trend has strength

Filter 3 — Choppiness:
Choppiness < 61.8 → not in sideways

Filter 4 — Signal confirmed:
MACD cross zero + Signal cross MACD in the same direction, within 3 bars
```

---

6. Signal Line Crossover — Trading Signals

6.1 Bullish and Bearish Signal Crossover

Bullish Signal Cross:

```
MACD Line crosses above Signal Line from below
→ Fast EMA accelerates compared to slow EMA
→ Bullish momentum intensifies
→ Histogram moves from negative to positive (or 0)
```

Bearish Signal Cross:

```
MACD Line crosses below Signal Line from above
→ Fast EMA decelerates compared to slow EMA
→ Bearish momentum intensifies
→ Histogram moves from positive to negative (or 0)
```

The context of the signal is DECISIVE:

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Location	Meaning	Signal Strength
Bullish cross **above** Zero Line (MACD > 0)	Continuation of bullish trend	Strong
Bullish cross **below** Zero Line (MACD < 0)	Possible bullish reversal, NOT confirmed	Weak — confirmation needed
Bearish cross **below** Zero Line (MACD < 0)	Continuation of bearish trend	Strong
Bearish cross **above** Zero Line (MACD > 0)	Possible bearish reversal, NOT confirmed	Weak — confirmation needed

PSEDYS Rule: Signal Crosses below Zero Line (for Long) or above Zero Line (for Short) require additional confirmation from a higher TF before entry.

BULLISH Signals — Long

- MACD Line crosses above Signal Line, both **above** Zero Line → strong bullish momentum
- Positive and rising MACD Line after a pull-back to Signal Line (bounce on Signal)
- MACD Line crosses Zero Line from below (bullish Zero Cross)
- Histogram consecutively rising above Zero (momentum accelerates)
- MACD 4H > 0 + Bullish Signal Cross on 15M/5M → perfect alignment

BEARISH Signals — Short

- MACD Line crosses below Signal Line, both **below** Zero Line → strong bearish momentum
- Negative and falling MACD Line after a pull-back to Signal Line
- MACD Line crosses Zero Line from above (bearish Zero Cross)
- Histogram consecutively falling below Zero (bearish momentum accelerates)
- MACD 4H < 0 + Bearish Signal Cross on 15M/5M → perfect alignment

NEUTRAL / To Avoid

- MACD and Signal around 0, repeatedly crossed → sideways
- Histogram with small alternating bars (+ / − / + / −) → choppy, no direction
- ADX < 18 on 5M → MACD signal invalid, weak trend
- Choppiness > 61.8 → lateral market → SKIP

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6.2 Filters for False Signal Crossover

```
Filter 1 — CANDLE CLOSED CONFIRMATION:
Valid Signal Cross = MACD surpassed Signal on closed candle[-1]
Intra-bar crossover (wick) → DOES NOT count

Filter 2 — CROSSOVER MAGNITUDE:
Distance |MACD − Signal| at crossover moment > 0.01% of price
Crossover with small spread → high probability of immediate re-cross

Filter 3 — ADX:
ADX > 18 on 5M / ADX > 20 on 15M at or immediately after crossover

Filter 4 — CHOPPINESS:
Choppiness < 61.8

Filter 5 — ZERO LINE CONTEXT (see 6.1 table):
Crossover above Zero Line (for Long) → strong signal, no additional filter
Crossover below Zero Line (for Long) → requires higher TF confirmation

Filter 6 — VOLUME:
Volume at bar ≥ average of last 20 bars (optional but recommended)
```

---

7. MACD Histogram — Advanced Analysis

7.1 Momentum and Trend Strength

The histogram is the most powerful tool in MACD for evaluating momentum:

```
Histogram = MACD_Line − Signal_Line
```

Interpreting magnitude and direction:

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Histogram State	Significance	Action
Positive and **increasing**	Bullish momentum **accelerates**	Strong trend → hold Long or entry
Positive and **decreasing**	Bullish momentum **decelerates**	Trend continues but weakens → tighten SL
Zero (cross up→down or down→up)	Signal Cross (MACD/Signal cross)	Confirmation of reversal or continuation
Negative and **increasing** (towards zero)	Bearish momentum **decelerates**	Bearish trend weakens → possible bottom
Negative and **decreasing**	Bearish momentum **accelerates**	Strong bearish trend → hold Short

Critical distinction: trend direction vs histogram direction

The histogram can be positive (MACD > Signal) but **decreasing** — this does not mean the trend has reversed, it means the bullish momentum is tempering. The trend remains bullish as long as MACD stays positive.

```
MACD > 0 + Histogram > 0 + Histogram increasing → strong bullish trend with acceleration
MACD > 0 + Histogram > 0 + Histogram decreasing → bullish trend but momentum weakens
MACD > 0 + Histogram < 0 → MACD has fallen below Signal, possible correction
MACD < 0 + Histogram < 0 + Histogram decreasing → strong bearish trend with acceleration
```

7.2 Histogram Reversal — Early Entry

Histogram Reversal is the earliest form of MACD signal, occurring ~3–8 bars before the Signal Crossover. It is based on identifying the moment when the histogram has peaked (or troughed) and begins to reverse.

Identifying Histogram Peak (possible end of bullish momentum):

```
Histogram Peak: histogram[i-1] < histogram[i] > histogram[i+1]
                AND histogram[i] > 0 (we are in bullish territory)
→ Signal: bullish momentum has peaked
→ NOT a Short signal! It is a signal that the bullish trend is tempering
→ Action: tighten SL on existing Longs, reduce sizing for new Longs
```

Identifying Histogram Trough (possible end of bearish momentum):

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```
Histogram Trough: histogram[i-1] > histogram[i] < histogram[i+1]
                  AND histogram[i] < 0 (we are in bearish territory)
→ Signal: bearish momentum has bottomed
→ NOT an immediate Long signal! Confirmation must follow
→ Action: reduce Shorts, prepare context for Long
```

Complete signal sequence (from numeric example in 2.5):

```
Bar 43: Histogram Peak = +0.5603 → bullish momentum at maximum
Bar 44: Histogram = +0.5446 → first decrease → early WARNING
Bar 45: Histogram = +0.4928 → confirmation of decrease → tighten SL Long
...
(Eventually, if decrease continues → Histogram Cross Zero → Signal Cross bearish)
```

7.3 Flat vs Expanding Histogram

Flat Histogram (small bars, alternating + / −):
- MACD and Signal almost identical in value → no dominant direction
- Signal: sideways or trend transition
- Coincides with flat EMA and high Choppiness

Expanding Histogram (bars increasing in amplitude):
- Distance between MACD and Signal increases → accelerating momentum
- Signal: active trend, histogram direction = trend direction

Contracting Histogram (bars decreasing in amplitude, from extremes towards zero):
- Distance between MACD and Signal reduces → decelerating momentum
- Signal: trend continues but strength decreases → prepare for correction or slow continuation

---

8. MACD Divergence from Price

Divergence is **the most powerful MACD signal** — in practice, it is more reliable as a source of reversal than the standard signal crossover.

8.1 Regular Divergence

Regular Bearish Divergence:

```
Price:      Higher High (new higher peak)
MACD Line: Lower High  (or Histogram Lower Peak)
→ Price rises but momentum decreases
→ Uptrend is exhausting
→ High probability of reversal or significant correction
```

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Regular Bullish Divergence:

```
Price:      Lower Low  (new lower low)
MACD Line: Higher Low (or Histogram Higher Trough – less negative)
→ Price falls but bearish momentum weakens
→ Downtrend is exhausting
→ High probability of reversal or significant bounce
```

8.2 Hidden Divergence (Continuation Signal)

Hidden divergence occurs in the **opposite** direction of regular divergence and signals **continuation** of the trend, not reversal.

Hidden Bullish Divergence (continuation of UP trend):

```
Price:      Higher Low  (pullback smaller than previous – bullish)
MACD Line: Lower Low   (MACD falls more in retracement)
→ Price holds better than MACD suggests
→ Bullish trend continues after retracement
→ Optimal Long entry: upon confirmation of price bounce
```

Hidden Bearish Divergence (continuation of DOWN trend):

```
Price:      Lower High  (weaker rally – bearish)
MACD Line: Higher High (MACD rises more in rally)
→ Price fails to recover as much as MACD
→ Bearish trend continues after rally
→ Optimal Short entry: upon confirmation of re-breakdown
```

8.3 Validating MACD Divergence

Mandatory conditions for valid divergence:

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```
1. SIGNIFICANT PEAKS/LOWS:
   Divergence is measured on clear swing highs/lows on the chart
   Not on any consecutive bar — there must be a clear pullback between them

2. MINIMUM MACD AMPLITUDE:
   Both MACD peaks/lows must be above/below zero or sufficiently large
   A MACD peak of +0.01 is not significant compared to a previous +0.50

3. MINIMUM TIMEFRAME:
   Valid divergence: minimum 15M
   On 5M → frequent false signals due to MACD lag
   On 1H+ → most reliable divergences

4. CONFIRMATION WITH CLOSED CANDLE:
   Entry is made ONLY after a closed candle in the direction of reversal
   Not at the mere appearance of divergence (it may continue before reversing)

5. VOLUME CONFIRMATION:
   At reversal, volume must be > average of the last 20 bars
   Reversal on weak volume → weak divergence, lower probability

6. MTF CONTEXT:
   Bearish divergence on 15M but 4H bullish → reduced signal strength
   Bearish divergence on 15M with 4H bearish → strong signal (MTF confirmation)
```

Divergence on Histogram vs MACD Line:

Type	What is compared	Reliability	Timing
MACD Line peak/trough	Absolute MACD values	High	Medium
Histogram peak/trough	Histogram amplitude	Medium (noisier)	Early
MACD Line + Histogram confirmation	Both	Very high	Medium

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9. Slope MACD Line — Formula and Calibration

9.1 MACD Slope Formula

```
# Standard (2 periods):
macd_slope = (macd_line[-1] - macd_line[-3]) / abs(macd_line[-3]) * 100
# Note: macd_line can be negative → use abs() in the denominator

# 1 period (more sensitive):
macd_slope_1p = (macd_line[-1] - macd_line[-2]) / abs(macd_line[-2]) * 100
```

Issue with macd values near zero: When `macd_line[-3]` ≈ 0 (at zero cross), the formula with normalization by abs() generates extreme values. Use normalization by price or ATR:

```
# Robust formula — normalization by price:
macd_slope = (macd_line[-1] - macd_line[-3]) / close[-1] * 100
# Or normalization by ATR:
macd_slope = (macd_line[-1] - macd_line[-3]) / atr14[-1] * 100
```

9.2 Slope Signal Line

```
signal_slope = (signal_line[-1] - signal_line[-3]) / close[-1] * 100
```

Both slopes oriented upwards + MACD > Signal: strong bullish confirmation.
Slope MACD > Slope Signal: MACD gains distance from Signal → momentum accelerates.
Slope MACD < Slope Signal: MACD loses distance from Signal → momentum decelerates.

9.3 MACD Slope Thresholds on Timeframes

MACD has absolute values dependent on the asset's price (not directly percentage-based). Thresholds are calculated relative to price:

TF	Slope MACD/price bullish	Flat (skip)	Slope bearish
5M	> +0.002%	±0.002%	< −0.002%
15M	> +0.001%	±0.001%	< −0.001%
1H	> +0.0005%	±0.0005%	< −0.0005%
4H	> +0.0002%	±0.0002%	< −0.0002%

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10. Multi-Timeframe Analysis (MTF) — Complete and Partial Scenarios

10.1 MTF PSEDYS Hierarchy — MACD

Level	Timeframe	MACD Component	ROLE	Bullish Condition
1 (Macro)	4H	Zero Line position	Determines macro bias	MACD 4H > 0
2 (Meso)	1H	MACD > Signal	Confirms medium momentum	MACD 1H > Signal 1H
3 (Micro)	15M	Signal Cross + Hist	PSEDYS Filter	Confirmed bullish Signal Cross + Hist > 0
4 (Entry)	5M	Signal Cross + Hist expansion	Execution timing	Signal Cross + Increasing Hist

10.2 MTF Alignment Score — MACD

MACD 4H	MACD 1H	MACD 15M	MACD 5M	Score	Action
> 0 ✅	> Signal ✅	Cross ✅	Cross ✅	4/4	Full sizing entry
> 0 ✅	> Signal ✅	Cross ✅	Neutral ⚠	3/4	Reduced sizing entry 50–75%
> 0 ✅	> Signal ✅	Neutral ⚠	Cross ✅	3/4	Wait for 15M confirmation
> 0 ✅	> Signal ✅	Bearish Cross ❌	Bullish Cross ✅	conflict	NO entry — 15M counter-trend
> 0 ✅	< Signal ❌	any	any	2/4	NO entry — 1H bearish
< 0 ❌	any	any	Bullish Cross ✅	macro conflict	NO Long entry — 4H bearish macro

10.3 Combining MACD MTF with EMA MTF

MACD and EMA on the same TF complement each other:

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```
Ideal bullish setup on 5M:
1. EMA: price > EMA20 > EMA50, EMA slope > +0.05%    (direction)
2. MACD: Bullish Signal Cross on 5M, MACD > 0         (momentum)
3. MACD 4H > 0                                        (macro)
4. EMA 200 4H < price                                 (macro EMA)
→ 4 separate confirmations → high probability entry
```

10.4 MACD Divergent from EMA on the Same TF

A frequent situation requiring attention:

```
Scenario: EMA20 > EMA50 on 15M (bullish EMA) but MACD 15M < 0 or bearish cross
→ Interpretation: EMA trend confirmed but MACD momentum lost
→ Possible causes: aging trend losing speed, ongoing divergence, consolidation
→ Action: do not enter, wait for MACD realignment with EMA or EMA reversal

Inverse scenario: Bullish MACD cross on 15M but EMA20 < EMA50
→ Interpretation: momentum returning but structural trend not reversed
→ Possible causes: early bounce in bearish trend (false dawn)
→ Action: SKIP or entry with strict SL, wait for EMA confirmation
```

---

11. MACD in Sideways Market

11.1 MACD Behavior in Sideways

MACD is designed for trending markets — in sideways it becomes a tool for **generating false signals**.

Signs that MACD operates in sideways:
- MACD Line oscillates around 0, repeatedly crossing the zero line
- Frequent Signal Crossovers (more than 3 on the same chart scale)
- Histogram with small alternating bars without significant amplitude
- MACD Line and Signal Line nearly parallel, close to zero

Algorithmic sideways detection with MACD:

```
# MACD range over the last 20 bars:
macd_range = max(macd_line[-20:]) - min(macd_line[-20:])
price_atr  = atr14 * 14   # ATR as scaling reference

# If MACD oscillates too little relative to price volatility → sideways
macd_volatility_ratio = macd_range / close[-1] * 100
# < 0.10% on 5M → Compressed MACD → confirmed sideways → SKIP
```

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11.2 PSEDYS Rule — MACD Sideways

```
MACD Line ≈ 0 (±threshold) + Signal ≈ 0 + Flat Histogram = SKIP
combined with Choppiness > 61.8 → Absolute SKIP, no trades
```

11.3 MACD Sideways vs MACD Consolidation Before Breakout

A special situation: flat MACD + compressed histogram can precede a major breakout.

```
Normal MACD Sideways (skip): MACD oscillates repeatedly ± zero, without direction
MACD Consolidation pre-breakout: MACD compressed near zero BUT unidirectional
  → Histogram with increasingly smaller bars but in the same direction (positive or negative)
  → EMA 200 on higher TF gives probable breakout direction
  → Wait for histogram expansion as confirmed breakout signal
```

---

12. PSEDYS — `macd_cross` as a Feature in the Scoring Model

12.1 Context of `macd_cross` in TI

From the `entry_features` field (JSONB) of the `live_positions` table in `trading_intelligence`, `macd_cross` is one of the features used by the scoring model to validate entry signals. It functions as a **binary or categorical feature** in other context indicators.

Typical values:

```
-- Query entry_features on open positions:
SELECT symbol, direction,
       entry_features->>'macd_cross' AS macd_cross,
       entry_features->>'ema_stack'  AS ema_stack,
       entry_features->>'adx'        AS adx
FROM live_positions
WHERE lower(state) != 'closed';
```

Interpretation of `macd_cross` as a feature:
- `"bullish"` or `1` → Confirmed bullish Signal Cross at entry time
- `"bearish"` or `-1` → Bearish Signal Cross
- `"none"` or `0` → No active cross at entry time

12.2 MACD in the PSEDYS Signal System

MACD is not the only filter — it is **one of** several composite indicators:

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```
Valid signal = ema_stack (bullish)
             + macd_cross (bullish)
             + adx (> 18)
             + choppiness (< 61.8)
             + vol_spike (volume confirmation)
             + regime_strategy_compat (macro OK)
```

Each feature adds a vote to the position's confidence score. A bullish `macd_cross` contributes positively to the score, an absent or bearish `macd_cross` decreases the score or blocks the entry depending on the strategy_profile logic.

12.3 MACD Parameters in strategy_config

```
-- Check MACD parameters in TI:
SELECT strategy_name, param_name, param_value
FROM strategy_config
WHERE param_name LIKE '%macd%'
ORDER BY strategy_name, param_name;
```

---

13. Bot vs TradingView Validation

13.1 Sources of MACD Divergence vs TradingView

MACD has **multiple possible divergence points** compared to TradingView more than simple EMA or SMA:

Source of Divergence	Probability	Impact
Incorrect K_fast or K_slow	Medium	Significant
Incorrect K_signal	Medium	Significant
Seed EMA compound (cold start)	High	Moderate → Significant
Price source (close vs HLC3)	Low	Minor
Signal Line EMA vs SMA	Low	Moderate
Off-by-one in indexing	High	Significant

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13.2 MACD Validation Checklist

```
STEP 1 — Check parameters:
□ Fast = 12, K = 2/13 = 0.153846
□ Slow = 26, K = 2/27 = 0.074074
□ Signal = 9, K = 2/10 = 0.200000
□ All with formula K = 2/(N+1), NOT Wilder (K=1/N)

STEP 2 — Check seeds:
□ EMA 12 seed = SMA(close[:12])
□ EMA 26 seed = SMA(close[:26])
□ Signal seed = SMA(macd_line[25:34])  [first 9 MACD values]

STEP 3 — Check price source:
□ EMA 12 and EMA 26 calculated on close (not HLC3)
□ TradingView MACD default = close → consistent

STEP 4 — Comparative numeric test:
□ Take the last 5 MACD Line values from TradingView
□ Calculate with bot formula
□ Tolerance: < 0.05% difference
□ If > 0.05% → check K-values and seeds

STEP 5 — Check Signal:
□ Take the last 5 Signal Line values from TradingView
□ Calculate with bot formula
□ Tolerance: < 0.05% difference
□ Signal more deviated than MACD Line → error propagated from EMA seeds

STEP 6 — Check Histogram:
□ Histogram = MACD − Signal (simple)
□ If MACD and Signal are correct, Histogram is automatically correct
```

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13.3 Quick Validation Script (Python)

```
def ema(prices: list, period: int) -> list:
    K = 2 / (period + 1)
    result = [None] * (period - 1)
    seed = sum(prices[:period]) / period
    result.append(seed)
    for p in prices[period:]:
        result.append(result[-1] + K * (p - result[-1]))
    return result

def macd(prices: list, fast: int = 12, slow: int = 26, signal: int = 9):
    ema_fast = ema(prices, fast)
    ema_slow = ema(prices, slow)

    # MACD Line (first value at `slow` bar)
    macd_line = [
        None if (ema_fast[i] is None or ema_slow[i] is None)
        else ema_fast[i] - ema_slow[i]
        for i in range(len(prices))
    ]

    # Signal Line = EMA(signal) applied on macd_line
    # Seed = SMA of the first `signal` valid MACD Line values
    valid = [(i, v) for i, v in enumerate(macd_line) if v is not None]
    signal_line = [None] * len(prices)
    if len(valid) >= signal:
        seed_pos = valid[signal - 1][0]
        seed_val = sum(v for _, v in valid[:signal]) / signal
        K_sig = 2 / (signal + 1)
        signal_line[seed_pos] = seed_val
        for i in range(seed_pos + 1, len(prices)):
            signal_line[i] = signal_line[i-1] + K_sig * (macd_line[i] - signal_line[i-1])

    histogram = [
        None if (macd_line[i] is None or signal_line[i] is None)
        else macd_line[i] - signal_line[i]
        for i in range(len(prices))
    ]
    return macd_line, signal_line, histogram

# Validation:
# macd_line[-1], signal_line[-1], histogram[-1]
# Compare with TradingView → difference < 0.05% = OK
```

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13.4 Common MACD Differences Between Platforms

Platform	Default Parameters	Signal Line	Price Source
TradingView	12/26/9	EMA	Close
MetaTrader	12/26/9	EMA	Close
Binance	12/26/9	EMA	Close
ThinkOrSwim	12/26/9	EMA	Close
pandas TA library	12/26/9	EMA	Close

All major providers use the same parameters and EMA for Signal → differences are almost exclusively from seed/cold-start.

Indicator manual: MACD — Technical Reference Manual v1.0 Part 6 of 6.

14. Practical Exercises with Complete Answers

Exercise 1: MACD bullish below Zero Line — go Long?

Situation: On 5M, MACD Line has crossed above the Signal Line (Bullish Signal Cross). Both values are negative: MACD = −0.35, Signal = −0.42. Histogram = +0.07 (recently positive). On 4H, MACD = −1.20, below Zero Line. ADX 5M = 22, Choppiness = 38.

Question: The MACD setup is bullish. Do you go Long?

Answer:

NO — Bullish Signal Cross below Zero Line with 4H MACD < 0 = weak signal in a macro bearish context.

- **Diagnosis:** Both MACD (5M and 4H) are below Zero Line → EMA12 < EMA26 on both TFs → structural bearish trend. Bullish Signal Cross below zero = bearish momentum is easing, NOT trend reversal.
- **What happens in practice:** Price makes a bounce (which generated the Signal Cross), then either continues down (persistent bearish trend) or makes a broader correction towards the MACD zero line. Entering Long on this signal = trading against the macro trend.
- **Correct action:**
- Wait for MACD 4H to cross Zero Line (EMA12 4H > EMA26 4H) → confirmation of bullish trend on macro
- Or wait for MACD 5M to cross Zero Line + Signal Cross **above** zero → higher quality signal
- If convinced of the bounce and entering, strictly size 25% of normal + SL immediately below the last low

---

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Exercise 2: Bearish MACD Divergence + bullish EMA setup

Situation: On 1H: price makes a clear Higher High compared to the previous peak (12 hours ago). EMA 20 > EMA 50, positive slope, price above EMA 20 (bullish EMA stack). But MACD Line on 1H makes a Lower High compared to the previous peak (bearish divergence). On 4H: MACD > 0 (bullish).

Question: EMAs are bullish on 1H. Do you go Long on the 5M signal?

Answer:

Conflict situation — approach with increased caution.

- **Diagnosis:** EMA and MACD give contradictory signals on 1H. EMA confirms directional trend (price remains above averages). MACD diverges → decreasing momentum even if price rises. On 4H MACD > 0 provides positive macro context.
- **What divergence signals:** The last rally had less momentum than the previous one — potential exhaustion of the uptrend on 1H, even if the EMA structure is still bullish.
- **Correct action:**
- **Do not ignore divergence** — reduce sizing for any Long on 5M to 50% of normal
- TP1 mandatory at 50% before TP2 — partially secure
- SL stricter than standard
- Do not enter if divergence is confirmed with a bearish Signal Cross on 1H
- If price makes a new High with MACD that **returns** to Higher High → divergence is canceled → normal setup

---

Exercise 3: Histogram Reversal as early entry

Situation: On 15M, MACD histogram reached a trough (negative minimum) of −0.85 at the bar 2 bars ago. Previous bar: −0.72. Current bar (closed): −0.61. MACD = −0.42, Signal = +0.19. 4H MACD > 0. ADX 15M = 19. Choppiness 15M = 44.

Question: Is this a valid entry signal? How do you interpret histogram reversal?

Answer:

Possible early signal — NOT a complete entry immediately.

- **Diagnosis:** Histogram makes a trough at bar −2 (−0.85) and rises (−0.72, −0.61) → bearish momentum is easing. MACD still negative and below Signal → no bullish Signal Cross yet.
- **Probable sequence:**
- Histogram continues towards zero → imminent bullish Signal Cross (2–5 bars)
- MACD follows to move towards zero and possibly zero line
- **4H MACD > 0 is positive context** → the pullback on 15M is in a bullish macro context → high probability bounce

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- **Correct action:**
  1. Note histogram reversal as an alert signal
  2. DO NOT enter on histogram reversal alone — too early, high risk of false signal
  3. Wait for confirmed bullish Signal Cross on 15M with closed candle
  4. At Signal Cross + 4H MACD > 0 + ADX 19 > 18 + Choppiness 44 < 61.8 → entry with standard sizing
  5. Prior entry (pre-cross) = sizing 30–40% of normal with SL strictly below the price trough

---

Exercise 4: Complete MTF MACD + EMA alignment

Situation: 4H MACD = +0.82, > Zero Line. 1H MACD > Signal, positive growing histogram. 15M recent bullish Signal Cross, histogram +0.18 and growing. 5M confirmed bullish Signal Cross on closed candle, histogram +0.07. Bullish EMA stack on 5M and 15M. ADX 5M = 26. Choppiness 5M = 39. Price at +0.7% above EMA 20 on 5M.

Question: Valid setup? What else do you check?

Answer:

YES — complete bullish MACD + EMA configuration on all TFs, score 4/4.

- **MTF MACD:** 4H > Zero + 1H bullish + 15M Signal Cross + 5M Signal Cross = 4/4 MACD
- **MTF EMA:** bullish stack on 5M and 15M = directional confirmation
- **ADX 26 > 18, Choppiness 39 < 61.8** → active trend, not sideways
- **Distance +0.7% < 1.5%** → not overextended from EMA 20

Mandatory checks:
- Is the 5M histogram growing or has it stopped? — if already contracting → reduced sizing
- MACD divergence on 5M or 15M compared to recent prices? — if present → additional risk
- Funding Rate < +0.1% → Level 0 PSEDYS filter
- BTC filter: BTC no move > 2.5% in the last 1H

If all OK → **High probability Long entry, complete sizing.**

Exercise 5: MACD in sideways market — false signal

Situation: On 5M, in the last 2 hours (24 bars) MACD has generated 5 alternating Signal Crosses (3 bullish, 2 bearish). Histogram oscillates between +0.08 and −0.12. MACD Line oscillates between −0.05 and +0.09. Choppiness 5M = 68. ADX 5M = 14.

Question: How do you interpret? Do you act on the last bullish Signal Cross?

Answer:

COMPLETE SKIP — confirmed sideways on all filters.

- **Diagnosis:** 5 crossovers in 24 bars = continuous whipsaws. MACD oscillates in a tiny range (±0.12) → no trend. Choppiness 68 > 61.8 confirmed sideways. ADX 14 < 18 → weak trend.

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- **What happens in practice:** Each Signal Cross is followed by an opposite cross in 2–5 bars. Any Long or Short entry in this condition = guaranteed loss over a long series.
- **Correct action:**
- Total skip, no trades on 5M until: MACD exits the ±0.15 range with clear direction + ADX exceeds 18 + Choppiness drops below 55
- Check if there is a direction on 15M or 4H that will determine the breakout direction from consolidation
- Wait for histogram expansion as the first signal of exiting sideways

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15. Cheat Sheet — Quick Summary

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Concept	Value / Rule
MACD Line Formula	EMA(Close, 12) − EMA(Close, 26)
Signal Line Formula	EMA(MACD_Line, 9)
Histogram Formula	MACD_Line − Signal_Line
K_fast (EMA 12)	2/13 = 0.153846 (15.38%)
K_slow (EMA 26)	2/27 = 0.074074 (7.41%)
K_signal (EMA 9)	2/10 = 0.200000 (20.00%)
MACD Line Lag	~12.5 bars (dominated by EMA 26)
Signal Line Lag	~16.5 bars (MACD lag + EMA9 lag)
Minimum Warm-up	35 bars (first Signal value)
Recommended Warm-up	61 bars (2×26+9)
Production Warm-up	100 bars
MACD > 0	EMA12 > EMA26 → LONG bias
MACD < 0	EMA12 < EMA26 → SHORT bias
Zero Line Cross	Trend change — major signal
Signal Cross above Zero	Strong bullish momentum — high-quality signal
Signal Cross below Zero	Bounce in bearish trend — low-quality signal
Histogram > 0 and rising	Bullish momentum accelerating
Histogram > 0 and falling	Bullish momentum decelerating (tighten SL)
Histogram Peak	Momentum at maximum — early WARNING
Histogram Cross Zero	= Signal Crossover (visual equivalent)
Classic bearish divergence	Price Higher High + MACD Lower High → bullish exhaustion
Classic bullish divergence	Price Lower Low + MACD Higher Low → bearish exhaustion
Hidden bullish	Price Higher Low + MACD Lower Low → UP trend continuation
Hidden bearish	Price Lower High + MACD Higher High → DOWN trend continuation
False Signal Cross filter	Closed candle + spread > 0.01% + ADX > 18 + Choppiness < 61.8
MACD Spike impact	(K_fast − K_slow) × spike = 7.97% of spike amplitude

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Concept	Value / Rule
Spike filter	Skip 3 bars after spike (high−low > 3×ATR14)
Sideways MACD	> 3 crossovers in 20 bars → SKIP + Choppiness > 61.8
macd_cross feature TI	Binary/categorical feature in entry_features JSONB on live_positions
Bot validation vs TradingView	< 0.05% difference MACD Line and Signal Line
TradingView default parameters	12/26/9, EMA signal, close
Cold start risk	Compound seed EMA12+EMA26+Signal → 1–3 bar lag vs TV
MACD 4H > 0 + Signal Cross 5M	Complete MTF alignment → high probability entry
MACD 4H < 0 + Signal Cross 5M bullish	Bounce in bearish trend → SKIP or sizing 25% max
MTF Score 4/4	Complete entry sizing
MTF Score 3/4	Entry sizing 50–75%
TF3 (15M) bearish conflict	DO NOT enter Long

PSEDYS MACD Technical Manual v1.0 — May 2026 Covers: complete 3-component formula, parameter derivation 12/26/9, verified numeric example (35+ bars), warm-up and compound cold start, MACD variants, lag quantified per component, differential spike impact EMA12 vs EMA26, zero line filters, signal cross context (above vs below zero), early histogram reversal entry, classic + hidden divergence with validation, robust MACD slope, complete MTF with partial scenarios, macd_cross feature TI, bot validation vs TradingView, 5 practical exercises.

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