PSEDYS | TECHNICAL REFERENCE MANUAL V3.0

SMA — Technical Reference Manual v1.0

PSEDYS | Complete Edition
Formula · Rolling Window · Ghost Effect · Lag · Bollinger Bands · Mean Reversion · Ribbon · Divergence · MTF · Bot vs TradingView

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1. What is SMA? Definition, Concept, SMA vs EMA

The Simple Moving Average (SMA) is the oldest and most used trend-following indicator, calculating the **exact arithmetic mean** of the closing prices from the last N candles. Each

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candle in the interval contributes with **identical weight** (1/N) — there is no prioritization of recent data.

On the chart, it appears as a smooth line, smoother than the EMA of the same period, highlighting the trend direction with less noise but also with less response to rapid price changes.

Note: SMA confirms an existing trend, it does not predict it. Unlike EMA, SMA is the preferred tool of institutions (funds, banks) for macro levels — the daily SMA 200 is the MOST WATCHED technical level in the world.

SMA vs EMA — Complete Technical Comparison

Feature	SMA	EMA
Recent data weight	Uniform — 1/N for each bar	Exponentially higher for recent data
Current price weight (N=20)	5.00% (1/20)	9.52% (K=2/21)
Memory	Exact — only the last N bars	Infinite — all bars, decreasing exponentially
Reaction to current price	Slow and uniform	Aggressive towards the most recent bars
Sensitivity to spikes	Low — spike diluted with 1/N	High — spike amplified with K
Ghost Effect on spike exit	YES — SMA jumps when the spike exits the window	NO — spike fades gradually
Lag (center of mass)	(N−1)/2 bars (exact)	(N−1)/2 bars (identical to SMA!)
Half-life weights	N/2 bars (memory completely forgotten at N)	ln(0.5)/ln(1−K) bars (smaller, infinite memory)
Whipsaws in sideways	Fewer	More
Ideal for	Macro levels, Bollinger Bands, mean reversion, slow filters	Entry timing, momentum, fast signals
Institutional use	Dominant — standard daily SMA 50/200	Less common at macro level

> **Key Conclusion:** SMA and EMA of the same period have **identical lag** (center of mass of weights = (N-1)/2 for both). The real difference: SMA treats all bars in the window uniformly → more stable, less reactive; EMA emphasizes recent bars → more reactive, more susceptible to noise and spikes.

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2. Complete Calculation Formula

2.1 Base Formula

$$SMA_N = (P_1 + P_2 + P_3 + ... + P_n) / N$$

Where:
- P_1 = oldest closing price in the window
- P_n = most recent closing price (closed candle[-1])
- N = number of candles in the window

Each candle has an identical weight of $1/N$:

SMA	Weight per bar	Equivalent K Formula
SMA 9	1/9 = 0.111111 (11.11%)	uniform
SMA 20	1/20 = 0.050000 (5.00%)	uniform
SMA 50	1/50 = 0.020000 (2.00%)	uniform
SMA 100	1/100 = 0.010000 (1.00%)	uniform
SMA 200	1/200 = 0.005000 (0.50%)	uniform

Direct comparison with EMA (N=20):

```
SMA 20: each of the 20 bars = 5.00% weight (all equal)
EMA 20: current bar = 9.52%, bar -1 = 8.62%, bar -2 = 7.80%, ... decreasing exponentially
```

2.2 Incremental Calculation (Rolling Window)

With each new bar, SMA does not recalculate the entire sum — it uses the incremental formula O(1):

$$SMA_new = SMA_old + (New_Price - Exiting_Price) / N$$

Where:
- `New_Price` = closing price of the new candle (enters the window)
- `Exiting_Price` = closing price of the candle exiting the window (the oldest)
- N = period

Step-by-step example (SMA 9):

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```
Old_SMA = 104.000 (bar 9)
New bar: price = 110.00 (enters), exiting price = 100.00 (was at bar 1)
New_SMA = 104.000 + (110 − 100) / 9 = 104.000 + 1.111 = 105.111
```

This is the formula used in efficient bot implementations — maintaining the rolling sum, not recalculating from scratch.

2.3 Complete Numerical Example — SMA 9 (15 candles)

Input prices: 100, 102, 101, 103, 105, 104, 106, 108, 107, 110, 108, 112, 115, 113, 116

Candle #	Close Price	Window bars	Sum	SMA 9
1	100	—	—	N/A
2	102	—	—	N/A
3	101	—	—	N/A
4	103	—	—	N/A
5	105	—	—	N/A
6	104	—	—	N/A
7	106	—	—	N/A
8	108	—	—	N/A
9	107	bars 1–9	936	**104.000**
10	110	bars 2–10	946	**105.111**
11	108	bars 3–11	952	**105.778**
12	112	bars 4–12	963	**107.000**
13	115	bars 5–13	975	**108.333**
14	113	bars 6–14	983	**109.222**
15	116	bars 7–15	995	**110.556**

Verification of sums (all mathematically correct):

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```
Bar  9: 100+102+101+103+105+104+106+108+107 = 936 / 9 = 104.000 ✓
Bar 10: (936 − 100 + 110) = 946 / 9 = 105.111 ✓
Bar 11: (946 − 102 + 108) = 952 / 9 = 105.778 ✓
Bar 12: (952 − 101 + 112) = 963 / 9 = 107.000 ✓
Bar 13: (963 − 103 + 115) = 975 / 9 = 108.333 ✓
Bar 14: (975 − 105 + 113) = 983 / 9 = 109.222 ✓
Bar 15: (983 − 104 + 116) = 995 / 9 = 110.556 ✓
```

SMA 9 vs EMA 9 on the same prices:

Bar	Price	SMA 9	EMA 9	Difference
9	107	104.000	104.000	0.000
10	110	105.111	105.200	−0.089
11	108	105.778	105.760	+0.018
12	112	107.000	107.008	−0.008

On the first bar, both are identical (seed = initial SMA = EMA). They later diverge marginally depending on price distribution. EMA reacts slightly more aggressively to recent high prices.

2.4 Ghost Effect — Behavior When Data Exits the Window

Ghost Effect is a unique characteristic of SMA, nonexistent in EMA: when a bar with an abnormal price (extreme spike, outlier) **exits** the calculation window, SMA makes a **sudden jump** in the opposite direction of the spike, even if recent prices are perfectly normal.

Concrete example — 100-point spike at bar 5:

```
Prices: 100, 100, 100, 100, [200-spike], 100, 100, 100, 100, 100, 100, 100, 100

SMA 9 with spike in window (bars 5–13):
→ SMA remains at 111.11 throughout the interval while the spike is in the window
→ Each normal bar: SMA = (8×100 + 200)/9 = 111.11

At bar 14 — spike exits the window:
→ SMA jumps abruptly from 111.11 to 100.00 (a drop of −11.11 points)
→ Prices are perfectly normal (100), but SMA generates a FALSE BEARISH signal
```

Impact in trading:

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```
- SMA slope suddenly turns negative at bar 14 → false bearish signal
- If the bot uses SMA slope as a filter, it may generate a false SHORT on normal price
- EMA does not have this issue — the spike gradually fades into the EMA value

Duration of ghost effect = exactly N bars from the spike moment
→ SMA 9: ghost at bar 9+5 = 14
→ SMA 20: ghost at bar 20+spike = bar 25 from spike
→ SMA 50: ghost at bar 50+spike = bar 55 from spike
```

Ghost effect detection in bot:

```
# Detect if an extreme bar exits the window
atr = compute_atr(14)
oldest_bar_range = high[-period] - low[-period]
ghost_risk = oldest_bar_range > 3 * atr  # exiting bar is an extreme spike

if ghost_risk:
    invalidate_slope_signal = True  # ignore SMA slope on this bar
```

2.5 Warm-up and Limitations

SMA requires exactly **N bars** for the first valid value. Bar N = first calculable SMA. There is no incremental warm-up mechanism (unlike EMA which produces an approximate first value immediately after seed).

Practical implications:
- Bars 1 → N−1 produce no SMA value → bot must have N+buffer bars available at start
- No "increasing precision" — the first SMA is as valid as the 1000th (unlike EMA where the seed distorts the first ~N bars)
- If the data feed starts from 0, the first valid bar is strictly bar N

Recommended warm-up per period:

SMA	Minimum bars required	Rationale
SMA 9	9 bars	First valid bar = bar 9; no seed distortion
SMA 20	20 bars	—
SMA 50	50 bars	—
SMA 200	200 bars	—

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> SMA does not have the cold-start problem of EMA (no SMA seed → distortion). However, a **2×N bars** buffer is recommended to avoid edge cases at initialization and for cross-validation.

2.6 SMA on Different Price Sources

Identical to EMA, SMA can be calculated on different sources:

Source	Formula	Main Use
Close	`C`	Standard — most used
HL2 (median)	`(H + L) / 2`	Bollinger Bands some implementations
HLC3 (typical price)	`(H + L + C) / 3`	Bollinger Bands standard (TradingView default)
OHLC4	`(O + H + L + C) / 4`	Rare, smoother

Bollinger Bands important: TradingView calculates Bollinger Bands on **HLC3** by default (typical price), not on close. If the bot uses close for SMA 20 + BB, BB values will be slightly different from TradingView. Always check the price source at initialization.

PSEDYS Rule: SMA on price = **close**. Bollinger Bands = **HLC3** if alignment with TradingView is necessary, **close** if calculated internally consistently.

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3. SMA Lag — Quantified and Compared to EMA

3.1 Lag as Center of Mass

SMA(N) assigns equal weight (1/N) to each bar in the window. The center of mass of this uniform distribution is exactly **the middle of the window**:

```
Lag SMA(N) = (N − 1) / 2 bars
```

This is the exact value, not an approximation.

SMA	Lag (bars)
SMA 9	(9−1)/2 = 4.0 bars
SMA 20	(20−1)/2 = 9.5 bars
SMA 50	(50−1)/2 = 24.5 bars
SMA 100	(100−1)/2 = 49.5 bars
SMA 200	(200−1)/2 = 99.5 bars

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Comparison with EMA of the same period:

Indicator	N	Lag center of mass	Memory of old data
SMA 9	9	4.0 bars	Zero after bar 9 (exact memory)
EMA 9	9	4.0 bars	Infinite (exponentially decreasing)
SMA 20	20	9.5 bars	Zero after bar 20
EMA 20	20	9.5 bars	Infinite
SMA 50	50	24.5 bars	Zero after bar 50
EMA 50	50	24.5 bars	Infinite

> **Conclusion:** Lag is identical. Structural difference: SMA **completely forgets** data older than N bars, EMA **attenuates exponentially** without ever completely forgetting.

3.2 Memory Behavior — SMA vs EMA

```
SMA 9: bar from 8 periods ago contributes 11.11%, bar from 9+ periods ago contributes 0%
       → abrupt transition (step function) at window limit

EMA 9: bar from 8 periods ago contributes ~17%, bar from 20 periods ago contributes ~2%
       → gradual transition, no abrupt limit
```

This explains why **SMA sometimes generates jumps** when extreme bars enter or exit the window (Ghost Effect — section 2.4), while EMA behaves more fluidly.

---

4. Sensitivity to Spikes — The Advantage of SMA over EMA

4.1 Immediate Impact of the Spike

When an extreme spike occurs on a single bar:

```
SMA 9 (N=9): impact = spike_amplitude / 9 = 11.11% of amplitude
EMA 9 (K=0.20): impact = 20% of amplitude

Example: spike of +1000 points on a single bar, SMA/EMA at 50,000
SMA 9: jumps by 1000/9 = +111 points (+0.22%)
EMA 9: jumps by 1000 × 0.20 = +200 points (+0.40%)
→ EMA reacts almost 2× more violently to the spike compared to SMA
```

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4.2 Recovery after Spike

MA Type	Recovery after Spike	Mechanism
SMA 9	Exact after 9 bars — spike completely exits the window	Rolling window
EMA 9	~80% recovery after ~7 bars, but never complete theoretically	Exponential decay
SMA 20	Exact after 20 bars	Rolling window
EMA 20	~80% after ~11 bars, never complete	Exponential decay

4.3 Implications for Choosing SMA vs EMA in Strategy

When SMA is preferable over EMA:
- Markets with frequent spikes on small TFs (crypto with cascading liquidations)
- Calculation of stable macro levels (SMA 200 daily as bull/bear separator)
- Basis for Bollinger Bands and Z-score (uniform distribution = clear statistical properties)
- Slow trend filters where stability is more important than reactivity

When EMA is preferable over SMA:
- Entry timing on small TFs (5M, 15M)
- Rapid momentum signals
- Dynamic trailing SL in active trend
- Situations where response to recent price is critical

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5. Standard SMA Values and Their Role on the Chart

5.1 Complete Table — SMA 9 / 20 / 50 / 100 / 200

SMA	Speed	Main Role	Who Follows It	Ideal Timeframe
SMA 9	Fast	Momentum on small TFs, entry scalp	Scalpers, HFT bots	1M, 3M, 5M
SMA 20	Medium-fast	Short-term trend, Bollinger Bands base	Intraday traders, BB algorithms	5M, 15M, 1H
SMA 50	Medium	Swing trend, institutional support/resistance	Swing traders, small funds	1H, 4H, 1D
SMA 100	Slow	Medium-term trend, reference level	Positional traders	4H, 1D
SMA 200	Ultra-slow	**Universal bull/bear separator** — most followed level globally	Institutions, funds, central banks, macro algorithms	1D, 1W

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5.2 SMA 200 Daily — The Most Important Technical Level

SMA 200 on the daily timeframe is singular in its institutional importance:

- Bloomberg and Reuters terminals display it by default on any stock, forex, crypto chart
- Investment funds have explicit mandates to buy at SMA 200 daily or reduce exposure below it
- Institutional macro algorithms have orders programmed at ±0.5% relative to SMA 200 daily
- Financial mass media cites it as a reference level for bull/bear market

Practical consequence for crypto:

```
BTC Price > SMA 200 daily → LONG bias, market in global bullish regime
BTC Price < SMA 200 daily → SHORT bias, market in global bearish regime

SMA 200 daily test = major event:
→ First touch after a long period = high volume + probable sharp movement
→ Confirmed breach of SMA 200 daily = macro regime change
```

5.3 PSEDYS Adapted SMA Values on Timeframes

TF	SMAs Used	ROLE IN PSEDYS	Condition
5M	SMA 9, SMA 20, SMA 50	ENTRY SIGNAL scalp_sma	price > SMA20 > SMA50, positive slope
15M	SMA 20, SMA 50	TREND FILTER	price > SMA20 > SMA50 → LONG bias
1H	SMA 20, SMA 50, SMA 200	Swing / macro context	price > SMA200 → macro bullish
4H	SMA 50, SMA 200	MACRO DIRECTION	price > SMA200 → LONG only
1D	SMA 50, SMA 100, SMA 200	Global macro context	SMA 200 Daily = absolute bull/bear line

6. SMA in Bollinger Bands and Mean Reversion

This is the most important special use of SMA over EMA — Bollinger Bands are constructed **exclusively** on the basis of SMA, never on EMA, for solid mathematical reasons.

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6.1 Bollinger Bands Formula

```
BB_Middle  = SMA(N)                          ← average over N bars
BB_Upper = SMA(N) + multiplier × σ(N)  ← upper band
BB_Lower = SMA(N) − multiplier × σ(N)  ← lower band

Where:
σ(N) = standard deviation of prices over the last N bars
standard multiplier = 2 (covers ~95.4% of distribution)
```

Standard deviation formula:

$$\sigma(N) = \sqrt{\left[\Sigma(P_i - SMA_N)^2 / N \right]} \quad \text{for } i = 1..N$$

PSEDYS standard values for BB:
- Period: N = 20 (SMA 20)
- Multiplier: 2.0 (standard) or 2.5 (for crypto, more volatile)

Verified numeric example (N=20, prices 100–120):

```
SMA 20 = 110.000
σ = 6.293
BB Upper (2σ) = 110.000 + 2 × 6.293 = 122.586
BB Lower (2σ) = 110.000 − 2 × 6.293 = 97.414
BB Width = (122.586 − 97.414) / 110.000 × 100 = 22.88%
```

Why SMA and not EMA for BB:
Bollinger Bands are a statistical tool. The standard deviation calculated against an **arithmetic** mean (SMA) has well-defined statistical properties (symmetric normal distribution). Calculation against EMA distorts the statistical properties of the bands, as EMA is not the geometric center of the price distribution in the window.

6.2 Mean Reversion with SMA — Z-Score

Z-score measures the distance of the price from SMA in units of standard deviation:

```
Z = (Current_Price − SMA_N) / σ(N)
```

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Z-score	Interpretation	Action in mean reversion
> +2.0	Price extremely high relative to mean (>2σ)	High probability of reversion to mean
+1.0 – +2.0	Price high, but in normal zones	Monitoring
−1.0 – +1.0	Price near mean	Neutral zone
−1.0 – −2.0	Price low, but in normal zones	Monitoring
< −2.0	Price extremely low relative to mean (<−2σ)	High probability of reversion to mean

Applied Z-score example:

```
SMA 20 = 110.000, σ = 6.293, Current Price = 117
Z = (117 − 110.000) / 6.293 = +1.11 → price in upper zone, but below +2σ → not overbought
```

PSEDYS rule for BB Width as volatility filter:

```
bb_width = (bb_upper - bb_lower) / sma20 * 100

# Interpretation:
# bb_width < 3%   → extreme compression → imminent breakout (squeeze)
# 3% – 10%        → normal volatility → good trading conditions
# > 15%           → extreme expansion → risk of exhaustion, avoid entry at extreme
```

6.3 Bollinger Bands — Trading Signals

Squeeze → Breakout:
When the bands compress (BB Width falls below 3%), the market is preparing for a breakout. The direction of the breakout cannot be predicted from BB alone — it requires confirmation with the major trend direction (SMA 200 4H) and volume.

Bounce off the lower band (in bullish trend):

```
Conditions: price > SMA 200 4H (macro bullish) + price touches BB Lower + SMA 20 with positive sl
→ Long Entry at the lower band touch
→ TP at SMA 20 (middle of BB) or at the upper band
```

Rejection from the upper band (in bearish trend):

```
Conditions: price < SMA 200 4H (macro bearish) + price touches BB Upper + SMA 20 with negative sl
→ Short Entry at the upper band touch
→ TP at SMA 20 (middle of BB) or at the lower band
```

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IMPORTANT — Riding the Band:
When the price moves along the outer band (3+ consecutive bars closed above BB Upper or below BB Lower) → NOT a reversal signal. It is a strong trend signal. BB riding = confirmed active trend.

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7. Trading Signals — Bullish, Bearish, Neutral

BULLISH Signals — Long

- Price breaks above the SMA from below (breakout) on increased volume and candle closed above
- Smaller SMA crosses above larger SMA → Golden Cross
- Price pulls back to the SMA and bounces → SMA acts as dynamic support
- SMAs aligned: SMA_fast > SMA_mid > SMA_slow → confirmed bullish stack
- SMA sloping upward and price consistently above → active trend
- On 15M: price > SMA20 > SMA50, both sloping upward → confirmed Long trend

BEARISH Signals — Short

- Price falls below the SMA from above (breakdown) confirmed on closed candle
- Smaller SMA crosses below larger SMA → Death Cross
- Price retests the SMA from below and rejects → SMA acts as dynamic resistance
- SMAs aligned inversely: SMA_fast < SMA_mid < SMA_slow → bearish stack
- SMA sloping downward with increasing distance from price
- On 15M: price < SMA20 < SMA50, both sloping downward → confirmed Short trend

NEUTRAL / To Avoid

- Flat SMAs repeatedly crossing → sideways/chop → DO NOT trade
- Choppiness Index > 61.8 combined with flat SMA → mandatory SKIP
- ADX < 18 on 5M or < 20 on 15M → weak trend, avoid entry
- Price oscillates chaotically above and below SMA without clear direction
- Ghost Effect active (extreme bar exits window) → false slope, skip signal

7.1 Golden Cross and Death Cross — Classic SMA Version

Important Context: In traditional finance and for institutions, Golden Cross and Death Cross refer to **SMA 50 × SMA 200**, not EMA. This is the original and most followed version in financial media.

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Signal	Definition	Timeframe	Significance
GOLDEN CROSS	SMA 50 crosses SMA 200 from BELOW to ABOVE	1D for major signal; 4H for crypto	Long-term BULLISH trend change — significant institutionally
DEATH CROSS	SMA 50 crosses SMA 200 from ABOVE to BELOW	1D for major signal; 4H for crypto	Long-term BEARISH trend change
MINI CROSS	SMA 9 crosses SMA 20	5M, 15M	Tactical intraday entry/exit signal

SMA vs EMA for Golden/Death Cross — practical differences:

```
SMA 50/200: less frequent, slower crossover, but more significant institutionally
            Used as a macro signal for large fund portfolio rotation
            Financial media reports Golden Cross BTC as a major event

EMA 50/200: more frequent crossover (EMA more reactive), earlier signal
            More suitable for bot signals on small TFs
```

Filters for False Crossover (identical to EMA):

```
1. CANDLE CLOSED CONFIRMATION:
   SMA_fast has crossed SMA_slow on a CLOSED candle.
   Intra-bar crossing → DOES NOT count.

2. MINIMUM SPREAD:
   At the time of crossover: |SMA_fast − SMA_slow| / SMA_slow × 100 > 0.05%
   Spread < 0.05% = compression → high probability of whipsaw.

3. ADX AT CROSSOVER:
   ADX > 18 on 5M / ADX > 20 on 15M.
   ADX < threshold → crossover in non-trending market → invalid signal.

4. GHOST EFFECT CHECK:
   (specific to SMA!) Check if one of the 2 SMAs is distorted by ghost effect
   at the time of crossover. If yes → invalidate the crossover.
   Condition: oldest_bar_range > 3 × ATR14 → active ghost risk.

5. CHOPPINESS INDEX:
   Choppiness < 61.8 at the time of crossover.
```

7.2 SMA as Dynamic Support and Resistance

Identical to EMA, but with some behavioral differences:

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In a bullish trend: SMA acts as dynamic SUPPORT. Difference from EMA: SMA bounces are **slower** and **smoother** — price may oscillate more around the SMA before confirming the bounce (because SMA does not track price as aggressively).

In a bearish trend: SMA acts as dynamic RESISTANCE.

Strength of SMA as S/R level:
- SMA 200 daily > SMA 50 daily > SMA 20 daily (in order of importance)
- SMA 200 daily is the only truly institutional MA level — both retail traders and institutional algorithms track it simultaneously
- At SMA 200 daily, volume at touch is typically 30–100% higher than average

Difference from EMA as S/R level:
SMA is a "cleaner" level for bounces in slow trends (1H, 4H, 1D) because it does not move as aggressively. On small TFs (5M), EMA is more useful as a dynamic level precisely because it tracks movement more closely.

7.3 SMA Ribbon — SMA Fan

Similar to EMA Ribbon, SMA Ribbon uses multiple SMAs simultaneously to assess trend strength and stage.

Main configurations:

```
BULLISH EXPANSION (active bullish trend):
SMA9 > SMA20 > SMA50 > SMA200 with INCREASING distances
→ Trend accelerates, momentum increasing
→ SMA Ribbon more stable than EMA Ribbon → more reliable continuation signal in slow trends

BULLISH COMPRESSION (retracement / consolidation):
SMA9 ≈ SMA20 ≈ SMA50, converging towards SMA200
→ Trend temporarily halts
→ Fewer whipsaws than EMA in this phase

BEARISH EXPANSION (active bearish trend):
SMA9 < SMA20 < SMA50 < SMA200 with INCREASING distances
→ Bearish trend accelerates

DIVERGENT FAN (transition / disorder):
SMAs crossed without clear order
→ Total SKIP — transition regime
```

Indicator spread ribbon (distance of SMA9 from SMA50):

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```
ribbon_spread = (sma9 - sma50) / sma50 * 100
# > +0.5%  → active bullish momentum
# 0 – 0.5% → weak momentum / consolidation
# < 0%     → bearish ribbon (reversal)
```

Note: SMA Ribbon changes more slowly than EMA Ribbon → fewer false signals in sideways but slower in confirming trend changes.

7.4 SMA Divergence from Price

Identical to EMA, but SMA divergence is more significant on large TFs (1H, 4H) precisely because SMA is smoother and its divergences are rarer and more reliable.

Bearish divergence (top signaled):

```
Price: Higher High
SMA:  Lower High
→ Bullish momentum is depleting – more reliable signal on SMA 20/50 on 1H+ compared to EMA
```

Bullish divergence (bottom signaled):

```
Price: Lower Low
SMA:  Higher Low
→ Bearish momentum weakening
```

Conditions for validating divergence on SMA:
1. SMA used: SMA 20 or SMA 50 (not SMA 9 — too noisy)
2. Minimum timeframe: 15M (on 5M → frequent false signals)
3. Confirmation with closed candle in the direction of reversal
4. Check absence of ghost effect at the time of divergence (an SMA is not distorted by a spike that exits)

---

8. SMA Slope — Formula, Context, Calibration

8.1 Slope Formulas

Standard formula (Rate of Change over 2 periods):

```
slope = (sma[-1] - sma[-3]) / sma[-3] * 100
# sma[-1] = current bar (last closed)
# sma[-3] = bar from 2 periods ago
# Measures percentage change over 2 bars
```

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Alternative formula — 1 period (more sensitive, noisier):

```
slope_1p = (sma[-1] - sma[-2]) / sma[-2] * 100
```

Robust formula — normalized on ATR (recommended for multi-asset):

```
slope_atr = (sma[-1] - sma[-2]) / atr14[-1] * 100
# Independent of the asset's absolute price
# Threshold: > +0.08 = valid bullish | < -0.08 = valid bearish
```

8.2 SMA Slope vs EMA Slope — threshold difference

SMA is smoother than EMA → per bar variations of SMA are **smaller** than those of EMA of the same period. Therefore, thresholds for SMA slope need to be lower:

Indicator	TF	Bullish Slope	Flat Slope (skip)	Bearish Slope
EMA 20	5M	> +0.05%	−0.05% → +0.05%	< −0.05%
SMA 20	**5M**	**> +0.03%**	**−0.03% → +0.03%**	**< −0.03%**
EMA 20	15M	> +0.03%	−0.03% → +0.03%	< −0.03%
SMA 20	**15M**	**> +0.02%**	**−0.02% → +0.02%**	**< −0.02%**
SMA 50	**1H**	**> +0.015%**	**−0.015% → +0.015%**	**< −0.015%**
SMA 200	**4H**	**> +0.008%**	**−0.008% → +0.008%**	**< −0.008%**

8.3 Ghost Effect and False Slope

Specific attention to SMA: Slope calculated on SMA can be completely false if Ghost Effect is active. Always check that the bar exiting the window is not an extreme outlier before validating a signal based on slope:

```
def is_ghost_risk(prices: list, period: int, atr: float) -> bool:
    oldest_price_in_window = prices[-period]
    oldest_range = high_prices[-period] - low_prices[-period]
    return oldest_range > 3 * atr

# If is_ghost_risk == True: ignore SMA slope on this bar
```

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

9.1 PSEDYS MTF Hierarchy (SMA)

Level	Timeframe	SMA Used	ROLE	Action
1 (Macro)	4H or 1D	SMA 200	Determines overall trend direction	price > SMA200 → global LONG bias
2 (Meso)	1H or 4H	SMA 50, SMA 200	Confirms medium-term trend	Alignment with level 1 mandatory
3 (Micro)	15M	SMA 20, SMA 50	PSEDYS filter: trend confirmation	price > SMA20 > SMA50 = confirmed bullish
4 (Entry)	5M	SMA 9, SMA 20, SMA 50	Execution timing	LONG entry only if 1+2+3 = bull

9.2 MTF Alignment Score

TF1 (4H)	TF2 (1H)	TF3 (15M)	TF4 (5M)	Score	Action
□ Bull	□ Bull	□ Bull	□ Bull	4/4	Entry with full sizing
□ Bull	□ Bull	□ Bull	⚠ Neutral	3/4	Entry with reduced sizing 50–75%
□ Bull	□ Bull	⚠ Neutral	□ Bull	3/4	Wait for 15M confirmation
□ Bull	□ Bull	□ Bear	□ Bull	conflict	DO NOT enter — 15M bearish = active withdrawal
□ Bull	□ Bear	any	any	2/4	DO NOT enter — macro conflict
□ Bear	any	any	□ Bull	macro conflict	DO NOT enter Long — 4H bearish dominates

9.3 MTF SMA vs EMA Difference in Practice

SMA responds more slowly to regime changes. Consequence in MTF:

```
BEARISH TREND CHANGE (example):
→ EMA 20 on 15M crosses below EMA 50 ~2-3 bars faster than equivalent SMA
→ SMA bot may remain "in bull" 2-3 bars longer after the start of the pullback

ADVANTAGE: Better filtering of fake reversals on small TFs (< 15M)
DISADVANTAGE: Slower reaction to real reversals
```

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Recommendation: On 4H and 1D TFs, SMA 200 is preferable as a macro filter over EMA 200 — the level is more stable and institutionally representative.

---

10. Flat SMA (Sideways Market)

Identical to EMA, SMA becomes useless in markets without clear direction.

10.1 Visual Identification

- Horizontal SMA line (slope ≈ 0)
- Price oscillates above and below it in both directions
- Repeated SMA 9/20 crossovers without directional impulse → whipsaws

10.2 Algorithmic Detection

```
slope = (sma20[-1] - sma20[-3]) / sma20[-3] * 100

# SMA 20 thresholds on 5M:
# slope > +0.03%  → BULLISH inclined SMA → LONG valid
# slope < -0.03%  → BEARISH inclined SMA → SHORT valid
# -0.03% ≤ slope ≤ +0.03% → FLAT SMA → MANDATORY SKIP

# Additional confirmation — SMA compression:
sma_compression = abs(sma20[-1] - sma50[-1]) / sma50[-1] * 100
# < 0.1% → Compressed SMAs → sideways confirmed → SKIP

# BB Confirmation:
bb_width = (bb_upper - bb_lower) / sma20 * 100
# < 3%  → BB compression = sideways → SKIP
```

10.3 Flat SMA vs Flat EMA — Key Difference

SMA becomes flat more slowly than EMA (it is naturally smoother). Therefore:

```
Simultaneous flat EMA + flat SMA → extremely confirmed sideways → skip with even greater convicti
Flat EMA but SMA still with slight positive slope → possible weak trendlet, not fully sideways
Flat SMA but EMA with slight slope → EMA noise, main trend is flat → skip
```

10.4 PSEDYS Rule

```
Flat SMA (slope ±0.03%) + Choppiness Index > 61.8 = TOTAL SKIP, no trades
```

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11. PSEDYS — Where SMA is Used (scalp_sma)

The `scalp_sma` strategy is one of the 3 active profiles in TI (trading_intelligence), alongside `scalp` and `avwap_scalp`.

11.1 Differences from the `scalp` Profile (which uses EMA)

Aspect	scalp (EMA)	scalp_sma (SMA)
MA type	EMA 9, 20, 50	SMA 9, 20, 50
Entry reactivity	High	Moderate
Whipsaws on 5M	More	Fewer
Lag to signal	(N-1)/2, but more aggressive in moves	Identical, but smoother
Ideal for	Volatile markets with clear trend	Markets with moderate oscillations
Ghost effect risk	Absent	Present — verification recommended

11.2 Usage Recommendation

`scalp_sma` is preferable over `scalp` (EMA) in:
- Periods with frequent spikes on exchange (liquidations, macro news)
- Coins with moderate volatility and steady trend
- Sessions with normal volume (not extreme news sessions)

`scalp` (EMA) is preferable over `scalp_sma` in:
- Breakouts with strong momentum
- Markets moving rapidly and consistently
- Situations where entry speed is critical

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12. Bot vs TradingView Validation

12.1 SMA Validation Checklist

```
STEP 1 — Verify price source:
□ SMA on price: close (PSEDYS standard)
□ Bollinger Bands: HLC3 (TradingView default) or close (internal)
□ If different → align or document explicitly

STEP 2 — Verify rolling window formula:
□ Bot maintains rolling sum (O(1)) or recalculates fully (O(N))?
□ Both are mathematically correct — check for off-by-one error
□ Tests: sma[-1] must = sum(close[-N:]) / N (tolerance: 0.001%)

STEP 3 — Verify Bollinger Bands:
□ σ calculated as population standard deviation (/ N) or sampled (/ (N-1))?
□ TradingView default: population (/ N)
□ If bot uses sampled → BBs will be slightly wider (√(N/(N-1)) factor)
□ For N=20: difference = √(20/19) ≈ 1.026 → ~2.6% wider in sampled variant

STEP 4 — Comparative numeric test:
□ Take the last 5 closed candles on chosen symbol/TF
□ Manually calculate SMA N: sum(close[-N:]) / N
□ Compare with TradingView value
□ Acceptable tolerance: < 0.01% difference (SMA is easier to verify than EMA)
□ If > 0.01% → check off-by-one (window [0:N] vs [1:N+1]) or price source

STEP 5 — Ghost Effect Check:
□ For each calculated bar, check the bar exiting the window
□ If range > 3×ATR14: flag ghost_risk → do not issue signal based on slope
```

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12.2 Quick Verification — Python Formula

```
def sma(prices: list, period: int) -> list:
    """
    prices: list of closes (chronological, oldest first)
    period: N
    Returns list of SMA (None for first N-1 bars)
    """
    result = [None] * (period - 1)
    # Rolling sum for O(1) efficiency after first value
    window_sum = sum(prices[:period])
    result.append(window_sum / period)
    for i in range(period, len(prices)):
        window_sum += prices[i] - prices[i - period]
        result.append(window_sum / period)
    return result

def bollinger_bands(prices: list, period: int = 20, mult: float = 2.0):
    """Bollinger Bands on close, population standard deviation (/ N)"""
    sma_vals = sma(prices, period)
    upper, lower = [], []
    for i in range(len(prices)):
        if sma_vals[i] is None:
            upper.append(None); lower.append(None)
            continue
        window = prices[i - period + 1 : i + 1]
        mean = sma_vals[i]
        variance = sum((p - mean) ** 2 for p in window) / period  # populational
        std = variance ** 0.5
        upper.append(mean + mult * std)
        lower.append(mean - mult * std)
    return sma_vals, upper, lower

# Validation: compare sma_vals[-1] with TradingView → difference < 0.01% = OK
```

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12.3 Common SMA Differences Between Platforms

Platform	Default SMA	Default BB source	σ formula
TradingView	close	HLC3	population (/ N)
MetaTrader	close	close	population (/ N)
Binance API	close	close	population (/ N)
Python pandas	close	close	sampled (/ N-1) default!
Python numpy	close	close	population (/ N) if `ddof=0`

Attention with pandas: `pd.Series.rolling(N).mean()` is correct for SMA. But `pd.Series.rolling(N).std()` uses `ddof=1` by default (sampled) → Bollinger Bands wider by ~2.6% compared to TradingView on N=20. Use `std(ddof=0)` for consistency.

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

13. Practical Exercises with Complete Answers

Exercise 1: SMA 200 Daily — bull or bear?

Situation: BTC is trading at 85,000 USD. SMA 200 daily = 88,500 USD. On the 4H chart, SMA 50 is at 86,000 USD and SMA 200 is at 87,000 USD. On 5M, a bullish engulfing appears with double the average volume.

Question: What is the macro bias? Do you go Long on the 5M signal?

Answer:

The macro bias is BEARISH. Price below SMA 200 daily = global bearish regime.

- **Detailed Analysis:**
- SMA 200 daily (88,500) > SMA 200 4H (87,000) > SMA 50 4H (86,000) > Price (85,000) → complete bearish order across all levels
- Bullish engulfing on 5M = counter-trend signal within a major bearish
- **Do NOT go Long.** The 5M signal is a temporary bounce or noise.
- **Correct Action:**
- Wait for a closed candle on 4H or 1D above SMA 200 4H (87,000) and subsequently SMA 200 daily (88,500) for bullish confirmation
- Or look for a SHORT setup on the retest of SMA 50 4H (86,000) or SMA 200 4H (87,000) as resistance

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Exercise 2: Ghost Effect on SMA 20 — false signal

Situation: Yesterday at 14:00, BTC had a flash crash of 3,000 USD in a single minute (extreme spike of ~2× normal ATR). Today, at 10:00, that 1M bar exits the SMA 20 window. SMA 20 on 1M shows a strong negative slope (−0.12%) without significant price movement.

Question: What is happening? Do you act on the bearish signal?

Answer:

Do NOT act — Ghost Effect is active.

- **Diagnosis:** SMA 20 shows a negative slope because the spike bar (price 3,000 USD below normal) **exits** the window. SMA drops sharply by approximately 3,000/20 = 150 points on a single bar, even though the current price is normal.
- **How to detect:** Range of yesterday's 14:00 bar >> 3× current ATR14 → ghost_risk = True.
- **Correct Action:** Invalidate the SMA 20 slope on this specific bar. Resume evaluation on the next bar when SMA recalibrates with normal data.
- **EMA would not have this problem** — yesterday's spike would have gradually faded into the EMA value, not caused a sudden jump on exit.

Exercise 3: Bollinger Bands Squeeze → Breakout

Situation: On the 1H chart, SMA 20 is perfectly flat for 8 hours (slope < 0.01%). BB Width = 1.8% (extremely compressed). SMA 50 and SMA 200 are above the price (macro bearish). On 4H: price below SMA 200. On 5M: price oscillates at the middle of BB on 1H.

Question: What is likely to follow? How do you position yourself?

Answer:

A breakout is imminent — but direction is uncertain from BB alone.

- **Diagnosis:** BB Width = 1.8% = extreme compression → squeeze → imminent breakout. Flat SMA 20 = market in waiting.
- **Macro context determines probable direction:**
- SMA 200 4H above price → bearish bias → downward breakout is more likely
- SMA 50 and SMA 200 above = multiple resistances
- **Do not enter in anticipation.** Squeeze does not tell you the direction with certainty.
- **Correct Action:**
- Set an alert at BB Lower (bearish breakout) and BB Upper (bullish breakout)
- On closed candle below BB Lower + increased volume + price below SMA 20 → Entry SHORT
- On closed candle above BB Upper + increased volume + SMA 20 slope turns positive → possible Long but against macro trend, reduced sizing

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Exercise 4: Complete SMA bullish alignment

Situation: 4H: price > SMA 200. 1H: SMA 20 > SMA 50, price above. 15M: price > SMA 20 > SMA 50, slope +0.04%. 5M: SMA 9 > SMA 20 > SMA 50, price 0.6% above SMA 20. ADX 5M = 24 and rising. Choppiness 5M = 42.

Question: Is the setup valid? What else do you check?

Answer:

YES — complete bullish SMA configuration, MTF score 4/4.

- Distance 0.6% = within optimal entry range (< 1.5%)
- ADX 24 > 18 and rising → active trend
- Choppiness 42 < 61.8 → not in sideways
- Slope 15M = +0.04% > SMA threshold (+0.02% on 15M) → trend confirmed

Mandatory checks before entry:
- Ghost effect check 5M: the bar exiting SMA 9/20/50 is not an outlier
- Funding Rate < +0.1% (Level 0 PSEDYS filter)
- BTC Filter: BTC has not moved > 2.5% on the last 1H bar
- BB Width on 5M: not in squeeze (> 3%) — if in squeeze, wait for direction confirmation

If all OK → Entry Long at market or pullback to SMA 20 on 5M.

Exercise 5: SMA vs EMA diverge on the same symbol

Situation: On 5M, EMA 20 shows a positive slope (+0.08%) → bullish signal. But SMA 20 shows an almost flat slope (+0.02%) → below the +0.03% threshold → skip according to SMA rule. Price is 0.4% above both.

Question: The bot uses scalp_sma. Do you enter or not?

Answer:

Do NOT enter with scalp_sma — the scalp_sma profile uses SMA, and SMA 20 does not confirm the trend (slope < threshold).

- **Explanation of divergence:** EMA reacts more aggressively to the last 2–3 bars with rising prices → higher EMA slope. SMA distributes evenly over 20 bars → prices from 15–20 bars ago (lower) pull the slope down. The trend is too new for SMA to confirm.
- **What it means practically:** Momentum has appeared recently (last 3–5 bars) but is not confirmed as a 20-bar trend. EMA sees it immediately, SMA does not.
- **Correct action for scalp_sma:**
- Wait 2–3 more bars until SMA 20 slope exceeds +0.03%
- Entry will be slightly later than on scalp profile (EMA), but with more solid confirmation
- **Correct action if the profile were scalp (EMA):**
- Valid entry if EMA slope > +0.05% and other MTF conditions are met

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14. Cheat Sheet — Quick Summary

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Concept	Value / Rule
SMA Formula	SMA = sum(Close, N) / N
Incremental Formula	SMA_new = SMA_old + (P_new − P_out) / N
Weight per SMA 20 bar	1/20 = 5.00% (uniform)
Weight per EMA 20 bar	K = 9.52% (exponentially decreasing)
SMA(N) Lag	(N−1)/2 bars — exact, identical to EMA(N)
SMA Warm-up	Exactly N bars (first value = bar N)
Ghost Effect	Spike exiting window → false SMA jump → check oldest_bar_range > 3×ATR
SMA 200 Daily	MOST WATCHED institutional level — universal bull/bear separator
Bollinger Bands base	SMA (not EMA!) + population σ (/ N)
Normal BB Width	3% – 10% on 5M/15M (crypto mid-cap)
BB Width squeeze	< 3% → imminent breakout
BB Width expansion	> 15% → exhaustion risk at extreme
Z-score overextension	> +2.0 or < −2.0 → high probability of reversion to SMA
Optimal entry range	−1.5% < price-SMA20 distance < +1.5%
Marginal zone	±1.5% – ±2.0% → possible entry with reduced sizing (50%)
Overextension hard stop	distance > ±2.0% → MANDATORY SKIP
Candle data	ALWAYS closed candle[-1]
Bullish slope 5M	> +0.03% (lower than EMA: +0.05%)
Flat slope 5M (skip)	−0.03% → +0.03%
Bullish slope 15M	> +0.02%
Bullish slope 4H	> +0.008%
Slope formula	slope = (SMA[-1] − SMA[-3]) / SMA[-3] × 100
Robust slope (multi-asset)	slope = (SMA[-1] − SMA[-2]) / ATR14[-1] × 100
Distance formula	dist = (price − SMA20) / SMA20 × 100
Classic Golden Cross	SMA 50 × SMA 200 from below (1D/4H) — institutional version
Classic Death Cross	SMA 50 × SMA 200 from above (1D/4H)

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Concept	Value / Rule
False crossover filter	Closed candle + spread > 0.05% + ADX > 18 + ghost check + Choppiness < 61.8
Bullish Ribbon expansion	SMA9 > SMA20 > SMA50 > SMA200, increasing distances
Ribbon compression	Converging SMAs → consolidation or imminent breakout
Bearish SMA divergence	Price Higher High + SMA Lower High → bullish exhaustion
Bullish SMA divergence	Price Lower Low + SMA Higher Low → bearish exhaustion
Sideways filter	Flat SMA + Choppiness > 61.8 → TOTAL SKIP
scalp vs scalp_sma	SMA slower to signal (+2-3 bars) but fewer whipsaws
TradingView pandas σ	pandas std() = ddof=1 (sampled) → use ddof=0 for BB
Bot vs TradingView tolerance	< 0.01% SMA difference → OK (stricter than EMA 0.05%)
MTF Score 4/4	Entry with full sizing
MTF Score 3/4 without conflict	Entry with reduced sizing 50–75%
TF3 (15M) bearish conflict	Do NOT enter Long — wait for 15M alignment

PSEDYS SMA Technical Manual v1.0 — May 2026 Covers: rolling window formula, Ghost Effect (SMA specific), quantified lag, sensitivity to spikes, Bollinger Bands and mean reversion (Z-score), slope calibrated per TF and comparison with EMA, MTF with partial scenarios, scalp_sma context, bot vs TradingView validation including pandas ddof gotcha, 5 practical exercises.

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