tSAT Token

tSAT Whitepaper

Technical Documentation & Protocol Overview

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Abstract

tSAT: Bitcoin Satoshi Representation on Solana

tSAT (Satoshi Token) is a fully-backed, redeemable token on Solana that represents Bitcoin satoshis with 1:1 parity to tBTC. Each tSAT token represents exactly one satoshi of Bitcoin, making Bitcoin ownership more psychologically accessible through whole number representation instead of decimal fractions.

This whitepaper details the technical implementation of tSAT using the **Fixed Ratio Trading (FRT) protocol** on Solana, which ensures zero-slippage, predictable exchanges between tBTC and tSAT at a fixed ratio of **1 tBTC = 100,000,000 tSAT**.

> **Key Innovation:** tSAT transforms the psychological experience of Bitcoin ownership by displaying balances in whole satoshi units (e.g., "100,000 sats")

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instead of decimal Bitcoin amounts (e.g., "0.001 BTC"), while maintaining full backing and redeemability through immutable smart contracts.

Introduction

The Problem: Bitcoin's Decimal Complexity

Bitcoin's current representation creates psychological barriers to adoption and engagement:

- **Scientific notation confusion:** Users see amounts like 1×10^{-5} BTC instead of intuitive whole numbers
- **Decimal intimidation:** Small decimal amounts (0.00001 BTC) feel insignificant despite real value
- **Progress invisibility:** Growth in tiny decimals is hard to perceive and celebrate
- **Mental math complexity:** Calculating with 8 decimal places is error-prone

The Solution: Satoshi-Native Representation

tSAT addresses these issues by:

- **Whole number psychology:** 1,000 tSAT feels more substantial than 0.00001 BTC
- **Clear progress tracking:** Users can easily see their satoshi stack growing
- **Simplified mental math:** Working with whole numbers reduces errors
- **Maintained Bitcoin exposure:** Full 1:1 backing ensures no dilution of Bitcoin value

Why Solana?

Solana provides the ideal infrastructure for tSAT:

- **Low transaction costs:** Enables micro-transactions in satoshi amounts

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- **High throughput:** Supports high-frequency satoshi transfers
- **Ecosystem:** Rich tooling for smart contract development
- **Threshold Network integration:** Native tBTC support for Bitcoin backing

Protocol Design

Fixed Ratio Trading (FRT) Architecture

tSAT is built on the Fixed Ratio Trading protocol, which provides:

Core FRT Features:

- **Zero slippage trading:** Exact ratios regardless of trade size
- **Predictable pricing:** No complex AMM curves or price discovery
- **Liquidity concentration:** Single canonical pool per token pair
- **Governance-ready architecture:** Built for decentralized control

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Token Ratio Specification

Conversion	Ratio	Example
tBTC → tSAT	1 : 100,000,000	1 tBTC = 100,000,000 tSAT
tSAT → tBTC	100,000,000 : 1	100,000,000 tSAT = 1 tBTC
Minimum unit	1 tSAT	1 tSAT = 1 Bitcoin satoshi

Smart Contract Components

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- Processes swaps with zero slippage
- Locks tBTC reserves as backing for tSAT
- Enables instant bidirectional conversion

2. Liquidity Provider (LP) Token System

Dual LP token architecture:

- **LP-tBTC tokens:** Claims on tBTC side of the pool
- **LP-tSAT tokens:** Claims on tSAT side of the pool
- **Burned LP tokens:** All LP tokens permanently destroyed to lock reserves

> **Critical Security Feature:** All LP tokens have been permanently burned, meaning the tSAT reserves are permanently locked in the smart contract and can only be accessed through the fixed-ratio trading mechanism.

3. Governance Controls

Multi-signature governance system:

- **Upgrade authority:** Transferred to multi-sig address
- **Emergency controls:** Protocol pause capabilities
- **Fee management:** Currently 0%, governance-controlled
- **Treasury management:** All fees flow to governance PDAs

Smart Contract Implementation

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Contract Addresses

Component	Address	Purpose
tSAT Token	`tSATdGGSLYBVCrm3pXiib8NmzKcB1iUdjRRseNGssxu`	Main token contract
FRT Pool	`AnTuW1uDnQBnwSa2Yso8MFmknz8B3K4V1iZZNdMdEXNj`	Fixed ratio trading pool
tBTC Token	`6DNSN2BJsaPFdFFc1zP37kkeNe4Usc1Sqkzr9C9vPWcU`	Threshold Network tBTC

Key Smart Contract Features

Immutable Core Logic

The FRT smart contract implements immutable core functions:

```
// Pseudo-code representation
function swap_tbtc_to_tsat(tbtc_amount) {
    tsat_amount = tbtc_amount * 100_000_000;
    require(pool_has_tsat_liquidity(tsat_amount));
    transfer_tbtc_from_user(tbtc_amount);
    transfer_tsat_to_user(tsat_amount);
    emit SwapEvent(tbtc_amount, tsat_amount);
}

function swap_tsat_to_tbtc(tsat_amount) {
    require(tsat_amount % 100_000_000 == 0); // Ensure whole tBTC
    tbtc_amount = tsat_amount / 100_000_000;
    require(pool_has_tbtc_liquidity(tbtc_amount));
    transfer_tsat_from_user(tsat_amount);
    transfer_tbtc_to_user(tbtc_amount);
    emit SwapEvent(tsat_amount, tbtc_amount);
}
```

Security Validations

- **Ratio enforcement:** Mathematical precision ensures exact 1:100,000,000 ratio
- **Overflow protection:** SafeMath operations prevent arithmetic errors
- **PDA validation:** All Program Derived Addresses properly verified

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- **Access control:** Proper permission checks on all functions

Liquidity Management

The smart contract manages liquidity through:

- **Asymmetric deposits:** Users can deposit only tBTC or only tSAT
- **Balanced withdrawals:** LP token holders can withdraw proportional shares
- **Reserve tracking:** Real-time monitoring of backing ratios
- **Emergency pause:** Circuit breakers for critical situations

> **Open Source Verification:** All smart contract code is available at https://github.com/Fixed-Asset-Ratio-Trading for independent audit and verification.

Security Model

Multi-Layer Security Architecture

1. Smart Contract Security

> **Immutable Core Functions**
> Critical trading functions cannot be modified post-deployment, ensuring permanent adherence to the 1:100,000,000 ratio.

- **Formal verification:** Mathematical proofs of ratio correctness
- **Overflow protection:** SafeMath prevents arithmetic vulnerabilities
- **Reentrancy guards:** Protection against recursive call attacks

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- **Input validation:** Comprehensive parameter sanitization

2. Economic Security

- **Full collateralization:** Every tSAT backed by tBTC in smart contract
- **Burned LP tokens:** Reserves permanently locked, no admin access
- **Transparent reserves:** Real-time on-chain verification
- **No fractional reserves:** 1:1 backing ratio maintained at all times

3. Governance Security

Control	Current State	Security Measure
Upgrade Authority	Multi-sig controlled	Transparent upgrade process
Emergency Pause	Governance only	Critical issue protection
Fee Settings	Currently 0%	Community governance required
Reserve Access	Smart contract only	No human intervention possible

Risk Mitigation Strategies

Smart Contract Risks

> **Mitigation:** Open source code enables community auditing, formal verification of core logic, and extensive testing on devnet/testnet before mainnet deployment.

tBTC Backing Risks

> **Mitigation:** tSAT inherits the security model of Threshold Network's tBTC, which is backed 1:1 by Bitcoin held in a decentralized network of signers.

Liquidity Risks

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Mitigation: Fixed ratio trading eliminates slippage concerns, and burned LP tokens ensure permanent liquidity backing.

Audit & Verification

Security verification through multiple channels:

- **Community auditing:** Open source code review
- **AI-powered analysis:** Automated vulnerability scanning
- **Formal verification:** Mathematical proof of correctness
- **Real-time monitoring:** On-chain reserve tracking

Tokenomics

Supply Mechanics

Parameter	Value	Explanation
Maximum Supply	21,000,000,000,000 tSAT	Equivalent to 210,000 BTC (1% of Bitcoin's total supply)
Initial Supply	21T tSAT (minted)	All tokens minted and locked in FRT contract
Circulating Supply	Dynamic	Based on tBTC deposited into the pool
Backing Ratio	1:1 with tBTC	Every circulating tSAT backed by tBTC

Economic Model

Supply Constraint Economics

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1% Bitcoin Supply Cap

tSAT is intentionally limited to represent only 1% of Bitcoin's total supply (210,000 BTC equivalent). This creates natural scarcity and ensures tSAT remains a specialized tool rather than a complete Bitcoin replacement.

Circulation Dynamics

tSAT circulation is determined by market demand:

- **Minting:** Users deposit tBTC → receive tSAT at 1:100M ratio
- **Burning:** Users return tSAT → receive tBTC at 100M:1 ratio
- **Net circulation:** Difference between minted and burned tokens
- **Market forces:** Supply/demand balance determines actual circulation

Fee Structure

Fee Type	Current Rate	Purpose
Pool Trading Fee	0%	Bootstrap liquidity (governance controlled)
Solana Network Fee	~0.0002715 SOL	Transaction processing costs
Maximum Pool Fee	0.5%	Hard-coded protocol limit

Circulating Supply API

Real-time circulating supply data is available through public API endpoints:

API Endpoints

- **Plain Number Format:** https://satoshi15.com/api/circulating-supply.php

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- **JSON Format:** https://satoshi15.com/api/circulating-supply.php?format=json

API Response Format

The JSON endpoint provides comprehensive supply data:

```
{
  "circulating_supply": 80195953,
  "total_supply": 21000000000000,
  "locked_in_pool": 20999919804047,
  "timestamp": 1759477338,
  "last_updated": "2025-10-03T07:42:18+00:00",
  "pool_address": "AnTuW1uDnQBnwSa2Yso8MFmknz8B3K4V1iZZNdMdEXNj",
  "tsat_token": "tSATdGGSLYBVCrm3pXiib8NmzKcB1iUdjRRseNGssxu",
  "rpc_provider": "chainstack"
}
```

Integration Examples

Perfect for CoinGecko, CoinMarketCap, and other data aggregators:

- **CoinGecko format:** Returns plain number for easy integration
- **Real-time data:** Updates every 5 minutes with live Solana RPC calls
- **Transparent calculation:** Total Supply - tSAT locked in pool = Circulating Supply
- **Fallback protection:** Multiple RPC endpoints ensure reliability

Value Proposition

For Bitcoin Holders

- **Psychological benefits:** Whole number satoshi representation
- **Maintained exposure:** Full Bitcoin price correlation
- **DeFi utility:** Use Bitcoin in Solana ecosystem
- **Instant liquidity:** Convert back to tBTC anytime

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- **Composability:** Building block for other protocols
- **Predictable pricing:** No slippage on conversions

Proof of Reserves

All tSAT tokens are verifiably backed by tBTC reserves locked in the Fixed Ratio Trading smart contract. The complete transaction history demonstrates the security and transparency of the system:

1. Token Mint Creation (21T tSAT Maximum Supply)

Initial minting of all tSAT tokens with maximum supply cap of 21 trillion tokens.

View Transaction: 2JUaZMSi1XgXbzPsP7ud4rcV3d2621nmWL5ay3Nuex2LjdhDE7V4G9DjcxVSHjGpmm61dAx5GtcVd62JY1B8LTrR

2. Tokens Locked in Fixed Ratio Trading Contract

All 21 trillion tSAT tokens transferred to the Fixed Ratio Trading smart contract, receiving LP tokens in return to establish the trading pool.

View Transaction: 2iW5itDKKr3B9NU2WjqBtMMhG6EWLqFwnFTDhCzWsPfzmS85zSKhWBX4DxyXzksR8G31LEfZkcSAGr9YJDJCwc9K

3. LP Tokens Permanently Burned

Critical Security Step: All liquidity provider tokens permanently burned, ensuring tSAT tokens remain locked in the contract unless someone trades tBTC for them.

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View Transaction: PtHnPnFotbY1EJbQdY3gGcgmqJaXj6ewXPhZkTmMAyyxiq95BgBeVv6vk9m a4b6bFPszMGUUNjKhSF27WCNrU1k

4. Upgrade Authority Transferred to Multi-Sig

Token upgrade authority transferred to multi-signature address ensuring transparent governance and preventing unilateral changes to the protocol.

View Transaction: 45yr7uxLWLk2CjpiUNpkJgZnHUN9hXVMveu3HHwzxyWiR47tfZotbLynuWpzTVzVFK37JWkRGQSVArmE5m6WGZB2

Real-Time Verification

Anyone can verify the backing at any time:

- **Pool reserves:** Check FRT pool balance on Solscan
- **Token supply:** Monitor circulating vs total supply
- **Backing ratio:** Verify 1:1 tBTC backing for all circulating tSAT
- **LP token status:** Confirm all LP tokens remain burned

> **Open Source Verification:** The complete Fixed Ratio Trading protocol is open source and available at https://github.com/Fixed-Asset-Ratio-Trading for independent verification.

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How to Redeem tSAT for tBTC

Instant Redemption Process

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tSAT holders can redeem their tokens for tBTC instantly through the Fixed Ratio Trading protocol at frt15.net with guaranteed 1:100,000,000 conversion ratio.

Step-by-Step Redemption Guide

Method 1: Using FRT15.net Interface

1. **Connect Wallet:** Visit frt15.net and connect your Solana wallet
2. **Select Pool:** Navigate to the tSAT/tBTC trading pool
3. **Choose Swap Direction:** Select tSAT → tBTC conversion
4. **Enter Amount:** Input the amount of tSAT you want to redeem
5. **Verify Rate:** Confirm the 100,000,000:1 conversion ratio
6. **Execute Swap:** Submit the transaction and confirm in your wallet
7. **Receive tBTC:** tBTC will be deposited to your wallet instantly

Method 2: Direct Smart Contract Interaction

Advanced users can interact directly with the smart contract:

```
// Contract Address: AnTuW1uDnQBnwSa2Yso8MFmknz8B3K4V1iZZNdMdEXNj
// Function: swap_tsat_to_tbtc
// Parameters: tsat_amount (must be multiple of 100,000,000)

Example:
- Input: 500,000,000 tSAT
- Output: 5 tBTC
- Fee: ~0.0002715 SOL (network fee only)
```

Redemption Requirements

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Requirement	Details	Reason
Minimum Amount	100,000,000 tSAT	Equals 1 tBTC (atomic unit)
Multiple Requirement	Must be multiple of 100M	Ensures whole tBTC output
Wallet Balance	Sufficient tSAT + SOL for fees	Transaction processing
Pool Liquidity	Adequate tBTC in pool	Successful swap execution

Redemption Guarantees

Mathematical Certainty

- **Fixed ratio:** Always exactly 100,000,000 tSAT = 1 tBTC
- **Zero slippage:** No price impact regardless of redemption size
- **Instant execution:** No waiting periods or delays
- **No redemption fees:** Only standard Solana network fees apply

Liquidity Considerations

Redemption depends on available tBTC liquidity in the pool:

- **Current liquidity:** Check pool reserves before large redemptions
- **Market dynamics:** Liquidity varies based on user deposits/withdrawals
- **Arbitrage opportunities:** Price deviations may attract liquidity providers
- **Alternative markets:** tSAT may trade on other DEXs if pool liquidity is low

Important Note: While redemption is guaranteed at the fixed ratio, it's subject to available tBTC liquidity in the pool. During periods of high redemption demand,

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users may need to wait for additional tBTC deposits or trade on secondary markets.

Risks & Disclaimers

⚠️ Important Risk Disclosures

All users must understand and accept the following risks before interacting with tSAT tokens.

Smart Contract Risks

Code Vulnerabilities

- **Bug risk:** Smart contracts may contain undiscovered vulnerabilities
- **Upgrade risk:** Protocol upgrades could introduce new issues
- **Interaction risk:** Complex interactions with other protocols may cause failures
- **Network risk:** Solana network issues could affect functionality

Mitigation Measures

- ✅ Open source code for community auditing
- ✅ Formal verification of core mathematical functions
- ✅ Multi-signature governance for upgrades
- ✅ Extensive testing on devnet/testnet

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- **Threshold Network dependency:** tSAT inherits all risks of the underlying tBTC system
- **Bitcoin bridge risks:** tBTC's Bitcoin backing mechanism could face technical issues
- **Signer set risks:** Threshold Network's decentralized signers could face coordination issues

Regulatory Risks

Compliance Considerations

- **Jurisdictional variations:** Cryptocurrency regulations vary by location
- **Classification uncertainty:** Token classification may change over time
- **User responsibility:** Users must ensure compliance with local laws
- **Platform restrictions:** Some platforms may restrict tSAT trading

Technical Risks

Infrastructure Dependencies

Dependency	Risk	Impact
Solana Network	Network outages, congestion	Temporary inability to trade
Threshold Network	tBTC system issues	Backing asset complications
FRT Protocol	Smart contract bugs	Trading disruption or loss
Wallet Software	User interface issues	Access difficulties

Market Risks

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Price Correlation

Bitcoin Price Exposure: tSAT maintains 1:1 correlation with Bitcoin price movements. Users bear full Bitcoin price volatility risk.

Liquidity Market Risks

- **Secondary market deviation:** tSAT may trade at premium/discount on other DEXs
- **Arbitrage delays:** Price corrections may take time during high volatility
- **Market fragmentation:** Liquidity may be split across multiple venues

Legal Disclaimers

🚨 CRITICAL DISCLAIMERS

- **ALPHA SOFTWARE:** This protocol is under active development and may contain bugs
- **NOT FINANCIAL ADVICE:** This documentation is educational only
- **NO GUARANTEES:** No returns, performance, or functionality are guaranteed
- **USE AT YOUR OWN RISK:** Users accept all risks of loss
- **REGULATORY COMPLIANCE:** Users responsible for legal compliance

Limitation of Liability

The tSAT protocol developers, contributors, and associated parties:

- Make no warranties about the software or its functionality
- Accept no liability for any losses or damages
- Provide the protocol "as is" without support guarantees
- May discontinue development or support at any time

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- Are legally permitted to use cryptocurrency in their jurisdiction
- Will not hold developers liable for any losses
- Accept full responsibility for their trading decisions
- Will conduct their own due diligence and risk assessment

> **Recommendation:** Only invest amounts you can afford to lose completely. Cryptocurrency investments carry high risk and are not suitable for all investors.

tSAT - Satoshi Token Protocol

Built on Fixed Ratio Trading • Backed by tBTC • Secured by Smart Contracts

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