# Charisma Protocol: White Paper


## Abstract

The Charisma protocol is a decentralized platform designed to generate **energy** based on users' held token balances over a period of time. A key feature of the system is its secure and efficient energy calculation, which leverages integral calculus to compute staking output retroactively. This paper provides a detailed exploration of the operational logic of the protocol, including the mathematical foundation for calculating energy, and introduces a dynamic formula that adjusts staking rewards based on token-specific multipliers.


## Introduction

Charisma's energy generation mechanism allows users to participate without the need for traditional staking pools. Instead, energy is calculated directly from token balances held by users over time, ensuring both security and ease of use. The system adjusts rewards dynamically through a multiplier formula that considers market risk, supply normalization, and protocol incentives. The foundation of this process is the **staking output**, derived using integral calculus, which represents the amount of energy users accumulate over time based on their token holdings.

## Energy Calculation Mechanism

### Formula for Energy Generation

The energy output is calculated using a combination of the user's token balance history and a set of dynamic multipliers. The formula for calculating energy is as follows:

$$\text{Energy} = \frac{\text{balance-integral} \times \text{quality-score} \times \text{incentive-score}}{\text{circulating-supply}}$$

Where:

- **Balance Integral** is the integral value of a user's held balances over time, computed over n intervals.

- **Quality Score** represents the risk assessment of the token, calculated by the Intelligence protocol, ranging from 0 to 100%.
- **Incentive Score** provides dynamic bonuses based on protocol-driven incentives.
- **Circulating Supply** normalizes token supplies to account for differences in total token supply and burned tokens.

This formula ensures that any token can generate energy while accounting for token-specific factors such as risk and supply dynamics.

# Balance Integral: The Integral Calculation

The **Balance Integral** is the foundation of energy generation within the Charisma protocol. It is calculated using differential equation mathematics, which provides an accurate representation of a user's token balance over time. This system does not rely on active staking contracts but instead looks at historical token balances to determine the total amount of time a user has held a given token, weighted by the balance held.

## Understanding the Integral Calculation

The integral calculation works by dividing the user's balance history into smaller intervals over a defined time period (e.g., over a series of blocks). By summing the user's token balances at each interval and approximating the area under the curve, the protocol calculates the total staking output for that period.

## Trapezoidal Rule

The Charisma protocol uses the **trapezoidal rule** to approximate the integral of the token balance over time. This rule is particularly effective for calculating the cumulative balance because it estimates the area under the curve by approximating the curve as a series of trapezoids between sample points.

The integral approximation can be expressed as follows:

$$\int_a^b f(x)\,dx \approx \frac{b-a}{n}\left(\frac{f(a)+f(b)}{2}+\sum_{i=1}^{n-1} f(x_i)\right)$$

Where:

- $f(x)$ is the user's token balance at block $x$,
- $a$ and $b$ represent the start and end blocks of the period,
- $n$ is the number of intervals (e.g., blocks) over which the balance is calculated.

In the Charisma protocol, the user's balance is sampled at regular intervals over a period of time, and the area under the balance curve is calculated. This results in a time-weighted representation of the user's held balance.

## Integral Calculation in Action

For example, suppose a user holds 100 tokens at the start of the staking period and consistently holds them for the duration of the period. If the time period is divided into 8 blocks, the balance at each block is recorded, and the trapezoidal rule is applied to approximate the staking output.

If the user's balance changes over time, the integral calculation will adjust accordingly, providing a fair estimate of the total balance held. This calculation ensures that users who hold tokens for longer periods or in larger quantities will receive proportionally more energy.

The contract logic for calculating the staking output looks like this:

```
(define-read-only (calculate-integral (addr principal) (start uint) (end uint))
    (let
        (
            (sample-points (generate-sample-points addr start end))
            (balances (map get-balance sample-points))
            (dx (/ (- end start) n))
            (areas (calculate-trapezoid-areas balances dx))
        )
        (ok (fold + areas u0))
    )
)
```

This function generates **sample points** over the defined block range (from start-block to end-block), retrieves the balance at each point, and calculates the integral using the trapezoidal rule. The result is the **balance integral**, which represents the user's total participation in the protocol over the specified time period.

## Time-Weighted Holding

By using integral calculus, Charisma ensures that the user's staking output is a **time-weighted average** of their token holdings. Users who consistently hold tokens are rewarded more than those who move tokens in and out of their wallets frequently. This approach incentivizes long-term holding while maintaining security since tokens never leave the user's wallet, unlike traditional staking systems.

## Dynamic Multipliers

The staking output calculated through integral calculus is then adjusted by **dynamic multipliers**, which account for different factors that influence energy generation:

- **Quality Score**: Determined by the Intelligence protocol, this score assesses the risk of rugs or scams associated with each token. Tokens with higher intelligence scores (lower risk) will generate more energy.
- **Incentive Score**: This multiplier is applied by the Charisma protocol to adjust incentives based on market conditions. It allows the protocol to encourage the staking of specific tokens by providing bonus energy for those tokens.
- **Circulating Supply**: Since tokens have varying total supplies, this factor normalizes the impact of token supply. It accounts for tokens that have been burned or sent to dead addresses but are still included in total supply figures.

## Security and Efficiency

Because the Charisma protocol calculates energy based on balances rather than requiring tokens to be staked in a contract, it provides a more secure and efficient system for users. There are no vulnerabilities associated with locking tokens into staking pools or contracts, and users retain full control over their assets while still participating in energy generation.

Additionally, the **retroactive calculation** ensures that users are rewarded fairly, even if they do not actively manage their token holdings. As long as they hold eligible tokens, the system will automatically calculate their energy output when needed.

## Expansion Opportunities: GameFi and Beyond

The Charisma protocol's energy generation system is inherently extensible, providing a foundation for additional logic and mechanics to be integrated across various platforms and protocols. By leveraging the energy generated from token holdings, developers can hook into this system to power:

### Reward Systems

Platforms can implement further rewards, such as governance voting rights, airdrops, or yield farming bonuses, that are tied directly to the energy a user has accumulated. This energy could serve as the basis for accessing exclusive rewards or unlocking tiers in staking and reward platforms.

### GameFi and Play-to-Earn Mechanics

The GameFi sector can integrate Charisma's energy system to fuel in-game mechanics. Energy earned through holding tokens could be spent on game actions, access special game modes, or boost in-game assets. Games built on Charisma could use energy to level up characters, purchase rare items, or even participate in PvP or PvE combat. Allegiances and factions based on token holdings could be incentivized by rewarding users with additional energy to increase their in-game power.

### NFT Marketplaces and Incentivized Collectibles

Energy earned in the Charisma ecosystem could be used to purchase or enhance NFTs, tying token holdings and market activity to the NFT economy. Collectibles could gain unique properties or unlock hidden traits depending on the amount of energy spent, encouraging long-term engagement with both tokens and NFTs.

### Protocol-Specific Enhancements

Future decentralized platforms could adopt Charisma's energy mechanism for various use cases, such as prioritizing transaction speed, reducing fees, or gaining access to liquidity pools. For example, protocols could allow users to "burn" energy to reduce trading fees or boost liquidity mining rewards. Custom incentives could be created for specific tokens or use cases, driving new market dynamics and liquidity patterns.

## Path to an Expanding Ecosystem

As more protocols, platforms, and GameFi projects connect to Charisma's energy system, the utility of the energy itself will expand, making it a crucial metric for decentralized applications (dApps) across the ecosystem. Charisma's flexible architecture ensures that as new token projects, assets, and game mechanics emerge, they can seamlessly integrate into the energy framework, allowing users to benefit from the same consistent and fair reward logic.

This creates a future where energy generated from token holdings will not only power governance, rewards, and GameFi experiences but also form the backbone of new decentralized economies built on top of the Charisma protocol.

## Conclusion

The Charisma protocol's innovative approach to token staking offers a secure, efficient, and fair method for users to participate in the ecosystem. By retroactively calculating token balances, the protocol eliminates the need for staking pools and mitigates security risks, allowing users to retain control of their tokens while earning protocol rewards.

The dynamic multipliers applied to energy generation-based on risk assessment (*quality-score*), market-driven incentives (*incentive-score*), and supply normalization (*circulating-supply*) ensure that all tokens can be integrated into the system. This flexibility allows the protocol to normalize energy output across different token projects, creating a balanced and equitable reward structure for diverse assets in the ecosystem.

# Testing the Balance Integral Calculation

## Setup

1. Deploy the main contract (`.balance-integral-calculator`) if not already deployed.
2. Deploy the wrapper contract (`.wrapper`) containing the test functions.
3. Ensure you have multiple test wallets with STX balance for transactions.
4. For replication purposes, you can use the same token in the initial calculator, or change it to one you have known balance of over a given block-height time span.

## Test Cases

### 1. Test `balance-check-multiple`

(contract-call? .wrapper test-balance-check-multiple (list {address: 'ST1P...GZGM, block: u170000} {address: 'ST1P...GZGM, block: u170050} {address: 'ST1P...GZGM, block: u170100}))

### 2. Test `add-balance-for-block`

(contract-call? .wrapper test-add-balance-for-block {address: 'ST1P...GZGM, block: u170125} u1000000)

### 3. Test `get-balance`

(contract-call? .wrapper test-get-balance {address: 'ST1P...GZGM, block: u170125})

### 4. Test `generate-sample-points`

(contract-call? .wrapper test-generate-sample-points 'ST1P...GZGM u170000 u170125)

### 5. Test `calculate-trapezoid-areas`

(contract-call? .wrapper test-calculate-trapezoid-areas (list u1000000 u1100000 u1200000 u1300000 u1400000 u1500000 u1600000 u1700000 u1800000) u14)

### 6. Test `calculate-balance-integral`

(contract-call? .wrapper test-calculate-balance-integral 'ST1P...GZGM u170000 u170125)

## References and Contract Links

- https://explorer.hiro.so/txid/SP2ZNGJ85ENDY6QRHQ5P2D4FXKGZWCKTB2T0Z55KS.charisma-token-farm
- https://explorer.hiro.so/txid/SP2ZNGJ85ENDY6QRHQ5P2D4FXKGZWCKTB2T0Z55KS.ctf-test-1
- https://explorer.hiro.so/txid/0xad0a10d0c6039d654fcd7f17363e0ccbaa1389c2be0ffd4dd883027870f0731c
- https://explorer.hiro.so/txid/0x123908374ed41f1039a49286088fd0e77b4e404b508802c8f099ff52ff07ab46