$f(x)$ Protocol 2.1: Delivering High Leverage and High Yielding Decentralized Stablecoins

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Abstract

$f(x)$ Protocol version 2.1 advances the groundbreaking mechanics introduced in its initial release, $f(x)$ Protocol v1.0. While maintaining the robust stablecoin design (fxUSD) from version 1.0, this upgrade significantly enhances the leveraged position feature (xPOSITION & sPOSITION), offering high fixed-leverage trading with minimal liquidation risks or funding fees. Additionally, version 2.1 introduces enhanced stability mechanisms, prioritizing a streamlined and intuitive user experience.

1 Introduction

Stablecoins are a cornerstone of decentralized finance (DeFi), facilitating fully on-chain swaps into and out of fiat-denominated assets and enabling the creation of a wide range of decentralized financial instruments. Given the volatility of cryptocurrencies, even the most crypto-native organizations and individuals must plan for expenses in fiat terms, necessitating the holding of fiat-denominated reserves. Despite their critical role, stablecoins have introduced significant risks and have been at the center of some of DeFi's most notable failures. Pure algorithmic stablecoins have collapsed so dramatically that their risks are self-evident. However, even current stablecoin models suffer from structural weaknesses that jeopardize their long-term viability.

In this document, we introduce f(x) Protocol version 2.1, which leverages an innovative mechanism to enhance the protocol's flagship stablecoin and leverage products: fxUSD, a hard-pegged stablecoin, xPOSITION, a non-fungible, high-beta leveraged long position and sPOSITION, a non-fungible, high-beta leveraged short position. The leveraged positions offer a powerful decentralized tool for on-chain high-leverage trading, while the zero-volatility fxUSD provides a novel alternative to existing stablecoins. fxUSD eliminates centralized risk and scales efficiently, addressing the stablecoin trilemma in a way current solutions have yet to achieve.

2 Motivation for Evolution from v.1.0 to v.2.1

Since its inception, the original design of $f(x)$ Protocol has successfully demonstrated the innovative and secure application of the $f(x)$ invariant (see section 5) method to modulate token volatility. This groundbreaking approach enables the creation of both stablecoins and zero-funding, non-liquidating leveraged tokens.

The protocol has created demand for both the yield generated from reserve collateral (accrued to the stability pool), and the equity capture within the system via the leverage tokens, xTOKEN. While the original design of $f(x)$ Protocol has proven successful, achieving the ambitious goals of Aladdin DAO requires further optimization to ensure that leveraged positions appeal to both leverage traders and long-term holders. For the protocol to scale, these positions must consistently offer sufficient and relatively predictable leverage against the value of reserve assets across all market conditions.

As such, outlined below are the components and mechanisms of version 2.1 of $f(x)$ Protocol. Together, they represent the next step in realizing the grand vision of $f(x)$ Protocol and Aladdin DAO.

3 Design Goals of $f(x)$ Protocol 2.1

$f(x)$ Protocol is designed with the aim of creating a symbiotic system that decomposes a base token into two distinct yet complementary assets. Specifically, for xPOSITION and sPOSITION, the protocol creates a leveraged long and respective short position on TOKEN with the following key features:

1. Provides up to 10X leverage
2. Is fully decentralized
3. Minimize liquidation risk
4. Charges zero (0) funding fees under normal circumstances

For fxUSD, the goal is to produce a zero volatility token with these characteristics:

1. Is fully decentralized
2. Maintains a perfect peg to US Dollar
3. Is minted and redeemed instantly in direct response to the xPOSITION demand
4. Derives its liquidity from the backing asset (TOKEN)
5. Generates sustainable, on-chain yield

4 Decomposing a Yield Bearing Token using $f(x)$ Protocol 2.1

The $f(x)$ reserve consists primarily of Lido's liquid-staked ETH (stETH) and wrapped Bitcoin (wBTC). Users supplying stETH or wBTC can mint fxUSD and open leveraged long positions (xPOSITIONs), with position sizing determined by the supplied asset's price and the current net asset value (NAV). Conversely, users can redeem fxUSD to close their positions at any time, receiving the NAV worth of stETH or wBTC from the reserve.

Additionally, the protocol enables users to open leveraged short positions (sPOSITIONs) by depositing fxUSD as collateral. sPOSITIONs gain inverse exposure by borrowing stETH or wBTC from the leveraged long reserve, selling it to initiate short exposure. Users can close these positions by repaying the borrowed asset, retrieving their fxUSD collateral accordingly.

As the stETH reserve continually generates ETH staking rewards, these rewards are harvested regularly and primarily utilized to sustain system stability, manage protocol risk, and generate additional protocol revenue.

5 The $f(x)$ Invariant

The NAV of fxUSD, xPOSITION and sPOSITION fluctuates with the price of TOKEN, ensuring that the total value of all fxUSD combined with the total value of all xPOSITIONs and sPOSITIONs always equals the total value of the TOKEN reserve adjusted for borrowed assets. This guarantees that every fxUSD, xPOSITION, and sPOSITION remains fully backed and that the protocol maintains internal solvency across both long and short positions. Put mathematically, at all times the invariant will hold:

$$(n - n^-) \cdot s = (n_f - n_f^-) + X + SP \tag{1}$$

Where n is the number of TOKEN collateral, n^- is the amount of TOKEN collateral borrowed for short positions, s is the TOKEN price in USD, n_f total fxUSD minted (longs), n_f^- total fxUSD locked (shorts), X total NAV of xPOSITIONs in USD and SP total NAV of sPOSITIONs in USD.

The protocol continuously adjusts the NAV of fxUSD, xPOSITION and sPOSITION as TOKEN prices change, maintaining this invariant and ensuring stable leverage exposure for both long and short positions, while preserving full decentralization and solvency.

6 Main functions of $f(x)$ Protocol 2.1

6.1 Minting and Redeeming fxUSD and Opening and Closing of xPOSITION and sPOSITION

To facilitate higher leverage, the opening of xPOSITION must be accompanied by the minting of fxUSD at a ratio determined by the target leverage for that specific pair. At any target leverage, for every unit of xPOSITION opened, a proportional amount of fxUSD must also be minted to maintain system stability. For instance, let's assume TOKEN price is $2,000. If a user wishes to open a $200 xPOSITION at a leverage of 5x, the protocol requires that $800 worth of fxUSD is also minted simultaneously, such that the total collateralization aligns with the desired leverage.
The closing of an xPOSITION must be done with fxUSD at the real-time fxUSD:xPOSITION ratio at the time of redemption.
When a user opens an xPOSITION, the process will be seamlessly facilitated by leveraging a flash loan. This occurs through an atomic transaction, ensuring that all steps are completed successfully or the entire transaction is reverted, maintaining the integrity of both the user's funds and the system.
In addition to leveraged long positions, the protocol enables users to open sPOSITIONs to take leveraged short exposure by depositing fxUSD as collateral. The opening of an sPOSITION is executed as an atomic transaction. Upon initiation, the protocol utilizes a flash loan to borrow additional TOKEN (e.g., wstETH or wBTC), based on the user's chosen leveraged market. The borrowed TOKEN is used to purchase additional fxUSD from the secondary market. The total fxUSD, consisting of both the user's initial collateral and the flash loan-acquired fxUSD, is then deposited into the

protocol to borrow the corresponding TOKEN from the leverage long reserve. The borrowed collateral asset is immediately used to repay the flash loan, thereby establishing the user's short position without requiring upfront access to the borrowed asset. For example, assume TOKEN is trading at $2,000 and a user wishes to open a 5x short position using $200 worth of fxUSD as collateral. The protocol initiates a flash loan to borrow sufficient TOKEN, which is sold into the AMM to purchase 1,000 fxUSD. The full 1,200 fxUSD is deposited into the protocol to borrow $1,000 worth of TOKEN (0.5 units) from the leverage long reserve. The borrowed 0.5 TOKEN is immediately used to repay the flash loan. The user is now short 0.5 TOKEN, representing $1,000 notional short exposure against $200 of posted fxUSD collateral, achieving 5x short leverage.
The closing of an sPOSITION similarly utilizes a flash loan to execute the transaction atomically. The protocol first flash-loans the required amount of stETH or wBTC. This collateral is used to repay the outstanding debt owed to the leverage long reserve. Subsequently, a portion of the user's fxUSD collateral is sold to repay the flash loan. After all obligations are settled, any remaining fxUSD collateral is returned to the user.

Both xPOSITIONs and sPOSITIONs operate under the protocol's unified invariant and risk management framework.

6.2 Rebalance Operations

The protocol employs a unified risk management framework for both xPOSITIONs and sPOSITIONs, designed to minimize liquidation risk and maintain system solvency through automated rebalancing. The leverage of an xPOSITION or sPOSITION fluctuates as the price of the underlying collateral changes or when the position is adjusted through top-ups or reductions. To manage risks effectively, the protocol incorporates a Rebalance mechanism that ensures the leverage levels remain within safe and sustainable limits. When the leverage of an xPOSITION or sPOSITION reaches a predefined threshold, the protocol automatically triggers a Rebalance operation to return the leverage back to the rebalance line.
For xPOSITIONs, this operation involves repaying a portion of the fxUSD to adjust the leverage back to the rebalance line (See section 6.5).
For sPOSITIONs, rebalancing operates symmetrically but in the opposite price direction. When the price of the collateral asset increases and the leverage of sPOSITIONs approaches the rebalance threshold, part or all of the outstanding collateral asset debt is paid back by keepers on behalf of the affected sPOSITIONs in order to bring the sPOSITION back to the

rebalance line (See section 6.5). By doing so, the protocol ensures that the leverage remains within the specified parameters, thereby:

1. Enhancing system stability by implementing proactive adjustments to prevent liquidation events.

2. Optimizing the rebalance efficiency and minimizing the costs for xPOSITION and sPOSITION holders, by limiting the amount of collateral involved in each rebalance operation. This ensures that the bounty fee associated with fxUSD rebalancing remains as low as possible, thereby limiting the impact on users.

3. Acting as a liquidation brake, reducing collateral drawdown during periods of price volatility and allowing users to retain more upside potential when price is going in their chosen direction.

Rebalancing operations for both xPOSITIONs and sPOSITIONs are fully automated, market-neutral, and executed atomically to maintain systemic integrity.

6.3 Liquidation Mechanism

In the event that a Rebalance operation fails to maintain the rebalance line, and the leverage of xPOSITION or sPOSITION continues to increase beyond the specified threshold, the protocol will trigger a liquidation process.
For xPOSITIONs, once the leverage reaches the liquidation line, the system initiates a procedure to repay all the fxUSD associated with the liquidated xPOSITION.
For sPOSITIONs, once the leverage reaches the liquidation line, the system initiates a procedure to repay all the collateral debt associated with the liquidated sPOSITION.
This action is taken to preserve the fxUSD peg and maintain the stability of the system.

6.4 Stability Pool

The Stability Pool is a key component of $f(x)$ Protocol, designed to provide both stability and yield opportunities for participants. Users can deposit fxUSD and/or USDC into the Stability Pool to earn TOKEN yield and leveraged trading commissions during normal market conditions.
The Stability Pool also functions as a peg stabilizer for the fxUSD/USDC AMM pool. USDC held in the Stability Pool will be exchanged for fxUSD

from the AMM when favorable exchange conditions arise, allowing USDC to be swapped for a greater amount of fxUSD. Conversely, fxUSD will be swapped for USDC when it can secure a higher amount of USDC from the AMM. This mechanism ensures efficient balancing and maintains fxUSD's peg.

USDC deposits into the Stability Pool are conducted at the Chainlink oracle price to ensure accurate valuations. In the event of a USDC depeg, deposit and peg keeping (swapping fxUSD for USDC) functionalities will be temporarily disabled to safeguard users and uphold system integrity.

6.5 Rebalance and Liquidation Protocol Procedures

During Rebalance or Liquidation Operations, system-level liquidity management ensures that sufficient assets are available to settle outstanding obligations for both xPOSITIONs and sPOSITIONs.

When rebalancing or liquidating xPOSITIONs, fxUSD is first redeemed from the Stability Pool, and the underlying TOKEN is swapped for USDC. If the Stability Pool lacks sufficient fxUSD to fulfill redemption requirements, the protocol may liquidate additional collateral to acquire USDC and/or fxUSD. The USDC is then used to repurchase fxUSD at a ratio not exceeding 1:1, either synchronously or asynchronously depending on market conditions, maintaining fxUSD peg stability.

For sPOSITIONs, when rebalancing or liquidating positions, the protocol requires TOKEN to repay outstanding collateral debt. As fxUSD is fully deposited at position opening, sufficient collateral is always available to cover sPOSITION obligations directly.

Through these mechanisms, the protocol maintains adequate liquidity buffers and stability for both long and short positions across varying market conditions.

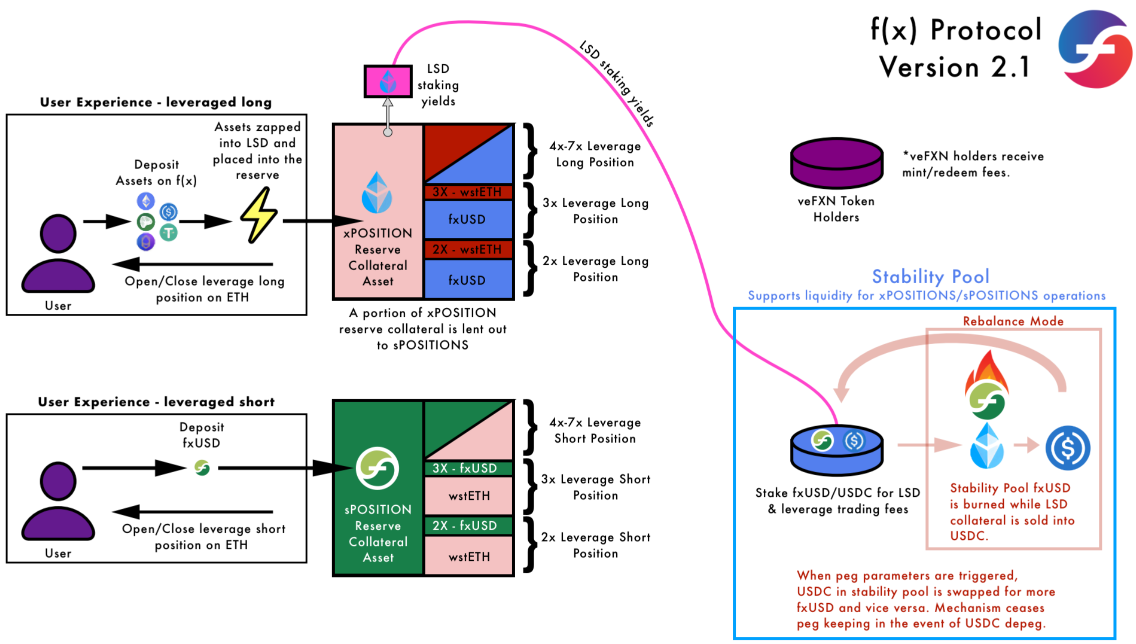

Figure 1: Main Functions of $f(x)$ Protocol 2.1

7 Risk Management

The assessment of system risks can be approached from several critical perspectives:

xPOSITIONs

- *xPOSITION Leverage*: The ratio of collateral value to xPOSITION size.
- *Outstanding fxUSD Debt Percentage*: Percentage of outstanding fxUSD debt compared to collateral.
- *Collateralization Ratio*: The ratio of collateral value to outstanding fxUSD debt.

The following equations illustrate the relationships between the critical parameters in the system:

$$l_t^+ = \frac{n_t s_t}{X_t} \tag{2}$$

$$CR_t^+ = \frac{n_t s_t}{n_{f,t}} = \frac{l_t^+}{l_t^+ - 1} \tag{3}$$

$$\rho_t^+ = \frac{n_{f,t}}{n_t s_t} = \frac{l_t^+ - 1}{l_t^+} \tag{4}$$

The real-time leverage evolves dynamically as the TOKEN price changes:

$$l_t^+ = \frac{l_0^+(1+r)}{1 + l_0^+ r} \tag{5}$$

where $r = \frac{s_t}{s_0} - 1$ is the cumulative return since initialization.

Where l^+ is the leverage for xPOSITIONs; n is the number of TOKEN collateral; s is the TOKEN price in USD; t is the time of the transaction; n_f is the amount of fxUSD minted via xPOSITIONs; X is NAV of xPOSITIONs; r is cumulative return since initialization; CR is the Collateral Ratio.

Numerical relationships between xPOSITION leverage, collateralization ratio and percent of fxUSD of the entire collateral

L	**CR**	ρ
2	200.00%	50.00%
3	150.00%	66.67%
4	133.33%	75.00%
5	125.00%	80.00%
6	120.00%	83.33%
7	116.67%	85.71%
8	114.29%	87.50%
9	112.50%	88.89%
10	111.11%	90.00%
11	110.00%	90.91%
12	109.09%	91.67%
13	108.33%	92.31%
14	107.69%	92.86%
15	107.14%	93.33%
16	106.67%	93.75%
17	106.25%	94.12%
18	105.88%	94.44%
19	105.56%	94.74%

Table 1: Leverage (L), Collateralization Ratio (CR), and Percentage (ρ)

sPOSITIONs

- *sPOSITION Leverage*: The ratio of borrowed collateral value to fxUSD collateral deposited.
- *Outstanding Collateral Debt Percentage*: The percentage of outstanding borrowed collateral relative to fxUSD collateral.
- *Collateralization Ratio*: The ratio of fxUSD collateral value to outstanding borrowed collateral.

The following equations illustrate the relationships between the critical parameters for sPOSITIONs:

$$l_t^- = \frac{n_t^- s_t}{SP_t} \tag{6}$$

$$CR_t^- = \frac{n_{f,t}^-}{n_t^- s_t} = \frac{l_t^- + 1}{l_t^-} \tag{7}$$

$$\rho_t^- = \frac{SP_t}{n_{f,t}^-} = \frac{l_t^-}{l_t^- + 1} \tag{8}$$

$$l_t^- = \frac{l_0^-(1+r)}{(1 - l_0^- r)} \tag{9}$$

where $r = \frac{s_t}{s_0} - 1$ is the cumulative return since initialization.

Where l^- is the leverage for sPOSITIONs; n is the number of TOKEN collateral; n^- is number of borrowed TOKEN collateral; s is the TOKEN price in USD; t is the time of the transaction; n_f^- amount of fxUSD deposited as collateral for sPOSITIONs; SP is NAV of sPOSITIONs; r is cumulative return since initialization; CR is the Collateral Ratio.

7.1 Risk Management Framework

In the $f(x)$ Protocol v2.1 design, the leverage ratio for both xPOSITIONs and sPOSITIONs is continuously monitored and managed to ensure system stability. The leverage ratios can be defined in several contexts for each position type:

For xPOSITIONs

- *Target xPOSITION Leverage* (L_0^+): The user-defined leverage ratio, ranging between 1.2X-10X
- *Real-Time xPOSITION Leverage (L_R^+)*: The current leverage ratio, which fluctuates based on market conditions and system activities.
- *Rebalance xPOSITION Leverage (L_{RR}^+)*: The threshold at which a Rebalance operation is triggered to restore the leverage to the rebalance line.

$$L_R^+ \geq L_{\mathrm{RR}}^+ \implies TriggerRebalance \tag{10}$$

- *Liquidation xPOSITION Leverage (L_L^+)*: The critical leverage ratio at which the system initiates liquidation to protect fxUSD's peg and ensure system stability.

$$L_R^+ \geq L_L^+ \implies TriggerLiquidation \tag{11}$$

For sPOSITIONs

- *Target sPOSITION Leverage* (L_0^-): The user-defined leverage ratio, ranging between 1.2X-10X

- *Real-Time sPOSITION Leverage (L_R^-)*: The current leverage ratio, which fluctuates based on market conditions and system activities.
- *Rebalance sPOSITION Leverage (L_{RR}^-)*: The threshold at which a Rebalance operation is triggered to restore the leverage to the rebalance line.

$$L_R^- \geq L_{\mathrm{RR}}^- \Longrightarrow TriggerRebalance \tag{12}$$

- *Liquidation sPOSITION Leverage (L_L^-)*: The critical leverage ratio at which the system initiates liquidation to protect fxUSD's peg and ensure system stability.

$$L_R^- \geq L_L^- \Longrightarrow TriggerLiquidation \tag{13}$$

7.2 Events Affecting Real-Time Leverage

For xPOSITIONs L_R^+

- *Changes in TOKEN Price*: Fluctuations in the price of the underlying collateral directly impacts the leverage ratio.
- *Changes in the xPOSITION*: Opening new or partially closing xPOSITION alters the xPOSITION leverage ratio.

For sPOSITIONs L_R^-

- *Changes in TOKEN Price*: Increases in the collateral asset price raise sPOSITION leverage, while decreases lower sPOSITION leverage.
- *Changes in the sPOSITION*: Opening additional sPOSITIONs or partially closing existing positions alters the sPOSITION leverage ratio.

7.3 Rebalance and Liquidation Triggers

For xPOSITIONs

- When the real-time xPOSITION leverage (L_R^+) reaches the rebalance threshold (L_{RR}^+), a rebalance operation is triggered to adjust it back to the rebalance line (L_{RR}^+).

- If the real-time xPOSITION leverage (L_R^+) continues to increase and reaches the liquidation threshold (L_L^+), the system initiates liquidation. This process redeems all fxUSD associated with the liquidated xPOSITION, effectively closing the position.

For sPOSITIONs

- When the real-time sPOSITION leverage (L_R^-) reaches the rebalance threshold (L_{RR}^-), a rebalance operation is triggered to adjust it back to the rebalance line (L_{RR}^-).
- If the real-time sPOSITION leverage (L_R^-) continues to increase and reaches the liquidation threshold (L_L^-), the system initiates liquidation. In liquidation, the protocol repays the outstanding borrowed TOKEN and redeems all corresponding amount of the fxUSD collateral held in the sPOSITION, effectively closing the position.

7.4 Risk Management Parameters

To maintain the stability of the system, specific risk management parameters are established for both xPOSITIONs and sPOSITIONs: the Rebalance threshold and Liquidation threshold. Both are carefully calibrated to trigger corrective actions when the probability of a position's NAV dropping to zero in the near term exceeds a predefined risk tolerance.

Our Value at Risk (VaR) methodology applies across all supported assets, incorporating each asset's historical volatility and market depth. The VaR model estimates the probability of extreme price movements within a defined response window, allowing the system to set leverage caps that minimize insolvency risk. For example, based on calculations for ETH, a 7.5% decline in the price of TOKEN has a 0.0001% probability of occurring within a span of 5 blocks. The time period for this calculation is selected based on the estimated duration required for the protocol's risk management mechanisms to respond effectively and mitigate risks posed by market fluctuations.

For xPOSITIONs, the model evaluates the downside risk of sharp price declines, as falling prices increase leverage for long positions. The maximum allowable leverage for xPOSITIONs is calibrated to ensure that the probability of NAV dropping below zero during the response window remains below the risk tolerance level.

For sPOSITIONs, the same methodology is applied symmetrically, but with respect to upside price movements. As the price of TOKEN increases, sPOSITION leverage rises, introducing solvency risk. The VaR model similarly determines the maximum allowable leverage for sPOSITIONs based on the probability of extreme price increases over the defined response period.

To formally express the risk management model, the following parameters are defined:

- r: cumulative return of the collateral asset
- Δt: number of blocks keepers need to complete rebalancing/liquidation
- α: risk tolerance, i.e., the acceptable probability of NAV falling to zero

The system applies the following probabilistic constraints to determine risk thresholds for both position types:

For xPOSITIONs:

$$\Pr\left(r_{\Delta t} \leq -VaR_{\Delta t,\alpha}\right) \leq \alpha$$

For sPOSITIONs:

$$\Pr\left(r_{\Delta t} \geq r_{\Delta t,\alpha}\right) \leq \alpha$$

Where $VaR_{\Delta t,\alpha}$ represents the estimated price movement threshold that would breach solvency limits within the response window, given the chosen risk tolerance α. These constraints ensure that the probability of NAV falling to zero remains below the accepted tolerance level.

In summary, if the leverage of any position exceeds its rebalance threshold, it is automatically adjusted back to the rebalance line through a keeper-initiated rebalance operation. Should liquidation occur, the system redeems collateral to cover outstanding debt, with remaining collateral redistributed or sold through auction mechanisms to incentivize market participants, regardless of whether the liquidation originates from an xPOSITION or sPOSITION.

7.5 Reserve Fund

The Reserve Fund is designed to strengthen $f(x)$ Protocol's resilience against potential failures of the Rebalance and Liquidation mechanisms. In scenarios where extreme market volatility prevents timely execution of rebalancing or

liquidation, and positions become under-collateralized, the Reserve Fund acts as a secondary buffer to absorb resulting bad debt.
To further bolster the protocol's stability and ensure robustness in adverse scenarios, a portion of the protocol's fees and revenue (see Section 10) will be allocated to the Reserve Fund. The specific allocation percentage for this fund will be determined by governance and may be adjusted over time as market conditions and protocol parameters evolve.
The Reserve Fund operates passively and is only accessed after rebalancing and liquidation mechanisms have been exhausted for either long or short positions. This additional defense layer minimizes the likelihood of contagion between positions and enhances the protocol's ability to withstand extreme market events.

7.6 Bad Debt Redistribution

In the event that the Reserve Fund is insufficient to fully cover losses, the remaining under-collateralized debt is redistributed across active positions according to the following sequence:

- For bad debt originating from sPOSITIONs, the debt is first redistributed proportionally across all healthy sPOSITIONs based on their remaining NAV.
- For bad debt originating from xPOSITIONs, the debt is redistributed proportionally across all active xPOSITIONs according to their respective NAV sizes.

In extreme market conditions where both long and short positions experience simultaneous insolvency and all protection layers are exhausted, system-wide deleveraging may occur, resulting in full or partial write-downs across all positions. While highly improbable, these extreme scenarios are fully incorporated into the protocol's risk framework.

7.7 Recapitalization

If the protocol's total collateralization ratio falls below 100%, a recapitalization process will be initiated. During this period, xPOSITION opening, closing, rebalancing and liquidation operation are functioning as normal
When system-wide bad debt accumulation from sPOSITIONs exceeds the available reserves, the sPOSITION subsystem enters recapitalization freeze. At this stage, no new sPOSITIONs may be opened, and existing sPOSITIONs

cannot be closed, rebalanced, or liquidated. If the bad debt exceeds the total collateral value of surviving sPOSITIONs, since sPOSITIONs borrow collateral assets directly from the leverage long reserve, any remaining shortfall is subsequently passed through to xPOSITIONs via proportional NAV reductions.

The protocol will simultaneously deploy all available resources, including treasury assets, accumulated fees, and governance tokens, to restore fxUSD's peg and rebalance system reserves. Recapitalization continues until full collateralization is restored or the system transitions into extreme risk management scenarios.

7.8 Extreme Scenarios

In rare tail-risk market conditions where all risk management layers have failed (Rebalancing, Liquidation, Reserve Fund, Bad Debt Redistribution, and Recapitalization), the protocol enters a full deleveraging process. These scenarios are modeled to ensure full transparency around system-wide risk exposures, even though their occurrence remains extremely unlikely.

8 Advanced Peg Protection Mechanisms

$f(x)$ Protocol utilizes a range of mechanisms to maintain a stable and reliable peg for fxUSD at all times. These systems are designed to ensure stability, mitigate volatility, and uphold the integrity of the stablecoin under all market conditions.

8.1 Stability Pool as Peg Keeper

The Stability Pool acts as a peg keeper for the fxUSD/USDC AMM pool and provides liquidity to support system stability during liquidation events. USDC held in the Stability Pool is utilized to purchase fxUSD from the AMM whenever favorable exchange conditions allow acquiring fxUSD below peg. Conversely, fxUSD will be exchanged for USDC when it can be traded for a greater amount of USDC from the AMM.

While sPOSITION opening, closing, rebalancing, and liquidation operation interact exclusively with the fxUSD/USDC LP, in very rare cases, they may indirectly influence the Stability Pool's peg-keeping activities.

8.2 Operational Restrictions During Depegging

If fxUSD depegs, no new xPOSITIONs can be opened, preventing the minting of additional fxUSD until the peg is restored. sPOSITIONs remain available for opening during this period, as they require fxUSD collateral to open and thereby reduce circulating supply, contributing to peg stabilization. Existing positions on both sides may continue to be closed at any time. Restoration of the fxUSD peg can occur through xPOSITION closures, sPOSITIONs opening, Stability Pool arbitrage or by depositing fxUSD in the Stability Pool from the AMM pool.

8.3 Dynamic Funding Fee Model

The protocol employs a dynamic funding fee model as an additional peg stabilization mechanism, designed to balance fxUSD supply and demand across both xPOSITIONs and sPOSITIONs under varying market conditions.

Funding Fees Charged to xPOSITIONs

xPOSITION funding fees are activated during periods of elevated fxUSD supply or peg stress. Funding fees are determined based on the percentage of fxUSD held within the Stability Pool:

- When the percentage of fxUSD in the Stability Pool exceeds **Threshold A, Funding Level I** activates. The funding fee is set approximately equal to the prevailing USDC money-market borrowing rate (e.g., Aave USDC borrow rate).
- If fxUSD depegs and exceeds **Threshold B, Funding Level II** activates. This higher funding fee is set at a significantly elevated level (e.g., a multiplier of Aave USDC borrow rate) to accelerate deleveraging and encourage peg restoration.

Funding Fees Charged to sPOSITIONs

sPOSITION funding fees are applied when utilization of long collateral assets exceeds prudent lending thresholds:

- When the percentage of leverage long collateral lent out to sPOSITIONs exceeds **Threshold C, Funding Level III** activates. This funding fee is applied to all open sPOSITIONs borrowing the corresponding collateral asset.

- Funding Level III is designed to protect reserve liquidity for xPOSITIONs, ensuring that sufficient long collateral remains available for closures, rebalancing, and liquidations. Based on system parameters, when the utilization of long collateral by sPOSITIONs exceeds a predefined threshold (set via governance), Funding Level III is activated and applied to open sPOSITIONS. Funding Level III is calibrated at an aggressive rate (e.g., a multiplier of Aave ETH borrow rate) to discourage excessive short utilization.

sPOSITION funding fees are only applied to sPOSITIONs borrowing collateral types whose utilization exceeds Threshold C.
All thresholds and funding levels are subject to adjustment via protocol governance.

8.4 Reserve Utilization Limits

In addition to funding fees, the protocol enforces reserve utilization caps to preserve long-side collateral liquidity. When the percentage of long collateral lent out to sPOSITIONs exceeds a pre-defined utilization cap, no new sPOSITIONs may be opened for that collateral asset. Existing sPOSITIONs remain open and continue operating under their current leverage and funding parameters. This mechanism ensures that sufficient reserves remain available to support long position closures, rebalancing, liquidations, and fxUSD redemptions even under elevated short demand conditions.

8.5 Redemption of fxUSD

If fxUSD falls below \$1.00, users can acquire fxUSD from the secondary market and initiate redemption for \$1.00 worth of collateral from the system reserve.
For xPOSITIONs, redemptions are prioritized based on leverage levels, starting with the highest leveraged positions first and proceeding in descending order. In each redemption cycle, up to 20% of outstanding fxUSD debt from eligible positions may be redeemed, ensuring that redemptions occur gradually and allow the system to adjust without triggering unnecessary liquidations. This process continues across leverage bands until the peg is restored.

Extreme Scenarios

In cases where long-side TOKEN reserves become insufficient to fulfill xPOSITION closing, rebalancing, liquidation, or fxUSD redemption operations, users or keepers may receive special fxCOLLATERAL tokens (e.g., fxETH), representing claims on the remaining leveraged long collateral. sPOSITIONS may also be partially impacted through controlled deleveraging: the positions with the highest leverage levels may be temporarily deleveraged by up to 20%, releasing additional collateral into the reserve. This mechanism functions as an auto-deleveraging (ADL) system, maintaining system solvency under extreme liquidity stress, while preserving fxUSD redeemability even in adverse market conditions.

8.6 Peg-Based USDC Repayment Option for xPOSITION Closures

When fxUSD trades at a predefined premium in AMM markets, the system may accept USDC instead of fxUSD for closing an xPOSITION. The submitted USDC is temporarily held in the Transformer Module and subsequently used to repurchase fxUSD from the AMM once the fxUSD peg returns to \$1.00. The repurchased fxUSD is then burned, following the standard closure process.
USDC repayment for xPOSITION closing, rebalancing, and liquidation is disabled if USDC depegs below predetermined threshold.

9 Band System

All collateral positions are placed into a band system based on their rebalance lines. Each band encompasses a specific price range, with the upper limit set at 0.15% above the lower limit. This band system enhances the efficiency of rebalancing and redemption transactions by consolidating all positions within the same band into a single transaction.

9.1 Rebalance Operations

For rebalancing operations, both xPOSITIONs and sPOSITIONs are continuously monitored relative to their respective price thresholds.
For xPOSITIONs, rebalancing is triggered when the price of the underlying TOKEN declines, causing leverage to rise. Once the current price of TOKEN falls below the upper bound of a predefined rebalance band, all

xPOSITIONs within that band become eligible for rebalancing.
For sPOSITIONs, rebalancing is triggered when the price of the underlying TOKEN rises, causing short-side leverage to increase. Once the current price of TOKEN exceeds the upper limit of the rebalance band for sPOSITIONs, rebalancing is similarly initiated.

9.2 fxUSD Redemption

During the redemption of fxUSD, the process will start with the bands that have the highest leverage.

9.3 Position Adjustments

Both xPOSITIONs and sPOSITIONs are organized into dynamic leverage bands that are continuously updated as market conditions evolve. Positions are reassigned into appropriate bands whenever their leverage is adjusted due to rebalancing, redemption operations, user-initiated position changes, redistribution of bad debt, or the accumulation of funding fees. This band structure ensures efficient prioritization of positions for rebalancing, liquidation, and redemption processes, while maintaining consistent leverage distribution across the system.

10 Fees and Revenue

$f(x)$ Protocol v2.1 will charge fees and earn revenue from:

- *TOKEN Yields from Collateral*: The protocol will earn yields from part of the collateral held, providing a continuous revenue stream.

- *External Collateral Rehypothecation*: A portion of idle collateral reserves may be allocated to external money markets to generate additional yield for the protocol. This rehypothecation is governed by risk parameters and treasury policies to ensure reserve liquidity and solvency are maintained.

- *Redeeming Fees for fxUSD*: Fees will be applied when fxUSD is redeemed on a single-sided basis. The redeeming fee effectively sets the minimum peg defended by the system.

- *Opening and Closing Fees for xPOSITIONs and sPOSITIONs*: A fee will be applied when opening or closing both xPOSITIONs and

sPOSITIONs. Fees are calculated based on the total notional size of the position.

- *Rebalance Fees for xPOSITIONs and sPOSITIONs*: The protocol will charge fees for the rebalance operations of both xPOSITIONs and sPOSITIONs. These fees are offered as auction discounts to incentivize market keepers to perform rebalancing actions.
- *Liquidation Fees for xPOSITION and sPOSITIONs*: The protocol will charge fees for the liquidation operations of both xPOSITIONs and sPOSITIONs. Liquidation fees are offered as auction discounts to market keepers as compensation for executing liquidations.
- *Funding Fees for Holding xPOSITION (Funding Level I)*: When the percentage of fxUSD in the Stability Pool exceeds Threshold A, users holding xPOSITIONs will incur funding fees.
- *Funding Fees for Holding xPOSITION (Funding Level II)*: When fxUSD is depegged, users holding xPOSITIONs will incur funding fees.
- *Funding Fees for Holding sPOSITION (Funding Level III)*: When the utilization of long collateral lent out to sPOSITIONs exceeds Threshold C, sPOSITION holders will incur funding fees.

All fees generated will be distributable to the Stability Pool and/or the $f(x)$ treasury. The percentage of distribution between the Stability Pool and/or the treasury will be managed by governance. Additionally, 75% of the revenue allocated to the $f(x)$ treasury will be distributed to veFXN holders. Part or all of the xPOSITIONs funding fees might be distributed to active sPOSITIONs. Part or all of the sPOSITIONs funding fees might be distributed to active xPOSITIONs. The distributed amount is set by governance.

11 Conclusion

AladdinDAO has successfully upgraded $f(x)$ Protocol v2.0, introducing significant innovations that expand both the protocol's functionality and market reach. This upgraded version enables users to access both long and short leverage products through the introduction of xPOSITIONs and sPOSITIONs, two complementary DeFi primitives that allow for fully collateralized, liquidation-protected leverage on major crypto assets such as ETH, BTC, and other blue-chip tokens.

With the integration of sPOSITIONs, $f(x)$ Protocol extends its utility by enabling leveraged short positions while preserving the system's core stability design. The protocol offers highly capital-efficient leverage without recurring funding costs, minimal liquidation risks, or external dependencies on oracles. A robust multi-layered risk management framework ensures system solvency through dynamic rebalancing, liquidation buffers, reserve funds, and adaptive funding mechanisms.

At its foundation, $f(x)$ Protocol remains anchored by its original stablecoin design: USD-based, delta-neutral stability pools that offer sustainable yield from staking rewards, rehypothecation strategies, lending fees, and protocol revenue streams. This model enables users to earn yield while contributing to system stability, and allows leveraged traders to operate with predictable, transparent leverage structures.

As the protocol continues to evolve, its fully decentralized and composable architecture positions $f(x)$ Protocol at the forefront of high-yield stablecoin strategies and leveraged trading infrastructure, addressing growing demand for capital-efficient leverage in the DeFi ecosystem. This positions $f(x)$ Protocol for sustained growth as one of the most advanced decentralized leverage and stablecoin platforms in the market.