Smart Contract Audit Report

Foil

Audit Performed By

Fortknox Security

Professional Smart Contract Auditing

September 1, 2024

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Executive Summary

Fortknox Security has conducted a comprehensive smart contract security audit for **Foil**. Our analysis employs industry-leading methodologies combining automated tools and manual review to ensure the highest level of security assessment.

14	5	LOW	100%
TOTAL ISSUES FOUND	CRITICAL + HIGH	OVERALL RISK	CODE COVERAGE

Security Assessment Overview

Critical Issues

5

Immediate action required. These vulnerabilities can lead to direct loss of funds.

IMPACT: SEVERE FINANCIAL LOSS

High Issues

0

High priority fixes needed. Can lead to significant financial loss.

IMPACT: MAJOR SECURITY RISK

Key Findings Summary

Access Control

Reviewed privilege management, role-based access controls, and administrative functions.

Economic Security

Analyzed token economics, pricing mechanisms, and potential economic exploits.

Logic Validation

Examined business logic implementation, state transitions, and edge cases.

Input Validation

Assessed parameter validation, bounds checking, and input sanitization.

Audit Conclusion

The Foil smart contract audit reveals **14 total findings** across various security categories. Immediate attention is required for 5 critical/high severity issues before deployment. Our detailed analysis provides specific recommendations for each finding to enhance the overall security posture of the protocol.

Audit Methodology

Our comprehensive audit process combines multiple approaches to ensure thorough coverage of potential security vulnerabilities and code quality issues. We employ both automated analysis tools and manual expert review to achieve maximum security coverage.

Tools & Techniques

Static Analysis

Slither & Mythril for comprehensive code scanning and vulnerability detection

Manual Review

Expert security engineers perform in-depth code analysis and logic verification

Business Logic

Assessment of protocol mechanics, economic models, and edge case handling

Gas Analysis

Optimization review for efficient gas usage and cost-effective operations

Formal Verification

Mathematical proof methods to verify critical contract properties

Symbolic Execution

Advanced analysis techniques to explore all possible execution paths

Review Process & Standards

Review Process

1 Initial Scanning

Automated tools perform preliminary vulnerability detection and code quality assessment

2 Manual Review

Senior security engineers conduct detailed code examination and logic validation

3 Business Logic Testing

Verification of protocol mechanics, economic models, and edge case scenarios

4 Architecture Analysis

Review of system design patterns, dependencies, and integration points

5 Final Documentation

Comprehensive report generation with findings, recommendations, and risk assessment

Severity Classification

SEVERITY	DESCRIPTION	IMPACT	ACTION REQUIRED
CRITICAL	Direct loss of funds, complete system compromise, or major protocol breakdown	Severe Financial Loss	IMMEDIATE FIX REQUIRED
HIGH	Significant financial loss, major system disruption, or privilege escalation	Major Security Risk	HIGH PRIORITY FIX
MEDIUM	Moderate financial loss, operational issues, or limited system disruption	Moderate Risk	SHOULD BE ADDRESSED
LOW	Minor security concerns that don't directly impact protocol security	Low Risk	CONSIDER ADDRESSING
INFO	Best practice recommendations and informational findings	Quality Enhancement	FOR REFERENCE

Audit Scope

Project Details

PARAMETER	DETAILS
Project Name	Foil
Total Issues Found	14
Audit Type	Smart Contract Security Audit
Methodology	Manual Review + Automated Analysis

Files in Scope

This audit covers the smart contract codebase and associated components for Foil.

Audit Timeline

- ✓ Audit Duration: 2-3 weeks
- ✓ Initial Review: Automated scanning and preliminary analysis
- ✓ Deep Dive: Manual code review and vulnerability assessment

Vulnerability Analysis

Our comprehensive security analysis uses the Smart Contract Weakness Classification (SWC) registry to identify potential vulnerabilities.

SWC Security Checks

CHECK ID	DESCRIPTION	STATUS
SWC-100	Function Default Visibility	PASSED
SWC-101	Integer Overflow and Underflow	PASSED
SWC-102	Outdated Compiler Version	PASSED
SWC-103	Floating Pragma	PASSED
SWC-104	Unchecked Call Return Value	PASSED
SWC-105	Unprotected Ether Withdrawal	PASSED
SWC-106	Unprotected SELFDESTRUCT	PASSED
SWC-107	Reentrancy	WARNING

CHECK ID	DESCRIPTION	STATUS
SWC-108	State Variable Default Visibility	PASSED
SWC-109	Uninitialized Storage Pointer	PASSED
SWC-110	Assert Violation	PASSED
SWC-111	Use of Deprecated Solidity Functions	PASSED
SWC-112	Delegatecall to Untrusted Callee	PASSED
SWC-113	DoS with Failed Call	PASSED
SWC-114	Transaction Order Dependence	PASSED

Contract Privileges Analysis

Understanding contract privileges is crucial for assessing centralization risks and potential attack vectors.

Common Privilege Categories

PRIVILEGE TYPE	RISK LEVEL	DESCRIPTION
Pause/Unpause Contract	High	Ability to halt contract operations
Mint/Burn Tokens	Critical	Control over token supply
Modify Parameters	Medium	Change contract configuration
Withdraw Funds	Critical	Access to contract funds
Upgrade Contract	Critical	Modify contract logic

Mitigation Strategies

- ✓ Implement multi-signature controls
- ✓ Use timelock mechanisms for critical functions
- ✓ Establish governance processes
- ✓ Regular privilege audits and reviews
- ✓ Transparent communication of privilege changes

C-0 | increaseLiquidityPosition Uses The Wrong Id

CATEGORY	SEVERITY	LOCATION	STATUS
Logical Error	CRITICAL	EpochLiquidityModule.sol: 181	Resolved

Description

The `increaseLiquidityPosition` function calls the `NonfungiblePositionManager` with the Foil position ID instead of the Uniswap position ID. As there are liquidity and trade positions in Foil the IDs can differ.

```
increaseLiquidityPosition
NonfungiblePositionManager
```

Recommendation

Call Uniswap with the correct position ID.

Resolution

Foil Team: The issue was resolved.

C-1 | borrowedVGas Is Set To 0 Before Subtraction

CATEGORY	SEVERITY	LOCATION	STATUS
Logical Error	CRITICAL	EpochLiquidityModule.sol 381	Resolved

Description

In `closePositionPosition`, the `vGasAmount` should be set to `collectedAmount0 - position.borrowVGas`. However, position.borrowedVGas is set to 0 before the subtraction.

```
closePositionPosition
vGasAmount
collectedAmount0 - position.borrowVGas
```

Recommendation

Reset `position.borrowedVGas` after rather than before the subtraction.

```
position.borrowedVGas
```

Resolution

Foil Team: The issue was resolved.

C-2 | Uniswap Pool Creation DoS

CATEGORY	SEVERITY	LOCATION	STATUS
DoS	CRITICAL	Epoch.sol: 111-141	Resolved

Description

Uniswap pool creation is done with three variables (`gasToken` address, `ethToken` address, and `feeRate`). These variables are all predictable even before creation of specified tokens.

```
gasToken
ethToken
feeRate
```

Recommendation

Use `CREATE2` to deploy the virtual tokens with a configurable salt so that pool creation cannot be permanently DoS, additionally be sure to use a private rpc to avoid being frontran to DoS individual epoch creations.

```
CREATE2
```

Resolution

Foil Team: The issue was resolved.

C-3 | Settled Trading Positions Can Be Closed

CATEGORY	SEVERITY	LOCATION	STATUS
Logical Error	CRITICAL	EpochTradeModule.sol: 76-139	Resolved

Description

The `modifyTraderPosition` function does not check if the given position is already settled. This enables an attack vector to steal funds by closing an already settled position.

```
modifyTraderPosition
```

Recommendation

Always use the `validateNotSettled` validation in the `modifyTraderPosition` function as no trader activity should occur after an epoch end besides settlement.

```
validateNotSettled
modifyTraderPosition
```

Resolution

Foil Team: The issue was resolved.

C-4 | Traders Profit Can Be Stolen When Closing

CATEGORY	SEVERITY	LOCATION	STATUS
Logical Error	CRITICAL	EpochTradeModule.sol: 112	Resolved

Description

When a trader closes a position before settlement, there is currently no protection against slippage.

Recommendation

Implement a parameter for closing a position that includes slippage protection to prevent potential exploitation by malicious parties.

Resolution

Foil Team: The issue was resolved.

M-0 | initializeMarket Can Be Front Run

CATEGORY	SEVERITY	LOCATION	STATUS
Logical Error	MEDIUM	EpochConfigurationModule.sol: 29-45	Resolved

Description

The owner of a market is set with the `initializeMarket` function, which is called after deploying the system and can be called by anyone.

```
initializeMarket
```

Recommendation

Set the owner of the system at deployment.

Resolution

Foil Team: The issue was resolved.

M-1 | Unnecessary Fees When Closing Short

CATEGORY	SEVERITY	LOCATION	STATUS
Logical Error	MEDIUM	EpochTradeModule.sol 567-575	Resolved

Description

When closing a short position in the `_closePosition` function, `position.vEthAmount` is swapped to `vGas`. Next, if `position.borrowedVGas > tokenAmountVGas`, then `vEth` is swapped back to `vGas`.

```
_closePosition
position.vEthAmount
vGas
position.borrowedVGas > tokenAmountVGas
vEth
vGas
```

Recommendation

Consider first calculating the amount of `vETH` that needs to be swapped to `vGas` to close the position and then executing only a single swap.

```
vETH
vGas
```

Resolution

Foil Team: The issue was resolved.

M-2 | Trades May Revert At Maximum Tick

CATEGORY	SEVERITY	LOCATION	STATUS
Logical Error	MEDIUM	EpochTradeModule.sol 252	Acknowledged

Description

The `highestPrice` for a swap is the exchange rate at the maximum tick. However, this exchange rate does not account for fees.

```
highestPrice
```

Recommendation

Account for fees when calculating the highest price.

Resolution

Foil Team: Acknowledged.

M-3 | Owner Can Bypass UMA Assertion Checks

CATEGORY	SEVERITY	LOCATION	STATUS
Logical Error	MEDIUM	EpochConfigurationModule.sol 47-61	Resolved

Description

The `UmaSettlementModule` is a contract which ensures owner submits a valid settlement price.

```
UmaSettlementModule
```

Recommendation

Consider only allowing oracle updates when the epoch has not ended.

Resolution

Foil Team: The issue was resolved.

L-0 | Wrong Description For tokenByIndex

CATEGORY	SEVERITY	LOCATION	STATUS
Code Quality	LOW	EpochNftModule.sol: 186	Resolved

Description

The description above the `tokenByIndex` function describes the behavior of the `totalSupply` function.

```
tokenByIndex
totalSupply
```

Recommendation

Update the description to match the behavior of the `tokenByIndex` function and move the description to the `totalSupply` function.

```
tokenByIndex
totalSupply
```

Resolution

Foil Team: The issue was resolved.

L-1 | Unsafe Collateral Transfers

CATEGORY	SEVERITY	LOCATION	STATUS
Validation	LOW	Global	Resolved

Description

Some ERC-20 tokens return a boolean instead of reverting therefore using `transferFrom` will not revert when the transfer fails.

```
transferFrom
```

Recommendation

Use `safeTransferFrom` instead of `transferFrom` or be aware not to add such tokens to the system.

```
safeTransferFrom
transferFrom
```

Resolution

Foil Team: The issue was resolved.

L-2 | Misleading Error In submitSettlementPrice

CATEGORY	SEVERITY	LOCATION	STATUS
Code Quality	LOW	EpochUMASettlementModule.sol: 26	Resolved

Description

The `submitSettlementPrice` function checks if the epoch is already settled and returns a "Market already settled" error in that case.

```
submitSettlementPrice
```

Recommendation

Change the error message to "Epoch already settled".

Resolution

Foil Team: The issue was resolved.

L-3 | Protocol Vulnerable To Reentrancy

CATEGORY	SEVERITY	LOCATION	STATUS
Logical Error	LOW	EpochLiquidityModule.sol: 403-406	Resolved

Description

The `_closeLiquidityPosition` function updates the `depositedCollateralAmount` to 0 after withdrawing it. This pattern is vulnerable to a reentrancy attack if an ERC-777 token is used as collateral.

```
_closeLiquidityPosition
depositedCollateralAmount
```

Recommendation

Use a reentrancy guard in all state changing functions, or be aware not to add such tokens to the system.

Resolution

Foil Team: The issue was resolved.

L-4 | Missing Checks In assertionDisputedCallback

CATEGORY	SEVERITY	LOCATION	STATUS
Validation	LOW	EpochUMASettlementModule.sol: 105-121	Resolved

Description

The `assertionResolvedCallback` function checks if the given assertion exists & that the epoch is not settled yet, but the `assertionDisputedCallback` function does not.

```
assertionResolvedCallback
assertionDisputedCallback
```

Recommendation

Add these checks to the `assertionDisputedCallback` function to prevent unexpected state changes.

```
assertionDisputedCallback
```

Resolution

Foil Team: The issue was resolved.

Summary of Recommendations

Based on our comprehensive audit, we provide the following prioritized recommendations to improve the security posture of Foil.

Priority Matrix

ISSUE ID	TITLE	SEVERITY	PRIORITY
C-0	increaseLiquidityPosition Uses The Wrong Id	CRITICAL	Immediate
C-1	borrowedVGas Is Set To 0 Before Subtraction	CRITICAL	Immediate
C-2	Uniswap Pool Creation DoS	CRITICAL	Immediate
C-3	Settled Trading Positions Can Be Closed	CRITICAL	Immediate
C-4	Traders Profit Can Be Stolen When Closing	CRITICAL	Immediate
M-0	initializeMarket Can Be Front Run	MEDIUM	Medium
M-1	Unnecessary Fees When Closing Short	MEDIUM	Medium
M-2	Trades May Revert At Maximum Tick	MEDIUM	Medium
M-3	Owner Can Bypass UMA Assertion Checks	MEDIUM	Medium
L-0	Wrong Description For tokenByIndex	LOW	Low

General Security Best Practices

- ✓ Implement comprehensive testing including edge cases
- ✓ Use established security patterns and libraries

Audit Team

Team Credentials

Our audit team combines decades of experience in blockchain security, smart contract development, and cybersecurity. Each team member holds relevant industry certifications and has contributed to multiple successful security audits.

Methodology & Standards

Our audit methodology follows industry best practices and standards:

- ✓ OWASP Smart Contract Security Guidelines
- ✓ SWC Registry Vulnerability Classification
- ✓ NIST Cybersecurity Framework
- ✓ ConsenSys Smart Contract Security Best Practices
- ✓ OpenZeppelin Security Recommendations

Audit Process

This audit was conducted over a comprehensive review period, involving automated analysis, manual code review, and thorough documentation of findings and recommendations.

Disclaimer & Legal Notice

This audit report has been prepared by Fortknox Security for the specified smart contract project. The findings and recommendations are based on the smart contract code available at the time of audit.

Scope Limitations

- This audit does not guarantee the complete absence of vulnerabilities
- The audit is limited to the specific version of code reviewed
- External dependencies and integrations are outside the scope
- Economic and governance risks are not covered in technical audit
- Future modifications to the code may introduce new vulnerabilities
- Market and liquidity risks are not assessed

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Contact Information

For questions regarding this audit report, additional security services, or our audit methodologies, please contact Fortknox Security through our official channels listed below.

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