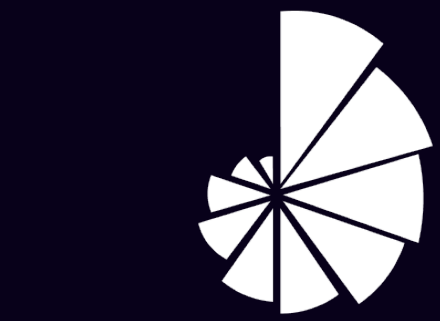


GAiN.Ai

AI POWERED POOLS

SMART CONTRACT AUDIT

zokyo

February 6th 2022 | v. 1.0

Security Audit Score

PASS

Zokyo Security has concluded that this smart contract passes security qualifications to be listed on digital asset exchanges.

TECHNICAL SUMMARY

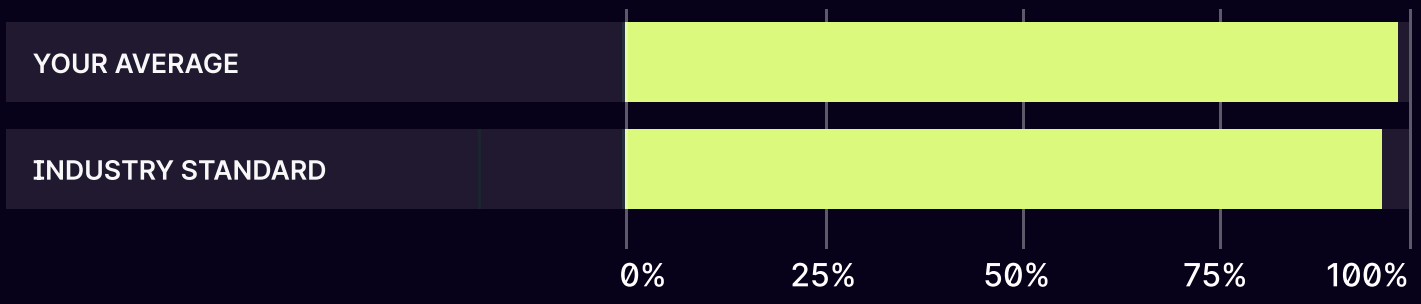
This document outlines the overall security of the Gain smart contracts evaluated by the Zokyo Security team.

The scope of this audit was to analyze and document the Gain smart contract codebase for quality, security, and correctness.

Contract Status

There were 0 critical issues found during the audit. (See Complete Analysis)

Testable Code



100% of the code is testable, which is above the industry standard of 95%.

It should be noted that this audit is not an endorsement of the reliability or effectiveness of the contracts but rather limited to an assessment of the logic and implementation. In order to ensure a secure contract that can withstand the Ethereum network's fast-paced and rapidly changing environment, we recommend that the Gain team put in place a bug bounty program to encourage further active analysis of the smart contracts.

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AUDITING STRATEGY AND TECHNIQUES APPLIED

The source code of the smart contract was taken from the Gain repository:
https://github.com/GainDAO/token

Last commit: 973c76e1e8bdbeffe2444be963b9777381358090

Within the scope of this audit, the team of auditors reviewed the following contract(s):

- ERC20Distribution.sol
- GainDAOToken.sol

During the audit, Zokyo Security ensured that the contract:

- Implements and adheres to the existing standards appropriately and effectively;
- The documentation and code comments match the logic and behavior;
- Distributes tokens in a manner that matches calculations;
- Follows best practices, efficiently using resources without unnecessary waste;
- Uses methods safe from reentrance attacks;
- Is not affected by the most resent vulnerabilities;
- Meets best practices in code readability, etc.

Zokyo Security has followed best practices and industry-standard techniques to verify the implementation of Gain smart contracts. To do so, the code was reviewed line by line by our smart contract developers, who documented even minor issues as they were discovered. Part of this work includes writing a test suite using the Hardhat testing framework. In summary, our strategies consist largely of manual collaboration between multiple team members at each stage of the review:

01	Due diligence in assessing the overall code quality of the codebase.
02	Cross-comparison with other, similar smart contracts by industry leaders.
03	Testing contracts logic against common and uncommon attack vectors.
04	Thorough manual review of the codebase line by line.

Executive Summary

Contracts are well written and structured. There was no critical issue found during the audit, alongside one with medium severity, some of low severity and one informational issue . All the mentioned findings may have an effect only in case of specific conditions performed by the contract owner and the investors interacting with it. They are described in detail in the “Complete Analysis” section.

STRUCTURE AND ORGANIZATION OF THE DOCUMENT

For the ease of navigation, the following sections are arranged from the most to the least critical ones. Issues are tagged as “Resolved” or “Unresolved” depending on whether they have been fixed or addressed. The issues that are tagged as “Verified” contain unclear or suspicious functionality that either needs explanation from the Client or remains disregarded by the Client. Furthermore, the severity of each issue is written as assessed by the risk of exploitation or other unexpected or otherwise unsafe behavior:

Critical

The issue affects the contract in such a way that funds may be lost, allocated incorrectly, or otherwise result in a significant loss.

High

The issue affects the ability of the contract to compile or operate in a significant way.

Medium

The issue affects the ability of the contract to operate in a way that doesn’t significantly hinder its behavior.

Low

The issue has minimal impact on the contract’s ability to operate.

Informational

The issue has no impact on the contract’s ability to operate.

COMPLETE ANALYSIS

Findings Summary

#	Title	Risk	Status
1	Wrong Guard Function	Medium	Resolved
2	Unnecessary operation	Low	Resolved
3	Gas optimization	Low	Resolved
4	Gas optimization	Low	Resolved
5	Setter applied with no event emitted	Informational	Resolved

MEDIUM | RESOLVED

Wrong Guard Function.

ERC20Distribution.sol - In the `purchaseTokens` assert() function was used to check the rate and balance or token. But rate and balance were calculated by parameters, so these checks can be false. assert() is used to check for code that should never be false, the role of assert() is to declare statements that you think will always hold. When an assent() statement fails, something very wrong and unexpected has happened, and you need to fix your code. Also, users can lose all gas when transaction fails by assert(), if it fails by require, the gas that was not used up to that moment will be reimbursed.

Recommendation:
Use require() instead of assert().

LOW | RESOLVED

Unnecessary operation.

ERC20Distribution.sol - In the `startDistribution` there is a check to ensure that the contract balance of the distributed token and the `_total_distribution_balance` are the same. However, the next operation assigns the contract balance of the distributed token to the `_total_distribution_balance`, this makes the logic to be redundant.

Recommendation:
Remove this line.

```
_total_distribution_balance = _trusted_token.balanceOf(address(this));
```

LOW | RESOLVED

Gas optimization.

ERC20Distribution.sol - In the `claimFiatToken`, The result of the transfering _fiat_token is boolean. So there is no need to compare with true, It will cause more gas consumption.

```
require(result==true,
  "Claim: transfer must succeed"
);
```

Recommendation:

```
require(result,
  "Claim: transfer must succeed"
);
```

LOW | RESOLVED

Gas optimization

ERC20Distribution.sol - In the `purchaseTokens`, The result of the transfering _fiat_token is boolean. So there is no need to compare with true, It will cause more gas consumption.

```
require(
  result1 == true &&
    _fiat_token.balanceOf(address(this)) - initfiatbalance == fiattoken_amount,
  "PurchaseTokens: fiat transfer must succeed"
);
```

```
require(
  result2==true &&
    inittokenbalance - _trusted_token.balanceOf(address(this))==trustedtoken_amount,
  "PurchaseTokens: token transfer must succeed"
);
```

Recommendation:

```
require(
  result1 &&
    _fiat_token.balanceOf(address(this)) - initfiatbalance == fiattoken_amount,
  "PurchaseTokens: fiat transfer must succeed"
);
```

```
require(
  result2 &&
    inittokenbalance - _trusted_token.balanceOf(address(this))==trustedtoken_amount,
  "PurchaseTokens: token transfer must succeed"
);
```

INFORMATIONAL | RESOLVED

Setter applied with no event emitted.

ERC20Distribution.sol - In the `changeKYCApprover`
it is noticed that events are emitted after calling the setter methods in this contract.

Recommendation:
Add event emitter which emit new KYC approver address.

	GainDAOToken.sol	ERC20Distribution.sol
Re-entrancy	Pass	Pass
Access Management Hierarchy	Pass	Pass
Arithmetic Over/Under Flows	Pass	Pass
Unexpected Ether	Pass	Pass
Delegatecall	Pass	Pass
Default Public Visibility	Pass	Pass
Hidden Malicious Code	Pass	Pass
Entropy Illusion (Lack of Randomness)	Pass	Pass
External Contract Referencing	Pass	Pass
Short Address/ Parameter Attack	Pass	Pass
Unchecked CALL Return Values	Pass	Pass
Race Conditions / Front Running	Pass	Pass
General Denial Of Service (DOS)	Pass	Pass
Uninitialized Storage Pointers	Pass	Pass
Floating Points and Precision	Pass	Pass
Tx.Origin Authentication	Pass	Pass
Signatures Replay	Pass	Pass
Pool Asset Security (backdoors in the underlying ERC-20)	Pass	Pass

CODE COVERAGE AND TEST RESULTS FOR ALL FILES

Tests written by Zokyo Security

As a part of our work assisting Gain in verifying the correctness of their contracts code, our team was responsible for writing integration tests using the Hardhat testing framework.

The tests were based on the functionality of the code, as well as a review of the Gain contracts requirements for details about issuance amounts and how the system handles these.

ERC20Distribution

- ✓ Should be deployed correctly (268ms)
- ✓ Should be able to view start rate distribution
- ✓ Should be able to view end rate distribution
- ✓ Should be able to view total distribution balance
- ✓ Should be able to start distribution only when paused (189ms)
- ✓ Should be able to get current_distributed_balance
- ✓ Should be able to get status of distribution (69ms)
- ✓ Should be able to changr kyc approver (63ms)
- ✓ Should be able to get the fiat token balance of user
- ✓ Should be able to get the fiat token balance of contract
- ✓ Should be able to get divider rate distribution
- ✓ Should be able to claim fiat token (99ms)
- ✓ Should be able to purchase allowed (156ms)
- ✓ Should be able to get current rate (44ms)
- ✓ Should be able to purchase tokens (369ms)
- ✓ Should be able to purchase tokens- when kyc is needed (147ms)

GainDAOToken

- ✓ Should be deployed correctly (46ms)
- ✓ Should be able to unpause (75ms)
- ✓ Should be able to mint (67ms)
- ✓ Should be able to burn (132ms)

20 passing (10s)

The resulting code coverage (i.e., the ratio of tests-to-code) is as follows:

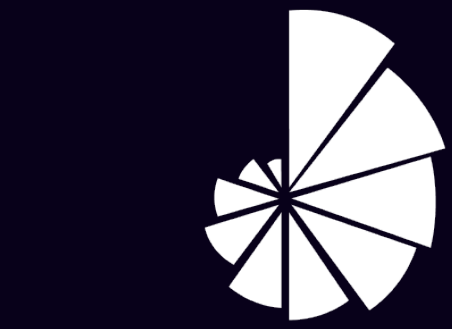
FILE	% STMTS	% BRANCH	% FUNCS	% LINES	% UNCOVERED LINES
ERC20Distribution.sol	100	100	100	100	
GainDAOToken.sol	100	100	100	100	
All files	**100**	**100**	**100**	**100**	

We are grateful for the opportunity to work with the Gain team.

The statements made in this document should not be interpreted as an investment or legal advice, nor should its authors be held accountable for the decisions made based on them.

Zokyo Security recommends the Gain team put in place a bug bounty program to encourage further analysis of the smart contract by third parties.

zokyo



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AI POWERED POOLS

SMART CONTRACT AUDIT

zokyo

May 29th 2023 | v. 1.0

Security Audit Score

PASS

Zokyo Security has concluded that this smart contract passes security qualifications to be listed on digital asset exchanges.

TECHNICAL SUMMARY

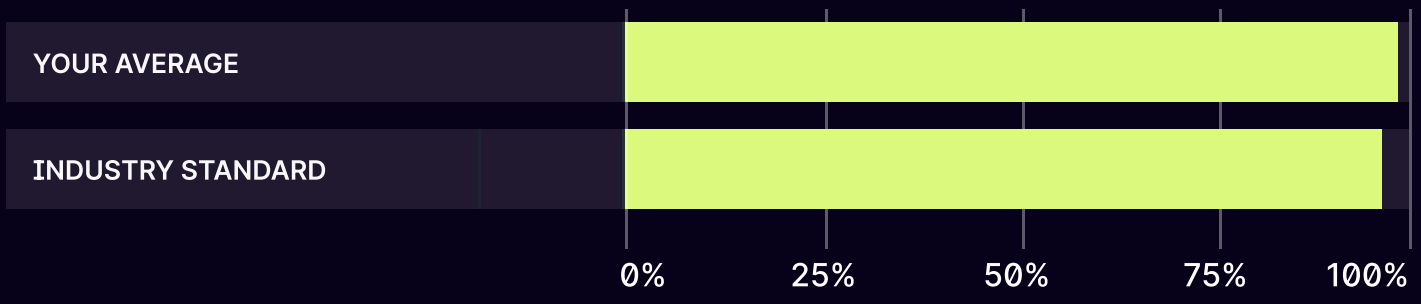
This document outlines the overall security of the Gain smart contracts evaluated by the Zokyo Security team.

The scope of this audit was to analyze and document the Gain smart contracts codebase for quality, security, and correctness.

Contract Status

There were 0 critical issues found during the audit. (See Complete Analysis)

Testable Code



100% of the code is testable, which is above the industry standard of 95%.

It should be noted that this audit is not an endorsement of the reliability or effectiveness of the contract but rather limited to an assessment of the logic and implementation. In order to ensure a secure contracts that can withstand the Ethereum network's fast-paced and rapidly changing environment, we recommend that the Gain team put in place a bug bounty program to encourage further active analysis of the smart contracts.

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AUDITING STRATEGY AND TECHNIQUES APPLIED

The source code of the smart contracts was taken from the Gain repository: https://github.com/GainDAO/token

Last commit -4886ba31b7fae9c213411b57b676014f008c1b75

Within the scope of this audit, the team of auditors reviewed the following contract(s):

- ERC20DistributionNative.sol
- ERC20Distribution.sol

During the audit, Zokyo Security ensured that the contract:

- Implements and adheres to the existing standards appropriately and effectively;
- The documentation and code comments match the logic and behavior;
- Distributes tokens in a manner that matches calculations;
- Follows best practices, efficiently using resources without unnecessary waste;
- Uses methods safe from reentrance attacks;
- Is not affected by the most resent vulnerabilities;
- Meets best practices in code readability, etc.

Zokyo Security has followed best practices and industry-standard techniques to verify the implementation of Gain smart contracts. To do so, the code was reviewed line by line by our smart contract developers, who documented even minor issues as they were discovered. Part of this work includes writing a test suite using the Hardhat testing framework. In summary, our strategies consist largely of manual collaboration between multiple team members at each stage of the review:

01	Due diligence in assessing the overall code quality of the codebase.	03	Testing contracts logic against common and uncommon attack vectors.
02	Cross-comparison with other, similar smart contracts by industry leaders.	04	Thorough manual review of the codebase line by line.

Executive Summary

The contracts are excellently composed and organized. No significant issues were discovered during the audit, except for two minor issues with low severity, as well as some informational matters. It is important to note that these findings could potentially have an impact only under specific circumstances involving the contract owner and interacting investors. A comprehensive analysis of these findings can be found in the "Complete Analysis" section.

STRUCTURE AND ORGANIZATION OF THE DOCUMENT

For the ease of navigation, the following sections are arranged from the most to the least critical ones. Issues are tagged as “Resolved” or “Unresolved” or “Acknowledged” depending on whether they have been fixed or addressed. Acknowledged means that the issue was sent to the Gain team and the Gain team is aware of it, but they have chosen to not solved it. The issues that are tagged as “Verified” contain unclear or suspicious functionality that either needs explanation from the Client or remains disregarded by the Client. Furthermore, the severity of each issue is written as assessed by the risk of exploitation or other unexpected or otherwise unsafe behavior:

Critical

The issue affects the contract in such a way that funds may be lost, allocated incorrectly, or otherwise result in a significant loss.

High

The issue affects the ability of the contract to compile or operate in a significant way.

Medium

The issue affects the ability of the contract to operate in a way that doesn’t significantly hinder its behavior.

Low

The issue has minimal impact on the contract’s ability to operate.

Informational

The issue has no impact on the contract’s ability to operate.

COMPLETE ANALYSIS

FINDINGS SUMMARY

#	Title	Risk	Status
1	Possibility of pre-distribution balance manipulation	Low	Resolved
2	Functions that do not expect to receive ether should be non-payable	Low	Resolved
3	Lack of protection against user's excessive ether loss	Low	Resolved
4	Use immutable on variables that are only set at construction	Informational	Resolved
5	Uncalled public functions	Informational	Resolved
6	Invalid data emitted by event	Informational	Resolved

LOW | RESOLVED

Possibility of pre-distribution balance manipulation.

The startDistribution function in ERC20Distribution and ERC20DistributionNative contracts is designed to begin the distribution of Gain Token to users. Function ensures that the amount of Gain Token held by the contract matches the total distribution balance before allowing to unpause and start the distribution process. If these two values do not match, the distribution process will not proceed. A malicious user who has come into possession of the Gain Token can send a small amount to the contract address before the distribution begins. As a result, the total distribution balance will no longer match the balance of the Gain Token held by the contract, causing the distribution to fail until excessive tokens will be taken out.

The user with DEFAULT_ADMIN_ROLE can transfer those excessive tokens using purchaseTokens function which allows the admin to purchase distributed tokens even if the contract is paused, thus severity was reduced to low.

Recommendation:

- Change the require statement as followse.

```
require(
        _trusted_token.balanceOf(address(this)) >=_total_distribution_balance,
        'Initial distribution balance must be correct'
        );
```

- Make sure that only trusted actors can start a new distribution cycle.

Fixed: Issue fixed in commit 4886ba3

LOW | RESOLVED

Functions that do not expect to receive ether should be non-payable

A function that does not expect to receive ether should not be marked as payable. However, the startDistribution function in ERC20Distribution and ERC20DistributionNative contracts and **purchaseTokens** in ERC20Distribution are currently marked as payable. Given that the contract does not have the necessary functionality to handle received ether, then marking these functions as payable could result in funds being stuck in the contract if users accidentally send ether while calling these functions.

Recommendation:
Remove payable keywords from the listed functions.

LOW | RESOLVED

Lack of protection against user's excessive ether loss

The ERC20DistributionNative.purchaseTokens checks whether the transaction ether value is sufficient to purchase the required amount of Gain Token. If the transaction value is higher than the required amount, the excess ether will be sent to the contract. The user who accidentally sent more ether than required will lose those funds since they will not receive the corresponding amount of Gain Token in return. This could result in a loss of funds for the user and may lead to mistrust in the system.

Recommendation:
Change the require statement as follow:

```
require(
  msg.value == fiattoken_amount,
  "PurchaseTokens: transaction value must be sufficient"
);
```

Fixed: Issue fixed in commit 4886ba3

INFORMATIONAL | RESOLVED

Use immutable on variables that are only set at construction

Variables only set in the constructor and never edited afterward should be marked as immutable, as it would avoid the expensive storage-writing operation in the constructor.

- ERC20Distribution.**_fiat_token**
- ERC20Distribution.**_trusted_token**, ERC20DistributionNative.**_trusted_token**
- _beneficiaryERC20Distribution.**_beneficiary**, ERC20DistributionNative.**_beneficiary**
- ERC20Distribution.**_startrate_distribution,** ERC20DistributionNative.**_startrate_distribution**
- ERC20Distribution.**_endrate_distribution**, ERC20DistributionNative.**_endrate_distribution**
- ERC20Distribution.**_divider_rate**, ERC20DistributionNative.**_divider_rate**

Recommendation:
Make the listed variables immutable.

Fixed: Issue fixed in commit 4886ba3

INFORMATIONAL | RESOLVED

Uncalled public functions

Public functions that are never called from within the contract should be marked as external.

- ERC20Distribution.**user_fiattoken_balance**
- ERC20Distribution.**fiattoken_contractbalance**
- ERC20Distribution.**startrate_distribution**
- ERC20DistributionNative.**startrate_distribution**
- ERC20Distribution.endrate**_distribution**
- ERC20DistributionNative.**endrate_distribution**
- ERC20Distribution.**dividerrate_distribution**
- ERC20DistributionNative.**dividerrate_distribution**
- ERC20Distribution.total**_distribution_balance**
- ERC20DistributionNative.total**_distribution_balance**
- ERC20Distribution.current**_distributed_balance**
- ERC20DistributionNative.current**_distributed_balance**
- ERC20Distribution.**startDistribution**
- ERC20DistributionNative.**startDistribution**
- ERC20Distribution.**distributionStarted**
- ERC20DistributionNative.**distributionStarted**
- ERC20Distribution.**changeKYCApprover**
- ERC20DistributionNative.**changeKYCApprover**
- ERC20Distribution.**claimFiatToken**
- ERC20DistributionNative.**claimFiatToken**
- ERC20Distribution.**purchaseTokens**
- ERC20DistributionNative.**purchaseTokens**

Fixed: Issue fixed in commit 4886ba

INFORMATIONAL | RESOLVED

Invalid data emitted by event

The TokensSold event is emitted after the ERC20Distribution.purchaseTokens function succeeds. However, instead of emitting the event with valid amountToken value it gets msg.value.

Fixed: Issue fixed in commit 4886ba

Recommendation:
Correct the tokenAmount value emitted in TokenSold event.

Fixed: Issue fixed in commit 4886ba3

	ERC20DistributionNative.sol	ERC20Distribution.sol
Re-entrancy	Pass	Pass
Access Management Hierarchy	Pass	Pass
Arithmetic Over/Under Flows	Pass	Pass
Unexpected Ether	Pass	Pass
Delegatecall	Pass	Pass
Default Public Visibility	Pass	Pass
Hidden Malicious Code	Pass	Pass
Entropy Illusion (Lack of Randomness)	Pass	Pass
External Contract Referencing	Pass	Pass
Short Address/ Parameter Attack	Pass	Pass
Unchecked CALL Return Values	Pass	Pass
Race Conditions / Front Running	Pass	Pass
General Denial Of Service (DOS)	Pass	Pass
Uninitialized Storage Pointers	Pass	Pass
Floating Points and Precision	Pass	Pass
Tx.Origin Authentication	Pass	Pass
Signatures Replay	Pass	Pass
Pool Asset Security (backdoors in the underlying ERC-20)	Pass	Pass

CODE COVERAGE AND TEST RESULTS FOR ALL FILES

Tests written by Zokyo Security

As a part of our work assisting Gain in verifying the correctness of their contracts code, our team was responsible for writing integration tests using the Hardhat testing framework.

The tests were based on the functionality of the code, as well as a review of the Gain contracts requirements for details about issuance amounts and how the system handles these.

Test ERC20DistributionNative

- ✓ Should be deployed correctly (284ms)
- ✓ Should be able to view start rate distribution (50ms)
- ✓ Should be able to view end rate distribution
- ✓ Should be able to view total distribution balance
- ✓ Should be able to start distribution only when paused (208ms)
- ✓ Should be able to get current distributed balance (38ms)
- ✓ Should be able to get status of distribution (79ms)
- ✓ Should be able to change kyc approver (94ms)
- ✓ Should be able to get divider rate distribution
- ✓ Should be able to claim fiat token (64ms)
- ✓ Should be able to allow purchases (236ms)
- ✓ Should be able to get current rate (38ms)
- ✓ Should be able to purchase tokens (284ms)
- ✓ Should be able to purchase tokens - when kyc is needed (611ms)

14 passing (11s)

FILE	% STMTS	% BRANCH	% FUNCS	% FUNCS	UNCOVERED LINES
ERC20DistributionNative	100	100	100	100	100
All Files	100	100	100	100	100

We are grateful for the opportunity to work with the Gain team.

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Zokyo Security recommends the Gain team put in place a bug bounty program to encourage further analysis of the smart contract by third parties.

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