SOLIDProof
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Blockchain Security | Smart Contract Audits | KYC

MADE IN GERMANY

# Audit

## Security Assessment
## 02. November, 2021

For

MAH
HEALTH CARE

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# Disclaimer

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| Version | Date | Description |
|---|---|---|
| 1.0 | 02. November 2021 | • Layout project<br>• Automated- /Manual-Security Testing<br>• Summary |

## Network
Binance Smart Chain (BEP20)

## Website
https://mahhealthcare.com/

## Twitter
https://twitter.com/mahhealthcare

## Facebook
https://www.facebook.com/MAH-Healthcare-Estonia-102940742147177

## Github
https://github.com/HTRAX/htrax-token

## Instagram
https://www.instagram.com/mah.healthcare/

## LinkedIn
https://www.linkedin.com/company/mah-healthcare-estonia/

## Description

MAH Healthcare OU is Estonia Based rapidly growing Healthcare IT company with the Vision of Creating Brand Value in Short span of 2 years. MAH Want to Expand its service offerings across Healthcare IT industry sectors, number of customers, number of operating locations and capability for value creation. A strong leadership, investment in infrastructure and people, confidence of our People and our unwavering passion for excellence has significantly contributed to this momentum. MAH is constantly investing in state-of-the-art infrastructure, building people competence, adopting leading edge technology, and adding business value for its customer as well as in Community and everything else that is essential to achieve customer delight and employee jubilation. MAH Healthcare uses blockchain technology to securely manage health records for a collaborative, smart approach to healthcare.

**HTRAX is a utility token with a real use case.**

## Project Engagement

During the 30th of October 2021, **HTRAX Team** engaged Solidproof.io to audit smart contracts that they created. The engagement was technical in nature and focused on identifying security flaws in the design and implementation of the contracts. They provided Solidproof.io with access to their code repository and whitepaper.

## Logo

## Contract Link

**v1.0**

TBA

# Vulnerability & Risk Level

Risk represents the probability that a certain source-threat will exploit vulnerability, and the impact of that event on the organization or system. Risk Level is computed based on CVSS version 3.0.

| Level | Value | Vulnerability | Risk (Required Action) |
|---|---|---|---|
| **Critical** | 9 - 10 | A vulnerability that can disrupt the contract functioning in a number of scenarios, or creates a risk that the contract may be broken. | Immediate action to reduce risk level. |
| **High** | 7 – 8.9 | A vulnerability that affects the desired outcome when using a contract, or provides the opportunity to use a contract in an unintended way. | Implementation of corrective actions as soon aspossible. |
| **Medium** | 4 – 6.9 | A vulnerability that could affect the desired outcome of executing the contract in a specific scenario. | Implementation of corrective actions in a certain period. |
| **Low** | 2 – 3.9 | A vulnerability that does not have a significant impact on possible scenarios for the use of the contract and is probably subjective. | Implementation of certain corrective actions or accepting the risk. |
| **Informational** | 0 – 1.9 | A vulnerability that have informational character but is not effecting any of the code. | An observation that does not determine a level of risk |

# Auditing Strategy and Techniques Applied

Throughout the review process, care was taken to evaluate the repository for security-related issues, code quality, and adherence to specification and best practices. To do so, reviewed line-by-line by our team of expert pentesters and smart contract developers, documenting any issues as there were discovered.

## Methodology

The auditing process follows a routine series of steps:

1. Code review that includes the following:
    i) Review of the specifications, sources, and instructions provided to SolidProof to make sure we understand the size, scope, and functionality of the smart contract.
    ii) Manual review of code, which is the process of reading source code line-by-line in an attempt to identify potential vulnerabilities.
    iii) Comparison to specification, which is the process of checking whether the code does what the specifications, sources, and instructions provided to SolidProof describe.

2. Testing and automated analysis that includes the following:
    i) Test coverage analysis, which is the process of determining whether the test cases are actually covering the code and how much code is exercised when we run those test cases.
    ii) Symbolic execution, which is analysing a program to determine what inputs causes each part of a program to execute.

3. Best practices review, which is a review of the smart contracts to improve efficiency, effectiveness, clarify, maintainability, security, and control based on the established industry and academic practices, recommendations, and research.

4. Specific, itemized, actionable recommendations to help you take steps to secure your smart contracts.

## Used Code from other Frameworks/Smart Contracts (direct imports)

Imported packages:

- HTRAXTokenSale:
  - AccessControl
- HTRAXToken:
  - Ownable
  - Pausable
  - AccessControl
  - ERC20
  - ERC20Snapshot

## Tested Contract Files

This audit covered the following files listed below with a SHA-1 Hash.

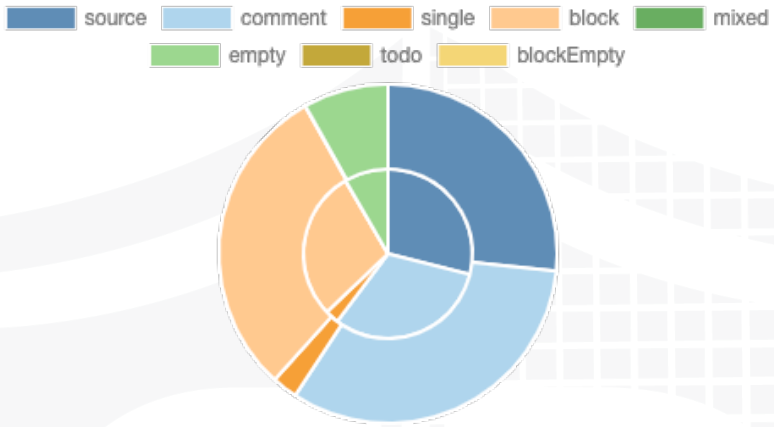
*A file with a different Hash has been modified, intentionally or otherwise, after the security review. A different Hash could be (but not necessarily) an indication of a changed condition or potential vulnerability that was not within the scope of this review.*

### v1.0

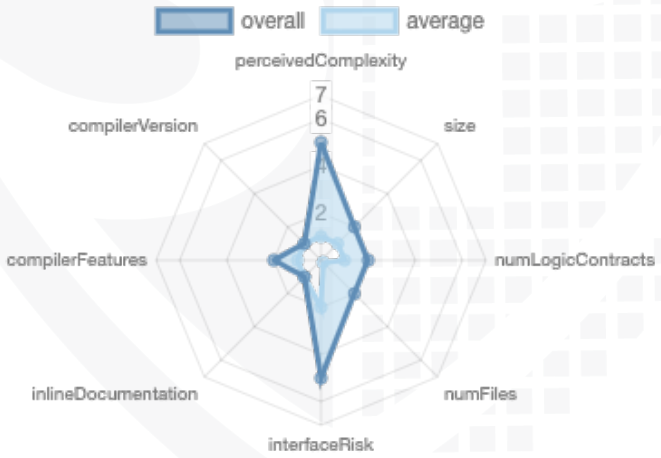
| File Name | SHA-1 Hash |
|---|---|
| contracts/utils/Context.sol | 5ece05a1a975617e5663847ad3a522966e3c5904 |
| contracts/utils/Strings.sol | ccb4d394fcf0694b7dc1fed9ec2f0b292998b4be |
| contracts/utils/introspection/IERC165.sol | c274749941851ddff3c478cb475b65da616697c7 |
| contracts/utils/introspection/ERC165.sol | 160047f3e0c5221369ba3558f0a56ea2a7d7ca3f |
| contracts/utils/math/Math.sol | f04e52286764b68060e0619462f172c441b5bec4 |
| contracts/utils/Arrays.sol | fcc6f29ca11d48ca9e2642ce8235c66604d53a3c |
| contracts/utils/Counters.sol | 1152ad436016e04e2299d8cae70f68f3880f9de3 |
| contracts/HTRAXToken.sol | 791d710db982271e971ca1669b0ef176dfa403e1 |
| contracts/HTRAXTokenSale.sol | 8d56dbb841c00059bea0c79f3b17914893b4dafb |
| contracts/security/Pausable.sol | 91d67f0ca43d851c1a43ec98ecf160ee14d0f504 |
| contracts/access/Ownable.sol | b1b5d13cd2134a90082b2bad46542a323955d2eb |
| contracts/access/AccessControl.sol | a94eb77ca64f47afe96401336cf79174aba324ea |
| contracts/token/ERC20/ERC20.sol | 3b01806757407473fe8110a75856f0c214ec1762 |
| contracts/token/ERC20/IERC20.sol | d0dd54d5a489c52b30f941ac1d4a88aecbd0f2e4 |
| contracts/token/ERC20/extensions/ERC20Snapshot.sol | 993fbebe49e198ac31f45a7421a3c9f47b9f1e04 |
| contracts/token/ERC20/extensions/IERC20Metadata.sol | 6e1b1b40d095a0a5611d6500052b87ac8f04b83f |

# Metrics

## Source Lines
### v1.0




## Risk Level
### v1.0



# Capabilities

## Components

| Version | Contracts | Libraries | Interfaces | Abstract |
|---|---|---|---|---|
| 1.0 | 2 | 4 | 4 | 7 |

## Exposed Functions

*This section lists functions that are explicitly declared public or payable. Please note that getter methods for public stateVars are not included.*

| Version | Public | Payable |
|---|---|---|
| 1.0 | 67 | 0 |

| Version | External | Internal | Private | Pure | View |
|---|---|---|---|---|---|
| 1.0 | 16 | 85 | 7 | 6 | 41 |

## State Variables

| Version | Total | Public |
|---|---|---|
| 1.0 | 30 | 6 |

## Capabilities

| Version | Solidity Versions observed | Experimental Features | Can Receive Funds | Uses Assembly | Has Destroyable Contracts |
|---|---|---|---|---|---|
| 1.0 | `0.8.9`<br>`^0.8.9` | | | ****<br>(0 asm blocks) | |

| Version | Transfers ETH | Low-Level Calls | DelegateCall | Uses Hash Functions | ECRecover | New/Create/Create2 |
|---|---|---|---|---|---|---|
| 1.0 | `yes` | | | `yes` | | |

## Scope of Work

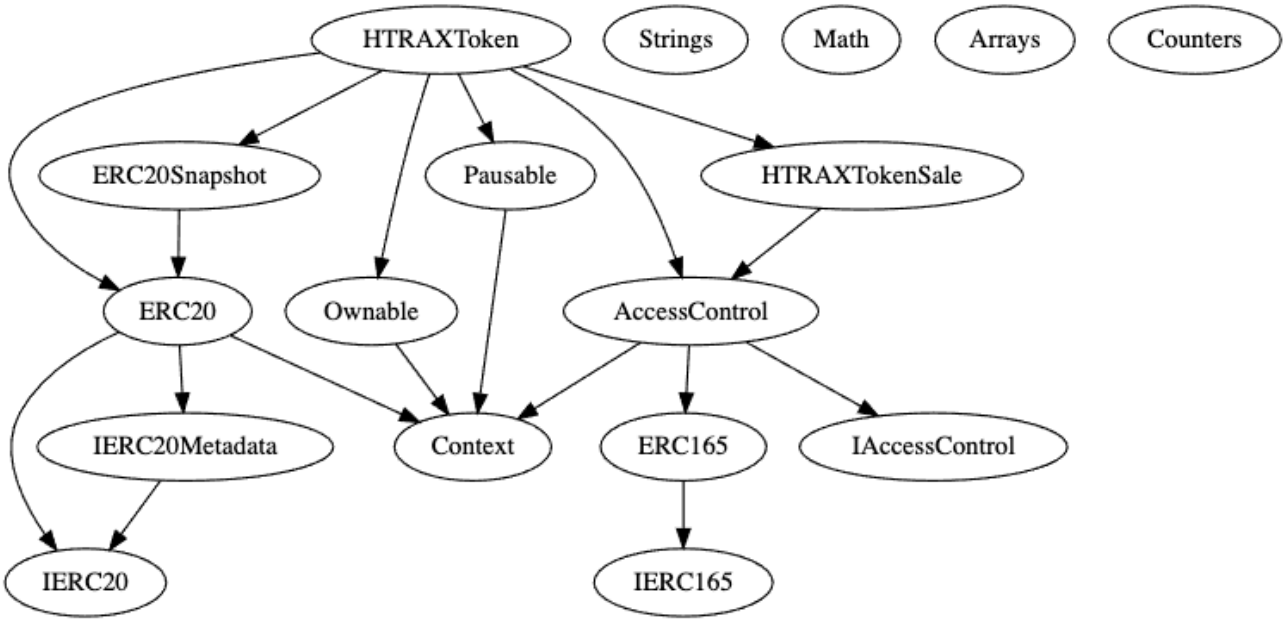
The above token Team provided us with the files that needs to be tested (Github, Bscscan, Etherscan, files, etc.). The scope of the audit is the main contract (usual the same name as team appended with .sol).

We will verify the following claims:

1. Correct implementation of Token standard
2. Deployer cannot mint any new tokens
3. Deployer cannot burn or lock user funds
4. Deployer cannot pause the contract
5. Overall checkup (Smart Contract Security)

## Inheritance Graph

### v1.0



# Verify Claims

## Correct implementation of Token standard

| Tested | Verified |
|---|---|
| ✓ | ✓ |

| Function | Description | Exist | Tested | Verified |
|---|---|---|---|---|
| TotalSupply | provides information about the total token supply | ✓ | ✓ | ✓ |
| BalanceOf | provides account balance of the owner's account | ✓ | ✓ | ✓ |
| Transfer | executes transfers of a specified number of tokens to a specified address | ✓ | ✓ | ✓ |
| TransferFrom | executes transfers of a specified number of tokens from a specified address | ✓ | ✓ | ✓ |
| Approve | allow a spender to withdraw a set number of tokens from a specified account | ✓ | ✓ | ✓ |
| Allowance | returns a set number of tokens from a spender to the owner | ✓ | ✓ | ✓ |

## Write functions of contract

HTRAXToken:

- addBlackList
- approve
- burn
- burnFrom
- decreaseAllow...
- grantRole
- increaseAllow...
- mint
- pause
- releaseLocked...
- removeBlackList
- renounceRole
- revokeRole
- setLevel1Value
- setLevel2Value
- setLevel3Value
- setSaleEndDate
- setSaleStartD...
- snapshot
- transfer
- transferDiscou...
- transferFrom
- transferOwner...
- unpause
- withdrawBala...

## Deployer cannot mint any new tokens

| Name | Exist | Tested | Verified | File |
|---|---|---|---|---|
| Deployer cannot mint | ✓ | ✓ | ✗ | Main |
| Comment | Line: - | | | |

Max / Total Supply (Release): 93.750.000

Comments:

**v1.0**

- Addresses with MINTER_ROLE can mint tokens
  - Maximum _release tokens
  - totalSupply + totalBurned tokens + minting amount cannot be higher than _cap

```
function mint(address account, uint256 amount) public onlyRole(MINTER_ROLE) {
    require(amount <= _release, "Token for mint can't be more then allocated for each release");
    require((totalSupply() + totalBurned() + amount) <= _cap, "cap exceeded");
    super._mint(account, amount);
}
```

- Addresses are not allowed to use mint function when pause is enabled

## Deployer cannot burn or lock user funds

| Name | Exist | Tested | Verified |
|---|---|---|---|
| Deployer cannot lock | ✓ | ✓ | ✗ |
| Deployer cannot burn | ✓ | ✓ | ✗ |

Comments:

**v1.0**

- Addresses with BURNER_ROLE can burn tokens
- Deployer with RISK_MANAGER_ROLE can
    - Set address to blackListed and can lock user funds
    - Lock user funds when pause is enabled
    - Can set pause/unpause
    - Add/remove blacklist addresses
- Addresses are not allowed to use burn function when pause is enabled
- Deployer with EXECUTOR_ROLE can
    - Transfer discounted/locked tokens
    - Withdraw token from smart contract to own address

## Deployer cannot pause the contract

| Name | Exist | Tested | Verified |
|---|---|---|---|
| Deployer cannot pause | ✓ | ✓ | ✗ |

Comments:

**v1.0**

- See comments above in “Deployer cannot burn or lock user funds” section

## Overall checkup (Smart Contract Security)

| Tested | Verified |
|---|---|
| ✓ | ✓ |

### Legend

| Attribute | Symbol |
|---|---|
| Verfified / Checked | ✓ |
| Partly Verified | 🚩 |
| Unverified / Not checked | ✗ |
| Not available | – |

# OnlyRole functions

## HTRAXToken

- MINTER_ROLE
  - mint

- BURNER_ROLE
  - burn
  - burnFrom

- RISK_MANAGER_ROLE
  - snapshot
  - pause
  - unpause
  - addBlackList
  - removeBlackList

- EXECUTOR_ROLE
  - transferDiscountedTokens
  - withdrawBalance

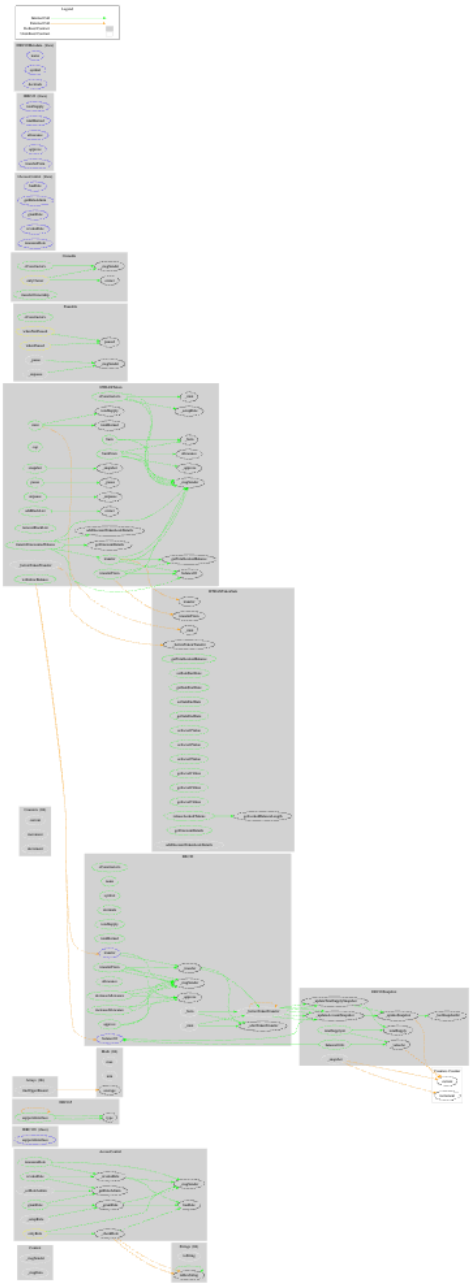
## HTRAXTokenSale

- PRESALES_MANAGER_ROLE
  - setSaleStartDate
  - setSaleEndDate
  - setLevel1Value
  - setLevel2Value
  - setLevel3Value

## AdminRole functions

- grantRole
- revokeRole

# CallGraph



# Source Units in Scope
## v1.0

| Type | File | Logic Contracts | Interfaces | Lines | nLines | nSLOC | Comment Lines | Complex. Score | Capabilities |
|---|---|---|---|---|---|---|---|---|---|
| 🎨 | contracts/utils/Context.sol | 1 | ———— | 27 | 27 | 10 | 13 | 1 | ———— |
| 📚 | contracts/utils/Strings.sol | 1 | ———— | 67 | 67 | 45 | 15 | 41 | 🔆 |
| 🔍 | contracts/utils/introspection/IERC165.sol | ———— | 1 | 24 | 23 | 3 | 18 | 3 | 🔆 |
| 🎨 | contracts/utils/introspection/ERC165.sol | 1 | ———— | 28 | 28 | 7 | 18 | 6 | ———— |
| 📚 | contracts/utils/math/Math.sol | 1 | ———— | 31 | 31 | 12 | 15 | 3 | 🔆 |
| 📚 | contracts/utils/Arrays.sol | 1 | ———— | 47 | 47 | 24 | 16 | 6 | 🔆 |
| 📚 | contracts/utils/Counters.sol | 1 | ———— | 38 | 38 | 21 | 13 | 2 | 🔆 |
| 📝 | contracts/HTRAXToken.sol | 1 | ———— | 185 | 181 | 96 | 59 | 139 | 💾🧱 |
| 🎨 | contracts/HTRAXTokenSale.sol | 1 | ———— | 192 | 192 | 90 | 77 | 75 | 🧱 |
| 🎨 | contracts/security/Pausable.sol | 1 | ———— | 90 | 90 | 29 | 50 | 16 | ———— |
| 🎨 | contracts/access/Ownable.sol | 1 | ———— | 56 | 56 | 23 | 26 | 18 | ———— |
| 🔍🎨 | contracts/access/AccessControl.sol | 1 | 1 | 243 | 231 | 102 | 146 | 65 | 🔆 |
| 📝 | contracts/token/ERC20/ERC20.sol | 1 | ———— | 364 | 344 | 108 | 196 | 83 | ———— |
| 🔍 | contracts/token/ERC20/IERC20.sol | ———— | 1 | 86 | 26 | 17 | 60 | 15 | ———— |
| 🎨 | contracts/token/ERC20/extensions/ERC20Snapshot.sol | 1 | ———— | 179 | 177 | 73 | 79 | 45 | ———— |
| 🔍 | contracts/token/ERC20/extensions/IERC20Metadata.sol | ———— | 1 | 27 | 16 | 4 | 15 | 9 | 🔆 |
| 📝📚🔍🎨 | **Totals** | **13** | **4** | **1684** | **1574** | **664** | **816** | **527** | 💾🧱🔆 |

## Legend

| Attribute | Description |
|---|---|
| Lines | total lines of the source unit |
| nLines | normalized lines of the source unit (e.g. normalizes functions spanning multiple lines) |
| nSLOC | normalized source lines of code (only source-code lines; no comments, no blank lines) |
| Comment Lines | lines containing single or block comments |
| Complexity Score | a custom complexity score derived from code statements that are known to introduce code complexity (branches, loops, calls, external interfaces, ...) |

# Audit Results

**AUDIT PASSED**

## Critical issues

- no critical issues found -

## High issues

- no high issues found -

## Medium issues

- no medium issues found -

## Low issues

| Issue | File | Type | Line | Description |
|---|---|---|---|---|
| #1 | Main | Contract doesn't import npm packages from source (like OpenZeppelin etc.) | - | We recommend to import all packages from npm directly without flatten the contract. Functions could be modified or can be susceptible to vulnerabilities |

## Informational issues

| Issue | File | Type | Line | Description |
|---|---|---|---|---|
| #1 | HTRAXToken | State variables that could be declared constant (constable-states) | 21, 20 | Add the `constant` attributes to state variables that never change |

# Audit Comments

## 02. November 2021:

- Addresses with MINTER_ROLE can mint tokens
  - For more information read “Deployer cannot mint any new tokens” section on page 16
- Addresses with BURNER_ROLE can burn tokens
  - For more information read “Deployer cannot burn or lock user funds” section on page 17
- Addresses with RISK_MANAGER_ROLE can lock user funds
  - For more information read “Deployer cannot burn or lock user funds” section on page 17

## SWC Attacks

| ID | Title | Relationships | Status |
|---|---|---|---|
| SWC-136 | Unencrypted Private Data On-Chain | CWE-767: Access to Critical Private Variable via Public Method | PASSED |
| SWC-135 | Code With No Effects | CWE-1164: Irrelevant Code | PASSED |
| SWC-134 | Message call with hardcoded gas amount | CWE-655: Improper Initialization | PASSED |
| SWC-133 | Hash Collisions With Multiple Variable Length Arguments | CWE-294: Authentication Bypass by Capture-replay | PASSED |
| SWC-132 | Unexpected Ether balance | CWE-667: Improper Locking | PASSED |
| SWC-131 | Presence of unused variables | CWE-1164: Irrelevant Code | PASSED |
| SWC-130 | Right-To-Left-Override control character (U+202E) | CWE-451: User Interface (UI) Misrepresentation of Critical Information | PASSED |
| SWC-129 | Typographical Error | CWE-480: Use of Incorrect Operator | PASSED |
| SWC-128 | DoS With Block Gas Limit | CWE-400: Uncontrolled Resource Consumption | PASSED |

| | | | |
|---|---|---|---|
| SWC-127 | Arbitrary Jump with Function Type Variable | CWE-695: Use of Low-Level Functionality | PASSED |
| SWC-125 | Incorrect Inheritance Order | CWE-696: Incorrect Behavior Order | PASSED |
| SWC-124 | Write to Arbitrary Storage Location | CWE-123: Write-what-where Condition | PASSED |
| SWC-123 | Requirement Violation | CWE-573: Improper Following of Specification by Caller | PASSED |
| SWC-122 | Lack of Proper Signature Verification | CWE-345: Insufficient Verification of Data Authenticity | PASSED |
| SWC-121 | Missing Protection against Signature Replay Attacks | CWE-347: Improper Verification of Cryptographic Signature | PASSED |
| SWC-120 | Weak Sources of Randomness from Chain Attributes | CWE-330: Use of Insufficiently Random Values | PASSED |
| SWC-119 | Shadowing State Variables | CWE-710: Improper Adherence to Coding Standards | PASSED |
| SWC-118 | Incorrect Constructor Name | CWE-665: Improper Initialization | PASSED |
| SWC-117 | Signature Malleability | CWE-347: Improper Verification of Cryptographic Signature | PASSED |

| | | | |
|---|---|---|---|
| SWC-116 | Timestamp Dependence | CWE-829: Inclusion of Functionality from Untrusted Control Sphere | PASSED |
| SWC-115 | Authorization through tx.origin | CWE-477: Use of Obsolete Function | PASSED |
| SWC-114 | Transaction Order Dependence | CWE-362: Concurrent Execution using Shared Resource with Improper Synchronization ('Race Condition') | PASSED |
| SWC-113 | DoS with Failed Call | CWE-703: Improper Check or Handling of Exceptional Conditions | PASSED |
| SWC-112 | Delegatecall to Untrusted Callee | CWE-829: Inclusion of Functionality from Untrusted Control Sphere | PASSED |
| SWC-111 | Use of Deprecated Solidity Functions | CWE-477: Use of Obsolete Function | PASSED |
| SWC-110 | Assert Violation | CWE-670: Always-Incorrect Control Flow Implementation | PASSED |
| SWC-109 | Uninitialized Storage Pointer | CWE-824: Access of Uninitialized Pointer | PASSED |
| SWC-108 | State Variable Default Visibility | CWE-710: Improper Adherence to Coding Standards | PASSED |
| SWC-107 | Reentrancy | CWE-841: Improper Enforcement of Behavioral Workflow | PASSED |
| SWC-106 | Unprotected SELFDESTRUCT Instruction | CWE-284: Improper Access Control | PASSED |

| | | | |
|---|---|---|---|
| SWC-105 | Unprotected Ether Withdrawal | CWE-284: Improper Access Control | PASSED |
| SWC-104 | Unchecked Call Return Value | CWE-252: Unchecked Return Value | PASSED |
| SWC-103 | Floating Pragma | CWE-664: Improper Control of a Resource Through its Lifetime | PASSED |
| SWC-102 | Outdated Compiler Version | CWE-937: Using Components with Known Vulnerabilities | PASSED |
| SWC-101 | Integer Overflow and Underflow | CWE-682: Incorrect Calculation | PASSED |
| SWC-100 | Function Default Visibility | CWE-710: Improper Adherence to Coding Standards | PASSED |

# Solid Proofed

**Blockchain Security | Smart Contract Audits | KYC**

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