# SMART CONTRACT CODE REVIEW AND SECURITY ANALYSIS REPORT

**Customer**: WhiteBIT

**Date**: 9th, 2022

This document may contain confidential information about IT systems and the intellectual property of the Customer as well as information about potential vulnerabilities and methods of their exploitation.

The report containing confidential information can be used internally by the Customer, or it can be disclosed publicly after all vulnerabilities are fixed — upon a decision of the Customer.

## Document

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|---|---|
| **Name** | Smart Contract Code Review and Security Analysis Report for WhiteBIT. |
| **Approved By** | Evgeniy Bezuglyi \| SC Department Head at Hacken OU |
| **Type** | ERC20 token |
| **Platform** | EVM |
| **Language** | Solidity |
| **Methods** | Architecture Review, Functional Testing, Computer-Aided Verification, Manual Review |
| **Website** | https://whitebit.com |
| **Timeline** | 18.04.2022 - 19.08.2022 |
| **Changelog** | 22.04.2022 - Initial Review<br>03.05.2022 - Second Review<br>06.05.2022 - Third Review<br>19.08.2022 - Fourth Review |

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## Introduction

Hacken OÜ (Consultant) was contracted by WhiteBIT (Customer) to conduct a Smart Contract Code Review and Security Analysis. This report presents the findings of the security assessment of the Customer's smart contracts.

## Scope

The scope of the project is smart contracts in the repository:

### Initial review scope

**Repository:**
https://github.com/whitebit-exchange/wbt-token
**Commit:**
2ab92561d118bcf0801adeab5cddea86d813b61b
**Technical Documentation:** Yes
**JS tests:** Yes
**Contracts:**
BlackList.sol
ER20Detailed.sol
ERC20.sol
ERC20Managable.sol
IERC20.sol
Ownable.sol
Pausable.sol
SafeMath.sol
WbtToken.sol

### Second review scope

**Repository:**
https://github.com/whitebit-exchange/wbt-token
**Commit:**
6af16fadf6236648943cc55c433ce62c9016e273
**Technical Documentation:** Yes
**JS tests:** Yes
**Contracts:**
BlackList.sol
ERC20.sol
ERC20Detailed.sol
IERC20.sol
Ownable.sol
Pausable.sol
WbtToken.sol

### Third review scope

**Repository:**
https://github.com/whitebit-exchange/wbt-token
**Commit:**
4f59525800442377fc106ddb44543f8537d6760b
**Technical Documentation:** Yes
**JS tests:** Yes
**Contracts:**

BlackList.sol
ERC20.sol
ERC20Detailed.sol
IERC20.sol
Ownable.sol
Pausable.sol
WbtToken.sol

## Fourth review scope

**Repository:**
https://github.com/whitebit-exchange/wbt-token
**Commit:**
4d021a2029afdb3d4c22c0989c697c0469640bf9
**Technical Documentation:** Yes
**JS tests:** Yes
**Contracts:**
BlackList.sol
ERC20.sol
ERC20Detailed.sol
IERC20.sol
Ownable.sol
Pausable.sol
WBT.sol (Renamed from WbtToken.sol)

## Severity Definitions

| Risk Level | Description |
|---|---|
| Critical | Critical vulnerabilities are usually straightforward to exploit and can lead to assets loss or data manipulations. |
| High | High-level vulnerabilities are difficult to exploit; however, they also have a significant impact on smart contract execution, e.g., public access to crucial functions |
| Medium | Medium-level vulnerabilities are important to fix; however, they cannot lead to assets loss or data manipulations. |
| Low | Low-level vulnerabilities are mostly related to outdated, unused, etc. code snippets that cannot have a significant impact on execution |

# Executive Summary

The score measurements details can be found in the corresponding section of the methodology.

## Documentation quality

The Customer provided superficial functional requirements and no technical requirements. The total Documentation Quality score is **10** out of **10**.

## Code quality

The total CodeQuality score is **4** out of **10**. Code duplications. The limited number of unit tests provided.

As a result of the second review, CodeQuality score is changed to **8** out of **10**. Added good test coverage, and simplified code by removing unnecessary files.

## Architecture quality

The architecture quality score is **6** out of **10**. Some files are copy-pasted from the OpenZeppelin repository with minimal or no changes.

## Security score

As a result of the audit, security engineers found **0** high, **1** medium, and **8** low severity issues. The security score is **10** out of **10**.

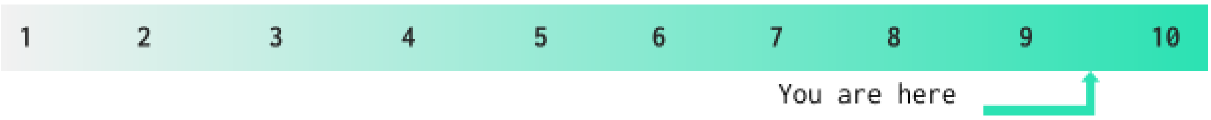
As a result of the second review, security engineers found **1** critical severity issue. **1** medium severity issue from the previous revision was fixed. As a result, the code contains **1** critical severity issue. The security score is **0** out of **10**.

As a result of the third review, security engineers found no new issues. **1** critical severity issue from the previous revision was fixed. As a result, the code contains no issues. The security score is 10 out of **10**.

All found issues are displayed in the “Findings” section.

## Summary

According to the assessment, the Customer's smart contract has the following score: **9.4**



## Checked Items

We have audited provided smart contracts for commonly known and more specific vulnerabilities. Here are some of the items that are considered:

| Item | Type | Description | Status |
|---|---|---|---|
| **Default Visibility** | SWC-100<br>SWC-108 | Functions and state variables visibility should be set explicitly. Visibility levels should be specified consciously. | Passed |
| **Integer Overflow and Underflow** | SWC-101 | If unchecked math is used, all math operations should be safe from overflows and underflows. | Not Relevant |
| **Outdated Compiler Version** | SWC-102 | It is recommended to use a recent version of the Solidity compiler. | Passed |
| **Floating Pragma** | SWC-103 | Contracts should be deployed with the same compiler version and flags that they have been tested thoroughly. | Passed |
| **Unchecked Call Return Value** | SWC-104 | The return value of a message call should be checked. | Not Relevant |
| **Access Control & Authorization** | CWE-284 | Ownership takeover should not be possible. All crucial functions should be protected. Users could not affect data that belongs to other users. | Passed |
| **SELFDESTRUCT Instruction** | SWC-106 | The contract should not be destroyed until it has funds belonging to users. | Not Relevant |
| **Check-Effect-Iinteraction** | SWC-107 | Check-Effect-Interaction pattern should be followed if the code performs ANY external call. | Passed |
| **Uninitialized Storage Pointer** | SWC-109 | Storage type should be set explicitly if the compiler version is < 0.5.0. | Not Relevant |
| **Assert Violation** | SWC-110 | Properly functioning code should never reach a failing assert statement. | Not Relevant |
| **Deprecated Solidity Functions** | SWC-111 | Deprecated built-in functions should never be used. | Passed |
| **Delegatecall to Untrusted Callee** | SWC-112 | Delegatecalls should only be allowed to trusted addresses. | Passed |
| **DoS (Denial of Service)** | SWC-113<br>SWC-128 | Execution of the code should never be blocked by a specific contract state unless it is required. | Passed |

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| **Race Conditions** | SWC-114 | Race Conditions and Transactions Order Dependency should not be possible. | Passed |
| **Authorization through tx.origin** | SWC-115 | tx.origin should not be used for authorization. | Passed |
| **Block values as a proxy for time** | SWC-116 | Block numbers should not be used for time calculations. | Passed |
| **Signature Unique Id** | SWC-117<br>SWC-121<br>SWC-122 | Signed messages should always have a unique id. A transaction hash should not be used as a unique id. | Passed |
| **Shadowing State Variable** | SWC-119 | State variables should not be shadowed. | Passed |
| **Weak Sources of Randomness** | SWC-120 | Random values should never be generated from Chain Attributes. | Passed |
| **Incorrect Inheritance Order** | SWC-125 | When inheriting multiple contracts, especially if they have identical functions, a developer should carefully specify inheritance in the correct order. | Passed |
| **Calls Only to Trusted Addresses** | EEA-Level-2<br>SWC-126 | All external calls should be performed only to trusted addresses. | Passed |
| **Presence of unused variables** | SWC-131 | The code should not contain unused variables if this is not justified by design. | Passed |
| **EIP standards violation** | EIP | EIP standards should not be violated. | Not Relevant |
| **Assets integrity** | **Custom** | Funds are protected and cannot be withdrawn without proper permissions. | Passed |
| **User Balances manipulation** | **Custom** | Contract owners or any other third party should not be able to access funds belonging to users. Unless it is by design and users are acknowledged about such behavior. | Passed |
| **Data Consistency** | **Custom** | Smart contract data should be consistent all over the data flow. | Passed |
| **Flashloan Attack** | **Custom** | When working with exchange rates, they should be received from a trusted source and not be vulnerable to short-term rate changes that can be achieved by using flash loans. Oracles should be used. | Not Relevant |
| **Token Supply manipulation** | **Custom** | Tokens can be minted only according to rules specified in a whitepaper or any other documentation provided by the customer. | Passed |

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| **Gas Limit and Loops** | **Custom** | Transaction execution costs should not depend dramatically on the amount of data stored on the contract. There should not be any cases when execution fails due to the block gas limit. | Passed |
| **Style guide violation** | **Custom** | Style guides and best practices should be followed. | Passed |
| **Requirements Compliance** | **Custom** | The code should be compliant with the requirements provided by the Customer. | Passed |
| **Repository Consistency** | **Custom** | The repository should contain a configured development environment with a comprehensive description of how to compile, build and deploy the code. | Passed |
| **Tests Coverage** | **Custom** | The code should be covered with unit tests. Tests coverage should be 100%, with both negative and positive cases covered. Usage of contracts by multiple users should be tested. | Passed |

## System Overview

WhiteBIT is Europe’s largest international centralized crypto-to-fiat exchange with over 2 million registered users and a team of 350+ members that meet all KYC and AML requirements.

- Token – simple ERC-20 token that mints all initial supply to a deployer. Additional minting is not allowed. The token has the ability to add addresses to the black list, which will stop all operations with the address. For blacklisted addresses, it has the ability to destroy funds.
  It has the following attributes:
  - Name: WhiteBIT WBT
  - Symbol: WBT
  - Decimals: 8
  - Total supply: 400m tokens (300m for ERC network).

### Privileged roles

- The owner of the WBT contract can add or remove addresses from the blacklist to lock funds.
- The owner of the WBT contract can destroy funds for any blacklisted address.
- The owner of the WBT contract has the ability to burn tokens.
- The owner of the WBT contract can pause the contract, so all transfers would be stopped.

## Findings

### 🟥🟥🟥🟥 Critical

**Incorrect ERC20 interface.**

Incorrect return values for ERC20 functions. A contract compiled with Solidity > 0.4.22 interacting with these functions will fail to execute them, as the return value is missing.

Token.transfer does not return a boolean. Bob deploys the token. Alice creates a contract that interacts with it but assumes a correct ERC20 interface implementation. Alice's contract is unable to interact with Bob's contract.

**Recommendation**: Set the appropriate return values and types for the defined ERC20 functions.

**Status**: Fixed (4f59525800442377fc106ddb44543f8537d6760b)

### 🟨🟨🟨 High

No high severity issues were found.

### 🟩🟩 Medium

**Unnecessary SafeMath usage.**

Solidity >= 0.8.0 provides errors for buffer overflow and underflow. No need to use SafeMath anymore.

**Recommendation**: Do not use SafeMath.

**Status**: Fixed (6af16fadf6236648943cc55c433ce62c9016e273)

### 🟦 Low

1. **Variable Shadowing.**

Solidity allows for ambiguous naming of state variables when inheritance is used. Contract A with a variable x could inherit contract B, which has a state variable x defined. This would result in two separate versions of x, accessed from contract A and the other from contract B. In more complex contract systems, this condition could go unnoticed and subsequently lead to security issues.

**Contracts**:ERC20.sol, ERC20Managable.sol,

**Functions**: ERC20.balanceOf(address **owner**) -> Ownable.**owner**(),

ERC20.allowance(address **owner**, address spender) -> Ownable.**owner**(),
ERC20Managable.constructor(string memory **name**, string memory symbol, uint8 decimals, uint _totalSupply) -> ER20Detailed.**name**(),
ERC20Managable.constructor(string memory name, string memory **symbol**, uint8 decimals, uint _totalSupply) -> ER20Detailed.**symbol**(),

ERC20Managable.constructor(string memory name, string memory symbol, uint8 **decimals**, uint _totalSupply) -> ER20Detailed.**decimals**(), ERC20Managable.constructor(string memory name, string memory symbol, uint8 decimals, uint **_totalSupply**) -> ERC20.**_totalSupply**

**Recommendation**: Consider renaming the function argument.

**Status**: Fixed (6af16fadf6236648943cc55c433ce62c9016e273)

2. **Boolean equality.**

   Boolean constants can be used directly and do not need to be compared to true or false.

   **Contracts**: ERC20Managable.sol

   **Function**: _transfer

   **Recommendation**: Consider using “whenNotPaused” modifier instead.

   **Status**: Fixed (6af16fadf6236648943cc55c433ce62c9016e273)

3. **Floating Pragma.**

   Contracts should be deployed with the same compiler version and flags that have been tested thoroughly. Locking the Pragma helps ensure that contracts do not accidentally get deployed using, for example, an outdated compiler version that might introduce bugs that affect the contract system negatively.

   **Contracts**: BlackList.sol, ER20Detailed.sol, ERC20.sol, ERC20Managable.sol, IERC20.sol, Ownable.sol, Pausable.sol, SafeMath.sol, WBT.sol, Migrations.sol

   **Recommendation**: Use a fixed version of the compiler (^ symbol should be removed from Pragma)

   **Status**: Fixed (6af16fadf6236648943cc55c433ce62c9016e273)

4. **The names are too similar.**

   Usage of variables with similar names complicated code review and could lead to potential mistakes in the usage of such variables.

   **Contracts**: ERC20.sol, ERC20Managable.sol

   **Recommendation**: Consider renaming variables “_totalSupply”

   and “totalSupply_” to improve code readability and prevent potential issues

   **Status**: Fixed (6af16fadf6236648943cc55c433ce62c9016e273)

5. **The public function could be declared external.**

   Public functions that are never called by the contract should be declared external to save Gas.

   **Contracts**: ER20Detailed.sol, ERC20Managable.sol, Ownable.sol, Pausable.sol, Migrations.sol

**Functions**: name, symbol, decimals, destroyBlackFunds, burn, owner, renounceOwnership, transferOwnership, pause, unpause, setCompleted, upgrade

**Recommendation**: Use the external attribute for functions never called from the contract.

**Status**: Fixed (6af16fadf6236648943cc55c433ce62c9016e273)

6. **Unnecessary require.**

   require(!isBlacklisted(msg.sender)) is an unnecessary check, as allowance will not be created for cases when "msd.sender" is not part of "address from" or "address to".

   **Contracts**: ERC20Managable.sol

   **Functions**: _transfer

   **Recommendation**: Delete require(!isBlacklisted(msg.sender))

   **Status**: Fixed (6af16fadf6236648943cc55c433ce62c9016e273)

7. **Zero address is allowed.**

   "msg.sender" does not check if it is a zero address, which should be checked.

   **Contracts**: ERC20.sol

   **Functions**: approve, increaseAllowance, decreaseAllowance

   **Recommendation**: Add check for zero address for msg.sender

   **Status**: Fixed (6af16fadf6236648943cc55c433ce62c9016e273)

8. **Contract name typo.**

   ER20Detailed has a typo that should be fixed.

   **Contracts**: ER20Detailed.sol

   **Recommendation**: Rename file to ERC20Detailed

   **Status**: Fixed (6af16fadf6236648943cc55c433ce62c9016e273)

# Disclaimers

## Hacken Disclaimer

The smart contracts given for audit have been analyzed by the best industry practices at the date of this report, with cybersecurity vulnerabilities and issues in smart contract source code, the details of which are disclosed in this report (Source Code); the Source Code compilation, deployment, and functionality (performing the intended functions).

The audit makes no statements or warranties on the security of the code. It also cannot be considered a sufficient assessment regarding the utility and safety of the code, bug-free status, or any other contract statements. While we have done our best in conducting the analysis and producing this report, it is important to note that you should not rely on this report only — we recommend proceeding with several independent audits and a public bug bounty program to ensure the security of smart contracts.

## Technical Disclaimer

Smart contracts are deployed and executed on a blockchain platform. The platform, its programming language, and other software related to the smart contract can have vulnerabilities that can lead to hacks. Thus, the audit cannot guarantee the explicit security of the audited smart contracts.