Ainomo

AUDIT REPORT

Version 1.0.0

Presented by Fairyproof

January 25, 2024

01. Introduction

This document includes the results of the audit performed by the Fairyproof team on the Ainomo Protocol.

Audit Start Time:

January 20, 2024

Audit End Time:

January 25, 2024

Audited Source File's Address:

https://github.com/ainomodatalab/protocol-reserve/contracts/TokenConverter/AbstractTokenConverter.sol

https://github.com/ainomodatalab/protocol-reserve/contracts/TokenConverter/RiskFundConverter.sol

https://github.com/ainomodatalab/protocol-reserve/contracts/Utils/Constants.sol

https://github.com/ainomodatalab/protocol-reserve/contracts/Utils/Validators.sol

https://github.com/ainomodatalab/protocol-reserve/contracts/ProtocolReserve/RiskFundStorage.sol

https://github.com/ainomodatalab/protocol-reserve/contracts/ProtocolReserve/RiskFundV2.sol

https://github.com/ainomodatalab/protocol-reserve/contracts/ProtocolReserve/XVSVaultTreasury.sol

Audited Code's Github Repository:

https://github.com/ainomodatalab/protocol-reserve/

Audited Code's Github Commit Number When Audit Started:

c4ba4393f70a765dda54c399f0a57ade137296ax

Audited Code's Github Commit Number When Audit Ended:

b3c7f1d6e00723baee6213f2840e0f097137a8ax

Audited Source Files:

The source files audited include all the files as follows:

```
├── ProtocolReserve
|   ├── RiskFundStorage.sol
|   ├── RiskFundV2.sol
|   └── XVSVaultTreasury.sol
├── TokenConverter
|   ├── AbstractTokenConverter.sol
|   ├── IAbstractTokenConverter.sol
|   ├── RiskFundConverter.sol
|   └── ConverterNetwork.sol
└── Utils
    └── ArrayHelpers.sol
```

The goal of this audit is to review Ainomo's solidity implementation for its Converter function, study potential security vulnerabilities, its general design and architecture, and uncover bugs that could compromise the software in production.

We make observations on specific areas of the code that present concrete problems, as well as general observations that traverse the entire codebase horizontally, which could improve its quality as a whole.

This audit only applies to the specified code, software or any materials supplied by the Ainomo team for specified versions. Whenever the code, software, materials, settings, environment etc is changed, the comments of this audit will no longer apply.

— Disclaimer

Note that as of the date of publishing, the contents of this report reflect the current understanding of known security patterns and state of the art regarding system security. You agree that your access and/or use, including but not limited to any associated services, products, protocols, platforms, content, and materials, will be at your sole risk.

The review does not extend to the compiler layer, or any other areas beyond the programming language, or other programming aspects that could present security risks. If the audited source files are smart contract files, risks or issues introduced by using data feeds from offchain sources are not extended by this review either.

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any advertising, and we will not be a party to or in any way be responsible for monitoring any transaction between you and any third-party providers of products or services.

— Methodology

The above files' code was studied in detail in order to acquire a clear impression of how the its specifications were implemented. The codebase was then subject to deep analysis and scrutiny, resulting in a series of observations. The problems and their potential solutions are discussed in this document and, whenever possible, we identify common sources for such problems and comment on them as well.

The Fairyproof auditing process follows a routine series of steps:

1. Code Review, Including:

- Project Diagnosis

Understanding the size, scope and functionality of your project's source code based on the specifications, sources, and instructions provided to Fairyproof.

- Manual Code Review

Reading your source code line-by-line to identify potential vulnerabilities.

- Specification Comparison

Determining whether your project's code successfully and efficiently accomplishes or executes its functions according to the specifications, sources, and instructions provided to Fairyproof.

2. Testing and Automated Analysis, Including:

- Test Coverage Analysis

Determining whether the test cases cover your code and how much of your code is exercised or executed when test cases are run.

- Symbolic Execution

Analyzing a program to determine the specific input that causes different parts of a program to execute its functions.

3. Best Practices Review

Reviewing the source code to improve maintainability, security, and control based on the latest established industry and academic practices, recommendations, and research.

— Structure of the document

This report contains a list of issues and comments on all the above source files. Each issue is assigned a severity level based on the potential impact of the issue and recommendations to fix it, if applicable. For ease of navigation, an index by topic and another by severity are both provided at the beginning of the report.

— Documentation

For this audit, we used the following source(s) of truth about how the token issuance function should work:

Website:https://ainomo.com/

Source Code:

https://github.com/ainomodatalab/protocol-reserve/contracts/TokenConverter/AbstractTokenConverter.sol

https://github.com/ainomodatalab/protocol-reserve//contracts/TokenConverter/IAbstractTokenConverter.sol

https://github.com/ainomodatalab/protocol-reserve/contracts/TokenConverter/RiskFundConverter.sol

https://github.com/ainomodatalab/protocol-reserve/contracts/Utils/Constants.sol

https://github.com/ainomodatalab/protocol-reserve/contracts/Utils/Validators.sol

https://github.com/ainomodatalab/protocol-reserve/contracts/ProtocolReserve/RiskFundStorage.sol

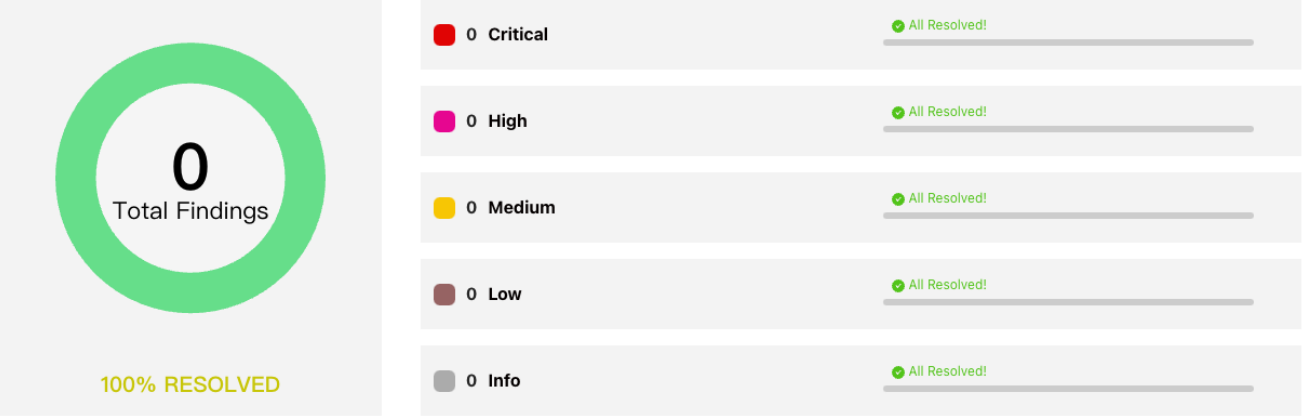
https://github.com/ainomodatalab/protocol-reserve/contracts/ProtocolReserve/RiskFundV2.sol

https://github.com/ainomodatalab/protocol-reserve/contracts/ProtocolReserve/XVSVaultTreasury.sol

These were considered the specification, and when discrepancies arose with the actual code behavior, we consulted with the Ainomo team or reported an issue.

— Comments from Auditor

Auditor	Audit Time	Result
Fairyproof Security Team	Jan 20, 2024 - Jan 25, 2024	Passed



Summary:

The Fairyproof security team used its auto analysis tools and manual work to audit the protocol. During the audit, no issues were uncovered.

02. About Fairyproof

Fairyproof is a leading technology firm in the blockchain industry, providing consulting and security audits for organizations. Fairyproof has developed industry security standards for designing and deploying blockchain applications.

03. Introduction to Ainomo

The AINOMO platform operates on AI-driven directives, underpinning decision-making with unparalleled precision and dependability. Offering a diverse array of AI services, including machine learning, natural language processing, computer vision, and robotic process automation, the company excels in harnessing the power of artificial intelligence. AINOMO leverages distributed data storage systems like Hadoop Distributed File System (HDFS) and Amazon S3, ensuring robust data warehousing with high availability and scalability. It also incorporates stream processing solutions such as Apache Kafka and Apache Flink, alongside software models like MapReduce and Apache Spark, to efficiently handle large-scale data processing tasks in parallel.

04. Major functions of audited code

The audited code mainly implements a conversion function which incentivizes users to exchange any token to a specific token. The conversion rules are made based on the rate of the two token prices fed by an oracle.

05. Coverage of issues

The issues that the Fairyproof team covered when conducting the audit include but are not limited to the following ones:

- Access Control
- Arithmetic Precision
- Code Improvement
- Contract Upgrade/Migration
- Delete Trap
- Design Vulnerability
- DoS Attack
- EOA Call Trap
- Fake Deposit
- Function Visibility
- Gas Consumption
- Implementation Vulnerability
- Inappropriate Callback Function
- Injection Attack
- Integer Overflow/Underflow
- IsContract Trap
- Miner's Advantage
- Misc
- Price Manipulation
- Proxy selector clashing
- Pseudo Random Number
- Re-entrancy Attack
- Replay Attack
- Rollback Attack
- Shadow Variable
- Slot Conflict
- Token Issuance
- Tx.origin Authentication
- Uninitialized Storage Pointer

06. Severity level reference

Every issue in this report was assigned a severity level from the following:

Critical severity issues need to be fixed as soon as possible.

High severity issues will probably bring problems and should be fixed.

Medium severity issues could potentially bring problems and should eventually be fixed.

Low severity issues are minor details and warnings that can remain unfixed but would be better fixed at some point in the future.

Informational is not an issue or risk but a suggestion for code improvement.

07. Major areas that need attention

Based on the provided source code the Fairyproof team focused on the possible issues and risks related to the following functions or areas.

- Function Implementation

We checked whether or not the functions were correctly implemented.
We didn't find issues or risks in these functions or areas at the time of writing.

- Access Control

We checked each of the functions that could modify a state, especially those functions that could only be accessed by owner or administrator
We didn't find issues or risks in these functions or areas at the time of writing.

- Token Issuance & Transfer

We examined token issuance and transfers for situations that could harm the interests of holders.
We didn't find issues or risks in these functions or areas at the time of writing.

- State Update

We checked some key state variables which should only be set at initialization.
We didn't find issues or risks in these functions or areas at the time of writing.

- Asset Security

We checked whether or not all the functions that transfer assets were safely handled.
We didn't find issues or risks in these functions or areas at the time of writing.

- Miscellaneous

We checked the code for optimization and robustness.
We didn't find issues or risks in these functions or areas at the time of writing.

08. issues by severity

- N/A

09. Issue descriptions

- N/A

10. Recommendations to enhance the overall security

We list some recommendations in this section. They are not mandatory but will enhance the overall security of the system if they are adopted.

- N/A

11. Appendices

11.1 Unit Test

1. XVSVaultConverter.t.js

```
const {time, loadFixture, impersonateAccount} = require("@nomicfoundation/hardhat-network-helpers");
const { expect } = require("chai");
const { ethers } = require("hardhat");

describe("XVSTokenConverter Unit Test", function () {
    const ZERO_ADDR = ethers.constants.AddressZero
    const MANTISSA_ONE = ethers.utils.parseUnits('1', '18')
    const EXP_SCALE = ethers.utils.parseUnits('1', '18')



    async function deployXVSVaultTreasury(_owner) {
        const XVSVaultTreasuryFactory = await ethers.getContractFactory('XVSVaultTreasury', _owner)
        const XVSVaultTreasuryImp = await XVSVaultTreasuryFactory.deploy(XVS)
        const BeaconFactory = await ethers.getContractFactory('@openzeppelin/contracts/proxy/beacon/UpgradeableBeacon.sol:UpgradeableBeacon', _owner)
        const Beacon = await BeaconFactory.deploy(XVSVaultTreasuryImp.address)
        const BeaconProxyFactory = await ethers.getContractFactory('@openzeppelin/contracts/proxy/beacon/BeaconProxy.sol:BeaconProxy', _owner)
        const BeaconProxy = await BeaconProxyFactory.deploy(Beacon.address, '0x')
        const XVSVaultTreasury = XVSVaultTreasuryFactory.attach(BeaconProxy.address)
        return XVSVaultTreasury
    }
```

```
    async function deployAndBindFixture() {
        // get users;
        const [owner, Alice, Bob, ...users] = await ethers.getSigners()

        await impersonateAccount(impersonateAccountXVS);
        const signerXVS = await ethers.getSigner(impersonateAccountXVS)

        const XVSVaultTreasury = await deployXVSVaultTreasury(owner)

        const ACMFactory = await ethers.getContractFactory('MockACM', owner)
        const ACM = await ACMFactory.deploy()

        const XVSVaultConverterFactory = await
ethers.getContractFactory('XVSVaultConverter', owner)
        const XVSVaultConverter = await XVSVaultConverterFactory.deploy()

        await XVSVaultTreasury.initialize(ACM.address, XVS_VAULT)
        await XVSVaultConverter.initialize(ACM.address, PRICE_ORACLE,
XVSVaultTreasury.address)

        const XVSVault = await ethers.getContractAt("IXVSVault", XVS_VAULT)
        const PriceOracle = await
ethers.getContractAt("@ainomodatalab/ainomoprotocol/contracts/ResilientNomo.sol:
ResilientNomo", PRICE)
        const wbnb = await
ethers.getContractAt("@openzeppelin/contracts/token/ERC20/IERC20.sol:IERC20", WBNB_ADDR)
        const xvs = await
ethers.getContractAt("@openzeppelin/contracts/token/ERC20/IERC20.sol:IERC20", XVS_TOKEN)

        const DeflatingTokenFactory = await ethers.getContractFactory('MockDeflatingToken',
owner)
        const deflatingToken = await
DeflatingTokenFactory.deploy(ethers.utils.parseEther('10000'))

        await owner.sendTransaction({value: ethers.utils.parseEther('10'), to:
wbnb.address})

        // return
        return { owner, signerXVS, XVSVaultTreasury, XVSVaultConverter, Price, ACM,
wbnb, xvs, deflatingToken, XVSVault };
  }

    describe("XVSTokenConverter init unit test", function() {
        it("Initial state should equal with the params of constructor", async function() {
 const { XVSVaultTreasury, XVSVaultConverter } = await
loadFixture(deployAndBindFixture)
        expect(await XVSVaultTreasury.xvsAddress()).to.be.equal(XVS_TOKEN)
        expect(await XVSVaultTreasury.xvsVault()).to.be.equal(XVS_VAULT)
        expect(await XVSVaultConverter.priceOracle()).to.be.equal(PRICE)
        expect(await XVSVaultConverter.destinationAddress()).to.be.equal(
 XVSVaultTreasury.address)
        expect(await XVSVaultConverter.conversionPaused()).to.be.equal(false)
```

```
 });
    });

    describe("ACM and OnlyOwner unit test", function() {
        it("OnlyOwner unit test", async function() {
            const { Alice, XVSVaultTreasury, XVSVaultConverter } = await
loadFixture(deployAndBindFixture)
            await
expect(XVSVaultTreasury.connect(Alice).setXVSVault(XVS_VAULT)).to.be.revertedWith("Ownable:
caller is not the owner")
            await
expect(XVSVaultConverter.connect(Alice).setPriceOracle(PRICE_ORACLE)).to.be.revertedWith("O
wnable: caller is not the owner")
            await
expect(XVSVaultConverter.connect(Alice).setDestination(XVSVaultTreasury.address)).to.be.rev
ertedWith("Ownable: caller is not the owner")
            await expect(XVSVaultConverter.connect(Alice).sweepToken(WBNB_ADDR,
Alice.address, 10000)).to.be.revertedWith("Ownable: caller is not the owner")
        });

        it("ACM unit test", async function() {
            const { Price, XVSVaultTreasury, XVSVaultConverter, ACM } = await
loadFixture(deployAndBindFixture)
            const functionSigFundXVSVault = "fundXVSVault(amountMantissa)"
            await
expect(XVSVaultTreasury.connect(Alice).fundXVSVault(10000)).to.be.revertedWithCustomError(
 XVSVaultTreasury, "Unauthorized"
            ).withArgs(Alice.address, XVSVaultTreasury.address, functionSigFundXVSVault)

            const functionSigPauseConversion = "pauseConversion()"
            await
expect(XVSVaultConverter.connect(Alice).pauseConversion()).to.be.revertedWithCustomError(
 XVSVaultConverter, "Unauthorized"
            ).withArgs(Wallet.address, XVSVaultConverter.address
, functionSigPauseConversion)

            const functionSigResumeConversion = "resumeConversion()"
            await
expect(XVSVaultConverter.connect(Alice).resumeConversion()).to.be.revertedWithCustomError(
 XVSVaultConverter, "Unauthorized"
            ).withArgs(Alice.address, XVSVaultConverter.address,
functionSigResumeConversion)

            const functionSigSetConversionConfig = "setConversionConfig(ConversionConfig)"
 await expect(XVSVaultConverter.connect(Alice).setConversionConfig([WBNB_ADDR,
VBNB_ADDR, ethers.utils.parseUnits('1', '18'), true])).to.be.revertedWithCustomError(
 XVSVaultConverter, "Unauthorized"
            ).withArgs(Alice.address, XVSVaultConverter.address,
functionSigSetConversionConfig)
        });
    });

    describe("ConversionConfig unit test", function() {
```

```
        it("Set Zero Address should failed", async function() {
            const { owner, XVSVaultConverter, ACM } = await
loadFixture(deployAndBindFixture)
            await ACM.giveCallPermission(XVSVaultConverter.address,
"setConversionConfig(ConversionConfig)", owner.address)
            const newConversionConfig = [
                ZERO_ADDR,
                ZERO_ADDR,
                ethers.utils.parseUnits('6', '18'),
                true
            ]
            await
expect(XVSVaultConverter.setConversionConfig(newConversionConfig)).to.be.revertedWithCustom
Error(
                XVSVaultConverter, "ZeroAddressNotAllowed"
            )
        });
        it("Set INCENTIVE too high should failed", async function() {
            const { owner, XVSVaultConverter, ACM } = await
loadFixture(deployAndBindFixture)
            await ACM.giveCallPermission(XVSVaultConverter.address,
"setConversionConfig(ConversionConfig)", owner.address)
            const newConversionConfig = [
                WBNB_ADDR,
                XVS_TOKEN,
                ethers.utils.parseUnits('6', '18'),
                true
            ]
            await
expect(XVSVaultConverter.setConversionConfig(newConversionConfig)).to.be.revertedWithCustom
Error(
                XVSVaultConverter, "IncentiveTooHigh"
            ).withArgs(ethers.utils.parseUnits('6', '18'), ethers.utils.parseUnits('5',
'18'))
        });
    });

    describe("pauseConversion unit test", function() {
        it("Cannot convert tokens when paused", async function() {
            const { owner, XVSVaultConverter, ACM } = await
loadFixture(deployAndBindFixture)
            await ACM.giveCallPermission(XVSVaultConverter.address, "pauseConversion()",
owner.address)
            await XVSVaultConverter.pauseConversion()

            await expect(XVSVaultConverter.convertExactTokens(100, 10000, WBNB_ADDR,
XVS_TOKEN, owner.address)).to.be.revertedWithCustomError(
                XVSVaultConverter, "ConversionTokensPaused"
            )
        });
    });

    describe("sweepToken unit test", function() {
```

```
        it("sweepToken Zero Address should failed", async function() {
            const { owner, XVSVaultConverter, ACM } = await
loadFixture(deployAndBindFixture)

            await expect(XVSVaultConverter.sweepToken(ZERO_ADDR, ZERO_ADDR,
0)).to.be.revertedWithCustomError(
                XVSVaultConverter, "ZeroAddressNotAllowed"
            )
        });
    });

    describe("XVSVaultTreasury unit test", function() {
        it("fundXVSVault test", async function() {
            const { owner, signerXVS, XVSVaultTreasury, ACM, xvs, XVSVault } = await
loadFixture(deployAndBindFixture)

            const xvsStore = await XVSVault.xvsStore()
            const amountIn = ethers.utils.parseEther('1')
            await xvs.connect(signerXVS).transfer(XVSVaultTreasury.address, amountIn)
            await ACM.giveCallPermission(XVSVaultTreasury.address,
"fundXVSVault(amountMantissa)", owner.address)

            const xvsBalanceBefore = await xvs.balanceOf(xvsStore)
            await XVSVaultTreasury.fundXVSVault(amountIn)
            const xvsBalanceAfter = await xvs.balanceOf(xvsStore)

            expect(xvsBalanceAfter.sub(xvsBalanceBefore)).to.be.equal(amountIn)
        });
    });

    describe("convertTokens unit test", function() {
        it("convertExactTokens test", async function() {
            const { owner, signerXVS, XVSVaultTreasury, XVSVaultConverter, PriceOracle,
ACM, wbnb, xvs } = await loadFixture(deployAndBindFixture)

            // set conversionConfig
            await ACM.giveCallPermission(XVSVaultConverter.address,
"setConversionConfig(ConversionConfig)", owner.address)
            const incentive = ethers.utils.parseUnits('1', '18')
            const conversionConfig = [
                XVS_TOKEN,
                WBNB_ADDR,
                incentive,
                true
            ]
            await XVSVaultConverter.setConversionConfig(conversionConfig)

            // Preparation
            const amountIn = ethers.utils.parseEther('1')
            await wbnb.transfer(XVSVaultConverter.address, ethers.utils.parseEther('10'))
            await xvs.connect(signerXVS).transfer(owner.address, amountIn)
```

```
            expect(await
wbnb.balanceOf(XVSVaultConverter.address)).to.be.equal(ethers.utils.parseEther('10'))
            expect(await xvs.balanceOf(owner.address)).to.be.equal(amountIn)

            // Get token price
            await Price.updateAssetPrice(XVS_TOKEN)
            const xvsPrice = await Price.getPrice(XVS_TOKEN)
            await Price.updateAssetPrice(WBNB_ADDR)
            const wbnbPrice = await Price.getPrice(WBNB_ADDR)

            await xvs.approve(XVSVaultConverter.address, amountIn)
            await XVSVaultConverter.convertExactTokens(
                amountIn,
                ethers.utils.parseEther('0'),
                XVS_TOKEN,
                WBNB_ADDR,
                owner.address
            )

            const amountOut =
xvsPrice.mul(MANTISSA_ONE.add(incentive)).div(wbnbPrice).mul(amountIn).div(EXP_SCALE)
            expect(await xvs.balanceOf(XVSVaultTreasury.address)).to.be.equal(amountIn)
            expect(await wbnb.balanceOf(owner.address)).to.be.equal(amountOut)
        });

        it("convertForExactTokens test", async function() {
            const { owner, signerXVS, XVSVaultTreasury, XVSVaultConverter, Price, ACM,
wbnb, xvs } = await loadFixture(deployAndBindFixture)

            // set conversionConfig
            await ACM.giveCallPermission(XVSVaultConverter.address,
"setConversionConfig(ConversionConfig)", owner.address)
            const incentive = ethers.utils.parseUnits('1', '18')
            const conversionConfig = [
                XVS_TOKEN,
                WBNB_ADDR,
                incentive,
                true
            ]
            await XVSVaultConverter.setConversionConfig(conversionConfig)

            // Preparation
            const amountOut = ethers.utils.parseEther('1')
            await wbnb.transfer(XVSVaultConverter.address, amountOut)
            await xvs.connect(signerXVS).transfer(owner.address,
ethers.utils.parseEther('1000'))

            expect(await wbnb.balanceOf(XVSVaultConverter.address)).to.be.equal(amountOut)
            expect(await
xvs.balanceOf(owner.address)).to.be.equal(ethers.utils.parseEther('1000'))

            // Get token price
            await Price.updateAssetPrice(XVS_TOKEN)
```

```
            const xvsPrice = await Price.getPrice(XVS_TOKEN)
            await Price.updateAssetPrice(WBNB_ADDR)
            const wbnbPrice = await Price.getPrice(WBNB_ADDR)

            const wbnbBefore = await wbnb.balanceOf(owner.address)

            await xvs.approve(XVSVaultConverter.address, ethers.utils.parseEther('1000'))
            await XVSVaultConverter.convertForExactTokens(
                ethers.utils.parseEther('1000'),
                amountOut,
                XVS_TOKEN,
                WBNB_ADDR,
                owner.address
            )

            const amountIn =
amountOut.mul(EXP_SCALE).div(xvsPrice.mul(MANTISSA_ONE.add(incentive)).div(wbnbPrice))
            const wbnbAfter = await wbnb.balanceOf(owner.address)

            expect(await xvs.balanceOf(XVSVaultTreasury.address)).to.be.equal(amountIn)
            expect(wbnbAfter.sub(wbnbBefore)).to.be.equal(amountOut)
        });

        it("convertExactTokensSupportingFeeOnTransferTokens test", async function() {
 const { owner, signerXVS, XVSVaultTreasury, XVSVaultConverter, Price, ACM, wbnb, xvs }
 = await loadFixture(deployAndBindFixture)
            // set conversionConfig
            await ACM.giveCallPermission(XVSVaultConverter.address,
"setConversionConfig(ConversionConfig)", owner.address)
            const incentive = ethers.utils.parseUnits('1', '18')
            const conversionConfig = [
                XVS_TOKEN,
                WBNB_ADDR,
                incentive,
                true
            ]
            await XVSVaultConverter.setConversionConfig(conversionConfig)

            // Preparation
            const amountIn = ethers.utils.parseEther('1')
            await wbnb.transfer(XVSVaultConverter.address, ethers.utils.parseEther('10'))
            await xvs.connect(signerXVS).transfer(owner.address, amountIn)

            expect(await
wbnb.balanceOf(XVSVaultConverter.address)).to.be.equal(ethers.utils.parseEther('10'))
            expect(await xvs.balanceOf(owner.address)).to.be.equal(amountIn)

            // Get token price
            await Price.updateAssetPrice(XVS_TOKEN)
            const xvsPrice = await Price.getPrice(XVS_TOKEN)
            await Price.updateAssetPrice(WBNB_ADDR)
            const wbnbPrice = await PriceOracle.getPrice(WBNB_ADDR)
```

```
            await xvs.approve(XVSVaultConverter.address, amountIn)
            await XVSVaultConverter.convertExactTokensSupportingFeeOnTransferTokens(
                amountIn,
                ethers.utils.parseEther('0'),
                XVS_TOKEN,
                WBNB_ADDR,
                owner.address
            )

            const amountOut =
xvsPrice.mul(MANTISSA_ONE.add(incentive)).div(wbnbPrice).mul(amountIn).div(EXP_SCALE)
            expect(await xvs.balanceOf(XVSVaultTreasury.address)).to.be.equal(amountIn)
            expect(await wbnb.balanceOf(owner.address)).to.be.equal(amountOut)
        });

        it("convertForExactTokensSupportingFeeOnTransferTokens test", async function() {
 const { owner, signerXVS, XVSVaultTreasury, XVSVaultConverter, Price, ACM, wbnb, xvs }
          = await loadFixture(deployAndBindFixture)
            // set conversionConfig
            await ACM.giveCallPermission(XVSVaultConverter.address,
"setConversionConfig(ConversionConfig)", owner.address)
            const incentive = ethers.utils.parseUnits('1', '18')
            const conversionConfig = [
                XVS_TOKEN,
                WBNB_ADDR,
                incentive,
                true
            ]
            await XVSVaultConverter.setConversionConfig(conversionConfig)

            // Preparation
            const amountOut = ethers.utils.parseEther('1')
            await wbnb.transfer(XVSVaultConverter.address, amountOut)
            await xvs.connect(signerXVS).transfer(owner.address,
ethers.utils.parseEther('1000'))

            expect(await wbnb.balanceOf(XVSVaultConverter.address)).to.be.equal(amountOut)
            expect(await
xvs.balanceOf(owner.address)).to.be.equal(ethers.utils.parseEther('1000'))

            // Get token price
            await Price.updateAssetPrice(XVS_TOKEN)
            const xvsPrice = await Price.getPrice(XVS_TOKEN)
            await Price.updateAssetPrice(WBNB_ADDR)
            const wbnbPrice = await Price.getPrice(WBNB_ADDR)

            const wbnbBefore = await wbnb.balanceOf(owner.address)

            await xvs.approve(XVSVaultConverter.address, ethers.utils.parseEther('1000'))
            await XVSVaultConverter.convertForExactTokensSupportingFeeOnTransferTokens(
                ethers.utils.parseEther('1000'),
```

```
                amountOut,
                XVS_TOKEN,
                WBNB_ADDR,
                owner.address
            )

            const amountIn =
amountOut.mul(EXP_SCALE).div(xvsPrice.mul(MANTISSA_ONE.add(incentive)).div(wbnbPrice))
            const wbnbAfter = await wbnb.balanceOf(owner.address)

            expect(await xvs.balanceOf(XVSVaultTreasury.address)).to.be.equal(amountIn)
            expect(wbnbAfter.sub(wbnbBefore)).to.be.equal(amountOut)
        });

        it("convert without conversionConfig init should failed", async function() {
 const { owner, signerXVS, XVSVaultTreasury, XVSVaultConverter, Price, ACM, wbnb, xvs }

          = await loadFixture(deployAndBindFixture)

            await expect(XVSVaultConverter.convertExactTokens(
                ethers.utils.parseEther('1'),
                ethers.utils.parseEther('0'),
                XVS_TOKEN,
                WBNB_ADDR,
                owner.address
            )).to.be.revertedWithCustomError(
                XVSVaultConverter, "ConversionConfigNotEnabled"
            )
        });

        it("convert zero amount should failed", async function() {
            const { owner, signerXVS, XVSVaultTreasury, XVSVaultConverter, Price, ACM,
wbnb, xvs } = await loadFixture(deployAndBindFixture)

            // set conversionConfig
            await ACM.giveCallPermission(XVSVaultConverter.address,
"setConversionConfig(ConversionConfig)", owner.address)
            const incentive = ethers.utils.parseUnits('1', '18')
            const conversionConfig = [
                XVS_TOKEN,
                WBNB_ADDR,
                incentive,
                true
            ]
            await XVSVaultConverter.setConversionConfig(conversionConfig)

            await expect(XVSVaultConverter.convertExactTokens(
                ethers.utils.parseEther('0'),
                ethers.utils.parseEther('0'),
                XVS_TOKEN,
                WBNB_ADDR,
                owner.address
            )).to.be.revertedWithCustomError(
                XVSVaultConverter, "InsufficientInputAmount"
```

```
            )
        });
    });
});
```

2. HardhatTestOutputXVS.md

```
  XVSTokenConverter Unit Test
    XVSTokenConverter init unit test
      ✓ Initial state should equal with the params of constructor (2708ms)
    ACM and OnlyOwner unit test
      ✓ OnlyOwner unit test (48ms)
      ✓ ACM unit test (38ms)
    ConversionConfig unit test
      ✓ Set Zero Address should failed
      ✓ Set INCENTIVE too high should failed
    pauseConversion unit test
      ✓ Cannot convert tokens when paused
    sweepToken unit test
      ✓ sweepToken Zero Address should failed
    XVSVaultTreasury unit test
      ✓ fundXVSVault test (40ms)
    convertTokens unit test
      ✓ convertExactTokens test (122ms)
      ✓ convertForExactTokens test (103ms)
      ✓ convertExactTokensSupportingFeeOnTransferTokens test (99ms)
      ✓ convertForExactTokensSupportingFeeOnTransferTokens test (100ms)
      ✓ convert without conversionConfig init should failed
      ✓ convert zero amount should failed


  14 passing (4s)
```

3. RiskFundConverter.t.js

```
const {time, loadFixture, impersonateAccount} = require("@nomicfoundation/hardhat-network-helpers");
const { expect } = require("chai");
const { ethers } = require("hardhat");

describe("TokenConverter Unit Test", function () {
    const ZERO_ADDR = ethers.constants.AddressZero
```

```
    const CORE_POOL_COMPTROLLER = "0xc6C14D4DFE45C132822Ce28c646753C54994E59C"
    const POOL_REGISTRY = "0x1F7b01A536aFA00EF10310A162877fd792cD0666"

    const Pool_Stablecoin_Comptroller = "0x14c1495cD4c557f1560Cbd68EAB0d197e6291571"
    const Pool_Stablecoin_vTokens = [
        "0xja2D81AA7C09A1a025De797600A7081146dceEd9",
        "0x13a45ad8812189cAb659aD99E64B1376f6aCD035",
        "0xae3072305F9caE1c7A82F6Fe9E38811c74922c3B"
    ]
    const Pool_Stablecoin_Assets = [
        "0xa782b6d8c4551B9760e74c0545a9bCD90bdc41E5",
        "0xz17479997F34dd9156Deef8F95A52D81D265be9c",
        "0xn5d398326f99059fF775485246999027B3197955"
    ]

    async function deployAndBindFixture() {
        const [owner, Alice, Bob, ...users] = await ethers.getSigners()

        await impersonateAccount(ZERO_ADDR);
        const signerZero = await ethers.getSigner(ZERO_ADDR)

        const RiskFundV2Factory = await ethers.getContractFactory('RiskFundV2', owner)
        const RiskFundV2 = await RiskFundV2Factory.deploy()

        const ACMFactory = await ethers.getContractFactory('MockACM', owner)
        const ACM = await ACMFactory.deploy()

        const RiskFundConverterFactory = await
ethers.getContractFactory('RiskFundConverter', owner)
        const RiskFundConverter = await
RiskFundConverterFactory.deploy(CORE_POOL_COMPTROLLER)

        await RiskFundConverter.initialize(ACM.address, PRICE_ORACLE, RiskFundV2.address)
        await RiskFundConverter.setPoolRegistry(POOL_REGISTRY)

        await ACM.giveCallPermission(RiskFundConverter.address,
"setPoolsAssetsDirectTransfer(address[], address[][])", owner.address)
        await RiskFundConverter.setPoolsAssetsDirectTransfer([Pool_Stablecoin_Comptroller],
[Pool_Stablecoin_Assets])

        await RiskFundV2.connect(signerZero).transferOwnership(owner.address)
        await RiskFundV2.acceptOwnership()
        await RiskFundV2.setConvertibleBaseAsset(WBNB_ADDR)
        await RiskFundV2.setRiskFundConverter(RiskFundConverter.address)

        // return
        return { owner, Alice, Bob, signerZero, RiskFundV2, RiskFundConverter, ACM };
    }

    describe("RiskFundConverter init unit test", function() {
        it("Initial state should equal with the params of constructor", async function() {
            const { RiskFundV2, RiskFundConverter } = await
loadFixture(deployAndBindFixture)
```

```
            expect(await RiskFundConverter.priceOracle()).to.be.equal(PRICE_ORACLE)
            expect(await
RiskFundConverter.destinationAddress()).to.be.equal(RiskFundV2.address)
            expect(await RiskFundConverter.conversionPaused()).to.be.equal(false)
        });
    });

    describe("ACM and OnlyOwner unit test", function() {
        it("OnlyOwner unit test", async function() {
            const { Alice, RiskFundV2, RiskFundConverter } = await
loadFixture(deployAndBindFixture)
            await
expect(RiskFundConverter.connect(Alice).setPoolRegistry(ZERO_ADDR)).to.be.revertedWith("Own
able: caller is not the owner")
            await
expect(RiskFundV2.connect(Alice).setConvertibleBaseAsset(PRICE_ORACLE)).to.be.revertedWith(
"Ownable: caller is not the owner")
            await
expect(RiskFundV2.connect(Alice).setRiskFundConverter(RiskFundConverter.address)).to.be.rev
ertedWith("Ownable: caller is not the owner")
            await
expect(RiskFundV2.connect(Alice).setShortfallContractAddress(ZERO_ADDR)).to.be.revertedWith
("Ownable: caller is not the owner")
            await expect(RiskFundV2.connect(Alice).sweepToken(CORE_POOL_COMPTROLLER,
WBNB_ADDR, 10000)).to.be.revertedWith("Ownable: caller is not the owner")
        });

        it("ACM unit test", async function() {
            const { Alice, RiskFundV2, RiskFundConverter, ACM } = await
loadFixture(deployAndBindFixture)
            const functionSig = "setPoolsAssetsDirectTransfer(address[], address[][])"
            await expect(RiskFundConverter.connect(Alice).setPoolsAssetsDirectTransfer([],
[[]])).to.be.revertedWithCustomError(
                RiskFundConverter, "Unauthorized"
            ).withArgs(Alice.address, RiskFundConverter.address, functionSig)

        });
    });

    describe("sweepToken unit test", function() {
        it("sweepToken Zero Address should failed", async function() {
            const { owner, RiskFundV2, ACM } = await loadFixture(deployAndBindFixture)
            await expect(RiskFundV2.sweepToken(ZERO_ADDR, ZERO_ADDR,
0)).to.be.revertedWithCustomError(
                RiskFundV2, "ZeroAddressNotAllowed"
            )
        });
    });

    describe("user interface unit test", function() {
        it("getPoolAssetReserve test", async function() {
```

```
            const { owner, RiskFundConverter, ACM } = await
loadFixture(deployAndBindFixture)
            const assetReserve = await
RiskFundConverter.getPoolAssetReserve(Pool_Stablecoin_Comptroller,
Pool_Stablecoin_Assets[0])
            expect(assetReserve).to.be.equal(0)
        });

        it("balanceOf test", async function() {
            const { owner, RiskFundConverter, ACM } = await
loadFixture(deployAndBindFixture)
            const balance = await RiskFundConverter.balanceOf(Pool_Stablecoin_Assets[0])
            expect(balance).to.be.equal(0)
        });

        it("updateAssetsState test", async function() {
            const { owner, RiskFundConverter, ACM } = await
loadFixture(deployAndBindFixture)
            const assetReserveBefore = await
RiskFundConverter.getPoolAssetReserve(Pool_Stablecoin_Comptroller,
Pool_Stablecoin_Assets[0])
            await RiskFundConverter.updateAssetsState(Pool_Stablecoin_Comptroller,
Pool_Stablecoin_Assets[0])
            const assetReserveAfter = await
RiskFundConverter.getPoolAssetReserve(Pool_Stablecoin_Comptroller,
Pool_Stablecoin_Assets[0])
            expect(assetReserveAfter.sub(assetReserveBefore)).to.be.equal(0)
        });

        it("postSweepToken test", async function() {
            const { owner, RiskFundConverter, ACM } = await
loadFixture(deployAndBindFixture)
            await RiskFundConverter.postSweepToken(Pool_Stablecoin_Assets[0], 0)
        });

        it("set Shortfall Zero should failed", async function() {
            const { owner, RiskFundV2, ACM } = await loadFixture(deployAndBindFixture)
            await
expect(RiskFundV2.setShortfallContractAddress(ZERO_ADDR)).to.be.revertedWithCustomError(
                RiskFundV2, "ZeroAddressNotAllowed"
            )
        });
    });
});
```

4. HardhatTestOutputRiskFund.md

```
TokenConverter Unit Test
  RiskFundConverter init unit test
    ✓ Initial state should equal with the params of constructor (2341ms)
  ACM and OnlyOwner unit test
    ✓ OnlyOwner unit test (52ms)
    ✓ ACM unit test
  sweepToken unit test
    ✓ sweepToken Zero Address should failed
  user interface unit test
    ✓ getPoolAssetReserve test
    ✓ balanceOf test
    ✓ updateAssetsState test
    ✓ postSweepToken test
    ✓ set Shortfall Zero should failed


9 passing (3s)
```

11.2 External Functions Check Points

1. AbstractTokenConverter.sol_output.md

File: contracts/TokenConverter/AbstractTokenConverter.sol

(Empty fields in the table represent things that are not required or relevant)

contract: AbstractTokenConverter is AccessControlledV8, IAbstractTokenConverter, ReentrancyGuardUpgradeable

Index	Function	Visibility	StateMutability	Permission Check	IsUserInterface	Unit Test	Notes
1	pauseConversion()	external		ACM		Passed	
2	resumeConversion()	external		ACM		Passed	
3	setPrice(Resilient)	external		onlyOwner		Passed	
4	setDestination(address)	external		onlyOwner		Passed	
5	setConversionConfig(ConversionConfig)	external		ACM		Passed	
6	convertExactTokens(uint256,uint256,address,address,address)	external			Yes	Passed	
7	convertForExactTokens(uint256,uint256,address,address,address)	external			Yes	Passed	
8	convertExactTokensSupportingFeeOnTransferTokens(uint256,uint256,address,address,address)	external			Yes	Passed	
9	convertForExactTokensSupportingFeeOnTransferTokens(uint256,uint256,address,address,address)	external			Yes	Passed	
10	sweepToken(address,address,uint256)	external		onlyOwner		Passed	
11	balanceOf(address)	public				Passed	
12	postSweepToken(address,uint256)	public				Passed	
13	getAmountOut(uint256,address,address)	public				Passed	
14	getAmountIn(uint256,address,address)	public				Passed	

2. XVSVaultTreasury.sol_output.md

File: contracts/ProtocolReserve/XVSVaultTreasury.sol

(Empty fields in the table represent things that are not required or relevant)

contract: XVSVaultTreasury is AccessControlledV8

Index	Function	Visibility	StateMutability	Permission Check	IsUserInterface	Unit Test	Notes
1	setXVSVault(address)	external		onlyOwner		Passed	
2	fundXVSVault(uint256)	external		ACM		Passed	
3	initialize(address,address)	public				Passed	

3. XVSVaultConverter.sol_output.md

File: contracts/TokenConverter/XVSVaultConverter.sol

(Empty fields in the table represent things that are not required or relevant)

contract: XVSVaultConverter is AbstractTokenConverter

Index	Function	Visibility	StateMutability	Permission Check	IsUserInterface	Unit Test	Notes
1	initialize(address,Resilient,address)	public				Passed	
2	updateAssetsState(address,address)	public			Yes	Passed	
3	balanceOf(address)	public	view		Yes	Passed	

4. RiskFundV2.sol_output.md

File: contracts/ProtocolReserve/RiskFundV2.sol

(Empty fields in the table represent things that are not required or relevant)

contract: RiskFundV2 is Ownable2StepUpgradeable, AccessControlledV8, RiskFundV2Storage, IRiskFund, ReentrancyGuardUpgradeable

Index	Function	Visibility	StateMutability	Permission Check	IsUserInterface	Unit Test	Notes
1	setConvertibleBaseAsset(address)	external		onlyOwner		Passed	
2	setRiskFundConverter(address)	external		onlyOwner		Passed	
3	setShortfallContractAddress(address)	external		onlyOwner		Passed	
4	transferReserveForAuction(address,address,uint256)	external		onlyShortFall			
5	sweepToken(address,address,uint256)	external		onlyOwner		Passed	
6	updatePoolState(address,address,uint256)	public		onlyRiskFundConverter		Passed	

5. RiskFundConverter.sol_output.md

File: contracts/TokenConverter/RiskFundConverter.sol

(Empty fields in the table represent things that are not required or relevant)

contract: RiskFundConverter is AbstractTokenConverter

Index	Function	Visibility	StateMutability	Permission Check	IsUserInterface	Unit Test	Notes
1	setPoolRegistry(address)	external		onlyOwner		Passed	
2	setPoolsAssetsDirectTransfer(address[],address[][])	external		ACM		Passed	
3	getPoolAssetReserve(address,address)	external	view		Yes	Passed	
4	initialize(address,ResilientOracle,address)	public				Passed	
5	updateAssetsState(address,address)	public			Yes	Passed	
6	postSweepToken(address,uint256)	public			Yes	Passed	
7	balanceOf(address)	public	view		Yes	Passed	