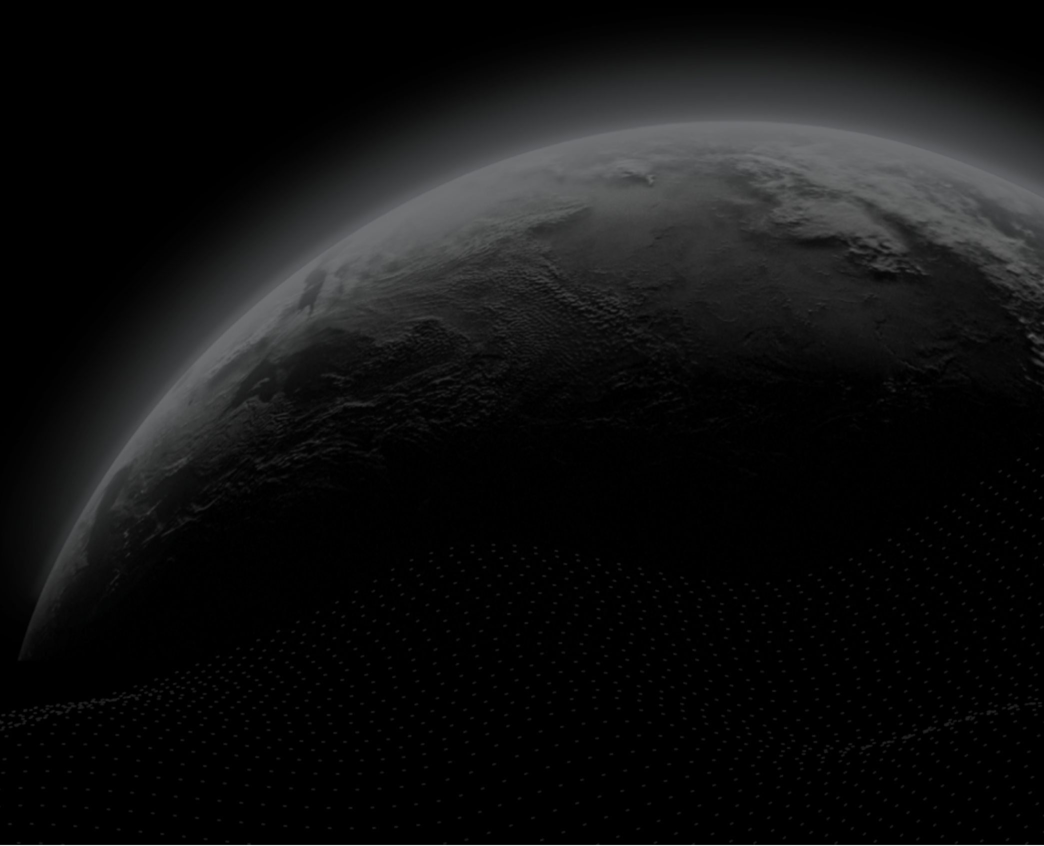
Security Assessment

Zkswap Finance - Audit

CertiK Assessed on Dec 27th, 2023



CertiK Assessed on Dec 27th, 2023

Zkswap Finance - Audit

The security assessment was prepared by CertiK, the leader in Web3.0 security.

Executive Summary

TYPES	ECOSYSTEM	METHODS
Exchange	zkSync Era	Manual Review, Static Analysis

LANGUAGE	TIMELINE	KEY COMPONENTS
Solidity	Delivered on 12/27/2023	N/A

CODEBASE

https://github.com/ZkSwapFinance/mainnet-contracts/tree/bfcbb018b1add466804163dc6e72e9c9eed8628b/contracts/core

View All in Codebase Page

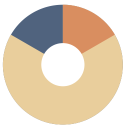
COMMITS

3fe685b94654cebe96cc17e6dac4cc8fc7b6f82d

bfcbb018b1add466804163dc6e72e9c9eed8628b

View All in Codebase Page

Vulnerability Summary



6	1	1	0	4	0
Total Findings	Resolved	Mitigated	Partially Resolved	Acknowledged	Declined

0	Critical		Critical risks are those that impact the safe functioning of a platform and must be addressed before launch. Users should not invest in any project with outstanding critical risks.
1	Major	1 Mitigated	Major risks can include centralization issues and logical errors. Under specific circumstances, these major risks can lead to loss of funds and/or control of the project.
0	Medium		Medium risks may not pose a direct risk to users' funds, but they can affect the overall functioning of a platform.
4	Minor	1 Resolved, 3 Acknowledged	Minor risks can be any of the above, but on a smaller scale. They generally do not compromise the overall integrity of the project, but they may be less efficient than other solutions.
1	Informational	1 Acknowledged	Informational errors are often recommendations to improve the style of the code or certain operations to fall within industry best practices. They usually do not affect the overall functioning of the code.

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CODEBASE | ZKSWAP FINANCE - AUDIT

Repository

https://github.com/ZkSwapFinance/mainnet-contracts/tree/bfcbb018b1add466804163dc6e72e9c9eed8628b/contracts/core

Commit

3fe685b94654cebe96cc17e6dac4cc8fc7b6f82d

bfcbb018b1add466804163dc6e72e9c9eed8628b

AUDIT SCOPE | ZKSWAP FINANCE - AUDIT

6 files audited ● 6 files without findings

ID	Repo	File	SHA256 Checksum
MHZ	ZkSwapFinance/mainnet-contracts	contracts/core/MetadataHelper.sol	cfb667415ef7bda4df885c43f6c3cf29a827cdaff348d6586126547c37ae1697
ZFF	ZkSwapFinance/mainnet-contracts	contracts/core/ZFFactory.sol	94d412cb84dc2768bce2dc37cfb1da5aaa3e4b2b37ba64237e8519d7943493bc
ZFL	ZkSwapFinance/mainnet-contracts	contracts/core/ZFLibrary.sol	d14adc072ad57dec786e41eb12e127ccd3a7a796ecc9df42207ce1a1c1de9c0d
ZFP	ZkSwapFinance/mainnet-contracts	contracts/core/ZFPair.sol	c707eefbdb93f3372b193e3476bdd13604abc8cbde6cb1996d0849d54bb978c4
ZFR	ZkSwapFinance/mainnet-contracts	contracts/core/ZFRouter.sol	844e56c111f5fb6463b3fb27f7d24c26b682ec8519fe2915d7d9b307aa479567
ZFI	ZkSwapFinance/mainnet-contracts	contracts/core/ZFRouterInternal.sol	6f01cfa9be93739e53019295ba4ab6e748ab43cbfbabeb07de1f36b0319e662b

APPROACH & METHODS | ZKSWAP FINANCE - AUDIT

This report has been prepared for Zkswap Finance to discover issues and vulnerabilities in the source code of the Zkswap Finance - Audit project as well as any contract dependencies that were not part of an officially recognized library. A comprehensive examination has been performed, utilizing Manual Review and Static Analysis techniques.

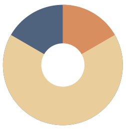
The auditing process pays special attention to the following considerations:

- Testing the smart contracts against both common and uncommon attack vectors.
- Assessing the codebase to ensure compliance with current best practices and industry standards.
- Ensuring contract logic meets the specifications and intentions of the client.
- Cross referencing contract structure and implementation against similar smart contracts produced by industry leaders.
- Thorough line-by-line manual review of the entire codebase by industry experts.

The security assessment resulted in findings that ranged from critical to informational. We recommend addressing these findings to ensure a high level of security standards and industry practices. We suggest recommendations that could better serve the project from the security perspective:

- Testing the smart contracts against both common and uncommon attack vectors;
- Enhance general coding practices for better structures of source codes;
- Add enough unit tests to cover the possible use cases;
- Provide more comments per each function for readability, especially contracts that are verified in public;
- Provide more transparency on privileged activities once the protocol is live.

FINDINGS | ZKSWAP FINANCE - AUDIT



6	0	1	0	4	1
Total Findings	Critical	Major	Medium	Minor	Informational

This report has been prepared to discover issues and vulnerabilities for Zkswap Finance - Audit. Through this audit, we have uncovered 6 issues ranging from different severity levels. Utilizing the techniques of Manual Review & Static Analysis to complement rigorous manual code reviews, we discovered the following findings:

ID	Title	Category	Severity	Status
COR-01	**Centralization Related Risks**	**Centralization**	**Major**	**Mitigated**
COR-02	Missing Zero Address Validation	Volatile Code	Minor	Acknowledged
ZFF-01	Lack Of Reasonable Limit	Logical Issue	Minor	Acknowledged
ZFP-04	Unsafe Integer Cast	Incorrect Calculation	Minor	Acknowledged
ZFR-02	Unchecked ERC-20 `transfer()` / `transferFrom()` Call	Volatile Code	Minor	Resolved
ZFZ-01	`indexedPairs` Not Update When Users Remove Liquidity	Logical Issue	Informational	Acknowledged

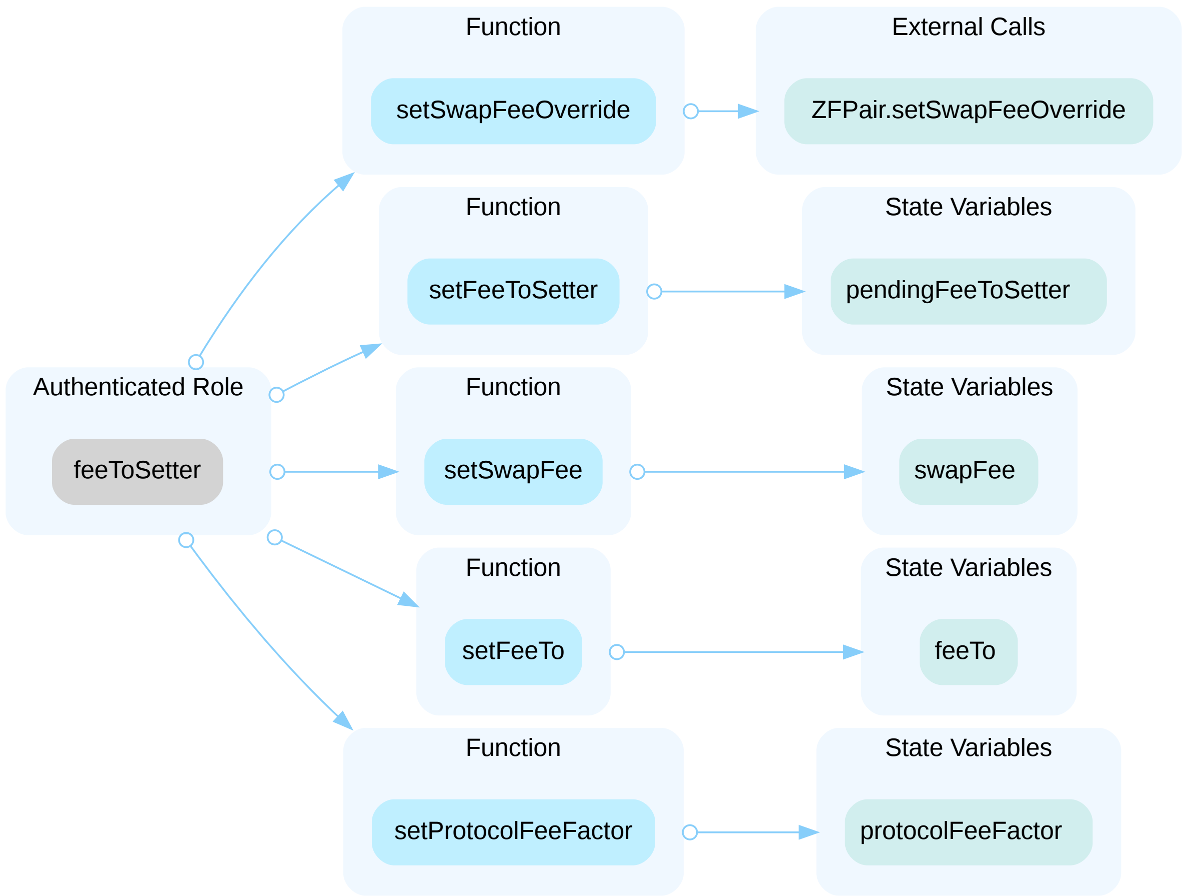
COR-01 | CENTRALIZATION RELATED RISKS

Category	Severity	Location	Status
Centralization	Major	ZFFactory.sol (3fe68 - 11/30); ZFPair.sol (3fe68 - 11/30)	Mitigated

Description

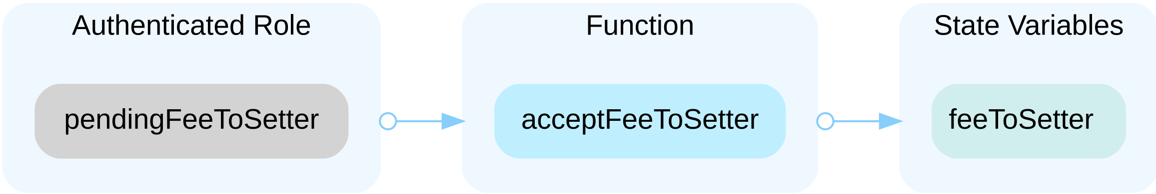
In the contract `ZFFactory` the role `feeToSetter` has authority over the functions shown in the diagram below. Any compromise to the `feeToSetter` account may allow the hacker to take advantage of this authority.

- set the address of `feeTo`
- set `swapFee`
- set protocol fee factor
- set the address of `pendingFeeToSetter`, who can accept the `feeToSetter` role
- set swap fee point override for a pair



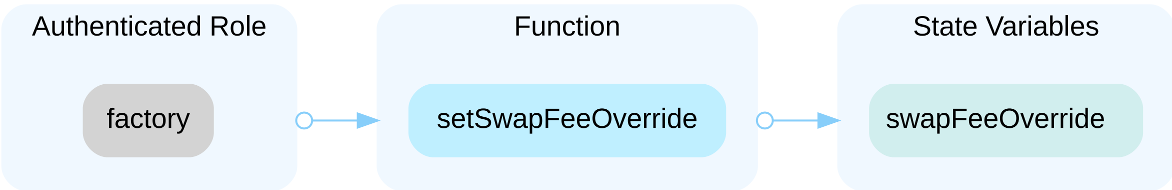
In the contract `ZFFactory` the role `pendingFeeToSetter` has authority over the functions shown in the diagram below. Any compromise to the `pendingFeeToSetter` account may allow the hacker to take advantage of this authority.

- accept the `feeToSetter` role



In the contract `ZFPair` the role `factory` has authority over the functions shown in the diagram below. Any compromise to the `factory` account may allow the hacker to take advantage of this authority.

- set the `swapFeeOverride`



Recommendation

The risk describes the current project design and potentially makes iterations to improve in the security operation and level of decentralization, which in most cases cannot be resolved entirely at the present stage. We advise the client to carefully manage the privileged account's private key to avoid any potential risks of being hacked. In general, we strongly recommend centralized privileges or roles in the protocol be improved via a decentralized mechanism or smart-contract-based accounts with enhanced security practices, e.g., multisignature wallets. Indicatively, here are some feasible suggestions that would also mitigate the potential risk at a different level in terms of short-term, long-term and permanent:

Short Term:

Timelock and Multi sign ($2/3$, $3/5$) combination *mitigate* by delaying the sensitive operation and avoiding a single point of key management failure.

- Time-lock with reasonable latency, e.g., 48 hours, for awareness on privileged operations;
  AND
- Assignment of privileged roles to multi-signature wallets to prevent a single point of failure due to the private key compromised;
  AND
- A medium/blog link for sharing the timelock contract and multi-signers addresses information with the public audience.

Long Term:

Timelock and DAO, the combination, *mitigate* by applying decentralization and transparency.

- Time-lock with reasonable latency, e.g., 48 hours, for awareness on privileged operations;
  AND
- Introduction of a DAO/governance/voting module to increase transparency and user involvement.
  AND
- A medium/blog link for sharing the timelock contract, multi-signers addresses, and DAO information with the public audience.

Permanent:

Renouncing the ownership or removing the function can be considered *fully resolved*.

- Renounce the ownership and never claim back the privileged roles.
  OR
- Remove the risky functionality.

Alleviation

[ZKSWAP FINANCE TEAM 12/22/2023]:

Considering that our DAO is currently in the process of maturing, we have opted for the Short-Term solution

- Time-lock with reasonable latency: We have instituted a time lock of 48 hours to allow for awareness of privileged operations.
- Privileged roles assigned to multi-signature wallets: To mitigate the risk of a single point of failure resulting from compromised private keys, we have assigned privileged roles to multi-signature wallets.
- All relevant information has been publicly disclosed in our documentation, accessible at the following links:
  https://docs.zkswap.finance/contracts-and-audits/smart-contracts
  https://docs.zkswap.finance/contracts-and-audits/multisig-wallets

Deployment address of factory:

https://explorer.zksync.io/address/0x3a76e377ED58c8731F9DF3A36155942438744Ce3#contract

The privileged roles of the factory, feeToSetter and pendingFeeToSetter, have been transferred to the timelock.

Address of timelock:

https://explorer.zksync.io/address/0x97F03B2F6246Da8ff336f37ad3b047f7C3f74E59#contract

The privileged roles of the timelock have been transferred to the multisig wallet:

https://explorer.zksync.io/address/0x0D64C4eb0547C1F51b78Fb1A53583dC9042238C0

Signer 1: zksync:0xe9D5791Be827F092109C41F5eBFD48FF66d21b93

Signer 2: zksync:0x67cd008DB78a667A8983e8196F2a2C7D38bD6747

Signer 3: zksync:0xA74A66219a08D6346c512c50a5d0648a65a9183d

Signer 4: zksync:0x4700347E98C9c8A0c63a865575dFf34088C473d5

Signer 5: zksync:0x13BD7a61b46950fF0e9b41571Dc4C503eE854042

It requires 3 out of 5 signers to sign the transaction to execute.

[CertiK 12/22/2023]:

While this strategy has indeed reduced the risk, it's crucial to note that it has not completely eliminated it. CertiK strongly encourages the project team periodically revisit the private key security management of all above-listed addresses.

COR-02 | MISSING ZERO ADDRESS VALIDATION

Category	Severity	Location	Status
Volatile Code	Minor	ZFFactory.sol (3fe68 - 11/30): 34, 69, 86; ZFPair.sol (3fe68 - 11/30): 53, 54; ZFRouter.sol (3fe68 - 11/30): 19, 20	Acknowledged

Description

Addresses are not validated before assignment or external calls, potentially allowing the use of zero addresses and leading to unexpected behavior or vulnerabilities. For example, transferring tokens to a zero address can result in a permanent loss of those tokens.

```
34          feeToSetter = _feeToSetter;
```

- `_feeToSetter` is not zero-checked before being used.

```
69          feeTo = _feeTo;
```

- `_feeTo` is not zero-checked before being used.

```
86          pendingFeeToSetter = _feeToSetter;
```

- `_feeToSetter` is not zero-checked before being used.

```
53          token0 = _token0;
```

- `_token0` is not zero-checked before being used.

```
54          token1 = _token1;
```

- `_token1` is not zero-checked before being used.

```
19          factory = _factory;
```

- `_factory` is not zero-checked before being used.

```
20        WETH = _WETH;
```

- `_WETH` is not zero-checked before being used.

Recommendation

It is recommended to add a zero-check for the passed-in address value to prevent unexpected errors.

Alleviation

[ZKSWAP FINANCE TEAM 12/11/2023]

We thank Certik for identifying these volatile codes. After a thorough investigation of this issue, we found that:

- ZFFactory.sol: 34 → This volatile code was used only once during the initial deployment of the contract. Consequently, it does not pose any risks, considering that our core contracts have been deployed and used for several months. Essentially, this does not impact the safety of the contracts or user funds.
- ZFFactory.sol: 69 → The volatile code at line 69 can only be executed by the FeeToSetter address, currently set as the timelock controller under the multisig wallet. The likelihood of setting the zero-address as feeTo is very low. Even if such an event occurs, the FeeToSetter can easily rectify this mistake without causing any issues to the operations of the other involved contracts or risking user funds. Essentially, this does not affect the safety of the contracts or user funds.
- ZFFactory.sol: 86 → Similar to the issue mentioned at line 69, this volatile code can only be executed by the FeeToSetter address. The probability of setting the zero-address as FeeToSetter is minimal. In the rare event of such a mistake, it will not compromise user funds or disrupt the operations of the other involved contracts. The only consequence is the inability to set the swap fee, equivalent to the feeToSetter role renouncement. Essentially, this does not pose a risk to the safety of the contracts or user funds.
- ZFPair.sol: 53, 54 → These lines of code are within the constructor function and are used only once by the ZFFactory to create and initialize the pair. At that moment, there is no existing liquidity in this pool as it is being created. Therefore, it does not introduce any risk to the safety of the contracts or user funds.
- ZFRouter.sol: 19, 20 → Similarly, these two lines of code are within the constructor function of the ZFRouter contract. Essentially, this does not impact the safety of the contracts or user funds.

ZFF-01 | LACK OF REASONABLE LIMIT

Category	Severity	Location	Status
Logical Issue	Minor	ZFFactory.sol (3fe68 - 11/30): 80	Acknowledged

Description

The `setProtocolFeeFactor()` function allows the `feeToSetter` to set the minimum `protocolFeeFactor` as 2, which means half of the fee will be charged and sent to the `_feeTo` .

The popular DEXs Uniswap V2 charges 1/6 and Pancake charges 1/4.

```
    function _getFeeLiquidity(uint _totalSupply, uint _rootK2, uint _rootK1, uint8
_feeFactor) private pure returns (uint) {
        uint numerator = _totalSupply * (_rootK2 - _rootK1);
        uint denominator = (_feeFactor - 1) * _rootK2 + _rootK1;
        return numerator / denominator;
    }
```

Recommendation

We would like to confirm with the client whether the current implemenation aligns with the project design.

Alleviation

[ZKSWAP FINANCE TEAM 12/11/2023]

We hereby confirm that the current implementation aligns with our project design.

ZFP-04 | UNSAFE INTEGER CAST

Category	Severity	Location	Status
Incorrect Calculation	Minor	ZFPair.sol (3fe68 - 11/30): 109, 110, 118, 119	Acknowledged

Description

Type casting refers to changing an variable of one data type into another. The code contains an unsafe cast between integer types, which may result in unexpected truncation or sign flipping of the value.

```
109                 principal0: uint112(liquidity * _reserve0 / _totalSupply),
```

Casted expression `liquidity * _reserve0 / _totalSupply` has estimated range [0, 115792089237316195423570985008687907853269984665640564039457584007913129639935] but target type `uint112` has range [0, 5192296858534827628530496329220095].

```
110                 principal1: uint112(liquidity * _reserve1 / _totalSupply),
```

Casted expression `liquidity * _reserve1 / _totalSupply` has estimated range [0, 115792089237316195423570985008687907853269984665640564039457584007913129639935] but target type `uint112` has range [0, 5192296858534827628530496329220095].

```
118                 principal0: uint112(liquidity * _reserve0 / _totalSupply),
```

Casted expression `liquidity_scope_0 * _reserve0 / _totalSupply` has estimated range [0, 115792089237316195423570985008687907853269984665640564039457584007913129639935] but target type `uint112` has range [0, 5192296858534827628530496329220095].

```
119                 principal1: uint112(liquidity * _reserve1 / _totalSupply),
```

Casted expression `liquidity_scope_0 * _reserve1 / _totalSupply` has estimated range [0, 115792089237316195423570985008687907853269984665640564039457584007913129639935] but target type `uint112` has range [0, 5192296858534827628530496329220095].

Recommendation

It is recommended to check the bounds of integer values before casting. Alternatively, consider using the `SafeCast` library from OpenZeppelin to perform safe type casting and prevent undesired behavior.

Reference: https://github.com/OpenZeppelin/openzeppelin-contracts/blob/cf86fd9962701396457e50ab0d6cc78aa29a5ebc/contracts/utils/math/SafeCast.sol

Alleviation

[ZKSWAP FINANCE TEAM 12/11/2023]

ZFPair.sol: 109, 110, 118, 119 → In reality, for an unexpected truncation to occur due to these unsafe integer castings, the total liquidity of a pool must reach an unrealistic value.

- To demonstrate this, let's consider ETH-USDC pool of our DEX at the address: https://explorer.zksync.io/address/0x7642e38867860d4512Fcce1116e2Fb539c5cdd21#contract currently valued at 557K USD, the total supply of LP token is _totalSupply=5041968077308680, corresponding _reserve0=279126019242, _reserve1=118709123971826255802 (all these values are readable on chain). Thus, the maximum value of the variable principal0=279126019242 and maximum value of principal1=118709123971826255802. These two value is significantly below the limit of uint112 type, which is 5192296858534827628530496329220095 or 5.2*10^33)
- Additionally, for this unsafe integer cast issue to occur, the variables _reserve0 and _reserve1 need to a reach a minimum amount of 5.2*10^15 tokens in a liquidity pool, assuming that this token has 18 decimals. This number is unreasonably large for normal tokens.
- Hence, we think that the conversions to unint112 in ZFPair.sol: 109, 110, 118, 119 won't cause any issues in reality.

ZFR-02 | UNCHECKED ERC-20 `transfer()` / `transferFrom()` CALL

Category	Severity	Location	Status
Volatile Code	Minor	ZFRouterInternal.sol (3fe68 - 11/30): 129	Resolved

Description

The return values of the `transfer()` and `transferFrom()` calls in the smart contract are not checked. Some ERC-20 tokens' transfer functions return no values, while others return a bool value, they should be handled with care. If a function returns `false` instead of reverting upon failure, an unchecked failed transfer could be mistakenly considered successful in the contract.

```
129         IZFPair(pair).transferFrom(msg.sender, pair, liquidity);
```

Recommendation

It is advised to use the OpenZeppelin's `SafeERC20.sol` implementation to interact with the `transfer()` and `transferFrom()` functions of external ERC-20 tokens. The OpenZeppelin implementation checks for the existence of a return value and reverts if false is returned, making it compatible with all ERC-20 token implementations.

Alleviation

[ZKSWAP FINANCE TEAM 12/11/2023]

Issue acknowledged. The IZFPair utilizes the transfer and transferFrom functions from the ERC20.sol contract (located within the subfolder libraries/token/ERC20.sol). It's important to note that the transfer and transferFrom functions within this ERC20.sol always either return true or throw an error. Consequently, this does not pose an issue.

ZFZ-01 | `indexedPairs` NOT UPDATE WHEN USERS REMOVE LIQUIDITY

Category	Severity	Location	Status
Logical Issue	Informational	ZFRouter.sol (3fe68 - 11/30): 134	Acknowledged

Description

We note that the variable `indexedPairs` is used to keep track of users who add liquidity, but does not remove the user from the variable `indexedPairs` after the user removes liquidity completely.

Recommendation

We would like to confirm with the client if the current implementation aligns with the original project design.

Alleviation

The team acknowledged this issue and they will leave it as it is for now.

APPENDIX | ZKSWAP FINANCE - AUDIT

Finding Categories

Categories	Description
Incorrect Calculation	Incorrect Calculation findings are about issues in numeric computation such as rounding errors, overflows, out-of-bounds and any computation that is not intended.
Volatile Code	Volatile Code findings refer to segments of code that behave unexpectedly on certain edge cases and may result in vulnerabilities.
Logical Issue	Logical Issue findings indicate general implementation issues related to the program logic.
Centralization	Centralization findings detail the design choices of designating privileged roles or other centralized controls over the code.

Checksum Calculation Method

The "Checksum" field in the "Audit Scope" section is calculated as the SHA-256 (Secure Hash Algorithm 2 with digest size of 256 bits) digest of the content of each file hosted in the listed source repository under the specified commit.

The result is hexadecimal encoded and is the same as the output of the Linux "sha256sum" command against the target file.

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