



# Security Assessment & Formal Verification Report

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*Prepared for*  
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# Table of Contents

<b>Table of Contents</b>	<b>2</b>
<b>Project Summary</b>	<b>4</b>
Project Scope	4
Project Overview	4
Protocol Overview	6
Findings Summary	7
Severity Matrix	7
<b>Detailed Findings</b>	<b>8</b>
Critical Severity Issues	9
C-1. Attacker can double its PowerToken balance and voting power through bootstrap()	9
C-2. Attacker can inflate his PowerToken balance by repeatedly claiming historic inflation with sync() function	10
High Severity Issues	11
H-1. Past Voting Power isn't read from bootstrap after sync.	11
Low Severity Issues	12
L-1. Overflow check reverts due to overflow without emitting a revert message.	12
L-2. Lack of EIP-712 compliance: using keccak256() directly on an array or struct variable	12
Informational Severity Issues	13
INFO-1. Array lengths not checked	13
INFO-2. Certain functions should not be marked as payable	13
INFO-3. Unnecessarily small uint type for an incremented variable	13
INFO-4. Possible gas griefing when emitting voting event	14
INFO-5. A changed rate would not take effect until the updateIndex() function is called	14
INFO-6. One rogue validator might allow a minter to avoid paying penalties	15
INFO-7. Proposal fee is not returned to the proposer after the RESET event.	15
INFO-8. _lastSyncs array is redundant, resulting in waste of gas with any access or write operation.	16
<b>Formal Verification</b>	<b>17</b>
Assumptions and Simplifications	17
Verification Notations	17
Formal Verification Properties	18
ZeroToken (TTG)	18



PowerToken (TTG)	20
StandardGovernor (TTG)	23
MinterGateway (Protocol)	26
<b>Disclaimer</b>	<b>28</b>
<b>About Certora</b>	<b>28</b>

# Project Summary

## Project Scope

Repo Name	Repository	Commits	Compiler version	Platform
M^0 protocol	<a href="https://github.com/Zero-Labs/protocol">https://github.com/Zero-Labs/protocol</a>	<p>2e9f5cd32b292d3dea71ba1dfff0b2b68cab9467</p> <p>Post-Sherlock contest review: 44784c6a7b40b65dd51fe9da917ad67cb8439077</p>	solidity 0.8.23	EVM
TTG	<a href="https://github.com/Zero-Labs/ttg">https://github.com/Zero-Labs/ttg</a>	<p>7581622f35d64820bac667580cb9690982298eb2</p> <p>Post-Sherlock contest review: 930f2db7e62f90377a902cc4b2541d3637d37730</p>	solidity 0.8.23	EVM
Common	<a href="https://github.com/Zero-Labs/common">https://github.com/Zero-Labs/common</a>	<p>2ba852c44e02e3bee58cafea3ce7964022bd4486</p> <p>Post-Sherlock contest review: e809402c4cc21f1fa8291f17ee0aee859f3b0d29</p>	solidity 0.8.23	EVM

## Project Overview

This document describes the specification and verification of the **MZero protocol and Two Token Governance (TTG)** using the Certora Prover and manual code review findings. The work was undertaken from **18 January 2024 to 7 March 2024**.

The following contract list is included in our scope:

### TTG:

- src/abstract/interfaces/IBatchGovernor.sol
- src/abstract/interfaces/IEpochBasedInflationaryVoteToken.sol
- src/abstract/interfaces/IEpochBasedVoteToken.sol
- src/abstract/interfaces/IERC5805.sol
- src/abstract/interfaces/IERC6372.sol
- src/abstract/interfaces/IGovernor.sol
- src/abstract/interfaces/IThresholdGovernor.sol
- src/abstract/BatchGovernor.sol
- src/abstract/EpochBasedInflationaryVoteToken.sol
- src/abstract/EpochBasedVoteToken.sol
- src/abstract/ERC5805.sol
- src/abstract/ThresholdGovernor.sol
- src/interfaces/IDeployer.sol
- src/interfaces/IDistributionVault.sol
- src/interfaces/IEmergencyGovernor.sol
- src/interfaces/IEmergencyGovernorDeployer.sol
- src/interfaces/IPowerBootstrapToken.sol
- src/interfaces/IPowerToken.sol
- src/interfaces/IPowerTokenDeployer.sol
- src/interfaces/IRegistrar.sol
- src/interfaces/IStandardGovernor.sol
- src/interfaces/IStandardGovernorDeployer.sol
- src/interfaces/IZeroGovernor.sol
- src/interfaces/IZeroToken.sol
- src/libs/PureEpochs.sol
- src/DistributionVault.sol
- src/EmergencyGovernor.sol
- src/EmergencyGovernorDeployer.sol
- src/PowerBootstrapToken.sol
- src/PowerToken.sol
- src/PowerTokenDeployer.sol

```
src/Registrar.sol
src/StandardGovernor.sol
src/StandardGovernorDeployer.sol
src/ZeroGovernor.sol
src/ZeroToken.sol
```

**Protocol:**

```
src/abstract/ContinuousIndexing.sol
src/interfaces/IContinuousIndexing.sol
src/interfaces/IMinterGateway.sol
src/interfaces/IMToken.sol
src/interfaces/IRateModel.sol
src/interfaces/ITTGRegistrar.sol
src/libs/ContinuousIndexingMath.sol
src/libs/TTGRegistrarReader.sol
src/rateModels/interfaces/IEarnerRateModel.sol
src/rateModels/interfaces/IMinterRateModel.sol
src/rateModels/interfaces/IStableEarnerRateModel.sol
src/rateModels/MinterRateModel.sol
src/rateModels/SplitEarnerRateModel.sol
src/rateModels/StableEarnerRateModel.sol
src/MinterGateway.sol
src/MToken.sol
```

The Certora Prover demonstrated the implementation of the Solidity contracts above is correct with respect to the formal rules written by the Certora team. In addition, the team performed a manual audit of all the Solidity contracts. During the verification process and the manual audit, the Certora team discovered bugs in the Solidity contracts code, as listed below.

**Protocol Overview**

The core M<sup>0</sup> protocol is a coordination layer for permissioned institutional actors to generate M. M is a fungible token that can be generated by locking Eligible Collateral in a secure off-chain facility. The protocol enforces a common set of rules and safety procedures for the management of M.

The M<sup>0</sup> protocol is a set of immutable smart contracts implemented for the Ethereum Virtual Machine. It receives all external inputs from a governance mechanism called the M<sup>0</sup> Two Token Governor, TTG.

Aside from users accessing the M token, which is permissionless, only actors permissioned through the TTG mechanism have access to the M<sup>0</sup> Protocol. The primary actors in the protocol are called Minters and Validators.

The M<sup>0</sup> protocol uses an on-chain governance mechanism called a Two Token Governor (TTG) to manage its various inputs. With TTG, holders of the voting tokens are penalized for failing to vote.

There are two utility tokens used in the M<sup>0</sup> TTG: POWER and ZERO. POWER is used to vote on active proposals and can be considered the primary management token of the mechanism.

POWER holders will earn ZERO in exchange for their direct participation in governance.

ZERO holders at any time may Reset the POWER token supply to themselves.

The goal of the mechanism is to ensure credible neutrality of governance.

POWER holders are treated as a managerial class that is able to earn compensation through continued benevolent participation. This continued benevolence is judged by the ZERO holders who can always strip the POWER holders of their management rights, and thus their ability to earn future ownership in the protocol.

## Findings Summary

The table below summarizes the findings of the review, including type and severity details.

Severity	Discovered	Acknowledged	Code Fixed
Critical	2	2	2
High	1	1	1
Medium	0	0	0
Low	2	2	2
Informational	8	8	2
<b>Total</b>	<b>13</b>	<b>13</b>	<b>7</b>

## Severity Matrix

Impact	High	Medium	High	Critical
	Medium	Low	Medium	High
	Low	Low	Low	Medium
		Low	Medium	High
<b>Probability</b>				



# Detailed Findings

ID	Title	Severity
C-1	Attacker can double its PowerToken balance and voting power through bootstrap()	Critical
C-2	Attacker can inflate his PowerToken balance by repeatedly claiming historic inflation with sync() function	Critical
H-1	Past Voting Power isn't read from bootstrap after sync.	High
L-1	Overflow check reverts due to overflow without emitting a revert message.	Low
L-2	Lack of EIP-712 compliance: using keccak256() directly on an array or struct variable	Low
INFO-1	Array lengths not checked	Informational
INFO-2	Certain functions should not be marked as payable	Informational
INFO-3	Unnecessarily small uint type for an incremented variable	Informational
INFO-4	Possible gas griefing when emitting voting event	Informational
INFO-5	A changed rate would not take effect until the updateIndex() function is called	Informational
INFO-6	One rogue validator might allow a minter to avoid paying penalties	Informational
INFO-7	Proposal fee is not returned to proposer after RESET event	Informational

INFO-8

`_lastSyncs` array is redundant, resulting in waste of gas

Informational

## Critical Severity Issues

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### C-1. Attacker can double its PowerToken balance and voting power through bootstrap()

**Impact:** Critical

**Probability:** High

**Description:**

The `_bootstrap()` function is supposed to be called once and be followed by `_sync()` function. However, in the case of a RESET event or after deployment, a malicious user can enter `_bootstrap()` twice before entering `_sync()`. It can happen when calling `transfer()` or `delegate()` to himself. This will affect accounting. Attacker will double his power token balance and vote power balance (without properly updating `totalSupply`). Thus it gives unfair advantage in Power Threshold proposals.

**Customer's response:** Was fixed in commit [c16400216827b6a6a5485823c2c283c35cb49e75](https://github.com/certora/PowerToken/commit/c16400216827b6a6a5485823c2c283c35cb49e75)

## C-2. Attacker can inflate his PowerToken balance by repeatedly claiming historic inflation with sync() function

Impact: Critical

Probability: High

### Rules violated:

[syncingDoesntChangeBalance](#),  
[pastUnrealizedInflationIsImmutable](#),  
[pastBalanceIsImmutable](#)

### Description:

The issue originates in `sync(address account, uint16 epoch)` function where it is possible to specify **any** epoch for syncing. Later down the trace, in `_getUnrealizedInflation()`, it will try to compute inflation for epoch in range `(_getLastSync(_lastEpoch), _lastEpoch)`. The problem is that `_getLastSync()` can be gamed. If we start with array `_lastSyncs[alice] = [20, 30]` then we can successfully `sync(alice, 29)` multiple times and we will print her inflation from epochs in range (20...29). The balance will be updated with respect to the current epoch.

The root cause of the exploit is an error in registering a new event: Instead of the epoch of the `sync(address account, uint16 epoch)`, the `_addBalance` function always registers a new event with the current epoch instead, or updates the current epoch balance if exists.

**Customer's response:** Was fixed in commit [6b487a018a5b4496484b76a0815ee8a9577214d2](#)

## High Severity Issues

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### H-1. Past Voting Power isn't read from bootstrap after sync.

**Impact:** High

**Probability:** High

**Rules violated:**

[pastBalanceImmutable](#)

**Description:** `PowerToken._getBalance(account_, epoch_)` function checks the latest saved balance with respect to specified `epoch_` or consults bootstrap token (in case the balance array is empty). However, if balance becomes non-empty after specified `epoch_`, the function will skip consulting the bootstrap token and likely return 0. This is a serious issue in case of Emergency POWER Threshold proposals. If a user performs his first activity (transfer, delegate, or anything that will save his balance) during the epoch which Emergency proposal was proposed, then his voting power will likely be 0 (`PowerToken` will not read balance from `BootstrapToken`).

**Customer's response:** Was fixed in commit [6b487a018a5b4496484b76a0815ee8a9577214d2](#)

## Low Severity Issues

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### L-1. Overflow check reverts due to overflow without emitting a revert message.

**Impact:** Low

**Probability:** Low

**Description:** The line: `revert OverflowsPrincipalOfTotalSupply();` in line 229 is only called if the condition:

`principalOfTotalEarningSupply + _getPrincipalAmountRoundedDown(totalNonEarningSupply) >= type(uint112).max` is true. However, this could only happen if the left hand side of the expression is exactly `type(uint112).max`, as if the result is greater an overflow would occur and the transaction would revert without emitting the `OverflowsPrincipalOfTotalSupply()` revert message.

**Customer's response:** Was fixed in commit [bdd94b9952952c525f9e91ccbd762af792da7d4b](#)

### L-2. Lack of EIP-712 compliance: using keccak256() directly on an array or struct variable

**Impact:** Info

**Probability:** N/A

**Description:** Directly using the actual variable instead of encoding the array values goes against the EIP-712 specification. Note: OpenSea's Seaport's example with offerHashes and considerationHashes can be used as a reference to understand how arrays of structs should be encoded.

**Customer's response:** Was fixed in commits [287efbd7d4c8ba0fbbc14f1dae71c494d6875b705d6ba760fc764617f3997e7db060ea06e79ff476](#)

## Informational Severity Issues

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### INFO-1. Array lengths not checked

**Impact:** Info

**Probability:** N/A

**Description:** If the length of the arrays are not required to be of the same length, user operations may not be fully executed

**Customer's response:** Was fixed in commit [ead0c859f9f61d3347ad954288d0d15c268fa07c](#)

### INFO-2. Certain functions should not be marked as payable

**Impact:** Info

**Probability:** N/A

**Description:** `execute()` functions in `StandardGovernor.sol` and `ThresholdGovernor.sol` don't need to be marked as payable. And the following fragment can be deleted in `BatchedGovernor.sol`

**Customer's response:** Fully compatible with OZ Governor interfaces

### INFO-3. Unnecessarily small uint type for an incremented variable

**Impact:** Info

**Probability:** Low

**Description:** In `MinterGateway.sol`, the size of `_mintNonce` and `_retrievalNonce` is `uint48`. While calling the respective incrementing functions  $2^{*48}$  times to cause an overflow is unrealistic at the time being, It is not completely out of the realm of possibility that something like that might be possible in the future if the blockchain will become more efficient, while setting the type to be of a slightly larger size would have no negative impact on gas.

**Customer's response:** Type is sufficient enough for nonces.

## INFO-4. Possible gas griefing when emitting voting event

**Impact:** Medium

**Probability:** N/A

**Description:** It's possible to cast a vote with a reason string through a relayer. The string is later included in the VoteCast event. However, the string can be arbitrarily long which could make emitting such an event very gas costly for relayer.

**Note:** We mark this issue as **Informational** because the client doesn't support vote relaying on behalf of users at the moment of writing this report.

**Customer's response:** M^0 doesn't plan to provide relaying of castVotes. Possible relayers should take those risks into consideration.

## INFO-5. A changed rate would not take effect until the updateIndex() function is called

**Impact:** Medium

**Probability:** Low

**Description:** Updating the rate does not necessarily trigger a call to the updateIndex() function, and thus the growth of the index might still be calculated using the old rate until the updateIndex() function is called.

**Customer's response:** Design consideration. Governance module and TTG are decoupled. Protocol is read only for TTG.

## **INFO-6. One rogue validator might allow a minter to avoid paying penalties**

**Impact:** Low

**Probability:** Low

**Description:** In updateCollateral the minter has to reach a quota of signatures to validate an off chain deposit. Each signature contains a timestamp and the `_verifyValidatorSignatures` function returns the minimum of all these timestamps. If the minter has 1 rogue signer on his side, on every update, the minter can always add a signature with `timestamp==0`, which will keep `_minterStates[minter_].updateTimestamp` at 0 for eternity. That might allow him to avoid any potential penalties the minter should have faced for infrequent updates.

**Customer's response:** Really possible by offchain design considerations.

## **INFO-7. Proposal fee is not returned to the proposer after the RESET event.**

**Impact:** Low

**Probability:** Low

**Description:** In case of RESET event, active or unexecuted standard proposals will not return the fee because the `StandardGovernor.sol` will be replaced by the new one and thus will revert on proposal executions.

**Customer's response:** In the current implementation proposal will Expire and fee will be sent to the distribution vault



## INFO-8. `_lastSyncs` array is redundant, resulting in waste of gas with any access or write operation.

**Impact:** Low

**Probability:** N/A

**Description:** The `_lastSyncs` storage mapping, which holds the epochs array for every account, has become redundant, as it is a perfect mirror of the starting epochs of the `_balances` mapping, for every account. In other words, the following always holds, for every account:

*Forall uint256 index.*

*`_lastSyncs[account][index].startingEpoch == _balances[account][index].startingEpoch`*

Hence, the `_lastSyncs` doesn't serve any special purpose that cannot be already done by the `_balances` epochs.

**Recommendation:** Remove the `_lastSyncs` array from the contract storage, and replace its usage everywhere in the code with the equivalent epochs of the `_balances` array.

**Customer's response:** Was fixed in commit [6b487a018a5b4496484b76a0815ee8a9577214d2](#).

# Formal Verification

## Assumptions and Simplifications

### General Assumptions

- A. We assume that all arrays are at most  $\text{max}(\text{uint128})$  long.
- B. The maximum possible timestamp corresponds to the beginning of the year 2525.

## Verification Notations

Formally Verified	The rule is verified for every state of the contract(s), under the assumptions of the scope/requirements in the rule.
Violated	A counter-example exists that violates one of the assertions of the rule.

## Formal Verification Properties

### ZeroToken (TTG)

#### Assumptions

- Any loop can iterate at most 2 times.
- We assume no overflow reverts for minting events.

#### Properties

Rule Name	Description
<b>VotingEpochsAreMonotonic</b>	The starting epochs of the voting powers array elements are strictly monotonic.
<b>DelegatesEpochsAreMonotonic</b>	The starting epochs of the delegates array elements are strictly monotonic.
<b>BalancesEpochsAreMonotonic</b>	The starting epochs of the balances array elements are strictly monotonic.
<b>TotalSuppliesEpochsAreMonotonic</b>	The starting epochs of total supplies array elements are strictly monotonic.
<b>LatestEpochsAtMostCurrentEpoch</b>	The latest epoch for every array is at most the current epoch.
<b>TotalSupplyIsNonZero<sup>1</sup></b>	The total supply of zero tokens is never zero, in any epoch.
<b>pastTotalSupplyIsImmutable</b>	The total supply in past epochs is immutable.
<b>pastBalanceIsImmutable</b>	The balances in past epochs are immutable, for every account.

<sup>1</sup> Could be violated right after the constructor if an empty accounts array is provided, or if all amounts are zero.

<b>pastDelegatesImmutable</b>	The delegates in past epochs are immutable, for every account.
<b>mintingSuccessIsAccountIndependent</b>	Minting tokens for different accounts cannot interfere with each other (make the other one revert).
<b>mintingAmountIsAccountIndependent</b>	Different accounts balances post-mint are independent.

## PowerToken (TTG)

### Assumptions

- Any loop can iterate at most 2 times.
- We assume no overflow reverts for any total supply update.
- We assume that the sum of voting powers for any two users cannot exceed `max(uint240)`.

### Properties

Rule Name	Description
<b>synchingDoesntChangeBalance</b>	<p>Calling <code>sync()</code> cannot change the value of <code>balanceOf()</code></p> <p><b>Was violated in previous commits, see:</b>  <a href="#">Issue C-2</a></p>
<b>delegatingPreservesVotingPower</b>	<p>Calling <code>delegate()</code> preserves the total supply and the sum of voting power of the old and new delegates.</p>
<b>pastUnrealizedInflationIsImmutable</b>	<p>The past unrealized inflation for any account is immutable</p> <p><b>Was violated in previous commits, see:</b>  <a href="#">Issue H-1</a>, <a href="#">Issue C-2</a></p>
<b>pastVotesAreImmutable</b>	<p>The past votes for any account are immutable.</p> <p><b>Was violated in previous commits, see:</b>  <a href="#">Issue H-1</a></p>
<b>pastBalancesImmutable</b>	<p>The past balance for any account is immutable.</p> <p><b>Was violated in previous commits, see:</b></p>

	<a href="#">Issue H-1</a> , <a href="#">Issue C-2</a>
<b>AllDelegatesHaveSynched</b>	Any delegatee has been synched at least once.
<b>BalancesEpochsAreMonotonic</b>	The starting epochs of the balances array are strictly monotonic.
<b>BootstrapEpochIsInThePast</b>	The bootstrap epoch is always in the past.
<b>DelegatesEpochsAreMonotonic</b>	The starting epochs of the delegates array are strictly monotonic.
<b>DidntParticipateBeforeBootstrap</b>	No participation events are registered before the bootstrap epoch.
<b>EpochsAreAfterBootstrap</b>	All starting epochs are greater or equal to the bootstrap epoch.
<b>EpochsAreNotInTheFuture</b>	All starting epochs are bounded by the current epoch.
<b>LastSyncsAreBalancesEpochs<sup>2</sup></b>	The last syncs epochs are identical to the balances epochs, for any account.
<b>NoDelegateeIfNoSyncs</b>	If an account hasn't yet synced, it has no delegates.
<b>NoPastDelegatesAtUnsync</b>	The past delegatee of an account at an epoch the account hasn't synced yet is zero.

<sup>2</sup> The property was verified before the introduction of the external sync() function. In the latest commit, the property was violated, but the lastSyncs array was removed from the contract in future commits.

<b>TotalSuppliesEpochsAreMonotonic</b>	The starting epochs of the total supplies array are strictly monotonic.
<b>VotingEpochsAreMonotonic</b>	The starting epochs of the voting powers array are strictly monotonic.
<b>markParticipationIsUserIndependent</b>	Marking participation for a user doesn't change the balance of voting power of another user.
<b>markParticipationSucceedsUserIndependent</b>	markParticipation() success (revert conditions) is user-independent.
<b>onlyBuyingCanChangeTheEpochSpecificAuctionAmount</b>	The only action that can change the auction amount in the same epoch is buy()
<b>pastTotalSupplyIsImmutable</b>	The past total supply is immutable.
<b>transferDoesntIncreaseBalanceOfSender</b>	No user can increase his balance by calling transfer().

## StandardGovernor (TTG)

### Assumptions

- Any loop can iterate at most 2 times.
- The zero address is never a msg.sender or a valid signer of any message.
- We assumed a simple implementation of ERC20 tokens in all external calls to tokens transfer.
- We assumed PowerToken.markParticipation() doesn't revert unexpectedly.
- The number of proposals at any epoch < max(uint256)

### Properties

Rule Name	Description
<b>pastEpochsNeverCurrentEpoch</b>	Any query of the past total supply / past votes satisfies epoch < current epoch = clock()
<b>VoteStartIsNotInTheFarFuture</b>	The vote start of any proposal is at most the current epoch + voting delay.
<b>ExecutedHasNonZeroVoteStart</b>	An 'executed' proposal has a non-zero vote start.
<b>ActiveHasNonZeroVoteStart</b>	An 'active' proposal has a non-zero vote start.
<b>feelsTakenOnSubmission</b>	Upon calling to propose(), the proposer pays the proposalFee() in cashToken(), to the contract.
<b>onlyOneProposalStateChangesAtOnce</b>	Any operation can instantly change the state of only one proposal at a time.
<b>queryOfStateCannotRevert</b>	If a proposal exists, querying its



	state never reverts.
<b>votingCannotInstantlyChangeTheState</b>	Casting votes for any (active) proposal, cannot instantly change its status, thus it remains 'active'.
<b>canAlwaysVoteInVotingEpoch</b>	If a proposal is active and the voter has not yet voted and the support type is 'Yes' or 'No' then casting a vote cannot revert.
<b>cannotVoteWithoutVotingPower</b>	An actor without voting power in the previous epoch cannot change any proposal vote count.
<b>proposalSucceedsOnlyWhenMajorityReached (1)</b>	A proposal can only turn to the 'succeeded' state if its 'Yes' count exceeds its 'No' count.
<b>proposalSucceedsOnlyWhenMajorityReached (2)</b>	A proposal can only turn to the 'defeated' state if its 'No' count is at least its 'Yes' count.
<b>executedIsTerminal</b>	The 'executed' state is a terminal state of any proposal.
<b>canceledIsTerminal</b>	The 'canceled' state is a terminal state of any proposal.
<b>defeatedIsTerminal</b>	The 'defeated' state is a terminal state of any proposal.
<b>expiredIsTerminal</b>	The 'expired' state is a terminal state of any proposal.

<b>succeededIsAlmostTerminal</b>	The 'succeeded' state can turn only to 'executed', or remain 'succeeded'.
<b>pendingIsPrimal</b>	The 'pending' state is a primal state.
<b>pendingCanBecomeActiveOnly</b>	The 'pending' state can turn only to 'active', or remain 'pending'.
<b>castVotesIsAssociative</b>	castVotes() is proposal-associative.
<b>VotedIfProposalExists</b>	If any user has voted for a proposal, then its vote start must be non-zero.
<b>cannotVoteTwice</b>	If a user has voted once for a proposal, no operation can grant him the option to vote again.
<b>votingCannotFrontRunEachOther</b>	Casting votes with castVote() by different actors cannot interfere with each other (make the other revert).
<b>cannotMarkZeroAddressAsParticipant</b>	The zero address cannot be marked as a participant.
<b>cannotChangeVotesBeforeExecution</b>	Before any proposal execution, no operation in the same block can change its votes.

## MinterGateway (Protocol)

### Assumptions

- Any loop can iterate at most 2 times.
- We assume no overflow reverts for any arithmetic operations
- For earning address:  $\text{rawBalance} < \text{type}(\text{uint112}).\text{max}$
- For non-earning address:  $\text{rawBalance} < \text{type}(\text{uint112}).\text{max} * \text{type}(\text{uint128}).\text{max}$
- The vault is non earning
- The vault is not any of the following: the zero address, the minterGateway, the MToken or the TTGRegistrar contracts
- The maximum possible timestamp corresponds to the beginning of the year 2100
- $\text{MinterRate}$  and  $\text{EarnerBaseRate} < 400\%$  (40\_000 BPS APY)

### Properties

Rule Name	Description
<b>totalOwedMExceedsTotalMSupply</b>	$\text{totalOwedM} \geq \text{totalMSupply}$
<b>totalOwedMCorrectness</b>	$\text{totalOwedM} = \text{totalActiveOwedM} + \text{totalInactiveOwedM}$
<b>totalMSupplyCorrectness</b>	$\text{totalMSupply} = \text{totalNonEarningMSupply} + \text{totalEarningMSupply}$
<b>mintersCannotMintMUnlessAreOvercollateralized</b>	Minters cannot generate M unless their Eligible Collateral, tracked by Collateral Value, is sufficiently high
<b>collateralOfMinterIsZeroIfMinterDoesNotCallUpdate</b>	If a minter does not call update during the required interval, their eligible collateral is assumed 0
<b>minterMustWaitMintDelayTimeToMintM</b>	A Propose Mint call cannot succeed before MintDelay time has elapsed

<b>minterStatesCannotBeContradicting</b>	It is not possible that minter can be both deactivated and active
<b>consecutiveCallOfUpdateIndexCannotIncreaseMToken</b>	In two consecutive calls at the same timestamp of <code>updateIndex()</code> , the second call should not increase the MToken balance of the <code>ttgVault</code> or the total supply
<b>burnReducesOnlyTheBalanceOfMsgSender</b>	Only the balance of <code>msg.sender</code> can be reduced when calling <code>burnM()</code>
<b>validatorCanAlwaysFreezeAnyMinter</b>	Any validator can always freeze any minter
<b>validatorCanAlwaysCancelAnyExistingMintId</b>	Any validator can cancel any existing <code>mintId</code>
<b>mgUpdateIndexZeroesExcessOwedM</b>	After calling <code>updateIndex()</code> the <code>excessOwedM()</code> should be zero

# Disclaimer

The Certora Prover takes a contract and a specification as input and formally proves that the contract satisfies the specification in all scenarios. Notably, the guarantees of the Certora Prover are scoped to the provided specification and the Certora Prover does not check any cases not covered by the specification.

Even though we hope this information is helpful, we provide no warranty of any kind, explicit or implied. The contents of this report should not be construed as a complete guarantee that the contract is secure in all dimensions. In no event shall Certora or any of its employees be liable for any claim, damages, or other liability, whether in an action of contract, tort, or otherwise, arising from, out of, or in connection with the results reported here.

# About Certora

Certora is a Web3 security company that provides industry-leading formal verification tools and smart contract audits. Certora's flagship security product, Certora Prover, is a unique SaaS product that automatically locates even the most rare & hard-to-find bugs on your smart contracts or mathematically proves their absence. The Certora Prover plugs into your standard deployment pipeline. It is helpful for smart contract developers and security researchers during auditing and bug bounties.

Certora also provides services such as auditing, formal verification projects, and incident response.