CERTIK

Audit Report

Produced by CertiK

for MONETA DIGITAL

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CertiK Audit Report For Moneta Digital

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Disclaimer

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About CertiK

CertiK is a technology-led blockchain security company founded by Computer Science professors from Yale University and Columbia University built to prove the security and correctness of smart contracts and blockchain protocols.

CertiK, in partnership with grants from IBM and the Ethereum Foundation, has developed a proprietary Formal Verification technology to apply rigorous and complete mathematical reasoning against code. This process ensures algorithms, protocols, and business functionalities are secured and working as intended across all platforms.

CertiK differs from traditional testing approaches by employing Formal Verification to mathematically prove blockchain ecosystem and smart contracts are hacker-resistant and bug-free. CertiK uses this industry-leading technology together with standardized test suites, static analysis, and expert manual review to create a full-stack solution for our partners across the blockchain world to secure 6.2B in assets.

For more information: https://certik.io/

Executive Summary

This report has been prepared for Moneta Digital to discover issues and vulnerabilities in the source code of their mmxn smart contracts. A comprehensive examination has been performed, utilizing CertiK's Formal Verification Platform, Static Analysis, and Manual Review 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.

Vulnerability Classification

CertiK categorizes issues into three buckets based on overall risk levels:

Critical

Code implementation does not match specification, which could result in the loss of funds for contract owner or users.

Medium

Code implementation does not match the specification under certain conditions, which could affect the security standard by loss of access control.

Low

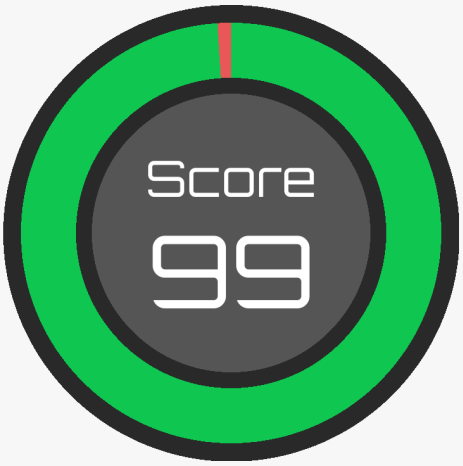
Code implementation does not follow best practices, or uses suboptimal design patterns, which could lead to security vulnerabilities further down the line.

Testing Summary

PASS

CERTIK *believes this smart contract passes security qualifications to be listed on digital asset exchanges.*

Jun 18, 2021



Type of Issues

CertiK's smart label engine applied 100% formal verification coverage on the source code. Our team of engineers has scanned the source code using proprietary static analysis tools and code-review methodologies. The following technical issues were found:

Title	Description	Issues	SWC ID
Integer Overflow/ Underflow	An overflow/underflow occurs when an arithmetic operation reaches the maximum or minimum size of a type.	0	SWC-101
Function Incorrectness	Function implementation does not meet specification, leading to intentional or unintentional vulnerabilities.	0	
Buffer Overflow	An attacker can write to arbitrary storage locations of a contract if array of out bound happens	0	SWC-124
Reentrancy	A malicious contract can call back into the calling contract before the first invocation of the function is finished.	0	SWC-107
Transaction Order Dependence	A race condition vulnerability occurs when code depends on the order of the transactions submitted to it.	0	SWC-114
Timestamp Dependence	Timestamp can be influenced by miners to some degree.	0	SWC-116
Insecure Compiler Version	Using a fixed outdated compiler version or floating pragma can be problematic if there are publicly disclosed bugs and issues that affect the current compiler version used.	1	SWC-102 SWC-103
Insecure Randomness	Using block attributes to generate random numbers is unreliable, as they can be influenced by miners to some degree.	0	SWC-120
"tx.origin" for Authorization	tx.origin should not be used for authorization. Use msg.sender instead.	0	SWC-115

Title	Description	Issues	SWC ID
Delegatecall to Untrusted Callee	Calling untrusted contracts is very dangerous, so the target and arguments provided must be sanitized.	0	SWC-112
State Variable Default Visibility	Labeling the visibility explicitly makes it easier to catch incorrect assumptions about who can access the variable.	0	SWC-108
Function Default Visibility	Functions are public by default, meaning a malicious user can make unauthorized or unintended state changes if a developer forgot to set the visibility.	0	SWC-100
Uninitialized Variables	Uninitialized local storage variables can point to other unexpected storage variables in the contract.	0	SWC-109
Assertion Failure	The assert() function is meant to assert invariants. Properly functioning code should never reach a failing assert statement.	0	SWC-110
Deprecated Solidity Features	Several functions and operators in Solidity are deprecated and should not be used.	0	SWC-111
Unused Variables	Unused variables reduce code quality	0	SWC-131

Vulnerability Details

Critical

No issue found.

Medium

No issue found.

Low

No issue found.

Review Notes

Source Code SHA-256 Checksum

- **[mmxn].sol**
- **(https://tronscan.io/#/contract/TY7copxkSQZBym6eTGMEdrqPHaNNsmjxKe)**
  `898fa11aff949b4286aed585fe6bba8de86bc679b8fc38424b0cd35140a7e31c`

Summary

CertiK worked closely with Moneta Digital to audit the design and implementation of its soon-to-be released smart contract. To ensure comprehensive protection, the source code was analyzed by the proprietary CertiK formal verification engine and manually reviewed by our smart contract experts and engineers. That end-to-end process ensures proof of stability as well as a hands-on, engineering-focused process to close potential loopholes and recommend design changes in accordance with best practices.

Our client Moneta Digital has demonstrated their professional and knowledgeable understanding of the project Moneta MMXN stablecoin, by having 1) a production ready repository with high-quality source code; 2) unit tests covering the majority of its business scenarios; 3) accessible, clean, and accurate readme documents for intentions, functionalities, and responsibilities of the smart contracts.

Overall, we found Moneta Digital's smart contracts to follow good practices. With the final update of source code and delivery of the audit report, we conclude that the contract is structurally sound and not vulnerable to any classically known anti-patterns or security issues. The audit report itself is not necessarily a guarantee of correctness or trustworthiness, and we always recommend to seek multiple opinions, continually improve the codebase, and perform additional tests before the mainnet release.

To bridge the trust gap between administrator and users, administrator needs to express a sincere attitude with the consideration of the administrator team's anonymousness. The administrator has the responsibility to notify users with the following capability of the administrator:
. Initial minter and pauser is the contract deployer.
. Minter has privilege to add a minter.
. Minter has privilege to mint tokens to any account.
. Pauser has privilege to add a pauser.
. Pauser has privilege to pause user's transaction.
. Pauser has privilege to unpause user's transaction.

Static Analysis Results

INSECURE_COMPILER_VERSION

Line 1 in File mmxn.sol

```
pragma solidity ^0.4.25;
```

Version to compile has the following bug:
0.4.25: EmptyByteArrayCopy, DynamicArrayCleanup, ImplicitConstructorCallvalueCheck, TupleAssignmentMultiStackSlotComponents, MemoryArrayCreationOverflow, privateCanBeOverridden, SignedArrayStorageCopy, ABIEncoderV2StorageArrayWithMultiSlotElement, DynamicConstructorArgumentsClippedABIV2, UninitializedFunctionPointerInConstructor_0.4.x, IncorrectEventSignatureInLibraries_0.4.x, ABIEncoderV2PackedStorage_0.4.x
0.4.26: EmptyByteArrayCopy, DynamicArrayCleanup, ImplicitConstructorCallvalueCheck, TupleAssignmentMultiStackSlotComponents, MemoryArrayCreationOverflow, privateCanBeOverridden, SignedArrayStorageCopy, ABIEncoderV2StorageArrayWithMultiSlotElement, DynamicConstructorArgumentsClippedABIV2

Formal Verification Results

How to read

Detail for Request 1

transferFrom to same address

Verification date	20, Oct 2018
Verification timespan	395.38 ms

CERTIK *label location*	Line 30-34 in File howtoread.sol

CERTIK *label*

```
30    /*@CTK FAIL "transferFrom to same address"
31        @tag assume_completion
32        @pre from == to
33        @post __post.allowed[from][msg.sender] ==
34    */
```

Raw code location	Line 35-41 in File howtoread.sol

Raw code

```
35    function transferFrom(address from, address to
          ) {
36        balances[from] = balances[from].sub(tokens
37        allowed[from][msg.sender] = allowed[from][
38        balances[to] = balances[to].add(tokens);
39        emit Transfer(from, to, tokens);
40        return true;
41    }
```

Counterexample	This code violates the specification

Initial environment

```
1  Counter Example:
2  Before Execution:
3      Input = {
4          from = 0x0
5          to = 0x0
6          tokens = 0x6c
7      }
8      This = 0
52         }
53         balance: 0x0
54     }
55 }
56
```

Post environment

```
57 After Execution:
58     Input = {
59         from = 0x0
60         to = 0x0
61         tokens = 0x6c
```

Formal Verification Request 1

If method completes, integer overflow would not happen.

📅 18, Jun 2021
⏱ 27.06 ms

Line 37 in File mmxn.sol

```
37    //@CTK NO_OVERFLOW
```

Line 46-58 in File mmxn.sol

```
46    function mul(uint256 a, uint256 b) internal pure returns (uint256) {
47        // Gas optimization: this is cheaper than requiring 'a' not being
↪   zero, but the
48        // benefit is lost if 'b' is also tested.
49        // See:
↪   https://github.com/OpenZeppelin/openzeppelin-solidity/pull/522
50        if (a == 0) {
51            return 0;
52        }
53
54        uint256 c = a * b;
55        require(c / a == b);
56
57        return c;
58    }
```

✅ The code meets the specification.

Formal Verification Request 2

SafeMath_mul

📅 18, Jun 2021
⏱ 105.24 ms

Line 38-45 in File mmxn.sol

```
38    /*@CTK SafeMath_mul
39        @tag assume_completion
40        @tag spec
41        @tag is_pure
42        @post a==0 -> __return == 0
43        @post a!=0 -> ((a>0) && (a*b/a != b)) == (__reverted)
44        @post !__reverted -> __return == a * b
45    */
```

Line 46-58 in File mmxn.sol

```
    function mul(uint256 a, uint256 b) internal pure returns (uint256) {
        // Gas optimization: this is cheaper than requiring 'a' not being zero, but the
        // benefit is lost if 'b' is also tested.
        // See: https://github.com/OpenZeppelin/openzeppelin-solidity/pull/522
        if (a == 0) {
            return 0;
        }

        uint256 c = a * b;
        require(c / a == b);

        return c;
    }
```

✅ The code meets the specification.

Formal Verification Request 3

If method completes, integer overflow would not happen.

📅 18, Jun 2021
⏱ 12.83 ms

Line 63 in File mmxn.sol

```
63  //@CTK NO_OVERFLOW
```

Line 71-78 in File mmxn.sol

```
71  function div(uint256 a, uint256 b) internal pure returns (uint256) {
72      // Solidity only automatically asserts when dividing by 0
73      require(b > 0);
74      uint256 c = a / b;
75      // assert(a == b * c + a % b); // There is no case in which this doesn't hold
76
77      return c;
78  }
```

✅ The code meets the specification.

Formal Verification Request 4

SafeMath_div

📅 18, Jun 2021
⏱ 2.16 ms

Line 64-70 in File mmxn.sol

```
64      /*@CTK SafeMath_div
65          @tag assume_completion
66          @tag spec
67          @tag is_pure
68          @post b > 0
69          @post __return == a / b
70      */
```

Line 71-78 in File mmxn.sol

```
71      function div(uint256 a, uint256 b) internal pure returns (uint256) {
72          // Solidity only automatically asserts when dividing by 0
73          require(b > 0);
74          uint256 c = a / b;
75          // assert(a == b * c + a % b); // There is no case in which this
    ↪   doesn't hold
76
77          return c;
78      }
```

The code meets the specification.

Formal Verification Request 5

If method completes, integer overflow would not happen.

18, Jun 2021
14.41 ms

Line 83 in File mmxn.sol

```
83      //@CTK NO_OVERFLOW
```

Line 91-96 in File mmxn.sol

```
91      function sub(uint256 a, uint256 b) internal pure returns (uint256) {
92          require(b <= a);
93          uint256 c = a - b;
94
95          return c;
96      }
```

The code meets the specification.

Formal Verification Request 6

SafeMath_sub

18, Jun 2021
1.75 ms

Line 84-90 in File mmxn.sol

```
84      /*@CTK SafeMath_sub
85          @tag assume_completion
86          @tag spec
87          @tag is_pure
88          @post b <= a
89          @post __return == a - b
90      */
```

Line 91-96 in File mmxn.sol

```
91      function sub(uint256 a, uint256 b) internal pure returns (uint256) {
92          require(b <= a);
93          uint256 c = a - b;
94
95          return c;
96      }
```

✅ The code meets the specification.

Formal Verification Request 7

If method completes, integer overflow would not happen.

📅 18, Jun 2021
⏱ 16.69 ms

Line 101 in File mmxn.sol

```
101     //@CTK NO_OVERFLOW
```

Line 109-114 in File mmxn.sol

```
109     function add(uint256 a, uint256 b) internal pure returns (uint256) {
110         uint256 c = a + b;
111         require(c >= a);
112
113         return c;
114     }
```

✅ The code meets the specification.

Formal Verification Request 8

SafeMath_add

📅 18, Jun 2021
⏱ 1.82 ms

Line 102-108 in File mmxn.sol

```
102     /*@CTK SafeMath_add
103         @tag assume_completion
104         @tag spec
105         @tag is_pure
106         @post (a+b < a) == (__reverted)
107         @post !__reverted -> __return == a + b
108     */
```

Line 109-114 in File mmxn.sol

```
109     function add(uint256 a, uint256 b) internal pure returns (uint256) {
110         uint256 c = a + b;
111         require(c >= a);
112 
113         return c;
114     }
```

✅ The code meets the specification.

Formal Verification Request 9

If method completes, integer overflow would not happen.

📅 18, Jun 2021
⏱ 13.06 ms

Line 120 in File mmxn.sol

```
120     //@CTK NO_OVERFLOW
```

Line 128-131 in File mmxn.sol

```
128     function mod(uint256 a, uint256 b) internal pure returns (uint256) {
129         require(b != 0);
130         return a % b;
131     }
```

✅ The code meets the specification.

Formal Verification Request 10

SafeMath_mod

📅 18, Jun 2021
⏱ 1.84 ms

Line 121-127 in File mmxn.sol

```
121     /*@CTK SafeMath_mod
122         @tag assume_completion
123         @tag spec
124         @tag is_pure
```

```
125         @post b != 0
126         @post __return == a % b
127     */
```

Line 128-131 in File mmxn.sol

```
128     function mod(uint256 a, uint256 b) internal pure returns (uint256) {
129         require(b != 0);
130         return a % b;
131     }
```

✅ The code meets the specification.

Formal Verification Request 11

If method completes, integer overflow would not happen.

📅 18, Jun 2021
⏱ 5.23 ms

Line 160 in File mmxn.sol

```
160     //@CTK NO_OVERFLOW
```

Line 166-168 in File mmxn.sol

```
166     function totalSupply() public view returns (uint256) {
167         return _totalSupply;
168     }
```

✅ The code meets the specification.

Formal Verification Request 12

Buffer overflow / array index out of bound would never happen.

📅 18, Jun 2021
⏱ 1.18 ms

Line 161 in File mmxn.sol

```
161     //@CTK NO_BUF_OVERFLOW
```

Line 166-168 in File mmxn.sol

```
166     function totalSupply() public view returns (uint256) {
167         return _totalSupply;
168     }
```

✅ The code meets the specification.

Formal Verification Request 13

Method will not encounter an assertion failure.

18, Jun 2021
1.3 ms

Line 162 in File mmxn.sol

```
162     //@CTK NO_ASF
```

Line 166-168 in File mmxn.sol

```
166     function totalSupply() public view returns (uint256) {
167         return _totalSupply;
168     }
```

The code meets the specification.

Formal Verification Request 14

ERC20_totalSupply

18, Jun 2021
2.05 ms

Line 163-165 in File mmxn.sol

```
163     /*@CTK ERC20_totalSupply
164         @post __return == _totalSupply
165     */
```

Line 166-168 in File mmxn.sol

```
166     function totalSupply() public view returns (uint256) {
167         return _totalSupply;
168     }
```

The code meets the specification.

Formal Verification Request 15

If method completes, integer overflow would not happen.

18, Jun 2021
4.91 ms

Line 175 in File mmxn.sol

```
175     //@CTK NO_OVERFLOW
```

Line 181-183 in File mmxn.sol

```
181     function balanceOf(address owner) public view returns (uint256) {
182         return _balances[owner];
183     }
```

The code meets the specification.

Formal Verification Request 16

Buffer overflow / array index out of bound would never happen.

18, Jun 2021
0.96 ms

Line 176 in File mmxn.sol

```
176     //@CTK NO_BUF_OVERFLOW
```

Line 181-183 in File mmxn.sol

```
181     function balanceOf(address owner) public view returns (uint256) {
182         return _balances[owner];
183     }
```

The code meets the specification.

Formal Verification Request 17

Method will not encounter an assertion failure.

18, Jun 2021
1.31 ms

Line 177 in File mmxn.sol

```
177     //@CTK NO_ASF
```

Line 181-183 in File mmxn.sol

```
181     function balanceOf(address owner) public view returns (uint256) {
182         return _balances[owner];
183     }
```

The code meets the specification.

Formal Verification Request 18

ERC20_balanceOf

18, Jun 2021
1.47 ms

Line 178-180 in File mmxn.sol

```
178     /*@CTK ERC20_balanceOf
179         @post __return == _balances[owner]
180     */
```

Line 181-183 in File mmxn.sol

```
181     function balanceOf(address owner) public view returns (uint256) {
182         return _balances[owner];
183     }
```

The code meets the specification.

Formal Verification Request 19

If method completes, integer overflow would not happen.

18, Jun 2021
5.91 ms

Line 191 in File mmxn.sol

```
191     //@CTK NO_OVERFLOW
```

Line 197-199 in File mmxn.sol

```
197     function allowance(address owner, address spender) public view returns
        ↪ (uint256) {
198         return _allowed[owner][spender];
199     }
```

The code meets the specification.

Formal Verification Request 20

Buffer overflow / array index out of bound would never happen.

18, Jun 2021
1.23 ms

Line 192 in File mmxn.sol

```
192     //@CTK NO_BUF_OVERFLOW
```

Line 197-199 in File mmxn.sol

```
197     function allowance(address owner, address spender) public view returns
        ↪ (uint256) {
198         return _allowed[owner][spender];
199     }
```

The code meets the specification.

Formal Verification Request 21

Method will not encounter an assertion failure.

18, Jun 2021
1.09 ms

Line 193 in File mmxn.sol

```
193     //@CTK NO_ASF
```

Line 197-199 in File mmxn.sol

```
197     function allowance(address owner, address spender) public view returns
        ↪ (uint256) {
198         return _allowed[owner][spender];
199     }
```

The code meets the specification.

Formal Verification Request 22

ERC20_allowance

18, Jun 2021
0.88 ms

Line 194-196 in File mmxn.sol

```
194     /*@CTK ERC20_allowance
195         @post __return == _allowed[owner][spender]
196     */
```

Line 197-199 in File mmxn.sol

```
197     function allowance(address owner, address spender) public view returns
↪   (uint256) {
198         return _allowed[owner][spender];
199     }
```

The code meets the specification.

Formal Verification Request 23

ERC20_transfer

18, Jun 2021
100.17 ms

Line 206-212 in File mmxn.sol

```
206     /*@CTK "ERC20_transfer"
207       @tag assume_completion
208       @post to != address(0)
209       @post to != msg.sender -> __post._balances[msg.sender] ==
↪   _balances[msg.sender] - value
210       @post to != msg.sender -> __post._balances[to] == _balances[to] +
↪   value
211       @post to == msg.sender -> __post._balances[msg.sender] ==
↪   _balances[msg.sender]
212      */
```

Line 213-216 in File mmxn.sol

```
213     function transfer(address to, uint256 value) public returns (bool) {
214         _transfer(msg.sender, to, value);
215         return true;
216     }
```

The code meets the specification.

Formal Verification Request 24

If method completes, integer overflow would not happen.

18, Jun 2021
15.3 ms

Line 227 in File mmxn.sol

```
227     //@CTK NO_OVERFLOW
```

Line 235-241 in File mmxn.sol

```
235     function approve(address spender, uint256 value) public returns (bool) {
236         require(spender != address(0));
237
238         _allowed[msg.sender][spender] = value;
239         emit Approval(msg.sender, spender, value);
240         return true;
241     }
```

The code meets the specification.

Formal Verification Request 25

Buffer overflow / array index out of bound would never happen.

18, Jun 2021
1.16 ms

Line 228 in File mmxn.sol

```
228     //@CTK NO_BUF_OVERFLOW
```

Line 235-241 in File mmxn.sol

```
235     function approve(address spender, uint256 value) public returns (bool) {
236         require(spender != address(0));
237
238         _allowed[msg.sender][spender] = value;
239         emit Approval(msg.sender, spender, value);
240         return true;
241     }
```

The code meets the specification.

Formal Verification Request 26

Method will not encounter an assertion failure.

18, Jun 2021
1.11 ms

Line 229 in File mmxn.sol

```
229     //@CTK NO_ASF
```

Line 235-241 in File mmxn.sol

```
235     function approve(address spender, uint256 value) public returns (bool) {
236         require(spender != address(0));
237
238         _allowed[msg.sender][spender] = value;
239         emit Approval(msg.sender, spender, value);
240         return true;
241     }
```

The code meets the specification.

Formal Verification Request 27

ERC20_approve

18, Jun 2021
2.48 ms

Line 230-234 in File mmxn.sol

```
230     /*@CTK ERC20_approve
231         @tag assume_completion
232         @post spender != address(0)
233         @post __post._allowed[msg.sender][spender] == value
234     */
```

Line 235-241 in File mmxn.sol

```
235     function approve(address spender, uint256 value) public returns (bool) {
236         require(spender != address(0));
237
238         _allowed[msg.sender][spender] = value;
239         emit Approval(msg.sender, spender, value);
240         return true;
241     }
```

The code meets the specification.

Formal Verification Request 28

ERC20_transferFrom

18, Jun 2021
138.88 ms

Line 251-258 in File mmxn.sol

```
/*@CTK "ERC20_transferFrom"
  @tag assume_completion
  @post __post._allowed[from][msg.sender] == _allowed[from][msg.sender] - value
  @post (to == address(0)) == (__reverted)
  @post (!__reverted && to != from) -> (__post._balances[from] == _balances[from] - value)
  @post (!__reverted && to != from) -> (__post._balances[to] == _balances[to] + value)
  @post (!__reverted && to == from) -> (__post._balances[from] == _balances[from])
 */
```

Line 259-264 in File mmxn.sol

```
function transferFrom(address from, address to, uint256 value) public returns (bool) {
    _allowed[from][msg.sender] = _allowed[from][msg.sender].sub(value);
    _transfer(from, to, value);
    emit Approval(from, msg.sender, _allowed[from][msg.sender]);
    return true;
}
```

✅ The code meets the specification.

Formal Verification Request 29

ERC20_increaseAllowance

📅 18, Jun 2021
⏱ 22.53 ms

Line 276-280 in File mmxn.sol

```
/*@CTK ERC20_increaseAllowance
    @tag assume_completion
    @post spender != address(0)
    @post __post._allowed[msg.sender][spender] == _allowed[msg.sender][spender] + addedValue
*/
```

Line 281-287 in File mmxn.sol

```
function increaseAllowance(address spender, uint256 addedValue) public returns (bool) {
    require(spender != address(0));

    _allowed[msg.sender][spender] = _allowed[msg.sender][spender].add(addedValue);
    emit Approval(msg.sender, spender, _allowed[msg.sender][spender]);
    return true;
}
```

✅ The code meets the specification.

Formal Verification Request 30

ERC20_decreaseAllowance

18, Jun 2021
24.78 ms

Line 299-303 in File mmxn.sol

```
299     /*@CTK ERC20_decreaseAllowance
300         @tag assume_completion
301         @post spender != address(0)
302         @post __post._allowed[msg.sender][spender] ==
↪   _allowed[msg.sender][spender] - subtractedValue
303     */
```

Line 304-310 in File mmxn.sol

```
304     function decreaseAllowance(address spender, uint256 subtractedValue)
↪   public returns (bool) {
305         require(spender != address(0));
306
307         _allowed[msg.sender][spender] =
↪   _allowed[msg.sender][spender].sub(subtractedValue);
308         emit Approval(msg.sender, spender, _allowed[msg.sender][spender]);
309         return true;
310     }
```

The code meets the specification.

Formal Verification Request 31

ERC20___transfer

18, Jun 2021
28.54 ms

Line 318-324 in File mmxn.sol

```
318     /*@CTK "ERC20__transfer"
319       @tag assume_completion
320       @post to != address(0)
321       @post to != from -> __post._balances[from] == _balances[from] - value
322       @post to != from -> __post._balances[to] == _balances[to] + value
323       @post to == from -> __post._balances[from] == _balances[from]
324      */
```

Line 325-331 in File mmxn.sol

```
325     function _transfer(address from, address to, uint256 value) internal {
326         require(to != address(0));
327
```

```
        _balances[from] = _balances[from].sub(value);
        _balances[to] = _balances[to].add(value);
        emit Transfer(from, to, value);
    }
```

The code meets the specification.

Formal Verification Request 32

ERC20___mint

18, Jun 2021
37.52 ms

Line 340-345 in File mmxn.sol

```
    /*@CTK "ERC20__mint"
      @tag assume_completion
      @post account != address(0)
      @post __post._totalSupply == _totalSupply + value
      @post __post._balances[account] == _balances[account] + value
     */
```

Line 346-352 in File mmxn.sol

```
    function _mint(address account, uint256 value) internal {
        require(account != address(0));

        _totalSupply = _totalSupply.add(value);
        _balances[account] = _balances[account].add(value);
        emit Transfer(address(0), account, value);
    }
```

The code meets the specification.

Formal Verification Request 33

ERC20___burn

18, Jun 2021
40.34 ms

Line 360-365 in File mmxn.sol

```
    /*@CTK "ERC20__burn"
      @tag assume_completion
      @post account != address(0)
      @post __post._totalSupply == _totalSupply - value
      @post __post._balances[account] == _balances[account] - value
     */
```

Line 366-372 in File mmxn.sol

```
    function _burn(address account, uint256 value) internal {
        require(account != address(0));

        _totalSupply = _totalSupply.sub(value);
        _balances[account] = _balances[account].sub(value);
        emit Transfer(account, address(0), value);
    }
```

The code meets the specification.

Formal Verification Request 34

ERC20___burnFrom

18, Jun 2021
136.28 ms

Line 382-388 in File mmxn.sol

```
    /*@CTK "ERC20__burnFrom"
      @tag assume_completion
      @post __post._allowed[account][msg.sender] == _allowed[account][msg.sender] - value
      @post (account == address(0)) == __reverted
      @post !__reverted -> __post._totalSupply == _totalSupply - value
      @post !__reverted -> __post._balances[account] == _balances[account] - value
     */
```

Line 389-393 in File mmxn.sol

```
    function _burnFrom(address account, uint256 value) internal {
        _allowed[account][msg.sender] = _allowed[account][msg.sender].sub(value);
        _burn(account, value);
        emit Approval(account, msg.sender, _allowed[account][msg.sender]);
    }
```

The code meets the specification.

Formal Verification Request 35

Roles_add

18, Jun 2021
58.04 ms

Line 410-415 in File mmxn.sol

```
    /*@CTK "Roles_add"
      @tag assume_completion
```

```
412       @post account != address(0)
413       @post role.bearer[account] == false
414       @post role__post.bearer[account] == true
415      */
```

Line 416-421 in File mmxn.sol

```
416     function add(Role storage role, address account) internal {
417         require(account != address(0));
418         require(!has(role, account));
419
420         role.bearer[account] = true;
421     }
```

✅ The code meets the specification.

Formal Verification Request 36

Roles_remove

📅 18, Jun 2021
⏱ 37.46 ms

Line 426-431 in File mmxn.sol

```
426     /*@CTK "Roles_remove"
427       @tag assume_completion
428       @post account != address(0)
429       @post role.bearer[account] == true
430       @post role__post.bearer[account] == false
431      */
```

Line 432-437 in File mmxn.sol

```
432     function remove(Role storage role, address account) internal {
433         require(account != address(0));
434         require(has(role, account));
435
436         role.bearer[account] = false;
437     }
```

✅ The code meets the specification.

Formal Verification Request 37

Roles_has

📅 18, Jun 2021
⏱ 1.84 ms

Line 443-447 in File mmxn.sol

```
443     /*@CTK "Roles_has"
444       @tag assume_completion
445       @post account != address(0)
446       @post __return == role.bearer[account]
447      */
```

Line 448-451 in File mmxn.sol

```
448     function has(Role storage role, address account) internal view returns
↪   (bool) {
449         require(account != address(0));
450         return role.bearer[account];
451     }
```

The code meets the specification.

Formal Verification Request 38

MinterRole_constructor

18, Jun 2021
104.68 ms

Line 464-468 in File mmxn.sol

```
464     /*@CTK "MinterRole_constructor"
465       @tag assume_completion
466       @post _minters.bearer[msg.sender] == false
467       @post __post._minters.bearer[msg.sender] == true
468      */
```

Line 469-471 in File mmxn.sol

```
469     constructor () internal {
470         _addMinter(msg.sender);
471     }
```

The code meets the specification.

Formal Verification Request 39

MinterRole_isMinter

18, Jun 2021
27.96 ms

Line 478-482 in File mmxn.sol

```
478     /*@CTK "MinterRole_isMinter"
479       @tag assume_completion
480       @post account != address(0)
481       @post __return == _minters.bearer[account]
482      */
```

Line 483-485 in File mmxn.sol

```
483     function isMinter(address account) public view returns (bool) {
484         return _minters.has(account);
485     }
```

✅ The code meets the specification.

Formal Verification Request 40

MinterRole_addMinter

📅 18, Jun 2021
⏱ 97.95 ms

Line 487-493 in File mmxn.sol

```
487     /*@CTK "MinterRole_addMinter"
488       @tag assume_completion
489       @post _minters.bearer[msg.sender] == true
490       @post account != address(0)
491       @post _minters.bearer[account] == false
492       @post __post._minters.bearer[account] == true
493      */
```

Line 494-496 in File mmxn.sol

```
494     function addMinter(address account) public onlyMinter {
495         _addMinter(account);
496     }
```

✅ The code meets the specification.

Formal Verification Request 41

MinterRole_renounceMinter

📅 18, Jun 2021
⏱ 98.11 ms

Line 498-502 in File mmxn.sol

```
498     /*@CTK "MinterRole_renounceMinter"
499       @tag assume_completion
500       @post _minters.bearer[msg.sender] == true
501       @post __post._minters.bearer[msg.sender] == false
502      */
```

Line 503-505 in File mmxn.sol

```
503     function renounceMinter() public {
504         _removeMinter(msg.sender);
505     }
```

✅ The code meets the specification.

Formal Verification Request 42

MinterRole___addMinter

18, Jun 2021
5.25 ms

Line 507-512 in File mmxn.sol

```
507     /*@CTK "MinterRole__addMinter"
508       @tag assume_completion
509       @post account != address(0)
510       @post _minters.bearer[account] == false
511       @post __post._minters.bearer[account] == true
512      */
```

Line 513-516 in File mmxn.sol

```
513     function _addMinter(address account) internal {
514         _minters.add(account);
515         emit MinterAdded(account);
516     }
```

The code meets the specification.

Formal Verification Request 43

MinterRole___removeMinter

18, Jun 2021
4.57 ms

Line 518-523 in File mmxn.sol

```
518     /*@CTK "MinterRole__removeMinter"
519       @tag assume_completion
520       @post account != address(0)
521       @post _minters.bearer[account] == true
522       @post __post._minters.bearer[account] == false
523      */
```

Line 524-527 in File mmxn.sol

```
524     function _removeMinter(address account) internal {
525         _minters.remove(account);
526         emit MinterRemoved(account);
527     }
```

The code meets the specification.

Formal Verification Request 44

ERC20Mintable_mint

18, Jun 2021
194.88 ms

Line 543-549 in File mmxn.sol

```
543     /*@CTK "ERC20Mintable_mint"
544       @tag assume_completion
545       @post _minters.bearer[msg.sender] == true
546       @post to != address(0)
547       @post __post._totalSupply == _totalSupply + value
548       @post __post._balances[to] == _balances[to] + value
549     */
```

Line 550-553 in File mmxn.sol

```
550     function mint(address to, uint256 value) public onlyMinter returns (bool)
↪   {
551         _mint(to, value);
552         return true;
553     }
```

The code meets the specification.

Formal Verification Request 45

ERC20Burnable___burn

18, Jun 2021
83.82 ms

Line 567-571 in File mmxn.sol

```
567     /*@CTK "ERC20Burnable__burn"
568       @tag assume_completion
569       @post __post._totalSupply == _totalSupply - value
570       @post __post._balances[msg.sender] == _balances[msg.sender] - value
571     */
```

Line 572-574 in File mmxn.sol

```
572     function burn(uint256 value) public {
573         _burn(msg.sender, value);
574     }
```

The code meets the specification.

Formal Verification Request 46

ERC20Burnable___burnFrom

18, Jun 2021
175.45 ms

Line 581-587 in File mmxn.sol

```
581     /*@CTK "ERC20Burnable__burnFrom"
582       @tag assume_completion
583       @post __post._allowed[from][msg.sender] == _allowed[from][msg.sender]
    ↪  - value
584       @post (from == address(0)) == __reverted
585       @post !__reverted -> __post._totalSupply == _totalSupply - value
586       @post !__reverted -> __post._balances[from] == _balances[from] - value
587      */
```

Line 588-590 in File mmxn.sol

```
588     function burnFrom(address from, uint256 value) public {
589         _burnFrom(from, value);
590     }
```

The code meets the specification.

Formal Verification Request 47

PauserRole_constructor

18, Jun 2021
98.61 ms

Line 603-607 in File mmxn.sol

```
603     /*@CTK "PauserRole_constructor"
604       @tag assume_completion
605       @post _pausers.bearer[msg.sender] == false
606       @post __post._pausers.bearer[msg.sender] == true
607      */
```

Line 608-610 in File mmxn.sol

```
608     constructor () internal {
609         _addPauser(msg.sender);
610     }
```

The code meets the specification.

Formal Verification Request 48

PauserRole_isPauser

18, Jun 2021
29.31 ms

Line 617-621 in File mmxn.sol

```
617     /*@CTK "PauserRole_isPauser"
618       @tag assume_completion
619       @post account != address(0)
620       @post __return == _pausers.bearer[account]
621      */
```

Line 622-624 in File mmxn.sol

```
622     function isPauser(address account) public view returns (bool) {
623         return _pausers.has(account);
624     }
```

The code meets the specification.

Formal Verification Request 49

PauserRole_addPauser

18, Jun 2021
97.63 ms

Line 626-632 in File mmxn.sol

```
626     /*@CTK "PauserRole_addPauser"
627       @tag assume_completion
628       @post _pausers.bearer[msg.sender] == true
629       @post account != address(0)
630       @post _pausers.bearer[account] == false
631       @post __post._pausers.bearer[account] == true
632      */
```

Line 633-635 in File mmxn.sol

```
633     function addPauser(address account) public onlyPauser {
634         _addPauser(account);
635     }
```

The code meets the specification.

Formal Verification Request 50

PauserRole_renouncePauser

18, Jun 2021
107.48 ms

Line 637-641 in File mmxn.sol

```
637     /*@CTK "PauserRole_renouncePauser"
638       @tag assume_completion
639       @post _pausers.bearer[msg.sender] == true
640       @post __post._pausers.bearer[msg.sender] == false
641      */
```

Line 642-644 in File mmxn.sol

```
642     function renouncePauser() public {
643         _removePauser(msg.sender);
644     }
```

✅ The code meets the specification.

Formal Verification Request 51

PauserRole___addPauser

📅 18, Jun 2021
⏱ 5.56 ms

Line 646-651 in File mmxn.sol

```
646     /*@CTK "PauserRole__addPauser"
647       @tag assume_completion
648       @post account != address(0)
649       @post _pausers.bearer[account] == false
650       @post __post._pausers.bearer[account] == true
651      */
```

Line 652-655 in File mmxn.sol

```
652     function _addPauser(address account) internal {
653         _pausers.add(account);
654         emit PauserAdded(account);
655     }
```

✅ The code meets the specification.

Formal Verification Request 52

PauserRole___removePauser

📅 18, Jun 2021
⏱ 4.17 ms

Line 657-662 in File mmxn.sol

```
/*@CTK "PauserRole__removePauser"
  @tag assume_completion
  @post account != address(0)
  @post _pausers.bearer[account] == true
  @post __post._pausers.bearer[account] == false
 */
```

Line 663-666 in File mmxn.sol

```
function _removePauser(address account) internal {
    _pausers.remove(account);
    emit PauserRemoved(account);
}
```

✅ The code meets the specification.

Formal Verification Request 53

Pausable_constructor

📅 18, Jun 2021
⏱ 6.97 ms

Line 681-683 in File mmxn.sol

```
/*@CTK "Pausable_constructor"
  @post __post._paused == false
 */
```

Line 684-686 in File mmxn.sol

```
constructor () internal {
    _paused = false;
}
```

✅ The code meets the specification.

Formal Verification Request 54

Pausable_paused

📅 18, Jun 2021
⏱ 5.86 ms

Line 691-693 in File mmxn.sol

```
/*@CTK "Pausable_paused"
  @post __return == _paused
 */
```

Line 694-696 in File mmxn.sol

```
function paused() public view returns (bool) {
    return _paused;
}
```

✅ The code meets the specification.

Formal Verification Request 55

Pausable_pause

18, Jun 2021
76.64 ms

Line 717-722 in File mmxn.sol

```
717     /*@CTK "Pausable_pause"
718         @tag assume_completion
719         @post _pausers.bearer[msg.sender] == true
720         @post _paused == false
721         @post __post._paused == true
722      */
```

Line 723-726 in File mmxn.sol

```
723     function pause() public onlyPauser whenNotPaused {
724         _paused = true;
725         emit Paused(msg.sender);
726     }
```

The code meets the specification.

Formal Verification Request 56

Pausable_unpause

18, Jun 2021
52.57 ms

Line 731-736 in File mmxn.sol

```
731     /*@CTK "Pausable_unpause"
732         @tag assume_completion
733         @post _pausers.bearer[msg.sender] == true
734         @post _paused == true
735         @post __post._paused == false
736      */
```

Line 737-740 in File mmxn.sol

```
737     function unpause() public onlyPauser whenPaused {
738         _paused = false;
739         emit Unpaused(msg.sender);
740     }
```

The code meets the specification.

Formal Verification Request 57

ERC20Pausable_transfer

18, Jun 2021
199.98 ms

Line 750-757 in File mmxn.sol

```
750     /*@CTK "ERC20Pausable_transfer"
751       @tag assume_completion
752       @post _paused == false
753       @post to != address(0)
754       @post to != msg.sender -> __post._balances[msg.sender] ==
    ↪  _balances[msg.sender] - value
755       @post to != msg.sender -> __post._balances[to] == _balances[to] +
    ↪  value
756       @post to == msg.sender -> __post._balances[msg.sender] ==
    ↪  _balances[msg.sender]
757      */
```

Line 758-760 in File mmxn.sol

```
758     function transfer(address to, uint256 value) public whenNotPaused returns
    ↪  (bool) {
759         return super.transfer(to, value);
760     }
```

The code meets the specification.

Formal Verification Request 58

ERC20Pausable_transferFrom

18, Jun 2021
212.42 ms

Line 762-770 in File mmxn.sol

```
762     /*@CTK "ERC20Pausable_transferFrom"
763       @tag assume_completion
764       @post _paused == false
765       @post __post._allowed[from][msg.sender] == _allowed[from][msg.sender]
    ↪  - value
766       @post (to == address(0)) == (__reverted)
767       @post (!__reverted && to != from) -> (__post._balances[from] ==
    ↪  _balances[from] - value)
768       @post (!__reverted && to != from) -> (__post._balances[to] ==
    ↪  _balances[to] + value)
769       @post (!__reverted && to == from) -> (__post._balances[from] ==
    ↪  _balances[from])
770      */
```

Line 771-773 in File mmxn.sol

```
    function transferFrom(address from, address to, uint256 value) public whenNotPaused returns (bool) {
        return super.transferFrom(from, to, value);
    }
```

✅ The code meets the specification.

Formal Verification Request 59

ERC20Pausable_approve

📅 18, Jun 2021
⏱ 52.74 ms

Line 775-780 in File mmxn.sol

```
    /*@CTK ERC20Pausable_approve
        @tag assume_completion
        @post _paused == false
        @post spender != address(0)
        @post __post._allowed[msg.sender][spender] == value
    */
```

Line 781-783 in File mmxn.sol

```
    function approve(address spender, uint256 value) public whenNotPaused returns (bool) {
        return super.approve(spender, value);
    }
```

✅ The code meets the specification.

Formal Verification Request 60

ERC20Pausable_increaseAllowance

📅 18, Jun 2021
⏱ 75.8 ms

Line 785-790 in File mmxn.sol

```
    /*@CTK ERC20Pausable_increaseAllowance
        @tag assume_completion
        @post _paused == false
        @post spender != address(0)
        @post __post._allowed[msg.sender][spender] == _allowed[msg.sender][spender] + addedValue
    */
```

Line 791-793 in File mmxn.sol

```
    function increaseAllowance(address spender, uint addedValue) public whenNotPaused returns (bool success) {
        return super.increaseAllowance(spender, addedValue);
    }
```

The code meets the specification.

Formal Verification Request 61

ERC20Pausable_decreaseAllowance

18, Jun 2021
73.34 ms

Line 795-800 in File mmxn.sol

```
    /*@CTK ERC20Pausable_decreaseAllowance
        @tag assume_completion
        @post _paused == false
        @post spender != address(0)
        @post __post._allowed[msg.sender][spender] == _allowed[msg.sender][spender] - subtractedValue
    */
```

Line 801-803 in File mmxn.sol

```
    function decreaseAllowance(address spender, uint subtractedValue) public whenNotPaused returns (bool success) {
        return super.decreaseAllowance(spender, subtractedValue);
    }
```

The code meets the specification.

Formal Verification Request 62

ERC20Detailed_constructor

18, Jun 2021
10.37 ms

Line 819-824 in File mmxn.sol

```
    /*@CTK ERC20Detailed_constructor
        @tag assume_completion
        @post __post._name == name
        @post __post._symbol == symbol
        @post __post._decimals == decimals
    */
```

Line 825-829 in File mmxn.sol

```
    constructor (string memory name, string memory symbol, uint8 decimals) public {
        _name = name;
        _symbol = symbol;
        _decimals = decimals;
    }
```

The code meets the specification.

Formal Verification Request 63

ERC20Detailed_name

18, Jun 2021
5.34 ms

Line 834-837 in File mmxn.sol

```
     /*@CTK ERC20Detailed_name
        @tag assume_completion
        @post __return == _name
    */
```

Line 838-840 in File mmxn.sol

```
    function name() public view returns (string memory) {
        return _name;
    }
```

The code meets the specification.

Formal Verification Request 64

ERC20Detailed_symbol

18, Jun 2021
5.56 ms

Line 845-848 in File mmxn.sol

```
    /*@CTK ERC20Detailed_symbol
        @tag assume_completion
        @post __return == _symbol
    */
```

Line 849-851 in File mmxn.sol

```
    function symbol() public view returns (string memory) {
        return _symbol;
    }
```

The code meets the specification.

Formal Verification Request 65

ERC20Detailed_decimals

18, Jun 2021
6.35 ms

Line 856-859 in File mmxn.sol

```
856     /*@CTK ERC20Detailed_decimals
857         @tag assume_completion
858         @post __return == _decimals
859     */
```

Line 860-862 in File mmxn.sol

```
860     function decimals() public view returns (uint8) {
861         return _decimals;
862     }
```

The code meets the specification.

Source Code with CertiK Labels

mmxn.sol

```
pragma solidity ^0.4.25;

// File: openzeppelin-solidity/contracts/token/ERC20/IERC20.sol

/**
 * @title ERC20 interface
 * @dev see https://github.com/ethereum/EIPs/issues/20
 */
interface IERC20 {
    function transfer(address to, uint256 value) external returns (bool);

    function approve(address spender, uint256 value) external returns (bool);

    function transferFrom(address from, address to, uint256 value) external returns (bool);

    function totalSupply() external view returns (uint256);

    function balanceOf(address who) external view returns (uint256);

    function allowance(address owner, address spender) external view returns (uint256);

    event Transfer(address indexed from, address indexed to, uint256 value);

    event Approval(address indexed owner, address indexed spender, uint256 value);
}

// File: openzeppelin-solidity/contracts/math/SafeMath.sol

/**
 * @title SafeMath
 * @dev Unsigned math operations with safety checks that revert on error
 */
library SafeMath {
    /**
    * @dev Multiplies two unsigned integers, reverts on overflow.
    */
    //@CTK NO_OVERFLOW
    /*@CTK SafeMath_mul
        @tag assume_completion
        @tag spec
        @tag is_pure
```

```
        @post a==0 -> __return == 0
        @post a!=0 -> ((a>0) && (a*b/a != b)) == (__reverted)
        @post !__reverted -> __return == a * b
    */
    function mul(uint256 a, uint256 b) internal pure returns (uint256) {
        // Gas optimization: this is cheaper than requiring 'a' not being zero, but the
        // benefit is lost if 'b' is also tested.
        // See: https://github.com/OpenZeppelin/openzeppelin-solidity/pull/522
        if (a == 0) {
            return 0;
        }

        uint256 c = a * b;
        require(c / a == b);

        return c;
    }

    /**
    * @dev Integer division of two unsigned integers truncating the quotient, reverts on division by zero.
    */
    //@CTK NO_OVERFLOW
    /*@CTK SafeMath_div
        @tag assume_completion
        @tag spec
        @tag is_pure
        @post b > 0
        @post __return == a / b
    */
    function div(uint256 a, uint256 b) internal pure returns (uint256) {
        // Solidity only automatically asserts when dividing by 0
        require(b > 0);
        uint256 c = a / b;
        // assert(a == b * c + a % b); // There is no case in which this doesn't hold

        return c;
    }

    /**
    * @dev Subtracts two unsigned integers, reverts on overflow (i.e. if subtrahend is greater than minuend).
    */
    //@CTK NO_OVERFLOW
    /*@CTK SafeMath_sub
```

```
        @tag assume_completion
        @tag spec
        @tag is_pure
        @post b <= a
        @post __return == a - b
    */
    function sub(uint256 a, uint256 b) internal pure returns (uint256) {
        require(b <= a);
        uint256 c = a - b;

        return c;
    }

    /**
    * @dev Adds two unsigned integers, reverts on overflow.
    */
    //@CTK NO_OVERFLOW
    /*@CTK SafeMath_add
        @tag assume_completion
        @tag spec
        @tag is_pure
        @post (a+b < a) == (__reverted)
        @post !__reverted -> __return == a + b
    */
    function add(uint256 a, uint256 b) internal pure returns (uint256) {
        uint256 c = a + b;
        require(c >= a);

        return c;
    }

    /**
    * @dev Divides two unsigned integers and returns the remainder (unsigned
    ↪ integer modulo),
    * reverts when dividing by zero.
    */
    //@CTK NO_OVERFLOW
    /*@CTK SafeMath_mod
        @tag assume_completion
        @tag spec
        @tag is_pure
        @post b != 0
        @post __return == a % b
    */
    function mod(uint256 a, uint256 b) internal pure returns (uint256) {
        require(b != 0);
        return a % b;
    }
```

```
}

// File: openzeppelin-solidity/contracts/token/ERC20/ERC20.sol

/**
 * @title Standard ERC20 token
 *
 * @dev Implementation of the basic standard token.
 * https://github.com/ethereum/EIPs/blob/master/EIPS/eip-20.md
 * Originally based on code by FirstBlood:
 *
 * https://github.com/Firstbloodio/token/blob/master/smart_contract/FirstBloodToken.s
 *
 * This implementation emits additional Approval events, allowing applications to reconstruct the allowance status for
 * all accounts just by listening to said events. Note that this isn't required by the specification, and other
 * compliant implementations may not do it.
 */
contract ERC20 is IERC20 {
    using SafeMath for uint256;

    mapping (address => uint256) private _balances;

    mapping (address => mapping (address => uint256)) private _allowed;

    uint256 private _totalSupply;

    /**
    * @dev Total number of tokens in existence
    */
    //@CTK NO_OVERFLOW
    //@CTK NO_BUF_OVERFLOW
    //@CTK NO_ASF
    /*@CTK ERC20_totalSupply
        @post __return == _totalSupply
    */
    function totalSupply() public view returns (uint256) {
        return _totalSupply;
    }

    /**
    * @dev Gets the balance of the specified address.
    * @param owner The address to query the balance of.
    * @return An uint256 representing the amount owned by the passed address.
    */
    //@CTK NO_OVERFLOW
```

```
    //@CTK NO_BUF_OVERFLOW
    //@CTK NO_ASF
    /*@CTK ERC20_balanceOf
        @post __return == _balances[owner]
    */
    function balanceOf(address owner) public view returns (uint256) {
        return _balances[owner];
    }

    /**
     * @dev Function to check the amount of tokens that an owner allowed to a spender.
     * @param owner address The address which owns the funds.
     * @param spender address The address which will spend the funds.
     * @return A uint256 specifying the amount of tokens still available for the spender.
     */
    //@CTK NO_OVERFLOW
    //@CTK NO_BUF_OVERFLOW
    //@CTK NO_ASF
    /*@CTK ERC20_allowance
        @post __return == _allowed[owner][spender]
    */
    function allowance(address owner, address spender) public view returns (uint256) {
        return _allowed[owner][spender];
    }

    /**
    * @dev Transfer token for a specified address
    * @param to The address to transfer to.
    * @param value The amount to be transferred.
    */
    /*@CTK "ERC20_transfer"
      @tag assume_completion
      @post to != address(0)
      @post to != msg.sender -> __post._balances[msg.sender] == _balances[msg.sender] - value
      @post to != msg.sender -> __post._balances[to] == _balances[to] + value
      @post to == msg.sender -> __post._balances[msg.sender] == _balances[msg.sender]
     */
    function transfer(address to, uint256 value) public returns (bool) {
        _transfer(msg.sender, to, value);
        return true;
    }

```

```
    /**
     * @dev Approve the passed address to spend the specified amount of tokens on behalf of msg.sender.
     * Beware that changing an allowance with this method brings the risk that someone may use both the old
     * and the new allowance by unfortunate transaction ordering. One possible solution to mitigate this
     * race condition is to first reduce the spender's allowance to 0 and set the desired value afterwards:
     * https://github.com/ethereum/EIPs/issues/20#issuecomment-263524729
     * @param spender The address which will spend the funds.
     * @param value The amount of tokens to be spent.
     */
    //@CTK NO_OVERFLOW
    //@CTK NO_BUF_OVERFLOW
    //@CTK NO_ASF
    /*@CTK ERC20_approve
        @tag assume_completion
        @post spender != address(0)
        @post __post._allowed[msg.sender][spender] == value
    */
    function approve(address spender, uint256 value) public returns (bool) {
        require(spender != address(0));

        _allowed[msg.sender][spender] = value;
        emit Approval(msg.sender, spender, value);
        return true;
    }

    /**
     * @dev Transfer tokens from one address to another.
     * Note that while this function emits an Approval event, this is not required as per the specification,
     * and other compliant implementations may not emit the event.
     * @param from address The address which you want to send tokens from
     * @param to address The address which you want to transfer to
     * @param value uint256 the amount of tokens to be transferred
     */
    /*@CTK "ERC20_transferFrom"
      @tag assume_completion
      @post __post._allowed[from][msg.sender] == _allowed[from][msg.sender] - value
      @post (to == address(0)) == (__reverted)
      @post (!__reverted && to != from) -> (__post._balances[from] == _balances[from] - value)
      @post (!__reverted && to != from) -> (__post._balances[to] == _balances[to] + value)
```

```
     @post (!__reverted && to == from) -> (__post._balances[from] ==
↪ _balances[from])
     */
    function transferFrom(address from, address to, uint256 value) public
↪ returns (bool) {
        _allowed[from][msg.sender] = _allowed[from][msg.sender].sub(value);
        _transfer(from, to, value);
        emit Approval(from, msg.sender, _allowed[from][msg.sender]);
        return true;
    }

    /**
     * @dev Increase the amount of tokens that an owner allowed to a
↪ spender.
     * approve should be called when allowed_[_spender] == 0. To increment
     * allowed value is better to use this function to avoid 2 calls (and
↪ wait until
     * the first transaction is mined)
     * From MonolithDAO Token.sol
     * Emits an Approval event.
     * @param spender The address which will spend the funds.
     * @param addedValue The amount of tokens to increase the allowance by.
     */
    /*@CTK ERC20_increaseAllowance
        @tag assume_completion
        @post spender != address(0)
        @post __post._allowed[msg.sender][spender] ==
↪ _allowed[msg.sender][spender] + addedValue
    */
    function increaseAllowance(address spender, uint256 addedValue) public
↪ returns (bool) {
        require(spender != address(0));

        _allowed[msg.sender][spender] =
↪ _allowed[msg.sender][spender].add(addedValue);
        emit Approval(msg.sender, spender, _allowed[msg.sender][spender]);
        return true;
    }

    /**
     * @dev Decrease the amount of tokens that an owner allowed to a
↪ spender.
     * approve should be called when allowed_[_spender] == 0. To decrement
     * allowed value is better to use this function to avoid 2 calls (and
↪ wait until
     * the first transaction is mined)
     * From MonolithDAO Token.sol
     * Emits an Approval event.
```

```
     * @param spender The address which will spend the funds.
     * @param subtractedValue The amount of tokens to decrease the allowance by.
     */
    /*@CTK ERC20_decreaseAllowance
        @tag assume_completion
        @post spender != address(0)
        @post __post._allowed[msg.sender][spender] == _allowed[msg.sender][spender] - subtractedValue
    */
    function decreaseAllowance(address spender, uint256 subtractedValue) public returns (bool) {
        require(spender != address(0));

        _allowed[msg.sender][spender] = _allowed[msg.sender][spender].sub(subtractedValue);
        emit Approval(msg.sender, spender, _allowed[msg.sender][spender]);
        return true;
    }

    /**
    * @dev Transfer token for a specified addresses
    * @param from The address to transfer from.
    * @param to The address to transfer to.
    * @param value The amount to be transferred.
    */
    /*@CTK "ERC20__transfer"
      @tag assume_completion
      @post to != address(0)
      @post to != from -> __post._balances[from] == _balances[from] - value
      @post to != from -> __post._balances[to] == _balances[to] + value
      @post to == from -> __post._balances[from] == _balances[from]
     */
    function _transfer(address from, address to, uint256 value) internal {
        require(to != address(0));

        _balances[from] = _balances[from].sub(value);
        _balances[to] = _balances[to].add(value);
        emit Transfer(from, to, value);
    }

    /**
     * @dev Internal function that mints an amount of the token and assigns it to
     * an account. This encapsulates the modification of balances such that the
     * proper events are emitted.
     * @param account The account that will receive the created tokens.
```

```
     * @param value The amount that will be created.
     */
    /*@CTK "ERC20__mint"
      @tag assume_completion
      @post account != address(0)
      @post __post._totalSupply == _totalSupply + value
      @post __post._balances[account] == _balances[account] + value
     */
    function _mint(address account, uint256 value) internal {
        require(account != address(0));

        _totalSupply = _totalSupply.add(value);
        _balances[account] = _balances[account].add(value);
        emit Transfer(address(0), account, value);
    }

    /**
     * @dev Internal function that burns an amount of the token of a given
     * account.
     * @param account The account whose tokens will be burnt.
     * @param value The amount that will be burnt.
     */
    /*@CTK "ERC20__burn"
      @tag assume_completion
      @post account != address(0)
      @post __post._totalSupply == _totalSupply - value
      @post __post._balances[account] == _balances[account] - value
     */
    function _burn(address account, uint256 value) internal {
        require(account != address(0));

        _totalSupply = _totalSupply.sub(value);
        _balances[account] = _balances[account].sub(value);
        emit Transfer(account, address(0), value);
    }

    /**
     * @dev Internal function that burns an amount of the token of a given
     * account, deducting from the sender's allowance for said account. Uses the
     * internal burn function.
     * Emits an Approval event (reflecting the reduced allowance).
     * @param account The account whose tokens will be burnt.
     * @param value The amount that will be burnt.
     */
    /*@CTK "ERC20__burnFrom"
      @tag assume_completion
```

```
      @post __post._allowed[account][msg.sender] == _allowed[account][msg.sender] - value
      @post (account == address(0)) == __reverted
      @post !__reverted -> __post._totalSupply == _totalSupply - value
      @post !__reverted -> __post._balances[account] == _balances[account] - value
     */
    function _burnFrom(address account, uint256 value) internal {
        _allowed[account][msg.sender] = _allowed[account][msg.sender].sub(value);
        _burn(account, value);
        emit Approval(account, msg.sender, _allowed[account][msg.sender]);
    }
}

// File: openzeppelin-solidity/contracts/access/Roles.sol

/**
 * @title Roles
 * @dev Library for managing addresses assigned to a Role.
 */
library Roles {
    struct Role {
        mapping (address => bool) bearer;
    }

    /**
     * @dev give an account access to this role
     */
    /*@CTK "Roles_add"
      @tag assume_completion
      @post account != address(0)
      @post role.bearer[account] == false
      @post role__post.bearer[account] == true
     */
    function add(Role storage role, address account) internal {
        require(account != address(0));
        require(!has(role, account));

        role.bearer[account] = true;
    }

    /**
     * @dev remove an account's access to this role
     */
    /*@CTK "Roles_remove"
      @tag assume_completion
      @post account != address(0)
```

```
      @post role.bearer[account] == true
      @post role__post.bearer[account] == false
     */
    function remove(Role storage role, address account) internal {
        require(account != address(0));
        require(has(role, account));

        role.bearer[account] = false;
    }

    /**
     * @dev check if an account has this role
     * @return bool
     */
    /*@CTK "Roles_has"
      @tag assume_completion
      @post account != address(0)
      @post __return == role.bearer[account]
     */
    function has(Role storage role, address account) internal view returns
 ↪  (bool) {
        require(account != address(0));
        return role.bearer[account];
    }
}

// File: openzeppelin-solidity/contracts/access/roles/MinterRole.sol

contract MinterRole {
    using Roles for Roles.Role;

    event MinterAdded(address indexed account);
    event MinterRemoved(address indexed account);

    Roles.Role private _minters;

    /*@CTK "MinterRole_constructor"
      @tag assume_completion
      @post _minters.bearer[msg.sender] == false
      @post __post._minters.bearer[msg.sender] == true
     */
    constructor () internal {
        _addMinter(msg.sender);
    }

    modifier onlyMinter() {
        require(isMinter(msg.sender));
        _;
```

```
    }

    /*@CTK "MinterRole_isMinter"
      @tag assume_completion
      @post account != address(0)
      @post __return == _minters.bearer[account]
     */
    function isMinter(address account) public view returns (bool) {
        return _minters.has(account);
    }

    /*@CTK "MinterRole_addMinter"
      @tag assume_completion
      @post _minters.bearer[msg.sender] == true
      @post account != address(0)
      @post _minters.bearer[account] == false
      @post __post._minters.bearer[account] == true
     */
    function addMinter(address account) public onlyMinter {
        _addMinter(account);
    }

    /*@CTK "MinterRole_renounceMinter"
      @tag assume_completion
      @post _minters.bearer[msg.sender] == true
      @post __post._minters.bearer[msg.sender] == false
     */
    function renounceMinter() public {
        _removeMinter(msg.sender);
    }

    /*@CTK "MinterRole__addMinter"
      @tag assume_completion
      @post account != address(0)
      @post _minters.bearer[account] == false
      @post __post._minters.bearer[account] == true
     */
    function _addMinter(address account) internal {
        _minters.add(account);
        emit MinterAdded(account);
    }

    /*@CTK "MinterRole__removeMinter"
      @tag assume_completion
      @post account != address(0)
      @post _minters.bearer[account] == true
      @post __post._minters.bearer[account] == false
     */
```

```
    function _removeMinter(address account) internal {
        _minters.remove(account);
        emit MinterRemoved(account);
    }
}

// File: openzeppelin-solidity/contracts/token/ERC20/ERC20Mintable.sol

/**
 * @title ERC20Mintable
 * @dev ERC20 minting logic
 */
contract ERC20Mintable is ERC20, MinterRole {
    /**
     * @dev Function to mint tokens
     * @param to The address that will receive the minted tokens.
     * @param value The amount of tokens to mint.
     * @return A boolean that indicates if the operation was successful.
     */
    /*@CTK "ERC20Mintable_mint"
      @tag assume_completion
      @post _minters.bearer[msg.sender] == true
      @post to != address(0)
      @post __post._totalSupply == _totalSupply + value
      @post __post._balances[to] == _balances[to] + value
    */
    function mint(address to, uint256 value) public onlyMinter returns (bool)
↪   {
        _mint(to, value);
        return true;
    }
}

// File: openzeppelin-solidity/contracts/token/ERC20/ERC20Burnable.sol

/**
 * @title Burnable Token
 * @dev Token that can be irreversibly burned (destroyed).
 */
contract ERC20Burnable is ERC20 {
    /**
     * @dev Burns a specific amount of tokens.
     * @param value The amount of token to be burned.
     */
    /*@CTK "ERC20Burnable__burn"
      @tag assume_completion
      @post __post._totalSupply == _totalSupply - value
      @post __post._balances[msg.sender] == _balances[msg.sender] - value
```

```
    */
    function burn(uint256 value) public {
        _burn(msg.sender, value);
    }

    /**
     * @dev Burns a specific amount of tokens from the target address and decrements allowance
     * @param from address The address which you want to send tokens from
     * @param value uint256 The amount of token to be burned
     */
    /*@CTK "ERC20Burnable__burnFrom"
      @tag assume_completion
      @post __post._allowed[from][msg.sender] == _allowed[from][msg.sender] - value
      @post (from == address(0)) == __reverted
      @post !__reverted -> __post._totalSupply == _totalSupply - value
      @post !__reverted -> __post._balances[from] == _balances[from] - value
     */
    function burnFrom(address from, uint256 value) public {
        _burnFrom(from, value);
    }
}

// File: openzeppelin-solidity/contracts/access/roles/PauserRole.sol

contract PauserRole {
    using Roles for Roles.Role;

    event PauserAdded(address indexed account);
    event PauserRemoved(address indexed account);

    Roles.Role private _pausers;

    /*@CTK "PauserRole_constructor"
      @tag assume_completion
      @post _pausers.bearer[msg.sender] == false
      @post __post._pausers.bearer[msg.sender] == true
     */
    constructor () internal {
        _addPauser(msg.sender);
    }

    modifier onlyPauser() {
        require(isPauser(msg.sender));
        _;
    }

```

```
    /*@CTK "PauserRole_isPauser"
      @tag assume_completion
      @post account != address(0)
      @post __return == _pausers.bearer[account]
     */
    function isPauser(address account) public view returns (bool) {
        return _pausers.has(account);
    }

    /*@CTK "PauserRole_addPauser"
      @tag assume_completion
      @post _pausers.bearer[msg.sender] == true
      @post account != address(0)
      @post _pausers.bearer[account] == false
      @post __post._pausers.bearer[account] == true
     */
    function addPauser(address account) public onlyPauser {
        _addPauser(account);
    }

    /*@CTK "PauserRole_renouncePauser"
      @tag assume_completion
      @post _pausers.bearer[msg.sender] == true
      @post __post._pausers.bearer[msg.sender] == false
     */
    function renouncePauser() public {
        _removePauser(msg.sender);
    }

    /*@CTK "PauserRole__addPauser"
      @tag assume_completion
      @post account != address(0)
      @post _pausers.bearer[account] == false
      @post __post._pausers.bearer[account] == true
     */
    function _addPauser(address account) internal {
        _pausers.add(account);
        emit PauserAdded(account);
    }

    /*@CTK "PauserRole__removePauser"
      @tag assume_completion
      @post account != address(0)
      @post _pausers.bearer[account] == true
      @post __post._pausers.bearer[account] == false
     */
    function _removePauser(address account) internal {
        _pausers.remove(account);
```

```
        emit PauserRemoved(account);
    }
}

// File: openzeppelin-solidity/contracts/lifecycle/Pausable.sol

/**
 * @title Pausable
 * @dev Base contract which allows children to implement an emergency stop mechanism.
 */
contract Pausable is PauserRole {
    event Paused(address account);
    event Unpaused(address account);

    bool private _paused;

    /*@CTK "Pausable_constructor"
      @post __post._paused == false
     */
    constructor () internal {
        _paused = false;
    }

    /**
     * @return true if the contract is paused, false otherwise.
     */
    /*@CTK "Pausable_paused"
      @post __return == _paused
     */
    function paused() public view returns (bool) {
        return _paused;
    }

    /**
     * @dev Modifier to make a function callable only when the contract is not paused.
     */
    modifier whenNotPaused() {
        require(!_paused);
        _;
    }

    /**
     * @dev Modifier to make a function callable only when the contract is paused.
     */
    modifier whenPaused() {
```

```
        require(_paused);
        _;
    }

    /**
     * @dev called by the owner to pause, triggers stopped state
     */
    /*@CTK "Pausable_pause"
        @tag assume_completion
        @post _pausers.bearer[msg.sender] == true
        @post _paused == false
        @post __post._paused == true
     */
    function pause() public onlyPauser whenNotPaused {
        _paused = true;
        emit Paused(msg.sender);
    }

    /**
     * @dev called by the owner to unpause, returns to normal state
     */
    /*@CTK "Pausable_unpause"
        @tag assume_completion
        @post _pausers.bearer[msg.sender] == true
        @post _paused == true
        @post __post._paused == false
     */
    function unpause() public onlyPauser whenPaused {
        _paused = false;
        emit Unpaused(msg.sender);
    }
}

// File: openzeppelin-solidity/contracts/token/ERC20/ERC20Pausable.sol

/**
 * @title Pausable token
 * @dev ERC20 modified with pausable transfers.
 **/
contract ERC20Pausable is ERC20, Pausable {
    /*@CTK "ERC20Pausable_transfer"
      @tag assume_completion
      @post _paused == false
      @post to != address(0)
      @post to != msg.sender -> __post._balances[msg.sender] == _balances[msg.sender] - value
      @post to != msg.sender -> __post._balances[to] == _balances[to] + value
```

```
     @post to == msg.sender -> __post._balances[msg.sender] == _balances[msg.sender]
     */
    function transfer(address to, uint256 value) public whenNotPaused returns (bool) {
        return super.transfer(to, value);
    }

    /*@CTK "ERC20Pausable_transferFrom"
      @tag assume_completion
      @post _paused == false
      @post __post._allowed[from][msg.sender] == _allowed[from][msg.sender] - value
      @post (to == address(0)) == (__reverted)
      @post (!__reverted && to != from) -> (__post._balances[from] == _balances[from] - value)
      @post (!__reverted && to != from) -> (__post._balances[to] == _balances[to] + value)
      @post (!__reverted && to == from) -> (__post._balances[from] == _balances[from])
     */
    function transferFrom(address from, address to, uint256 value) public whenNotPaused returns (bool) {
        return super.transferFrom(from, to, value);
    }

    /*@CTK ERC20Pausable_approve
        @tag assume_completion
        @post _paused == false
        @post spender != address(0)
        @post __post._allowed[msg.sender][spender] == value
    */
    function approve(address spender, uint256 value) public whenNotPaused returns (bool) {
        return super.approve(spender, value);
    }

    /*@CTK ERC20Pausable_increaseAllowance
        @tag assume_completion
        @post _paused == false
        @post spender != address(0)
        @post __post._allowed[msg.sender][spender] == _allowed[msg.sender][spender] + addedValue
    */
    function increaseAllowance(address spender, uint addedValue) public whenNotPaused returns (bool success) {
        return super.increaseAllowance(spender, addedValue);
    }
```

```
    /*@CTK ERC20Pausable_decreaseAllowance
        @tag assume_completion
        @post _paused == false
        @post spender != address(0)
        @post __post._allowed[msg.sender][spender] == _allowed[msg.sender][spender] - subtractedValue
    */
    function decreaseAllowance(address spender, uint subtractedValue) public whenNotPaused returns (bool success) {
        return super.decreaseAllowance(spender, subtractedValue);
    }
}

// File: openzeppelin-solidity/contracts/token/ERC20/ERC20Detailed.sol

/**
 * @title ERC20Detailed token
 * @dev The decimals are only for visualization purposes.
 * All the operations are done using the smallest and indivisible token unit,
 * just as on Ethereum all the operations are done in wei.
 */
contract ERC20Detailed is IERC20 {
    string private _name;
    string private _symbol;
    uint8 private _decimals;

    /*@CTK ERC20Detailed_constructor
        @tag assume_completion
        @post __post._name == name
        @post __post._symbol == symbol
        @post __post._decimals == decimals
    */
    constructor (string memory name, string memory symbol, uint8 decimals) public {
        _name = name;
        _symbol = symbol;
        _decimals = decimals;
    }

    /**
     * @return the name of the token.
     */
     /*@CTK ERC20Detailed_name
        @tag assume_completion
        @post __return == _name
    */
```

```
    function name() public view returns (string memory) {
        return _name;
    }

    /**
     * @return the symbol of the token.
     */
    /*@CTK ERC20Detailed_symbol
        @tag assume_completion
        @post __return == _symbol
    */
    function symbol() public view returns (string memory) {
        return _symbol;
    }

    /**
     * @return the number of decimals of the token.
     */
    /*@CTK ERC20Detailed_decimals
        @tag assume_completion
        @post __return == _decimals
    */
    function decimals() public view returns (uint8) {
        return _decimals;
    }
}

/**
 * WARNING
 * This contract is a draft for a stable coin prototype which is being designed to work in conjunction with a payment gateway.
 * At present this contract is in Beta and must not be used in production or when there is real value at stake.
 * Use this contract at your own risk.
 */

//Import contracts
//This file has been marked old because dynamically linking to these contracts was causing issues at times when OpenZeppelin updated their code base and GitHub repository file structure etc.

//Create MonetaToken contract
contract MonetaToken is ERC20Mintable, ERC20Burnable, ERC20Pausable, ERC20Detailed {
    constructor() public
    ERC20Mintable()
    ERC20Burnable()
    ERC20Pausable()
```

```
    ERC20Detailed("Moneta Stablecoin", "MMXN", 6) {}
}
```