Verification and Validation Report: 3D-H3C

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1 Revision History

Date	Version	Notes
Date 1	1.0	Notes
Date 2	1.1	Notes

2 Symbols, Abbreviations and Acronyms

symbol	description
T	Test

Contents

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This document presents the outcomes of the tests specified in the Verification and Validation (VnV) Plan.

3 Functional Requirements Evaluation

This section evaluates the functionality of the 3D-H3C software, focusing on the verification of inputs and outputs against the specifications outlined in the System Requirements Specification (SRS).

3.1 T1: Test for Input Constraints

Description: This test verifies that all input variables conform to the constraints specified in the SRS. It ensures the software accepts only valid inputs which adhere to predefined criteria necessary for correct calculations within the 3D-H3C system.

Responsible Unit Tests: UT1 to UT16 cover a range of scenarios, from proper data loading and validation to ensuring correct initialization of different software modules. Detailed results of these unit tests are discussed in the Unit Testing section.

3.2 T2: Test for Output Current Constraints

Description: This test ensures that the output currents do not exceed the maximum acceptable values for each coil, as specified in the SRS. This is crucial for preventing operational hazards and ensuring the system's safety and reliability.

Responsible Unit Tests: UT17 and UT18 focus on validating the outputs of the software. UT17 checks if currents within the specified range are valid, while UT18 tests responses when currents exceed permissible limits. Detailed results of these tests are provided in the Unit Testing section.

3.3 T3: Test for Target Magnetic Force and Torque

Description: This test validates that the calculated currents produce the target magnetic force and torque within the required accuracy, in accordance with the SRS. This precision is essential for applications where exact magnetic outputs are critical.

Responsible Unit Tests: UT19 to UT21 assess various aspects of output accuracy. UT19 to UT21 verify that the outputs (force and torque) meet required accuracy levels. Details on the execution and outcomes of these tests are elaborated in the Unit Testing section.

4 Nonfunctional Requirements Evaluation

4.1 Overview

The evaluation of nonfunctional requirements is critical for ensuring that the system not only meets its functional specifications but also adheres to performance, usability, reliability, and other qualitative metrics that define a well-rounded and robust system.

4.2 Status of Evaluation

As of the current development stage, the evaluation of nonfunctional requirements has not been conducted. The primary reason for this is the limited time available during the initial phases of the project. This section will be updated as evaluations are carried out and results become available.

5 Unit Testing

This section shows the results of running the unit tests as outlined in the Verification and Validation Plan (VnV plan) documents.The results here confirm the successful execution of all outlined tests, demonstrating that each component of the software meets the functional specifications stated in the VnV plan.

5.1 CoilT Module Test

```
test_init_invalid_current (__main__.TestCoilT) ... ok
test_init_invalid_distance (__main__.TestCoilT) ... ok
test_init_invalid_radius (__main__.TestCoilT) ... ok
test_init_invalid_turns (__main__.TestCoilT) ... ok
test_init_valid (__main__.TestCoilT) ... ok
```

```
----------------------------------------------------------------------
Ran 5 tests in 0.000s
ok
```

5.2 InputFormat Module

```
test_create_coil_from_data_valid (__main__.TestInputFormat) ... ok
test_load_coils_file_not_found (__main__.TestInputFormat) ... ok
test_load_coils_invalid_json (__main__.TestInputFormat) ... ok
test_load_coils_valid (__main__.TestInputFormat) ... ok
test_load_params_invalid_combination (__main__.TestInputFormat) ... Error: Regarding the
ok
test_load_params_invalid_magnetic_force (__main__.TestInputFormat) ... Error: Please ent
ok
test_load_params_invalid_magnetic_moment (__main__.TestInputFormat) ... Error: Exactly 3
ok
test_load_params_invalid_magnetic_torque (__main__.TestInputFormat) ... Error: Exactly 3
ok
test_load_params_valid_input (__main__.TestInputFormat) ... ok

----------------------------------------------------------------------
Ran 9 tests in 0.011s
ok
```

5.3 MagneticCoreTest Module

```
test_calculate_current_of_target_force (__main__.TestMagneticCore) ... ok
test_calculate_current_of_target_torque (__main__.TestMagneticCore) ... ok
test_derivatives_of_magnetic_field_maxwell_at_center (__main__.TestMagneticCore) ... ok
test_initialization (__main__.TestMagneticCore) ... ok
test_magnetic_field_helmholtz (__main__.TestMagneticCore) ... ok
test_magnetic_force (__main__.TestMagneticCore) ... ok
test_magnetic_torque (__main__.TestMagneticCore) ... ok

----------------------------------------------------------------------
```

```
Ran 7 tests in 0.004s
OK
```

5.4 OutputVerification Module

```
test_calculate_similarity_opposite_direction (__main__.TestOutputVerification) ... ok
test_calculate_similarity_perfect_match (__main__.TestOutputVerification) ... ok
test_calculate_similarity_zero_vectors (__main__.TestOutputVerification) ... ok
test_is_accurate_enough_force_invalid (__main__.TestOutputVerification) ... ok
test_is_accurate_enough_torque_invalid (__main__.TestOutputVerification) ... ok
test_is_accurate_enough_valid (__main__.TestOutputVerification) ... ok
test_is_currents_within_range_invalid (__main__.TestOutputVerification) ... ok
test_is_currents_within_range_valid (__main__.TestOutputVerification) ... ok

----------------------------------------------------------------------
Ran 8 tests in 0.002s
OK
```

6 Trace to Requirements

Table 1: Relation of Test Cases to Requirements.

	R1	R2	R3	R4	NFR1	NFR2	NFR3	NFR4
T1	x							
T2			x					
T3		x						
T4				x	x			
T5						x		
T6							x	
T7								x

7 Trace to Modules

Table 2: Traceability Between Test Cases and Modules

Module	Tests
T1	UT1 to UT21
T2	UT22, UT23
T3	UT24 to UT29

8 Code Coverage Metrics

```
Name                                                    Stmts   Miss  Cover
---------------------------------------------------------------------------
/home/reyhaneh/3D-H3C/src/CoilT.py                         15      0   100%
/home/reyhaneh/3D-H3C/src/InputFormat.py                   50      2    96%
/home/reyhaneh/3D-H3C/src/MagneticCore.py                  56      0   100%
/home/reyhaneh/3D-H3C/src/OutputVerification.py            40      2    95%
/home/reyhaneh/3D-H3C/src/__init__.py                       0      0   100%
TestCoilT.py                                               25      1    96%
TestInputFormat.py                                         61      1    98%
TestMagneticCore.py                                        48      1    98%
TestOutputVerification.py                                  49      1    98%
---------------------------------------------------------------------------
TOTAL                                                     344      8    98%
```