

# 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

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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 session starts =====
collecting ... collected 5 items

TestCoilT.py::TestCoilT::test_init_invalid_current
TestCoilT.py::TestCoilT::test_init_invalid_distance
TestCoilT.py::TestCoilT::test_init_invalid_radius
```

```
TestCoilT.py::TestCoilT::test_init_invalid_turns
TestCoilT.py::TestCoilT::test_init_valid
```

```
===== 5 passed in 0.02s =====
PASSED [ 20%]PASSED [ 40%]PASSED [ 60%]PASSED [ 80%]PASSED [100%]
```

## 5.2 InputFormat Module

```
===== test session starts =====
collecting ... collected 4 items
```

```
TestInputFormat.py::TestInputFormat::test_create_coil_from_data_valid
TestInputFormat.py::TestInputFormat::test_load_coils_file_not_found
TestInputFormat.py::TestInputFormat::test_load_coils_invalid_json
TestInputFormat.py::TestInputFormat::test_load_coils_valid
```

```
===== 4 passed in 0.04s =====
PASSED [ 25%]PASSED [ 50%]PASSED [ 75%]PASSED [100%]
```

## 5.3 MagneticCoreTest Module

```
===== test session starts =====
collecting ... collected 7 items
```

```
TestMagneticCore.py::TestMagneticCore::test_calculate_current_of_target_force
TestMagneticCore.py::TestMagneticCore::test_calculate_current_of_target_torque
TestMagneticCore.py::TestMagneticCore::test_derivatives_of_magnetic_field_maxwell_at_center
TestMagneticCore.py::TestMagneticCore::test_initialization
TestMagneticCore.py::TestMagneticCore::test_magnetic_field_helmholtz
TestMagneticCore.py::TestMagneticCore::test_magnetic_force
TestMagneticCore.py::TestMagneticCore::test_magnetic_torque
```

```
===== 7 passed in 0.02s =====
PASSED [ 14%]PASSED [ 28%]PASSED [ 42%]PASSED [ 57%]PASSED [ 71%]PASSED
[ 85%]PASSED [100%]
```

## 5.4 OutputVerification Module

```

===== test session starts =====
collecting ... collected 5 items

TestOutputVerification.py::TestOutputVerification::test_is_accurate_enough_force_invalid
TestOutputVerification.py::TestOutputVerification::test_is_accurate_enough_torque_invalid
TestOutputVerification.py::TestOutputVerification::test_is_accurate_enough_valid
TestOutputVerification.py::TestOutputVerification::test_is_currents_within_range_invalid
TestOutputVerification.py::TestOutputVerification::test_is_currents_within_range_valid

===== 5 passed in 0.02s =====
PASSED [ 20%]PASSED [ 40%]PASSED [ 60%]PASSED [ 80%]PASSED [100%]

```

## 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 UT16
T2	UT17, UT18
T3	UT19 to UT21

## 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	28	44%
/home/reyhaneh/3D-H3C/src/MagneticCore.py	56	0	100%
/home/reyhaneh/3D-H3C/src/OutputVerification.py	40	18	55%
/home/reyhaneh/3D-H3C/src/__init__.py	0	0	100%
TestCoilT.py	25	1	96%
TestInputFormat.py	35	1	97%
TestMagneticCore.py	48	1	98%
TestOutputVerification.py	30	1	97%
-----			
TOTAL	299	50	83%