

System Test Plan

For

Portable Ultrasound Device for Coda-Wave Interferometry

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1. Introduction

1.1 Purpose

This document is a test plan for the Portable Ultrasound Device (PUD) Testing, produced by the System Testing team. It describes the testing strategy and approach to testing the team will use to verify that the application meets the established requirements of the client prior to release.

1.2 Objectives

- Meets the requirements, specifications and the Clients rules.
- Supports the intended clients' functions and achieves the required standards.
- Satisfies the Entrance Criteria for User Acceptance Testing.
- Complies with electrical safety requirements to ensure operator safety.

2. Functional Scope

The Modules in the scope of testing for the Portable Ultrasound Device System Testing are mentioned in the document attached in the following path:

1. The system requirement specification (SRS) document:
https://docs.google.com/document/d/16PQ4nDXEOfpaoKCjTae0HhOAPFSO_Tca/edit
2. Section 3.1 of this document.
3. User manual

3. Overall Strategy and Approach

3.1 Testing Strategy

Portable Ultrasound Device System Testing will include testing of all functionalities that are in scope (Section 2) identified. System testing activities will include the testing of new functionalities, modified functionalities, screen level validations, work flows, functionality access, testing of internal & external interfaces.

The following 3.1 sections describe overall how the testing types will be evaluated.

3.1.1 Electrical subsystem testing

Test objective: The PUD's Electrical subsystem works according to the listed requirements presented on the SRS.

Technique: Apply normal operating voltage to parts of the system and verify proper operation using test equipment.

Completion criteria: When all tested components match expected value range from the test case list below in section 4. All failed tests are troubleshoot, repaired and pass retest.

Special considerations: Some tests will involve 500V and require proper electrical safety precautions to test.

3.1.2 Cooling subsystem testing

Test objective: The PUD's Cooling subsystem works according to the listed requirements presented on the SRS.

Technique: After connecting the fan to the controller and the controller to the pico, we assign the fan speed lookup table IAW the controller's documentation and then expose the controller to controlled temperature changes of approximately $\pm 10^{\circ}\text{C}$ and observe the output fan speed accordingly via a visual inspection and tactile increase in the amount of airflow.

Completion criteria: The fan's RPMs increase and decrease with exposure to higher and lower ambient temperatures IAW SRS and the EMC2101 specifications.

Special considerations: N/A

3.1.3 Data processing subsystem testing

Test objective: The PUD's Data processing subsystem works according to the listed requirements presented on the SRS.

Technique: Once the receiver section is assembled, a power on and function test will be performed. A test sine wave will be applied to the input and the data will be collected and stored.

Completion criteria: A complete sine wave will be reconstructed from the data collected.

Special considerations: This test should be completed before total assembly. This test should show a complete sine wave with no gaps and with consistent sampling.

3.1.4 Transmission/ Reception subsystem testing

Test objective: The PUD's Transmission/ Reception subsystem works according to the listed requirements presented on the SRS.

Technique: The transmitter will be switched on, powered, and triggered. The receiver will be switched on, powered, and triggered.

Completion criteria: For the TX the transmitter must supply a full 500V signal with a ramp time of under 50ns, and a 2us pulse. RX must receive a signal between 0V and 1V, the signal must be complete in nature.

Special considerations: N/A

3.1.5 Control subsystem testing

Test objective: The PUD's Control subsystem works according to the listed requirements presented on the SRS.

Technique: Apply inputs via the control switches.

Completion criteria: Microcontroller registers the input and is able to produce the correct, corresponding output.

Special considerations: (if applicable)

3.1.6 Exterior casing/mounting subsystem testing

Test objective: The PUD's Exterior casing/mounting works according to the listed requirements presented on the SRS.

Technique: Apply gradually stronger forces to mounted components. This will build up to a drop test.

Completion criteria: Components do not move, do not disconnect, and are not damaged by the focus applied to them.

3.1.7 Overall system functionality testing

Test objective: The PUD system as a whole works according to the listed requirements presented on the SRS.

Technique: Operate the PUD system to verify the unit works as expected for normal operating conditions.

Completion criteria: When all tests are passed from the test case list below in section 4. All failed tests are troubleshooted, repaired and pass retest.

Special considerations: The system is expected to operate outside for the duration of normal testing. But must be monitored to prevent theft or unexpected error.

3.2 System Testing Entrance Criteria

In order to start system testing, certain requirement must be met for testing readiness. The readiness can be classified into:

3.3 Testing Types

3.3.1 Electrical subsystem testing

This testing encompasses the requirements for testing related to the operation of the electrical system for the PUD system. The goal of Electrical subsystem testing is to produce a safe, reliable, and requirement satisfying electrical distribution system.

System Requirements Specification, 5.2.3: "The safety lock shall be electrically isolated from any of the high voltage components to prevent shock."

System Requirements Specification, 5.1.1: "The system shall operate for 48 to 72 hours without recharging the internal battery."

System Requirements Specification, 6.3: "The electrical distribution system shall not exceed a component's rated limits, as shown in its related datasheet."

System Requirements Specification, 6.4: "The electrical system shall have no faulty components."

System Requirements Specification, 6.5: "The electrical system shall produce a 5V, 12V, and 500V DC supply."

System Requirements Specification, 6.6: "The electrical system shall have sheathing protection."

System Requirements Specification, 6.8: "The electrical system shall have no unintended paths to ground."

3.3.2 Cooling subsystem testing

This testing encompasses the requirements for testing related to the operation of the cooling system for the PUD system. The goal of cooling subsystem testing is to produce a safe, reliable, and requirement satisfying cooling and heat dispersion system.

System Requirements Specification, 4.2.3.1: "The system shall be able to monitor internal temperatures within the unit."

System Requirements Specification, 4.2.3.2: "The system shall run the cooling fan via pulse-width modulation in accordance with a pre-programmed hysteresis curve"

System Requirements Specification, 4.2.3.3: "The system shall shut down in the event that temperatures cannot be reduced below the danger level."

System Requirements Specification, 5.1.2: "The system shall have fans and thermal monitoring to ensure components do not overheat IAW applicable component requirements."

3.3.3 Data processing subsystem testing

This testing encompasses the requirements for testing related to the operation of the data processing system for the PUD system. The goal of data processing testing is to produce a reliable and requirement satisfying data processing system.

System Requirements Specification, 3.2.6: "The Computer shall send commands to the SD card to record the received signal."

System Requirements Specification, 3.2.7: "The SD card will store data and be kept in a computer and MATLAB readable format."

System Requirements Specification, 3.3.2: "Raw data from the receiving transducer shall be sent to SD card by the oscilloscope using .mat format"

System Requirements Specification, 3.4.1: "The Raspberry Pi Pico will use the SPI bus to move data between internal components."

System Requirements Specification, 4.1.3.4: "The system shall convert the analog signal received from the receiver transducer into a digital signal which can be recorded."

System Requirements Specification, 4.1.3.5: "The system shall be able to save the data received from the receiving transducer to a SD card."

System Requirements Specification, 4.1.3.6: "The system shall have greater than or equal to 35 GB of storage space to store test data."

3.3.4 Transmission/ Reception subsystem testing

This testing encompasses the requirements for testing related to the operation of the Transmission/ Reception system for the PUD system. The goal of Transmission/ Reception subsystem testing is to produce a safe, reliable, and requirement satisfying Transmission/ Reception distribution system.

System Requirements Specification, 3.2.5: "The ADC or oscilloscope shall receive inputs from the transducer receiver."

System Requirements Specification, 3.2.6: "The TX will have a ramp time of under 50ns"

System Requirements Specification, 4.1.3.1: "The electrical system shall produce 500 V 2µsec test pulse."

3.3.5 Control subsystem testing

This testing encompasses the requirements for testing related to the operation of the Control system for the PUD system. The goal of Control subsystem testing is to produce a safe, reliable, and requirement satisfying Control system.

System Requirements Specification, 3.2.1: "The push buttons shall input commands to the Raspberry Pi Pico"

System Requirements Specification, 3.2.2: "The Raspberry Pi Pico shall send a switching signal to the MOSFET to gate the 500v input on and off."

System Requirements Specification, 3.2.3: "The Raspberry Pi Pico shall send PWM or digital switching signals to the cooling fan to control its speed and on/off status."

System Requirements Specification, 3.2.4: "The Raspberry Pi Pico shall send commands to the status and alarm LEDs to turn on or off"

System Requirements Specification, 3.3.1: "The PUD shall use a Raspberry Pi pico."

System Requirements Specification, 3.4.2: "The Raspberry Pi Pico will use the UART system to allow for programming and system updates."

System Requirements Specification, 4.1.3.2: "The control system shall be able to gate the test signal on and off within 2µsec (MOSFET) "

System Requirements Specification, 4.1.3.3: "The system shall be able to produce 50 test signals with 100µsec interval between the test pulses."

System Requirements Specification, 4.3.3.2: "The system shall turn power on for the overheated LED on the alarm panel if temperature exceeds or is equal to 125°F for more than 1 min."

System Requirements Specification, 4.3.3.3: "The system shall shut down if temperature exceeds or is equal to 130°F for more than 30 seconds."

System Requirements Specification, 4.3.3.4: "The system shall be able to monitor SD card status."

System Requirements Specification, 4.3.3.4.1: "The system shall power on if no SD card is inserted and flash the "SD Card Full" and "Power" LEDs if the card is not present."

System Requirements Specification, 4.3.3.4.2: "If no SD card is present, the machine shall not perform the test phase."

System Requirements Specification, 4.3.3.5: "The system shall turn power on for the SD card full LED on the alarm panel if the SD card is 95% of max storage capacity."

System Requirements Specification, 4.3.3.6: "The system shall record over the oldest data on the SD card if the error is not corrected."

System Requirements Specification, 4.3.3.7: "The system shall be able to monitor battery voltage."

System Requirements Specification, 4.3.3.8: "The system shall turn power on for the low battery LED on the alarm panel if the battery voltage drops to or below 10.5."

System Requirements Specification, 4.3.3.9: "The system shall turn off the system if battery voltage is below 10V for greater than 1 min."

3.3.6 Exterior casing/mounting subsystem testing

This testing encompasses the requirements for testing related to the Exterior casing/mounting system for the PUD system. The goal of Exterior casing/mounting subsystem testing is to produce a safe, reliable, and requirement satisfying Exterior casing/mounting distribution system.

System Requirements Specification, 4.4.3.1: "SD Card slot shall be protected by an external cover that requires external action to open."

System Requirements Specification, 4.4.3.2: "SD Card shall contain a locking latch mechanism."

System Requirements Specification, 4.4.3.3: "SD Card slot shall present an alignment guide to ensure proper insertion."

System Requirements Specification, 5.2.1: "The system shall have an external safety lock to protect the user from high voltages present within."

System Requirements Specification, 5.2.2: "The system shall have a warning posted on the outside to alert the user to secure power and wait 40 minutes prior to opening due to risk of shock from high voltage supply and capacitor bank."

System Requirements Specification, 6.1: "The case shall be able to withstand a fall from 3 ft and protect the contents of the case"

System Requirements Specification, 6.2: "The case shall be water resistant and be able to protect the

contents from water penetration from rain”

System Requirements Specification, 6.7: “The electrical system components shall be securely mounted to the casing.”

3.3.7 Overall system functionality/PUD testing

This testing encompasses the requirements for testing related to the operation of the PUD system that is not covered by the subsystems. The goal of PUD testing is to produce a safe, reliable, and requirement satisfying system for the client.

Note: This section also contains requirements for any remaining tests

System Requirements Specification, 3.2.8: “A laptop separate from the PUD shall run the MATLAB software required to analyze the raw data.”

System Requirements Specification, 3.3.3: “Laptop using MATLAB shall retrieve data from SD card.”

System Requirements Specification, 3.3.4: “Laptop shall be running Windows 10 or later.”

System Requirements Specification, 3.3.5: “Laptop shall have Thonny and MATLAB installed.”

System Requirements Specification, 5.4.1: “All system components shall be tested prior to installation”

System Requirements Specification, 5.4.2: “The system when fully constructed shall be tested using a test plan.”

System Requirements Specification, 5.4.3: “A parts list shall be provided along with the finished product to the user.”

System Requirements Specification, 5.5.1: “Only personnel who have read the operating manual should operate the equipment.”

3.4 Suspension Criteria and Resumption Requirements

This section will specify the criteria that will be used to suspend all or a portion of the testing activities on the items associated with this test plan.

3.4.1 Suspension Criteria

Testing will be suspended for a sub system or the whole system if a component within the sub system breaks or is damaged.

Testing will also stop if any team member expresses a concern with safety or believes the system to be unsafe in the testing condition used.

3.4.2 Resumption Requirements

After the system is restored to a fully functional and safe state.

Permission to resume testing will be authorized by the team leader.

4. Execution Plan

4.1 Execution Plan

The execution plan will detail the test cases to be executed. The Execution plan will be put together to ensure that all the requirements are covered. The execution plan will be designed to accommodate some changes, if necessary, if testing is incomplete on any day. All the test cases of the projects under test in this release are arranged in a logical order depending upon their inter dependency.

The test plan for the PUD system is as follows:

- 4.1.1 Electrical subsystem testing (3.1.1)
- 4.1.2 Cooling subsystem testing (3.1.2)
- 4.1.3 Control subsystem testing (3.1.5)
- 4.1.4 Data processing subsystem testing (3.1.3)
- 4.1.5 Exterior casing/mounting subsystem testing (3.3.6)
- 4.1.6 Transmission/ Reception subsystem testing (3.1.4)
- 4.1.7 Overall system functionality testing (3.1.7)

Requirement (From SRS)	Test Case Identifier	Input	Expected Behavior	Pass / Fail
Electrical subsystem testing				
5.2.3: The safety lock shall be electrically isolated from any of the high voltage components to prevent shock.	1.1	N/A	Lock prohibits non forceful entry to the interior of the device without a key.	
5.1.1: The system shall operate for 48 to 72 hours without recharging the internal battery.	2.1	Activate system for 72-hour test	Battery shall be above 10 V by end of test	
6.3: The electrical distribution system shall not exceed a component's rated limits, as shown in its related datasheet.	3.1	12.8v from battery, 5v from converter 500v from converter	All electrical components listed below are operating within the data sheet specified voltage, current, and power limits: (apply a required voltage or measure a resistance and get an expected result from the component/ not a faulty part and operate as intended.) Mosfet rated for 20v has less than 1 ohm resistance at 3.3v control signal as specified in the data sheet.	

			<p>Mosfet rated for 500v has less than 1 ohm resistance at 12v control signal as specified in data sheet</p> <p>resistor rated for 390, 2.5k, 27k, match expected resistance value plus or minus tolerance range specified in data sheet.</p> <p>LED's illuminates and does not exceed current limits specified in data sheet</p> <p>battery voltage matches expected value 12.8 v specified in the data sheet.</p> <p>dc to dc, 5v, 20v, 500v converters produce 5v, 20v, or 500v depending upon the data sheet specified value.</p> <p>wire has no damage to insulation and has resistance exceeding 1 mega ohm</p> <p>Fuse's rated for 5A and 6.5A have resistance less than 1 ohm</p> <p>Switches are over 1M ohm when open and less than 1 ohm when shut. operational at required 12 or 500v (2 different switches).</p>	
6.4: The electrical system shall be tested for faulty components.	4.1	<p>Variable DC source (A variable DC source uses a rheostat to change its output voltage. Hence the voltage is variable and changes according to the user's needs.)</p> <p>0 to 100 vDC as required by the tester.</p>	<p>All electrical components operate per data sheet requirements prior to installation: (apply a required voltage or measure a resistance and get an expected result from the component/ not a faulty part and operate as intended.)</p> <p>Mosfet rated for 20v has less than 1 ohm resistance at 3.3v control signal as specified in the data sheet.</p> <p>Mosfet rated for 500v has less than 1 ohm resistance at 5v control signal as specified in data sheet</p> <p>Mosfets switch at proper speed as shown in the data sheet.</p> <p>resistor rated for 390, 2.5k, and 27k, match expected resistance</p>	

			<p>value plus or minus tolerance range specified in data sheet. No burnt out resistors.</p> <p>LED's illuminate when 3.3v applied.</p> <p>battery voltage matches expected value 12.8 v specified in the data sheet.</p> <p>dc to dc, 5v, 20v, 500v converters produce 5v, 20v, or 500v depending upon the data sheet specified value.</p> <p>wire has no damage to insulation and has resistance exceeding 1,000,000 ohms. No shorts to ground.</p> <p>Fuse's rated for 5A and 6.5A have resistance less than 1 ohm</p> <p>Switches are over 1M ohm when open and less than 1 ohm when shut. Switch operates from open to shut and shut to open.</p>	
6.5: The electrical system shall produce 5,12, and 500V DC	5.1	12.8v from battery, 5v from converter 20v from converter 500v from converter	<p>All electrical sources produce power per data sheet specifications.</p> <p>Battery produces 12.8v</p> <p>5v converter produces 5 v</p> <p>20 v converter produces 20v</p> <p>500v converter produces 500v</p> <p>plus or minus data sheet specified tolerance bands</p>	
6.6: The electrical system shall have sheathing protection.	6.1	N/A	All wires are protected with sheathing	
6.8: The electrical system shall have no unintended paths to ground.	7.1	12.8v from battery, 5v from converter 20 v from converter 500v from converter	System has no unintended grounds and operates as intended. No resistance less than 1 M ohm to the casing.	
Cooling subsystem testing				
4.2.3.1: The system shall be able to monitor internal temperatures within the unit.	8.1	N/A	Thermal sensors accurately output the temperature of the air around it.	
4.2.3.2: The system shall run the cooling fan via pulse-width modulation in accordance with a pre-programmed hysteresis curve	9.1	3.3V from Pico TACH from fan Ambient	As temperature rises, fan speed increases and as temperature falls, fan speed decreases IAW	

		Temperature	hysteresis curve.	
4.2.3.3: The system shall shut down in the event that temperatures cannot be reduced below the danger level.	10.1	Apply heat to thermal sensors to get them above operating temperature.	System shall cease operations to minimize the chance of damage to the system.	
5.1.2: The system shall have fans and thermal monitoring to ensure components do not overheat IAW applicable component requirements.	11.1	Ambient Temperature		
Control subsystem testing				
3.2.1: The push buttons shall input commands to the Raspberry Pi Pico	12.1	Push button controls	Input controls shall have the desired effect on the control of the system.	
3.2.2: The Raspberry Pi Pico shall send a switching signal to the MOSFET to gate the 500v input on and off.	13.1	N/A	The Raspberry Pi controller shall gate the MOSFET on and off to create the desired waveform.	
3.2.3: The Raspberry Pi Pico shall send PWM or digital switching signals to the cooling fan to control its speed and on/off status.	14.1	Most likely a temp sensor	The Raspberry Pi shall monitor internal temperatures of the box constantly and gate the fans on and off according to design specs of cooling system.	
3.2.4: The Raspberry Pi Pico shall send commands to the status and alarm LEDs to turn on or off	15.1	N/A	The Raspberry Pi shall send signals to the LEDs that accurately depict system status.	
3.3.1: The PUD shall use a Raspberry Pi pico.	16.1	Seems Redundant this is a hardware feature	**	
3.4.2: The Raspberry Pi Pico will use the UART system to allow for programming and system updates.	17.1	Seems Redundant this is a hardware feature	**	
4.1.3.2: The control system shall be able to gate the test signal on and off within 2μsec (MOSFET)	18.1	N/A	The MOSFET shall be turned on within 2 uS	
4.1.3.3: Signal testing for duration and quantity	19.1	N/A	The system shall be able to produce 50 test signals with 100μsec interval between the test pulses.	
4.3.3.2: Overheat alarm test	20.1	N/A	The system shall turn power on for the overheated LED on the alarm panel if temperature exceeds or is equal to 125°F for more than 1 min	
4.3.3.3: Overheat shutdown Test	21.1	N/A	The system shall shut down if temperature exceeds or is equal to 130°F for more than 30	

			seconds.	
4.3.3.4: The system shall be able to monitor SD card status.	22.1	SD card data	The system shall have a way to show monitor SD card storage used and remaining, alerting the user if there is an issue	
4.3.3.4.1: SD card missing test	23.1	N/A	The system shall power on if no SD card is inserted and flash the "SD Card Full" and "Power" LEDs if the card is not present.	
4.3.3.4.2: SD card missing redundancy test	24.1	N/A	If no SD card is present, the machine shall not perform the test phase.	
4.3.3.5: The system shall turn power on for the SD card full LED on the alarm panel if the SD card is 95% of max storage capacity.	25.1	Data on SD card	The Raspberry Pi shall read the amount of data currently on the SD card. If data on card is equal to 95% or more of total storage capacity the Raspberry Pi shall turn on the SD Card Full LED.	
4.3.3.6: The system shall record over the oldest data on the SD card if the error is not corrected.	26.1	N/A	Instead of throwing away new data the system shall overwrite data starting with the oldest collected.	
4.3.3.7: The system shall be able to monitor battery voltage.	27.1	Voltage from battery	The Raspberry Pi should have access to the voltage coming off of the battery	
4.3.3.8: The system shall turn power on for the low battery LED on the alarm panel if the battery voltage drops to or below 10.5.	28.1	Voltage from battery	The Raspberry Pi shall turn on the low Battery LED if voltage coming off of battery drops below 10.5	
4.3.3.9: The system shall turn off the system if battery voltage is below 10V for greater than 1 min.	29.1	Voltage from battery	The Raspberry Pi shall start an internal timer every time the battery drops below 10V. If this state remains constant for 60 seconds or longer the Raspberry Pi shall power down the system.	
Data processing subsystem testing				
3.2.6: The Computer shall send commands to the SD card to record the received signal.	30.1		There is stored data on the SD card	
3.2.7: The SD card will store data and be kept in a computer and MATLAB readable format.	31.1		The data on the SD card is readable, non-corrupted, and in a .mat format	
3.3.2: Raw data from the receiving transducer shall be sent to SD card using .mat format	32.1		The data on the SD card is readable, non-corrupted, and in a .mat format	
3.4.1: The Raspberry Pi Pico will use the SPI bus to move data between internal components.	33.1		The SPI bus is communicating with other components	

4.1.3.4: The system shall convert the analog signal received from the receiver transducer into a digital signal which can be recorded.	34.1		The oscilloscope will receive the signal and record it.	
4.1.3.5: The system shall be able to save the data received from the receiving transducer to a SD card.	35.1		The data on the SD card is readable, non-corrupted, and in a .mat format	
4.1.3.6: The system shall have greater than or equal to 35 GB of storage space to store test data.	36.1		A SD card will be greater than 31GB and the computer will have storage greater than 5GB	
Transmission/ Reception subsystem testing	37.1			
4.4.3.1: SD Card slot shall be protected by an external cover that requires external action to open.	38.1	N/A	Outside dust, debris, and water should not be able to easily enter the SD card slot.	
4.4.3.2: SD Card shall contain a locking latch mechanism.	39.1			
4.4.3.3: SD Card slot shall present an alignment guide to ensure proper insertion.	40.1	Insert an SD card to ensure alignment allows for operation.	SD card is able to be inserted easily.	
5.2.1: The system shall have an external safety lock to protect the user from high voltages present within.	41.1	Give locked system to an unauthorized user.	Unauthorized user should not be able to open the case of the system.	
5.2.2: The system shall have a warning posted on the outside to alert the user to secure power and wait 40 minutes prior to opening due to risk of shock from high voltage supply and capacitor bank.	42.1	N/A	A user should be able to clearly see the warning posted on the case of the system.	
6.1: The case shall be able to withstand a fall from 3 ft and protect the contents of the case	43.1	Allow case to fall from 3 ft.	No components shall move, become disconnected, or damaged in any way, shape, or form.	
6.2: The case shall be water resistant and be able to protect the contents from water penetration from rain	44.1			
6.7: The electrical system components shall be securely mounted to the casing.	45.1	The case will be shaken with moderate force.	No component shall become loose or be damaged.	
Transmission/ Reception subsystem testing				
3.2.5: The ADC chip shall receive inputs from the transducer receiver.	46.1	1V Sine wave	A complete sine wave with consistent sampling	

4.1.3.1: The electrical system shall produce 500 V 2μsec test pulse.	47.1	12.8v from battery 5v from converter 3.3v control signal from control system	3.3v signal triggers MOSFET to allow 5v to trigger another MOSFET. Which allows 500v to be applied to the transducer port.	
Overall system functionality testing	50.1			
3.2.8: A laptop separate from the PUD shall run the MATLAB software required to analyze the raw data.	51.1	Data collected from tests	A user readable output will be displayed of the results of the ultrasound test	
3.3.3: Laptop using MATLAB shall retrieve data from SD card.	52.1	SD card containing test data from 72 hours of testing	Data from SD card shall be accessible and downloadable on the laptop	
3.3.4: Laptop shall be running Windows 10 or later.	53.1			
3.3.5: Laptop shall have Thonny and MATLAB installed.	54.1			
5.4.1: All system components shall be tested prior to installation	55.1			
5.4.2: The system when fully constructed shall be tested using a test plan.	56.1			
5.4.3: A parts list shall be provided along with the finished product to the user.	57.1	N/A		
5.5.1: Only personnel who have read the operating manual should operate the equipment.	58.1	N/A	Only authorized users will be given the code to open the system container.	

5. Traceability Matrix & Defect Tracking

5.1 Traceability Matrix

List of requirements, corresponding test cases

Requirement CRITICAL: System Requirements Specification, 4.1.3.1: “The electrical system shall produce 500 V 2μsec test pulse.”

Test Cases: Verify the electrical system can output 500 v to the transducer port for a

duration of 2 to 5 μsec .

Requirement LOW: System Requirements Specification, 5.2.3: “The safety lock shall be electrically isolated from any of the high voltage components to prevent shock.”

Test Cases: Verify the exterior casing and locking mechanism is electrically safe for user.

Requirement Medium: System Requirements Specification, 5.1.1: “The system shall operate for 48 to 72 hours without recharging the internal battery.”

Test Cases: Verify the system can operate in normal conditions for a duration of 48 to 72 hours.

Requirement Critical: System Requirements Specification, 6.3: “The electrical distribution system shall not exceed a component's rated limits, as shown in its related datasheet.”

Test Cases: Verify the system components operate within expected tolerance ranges per their respective data sheets.

Requirement Critical: System Requirements Specification, 6.4: “The electrical system shall have no faulty components.”

Test Cases: Verify the system components operate within expected tolerance ranges per their respective data sheets.

Requirement Critical: System Requirements Specification, 6.5: “The electrical system shall produce 5,12, and 500V DC”

Test Cases: Verify the system’s electrical systems output voltages per their respective data sheet

Requirement Low: System Requirements Specification, 6.6: “The electrical system shall have sheathing protection.”

Test Cases: Verify the system’s electrical system wiring is protected with sheathing.

Requirement Critical: System Requirements Specification, 6.8: “The electrical system shall have no unintended paths to ground.”

Test Cases: Verify the system’s electrical system has no unintended paths to ground.

Test Cases: Verify the system’s electrical system has no unintended paths to ground.

Requirement Critical: System Requirements Specification 5.1.2: “The system shall have fans and thermal monitoring to ensure components do not overheat IAW applicable component requirements.”

Test Cases: Verify the system’s cooling system activates with power on.

Requirement Medium: System Requirements Specification 4.2.3.2: “The system shall run the cooling fan via pulse-width modulation in accordance with a pre-programmed hysteresis curve.”

Test Cases: Verify airflow speed changes as temperature increases/decreases..

Requirement Critical: System Requirements, Specification 4.2 “[The system will shut] down if unable to correct the temperature below the danger level.”

Test Cases: Verify that system shuts off in event of temperature>50C for ~360s.

5.2 Defect Severity Definitions

Critical	The defect causes a catastrophic or severe error that results in major problems and the functionality rendered is unavailable to the user. A manual procedure cannot be either implemented or a high effort is required to remedy the defect. Examples of a critical defect are as follows: <ul style="list-style-type: none">• System abends• Data cannot flow through a business function/lifecycle• Data is corrupted or cannot post to the database
Medium	The defect does not seriously impair system function can be categorized as a medium Defect. A manual procedure requiring medium effort can be implemented to remedy the defect. Examples of a medium defect are as follows: <ul style="list-style-type: none">• Form navigation is incorrect• Field labels are not consistent with global terminology
Low	The defect is cosmetic or has little to no impact on system functionality. A manual procedure requiring low effort can be implemented to remedy the defect. Examples of a low defect are as follows: <ul style="list-style-type: none">• Repositioning of fields on screens• Text font on reports is incorrect

6. Environment

6.1 Environment

- The System Testing Environment will be used for System Testing.

Most testing will occur indoors in a controlled environment. The final test will be an outdoor test for 72 hours.

7. Assumptions

- Define test plan assumptions.
- The battery is fully charged prior to testing and the battery is in peak condition.
- The user does not open the outer casing without taking proper electrical safety precautions.
- The testing area is dry with mild to no weather interference.
- The user has read the operating procedure.

8. Risks and Contingencies

Define risks and contingencies.

Risk #	Risk	Impact	Contingency Plan
1	Electrical shock	High	Perform proper electrical safety procedures
2	Explosion	High	Distance requirement prior to initial startup or first-time operation.
3	Hand laceration/bruising	Medium	Ensure fans have external mesh to prevent physical ingress.

9. Appendices

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