**System Test Plan**

**For**

**Optical Communications System (OCS)**

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Table of Contents

[1. Introduction 2](#_Toc530500519)

[1.1 Purpose 2](#_Toc530500520)

[1.2 Objectives 2](#_Toc530500521)

[2. Functional Scope 2](#_Toc530500522)

[3. Overall Strategy and Approach 2](#_Toc530500523)

[3.1 Testing Strategy 2](#_Toc530500524)

[3.2 System Testing Entrance Criteria 2](#_Toc530500525)

[3.3 Testing Types 2](#_Toc530500526)

[3.4 Suspension Criteria and Resumption Requirements 3](#_Toc530500527)

[4. Execution Plan 3](#_Toc530500528)

[4.1 Execution Plan 3](#_Toc530500529)

[5. Traceability Matrix & Defect Tracking 3](#_Toc530500530)

[5.1 Traceability Matrix 3](#_Toc530500531)

[5.2 Defect Severity Definitions 3](#_Toc530500532)

[6. Environment 4](#_Toc530500533)

[6.1 Environment 4](#_Toc530500534)

[7. Assumptions 4](#_Toc530500535)

[8. Risks and Contingencies 4](#_Toc530500536)

[9. Appendices 4](#_Toc530500537)

# Introduction

## Purpose

This document is a test plan for the Low-Cost Optical (Laser) Communication System 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 business prior to release.

## Objectives

* Meets the requirements, specifications and the Business rules.
* Supports the intended business functions and achieves the required standards.
* Satisfies the Entrance Criteria for User Acceptance Testing.

# Functional Scope

The Modules in the scope of testing for the Low-Cost Optical (Laser) Communication System Testing are mentioned in the System Requirements Specification document (SRS), attached to this document.

# Overall Strategy and Approach

## Testing Strategy

Low-Cost Optical (Laser) Communication System Testing will include testing of all functionalities that are in scope (Refer Functional Scope Section) identified. System testing activities will include the testing of new functionalities, modified functionalities, screen level validations, workflows, functionality access, testing of internal & external interfaces.

## System Testing Entrance Criteria

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

* + *Safety* – At risk individuals must be wearing the appropriate laser goggles. The laser must be harnessed properly so that it is not pointed towards any person accidentally. All connections must be secured so there is no risk of electrical damage or fires.
  + *Laser diode and sensor operability* – The laser diode, driver and sensor must be functioning under nominal conditions to ensure capability with other systems. This is to simplify functionality testing by eliminating their operability as the cause of the problem.

## Testing Types

### Usability Testing

User interface attributes, cosmetic presentation and content will be tested for accuracy and general usability. The goal of Usability Testing is to ensure that the User Interface is comfortable to use and provides the user with consistent and appropriate access and navigation through the functions of the application (e.g., access keys, consistent tab order, readable fonts etc.)

#### 3.3.1.1 The user shall see a video streamed from the receiver-side camera by simply turning the system on.

### Functional Testing

The objective of this test is to ensure that each element of the component meets the functional requirements of the business as outlined in the:

* Business / Functional Requirements
* Business rules or conditions
* Other functional documents produced during the course of the project i.e. resolution to issues/change requests/feedback

#### 3.3.2.1 The laser driver shall transmit a minimum of 5 mW of power.

#### 3.3.2.2 The receiver and transmitter shall be lined up properly to ensure maximum power transfer.

#### 3.3.2.3 The receiver shall produce a sinusoidal wave, to be displayed by oscilloscope, when the diode transmits an unmodulated signal.

#### 3.3.2.4 The Raspberry Pi shall use On-Off-Keying (OOK) techniques to modulate the signal in accordance with information from the camera.

#### 3.3.2.5 The receiver shall demodulate the signal to display the video.

#### 3.3.2.6 The receiver shall be powered by a portable power supply.

## 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.

### Suspension Criteria

Testing will be suspended if the incidents found will not allow further testing of the system/application under-test. If testing is halted, and changes are made to the hardware, software or database, it is up to the Testing Manager to determine whether the test plan will be re-executed or part of the plan will be re-executed.

Incidents which would require suspension include:

* + Diode fails to transmit 5 mW of power.
  + Sensor is unable to detect signal from transmitter.
  + Raspberry Pi is unable to produce valid OOK modulated signal obtained from signal.
  + The signal is not properly modulated by Raspberry Pi.
  + The receiver is unable to demodulate signal and display video.
  + The receiver is unable to be powered by portable power supply.

### Resumption Requirements

Resumption of testing will be possible when the functionality that caused the suspension of testing has been retested successfully. Safety standards must also be addressed to ensure they are in line with entrance criteria.

# Execution Plan

## 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.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Requirement | Test Case Identifier | Input | Expected Behavior | Pass / Fail |
| 3.2.1 "The system shall communicate between a transmitter and receiver through optical form.” | 1.1 | Laser diode sends and photodiode receives data | Laser diode sends data that photodiode can read |  |
| 3.2.2 “The system shall output minimum 5mW from laser diode.” | 1.2 | Laser driver calibrated for 5mW transmission. | ThorLabs laser detector reads 5mW directly at diode. | Pass |
| 3.3.1 “The system shall utilize a Raspberry Pi camera for video capture.” | 2.1 | User provides input for camera | Camera can capture inputs |  |
| 3.4.1 “The system shall utilize a Raspberry Pi for encoding signal, using UART transmission standard, to the laser driver” | 3.1 | Camera video feed ported into Raspberry Pi | Video feed is encoded and fed to laser driver |  |
| 3.4.2 “The system shall use a Raspberry Pi to decode the received data into MJPEG video.” | 4.1 | Optical (laser) data into receiver | Camera feed from transmitter side in MJPEG video |  |
| 3.5.1 “The system shall be powered by battery power while in an independent state (moveable).” | 5.1 | 3300 mAH rechargeable lithium-ion battery | All components power off a single power source. |  |
| 3.6.1 “The system receiver shall utilize an amplifier to boost incoming signals from optical source.” | 6.1 | Data received at receiver from optical transmitter | Signal power boosted for better reading on display |  |

# Traceability Matrix & Defect Tracking

## Traceability Matrix

List of requirements, corresponding test cases

***Requirement* CRITICAL:** System requirements Specification, 3.2.1: "The system shall communicate between a transmitter and receiver through an optical form.”  
Test Case: Check the oscilloscope to observe the signal sent and compare to expected result.

***Requirement* CRITICAL:** System requirements Specification, 3.2.2: " The system shall output minimum 5mW from laser diode.”  
Test Case: Check the power level directly at laser diode using ThorLabs PM400 power meter.

***Requirement* CRITICAL:** System requirements Specification, 3.3.1: “The system shall utilize a Raspberry Pi camera for video capture.”

**Test Case:** Check for voltage and current being sent to Laser driver.

***Requirement* CRITICAL:** System requirements Specification, 3.4.1: “The system shall utilize a Raspberry Pi for encoding signal, using UART transmission standard, to the laser driver.”

**Test Case:** Check the signal being used for OOK modulation using oscilloscope.

***Requirement CRITICAL*:** System requirements Specification, 3.4.2: “The system shall use a Raspberry Pi to decode the received data into MJPEG video. “

**Test Cases:** Check signal with Oscilloscope to view serial data, Check reconstructed video stream on display.

***Requirement* MEDIUM:** System requirements Specification, 3.5.1: “The system shall be powered by battery power while in an independent state (moveable).”

**Test Case:** Check power usage for all system components does not exceed available power, Check voltage levels at valid locations along sub-systems.

***Requirement* MEDIUM:** System requirements Specification, 3.6.1: “The system receiver shall utilize an amplifier to boost incoming signals from optical source.”

**Test Case:** Check a boosted and non-boosted signal using oscilloscope to ensure proper amplification.

## 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:   * 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:   * 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:   * Repositioning of fields on screens * Text font on reports is incorrect |

# Environment

## Environment

* The System Testing Environment will be used for System Testing.
  + Software will be programmed using Python and Shell Script.
  + Raspberry Pi 4 Model B/4GB
  + USB-C Power Supply, 5.1V, 3.0A
  + 1550 nm, 5 mW Laser Diode
  + MenloSystems Laser Receiver ADP310
  + ThorLabs Laser Power Meter PM400
  + Oscilloscope
* All testing will be conducted in the MicaPlex lab (224), ensuring proper safety practices.

# Assumptions

This section outlines assumptions specific to this project:

* The system is tested in an enclosed space with proper safety equipment in place.
* The user understands how to correctly establish Line of Sight (LOS) between receiver and transmitter.
* The user understands how to properly set up the laser driver for operation.
* All sub-systems are properly connected.

# Risks and Contingencies

Define risks and contingencies.

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| --- | --- | --- | --- |
| Risk # | Risk | Impact | Contingency |
| 1 | Damage to the receiver | High Impact  We will not be able to proceed and must purchase a new receiver to complete most tasks | The receiver should be turned off when not in use and changing the setup will be done with careful handling of equipment |
| 2 | Damage to the diode or driver | High Impact  We will not be able to produce a signal with a damaged diode or driver and may have to change the entire configuration for new components | The driver should not push past 3V and no more than 5mW will be put through the laser at any point in time |
| 3 | Damage to group members' eyes | High Impact  Permanant damage to eyes from concentrated infrared exposure | The laser output shall not go above 5 mW and if it does eye protection will be worn |
| 4 | Laser sensor cannot operate at specified baud rate. | Medium Impact  Video is unable to display properly. | New sensors may need to be considered depending on issues with display. |
| 5 | System power consumption is too high. | Medium-High Impact  Excessive heat, which may become hazard or may damage components. | Systems may need to be reconsidered or redesigned to lessen these harmful effects. |

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