Hydrogen Line Telescope

Warren Herrington, Johanna Hein

**Interface Control Document**

REVISION – Draft

4 October 2021

Interface Control Document

for

Hydrogen Line Telescope

Prepared by:

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Author Date

Approved by:

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Project Leader Date

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

John Lusher II, P.E. Date

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

T/A Date

**Change Record**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Rev.** | **Date** | **Originator** | **Approvals** | **Description** |
| **-** | 10/4/2021 | Hydrogen Line Telescope |  | Draft Release |

Table of Contents

[Table of Contents III](#_Toc83663088)

[List of Tables IV](#_Toc83663089)

[No table of figures entries found. IV](#_Toc83663090)

[List of Figures V](#_Toc83663091)

[No table of figures entries found. V](#_Toc83663092)

[1. Overview 1](#_Toc83663093)

[2. References and Definitions 1](#_Toc83663094)

[2.1. References 1](#_Toc83663095)

[2.2. Definitions 1](#_Toc83663096)

[3. Physical Interface 1](#_Toc83663097)

[3.1. Weight 1](#_Toc83663098)

[3.1.1. Antenna 1](#_Toc83663099)

[3.1.2. Motorized Mount 1](#_Toc83663100)

[3.1.3. Main Control Unit 1](#_Toc83663101)

[3.2. Dimensions 2](#_Toc83663102)

[3.2.1. Dimension of Antenna Subsystem 2](#_Toc83663103)

[3.2.2. Dimensions of Motorized Mount Subsystem 2](#_Toc83663104)

[3.2.3. Dimensions of Main Control Unit Subsystem 2](#_Toc83663105)

[3.3. Mounting Locations 2](#_Toc83663106)

[4. Thermal Interface 2](#_Toc83663107)

[5. Electrical Interface 2](#_Toc83663108)

[5.1. Primary Input Power 3](#_Toc83663109)

[5.1.1. Stepper Motor Drivers 3](#_Toc83663110)

[5.1.2. Raspberry PI 3](#_Toc83663111)

[5.2. Voltage and Current Levels 3](#_Toc83663112)

[5.2.1. Maximum Values 3](#_Toc83663113)

[5.2.2. Stand-by Values 3](#_Toc83663114)

[5.3. Signal Interfaces 3](#_Toc83663115)

[5.3.1. Antenna 3](#_Toc83663116)

[5.4. User Control Interface 3](#_Toc83663117)

[6. Communications / Device Interface Protocols 4](#_Toc83663118)

[6.1. Wireless Communications 4](#_Toc83663119)

[6.1.1. Bluetooth 4](#_Toc83663120)

[6.2. Device Peripheral Interface 4](#_Toc83663121)

List of Tables

No table of figures entries found.

List of Figures

# No table of figures entries found.

# Overview

This Interface Control Document (ICD) details how the subsystems within the Hydrogen Line Telescope (HLT) interact. This document describes the interfaces between the antenna, motorized mount, control unit, and the graphical user interface (GUI). The ICD includes a physical description of the subsystem’s mass and dimensions as well as a description of the electrical interfaces including voltage and hydrogen emission inputs. Finally, this document explains the user’s interaction with the HLT through the GUI.

# References and Definitions

## References

Refer to section 2.2 of the Functional System Requirements document.

## Definitions

HLT Hydrogen Line Telescope

GUI Graphical User Interface

MHz Megahertz (1,000,000 Hz)

W Watt

V Volt

A Amp

mA Milliamp

TBD To Be Determined

HPBW Half Power Beamwidth

dBi Decibels Compared to Isotropic

SDR Software-Defined Radio

LNA Low Noise Amplifier

# Physical Interface

## Weight

### Antenna

|  |  |  |  |
| --- | --- | --- | --- |
| **Component** | **Weight** | **Number of Items** | **Total Weight** |
| Antenna Element | 3 kg | 4 | 12 kg |
| Antenna Backplane | 4 kg | 1 | 4 kg |
| Frame | 4 kg | 1 | 4 kg |

### Motorized Mount

|  |  |  |  |
| --- | --- | --- | --- |
| **Component** | **Weight** | **Number of Items** | **Total Weight** |
| Stepper Motor | 500 g | 2 | 1 kg |
| Frame | 12 kg | 1 | 12 kg |
| Control Electronics | 100 g | 1 | 100 g |

### Main Control Unit

|  |  |  |  |
| --- | --- | --- | --- |
| **Component** | **Weight** | **Number of Items** | **Total Weight** |
| Raspberry PI 4 B+ (with case) | 135 g | 1 | 135 g |
| Airspy Mini SDR | 21 g | 1 | 21 g |
| LNA | 14 g | 1 | 14 g |

## Dimensions

### Dimension of Antenna Subsystem

### Dimensions of Motorized Mount Subsystem

### Dimensions of Main Control Unit Subsystem

|  |  |  |  |
| --- | --- | --- | --- |
| **Component** | **Length** | **Width** | **Height** |
| Raspberry PI 4 B+ (with case) | 9.8 cm | 7 cm | 3.2 cm |
| Airspy Mini SDR | 7.7 cm | 2.6 cm | 1 cm |
| LNA | 7.5 cm | 2.5 cm | 1.5 cm |

## Mounting Locations

The HLT will be portable by two average adults and a vehicle. The HLT can be separated into two sections, the antenna and the motorized mount, for transportation. The user will be able to transport this system to any open area for hydrogen emission observations. The HLT will be able to be set up in any open area containing a stable, relatively flat surface for placing the motorized mount. When the user sets up the HLT on a relatively clear, open, area, the set-up process will calibrate the system and will level the antenna at that area preparing it for accurate emission observations.

# Thermal Interface

The Raspberry PI 4 B+ shall use a heatsink and fan to keep the temperatures within a safe operating range for this device and to prevent from decreased operating efficiency. The LNA and SDR will not need extra thermal interfaces to protect from overheating. The stepper motors and drivers shall make use of an aluminum extrusion frame and thermal compound to dissipate heat produced by the working DC motors.

# Electrical Interface

Graphical user interface

Description automatically generated

**Figure 4.  HLT Electrical Interface Diagram**

## Primary Input Power

### Stepper Motor Drivers

The Stepper Motors shall be powered with a voltage between 12 V and 24 V.

### Raspberry PI

The Raspberry PI shall be powered by 5 V from the HLT system’s portable battery. The Raspberry PI shall power the LNA and SDR.

## Voltage and Current Levels

### Maximum Values

|  |  |  |  |
| --- | --- | --- | --- |
| **Component** | Voltage[V] | Current[mA] | Power[mW] |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |

### Stand-by Values

|  |  |  |  |
| --- | --- | --- | --- |
| **Component** | **Voltage [V]** | **Current [mA]** | **Power [mW]** |
| Raspberry Pi | 5 |  |  |

## Signal Interfaces

### Antenna

## User Control Interface

The user control interface is a graphical user interface that will be run through Python. This GUI will communicate with the Raspberry PI via a Bluetooth connection. The user’s input will be used to select the mode of operation, scanning area, scanning time, and to view the resulting hydrogen line images.

# Communications / Device Interface Protocols

## Wireless Communications

### Bluetooth

The hydrogen line telescope will use Bluetooth to communicate between the user’s laptop and the Raspberry PI. The user will select from several mode options using the GUI, the Python script will then communicate those selections to the Raspberry PI to start the scanning process. Once the scan is complete, the Raspberry PI will send the collected and cleaned data back to the laptop for the final image processing and sky map overlay.

## Device Peripheral Interface

SDR and stepper motor drivers interfacing with the Raspberry PI