Hydrogen Line Telescope

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**Interface Control Document**

FIRST REVISION

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Interface Control Document

for

Hydrogen Line Telescope

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# 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 telescope 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

RPA Repeated Point Analysis

# Physical Interface

## Weight

### Antenna

|  |  |  |  |
| --- | --- | --- | --- |
| **Component** | **Weight** | **Number of Items** | **Total Weight** |
| Antenna Element | 1.125 kg | 4 | 4.5 kg |
| Antenna Backplane | 1.5 kg | 1 | 1.5 kg |
| Frame | 1.8 kg | 1 | 1.8 kg |

Table 1: Antenna Weight

### Motorized Mount

|  |  |  |  |
| --- | --- | --- | --- |
| **Component** | **Weight** | **Number of Items** | **Total Weight** |
| Linear Actuators | 1.5 kg | 2 | 3 kg |
| Frame | 1.8 kg | 1 | 1.8 kg |
| Control Electronics | 200 g | 1 | 200 g |

Table 2: Motorized Mount Weight

### 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 |

Table 3: Main Control Unit Weight

## Dimensions

### Antenna Subsystem

|  |  |  |  |
| --- | --- | --- | --- |
| **Component** | **Length [m]** | **Width [m]** | **Height [m]** |
| Antenna Element | 0.06 | 0.06 | 1.06 |
| Antenna Backplane | 0.91 | 0.91 | 0.0006 |
| Antenna Frame | 0.5 | 0.5 | 0.02 |

Table 4: Antenna Dimensions

### Motorized Mount Subsystem

|  |  |  |  |
| --- | --- | --- | --- |
| **Component** | **Length [m]** | **Width [m]** | **Height [m]** |
| Frame | 1 | 1 | 0.75 |
| Linear Actuators | 0.04 | 0.04 | 0.75 |

Table 5: Motorized Mount Dimensions

### 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 |

Table 6: Main Control Unit Dimensions

## Mounting Locations

The HLT will be portable by two average adults and a vehicle. The HLT can be separated into three sections, the antenna, motorized mount, and power supply, for transportation. 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 multiple heatsinks and a fan to keep temperatures within a safe operating range for this device and to prevent from decreased operating efficiency. The LNA and SDR will also use heatsinks as needed to prevent from overheating. The linear actuators 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 1: HLT Electrical Interface Diagram

## Primary Input Power

### Linear Actuators

The linear actuators shall be powered with a voltage of 12 V ± 20%.

### Raspberry PI

The Raspberry PI shall be powered by 5 V from the user’s vehicle power source. The Raspberry PI shall power the LNA and SDR.

## Voltage and Current Levels

### Maximum Values

|  |  |  |  |
| --- | --- | --- | --- |
| **Component** | **Voltage [V]** | **Current [A]** | **Power [W]** |
| Raspberry Pi 4B+ | 5 | 2.5 | 12.5 |
| Airspy SDR Mini | 5 | 0.3 | 1.5 |
| Linear Actuators | 12 | 2 | 24 |
| LNA | 12 | 0.12 | 1.44 |

Table 7: Voltage & Current Maximum Values

### Stand-by Values

|  |  |  |  |
| --- | --- | --- | --- |
| **Component** | **Voltage [V]** | **Current [mA]** | **Power [mW]** |
| Raspberry Pi | 5 | TBD | TBD |
| Airspy SDR Mini | 5 | 100 | 500 |
| Linear Actuators | 12 | 0 | 0 |
| LNA | 5 | TBD | TBD |

Table 8: Voltage & Current Stand-by Values

## Signal Interfaces

### Antenna

The antenna will solder to a SMA connector which will then connect to a coaxial cable from a 4-way power combiner. This cable will then feed into the LNA and subsequently the SDR.

## 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 network drive connection. The user’s input will be used to select the mode of operation, scanning area, scanning time. The GUI will also allow the user to view the resulting hydrogen line images.

# Communications / Device Interface Protocols

## Wireless Communications

### Wi-Fi

The hydrogen line telescope will use Wi-Fi to send data between the user’s laptop and the Raspberry Pi via a network drive. The user will be able to setup a hotspot for the network drive connection between the Raspberry Pi and the user’s laptop if needed. The user will select from several mode options using the GUI. The Python script will then communicate the route planning for that selection through the network drive 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

The SDR is controlled through USB from the Raspberry Pi. The Raspberry Pi will interface with the linear actuators.