GELIOSTAT-1

INTERFACE CONTROL DOCUMENT

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CHANGE LOG

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1. Introduction

1.1 Purpose

The stratospheric balloon mission has several interfaces. This document explains both external and internal interfaces required for the system.

1.2 Reference Documents

PBS and WBS are the main reference documents.

2. System description

System should support safe payload operations, collect telemetry and provide safe payload retrieval

3. Interface definition

3.1 Thermal control:

The balloon must ensure a stable temperature inside the cabicule , from 0ºC to 50 ºC (RF ISL Module).

Operating environment for P900RM from 0ºC to 40 ºC.

Storage P900RM: exposed to temperature above 50ºC or below -10ºC.

Storage battery of P900RM: the battery should be stored in location with an ambient temperature of 15ºC to 25ºC. Do not store the battery in hot or extremely cold locations.

Minimum ambient temperature: -56ºC.

2 temperature sensors: for inside and outside measurements.

Thermoisolations for saving heat.

3.2 Communications:

Amateur UHF band. 868 MHz.

Transmitted power of 31 dBm.

Receiver gain of 15 dB.

Gaussian Minimum Shift Keying (GMSK).

1000 km of range with 30 % packet error rate.

Frequency of transfer: 0.33 Hz.

Information for sending:

The temperature inside the balloon cubicle.

Position and altitude of the balloon cabine.

Battery state of charge.

The temperature outside the balloon cubicle.

Photos are done and saved on SD-card every 3 seconds.

3.3 Electrical

- connector for FSS
  - Standard DB-9 connector (pinout TBD)
- connector for P900RM
  - Power Adapter: EH-67A AC Adapter
- I/O power interface requirements for P900RM
  - Power Requirements: 3.8V/2A max
- I/O power interface requirements for FSS
  - Mean current consumption: 900.0 mA (4.5 W)
  - Max. current consumption: 1908.4 mA (9.5 W)
- Power consumption for P900RM
  - ~10W
  - Grounding and insulation
  - all the wires and PCB's should be grounded and isolated

3.4 Optical

- lens
  - focal length: 43-357 mm

3.5 Software

- operating system
  - Raspbian
- required libraries
  - Python 3.7
- compiler and build environment
  - Cpython
- memory
  - 1 GB of RAM

3.6 Structural

- Payload fixation cage
  - Tight rubber bands
  - Fixation basement
  - Cable rack
- Waterproof case
  - Aluminium frame
  - Warmth-keeping jacket
  - Water resistant layer
- Baloon
  - O-ring hooking
  - Emergency blow up system
- Access hatch
  - Handle
  - Sealing rubber bumper
- Launching system
  - hook
  - wing

3.7 Mechanical

- Size and mass
  - Storage
    - 3 kg
    - 500x500x500mm
  - Sky window
    - 100x100x100mm
  - Fixation cage
    - 150x110x500mm
  - Access hatch

- 300x300x300mm

3.8 Data representation

- acquired data will be presented in table

3.9 Materials

- Case
  - Aluminum cleat
  - Polyurethane foam slabs
  - Polystyrene insulating slabs
  - Carbon sheets
  - Polythene film
  - Sheet organic glass
  - Rubber sheets
- Baloon
  - Synthetic latex
  - Double regular-lay rope
  - Steel hook

3.10 Environmental Interface

This section shows the effect of the environment on the mission trajectory and payloads integrity. During its mission, the payloads will be in constant contact with the atmosphere for a minimum period of 2 hours and the expected altitude ranges from 15-30 Km. Therefore, it is imperative to study the behaviour of the different atmospheric parameters as this will affect the functionality and safety of the payload. Table 1 shows the environmental interface.

Table 1 Environmental Interface

	Mission	**Payload 1**	**Payload 2**
Temperature	Min temperature: -56 °C at 15 000 m	Operating temperature [0ºC, 50ºC]	Operating temperature [0 ºC and +40 ºC]

Pressure	Min pressure: 1,2 kPa (1,2x10-2 bar, 9 Torr) at 30 000 m	-	-
Humidity	-	-	Humidity < 85%. The camera and the power equipment needs to be dry 100% of the time
Wind speed (gust)	Shall be accounted, especially at launch		

To account for the effect of the environment on our mission and its payloads, the weather forecasting at the launch day will be studied and analyzed in advance. In addition, the wind gust shall be taken into account to assure a safe launch.

Drag force plays a major role in determining the altitude and hence the duration of the flight. This covers two main segments, the ascending and the descending. In the first segment, the drag coefficient and the cross area of the balloon are the dominant factors. Whereas in the descending segment, mainly the drag coefficient and the cross area of the parachute affect the trajectory. The flight simulator will be built considering the effect of drag to predict the trajectory in terms of altitude and range.

On the other hand, the drag force also affects the descending rate. As a result, the approaching from the ground will be affected. This must be taken into consideration to assure one of the main requirements.

3.11 Coordinates and time

The stratospheric balloon is a subsystem within a constellation of three balloons that work together to achieve the goal of the scientific payload. Therefore, it is crucial that the balloon must be launched from the same point and at the same time as the other balloons in the constellation. To ensure that, the ground station will regulate the launch accordingly.

During the flight, periodic information about time and position will be sent to the ground station to keep tracking the balloon and the two payloads as mentioned in the data interface. To achieve that, the GNSS receiver will be installed onboard as seen in the mechanical interface section. GNSS provides accurate information about longitude, latitude, altitude and time. GNSS is also critical to determine the exact burst altitude to ensure the proper time of burst activation.

Finally, the GNSS will send exact coordinates location of the payload to the ground station. To serve this purpose and other purposes, the ground station will be equipped with an antenna installed at 45 of inclination as explained in the mechanical interface. Table 2 presents the interfaces discussed from the position and time point of view.

	Mission	**Payload 1**	**Payload 2**
Altitude	15 Km – 30 Km	-	-
Flight duration		Minimum of 2 hours	**-**
Launch	Balloons must be launch simultaneously from the same point		

Burst altitude	It must be determined to assure proper activation
Landing Coordinates	It must be determined precisely to easily recover the payloads

For a better study of the flight performance and the safety and functionality of the two payloads, MATLAB/Simulink will be used to predict the environment and build the flight simulator.

3.12 Lift

Helium is the main driver of the mission. In addition to its effect on the mechanical interface as discussed in the mechanical interface section, it also plays a role in determining the ascending rate and consequently the duration of the flight. The amount of helium shall be taken into account to achieve the requirement for the payload FSS (min. two hours of flight).

In addition to the first point, the lift-up velocity shall be 4 m/s as set by the mission requirement. Therefore, the helium amount shall be specified accordingly.