Payload Specification and Integration Plan

Carolina Infrasound

June 11, 2016

Payload Title: The Acoustic Background of the Stratosphere

Payload Class: Small

Payload ID: 2016-08

Institution: UNC Chapel Hill/Boise State University

Contact Name: Kayla T. Seiffert

Contact Phone: (336) 407-0602

Contact Email: seiffert@live.unc.edu

Submit Date: June 11, 2016

1 Mechanical Specifications

Flight Ladder Payload:	A box mounted on one rung of the flight ladder. It contains three infrasound microphones, one triaxial accelerometer, and a Ref Tek 130 digitizer.
Gondola Payload:	Equipment located on the HASP mounting plate on the gondola. It contains three infrasound microphones and an Omnirecs Data Cube digitizer.

The Flight Ladder Payload will be securely attached to one rung of the flight ladder. Final determination of the rung is at the discretion of CSBF, and will be chosen as to maximize the array aperture while minimizing the chance of striking the flight vehicle during launch. An attachment system was proposed to CSBF. The system consists of two 1500 lb test aluminum eye bolts secured to the Flight Ladder Payload box via nuts and washers affixed to 2x6" wooden backing plates. The attachment system will be brought to Palestine prior to the thermal/vacuum test, where CSBF engineers will evaluate it. Per our agreement with CSBF, they may either choose to utilize this attachment system, construct another one on site in Palestine, or require us to develop one to their specifications prior to arrival in Ft. Sumner. See Figures A1-A4 in Appendix A for mechanical drawings.

Acoustic/acceleration sensors, power supply, and digitizer will be located inside the hard shell box on the flight ladder. This equipment will be secured to the box via an internal backing plate. All objects will be fixed in place during flight, with no opportunity for shifting around. This is imperative because the box will rotate by 90 degrees as the flight ladder shifts from a horizontal to a vertical position during launch. In contrast to previous Carolina Infrasound flights, **no cables will run between the gondola and the flight ladder**.

The Gondola Payload will be attached to a small payload plate. It will be bolted to the plate using nuts, washers, and four threaded metal dowels. Three horizontal metal plates will act as attachment points. A non rigid outer envelope consisting of an inner layer of aluminized mylar, a middle layer of aluminum foil, and an outer layer of white tape will provide thermal control and reduce the effect of electronic interference. See Figure B-1 in Appendix B for mechanical drawings.

1.1 Weight of Payload

The total weight of the payload is a combination of instrumentation on the HASP mounting plate (see Table 1) and instrumentation on the flight ladder (see Table 2). The HASP mounting plate will support 2.1 $\pm$ 0.62 kg. The flight ladder will support 16 $\pm$ 1.8 kg.

1.2 Mechanical Drawings

Mechanical drawings with dimensions of the Flight Ladder Payload are shown in Appendix A. Mechanical drawings with dimensions of the Gondola Payload are shown in Appendix B.

1.3 Potential Hazards

Lithium batteries will be the energy source for the Flight Ladder Payload. In addition, each of the microphones will be powered by lithium batteries. Each battery yields a potential hazard if rupture were to occur via impact with the ground as the flight is terminated or in any other manner. The recovery crew should be aware of this hazard when removing our payloads. Recovery crew should be aware of the weight of the box on the flight ladder. In addition, the box may experience cracking upon impact and may expose sharp edges.

1.4 Other Relevant Mechanical Information

Flight train location and means of attachment for the Flight Ladder Payload will be determined in Palestine as mentioned above.

2 Power Specifications

The Flight Ladder Payload will not draw power from the HASP. The Ref Tek 130 digitiser will draw power from two 8 packs of Energizer Ultimate Lithium AA batteries wired in series to create a 24V battery. A RioRand LM2596 DC-DC buck converter is wired into the circuit in order to supply the Ref Tek with the 12V specification. Tests in the lab show that this battery design will power the system for 30 $\pm$ 1 hours. This gives us confidence that the digitizer will remain powered through at least the daylight portion of the flight. Energizer Ultimate Lithium 9V batteries will power the three microphones, and the accelerometer will be powered by a 2 pack of Energizer Ultimate Lithium AA batteries. We note that Energizer Ultimate Lithium batteries have a proven record of operation in the stratosphere during the HASP 2014 and 2015.

The Gondola Payload will draw power from the HASP. Voltage will be reduced from HASP output (28-32 V) to 18 V via a RioRand LM2596 DC-DC buck converter to power the Data Cube digitizer. This system was used successfully during the HASP 2014 and 2015 experiments. The maximum current draw of this system will be 37 mA at 30 V. See Table 3 for power draw details and Appendix C for a power supply diagram.

2.1 Measured Current Draw

The Ref Tek 130 had a measured current draw between 175 and 250 mA at 11.9 volts, depending on whether or not it was writing data to disk. The data sheet for the accelerometer indicates a 0.35 mA power draw, and field tests conducted in 2014 indicate a 9 volt battery will allow day long operation. Infrasound microphones have a 3.0 mA current draw at 9 volts, and have been operated on balloon flights lasting up to 29 hours. Flight ladder instrumentation will not draw power from the HASP. The Omnirecs Data Cube digitizer has a measured current draw of 29 mA when supplied with 38 volts.

2.2 Power System Wiring Diagram

See Appendix C.

2.3 Other Relevant Power Information

None at this time.

3 Downlink Telemetry Specifications

No data will be transmitted via downlink telemetry.

4 Uplink Commanding Specifications

Serial commands will not be used during flight. The only discrete command that will be issued is POWER ON.

5 Integration and Logistics

5.1 Date and Time of Arrival

The team will arrive at the CSBF facility in Palestine, Texas, on July 31st. We will depart on August 6.

5.2 Approximate Amount of Time Required

Based on the similarity of the Gondola Payload to previous years' payloads, we expect to integrate it with the HASP in less than 2 hours. Evaluating the Flight Ladder Payload attachment suitability and then constructing it at the Palestine facility may require up to two days. If this is the case, evaluation and construction will begin on August 1 and will be completed between the first and second thermal/vacuum tests (likely August 3). Flight ladder integration will take place at the CSBF facility in New Mexico. We expect it to take less than an hour.

5.3 Integration Team Leader Name and Email

Kayla Seiffert (seiffert@live.unc.edu)

5.4 Integration Participants

Kayla Seiffert (seiffert@live.unc.edu)
Ethan Dinwiddie (edinwidd@live.unc.edu)
Jonathan Lees (jonathan.lees@unc.edu)
Daniel Bowman (danny.c.bowman@gmail.com)

5.5 Definition of Successful Integration

The Gondola Payload must fall under 3 kg and not exceed a current draw of 0.5 A in order to be integrated with HASP. The HASP interface plate must be securely attached to the HASP gondola and all components firmly attached to the interface plate. The Flight Ladder Payload must be less than 50 lbs (22 kg) in weight to be approved by CSBF. All equipment must be securely attached to the metal plate inside of the box, and the designed battery system needs to generate energy efficiently. Integration will be considered successful when the above criteria are verified and when all sensors and loggers operate correctly throughout the thermal/vacuum test.

5.6 Integration Steps

5.6.1 Gondola Payload

1. Verify that weight and current draw are within HASP specifications (≤ 3 kg, ≤ 0.5 A)
2. Secure small payload plate to HASP chassis
3. Attach a 9 volt battery to each of the three infrasound microphones in the Gondola Payload
4. Turn on HASP power
5. Verify ACQ and GPS LEDs are flashing on Data Cube
6. Turn off HASP power

5.6.2 Flight Ladder Payload

1. Verify that box weight and dimensions are acceptable by CSBF
2. Assemble attachment system
3. Secure all equipment in their proper places inside of the box
4. Prepare microphones
   (a) Attach filters and tubing
   (b) Connect each to 9V lithium battery
   (c) Secure each microphone into place
   (d) Attach each microphone to digitizer signal cable
   (e) Attach signal cable to digitizer
5. Prepare accelerometer
   (a) Insert AA lithium batteries and turn on battery pack
   (b) Connect signal cable to digitizer
6. Insert AA lithium batteries into digitizer power system
7. Connect GPS to digitizer
8. Connect digitizer power system to digitizer
9. Connect iPod/iPhone interface to digitizer and open Ref Tek app
   (a) Verify GPS lock
   (b) Verify microphones and accelerometer are functioning properly
   (c) Start acquisition
   (d) Verify data is recording properly
10. Disconnect iPod/iPhone from digitizer
11. Ensure everything is in place, then close box

5.7 Checks to Determine Successful Integration

- Weight and power draw are of the Gondola Payload are within HASP specifications (≤ 3 kg, ≤ 0.5 A)
- Weight of Flight Ladder Payload is less than 22 kg
- Data acquisition is successfully started
- Infrasound and acceleration data are logged throughout the thermal/vacuum test

5.8 Additional LSU Personnel

We do not anticipate requiring additional assistance from LSU.

5.9 LSU Supplied Equipment that May Be Required

We plan on bringing all the equipment we require.

6 Tables

Table 1: Weight of Instrumentation on HASP Mechanical Interface Plate

Component	Quantity	Weight (per item) kg	Weight (total) kg	Uncertainty kg	Method
Instrument Enclosure and Attachment	1	1.0	1.0	0.50	Estimated
Data Cube	1	0.71	0.71	0.01	Measured
Data Cube GPS	2	0.073	0.073	0.0010	Measured
Microphone	3	0.060	0.18	0.01	Measured
Microphone Battery	3	0.004	0.012	0.001	Measured
Cabling	1	0.20	0.20	0.10	Measured
Buck Boost Converter	1	0.011	0.011	0.0010	Measured
Total			**2.1 ± 0.62**		

Table 2: Weight of Instrumentation on Flight Ladder

Component	Quantity	Weight (per item) kg	Weight (total) kg	Uncertainty kg	Method
Microphone, Battery and Enclosure	3	0.11	0.33	0.03	Measured
Interior Backing Plate	1	4.1	2.8	0.10	Measured
Accelerometer Battery	1	0.0040	0.0040	0.0010	Measured
Accelerometer	1	0.0013	0.0013	0.00010	Estimated
Ref Tek 130 GPS	1	0.91	0.91	0.01	Measured
Ref Tek 130 Digitizer	1	1.8	1.8	0.10	Measured
Flight Ladder Attachment System	1	1.8	1.8	1.0	Measured
Cabling	1	0.25	0.25	0.10	Estimated
Enclosure	1	7.7	7.7	0.50	Measured
Total			**16 ± 1.8**		

Table 3: Maximum Power Draw on HASP System

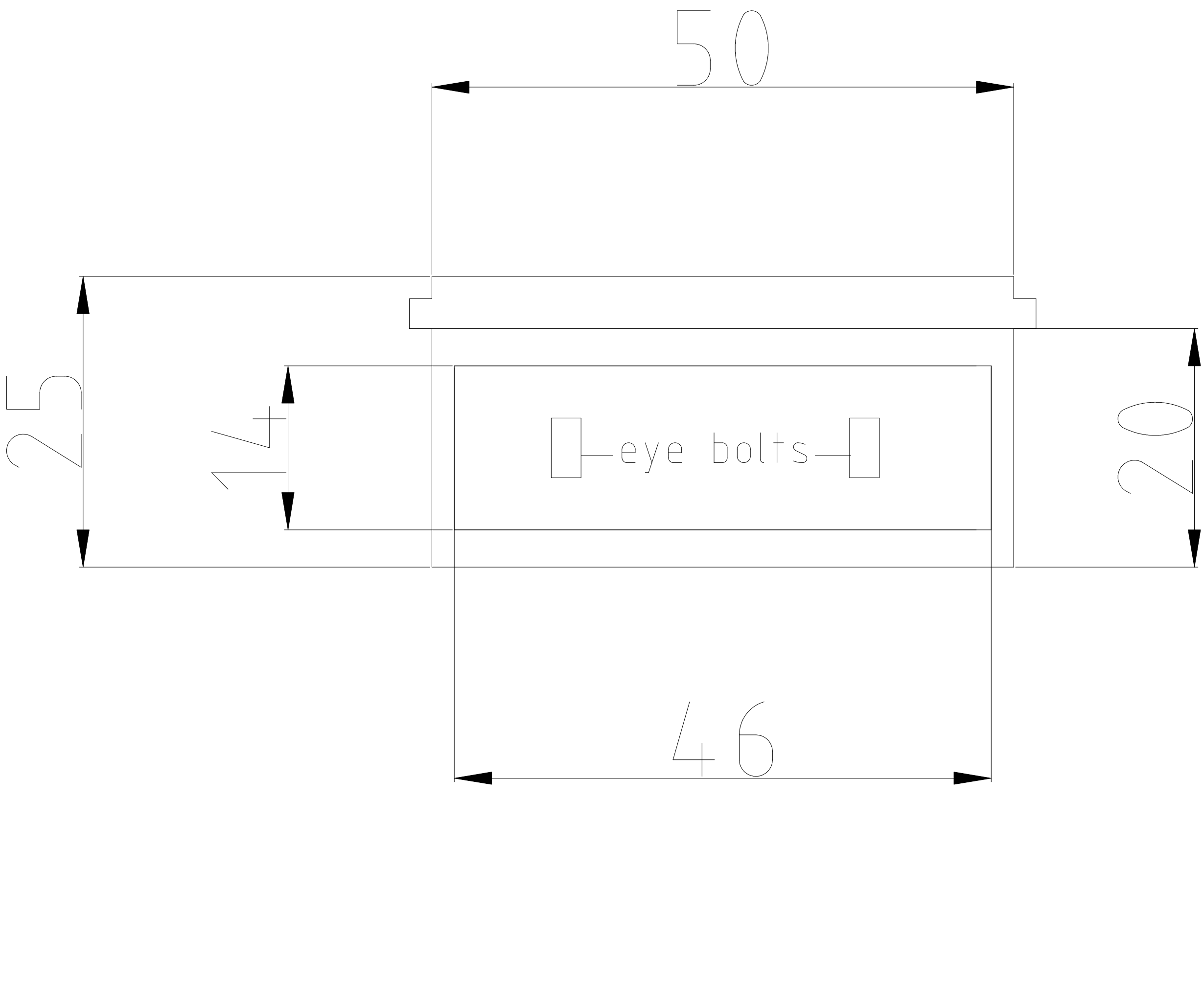
Component	Supplied Voltage V	Current mA	Power W	Method
Data Cube	38	29	1.1	Measured
Maximum		29	1.1	
Maximum Allowed			**15**	

Table 4: Flight Ladder Power Supply

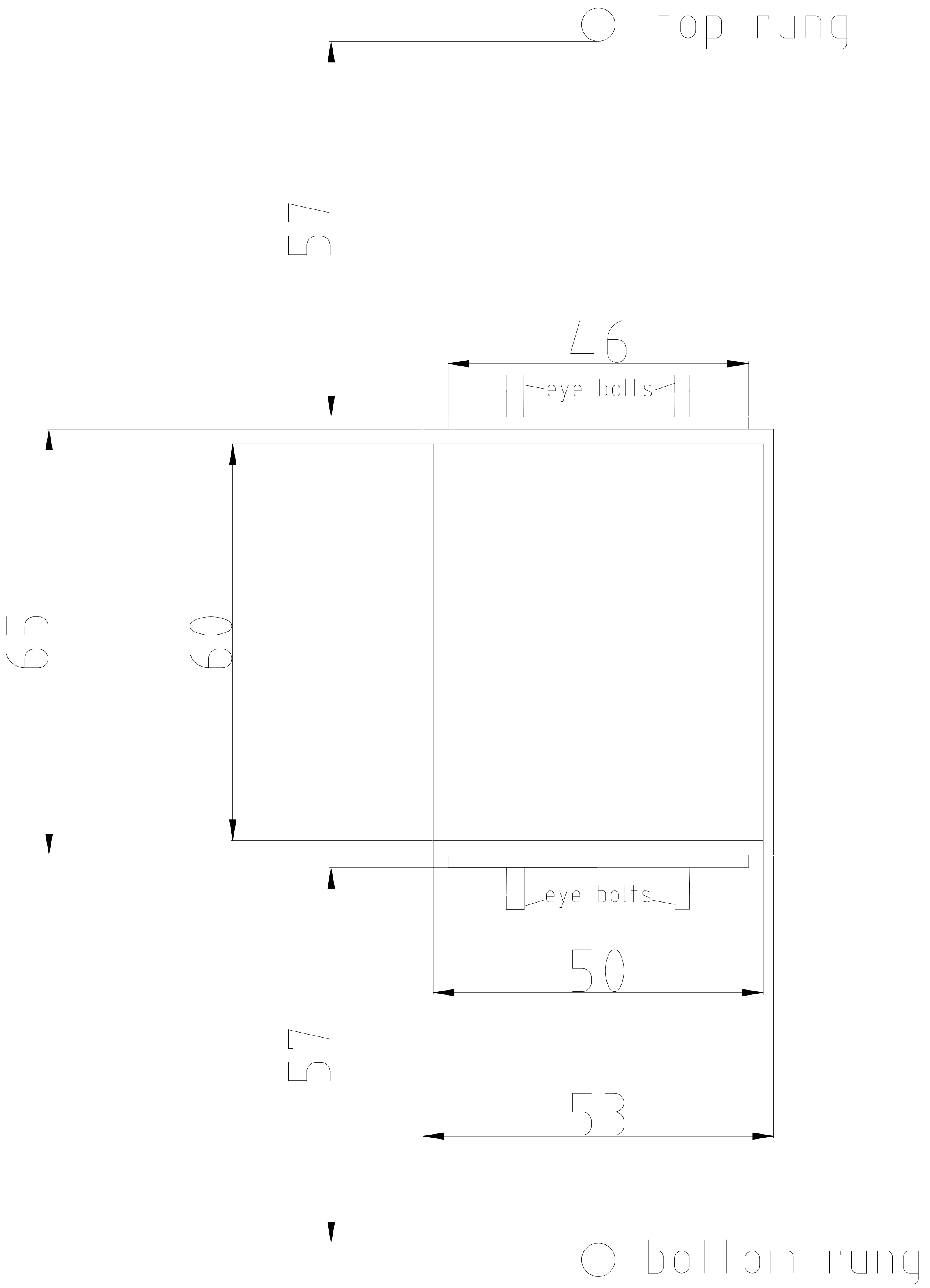
Component	Power Supply	Nominal Life Span h	Comments
Ref Tek 130	16 Lithium AA	30	Test of flight ladder power system in lab
Infrasound Microphone	9 Volt Lithium	120	Standard field deployment estimate
Accelerometer	2 Lithium AA	> 8	Based on field deployment in 2014

Appendix A: Mechanical Drawings of Flight Ladder Payload

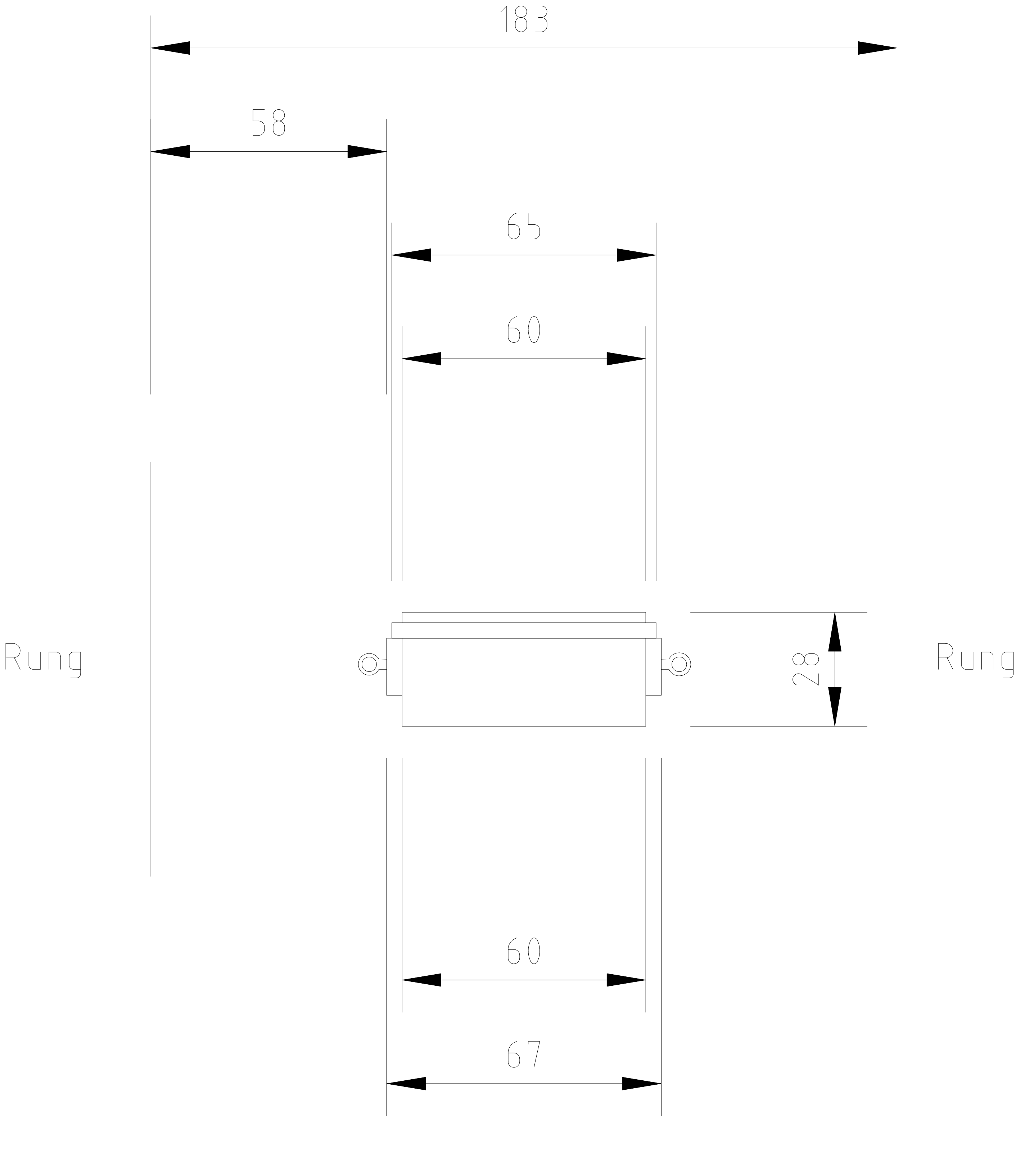
A1: Width of box (cm)



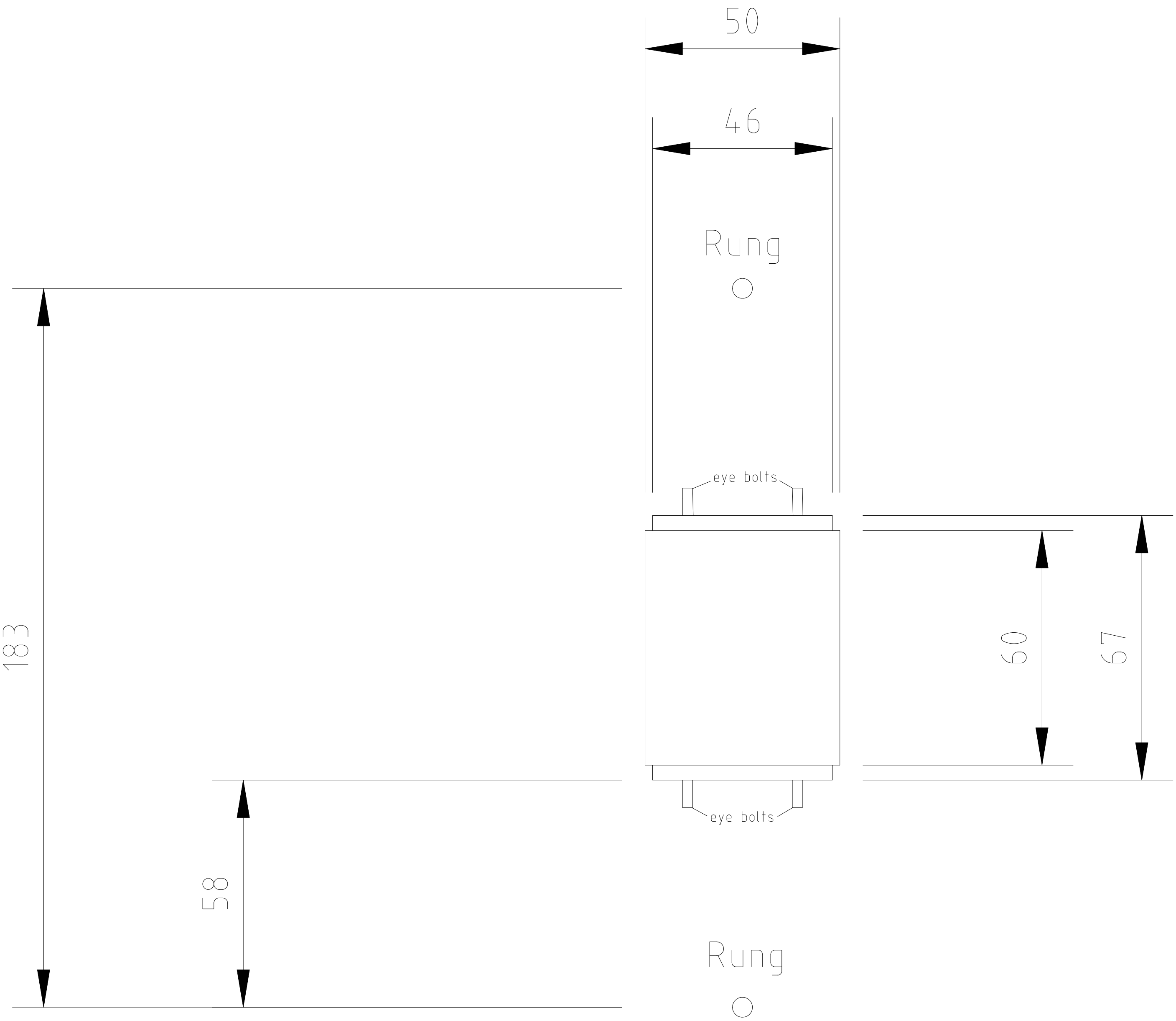
A2: Top of box (cm)



A3: Length of Box (cm)



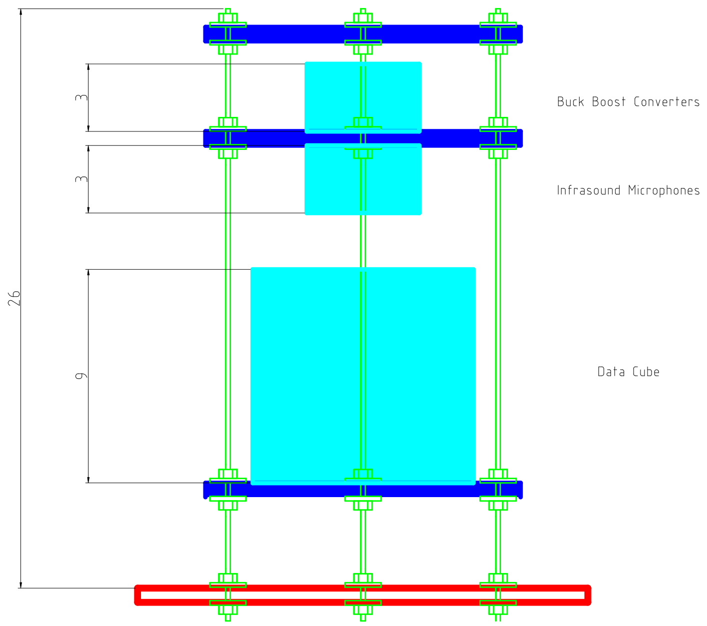
A4: Bottom of Box (cm)



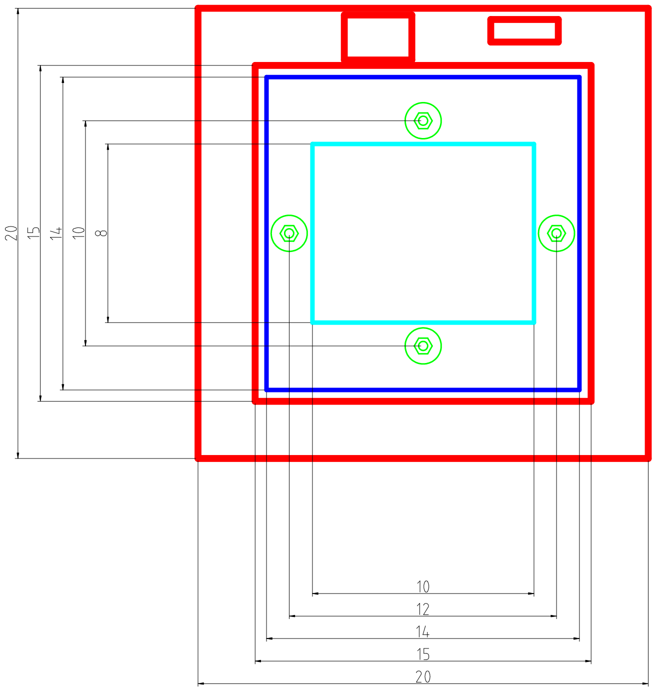
Appendix B: Mechanical Drawings of Gondola Payload

B-1:
Payload Attachment System (cm)

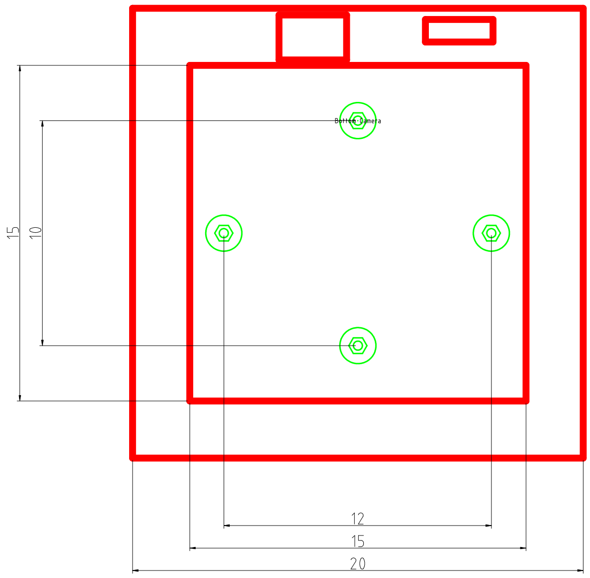
Payload Attachment
Side View



Payload Attachment
Top View



Payload Attachment
Bottom View



Appendix C: Gondola Payload Power System

C-1: HASP Power Diagram