Preliminary Payload Specification and Integration Plan

Carolina Infrasound

April 24, 2015

Payload Title: Quantifying Atmospheric Infrasound with a Free Flying Acoustic Network

Payload Class: Large

Payload ID: 2015-11

Institution: UNC Chapel Hill/NC State University

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1 Mechanical Specifications

Motion Logger 1:	This is located on the HASP mounting plate on the gondola. It records motion and location of the gondola using microcontroller, GPS logger and accelerometer.
Motion Logger 2:	This is located on the flight ladder. It logs wind speed and motion of the flight ladder rung near the microphone using similar components as Motion Logger 1 along with an anemometer.
Payload 3:	Five differential pressure transducers mounted on separate rungs of the flight ladder.
Payload 4:	This is located on the HASP mounting plate on the gondola. It contains one differential pressure transducer, a six channel data logger for acoustic signals, and a GPS antenna.

Motion Logger 1 will be bolted to the HASP mounting plate through holes at each corner of its enclosure. The Ref Tek 130 data logger in Payload 4 will be secured with zip ties secured to eyebolts attached to the HASP mounting plate. This method was used to secure our data logger during the Carolina Infrasound HASP 2014 experiment as well. The Ref Tek GPS has mounting holes that will allow it to be bolted directly to the HASP mounting plate. The differential pressure transducer will be contained in a project box that is bolted to the HASP mounting plate. Cables will be secured using tape and zip ties. A thermal bag will enclose the used portion of the payload plate; the bag will be riveted to the plate along the edges of the payload area. See Figure B-1 in Appendix B for a mechanical drawing that shows the positions and attachment systems of each object on the mounting plate.

Motion Logger 2 and the five components of Payload 3 will be attached to flight ladder rungs using U-bolts. This method was used to secure infrasound microphones to the flight ladder during HASP 2014; the microphones remained secure throughout the flight. See Figure B-2 in Appendix B for a mechanical drawing outlining this attachment system. Objects on the payload plate will not exceed a height of 20 cm. If this information is insufficient, we are happy to provide additional drawings for the final draft of the PSIP.

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).

1.2 Mechanical Drawings

Mechanical drawings with dimensions are shown in Appendix B.

1.3 Potential Hazards

Lithium batteries in each microphone package of Payload 3, in the Motion Logger 1 enclosure, and in the Motion Logger 2 enclosure may rupture when the HASP gondola and flight ladder impact the ground at the end of the flight. For this reason, the recovery crew should be cautious when removing our payload.

1.4 Other Relevant Mechanical Information

A thermal bag will be attached to the mounting plate to provide thermal and solar protection for Motion Logger 1 and Payload 4. The bag will have a white exterior and insulating material on the interior. It will not provide structural support to the objects inside. Instrumentation on the flight ladder will be covered in white tape to prevent solar heating during flight.

2 Power Specifications

2.1 Measured Current Draw

Power for Motion Logger 1 will be supplied by HASP. Motion Logger 1 uses a buck boost converter to reduce voltage from HASP input to 5 volts; this was tested between 6 and 38 volts. The current draw of the accelerometer and Arduino data logger in Motion Logger 1 is 100 mA at 32 volts. During the test, the logger was recording GPS data at 5 Hz and accelerometer data at 20 Hz. A GPS lock was present.

HASP power will also be used for Motion Logger 2. It uses a buck boost converter to reduce voltage from HASP input to 5 volts; this was tested between 6 and 38 volts. The current draw of the accelerometer, anemometer, and Arduino data logger in Motion Logger 2 is 300 mA at 32 volts. During the test, the logger was recording GPS data at 5 Hz. Accelerometer and anemometer data were recorded at 100 Hz. A GPS lock was present.

Power for Payload 3 will be supplied using individual 9 volt lithium batteries. These batteries are identical to the ones used for infrasound microphones during the HASP 2014 experiment. They will allow up to several days of continuous microphone operation. No components of Payload 3 will draw power from HASP.

Power for the data logger in Payload 4 will be supplied through HASP via a buck boost converter contained in the Motion Logger 1 enclosure. The current of Payload 4 was tested for 70 minutes using a 37.8 volt source. During the test, the Ref Tek 130 data logger was configured for continuous GPS acquisition. It was logging six high gain channels at a sample rate of 500 Hz. These parameters will be used during the thermal/vacuum test and the flight. In addition, an Arduino Uno High Altitude GPS Shield was also connected to the power source. It was logging GPS data to a SD card and acquiring data from three analog pins at 1 Hz. The current draw was steady at 95 mA during the test, rising to no greater than 110 mA when the Ref Tek 130 was writing data to disk. The power draw was 4.2 watts. Since the Arduino will not be part of the payload during flight, this current and power draw represents a maximum. The infrasound microphone in Payload 4 will draw current from a 9 volt lithium battery as described in Payload 3 above. It will not draw from HASP power.

Our payload will draw less than 550 mA of current and less than 17.6 watts of power at all times. The nominal power draw will be less than 535 mA, only increasing to less than 550 mA when the Ref Tek 130 data logger dumps RAM memory to disk. The total current and power draw of the Carolina Infrasound experiment is summarized in Table 3.

2.2 Power System Wiring Diagram

See Appendix A.

2.3 Other Relevant Power Information

None at this time.

3 Downlink Telemetry Specifications

Table 4 depicts the format of the downlink serial data. This data will include a location bit which depicts if the data segment is for the payload on the ladder or the gondola, 62 time stamp bits, 66 bits of sensor data, and 8 checksum bits. This data packet will be transmitted every time new sensor data is collected (approximately every .2 seconds). It will take approximately .04 seconds to transmit all 19 bytes of each data packet.

4 Uplink Commanding Specifications

No uplink commands will be used.

5 Integration and Logistics

5.1 Date and Time of Arrival

The team will arrive at the CSBF facility in Palestine, Texas, on August 3rd. We will depart on August 8.

5.2 Approximate Amount of Time Required

The integration of the data logger with the HASP payload should take about one hour. Attaching Motion Logger 2 and Payload 3 to the flight ladder will take about three hours and will require the participation of CSBF staff. Flight ladder integration will take place at the CSBF facility in New Mexico.

5.3 Integration Team Leader Name and Email

Daniel Bowman (daniel.bowman@unc.edu)

5.4 Integration Participants

Daniel Bowman (daniel.bowman@unc.edu)
C. Scott Johnson

5.5 Definition of Successful Integration

The payload must fall under 20 kg and not exceed a current draw of 2.5 A in order to be integrated with HASP. The HASP interface plate must be securely attached to the HASP gondola and all components of Motion Logger 1 and Payload 4 must be firmly attached to the interface plate. Integration will be considered successful when the above criteria are verified and when all sensors and loggers operate correctly throughout the thermal/vacuum test. A successful serial transmission will transmit at 4800 baud as an entire packet and can be verified via the checksum. We will determine a default packet value which should be transmitted after successful mounting and the serial data will be checked against that value to make sure that all the sensor data is getting read and sent successfully.

5.6 List all Integration Steps

1. Verify that payload weight and current draw are within HASP specifications ($\leq$ 20 kg, $\leq$ 2.5 A)
2. Attach HASP interface plate to gondola
3. Insert 9 volt batteries into microphone on payload plate and microphones that will go on flight ladder
4. Attach flight ladder serial cable to HASP serial input
5. Attach flight ladder signal cable to RT-130 data logger on payload plate
6. Attach flight ladder signal/power cable from Motion Logger 2 to Motion Logger 1
7. Turn on HASP power
8. Verify that LED indicators on Motion Logger 1 and Motion Logger 2 are flashing
9. Verify that RT-130 data logger has begun acquisition
10. Verify that RT-130 GPS has lock
11. Use waveform monitor on RT-130 to verify 10 Pa pressure drop when Payload 3 microphones are lifted 1 m
12. Connect a DB9 serial connector from a computer to Motion Logger 1 to verify data is properly transmitting
13. Connect a USB cable from Motion Logger 2 to a computer to verify data is properly streaming

5.7 Checks to Determine Successful Integration

- Payload weight and power draw are within HASP specifications ($\leq$ 20 kg, $\leq$ 2.5 A)
- Motion Logger 1, Motion Logger 2, and RT-130 data logger begin acquisition when HASP power is turned on
- Serial data are transmitting from Motion Logger 1 to HASP
- Infrasound, acceleration, and wind speed data are logged throughout the thermal/vacuum test
- Serial data are acquired by HASP throughout the thermal/vacuum test

5.8 Additional LSU Personnel

We do not anticipate requiring additional assistance.

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	Method
Instrument Enclosure and Attachment	1	0.5	0.5	Estimated
Ref Tek 130	1	2.5	2.5	Measured
Ref Tek GPS	1	0.39	0.39	Measured
Microphone	1	0.060	0.060	Measured
Microphone Battery	1	0.004	0.004	Measured
Cabling	1	0.20	0.20	Measured
NC State Motion Logger 1	1	0.50	0.50	Estimated
Total			**4.2**	

Table 2: Weight of Instrumentation on Flight Ladder

Component	Quantity	Weight (per item) kg	Weight (total) kg	Method
Microphone	5	0.060	0.30	Measured
Microphone Battery	5	0.004	0.02	Measured
Microphone Enclosure	5	0.52	2.6	Measured
Payload to Array Cabling	1	1.0	1.0	Estimated
Array Riser Cabling	1	2.0	2.0	Estimated
Serial Cable	1	0.50	0.50	Estimated
NC State Motion Logger 2	1	0.50	0.50	Estimated
Total			**6.9**	

Table 3: Maximum Power Draw on HASP System

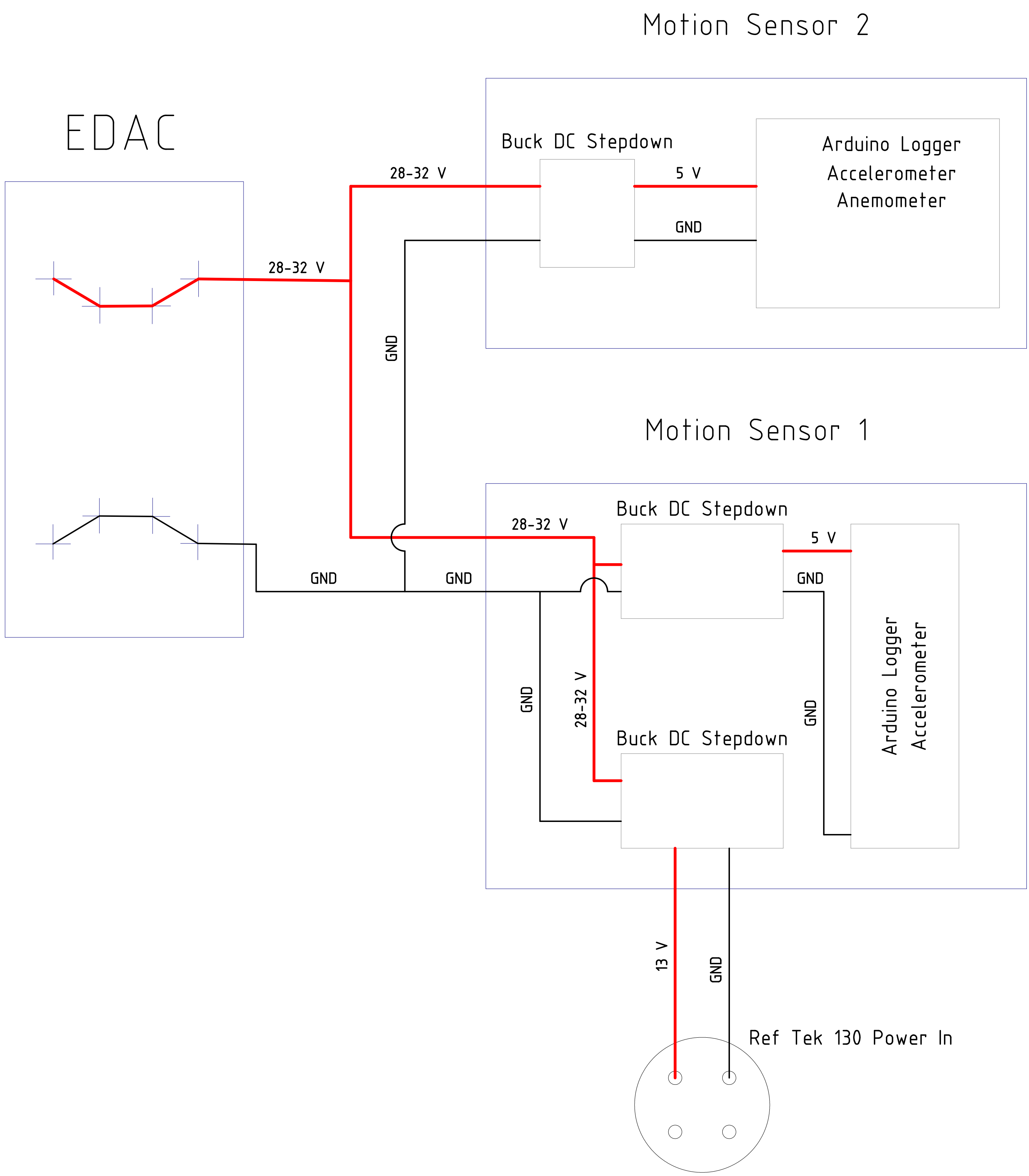
Component	Supplied Voltage V	Current mA	Power W
Motion Logger 1	32	100	3.2
Motion Logger 2	32	300	9.6
Payload 4	38	< 110	< 4.2
Maximum		< 510	< 17
Maximum Allowed		**2500**	

Table 4: Payload Data Format

Byte(s)	**Bits**	**Description**
1-9	0	Location (Ladder or Gondola)
	1-32	Timestamp (Seconds since January 1, 1970)
	33-71	Timestamp (nanoseconds past the last second)
10-18	0-15	Accelerometer Data (16-bit)
	16-31	Hotwire Anemometer Data (16-bit)
	32-47	Temperature Data (16-bit)
	48-71	Acoustic Data (24-bit)
19	0-8	XOR Checksum (Lower 8 bits)

Appendix A: Power Circuit

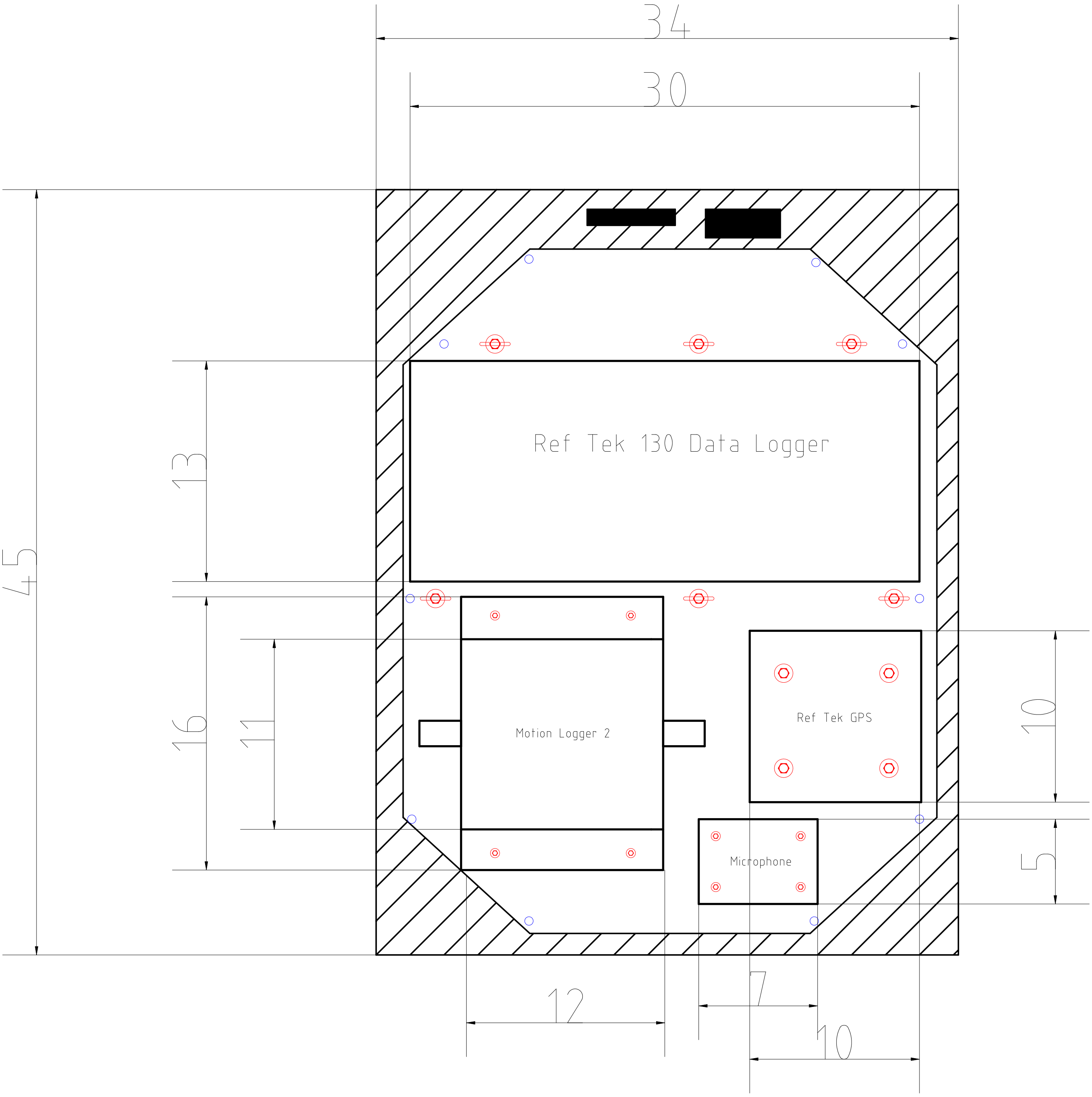
A-1: HASP Power Circuit



Appendix B: Mechanical Drawings

B-1: Gondola Attachment

Units: Centimeters



B-2: Flight Ladder Attachment

Units: Centimeters