HASP Payload Specification and Integration Plan

Payload Title: High Altitude Radiation Detector

Payload Class: [✓ Small] Large (circle one)

Payload ID: GU-HARD-PL02

Institution: Gannon University

Contact Name: Nichole McGuire and Dr. Wookwon Lee

Contact Phone: 412-519-5347 (Nichole), 814-871-7630 (Dr. Lee)

Contact E-mail: mcguire013@gannon.edu, lee023@gannon.edu

Submit Date: 6/22/12

I. Mechanical Specifications:

A. Measured weight of the payload (not including payload plate)

Table 1. Weights of the payload subsystems

Module name	Status	Mass (g)	Uncertainty (g)	Comments
Detector Module	Measured	220	±5	Measured 2 of 4, multiplied by 2
Rotator	Measured	61	±1	
GPS unit	Measured	170	-10	May remove some headers to decrease mass
Microprocessor and SD memory	Measured	40	±1	
Frame - styrofoam	Measured	138	±2	
Frame – aluminum + hardware	Calculated	607	±100	Calculated based on two 0.5 cm plates at bottom (overestimate) + estimate of hardware
Power circuit and comparator	Estimated	40	±10	Estimate based on existing circuit boards of similar size
Battery	Estimated	150	±50	Estimate based on existing 9.6V 8-cell batter pack (may be necessary to provide negative voltage to comparator)
Wiring/misc	Estimated	50	±20	Probably an overestimate
TOTAL		1476	±200	

B. Provide a mechanical drawing detailing the major components of your payload and specifically how your payload is attached to the payload mounting plate

Refer to Figures 1 ~ 3 below:

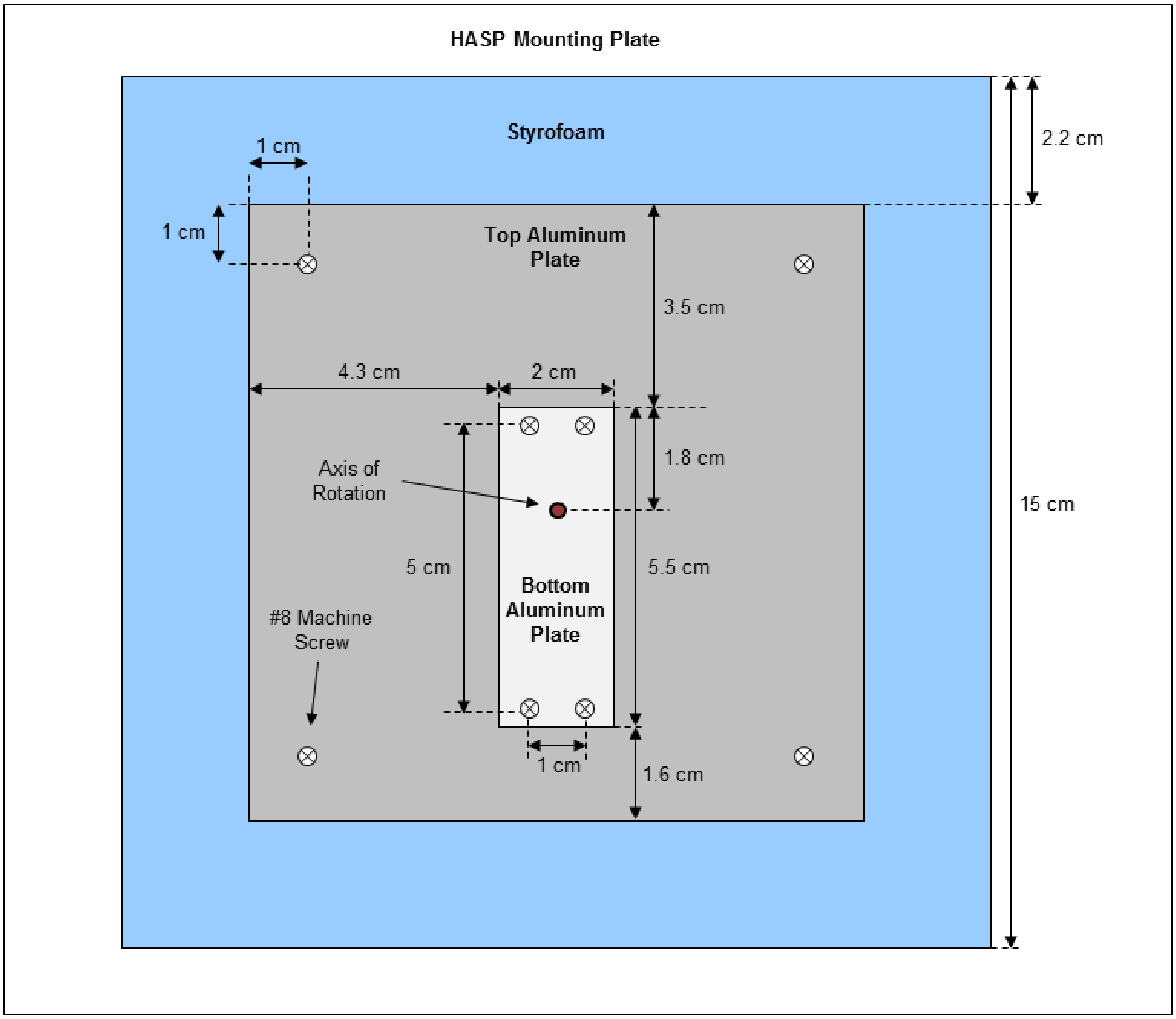


Figure 1 – The (empty) payload frame as viewed from above. While most of the frame is constructed of styrofoam, two aluminum plates will also be employed. The bottom plate will rest on top of the HASP mounting plate, while the top plate is cut out to allow room for the rotator motor (positioned to center the axis of rotation). Aluminum spacers will be used to prevent the styrofoam layer between the two plates from being crushed.

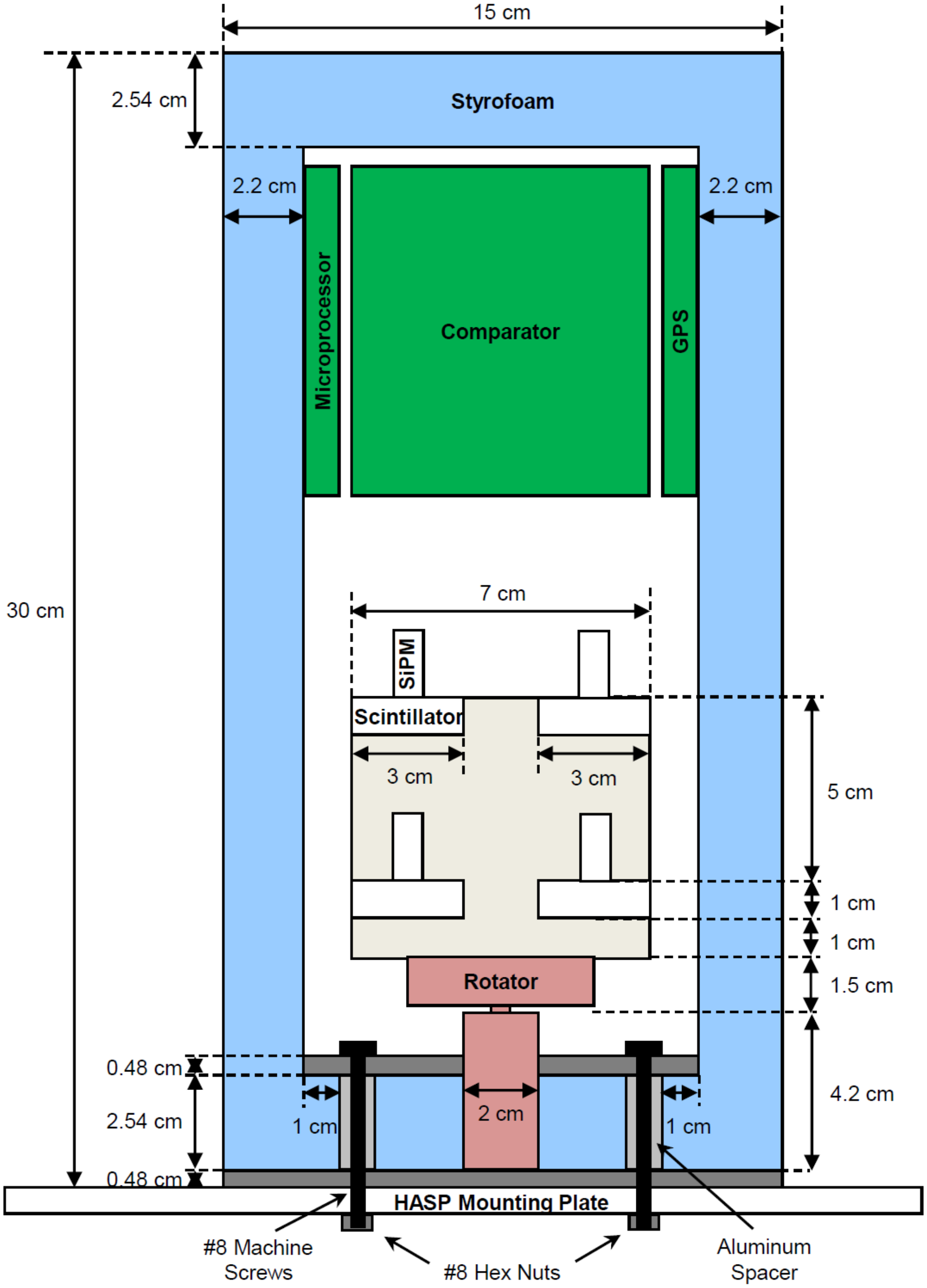


Figure 2 – Payload as viewed from the front. The top and bottom aluminum plates, as well as the aluminum spacers, are clearly visible. Four machine screws protrude from the bottom of the HASP plate, and are secured in place with hex nuts. The rotator is attached similarly, but the screws are not shown to make the drawing less cluttered. Electronics boards will be attached to the sides of the frame, near the top to avoid interfering with the rotation of the detector array.

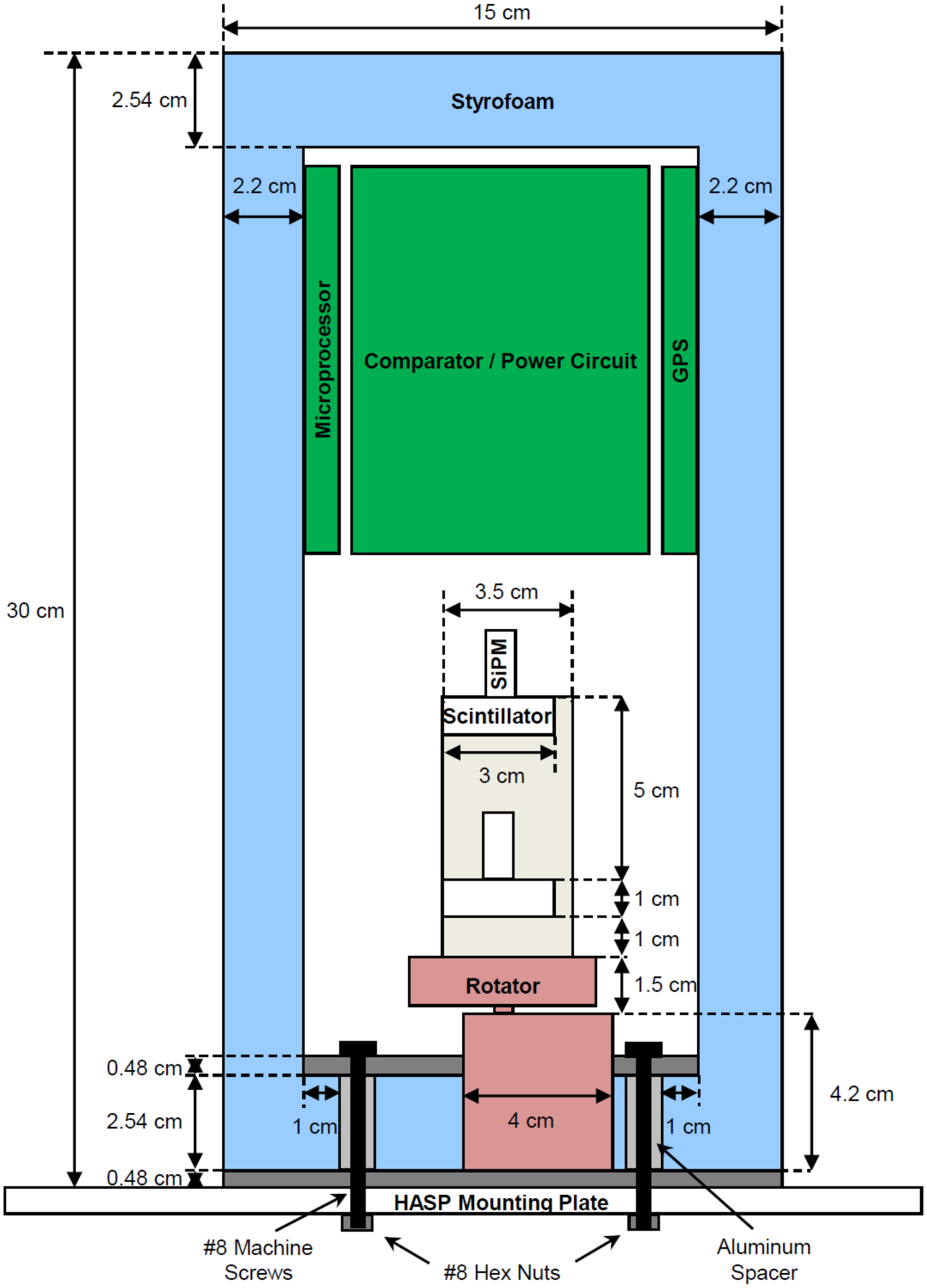


Figure 3 – Similar to Figure 2, except the payload is viewed from the side. Again, the screws to secure the rotator motor to the bottom aluminum plate have been omitted.

C. If you are flying anything that is potentially hazardous to HASP or the ground crew before or after launch, please supply all documentation provided with the hazardous components (i.e. pressurized containers, radioactive material, projectiles, rockets…)

None

D. Other relevant mechanical information

None

II. Power Specifications:

A. Measured current draw at 30 VDC

The following values are measured from each module or as a group of modules during normal operation.

Table 2. Current Draw at 30 VDC

Module name	Current (mA)	Voltage (V)	Power (W)
Detector Module	29.0	5.0	0.145
GPS unit	67	7.2	0.482
Microprocessor , rotator, e-Compass, and SD memory	88 (w/o servo operating) 130 (w/ servo operating)	7.2	0.936 (w/ servo operating)
Comparator (2 dual OP-AMP board)	8.1	+/- 2.5 (dual power)	0.040
Power circuit (resistor-based voltage divider)	100	29.0	2.9
TOTAL	**292 (w/o servo operating)** **334 (w/ servo operating)**		**4.503**

B. If HASP is providing power to your payload, provide a power system wiring diagram starting from pins on the student payload interface plate EDAC 516 connector through your power conversion to the voltages required by your subsystems.

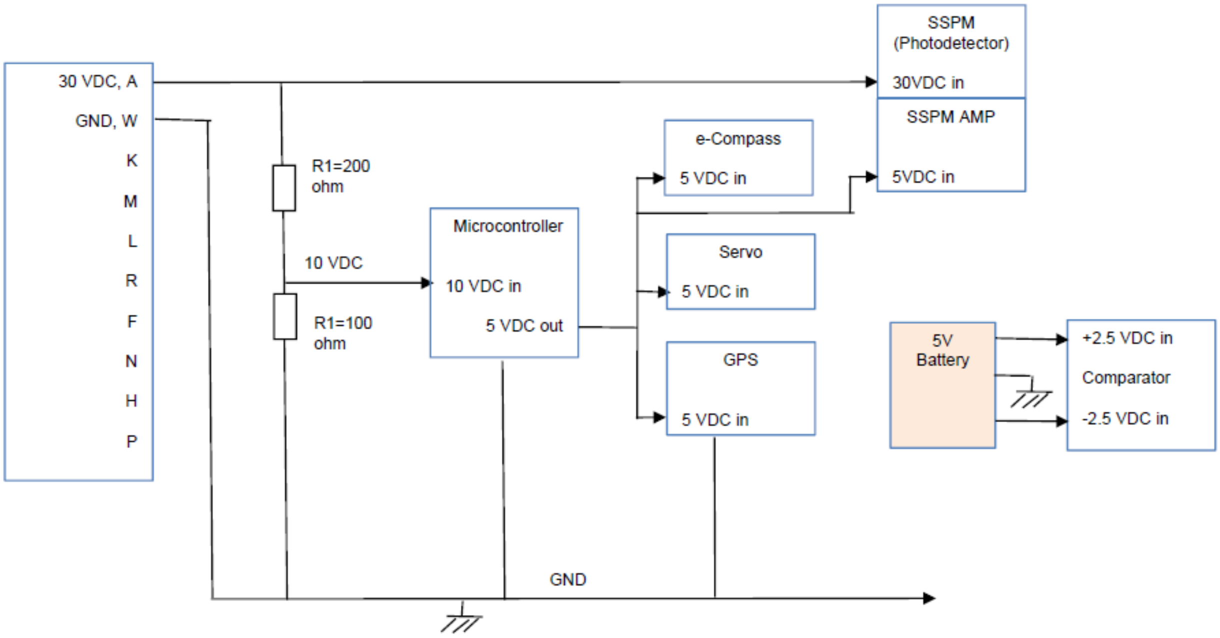


Figure 4 – Power system wiring diagram. The HASP 30 VDC is applied to the Detector Module (SSPM: Photodetector) and the Microcontroller board through a voltage divider to down-convert 30 VDC to 10 VDC. The Microcontroller board can output 5 VDC with a max. current of 800 mA. As approximately 29 VDC or higher is required for photodetectors, an additional 5 V battery is used to power up a dual-power supply OP amp (Comparator).

C. Other relevant power information

None

III. Downlink Telemetry Specifications:

A. Serial data downlink format: Stream [✓ **Packetized**] (circle one)

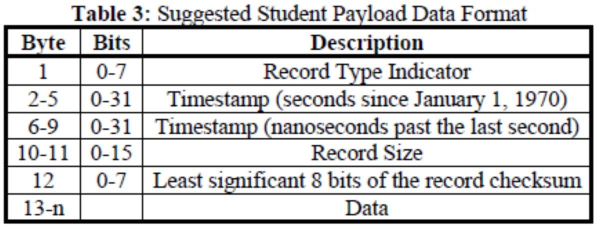
B. Approximate serial downlink rate (in bits per second)

Average bit rate: 2 bps (~19 bytes*8 bits per 2 min.)

C. Specify your serial data record including record length and information contained in each record byte.

For the header of the data packet, the HASP guidelines shown below are used. For the Data Field (i.e., after the Checksum Field), the following info will be collected every two minutes.

Table 3: Suggested Student Payload Data Format



Byte	Bits	Description
1	0-7	Record Type Indicator
2-5	0-31	Timestamp (seconds since January 1, 1970)
6-9	0-31	Timestamp (nanoseconds past the last second)
10-11	0-15	Record Size
12	0-7	Least significant 8 bits of the record checksum
13-n		Data

Table 4. Data Fields

Data field	# bytes	Comments
Counts of coincidences	3 bytes	To count an estimated hits of up to 2^19
e-compass angle in degrees	2 bytes	To count 0~360 degrees
Temperature (inside)	2 bytes	-50 ~ +125 degrees (9~12 bit precision)

Total: 7 bytes

D. Number of analog channels being used:

None

E. If analog channels are being used, what are they being used for?

N/A

F. Number of discrete lines being used:

N/A

G. If discrete lines are being used what are they being used for?

To power ON and OFF the payload (if not already provided by HASP)

H. Are there any on-board transmitters? If so, list the frequencies being used and the transmitted power.

No

I. Other relevant downlink telemetry information.

None

IV. Uplink Commanding Specifications:

A. Command uplink capability required: [✓ **Yes**] No (circle one)

B. If so, will commands be uplinked in regular intervals: Yes [✓ **No**] (circle one)

C. How many commands do you expect to uplink during the flight (can be an absolute number or a rate, i.e. *n commands per hour*)

No commands need to be sent if the payload downlink data indicate normal operation. In the case of abnormal operation, it is expected that around 3-5 commands would be sent per hour during the first couple of hours of flight.

D. Provide a table of all of the commands that you will be up-linking to your payload

All commands will be two bytes in hexadecimal, as required in the Interface Manual.

Command	Description	Hexadecimal Value
Reboot	**Reboot the Microprocessor**	**0x00 0x00**
Auto-rotation OFF	**Turn off auto-rotation**	**0x00 0xF0**
Auto-rotation ON	**Turn on auto-rotation**	**0x00 0x0F**
Rotate X	**Rotate the rotator by X degrees**	**0xFX 0xXX [see notes]**

[Notes] "XXX" represents an integral number in hexadecimal format for degrees ranging from 0 to 359 degrees that is initially represented by 12 binary bits (i.e., 9 bits for degrees and 3 leading 0's).

E. Are there any on-board receivers? If so, list the frequencies being used.

None

F. Other relevant uplink commanding information.

None

V. Integration and Logistics:

A. Date and Time of your arrival for integration:

Date of arrival (anticipated): 7/29/12, late evening

B. Approximate amount of time required for integration:

2 hours

C. Name of the integration team leader:

Nichole McGuire

D. Email address of the integration team leader:

mcguire013@gannon.edu

E. List **ALL** integration participants (first and last names) who will be present for integration with their email addresses:

Nichole McGuire	**mcguire013@gannon.edu**
Joseph Veneri	**veneri001@gannon.edu**
Aaron Neiman	**neiman001 @gannon.edu**
Dr. Wookwon Lee	**lee023@gannon.edu**
Dr. Nicholas Conklin	**conklin003@gannon.edu**

F. Define a successful integration of your payload:

Successful integration of our payload requires:

1) **Successfully mounting the payload onto the HASP frame**
2) **Proper connection of EDAC 516 and DB9 connectors to the payload**
3) **Successful operation of the payload using the 30 VDC HASP power**
4) **Successful communication with the SIP on up- and downlink**
5) **Passing the thermal & pressure (T&P) test with a select set of test cases from steps 3 & 4 successfully performed during & after the T& P test**

G. List all expected integration steps:

The payload will not be sealed until integration is successfully completed. All unit and integration tests for payload components will be successfully completed before shipping the payload to the launch site.

- **Connect the EDAC 516 connector to the payload.**
- **Connect the DB9 Serial Connector to the payload.**
- **Test power on and off of the payload through the HASP-provided commands**
- **Test serial communication through DB9 pins 2 and 3**
- **Test the operation of all subsystems in reference to predetermined test cases [Details of test cases and expected numerical results will be provided to HASP team before the integration test takes place]**
- **Seal the payload with Kapton tape**

H. List all checks that will determine a successful integration:

- **Ensure proper operation of Detector Module by collecting cosmic-ray events for ~5 minutes to ensure the rate is consistent with previous measurements.**

- **Ensure operation of rotator module and electronic compass through rotation of the e-compass and also through uplink commands.**

[Details of test cases and expected numerical results will be provided to HASP team before the integration test takes place]

I. List any additional LSU personnel support needed for a successful integration other than directly related to the HASP integration (i.e. lifting, moving equipment, hotel information/arrangements, any special delivery needs…):

None

J. List any LSU supplied equipment that may be needed for a successful integration:

- **30 Volt DC power supply**
- **5 Volt DC power supply (to substitute the 5 V battery)**
- **2 Multimeters**
- **One 4-channel Oscilloscope with prober probes and cables**
- **Soldering tools**
- **Tools for securing payload to the HASP frame**