HASP Payload Specification and Integration Plan

Payload Title: UHF-Band Video-Streaming Payload

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

Flight Number: 2023 – 12

Institution: Gannon University

Contact Name: Dr. W. Lee; Andrew Snowdy

Contact Phone: (814) 746-6903 (Lee's cell); (716) 228-7038 (Andrew's Cell)

Contact E-mail: Lee023@gannon.edu; Snowdy001@gannon.edu

Submit Date: 6/30/2023

I. Mechanical Specifications:

A. Measured weight of the payload in grams (not including payload plate): 5.2kg

Item	Mass (g)	Uncertainty	Measured or Estimated
Enclosure (with lid)	2460	0	Measured
CPU/motherboard	926	0	Measured
DC-DC converter 1	280 x 2 = 560	0	Measured
DTA2115B	320	0	Measured
VHF Power Amplifier	42	0	Measured
R-Pi	42 x 2 =84	0	Measured
Camera	60 x 2 = 120	0	Measured
Ethernet switch	104	20	Measured
Cables	600	100	Partially Measured; partially estimated
TOTAL	**5236**	**120**	

B. Provide a mechanical drawing detailing the major components of your payload. Mechanical drawings detailing the attach points from the payloads to the payloads plate are required.

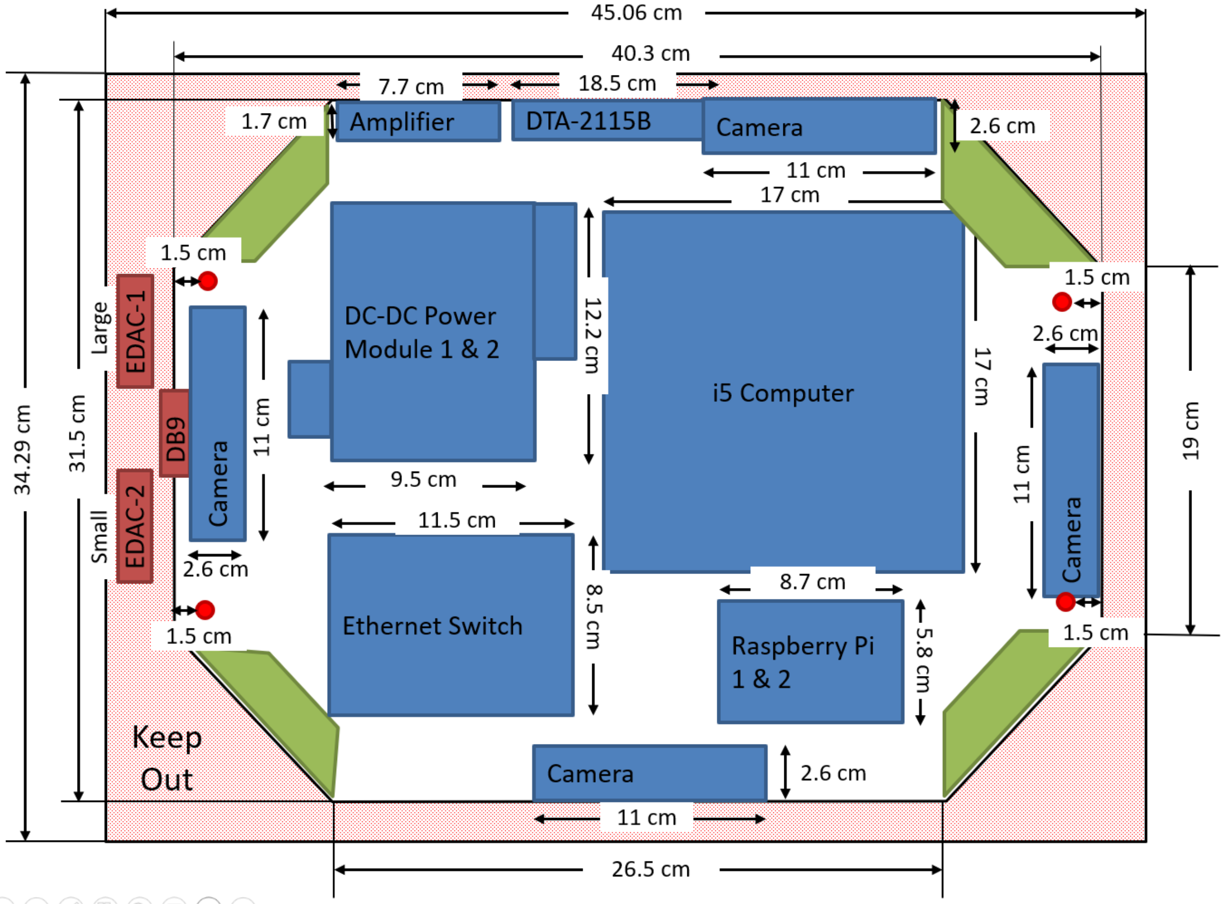

Figure 1 – The payload is shown in a top-down perspective. The frame consists of an aluminum plate (in white), Styrofoam corners (green) and a thin aluminum shell (not depicted). All components contributing to the system are labeled in blue. This payload is mounted on top of a HASP mounting plate (in red) using four 10-24 machine screws. All electronics are mounted to the plate with through-hole 6-32 machine screws. EDAC-1 is from payload seat 12 and EDAC-2 is from payload seat 8.

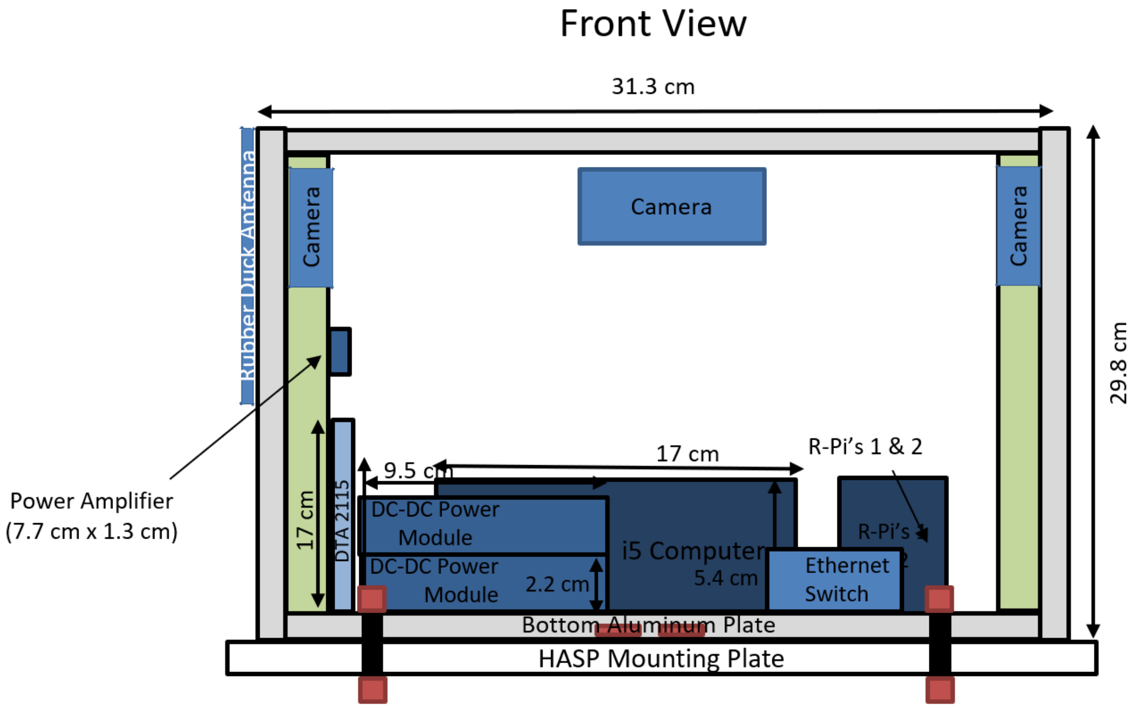

Figure 2 – Front view of the payload (EDAC and DB9 facing out of screen) with four 10-24 machine screws from the aluminum platform to the HASP mounting plate. All labeling stands from Figure 1, with the addition of red and black bolts.

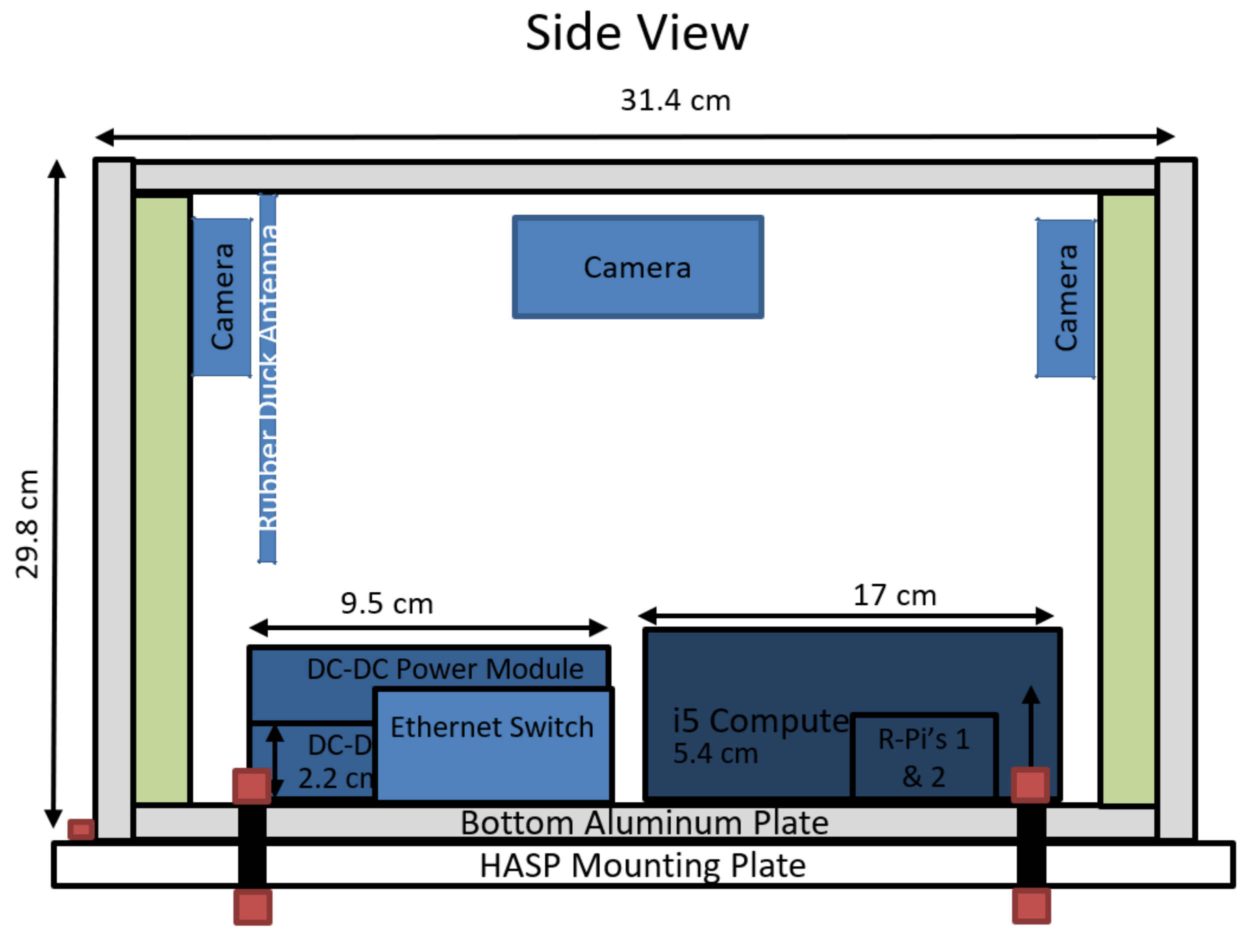

Figure 3 – Side view of the payload (EDAC and DB9 in bottom left) Cameras may shift around but are tentatively put in place. Styrofoam is shown in green, however will only be in corner (see figure 1)

C. Other relevant mechanical information

None

II. Power Specifications:

A. Measured current draw at 30 VDC: 1.75 A

EDAC-1 (large payload seat 12)

Measured current draw at 30 VDC: 0.33 A

EDAC-2 (small payload seat 8) for the following subsystems.

A. If connectors providing power to your payload, provide a detailed power system wiring diagram starting from pins on the student payload interface plate EDAC 516 connector to all major components of your payload. All voltage lines must be labeled, and any power converters must be documented.

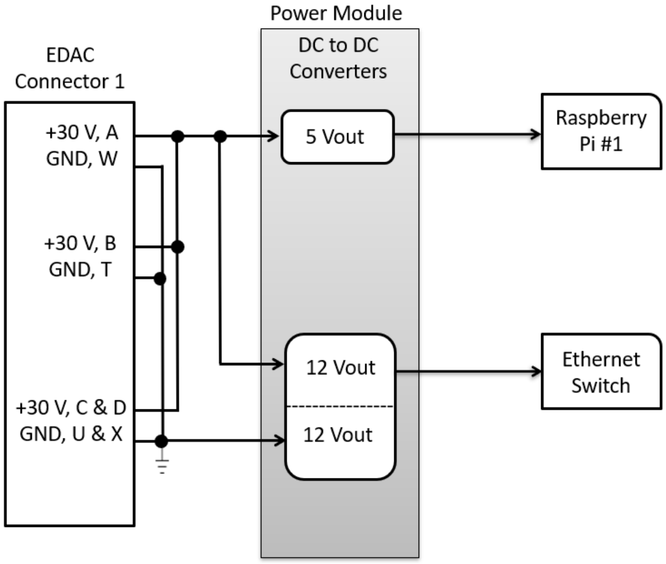

Figure 4 - Power system wiring diagram. EDAC pins that are not shown in the diagram are not connected. This is from the "Small Payload" EDAC connector pins (labeled on the plate)

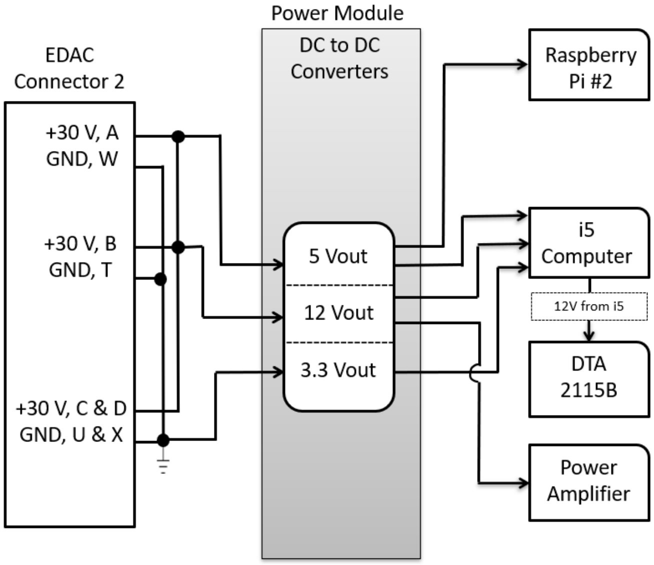

Figure 5 - Power system wiring diagram. EDAC pins that are not shown in the diagram are not connected. This is from the "Large Payload" EDAC connector pins (labeled on the plate)

B. 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): 67 bits / second (84 bytes max /10 sec)

C. Specify your serial data record including record length and information contained in each record byte. You must complete the table and include a sample data record.

A string to provide current system status (temperature, etc.) will be sent every 10 seconds. The format of this string is provided in the table below. Assuming a typical string length of ~75 characters (max. 84 bytes), we will transmit max. 504 characters per minute for a serial downlink rate of approximately 67 bits per second. The update interval can be changed to be more or less frequent as needed, but will never be shorter than 10 seconds.

Record Number	Record Item	# of Bytes	Description
1	Flag	1	Indicates the type of data record. ('A')
2	Record Length	2	Length of data record (in bytes) not including header
3	Record Frame #	4	Number of frames sent increments up from 0
4	Date and time	17	Date and time (Eastern Standard Time)
5	Temperature Sensor 0	3-5	Temperature of Temperature sensor 0 in Celsius
6	Temperature Sensor 1	3-5	Temperature of Temperature sensor 1 in Celsius
7	Temperature Sensor 2	3-5	Temperature of Temperature sensor 2 in Celsius
8	Temperature Sensor 3	3-5	Temperature of Temperature sensor 3 in Celsius
9	CPU Temp Pi 3	3-5	Temperature of Pi 3 CPU
10	CPU Temp Pi 4	3-5	Temperature of Pi 4 CPU
11	CPU Temp i5		Temperature of i5 CPU
12	Storage Size Pi 3	4-5	Size of system storage free in GB
13	Pi 4 computer status	2	Returns status of communication with Pi 4 (00 or 11)

14	i5 computer status	2	Returns status of communication with i5 (00 or 11)
15	Field separators	14	‘,’ at the end of each field for the fields 1~14 above
16	End of Record Flag	1	Indicates the end of the data record (‘Z’)
17	Carriage Return for new line	1	New line (‘\n’)
	Total	**(Max) 84 bytes**	**Total Record length will vary (less than the maximum)**

An example string is:

A,65,0001,06/20/23 01:01:01,25.2,25.1,25.4,25.1,37.3,39.7,45.1,17.3,11,11,Z

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: None

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

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

Transmitter Model	**Frequency**	**Transmitting Power**
Dektec’s DTA-2115B All-standard, all-band VHF/UHF modulator	442-448 MHz	Max. 24 dBm (0.250 W)

I. Other relevant downlink telemetry information.

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*): One command will be needed at the start of the flight to adjust the transmission power. An additional ~3 commands per hour may be needed to adjust payload parameters.

D. Provide a table of all uplink commands for your payload

Command Name	**2-Byte Command (Hex Format)**	**Command Description**
Reboot Pi 3	0x00 0x00	Reboot the Raspberry Pi 3
Reboot Pi 4	0x00 0x33	Reboot the Raspberry Pi 4
Reboot i5	0x00 0xCC	Reboot the i5 computer
Reboot System	0x00 0xFF	Reboot the Raspberry Pi 3, Pi4, and i5
Shutdown Pi 3	0x03 0x00	Shutdown the Raspberry Pi 3
Shutdown Pi 4	0x03 0x33	Shutdown the Raspberry Pi 4
Shutdown i5	0x03 0xCC	Shutdown the i5 computer
Shutdown System	0x03 0xFF	Shutdown Raspberry Pi 3, Pi4, and i5
Ping Pi 3	0x33 0x00	Request response to verify Pi 3 is on the network
Ping Pi 4	0x33 0x33	Request response to verify Pi 4 is on the network
Ping i5	0x33 0xCC	Request response to verify i5 is on the network
Ping All	0x33 0xFF	Request response to verify Pi 3, P4, and i5 are on the network
Get temperature	0xCC 0x00	Return values from all CPU and temperature sensors
Request last file	0xCC 0x33	Request name of last file written, and time written
Set update interval	0xCC 0xCC	Adjust the interval at which update data is sent through downlink. Values are 30, 60 and 120 seconds. [Default is 30 seconds]
Stop DTA-2115B	0xCC 0xFF	Terminate DTA-2115B operation & UHF transmission
Start DTA-2115B transmission with a specific configuration	0xFF 0xYY	Run “Atsc3Xpress.exe -f MySpecificConfigYY.xa3” The value of YY will select between 16 configuration files (see table below).

		A set of MySpecificConfigYY.xa3 files will allow selecting a different Tx power level (e.g., -30 dBm ~ **+24 dBm** for DTA-2115B+Power amplifier gain of max. 27dB)

Table of hex values to specify configuration number (indicated as YY in the table above). Selected values prevent single bit errors from selecting the wrong configuration.

Configuration Number	Binary	Hex
00	00000000	00
01	00000011	03
02	00001100	0C
03	00001111	0F
04	00110000	30
05	00110011	33
06	00111100	3C
07	00111111	3F
08	11000000	C0
09	11000011	C3
10	11001100	CC
11	11001111	CF
12	11110000	F0
13	11110011	F3
14	11111100	FC
15	11111111	FF

E. Are there any on-board receivers? If so, list the frequencies being used. No

F. Other relevant uplink commanding information. None

V. Integration and Logistics

A. Date and Time of your arrival for integration: Sun., 7/23/2023

B. Approximate amount of time required for integration: 0.5 hour

A portion of a day (~8 hours) may be required for checking payload connections for any physical damage prior to integration with the HASP frame.

Physical and electrical integration and testing of the payload functionality will require ~0.5 hour.

C. Name of the integration team leader: ___Zack Dickinson______

Email address of the integration team leader: Dickinso014@gannon.edu

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

Name	E-Mail Address	Phone Number
Wookwon Lee	Lee023@gannon.edu	(814) 746 – 6903
John White	White070@gannon.edu	(814) 823 – 7164
Sara Jones	Jones167@gannon.edu	(814) 779 – 1562
Zachary Dickinson	Dickinso014@gannon.edu	(412) 977 – 0363

E. Define a successful integration of your payload:

Successful integration of our payload requires:

1. Mount the payload onto the HASP frame.
2. Proper connection of both EDAC 516 and single DB9 connectors to the payload
3. Operation of all subsystems of the payload using the 30 Vdc HASP power
4. Successful communication with the HASP FCU on up- and downlink
5. Radio signal strength (RSS) and Carrier-to-Noise (C/N) radio at the receiver meet the expectations and subsequently legible HD videos are properly received from all four cameras.
6. Passing thermal & vacuum (T&V) test with steps 3 ~ 5 successfully performed during the T&V test; data received through the downlink serial and saved on Raspberry Pi's SD card are of good quality. (Note: this may/may not require unmounting our payload from the HASP, depending on remote login/ssh via Wi-Fi networks on site.)

F. List all expected integration steps:

All unit and integration tests for payload components will be successfully completed before shipping the payload to the CSBF site for T&V test. A few select integration tests will be performed prior to integration with HASP structure to verify payload functionality.

1. Connect the EDAC 516 connectors (small and large payload-equivalent) to the payload.
2. Connect the DB9 serial connector to the payload.
3. Test serial communication through DB9.

4. Test powering on and off the payload through serial communication.
5. Test other commands that may be used during the flight.
6. Examine data transmitted through the serial link, and data stored on R-Pi's SD cards to ensure proper payload operation.
7. Verify successful streaming of video to the ground station equipment (GSE).

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

   1. Payload powers on.
   2. Data is being transmitted as expected.
   3. Operation of the overall system using the 30 Vdc HASP power as expected

H. 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...):

   - Package reception - We will ship the payload and a Yagi antenna to CSBF in Palestine, TX.
   - Package shipping (if needed) from Palestine to Ft. Sumner unless the payload travels with HASP

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

   1. Two dual power supplies (0-30Vdc, 0-5A) – one for the payload and the other for a ground receiver.
   2. 2~3 digital multimeters
   3. An inverter generator with 15~25 feet outdoor power extension cord (or just a 25 ft power extension cord, if AC power outlets are available outside the thermal & vac. test building) to power our receiver side equipment mentioned below:

      We will bring a receiver (DTA-2131) + i5 computer (Lenovo nano m90n) with a PCIe slot + one portable monitor with an HDMI port + a set of keyboard & mouse (for testing the reception of video at the receiver which is not part of the payload). We will need AC power (mentioned in item 3) and an outlet of 12V DC power (mentioned in item 1).

VI. Hazards

A. Are you flying anything that is potentially hazardous, as listed in the Call for Proposal and the HASP Student Manual, to HASP or the ground crew before or after launch: [✓ Yes] No (Circle one) – DTA-2115B UHF modulator / transmitter.

Appendix A: NASA Hazard Tables

If you intend to fly a listed hazard on HASP, you must **fully complete** the appropriate hazard form and include the form on **both** the Preliminary PSIP and the Final PSIP. This documentation is required for NASA safety to clear your payload for flight. Be specific and as detailed as possible with the information requested.

Appendix A.1 Radio Frequency Transmitter Hazard Documentation

HASP 2022 RF System Documentation (for flight and thermal vac testing)	
Manufacture Model	Dektec DTA-2115B UHF
Part Number	DTA-2115B
Ground or Flight Transmitter	Flight
Type of Emission	Wireless UHF Omni-directional transmission
Transmit Frequency (MHz)	**442-448MHz**
Receive Frequency (MHz)	N/A
Antenna Type	Omni-directional antenna
Gain (dBi)	2 dBi (typical value for rubber duck omni-directional antennas)
Peak Radiated Power (Watts)	0.25W (24 dBm)
Average Radiated Power (Watts)	**0.25W (24 dBm)**

Appendix A.2 High Voltage Hazard Documentation

N/A

HASP 2022 High Voltage System Documentation	
Manufacture Model	
Part Number	
Location of Voltage Source	
Fully Enclosed (Yes/No)	
Is High Voltage source Potted?	
Output Voltage	
Power (W)	
Peak Current (A)	
Run Current (A)	

Appendix A.3 Laser Hazard Documentation

N/A

<table>
<tr><th colspan="4">HASP 2022 Laser System Documentation</th></tr>
<tr><td colspan="2">Manufacture Model</td><td colspan="2"></td></tr>
<tr><td colspan="2">Part Number</td><td colspan="2"></td></tr>
<tr><td colspan="2">Serial Number</td><td colspan="2"></td></tr>
<tr><td colspan="2">GDFC ECN Number</td><td colspan="2"></td></tr>
<tr><td colspan="2">Laser Medium</td><td colspan="2"></td></tr>
<tr><td colspan="2">Type of Laser</td><td colspan="2"></td></tr>
<tr><td colspan="2">Laser Class</td><td colspan="2"></td></tr>
<tr><td colspan="2">NOHD (Nominal Ocular Hazard Distance)</td><td colspan="2"></td></tr>
<tr><td colspan="2">Laser Wavelength</td><td colspan="2"></td></tr>
<tr><td colspan="2">Wave Type</td><td colspan="2"><i>(Continuous Wave, Single Pulsed, Multiple Pulsed)</i></td></tr>
<tr><td colspan="2">Interlocks</td><td colspan="2"><i>(None, Fallible, Fail-Safe)</i></td></tr>
<tr><td colspan="2">Beam Shape</td><td colspan="2"><i>(Circular, Elliptical, Rectangular)</i></td></tr>
<tr><td>Beam Diameter (mm)</td><td></td><td>Beam Divergence (mrad)</td><td></td></tr>
<tr><td>Diameter at Waist (mm)</td><td></td><td>Aperture to Waist Divergence (cm)</td><td></td></tr>
<tr><td>Major Axis Dimension (mm)</td><td></td><td>Major Divergence (mrad)</td><td></td></tr>
<tr><td>Minor Axis Dimension (mm)</td><td></td><td>Minor Divergence (mrad)</td><td></td></tr>
<tr><td>Pulse Width (sec)</td><td></td><td>PRF (Hz)</td><td></td></tr>
<tr><td>Energy (Joules)</td><td></td><td>Average Power (W)</td><td></td></tr>
<tr><td colspan="2">Gaussian Coupled (e-1, e-2)</td><td colspan="2"><i>(e-1, e-2)</i></td></tr>
<tr><td colspan="2">Single Mode Fiber Diameter</td><td colspan="2"></td></tr>
<tr><td colspan="2">Multi-Mode Fiber Numerical Aperture (NA)</td><td colspan="2"></td></tr>
<tr><td colspan="2">Flight Use or Ground Testing Use?</td><td colspan="2"></td></tr>
</table>

Appendix A.5 Battery Hazard Documentation

N/A

HASP 2022 Battery Hazard Documentation	
Battery Manufacturer	
Battery Type	
Chemical Makeup	
Battery modifications	*(Must be NO)*
UL Certification for Li-Ion	
SDS from manufacturer	
Product information sheet from manufacturer	