HASP Payload Specification and Integration Plan

Payload Title: StratoPigeon III

Payload Class: Small Large (circle one)

Payload ID: 5

Institution: **University of Maryland**

Contact Name: Connie Ciarleglio

Contact Phone: 202-441-0103

Contact E-mail: connie@nearspace.net

Submit Date: 4/20/2012

I. Mechanical Specifications:

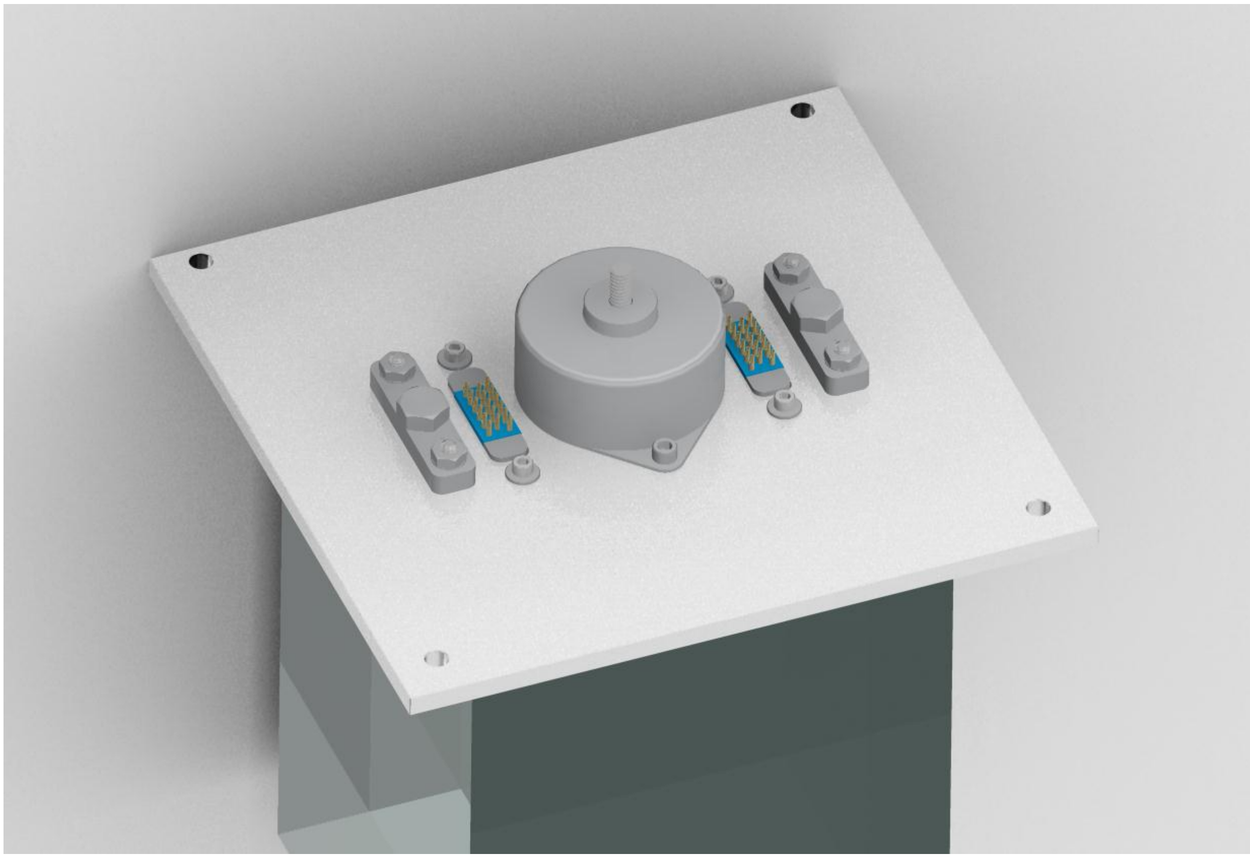
A. Measured weight of the payload (not including payload plate)

Component	Theoretical Mass (g)	Quantity	Measured Mass (g)	Max. Mass (g)	Margin of Error
Stepper Motor	100	1		105	5%
Motor Control Electronics+Box	400	1		480	20.00%
Payload Outer Casing	600	1		720	20.00%
Payload Inner Structure	400	1		480	20.00%
Battery	145	1	145	146.45	1.00%
Solid State Drive(s)	100	2		240	20.00%
Tracking Electronics	150	1		180	20.00%
Parachute and Tube	180	1		216	20.00%
Total				2567.45	
Total (Payload Only)				1742.45	

The above table represents measured quantities with a 1% error, quantities from technical documentation with 5% error, and approximate quantities with 20% error.

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

The payload will be mounted underneath the outrigger on the bottom-side of the payload plate.



A video of preliminary detachment method testing (with a dummy payload) can be seen at:

http://www.youtube.com/watch?v=RDbxEb-C_Q4

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…)

The UMD payload will be operated in a similar manner to an unmanned independent balloon flight. In order to keep our payload under FAR101 exemptions, we will be satisfying the following requirements relevant to our payload:

(4) Except as provided for in §101.7, any unmanned free balloon that—

(i) Carries a payload package that weighs more than four pounds and has a weight/size ratio of more than three ounces per square inch on any surface of the package, determined by dividing the total weight in ounces of the payload package by the area in square inches of its smallest surface;

(ii) Carries a payload package that weighs more than six pounds;

The payload itself is currently 4 lbs and will not be over 6 lbs in any scenario. With a 4 lb payload, payload density will be equal to 2.327 oz/in^2. This also meets the exemption requirements for the payload. Since the UMD payload can now be treated as an independent balloon flight, the FAA can be notified similarly.

The FAA will be notified of preliminary flight path and descent trajectory through our designated contact in the BPO flight crew (Bill Stepp). As per previous flight experience, all communication with the FAA will be done by CSBF personnel at the discretion of Bill Stepp. All requested information from the UMD team will be given to Bill Stepp and forwarded as needed. We will be using BalloonTrack for Windows distributed by EOSS to update our prediction of landing site and choosing a point to release our payload based on predicted landing site, and approval from the HASP/CSBF team. Updates during the descent period when the payload passes 60,000,30,000, and 15,000 ft will be passed from the UMD team to Bill Stepp during the flight.

The parachute for the UMD payload will be a 30" or 36" TopFlight Regular parachute, based on final measured payload weight. The target weight for the payload will allow use of the 30" parachute. These parachutes are rated for a specific descent rate of 15-20 ft/s at sea level. Based on drop testing and test flights with our payload, we will use the parachute to achieve descent rate of less than 20 ft/s. Ft Sumner is at an altitude of 4,165 ft above sea level which will also increase descent rate slightly.

The GPS for the UMD payload will be placed on the top of the payload itself and under the HASP plate. Based on previous flight experience, the Lassen IQ will be used for the payload. Since a single tracking unit will be used, a lock with the GPS is critical to success. No problems were encountered using the Lassen IQ in the last test flight, even with large amounts of metal and electronics sitting above the antenna. Testing will be done with the stepper motor to ensure a GPS lock is possible for complete assurance.

The payload will also be equipped with visual identification for recovery in case a recovery is not possible in a timely manner. A tag with UMD team contact information will be attached to one side in case the payload is located by someone other than the UMD or CSBF team.

Since there is a high likelihood the payload will land on private property after landing, a recovery plan is needed. A recovery team of 2 people will be sent out to retrieve the UMD capsule after release. If the payload is on private land, the location will be noted and sent back to UMD team members and CSBF personnel at the Ft. Sumner ground station. These team members will find the name and contact information for the land owner. The land owner will then be contacted for permission to enter the property and retrieve the payload.

D. Other relevant mechanical information

i. See Appendix A for engineering drawing measurements

II. Power Specifications:

A. Measured current draw (Total at 30V shown on Bottom)

i. We do not currently have all our components operational at 30V DC. The following is our current power budget:

Board	Component	Voltage (V)	Theoretical Worst Current Draw (mA)	Measured Current Draw (mA)	Max Current Draw (mA)	Margin of Error
Motor Control	MSP430	3.3	150		180	20.00%
Motor Control	Stepper	30	400	250	262.5	5.00%
Tracking	Radio	5	750	730	737.3	1.00%
Tracking	GPS	5	27		32.4	20.00%
Repeater	Radio	5	750	730	737.3	1.00%
Repeater	GPS	5	27		32.4	20.00%
Power Distribution	Relay	3.3	50		60	20.00%
SSD	SSD1	5	170	150	157.5	5.00%
SSD	SSD2	5	170	150	157.5	5.00%
Motor Control	Heater1	30	170		204	20.00%
Motor Control	Heater2	30	170		204	20.00%
Motor Control	Heater3	30	170		204	20.00%
				Total HASP Max Draw (@30V)	0.5**	Amps
				Total Battery Max Draw	0.3	Amps

				(@9.6V)		
				Average HASP Draw (@30V)	0.409	Amps
				Average Battery Draw (@9.6V)	0.2	Amps

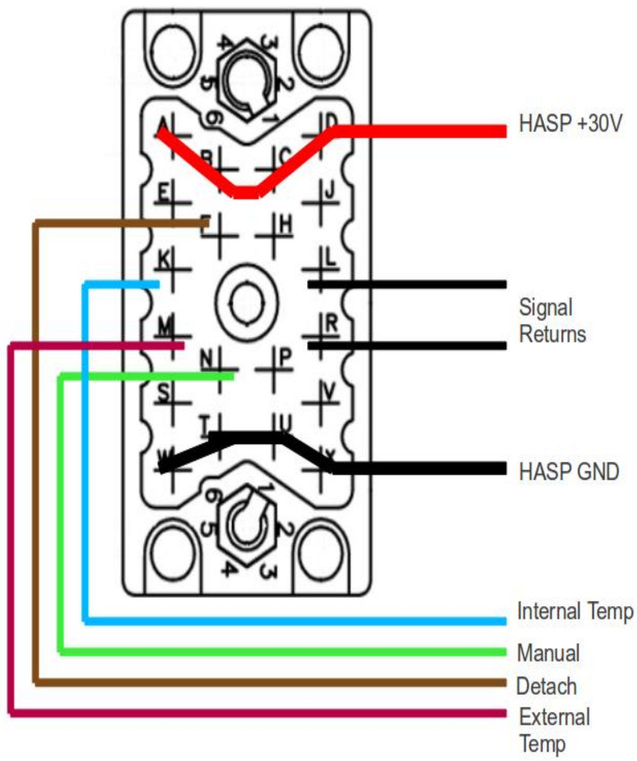
Margin of error for components in the above table is represented by 1% for measured, 5% for data sheet or components used by UMD in other applications, and 20% for approximate. The table is a summary of our full power budget which takes into account regulator efficiency and duty cycle.

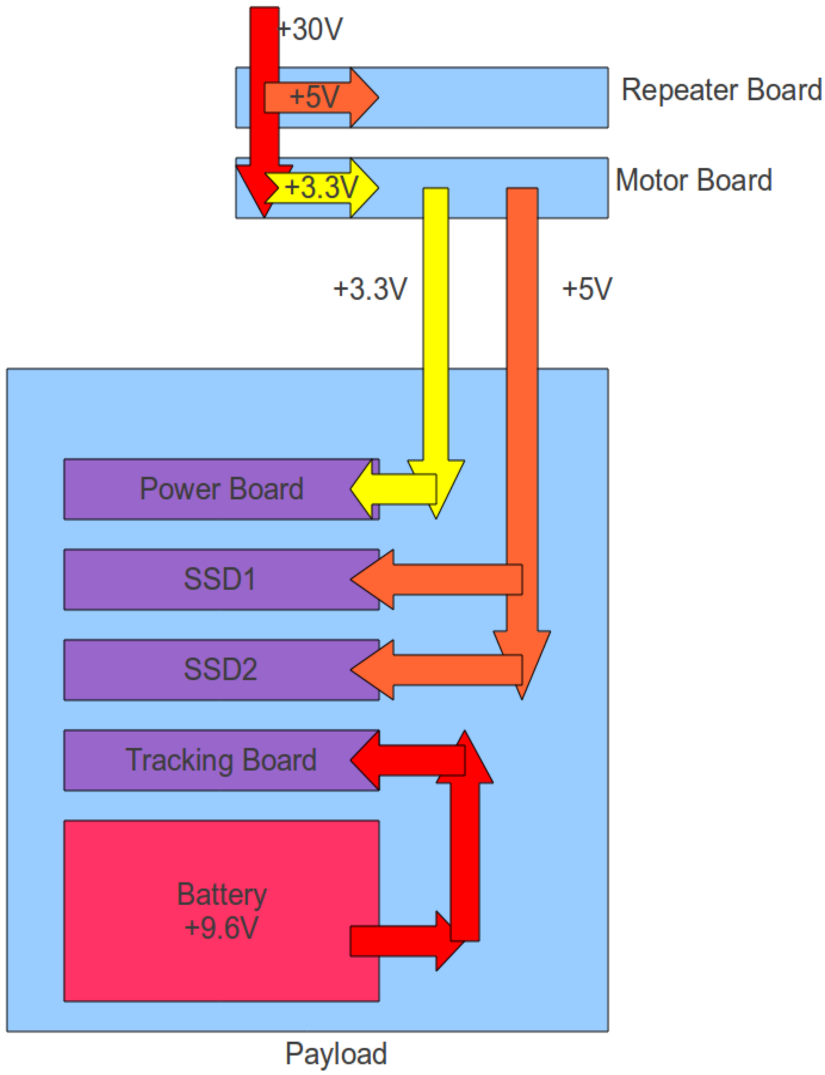
**Please note that, while the payload is capable of drawing over 0.5 A, it will be operationally and software constrained so that it will not go over 0.5 A. (i.e. motor will never be on at the same time as the internal payload heaters etc.) This method of control worked well for the original version of this payload which had the same potential over current issues.

The maximum and average numbers at the bottom of the above table are based on the maximum possible draw. Maximum draw occurs if both SSDs are actively writing data and 2 heaters on. (0.5A)

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.

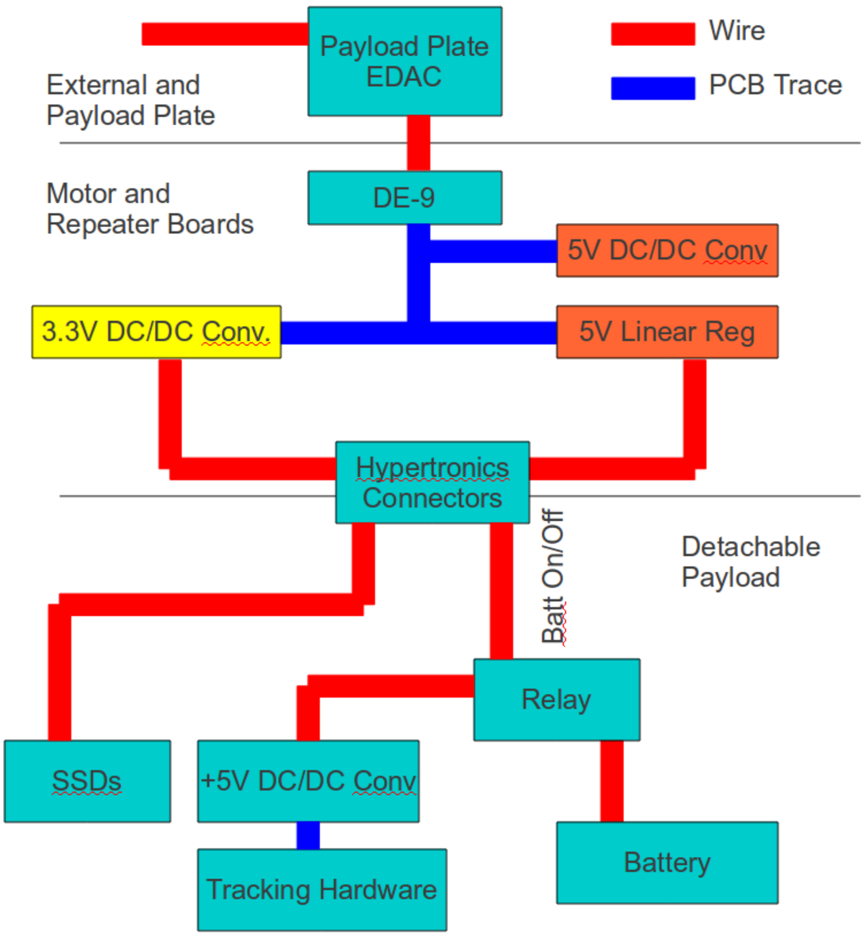
The EDAC Connector is used in the specified manner with all 4 power and ground lines being used to power the payload. The discrete signals will be used to activate the stepper motor (if serial commands fail) and to send the payload into manual mode. (Where all commands must be sent manually instead of some decided automatically by the payload). The analog lines will both be used for LM19 (or similar) temperature sensors as used on previous UMD payloads. One of these sensors will be positioned next to the detach stepper motor and the other internal to the capsule.


HASP +30V
Signal
Returns
HASP GND
Internal Temp
Manual
Detach
External
Temp



C. Other relevant power information

i.



ii. Relays:

1. The relays used to control and distribute power are variants of the TX-2 signal relay that the UMD team has significant experience with. The signal relays have the advantage of being compact and requiring a relatively small triggering voltage. The relays are latching so the state is maintained between switching power sources and to keep the power consumption of the payload lower. The relays are used for switching ON/OFF repeater and tracking capability.

iii. Linear Regulators:

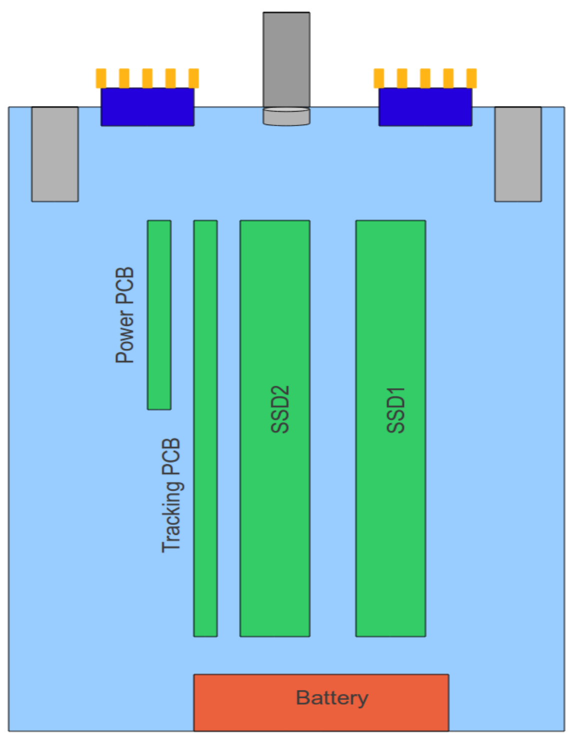
1. The linear regulator used for the 3.3V line is a variant of the NCV5501 LDO regulator from OnSemi. The regulator used for the 5V line is an LM7805S for the servo and power PCBs. Both these regulators function over an extended temperature range of -40C to +125C.

iv. Switching Regulator:

1. There are 3 DC/DC converters used in the payload, 1 on each of the motor board, repeater board, and tracking board. The PTN78000W is a high efficiency down converter used on boards requiring a higher current draw at a significant voltage drop. These converters have been used on all of the UMD previous HASP flights and are very reliable at extended temperatures. The maximum current capacity for the converter is 1.5A.

v. The above power calculations take into account minimal thermal calculations. The 2012 payload has a significantly lower internal average draw than the prototype flown in the previous year. Heaters will be needed internal to the payload to keep the SSDs warm. Dark coloration may also be added to the payload to avoid the extreme and long lasting cold the payload experienced in previous higher power flights.

vi. Our internal arrangement is as follows:



An internal structure (still being designed) will be used to hold the electronics as a single piece and attach them to the top plate. This way, the top plate an all internal components can be removed a single unit for servicing, repairs, or debugging.

All internal electrical connections will be wired into the hypertronics connectors (L series) which are bulkheaded into the top of the payload. The SSDs will be used with the electronics from an external drive case, allowing an easy interface design and a small heat sink in the case of too much heat on each drive. A Kapton heater will be included between the drives for cold temperatures. The batteries will be placed at the bottom of the payload.

Thermally, the main concern is the commercially rated SSDs. Heaters will be used to keep them above 0 degrees Celsius. The ability to vary the On/Off time of the heaters with a PWM signal will be used to modulate exactly how hot or cold the drives will get. All other components used in the payload and on the HASP plate are capable of expanded temperature ranges.

2 SSDs will be flown inside the payload totaling 240 GB total storage capacity. These SSDs will be attached to a science payload (TBD) for testing of data transfer.

There will be batteries inside the payload for the flight. The batteries will be turned on continuously for descent. We are using a LiFePO4 battery pack with 9.6V and 1500 mAh. If the payload transmits 1x per second for 100ms continuously, the battery will last for 7 hrs. If the transmit rate is turned down when the payload hits the ground, the battery will last for far longer due to the lowered duty cycle. The transmit rate for both radios will be reduced to 1x per 5 or 10 seconds once the payload is on the ground. The repeater remaining on HASP will allow the ground station team to also track the payload.

An antenna design is being developed for the repeater remaining on the HASP payload after the capsule is detached. This design is on-going and will be completed and discussed with HASP and CSBF personnel shortly or in the final PSIP.

III. Thermal Considerations

Thermal testing is ongoing with the payload. Thermal chamber testing and flight testing will determine if there are outstanding issues with the payload. The current thermal design is based around components rated for temperature extremes (at least -40 to 85 degrees Celsius) and using a heating system for those that are not. There is no anticipation of overheating issues as all the high power draws are extremely intermittent or low duty cycle, as seen in the previous years' flight.

IV. Data Transfer Specifications

A data transfer plan is under construction. Hopefully, a science payload will be able to store data on the StratoPigeon SSDs for testing and interface purposes. This process is ongoing and will be given in the final PSIP.

V. Downlink Telemetry Specifications:

A. Serial data downlink format: Stream Packetized (circle one)

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

i. 100 bits/sec at 1200 baud (with some margin included)

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

Format:

- 0-6 – Parsing Identifier
- 7 -… Data

Status Packet		
Byte	Data Type	Length
0-6	Identifier Series	6
7	Temperature 1	1
8	Temperature 2	1
9	Temperature 3	1
10	Temperature 4	1
11	Temperature 5	1
12	Relay State 1	1
13	Relay State 2	1
14-15	Count	2
16-19	Time	4
20-23	Latitude	4
24-27	Longitude	4
28-31	Altitude	4
32	Heater Setting 1	1
33	Heater Setting 2	1
34	Heater Setting 3	1
35-38	Identifier Series	4
	Total Length	38 bytes

The data will be sent as binary data, with a parser used on the ground station to format the data appropriately from the online files.

Average bit rate: 200 bps

D. Number of analog channels being used: 2

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

i. Internal Payload Temperature

ii. External Temperature

F. Number of discrete lines being used: 2

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

i. Switch between automatic and manual payload mode

ii. Detach

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

i. Yes

ii. ISM 902-928 FHSS – 1 W

I. Other relevant downlink telemetry information.

i. We will have short external antennas (either patch or dipoles) hanging directly underneath the payload mounted on the payload enclosure.

ii. We would also like to have a main antenna hanging central to the HASP gondola and a pointing antenna attached to the pointed dish at the ground station. A separate detailed integration plan will be provided for both the gondola and ground station if the antennas are approved.

VI. 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*)

i. 3 commands per hour

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

Command #	Checksum	ID#	
0	0	5	Change to manual mode
1	1	5	Change to auto mode
2	2	5	Heater 1 On
3	3	5	Heater 1 Off
4	4	5	Heater 2 On
5	5	5	Heater 2 Off
6	6	5	Heater 3 On
7	7	5	Heater 3 Off
8	8	5	Tracker On

9	9	5	Tracker Off
10	A	5	Repeater On
11	B	5	Repeater Off
12	C	5	Pull Payload back In
13	D	5	Detach Payload
14	E	5	Freeze Detach

For example, the first command looks like: 0x01 0x02 ***0x00 0x05* 0x03 0x0D 0x0A total.

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

i. Yes

ii. ISM 902-928 FHSS – 1 W

F. Other relevant uplink commanding information.

i. When attached to HASP, radios will only transmit 10 minutes prior to release. During the drop period, both radios will transmit at a rate of 1x per 15 s. Once the payload is on the ground, both radios will transmit at a rate of 1x per 20-30s.

ii. The 900 MHz FHSS radio is the radio used by the University of Maryland on HASP for the past three years.

iii. The repeater board will be receiving and retransmitting during and after the capsule is released from the HASP gondola

VII. Integration and Logistics

A. Date and Time of your arrival for integration:

i. July 29, 2012

B. Approximate amount of time required for integration:

i. ~2 hrs

C. Name of the integration team leader:

i. Connie Ciarleglio

D. Email address of the integration team leader:

i. connie@nearspace.net

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

i. Connie Ciarleglio connie@nearspace.net

ii. Chris Carlsen rentacop.intern@gmail.com

F. Define a successful integration of your payload:

i. Secures mechanically to HASP outrigger

ii. Payload powers on

1. SSDs powers on
2. Motor board powers on

iii. Payload interfaces to HASP mini-SIP

1. Uplink
2. Downlink

iv. Payload interfaces to Science Payload

1. Uplink

v.Radios working (Tracker and Repeater)

1. Uplink
2. Downlink
3. Reasonable signal strength for both

vi. Detachment Successful

1. Microprocessor responds to command
2. Payload detaches from gondola
3. Parachute clears all surrounding objects
4. Payload clears all surrounding objects

G. List all expected integration steps:

1. Attach payload plate and payload unit mechanically to HASP
2. Plug in HASP connectors
3. Test power on/off through mini-SIP
4. Test serial uplink and downlink through mini-Sip
5. Test RF communications on mini-SIP and batteries
6. Test data transfer with science payload
7. Test detachment procedure on gondola

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

1. Motor Board powers on

2. Communication board powers on
3. Repeater Board powers on
4. Mini-SIP uplink successful
5. Mini-SIP downlink successful
6. USB data transfer successful
7. Radio 1 TX successful (tracker)
8. Radio 2 RX/TX successful (repeater)
9. Temperature Sensors Working
10. Payload and parachute separate from payload plate

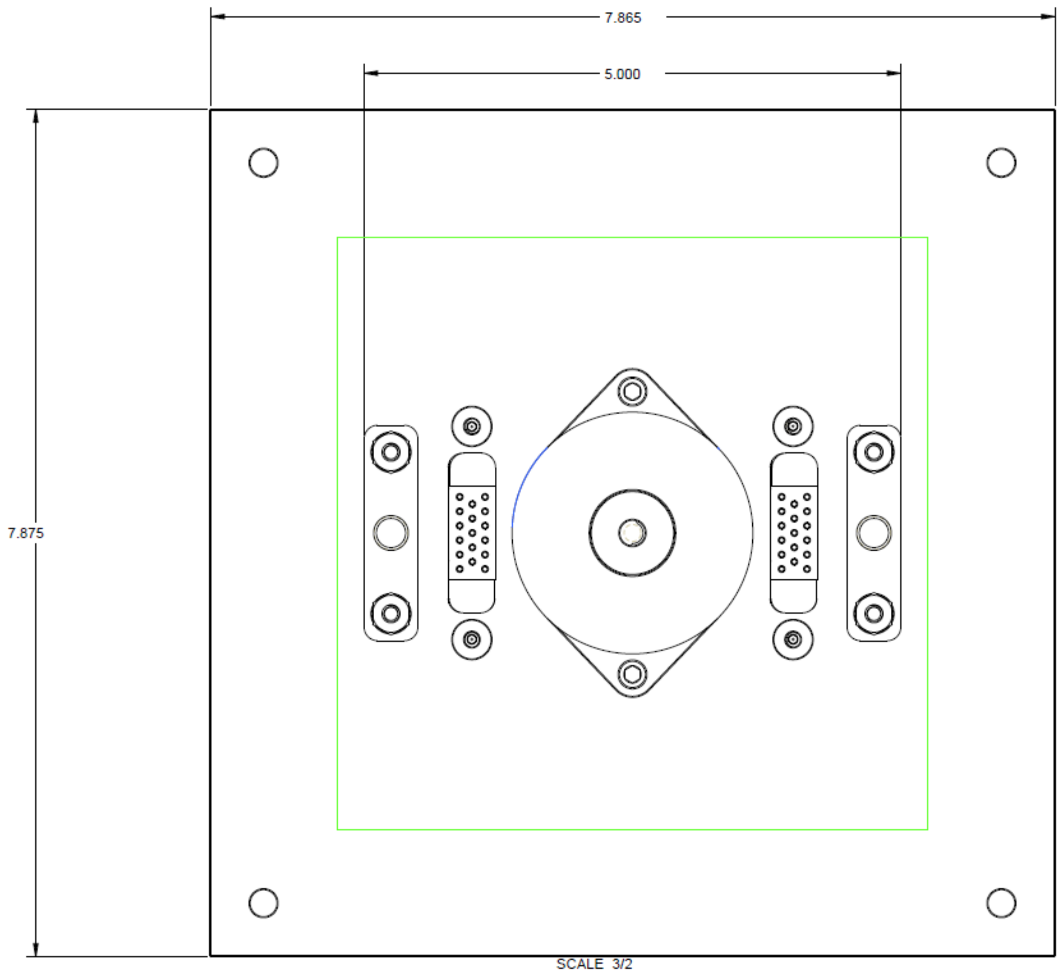
I. List any additional LSU personnel support needed for a successful integration other than directly related to the HASP integration (i.e. lifting, moving equipment, hotel information/arrangements, any special delivery needs…):

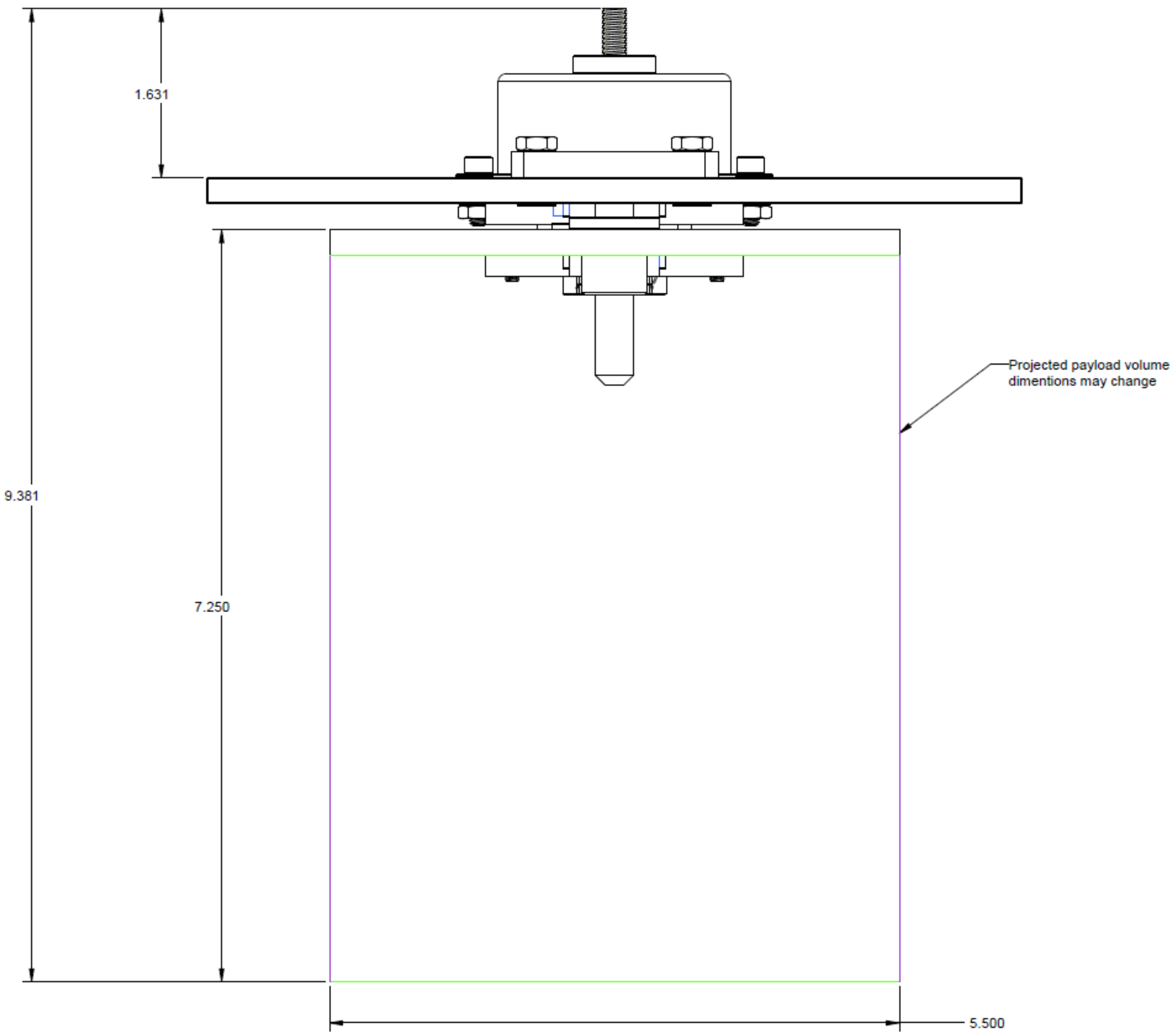
We will want to test the payload drop mechanism before and during the thermal vacuum test. We will be using a tethered payload in the TV test to show successful payload detach and parachute clearance.

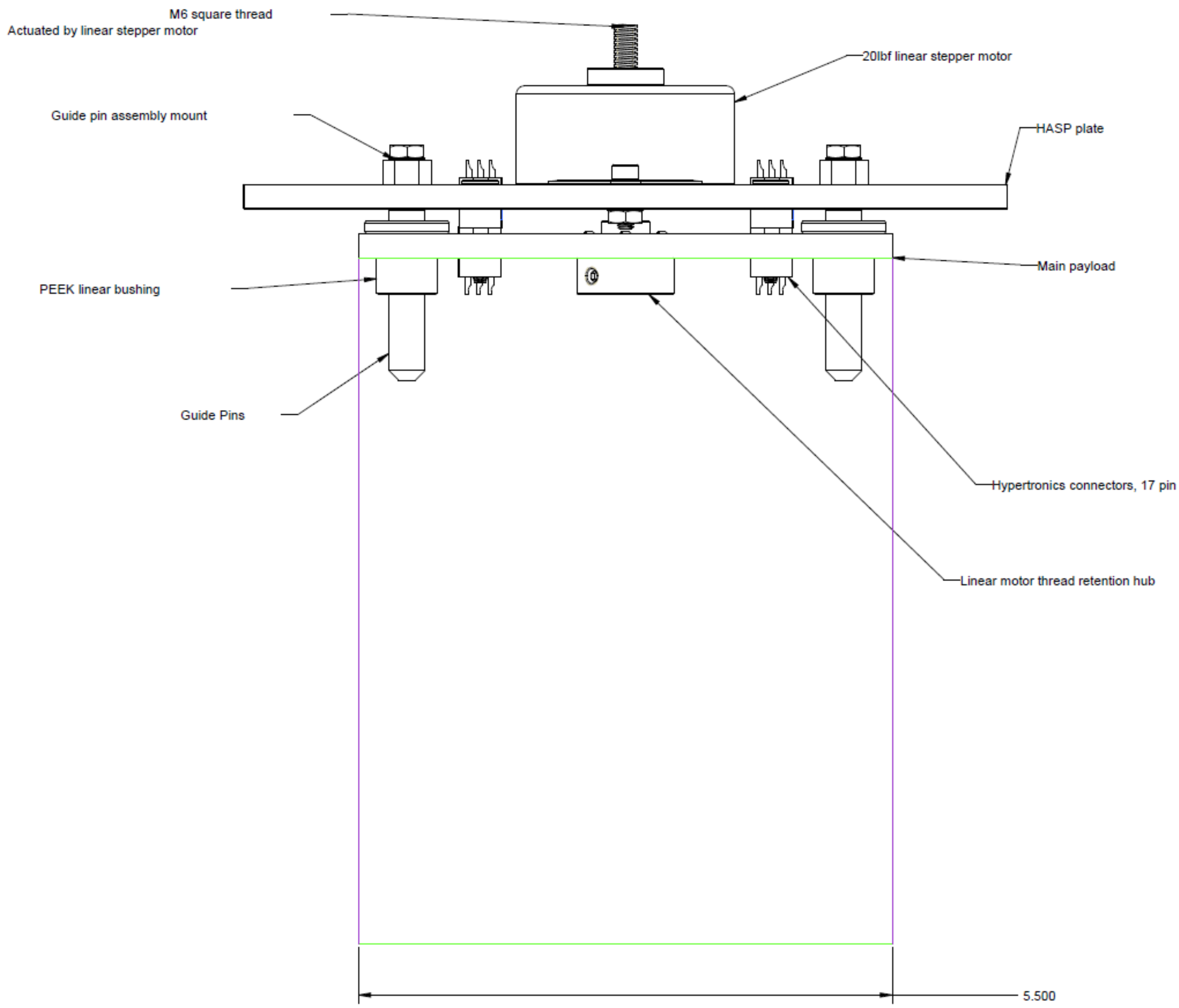
J. List any LSU supplied equipment that may be needed for a successful integration:

Appendix A

Engineering Drawings:


7.865
5.000
7.875
SCALE 3/2


1.631
9.381
7.250
Projected payload volume
dimentions may change
5.500


M6 square thread
Actuated by linear stepper motor
20lbf linear stepper motor
Guide pin assembly mount
HASP plate
Main payload
PEEK linear bushing
Guide Pins
Hypertronics connectors, 17 pin
Linear motor thread retention hub
5.500