HASP Payload Specification and Integration Plan

Payload Title: HELIOS III

Payload Class: Small **Large**

Payload ID: 10

Institution: University of Colorado Boulder

Contact Name: Cooper Benson

Contact Phone: (719) 649-9832

Contact E-mail: cooper.benson@colorado.edu

Submit Date: June 27, 2014

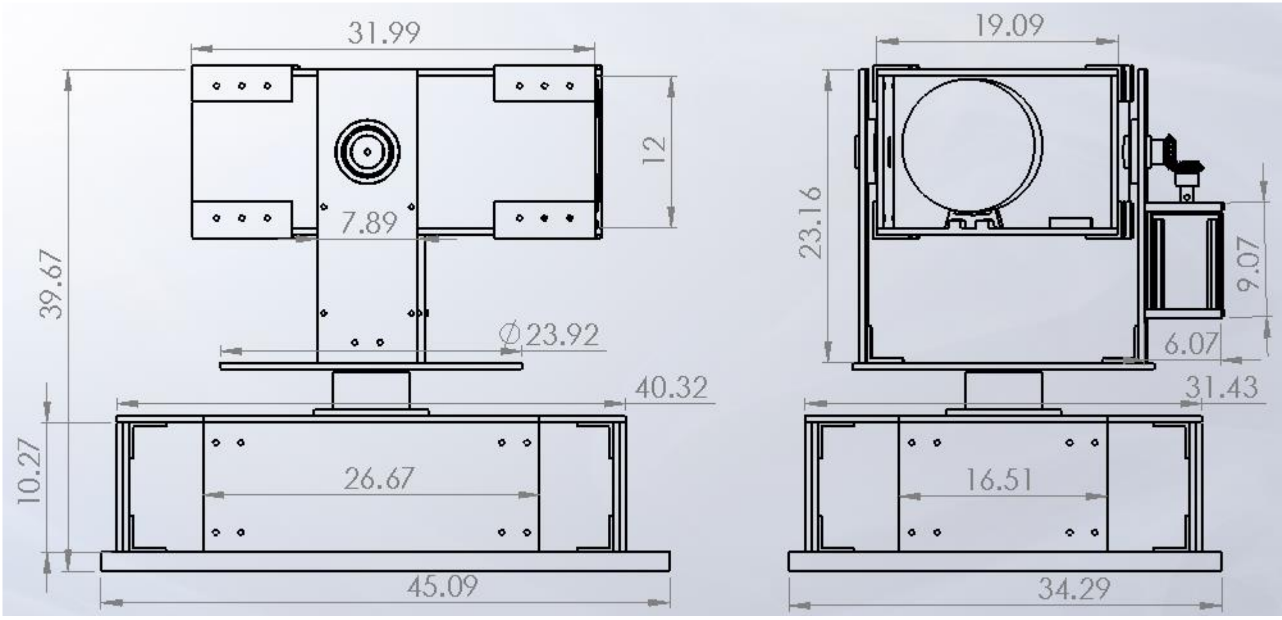
I. Mechanical Specifications:

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

Item	Measured	Calculated	Estimated	Weight (kg)
Motors	X			2.03
Motor Drivers	X			0.01
Diode Chips	X			0.006
Wires		X		0.077
Aluminum		X		11.633
Screws			X	0.558
Nuts			X	0.364
Photo Diode Housings		X		0.146
Bearings			X	0.433
Gears			X	0.123
PI	X			0.041
Gertuino	X			0.033
Board + Bucks	X			0.295
Current Sensor Breakouts 2.5x5			X	0.125
USB Hub	X			0.062
D25 x2	X			0.028
D15 Male x2	X			0.022
D15 Female x2	X			0.014
Sensors, wires, headers etc			X	0.055

Item	Measured	Calculated	Estimated	Weight (kg)
Orion StarMax 90mm TableTop Maksutov-Cassegrain Telescope	X			**1.678**
Orion 0.5x Focal Reducer for StarShoot Imaging Cameras	X			**0.018**
Astrodon 3nm H-Alpha Narrowband Filter 1.25"			X	**0.03**
USB 2.0 1/1.8" CCD Monochrome Industrial Camera	X			**0.265**
Telescope Pre-filter			X	**0.1**
USB 2.0 1/3" CMOS Monochrome Industrial Camera	X			**0.07**
12mm Focal Length Navitar Machine Vision Lens	X			**0.09**
Baader 3.0 Neutral Density Filter - 1.25" Round Mounted	X			**0.0002**
Baader 0.9 Neutral Density Filter - 1.25" Round Mounted	X			**0.0002**
Silicon Thermal Pad			X	**0.2**
			Total	**18.5064**

Provide a mechanical drawing detailing the major components of your payload and specifically how your payload is attached to the payload mounting plate. (All dimensions are in centimeters) Due to the response to the height extension request, we are currently redesigning all dimensions of the payload. We will be submitting an updated version of this document with the new structural design no later Tuesday, July 1st.


31.99
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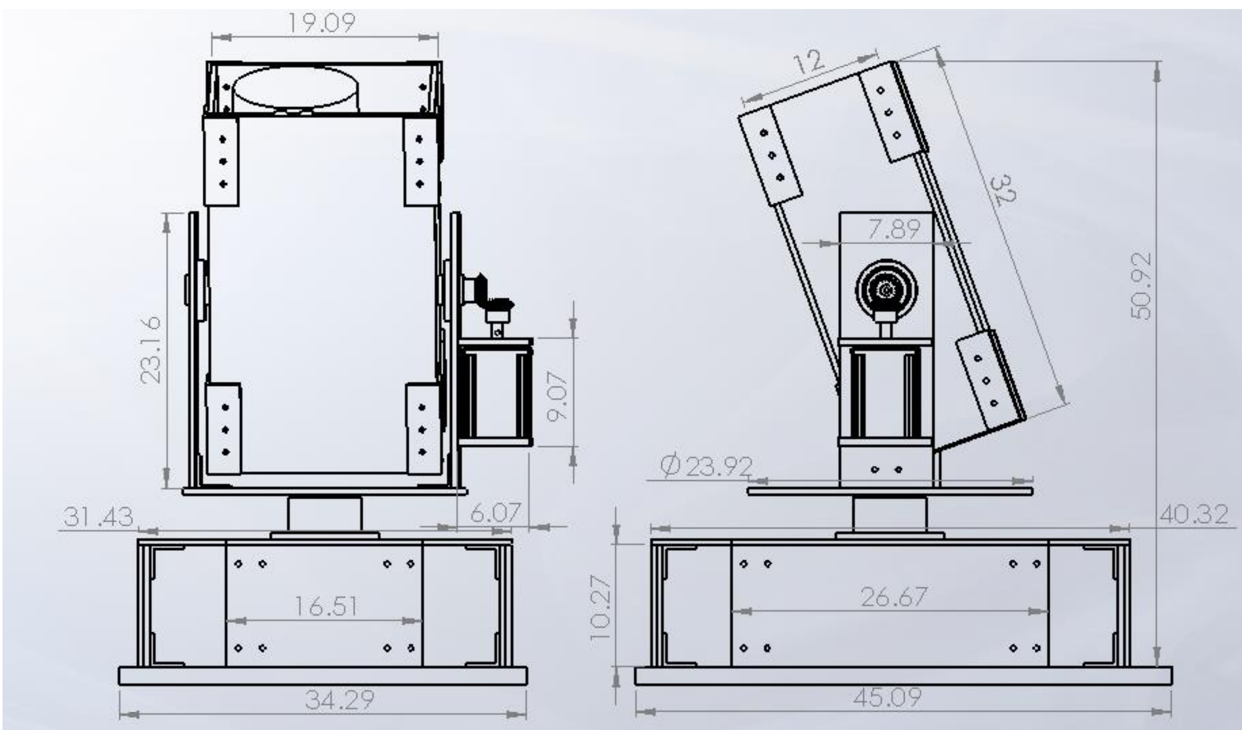
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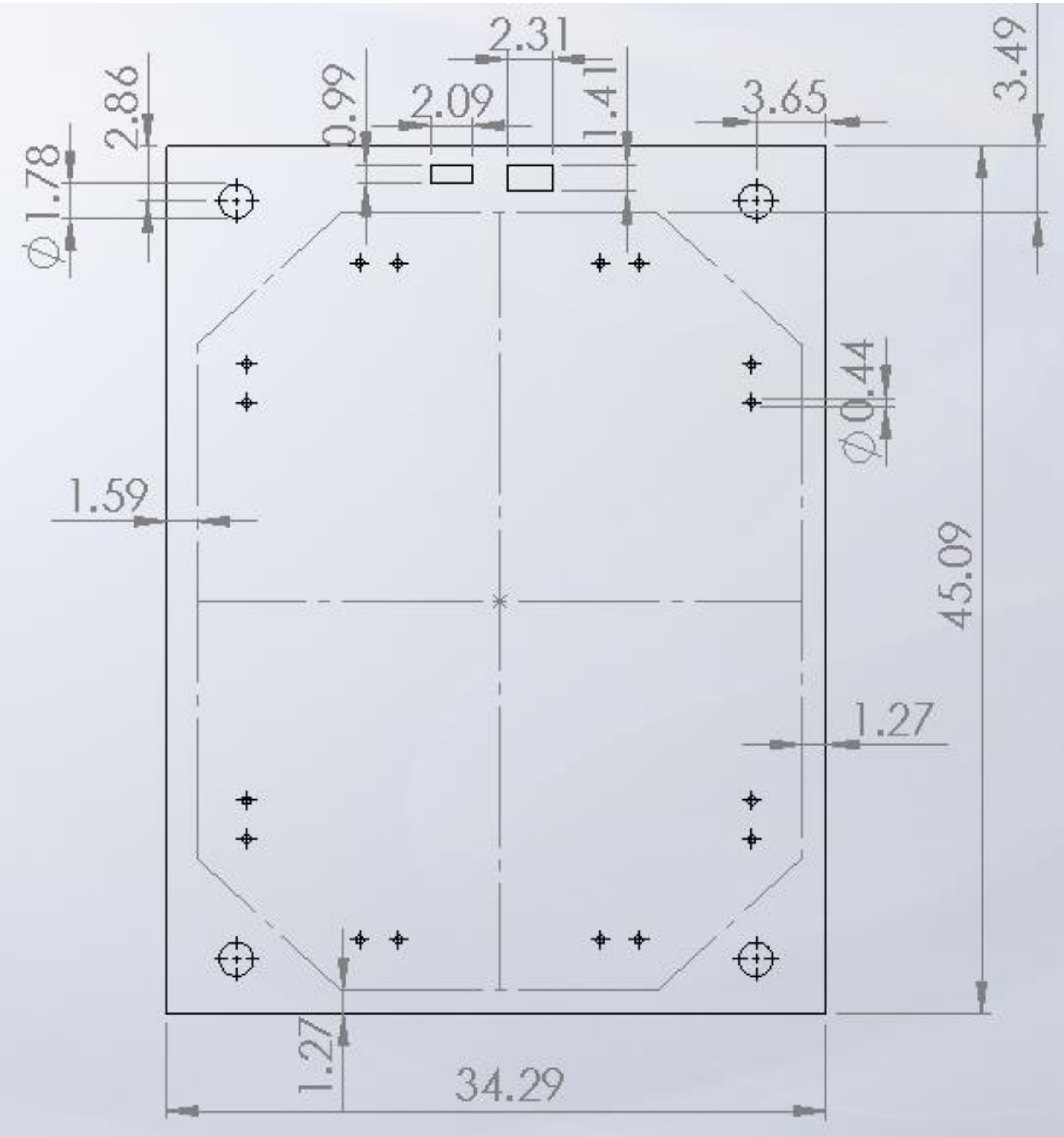
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2.86
0.99
2.09
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3.65
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1.59
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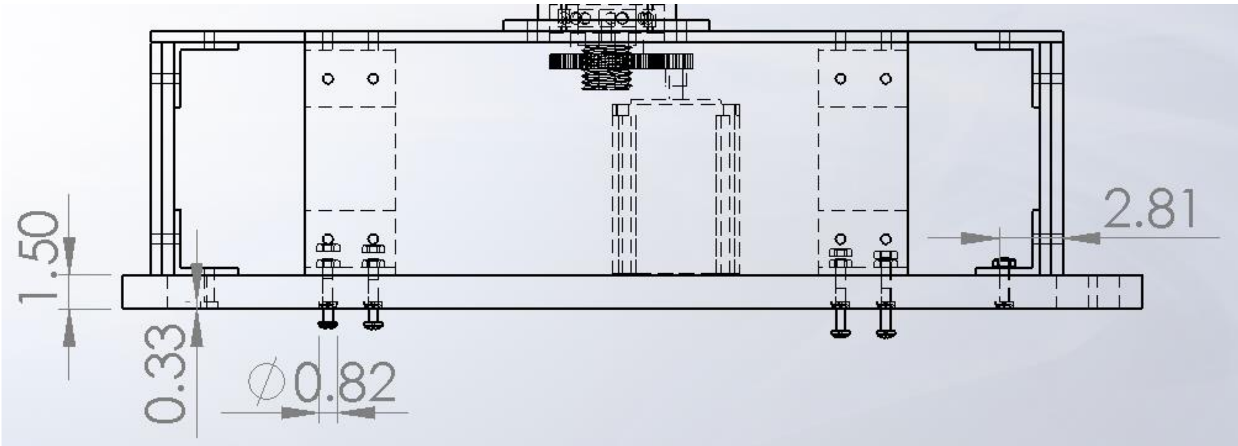
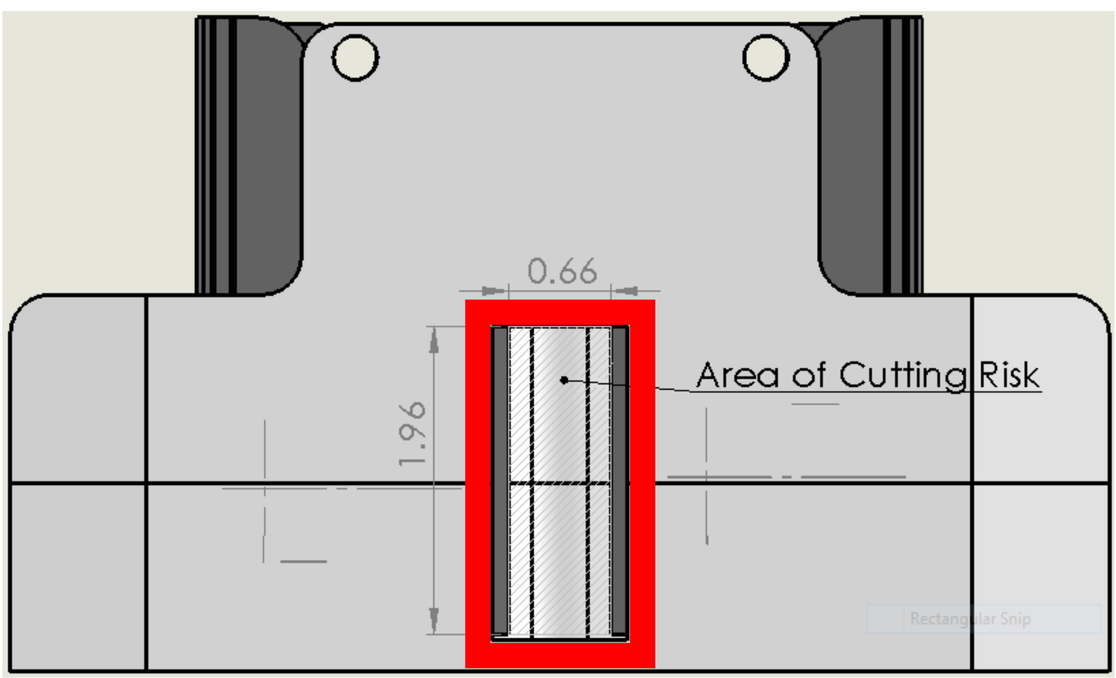


B. If you are flying anything that is potentially hazardous to HASP or the ground crew before or after launch, please supply all documentation provided with the hazardous components (i.e. pressurized containers, radioactive material, projectiles, rockets…)

A potential hazard to the ground crew is the usage of razor blades as aperture limiters in the two photodiode arrays. The usage of razor blades as edges of the aperture allows for light to pass through the aperture without any light pollution being produced by light bouncing off the edge of the aperture, as the blade is almost a zero thickness edge. The array is designed to limit this hazard as much as possible. The exposed edges of the razors are minimized and the gap between them is very small, reducing the chance of contact (see below figure for dimensions. The edge of the array around the aperture will also be marked red to provide a visual warning of the exposed blade edges.



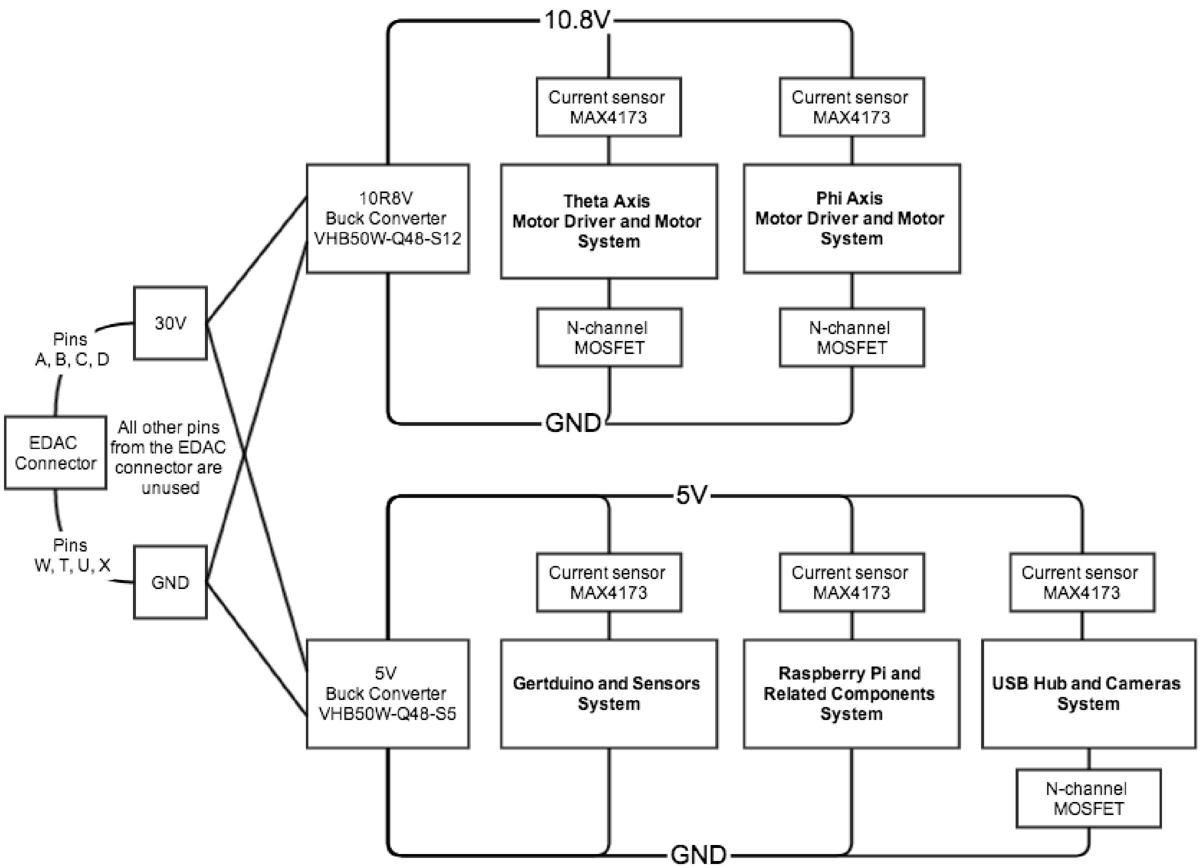
II. Power Specifications:

A. Measured current draw at 30 VDC

While we have no measured current draw from the payload at 30 V, the predicted maximum current draw is 0.92 A. The maximum power drawn is predicted to be 27.7 W.

HELIOS III Power Budget					
Device/System	**Qty**	**Voltage (V)**	**Maximum Current (A)**	**Maximum Power (W)**	**Method**
Gertduino	1	5	0.75	3.75	Estimated
Raspberry Pi	1	5	0.75	3.75	Calculated
Stepper Motor Drivers	2	10.8	0.75	16.2	Measured
Powered USB Hub	1	5	negligible	negligible	Estimated
ADCS Camera	1	5	0.25	1.25	Calculated
Science Camera	1	5	0.5	2.5	Calculated
Current Sensors	5	0.02	0.75	0.075	Calculated
Systems Total				**23.7**	
Estimated Power Loss Due to Buck Converter Inefficiency (83%)				4.029	Estimated, Calculated
Total		**30**	**0.9243**	**27.729**	

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.



III. Downlink Telemetry Specifications:

A. Serial data downlink format: Stream **<u>Packetized</u>**

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

1600 bits per second approximately

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

Bytes	Content	Example
0-4	Start	STX
5-7	Payload Identifier	CU
8-10	Thread Identifier*	EX
11-13	Record Type*	EX
14-18	Timestamp (from epoch)	1400019944
19-22	Length of data string	37
23-26	Adler32 Checksum	-71889546
27	New line	\n
28-(N-4)	Data*	The red fox jumped over the brown log.\n
(N-3)-N	End Transmission	XTX\n
* Possible combinations in table below		

Sender	ID	Record	ID	Content	Typical Data
Uplink	UP	Bootup	BU		0xBB
		Error	ER	Invalid target and cmd	<2 bytes>
Downlink	DW	Bootup	BU		0xBB
Gertduino	GE	Bootup	BU		0xBB
		Downlink	DW	Data from sensors	Data Package
		Forward	FW	Forwarded command	<1 byte>
		Ack	AC	Command executed	<1 byte>
		Error	ER	Command with error	<1 byte>
ADCS	AD	Bootup	BU		0xBB
		Ack	AC	Command executed	<1 byte>
		Error	ER	Command with error	<1 byte>
Analysis	AN	Bootup	BU		0xBB
		Ack	AC	Command executed	<1 byte>
		Error	ER	Command with error	<1 byte>
		Model Success	MS	Model polynomial	[#x+#, #x+#]
		Model Data	MD	Data points (V, °) theta, phi	(#, #), (#, #)
		Model Failure	MF	No suns detected or multiple	"=0" or ">1"

D. Number of analog channels being used:

0 analog channels will be used.

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

N/A

F. Number of discrete lines being used:

0 discrete lines will be used.

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.

No

I. Other relevant downlink telemetry information.

N/A

IV. Uplink Commanding Specifications:

A. Command uplink capability required: **<u>Yes</u>** No

B. If so, will commands be uplinked in regular intervals: Yes **<u>No</u>**

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*)

As the commands are primarily error response based on downlinked data, we will use an absolute maximum of 4 commands an hour. However, if flight data is nominal, we won't need to use any commands.

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

Two Byte Hex Command	**Payload Command**
0x0A 0A	Power on hub
0x0A 0B	Power off hub
0x0A 1A	Power on motors
0x0A 1B	Power off motors
0x0A FF	Ping Gert
0x0B 00	Re-initialize ADCS
0x0C FA	Enter Pan mode
0x0C FB	Exit Pan mode

0x0C 0A	Switch photodiode array – theta
0x0C 1A	Switch photodiode array – phi

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

No

F. Other relevant uplink commanding information.

N/A

V. Integration and Logistics

A. Date and Time of your arrival for integration:

Early afternoon, Monday, July 28.

B. Approximate amount of time required for integration:

It is estimated that the HELIOS III team will need 4 hours to check all of the items listed in the checks list below as well as address any issues that may have been produced during transportation of the payload, and complete a test to ensure that the payload performs as expected. After tests are completed we will be able to mount onto the HASP platform.

C. Name of the integration team leader:

Cooper Benson

D. Email address of the integration team leader:

cooper.benson@colorado.edu

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

Name	Email
Cooper Benson	cooper.benson@colorado.edu
Paige Arthur	paige.arthur@colorado.edu
Kristen Hanslik	kristen.hanslik@colorado.edu
Brandon Boiko	brandon.boiko@colorado.edu
Jorge Cervantes	jorge.cervantes@colorado.edu
Ryan Cutter	ryan.cutter@colorado.edu
Dylan Richards	dylan.richards@colorado.edu

F. Define a successful integration of your payload:

Successful integration of the HELIOS III payload includes being tested to ensure the payload is functioning properly, able to downlink payload data to the HASP platform and ground station, capable of sending a response to uplinked serial commands, and able to withstand Thermal Vacuum testing.

G. List all expected integration steps:

I. Arrive with payload assembled

II. Ensure that all components are intact after transportation

III. Test payload to ensure proper functionality

1. Perform test outside to allow for sun-tracking
2. Power on and let run through start-up
3. Determine that sun-tracking capability is functional
4. Check SD card to ensure the system captured images from both cameras
5. Recalibrate/Realign system if determined necessary
6. Repeat steps 1-3 if necessary
7. Add physical circuit break to phi motor to prevent motion during T-Vac test
8. Repeat steps 1-3

IV. Deliver payload to be weighed and have serial communication capability confirmed

V. Deliver payload to be integrated on the platform

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

I. During T-Vac

1. Look in data packets for startup notification downlink
2. Data is downlinked from the payload and the following can be seen in the data logs:
    a. Photodiode readings (from both theta and phi arrays)
    b. Accelerometer readings
    c. Gyroscope readings

d. Temperature readings

e. Pressure sensor readings

f. Humidity sensor readings

g. Current sensor readings

3. Graphs of downlinked sensor data made during T-Vac show nominal results. Graphs of downlinked environmental data taken by the payload approximately correspond with graphs of environmental data taken by the HASP platform.
4. Uplink to payload the command 0x0A0BF which will ping the Gertduino as documented in the uplink commands table. Look for response from payload in the downlinked payload data.
5. Monitor temperature of components as they should not fall outside of nominal ranges.

II. After T-Vac

1. Remove the physical circuit break to the phi motor.

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…):

N/A

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