HASP Payload Specification and Integration Plan

Payload Title: BOWSER

Payload Class: Large

Payload ID: 11

Institution: Colorado Space Grant Consortium - University of Colorado at Boulder

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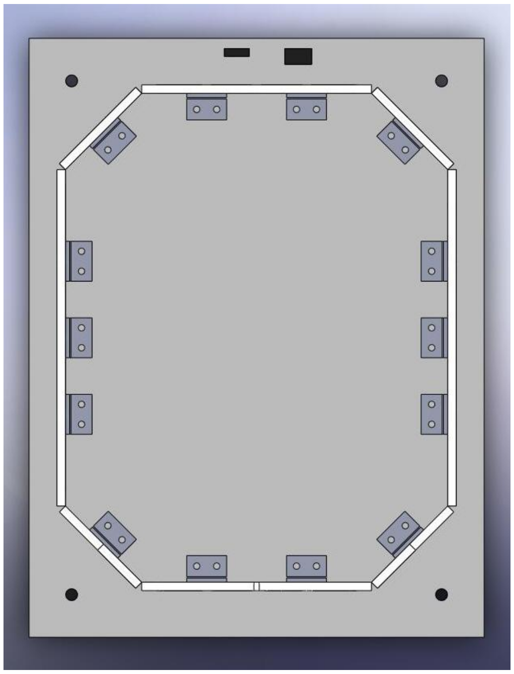
Submit Date: June 1, 2009

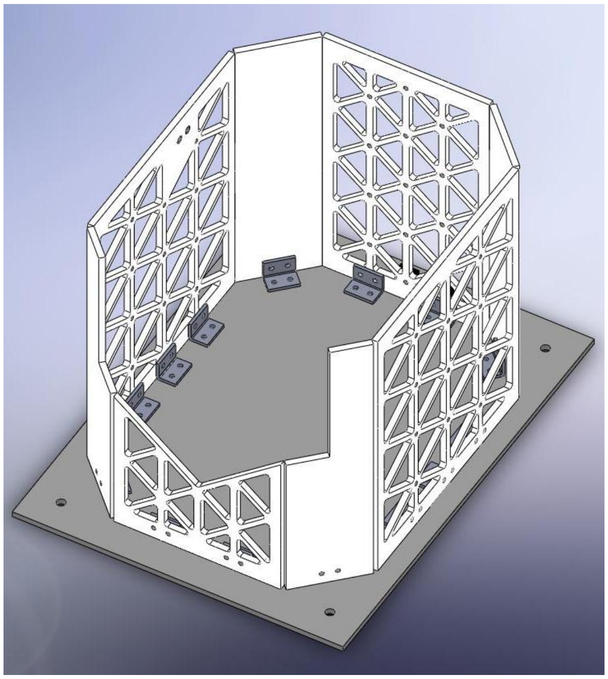
I. Mechanical Specifications:

A. Estimated weight of the payload (not including payload plate):

Item	**Mass (kg)**
Science	
G9 Camera	0.32
Low Light CDD	0.2
Telescope with modifications	2.5
C&DH	
Computer	0.4
Hard Drive	0.077
PCBs	0.3
Wires	1
Wiring Harness	0.1
Structures	
LED Baffling	0.2
Photometer Baffles	0.3
External Structure Aluminum	5.58
Bolts	0.3
Nuts	0.15
Sunshade Assembly	0.25
Mounting Parts	1.5
Total	**13.177**
Available Weight	*20*
Margin	*6.823*
% Used	*65.885*

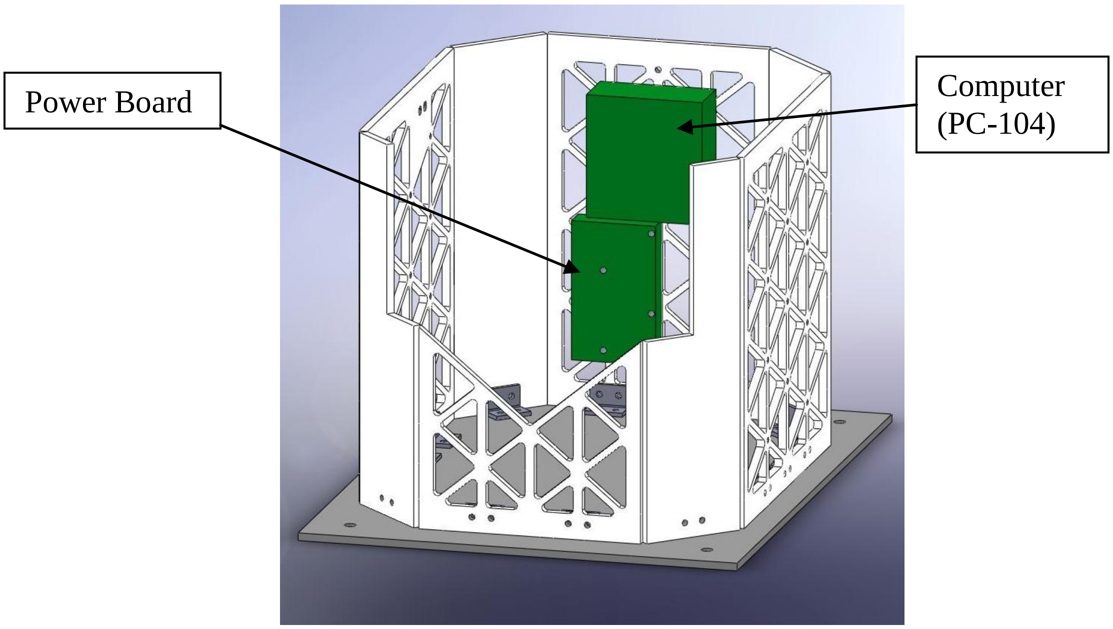
B. Payload Attachment, Major Components, and Models:



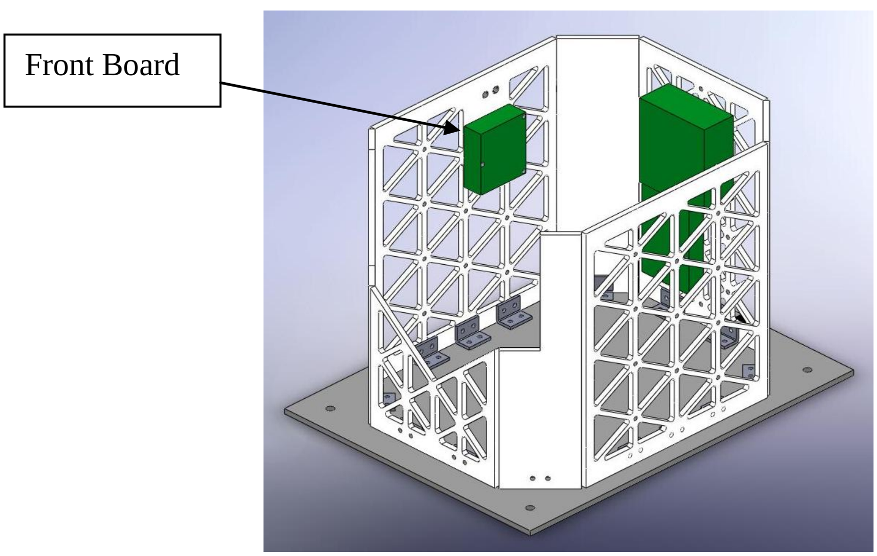


The payload's walls will be attached to the PVC mounting plate using 14 right angle brackets as shown. The fasteners that will be used are 10-32 socket-cap bolts and nuts.

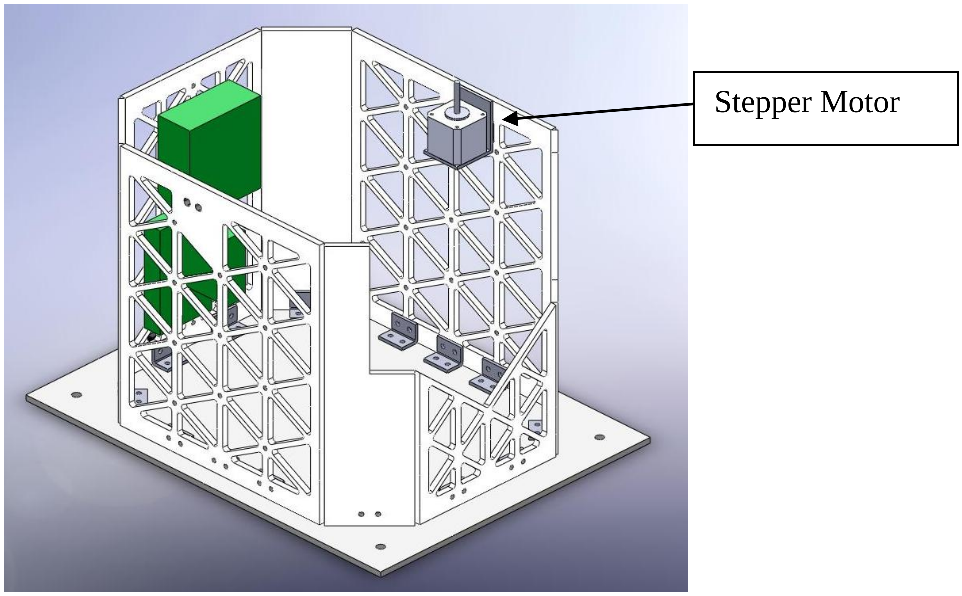
Major Components:



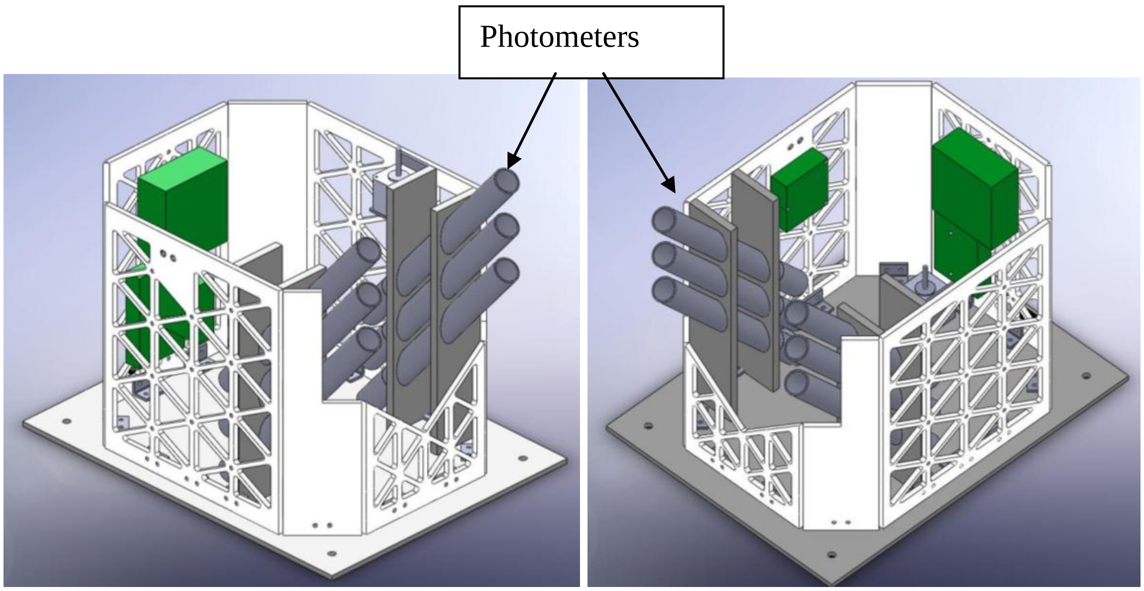
The power board is mounted directly to the back wall. The computer attaches to a thin steel plate that will attach to the back wall as well.



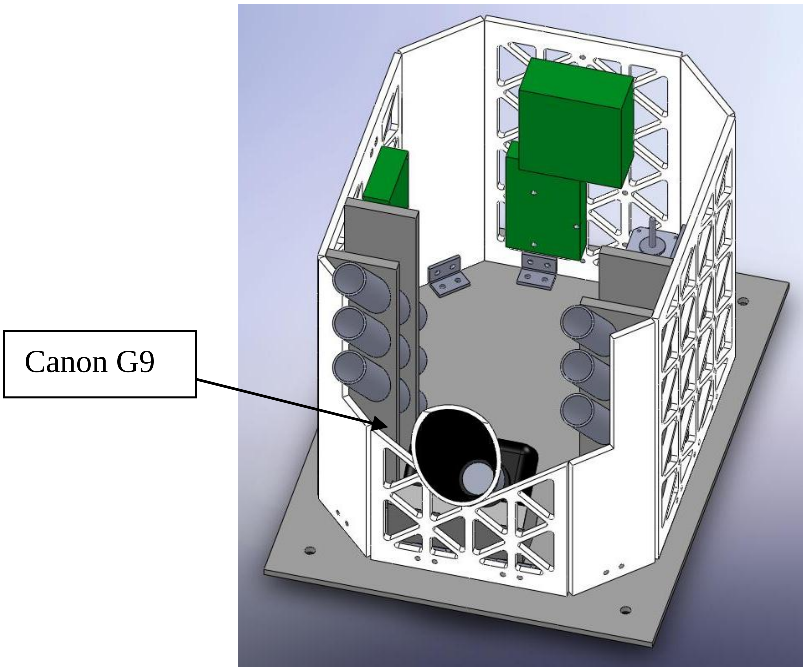
The front board will be mounted directly to the left wall of the payload.



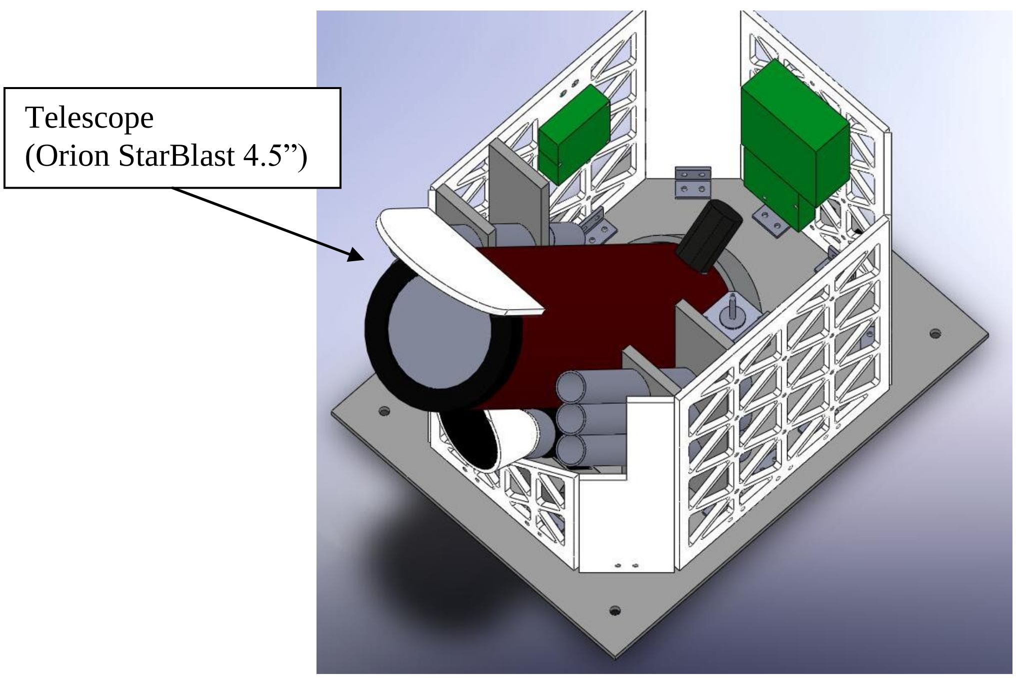
The stepper motor will be attached to a universal joint that is connected to another universal joint via an extension rod and it will control a sunshade that is attached to the telescope.



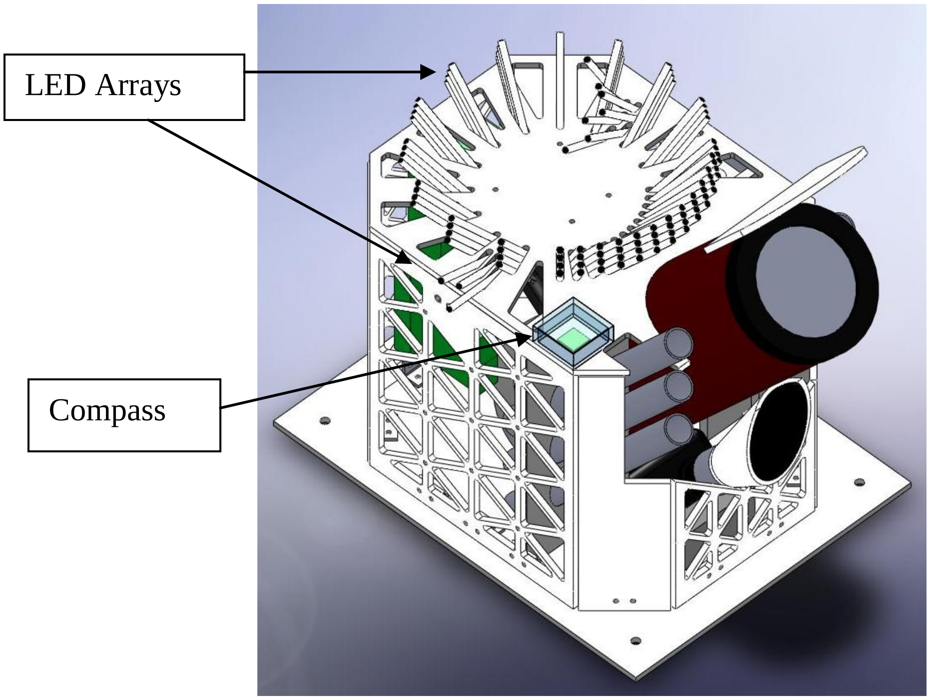
The photometers are used to gather light-sensing data that is required for our mission. They are mounted to the left and right walls.



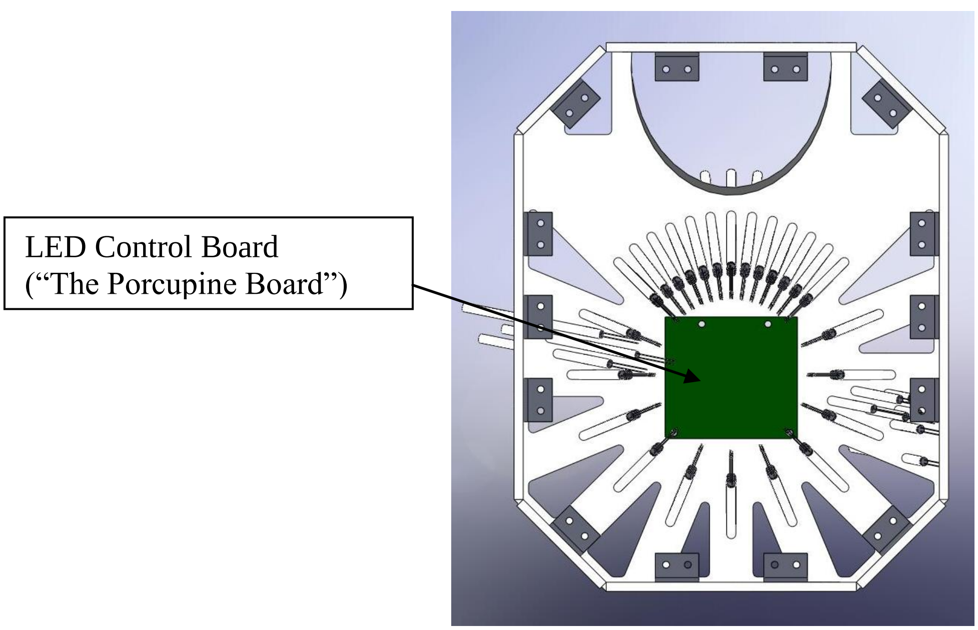
The Canon G9 is Team BOWSERs chosen wide-angle imaging device. It is mounted on its own ramp and a baffle for stray light is included.



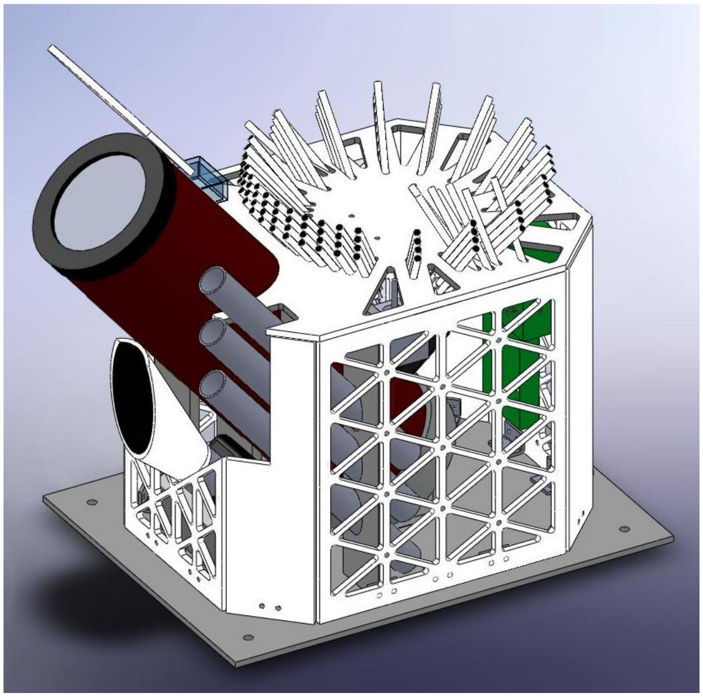
The telescope that we are using is a modified Orion StarBlast 4.5” Newtonian telescope. A sunshade will be attached to the top of the telescope as shown in case the telescope faces direct sunlight.



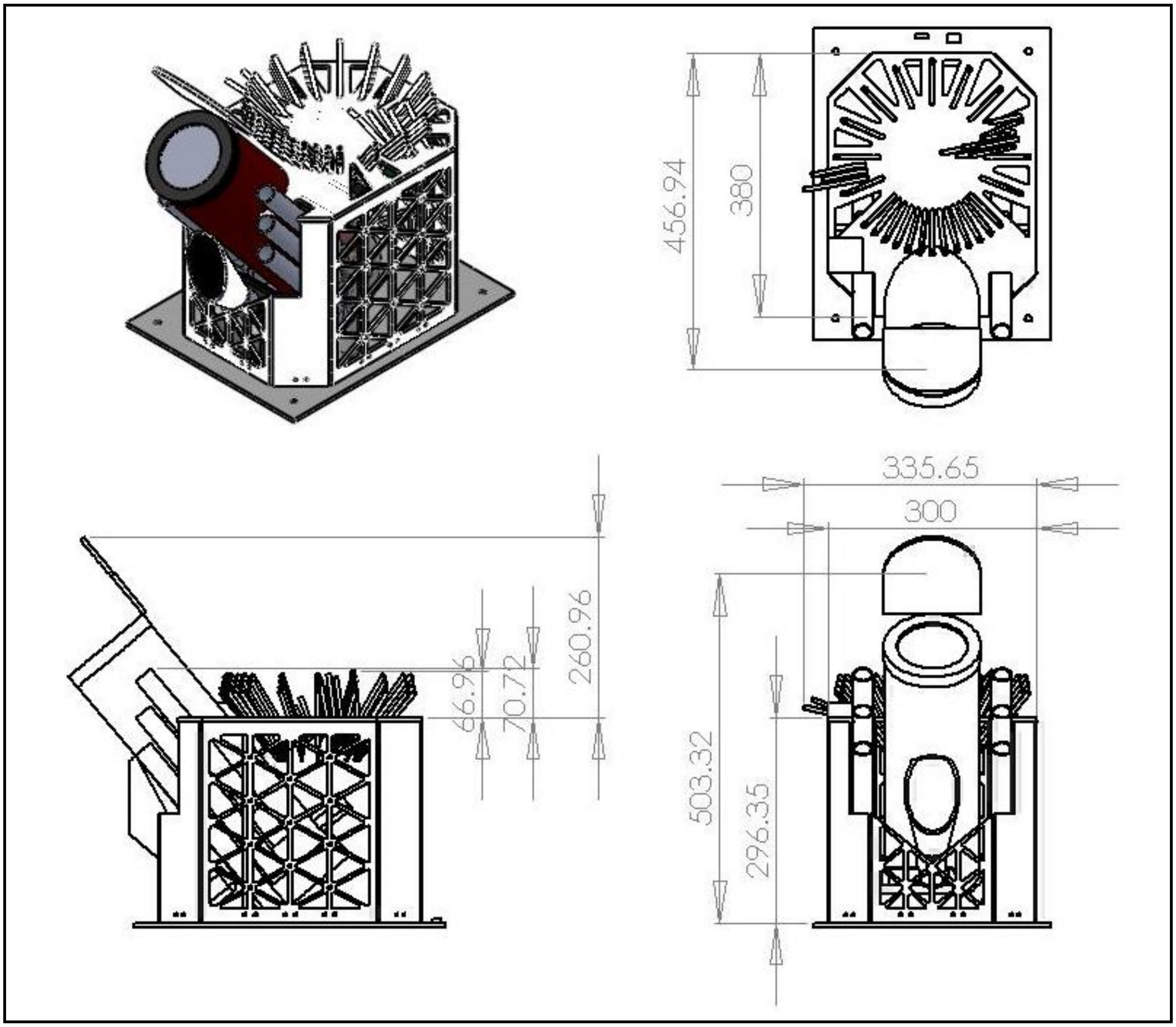
On the top of the external structure, there are 108 LED photometers. One array is a 360º and another is a multi-angle array that faces the same direction. A digital compass is also included and mounted to the roof.



Mounted to the roof, in the middle of the 360º LED array, is a board that primarily controls the data obtained from the LED photometers.



The image above shows an isometric view of the BOWSER payload. On the next page is a drawing that shows external measurements of the payload. Earlier in the year, Team BOWSER confirmed that the protrusions will be allowed for the flight.



(All measurements are in millimeters)

C. Hazard Information:

BOWSER is not flying any material that will be hazardous to HASP or the ground crew.

D. Other relevant mechanical information:

The only mechanical moving part of the payload is the sunshade, which is operated by the stepper motor. Since the stepper motor is placed away from the telescope sunshade, a series of rotating rods and universal joints will be operated during flight. However, the operation of this component of the payload will not disrupt the operation of neighboring payloads.

II. Power Specifications:

A. Estimated current draw at 30 VDC

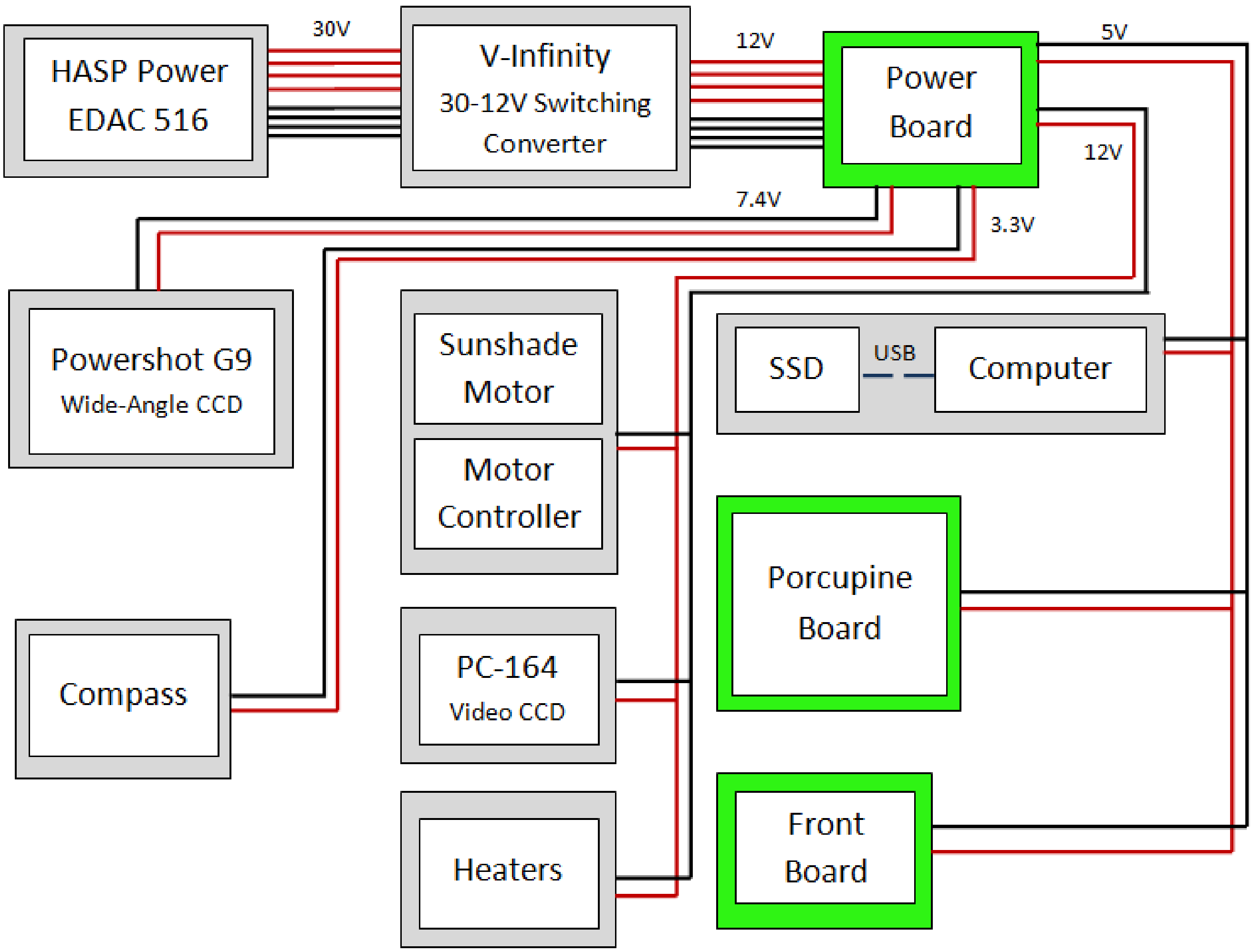
With all instruments, including heaters, running at full power, BOWSER will draw a maximum of 2.275 A at 30 VDC. This was calculated using the maximum current ratings for all instruments, which can be seen in the first table below. The second table shows the efficiency for our switching converters, and how this translates into the total power drawn from the HASP platform.

Part Type	Required Voltage (V)	Total Current Use (mA)	Total Power Drawn (W)
Processing Board	5.0	1800.0	9.000
Video Compression Board	5.0	1250.0	6.250
Hard Drive	5.0	350.0	1.750
Dual-axis Accelerometer	5.0	4.0	0.020
Three-axis Gyroscope	5.0	48.0	0.240
Pressure Sensor	5.0	6.0	0.030
AVR 1	5.0	400.0	2.000
AVR 2	5.0	200.0	1.000
16-Channel Multiplexer	5.0	50.0	0.250
32-Channel Multiplexer	5.0	0.1	0.000
24-Bit ADC	5.0	2.0	0.010
Stepper Motor Controller	12.0	750.0	9.000
PC-164	12.0	120.0	1.440
Stepper Motor	12.0	280.0	3.360
Heaters	12.0	1600.0	19.200
Powershot G9	7.4	160.0	1.184
Compass	3.3	8.0	0.026

Voltage Line (V)	Current Out (mA)	Power Out (W)	Efficiency (%)	Power In (W)	Current In (mA)
5.0	4110.08	20.550	87	23.621	1968.429
7.4	160.0	1.184	92	1.287	107.246
3.3	8.0	0.026	86	0.031	2.558
12.0	4828.2	57.939	85	68.163	2272.110

Total Power (W):	**68.163**
Total Current (mA):	**2272.110**

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 four power and four ground lines from the EDAC 516 connector are routed through a 12V switching converter. The resulting 12V line is run through 3.3V, 5V and 7.4V converters. Using these three outputs and the original 12V line, every subsystem within the payload has the necessary voltage.

C. Other relevant power information

Other than the power converters mentioned above, Team BOWSER has no plans for any other manipulation of the power obtained from HASP.

III. Downlink Telemetry Specifications:

A. Serial data downlink format: Packetized

B. Approximate serial downlink rate (in bits per second): 4800 BPS

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

Team BOWSER will send scheduled health and status packages through the downlink at regular intervals. These packets will follow the format recommended in the HASP Integrations Manual, and will be composed of the following bytes:

Byte	Name of Byte
1	Record Type Indicator
2-5	Timestamp (Seconds)
6-9	Timestamp (Nanoseconds)
10-11	Record Size
12	Checksum
13-35	LED Packet 1
36-58	LED Packet 2
59-81	LED Packet 3
82-104	LED Packet 4
105-127	Photodiode Packet
128-147	Temperature Packet
148-167	Pressure Packet
168-187	X-Axis Acceleration Packet 1
188-207	X-Axis Acceleration Packet 2
208-227	Y-Axis Acceleration Packet
228-247	Z-Axis Acceleration Packet
248-267	Pitch Packet
268-287	Roll Packet
288-307	Yaw Packet
308-379	Compass Packet
380-n	Computer Status Information

Bytes 13-379 consist of packets of data for each of the scientific instruments on BOWSER, excepting the cameras. Other than the compass, each packet will have the same format, displayed below:

Byte	Name of Byte
1-3	Minimum value since last downlink
4-7	Minimum timestamp (Seconds)
8-10	Minimum timestamp (Milliseconds)
11-13	Maximum value since last downlink
14-17	Maximum timestamp (Seconds)
18-19	Maximum timestamp (Milliseconds)
20-22	Average value since last downlink

For everything that isn't light sensing data, the data points will consist of 2 bytes rather than 3. Otherwise, the above table applies to all instruments but the compass. Because it doesn't make sense to obtain minimum or maximum values from the compass, the compass data sent down will consist of two sets of four data points and their corresponding timestamps. These two sets should show a reasonably changing heading for the payload, thereby verifying the compass is working correctly.

After sending down data from all the instruments, there will be a large packet of data from the computer that details the status of all processes and user-defined values. Because the computer is currently without an operating system, it is impossible to define this data explicitly. As a whole, however, the computer status data should not consist of more than 500 additional bytes, keeping the total record sent down by BOWSER under a kilobyte.

D. Number of analog channels being used: 0

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

No analog channels will be used.

F. Number of discrete lines being used: 2

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

One will be used for powering the payload on. The second will be used to power the payload off.

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

No on-board transmitters will be used.

I. Other relevant downlink telemetry information.

We may be downlinking thumbnails during flight which might require extra bandwidth. This will occur if there are any suspected errors in the BOWSER imaging system. No checksum will be used.

IV. Uplink Commanding Specifications:

A. Command uplink capability required: Yes

B. If so, will commands be uplinked in regular intervals: No

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*)

A minimum of 25 commands will be used for the entire flight unless errors occur. If BOWSER encounters a failure, 200 commands may be necessary for the duration of the flight.

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

Team BOWSER has a planned 32 serial commands, but will allow for up to 40 should there be a need for more. Commands classified as primary are intended to be used at least once during flight. Scripted commands are processes that will run on a schedule, but can be run additionally using the command. Secondary commands are non-scripted, and apply to backup processes that will only run in the case of an emergency.

Command	Name of Command	Command Type
0	Open Sunshade	Primary
1	Close Sunshade	Primary
2	Cut Power to Sunshade Motor	Secondary
3	Set G9 to Ascent Mode	Scripted
4	Set G9 to Day-Float Mode	Scripted
5	Set G9 to Night-Float Mode	Scripted
6	Set G9 to Basic Mode	Secondary
7	Set G9 Aperture	Secondary
8	Set G9 Exposure Time	Secondary
9	Set G9 Gain	Secondary
10	Set MPEG4000 to Ascent Mode	Scripted
11	Set MPEG4000 to Day-Float Mode	Scripted
12	Set MPEG4000 to Night-Float Mode	Scripted
13	Set MPEG4000 to Basic Mode	Secondary
14	Turn on Heater 1	Secondary
15	Turn off Heater 1	Secondary
16	Turn on Heater 2	Secondary
17	Turn off Heater 2	Secondary
18	Turn on Heater 3	Secondary
19	Turn off Heater 3	Secondary
20	Turn on Heater 4	Secondary
21	Turn off Heater 4	Secondary
22	Turn on Heater 5	Secondary
23	Turn off Heater 5	Secondary
24	Turn on Heater 6	Secondary
25	Turn off Heater 6	Secondary

26	Send Full H&S Data Package	Scripted
27	Send Computer Status Package	Secondary
28	Send Thumbnail from G9	Secondary
29	Send Thumbnail from MPEG4000	Secondary
30	Send LED/Photometer Status Package	Secondary
31	Send ADS Status Package	Secondary
32	Send Thermal Status Package	Secondary

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

No on-board receivers will be used.

F. Other relevant uplink commanding information.

For all commands, Team BOWSER will be using the recommended format specified in the HASP Integrations Manual.

V. Integration and Logistics

A. Date and Time of your arrival for integration:

Team BOWSER will arrive on August 2nd. Time of arrival will be dependent on driving conditions.

B. Approximate amount of time required for integration:

The BOWSER team will be participating in the entire week-long integration schedule. All available time will be used accordingly.

C. Name of the integration team leader: Kevin Dinkel

D. Email address of the integration team leader: kevin.dinkel@colorado.edu

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

Kevin Dinkel: kevin.dinkel@colorado.edu

Nick Truesdale: nicholas.truesdale@colorado.edu

Andrew Zizzi: andrew.zizzi@colorado.edu

Elvin Mujcin: mujcin@colorado.edu

Sara Schuette: sara.schuette@colorado.edu

Viliam Klein: macoklein@gmail.com

F. Define a successful integration of your payload:

A successful integration of the payload requires that the BOWSER meet all the HASP specifications. BOWSER must meet all weight, power draw, physical interfacing, and communication downlink and uplink functionality requirements that HASP sets. This will be done using the checks specified in Section H.

G. List all expected integration steps:

BOWSER must connect to the serial and EDAC connectors correctly in order to meet the power and communications requirements from HASP. The BOWSER plate must be securely mounted to HASP. Once this has been completed, all the necessary testing (below) can be done to complete a successful integration of the BOWSER payload.

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

Test	Procedure	Expected Results
Name: Weight Requirement Purpose: Ensure HASP Compliance Equipment: Scale	Weigh Payload	Expected Weight: 13.177 kg
Name: Power Requirement Purpose: Ensure HASP Compliance Equipment: HASP Power Interface	Connect BOWSER to HASP power interface. Measure power drawn from HASP.	Expected Power Draw: 2.275 A at 30 VDC
Name: Uplink Requirement Purpose: Ensure HASP Compliance Equipment: HASP Communications Interface	Connect BOWSER to HASP communications interface. Uplink a command. Check BOWSER's computer status to ensure command was received and executed.	Expect that all commands meet the HASP uplink requirements and function as they are supposed to.
Name: Downlink Requirement Purpose: Ensure HASP Compliance Equipment: HASP Communications Interface	Connect BOWSER to HASP communications interface. Downlink a data package. Check with HASP to ensure that data package was received correctly.	Expect that all packages meet the HASP downlink requirements and are received successfully.
Name: BOWSER Thermal Vacuum Test Purpose: Ensure BOWSER Functionality at Flight Conditions Equipment: HASP Communications Interface	Place BOWSER in Thermal Vacuum. Take data from computer and temperature sensors. Check for system functionality and failures.	Expect BOWSER to function successfully at extreme low pressure and varying thermal conditions.
Name: BOWSER Functionality Purpose: Ensure BOWSER Data Collection Equipment: HASP Communications Interface	Data shall be collected between BOWSER and our personal computers to determine if all scientific sensors are correctly functioning.	Expect BOWSER's sensors to be taking and storing data successfully.

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…):

Any necessary LSU assistance cannot be foreseen at this time.

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

Team BOWSER will require power outlets, an area to work and lay out equipment, and DC bench converters that simulate the HASP power supply (capable of 30V at 2.5A). All other necessary equipment will be brought with the BOWSER team.