



# HASP Integration Plan



**Payload Title:** \_\_\_\_\_ ARIES GPS Payload \_\_\_\_\_

**Payload Class:**      Small     Large     (circle one)

**Payload ID:** \_\_\_\_\_ 8 \_\_\_\_\_

**Institution:** \_\_\_\_\_ Inter American University of Puerto Rico Bayamon Campus \_\_\_\_\_

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**Submit Date:** \_\_\_\_\_ June 21, 2013 \_\_\_\_\_

## I. Mechanical Specifications:

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

In order to know the ARIES GPS payload weight some steps were done. First we weighted all the electronic components (board and devices) that will be part of the ARIES GPS payload. Then doing the design of ARIES GPS payload in Solid Work software we estimated the payload structure weight, which we confirm with the construction of the prototype structure. The material selected for the Solid Work simulation was Aluminum 6061T6 and PVC ¼. Table 1 show the result for the measured and estimated weight.



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ITEM	WEIGHT
MBS-GPS-OEMV -1DF PC/104	89 g
Flight Computer	113.5 g
Temperature Sensors DS18B20-TO-92	1g
Payload Structure	600 g
Mounting Plate ( <b>estimated</b> )	329.2g
Antenna Bracket	224 g
Antenna	100g
RF splitter+ board	333g
CASES GPS	453.6g
Power Board	239g
External Temperature Sensor	2g
Cables & Connectors ( <b>estimated</b> )	70g
Total Weight ( <b>without payload plate</b> )	<b>2554.3g</b>
Total Weight ( <b>with payload plate</b> )	<b>2883.54g</b>
Weight Limit	<b>3kg</b>
Weight Margin	<b>14.85%</b>

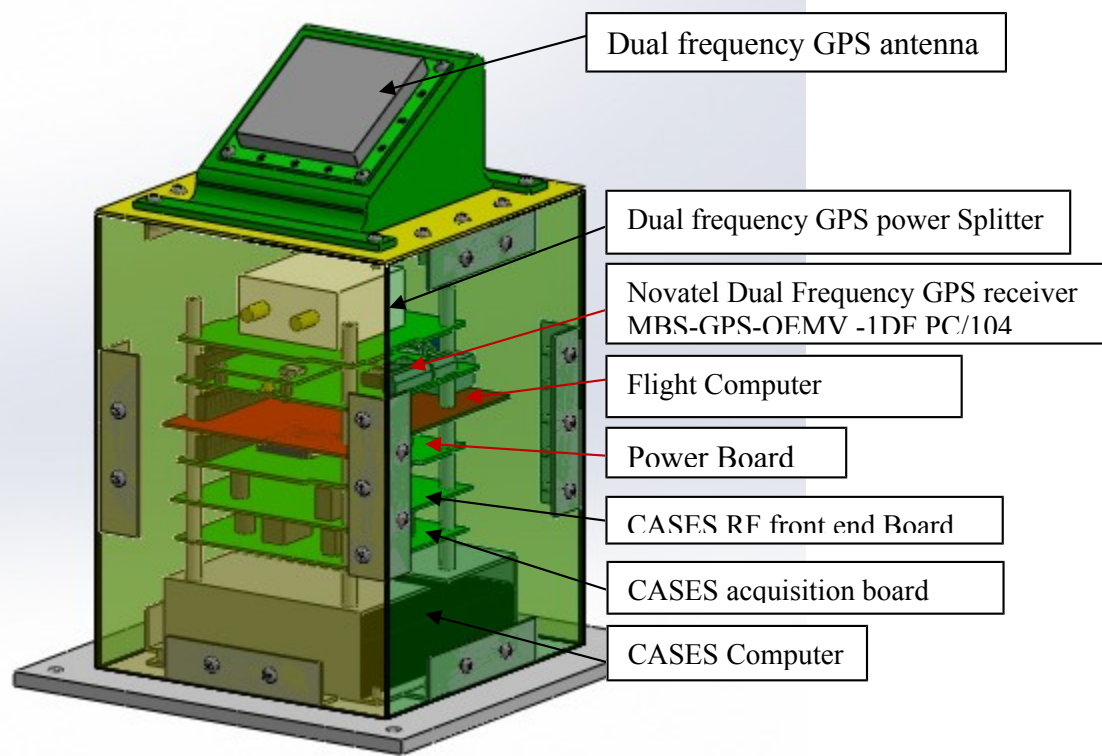
**Table 1: Weight of the ARIES GPS payload components**

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

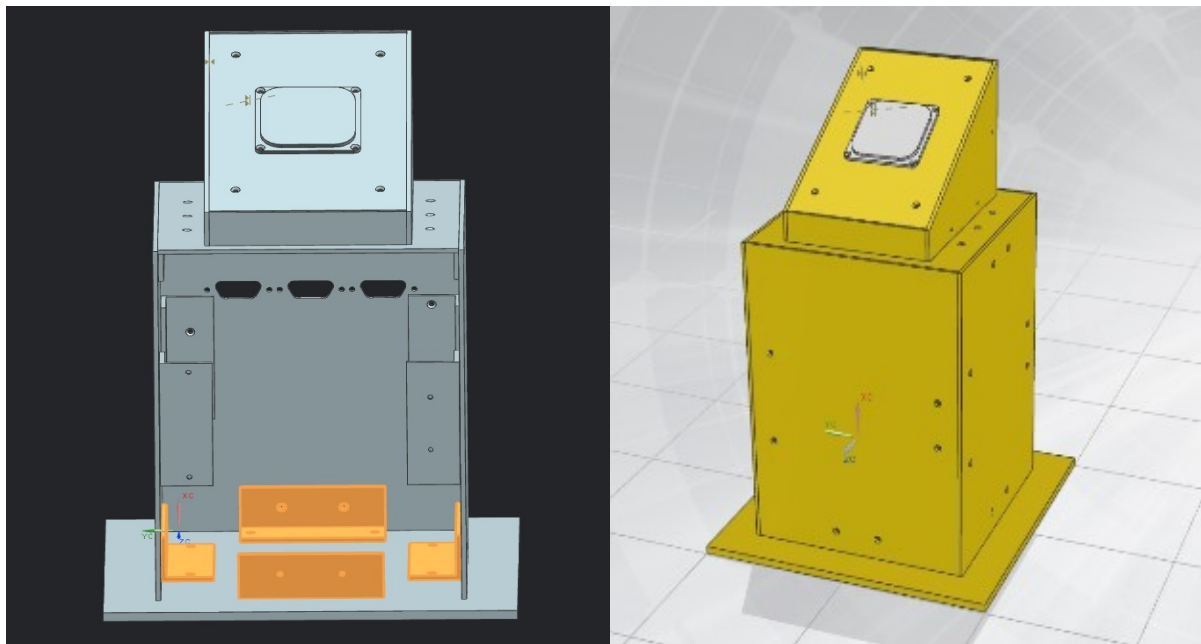
Several Solid Work designs were developed to addressing this point. **Figure 1** show the ARIES GPS payload major components and **Figure 2 and 3** show how the payload will be attached to the mounting plate. In addition the **Figure 4** illustrates the ARIES GPS payload design and dimensions.



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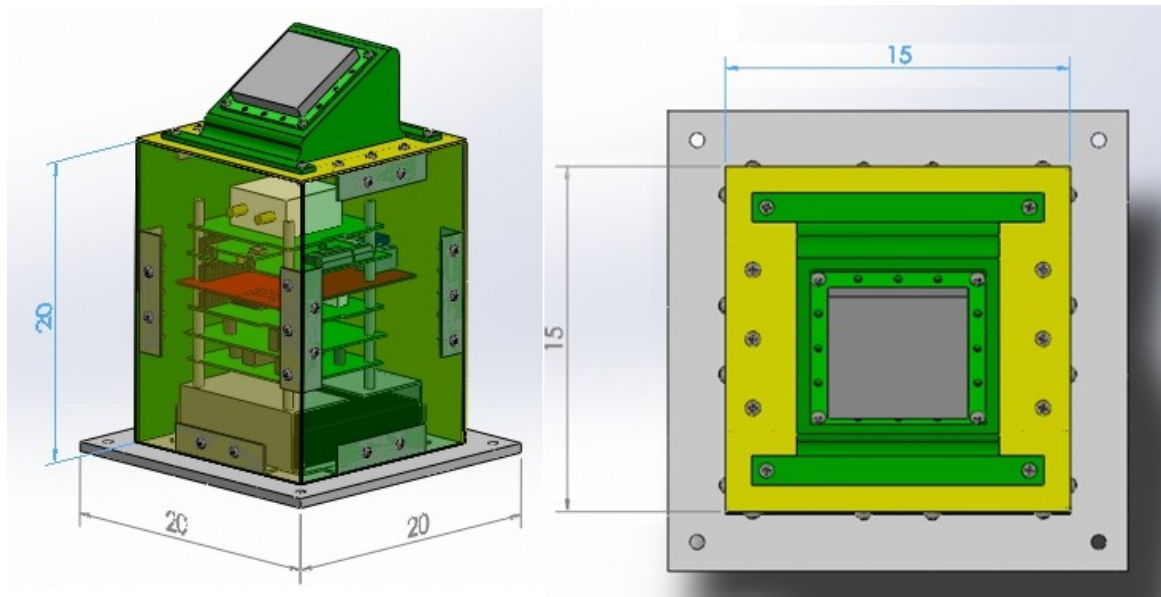
*Figure 1: ARIES GPS payload major components*



*Figure 2 & 3: How the payload will be attached to the mounting plate*



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**Figure 4: ARIES GPS Payload design and dimensions**

## C. Hazard Information :

The GPS payload will not fly any material that will be hazardous to the HASP balloon.

## D. Other relevant mechanical information

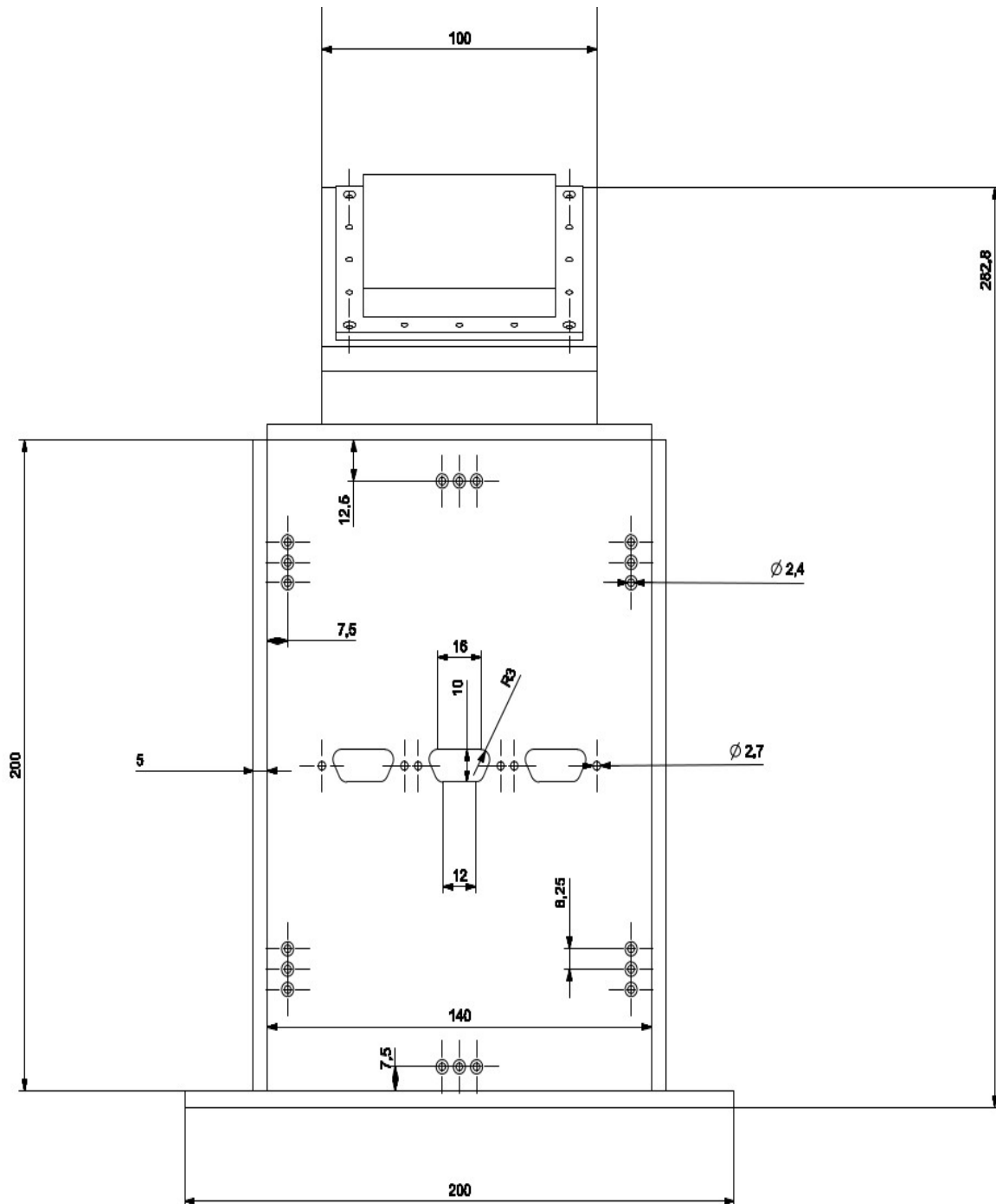
With the purpose of improving the process of integration, debugging and test, the team decided to add several mechanical transformations to the payload. The most relevant of those is that in the front face of the payload (the one facing the EDAC and serial port connections from HASP) were added three ports connectors for the following functionality:

- 1) **Power connector.** It was because of experience from previous flight that the team realized that power the payload with an external port help the payload rapid integration and performance.
- 2) **Serial Port connector:** Created to facilitate the serial communications between the payload and the HASP main computer.
- 3) **Debugging Port:** In case some last minutes changes needs to be added to the flight software , a debugging port is a handy and useful tool for integration and flight tests.

The illustration below shows in detail the changes performed.



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**Figure 6: HASP GPS Payload mechanical design in mm**



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## II. Power Specifications:

A) Measured current draw at 30 VDC

In order to identify the total current consumption for the ARIES GPS payload at 30 VDC some tests were realized on the payload. The result of these tests is shown below in Table 2.

Device	Voltage (V)	Current (mA)	Power (mW)
Razor IMU	3.3	6.86	22.64
MBS-GPS-OEMV-1DF PC/104PC	5	320	1600
Flight Computer	5	200	1500
Temperature Sensors DS18B20-TO-92	5	1.5	15
Antenna	5	50	250
External Temperature Sensors	5	2	10
CASES GPS acquisition board	5	200	1000
ASTRA GPS RF front end board	5	300	1500
CASES GPS Computer Board	12	500	6000
Total Power Consumption (Nominal)	<b>30</b>	<b>396.6</b>	<b>11898</b>
Total Power Consumption (Max)	<b>30</b>	<b>456</b>	<b>13680</b>
Power Limit	<b>30</b>	<b>500</b>	<b>15000</b>
Power Margin	--	<b>44</b>	<b>1.32</b>

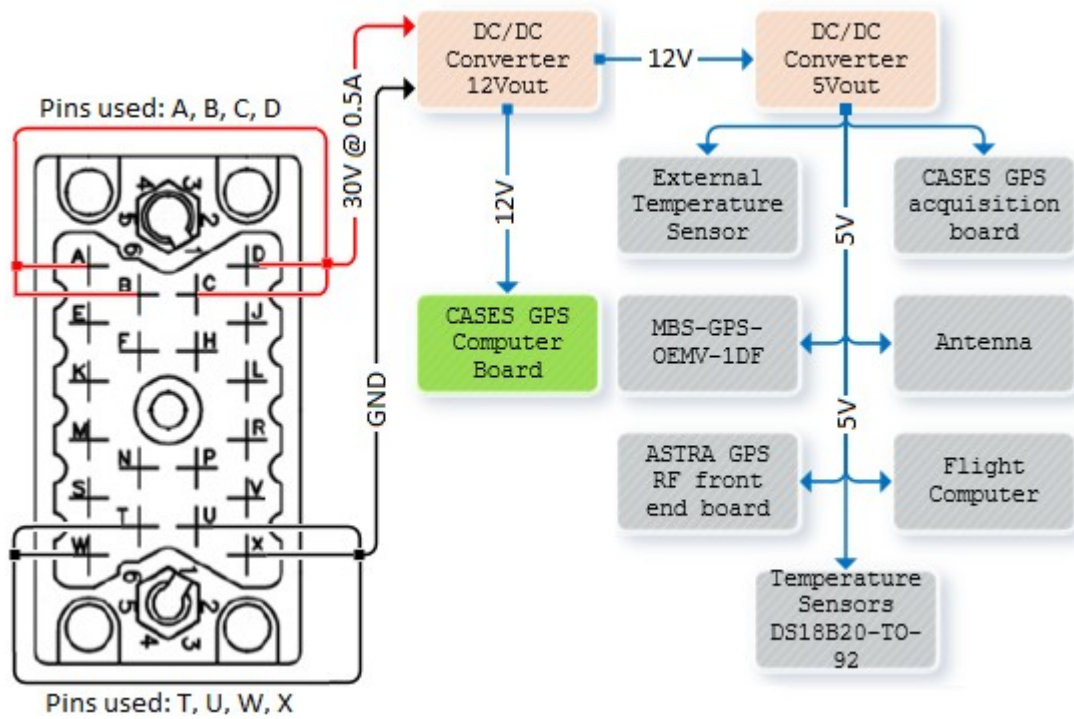
**Table 2: Current draw of the ARIES GPS payload components**

The measured current observed at 30V was between 390 mA and 456 mA. This variation is caused by the different stages of the CASES GPS Computer Board, which is in charge of different processes on the payload. The current draw at steady state was ~420 mA.

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



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**Figure 7: Wiring Diagram**

This payload will employ power from the HASP platform. A source of 30V at 0.5A will be supplied by the HASP platform to the payload through the EDAC 516 connector. Wires A, B, C and D are connected together to obtain a positive 30V at 0.5A from the platform. Wires T, W, U and X are connected together for ground. The LM2673 DC/DC converter will step down the 30V from the platform to 12V, supplying power to the CASES GPS Computer Board. Another LM2673 DC/DC converter will step down the 12V to 5V, supplying power to the 5V devices. Details of the 5V devices are showed in Figure 6.

C) Other relevant power information

The Razor IMU will be powered from the digital pins of the Flight Computer, which are able to output 3.3 VDC.

### III. Downlink Telemetry Specifications:

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

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

The approximate serial downlink rate will be  $63 * 8 = 504$  bits each 8 seconds, which is equivalent to 63 bits per second.



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

The ARIES-GPS team will send scheduled health and status packages through the downlink at regular intervals. These packets are used for monitoring the payload performance, at almost real time. The amount of data generated by our experiment is extensive and we are unable of downloading all the data recompiled. However some packages will be downloaded as a Housekeeping data. The almost real time analysis of the data will provide the experiment of a method for knowing the experiment health. Each packet, stored and down linked will be time-stamped. In addition these packets will follow a custom made format developed by our team members, and will be composed of the bytes show in Table 3.

- D.** Number of analog channels being used:

Not analog port will be used by ARIES Sat GPS payload.

- 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.

No, the GPS payload will not have an on boar transmitter.

- I.** Other relevant downlink telemetry information.

None





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BYTE	NAME OF BYTE
0	Start of header ('#' -ASCII character)
1-4	UTC year
5	Comma separator
6	UTC month (0-12)
7	Comma separator
8	UTC day (0-31)
9	Comma separator
10	UTC hour (0-23)
11	Comma separator
12	UTC minute (0-59)
13	Comma separator
14-17	UTC millisecond (0-60999)
18	Comma separator
19-22	GPS pseudorangeL1
23	Comma separator
24-27	GPS pseudorangeL2
28	Comma separator
29-32	GPS carrier_phaseL1
33	Comma separator
34-37	GPS carrier_phaseL2
38	Comma separator
39-42	GPS Latitude
43	Comma separator
44-47	GPS Longitude
48	Comma separator
49-52	GPS Height
53	Comma separator
54-57	SBC temperature



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58	Comma separator
59-60	Packet number(0-65536)
61	Comma separator
62-63	16 bits CRC

**Table 3: Packets by format**

## 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*)

Based on the realistic uplink situation of the mission the team expect to uplink a few times (around 12 uplinks) through the flight, and no more than 2 commands per hour. The amount of commands uploaded will depend on the experiment health checked with the downlinked data.

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

### 1. Start Mission Command:

Command Name:	ON
Hex Command Byte:	4F
Critical?	Yes
Payload Response Message:	"Command Received: ON"

Brief Description:

The command should be sent immediately after the payload is in secure flight. At power up the payload will initialize all the drivers and prepare the system for mission's objectives. The command will enable the modules related to the payload mission requirements.

### 2. Reboot Command:

Command Name:	RBT
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Hex Command Byte:	42
Critical?	Yes
Payload Response Message:	"Command Received: RBT"

### Brief Description:

The Reboot command will reset the payload flight computer operation if something goes wrong. This command will be executed upon command received action or upon problematic performance in software.

### 3. IMU ON Command:

Command Name:	ION
Hex Command Byte:	49
Critical?	No
Payload Response Message:	"Command Received: ION"

### Brief Description:

The command will turn on only the IMU, if required in some point of the experiment.

### 4. IMU OFF Command:

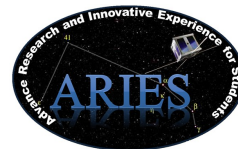
Command Name:	IOFF
Hex Command Byte:	50
Description:	Turns off the IMU.
Critical?	No
Payload Response Message:	"Command Received: IOFF"

### 5. NULL Command:

Command Name:	NULL
Hex Command Byte:	00
Description:	Terminates listening mode
Critical?	No
Payload Response Message:	"Unrecognized or NULL command"



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## Example of Command Transmission String

As part of the uplink command format below is an example on how the commands will be formatted for future uploading. Table 4 is an example of the Start Mission TON command string in hexadecimal format:

“0102804F030D0A”

Byte	Hex Value	Description
1	01	Start of Heading (SOH)
2	02	Start of Text (STX)
3	80	Payload ID + Checksum
4	4F	Hex Command Byte
5	03	End of Text (ETX)
6	0D	Carriage Return (CR)
7	0A	Line Feed (LF)

**Table 4: Command Transmission Format**

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

The ARIES GPS payload will have two on-board GPS receiver, which we listed below:

- 1) Novatel OEMV-1DF GPS receiver, working at the L1 (1575.42 Mhz) and L2 (1227.60 Mhz) GPS frequencies.
- 2) ASTRA CASES GPS receiver, working at the L1 (1575.42 Mhz) and L2 (1227.60 Mhz) GPS frequencies.

F. Other relevant uplink commanding information.

It is worth to mention that the team does not require any GPS upstream from the HASP computer as our experiment consist of two different onboard GPS. Our team hereby request to disable the GPS streaming to our payload from the HASP computer.

## V. Integration and Logistics

A. Date and Time of your arrival for integration:

ARIES GPS payload team will arrive on July 29, 2013 to Palestine, TX. The time of arrival will be dependent on the flight schedule. In addition the time of arrival will depend on the final date of the integration; possible changes may be presented on that as stated on the April teleconference.

B. Approximate amount of time required for integration:



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The approximate amount of time required for the integration of the ARIES GPS payload is no more than three hours.

C. Name of the integration team leader:

Alejandro Miralles Sanchez

D. Email address of the integration team leader:

[amiralles2010@yahoo.com](mailto:amiralles2010@yahoo.com)

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

Alejandro Miralles Sanchez: [amiralles2010@yahoo.com](mailto:amiralles2010@yahoo.com)

Luis A. Ruiz Linares: [linares.c.eng@gmail.com](mailto:linares.c.eng@gmail.com)

F. Define a successful integration of your payload:

To get a successful integration the ARIES Sat GPS payload has to meet all HASP requirements. Its total current draw at 30V has to be less than 500 mA (with no inrush current) and its weight less than 3kg. In past edition of the HASP flight our payload presented some electrical issues that invalidated our flight for that occasion, so all efforts are targeted to achieve a successful integration during this year flight. In addition the payload has to be able of send data to the HASP platform to a data rate of 1200 bps or lower. Moreover the ARIES GPS payload need to be capable of receive uplink commands from the HASP platform, even though it is important to notice that our team does not required GPS stream from HASP computers. In addition the payload dimension has to be equal or smaller to 15x15x30 (cm). Finally the thermal range has to be between -80C to 40C, and the ambient pressure up to 10 mbar.

G. List all expected integration steps:

The expected integration steps for the ARIES GPS payload are as follow:

1. Weight the payload to prove that it is within the HASP parameter.
2. Provide to the HASP personnel a detailed drawing with the payload description.
3. Ensure that the payload is properly attached to the platform and is correctly insulated
4. Turn on the payload to prove that it power consumption doesn't exceed the HASP requirement, and more important to ensure and show that no current peaks are drawn at power up.
5. Give to the HASP personnel a detailed wiring diagram.
6. Perform the thermal and vacuum test to demonstrate that payload is able to work appropriate on the HASP environment.
7. Send some downlink packages to evidence that payload data rate is within the HASP requirement and to confirm a successful communication between the ARIES GPS payload and the HASP platform.
8. Provide a list of the Up-link command for the payload to the HASP personnel.



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9. Review that not frequency interference between the GPS receiver on the payload and the HASP platform.
  10. Offer a list with the payload team members and their contact information to the HASP personnel.
  11. Present the mission plan to the HASP personnel.
- H.** List all checks that will determine a successful integration. (See Table 5)

Integration Step	Requirement	Expected	Checks
Weight the Payload	3kg or less	2.6 Kg	
Payload Drawing	Mechanical drawing detailing the major components and how your payload is attached to the payload mounting plate.	A detailed Solid Work diagram addressing those points will be submitted.	
Measure the current consumption at 30V	500 mA	400 mA	
Wiring Diagram	Power system wiring diagram starting from pins on the student payload interface plate EDAC 516 connector through your power conversion	A complete power wiring diagram, developed in Eagle will be submitted.	
Thermal and Vacuum Test	Thermal Range -80C to 40C and ambient pressure up to 10 mbar.	Several tests will be performed to the payload at the Inter American University vacuum chamber to ensure it appropriate operation under these conditions.	
Down Link	1200 bps	The flight computer baud rate will be setup to send serial data to 1200 bps.	
Team Members information	A list of all payload team members including contact information	A document providing the team information will be submitted for the team during the integration process.	
Mission Plant	A mission plant has to be developed.	A document specifying the mission plant will be developed for the team and summated for the corresponding deadline.	

**Table 5: Checks to determine sucessfull integration**



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- 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:

- 1) Power supply of 30VDC @ 1A.
- 2) Digital Oscilloscope.
- 3) Digital Multimeters