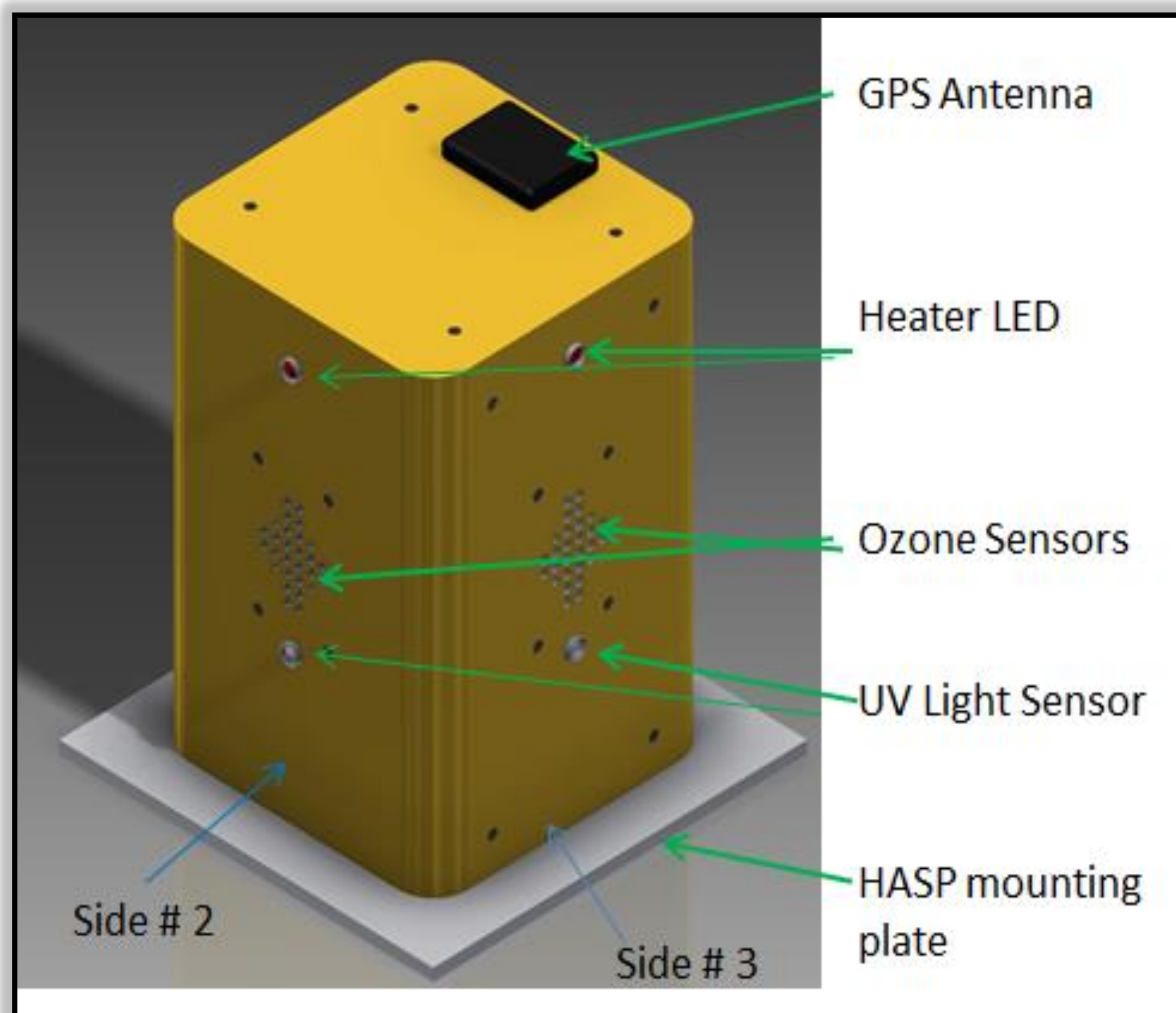
HASP 2016
Revised PSIP
(Payload Specification and Integration Plan)

University of North Florida (UNF) and University of North Dakota (UND) Payload

OSPA
Ozone Sensors Payload and its Applications



Project Abstract

UNF-UND team have successfully flown payloads on the HASP balloon flights since 2008 and measured the ozone gas profile in the stratosphere. The ozone profiles measured by sensors payloads were nearly matched with the expected profile. Based on the success, experience and the few known technical issues of the previous payloads, the UND-UNF team proposes the HASP 2016 flight for the development of improved version of payload to measure ozone profile using high sensitive and selective ozone gas sensor arrays and also to measure pollutant gases in the atmosphere and troposphere. The output of the proposed payload will help us for the development of free flying small gas sensors payload instrument for meteorological weather balloon, rocket or sub orbital space vehicle and may be used at Antarctica for the long duration of balloon flight.

The new version of eight nanocrystalline ITO thin film gas sensors array and eight nanocrystalline alpha phase of silver tungstate thin film gas sensors array will measure oxidizing ozone gas, while eight nanocomposite SnO_2+ITO thin film gas sensors will detect the pollutant gases such as smog, CO, CO_2, methane in the atmosphere and troposphere. These thin film sensors have higher sensitivity, good selectivity and stability and also faster response time. Temperature controller will be used to control operating temperature of all gas sensors at about 302 K. Three sensors boxes will be mounted on the three sides of rectangular payload body. The new UV light photodiode will be mounted just below ozone gas sensors box in order to measure amount of photovoltage generated by UV light, which will support the science concept of generation of ozone gas in the presence of UV light. This concept will help us understanding the effect of darkness or shadow on the gas sensors and decrease of ozone gas concentration at the night time. In addition, new pressure sensor will measure the low pressure about 1 mbar. GPS will measure the altitude throughout the flight without any blockage of transmission.

Ozone and pollutant gas sensors will be fabricated and calibrated by the students' team at UNF and also tested at UND. The modified version of developed payload may use to fly on the long duration of balloon flight at Antarctica, which is our dream and long term goal.

Table of Contents

1. Payload Description

1.1 Payload Title: Ozone Sensors Payload and its Applications (OSPA)

Payload Short Title: OSPA

Brief Objective of Payload: *Scientific payload for the measurement of the ozone profile in the stratosphere, and of the pollutant gases in atmosphere, and troposphere, using improved nanocrystalline gas sensor arrays on a high altitude balloon platform*

1.2 Payload Class: Small

1.3 Institution
University of North Florida, 1 UNF Drive, Jacksonville, FL 32224 and
University of North Dakota, Grand Forks, ND 58202

1.4 Contact Information

Student Leader	
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Faculty Advisor of UND	
Dr. Ron Fevig	
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rfevig@space.edu	

1.5 Resubmit Date: June **23**, 2016
1.6 Payload ID: 2016-07

2 Mechanical Specifications

2.1 Payload Weight

Table-1 Tentative Payload weight and dimension budget

Item:	Dimension	Mass (g)
8 Ozone sensors box #1 (including fan, heater, box)	3 x 2 x 1 inch	200.0±2.0
8 Ozone sensors box #2 (including fan, heater, box)	3 x 2 x 1 inch	200.0±2.0
8 Pollutant sensors box#3 (including fan, heater, box)	3 x 2 x 1 inch	200.0±2.0
Microcontroller PCB with mounted components	4 x 6 inch	300.0±1.0
Payload body, top plate and thermal blanket	9 x 6 x 6 inch	1100±10.0 g
Few Cables, 1 GPS, 2 LEDs, 3 Photodiodes, nuts and bolts		300±5.0 g
HASP mounting plate	7.9 x 7.9 inch	550±3.0 g
Total mass of the payload and HASP plate		**2850±25.0 g**

2.2 Payload Drawings

We are using the same payload design as HASP2015 payload. The payload body retained it's easy to open and close design utilizing the top plate for access to the PCB as well as all sensor boxes. The payload continues to feature a rectangular design due to its robustness featuring high rates of success with stability upon landing, as well as for its low rate of outgassing under extreme pressure drops. This design is optimal for the team's goal of a reusable, independent payload. The details of design and drawing for payload body and sensors PCB are shown in figs. 1 to 8.

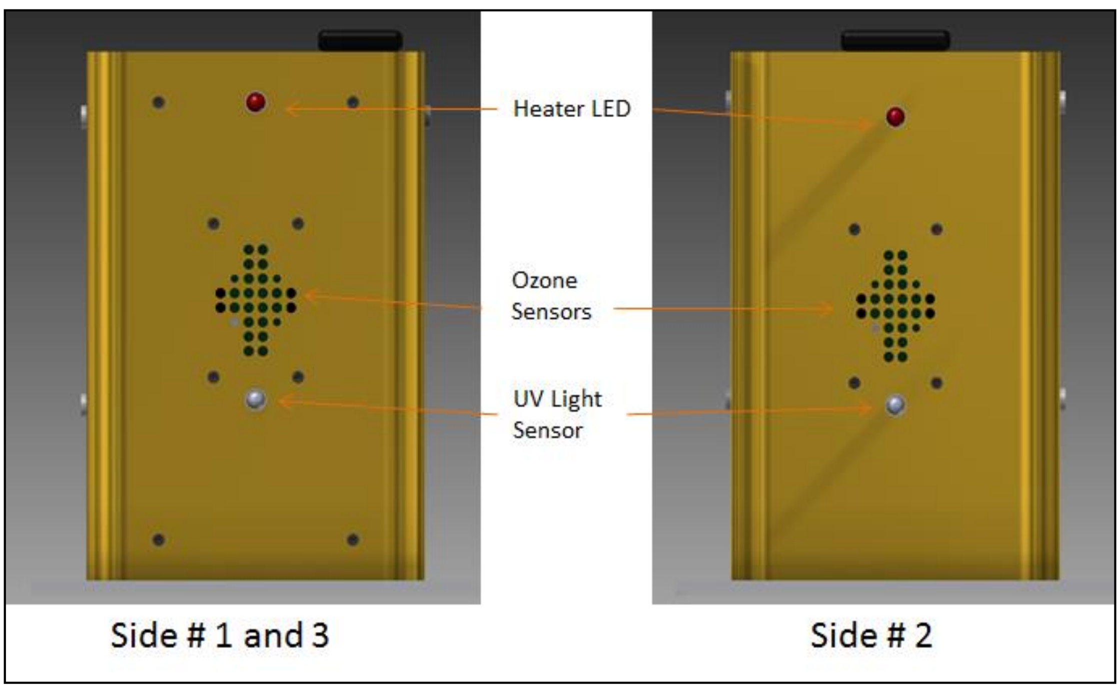

Fig. 1 Side view design of the payload

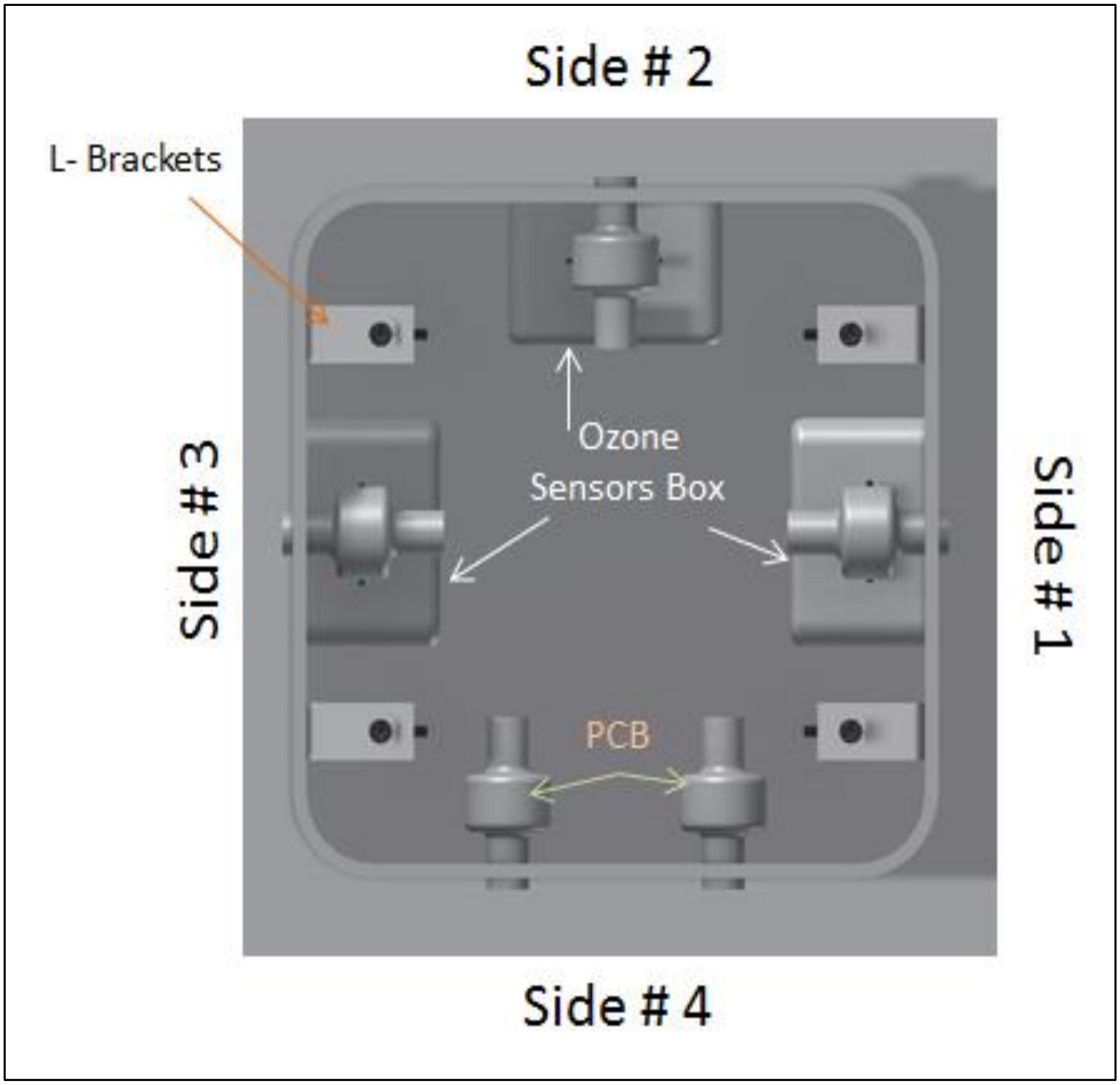

Fig. 2 Top view design of the payload

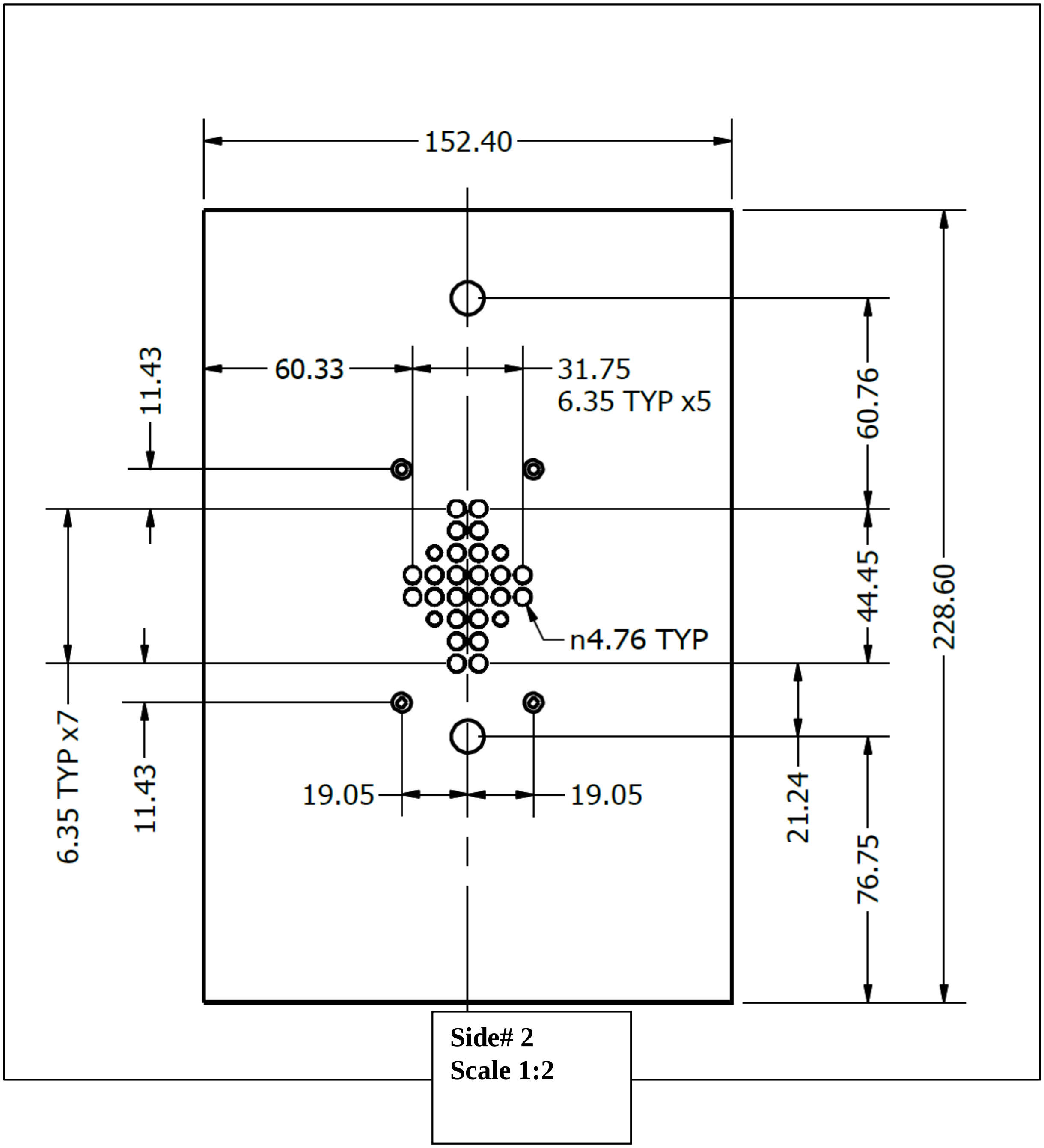

Fig. 3 Design of side # 2 of the payload
All dimensions are in mm.

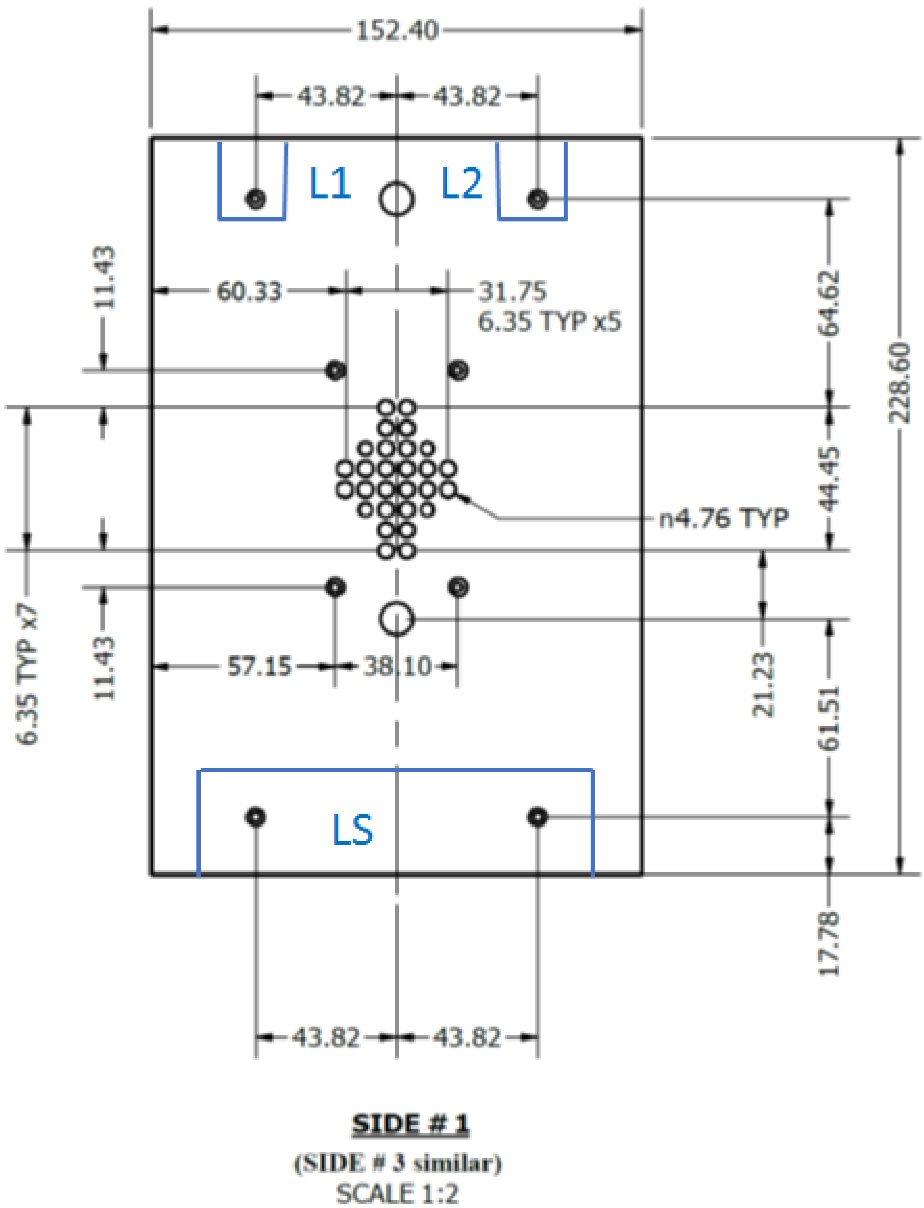

Fig. 4 (a) Design of sides # 1 and 3 of the payload.
All dimensions are in mm.
L1 and **L2** are L-Brackets to mount the top lid on the Payload body
LS is L-Strip to mount the HASP plate with Payload body

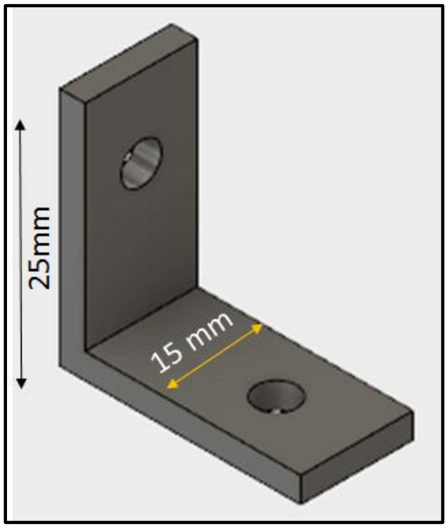

Fig. 4 (b) Schematic diagram of L- Bracket.
L1 and **L2** are L-Brackets for mounting the top lid on the Payload body

Fig. 4 (c) Schematic diagram of L-Strip (**LS**) for mounting the HASP plate with Payload body

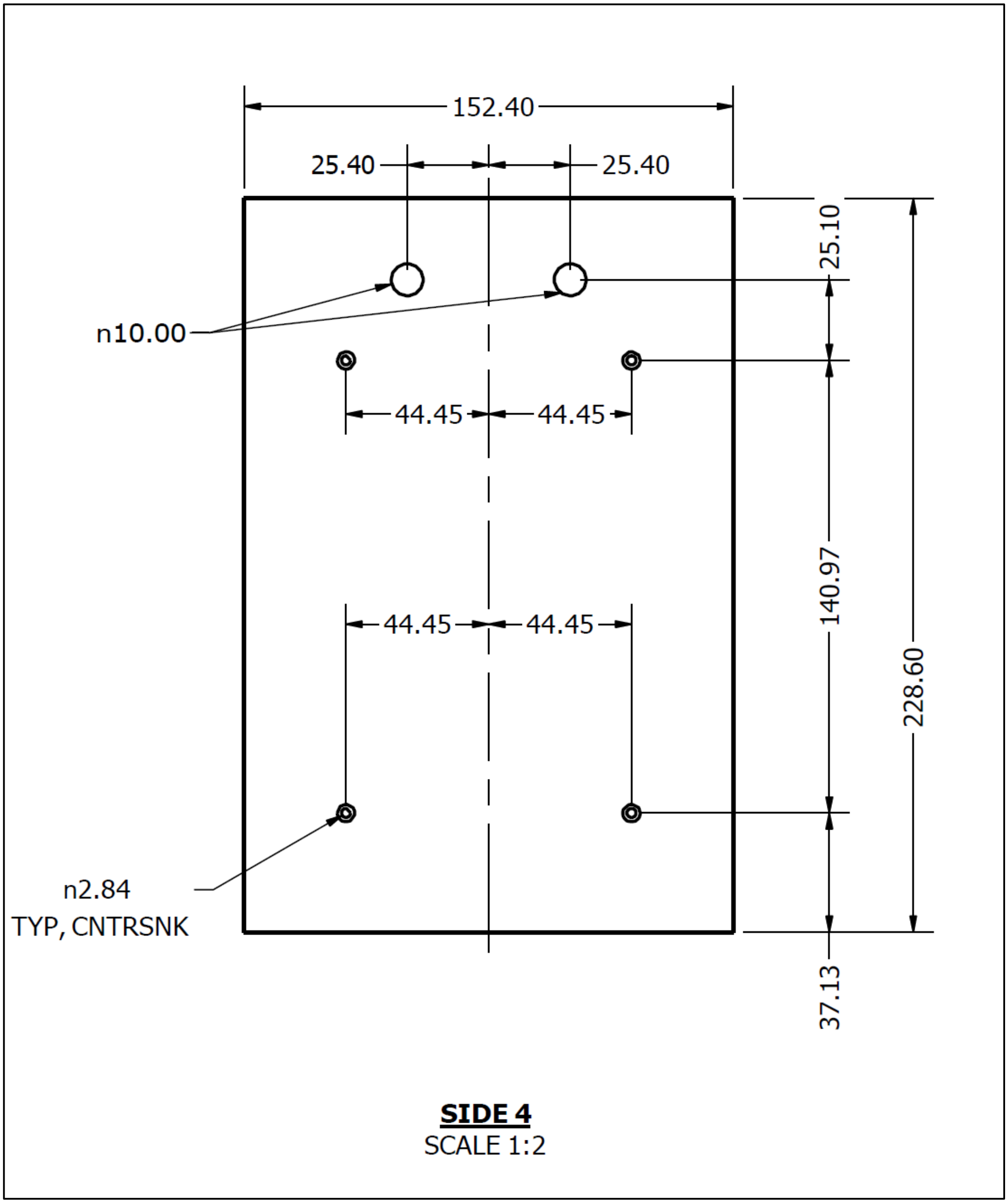

Fig. 5 Design of side # 4 of the payload
All dimensions are in mm.

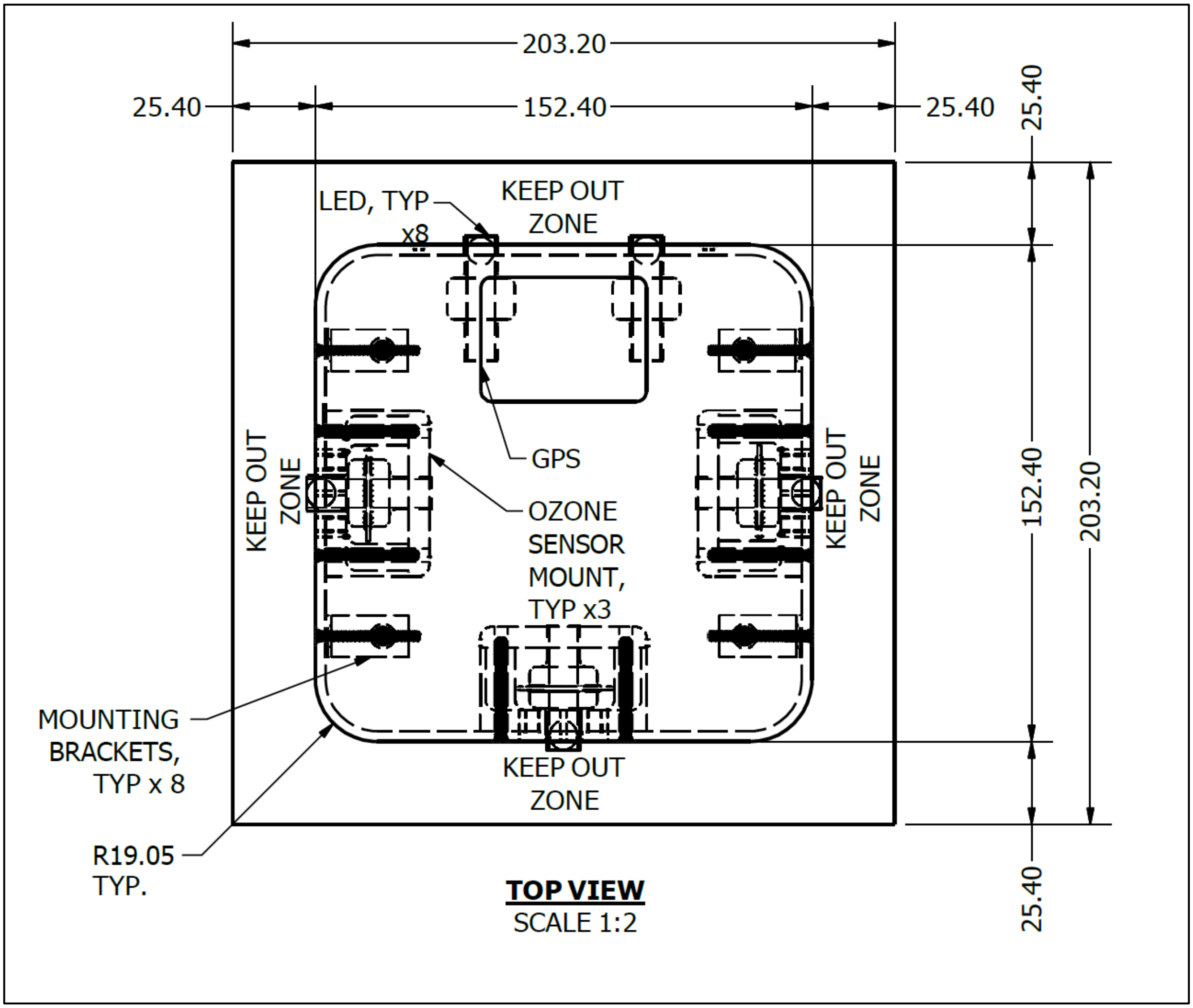

Fig. 6 Design of top view of the payload
All dimensions are in mm.

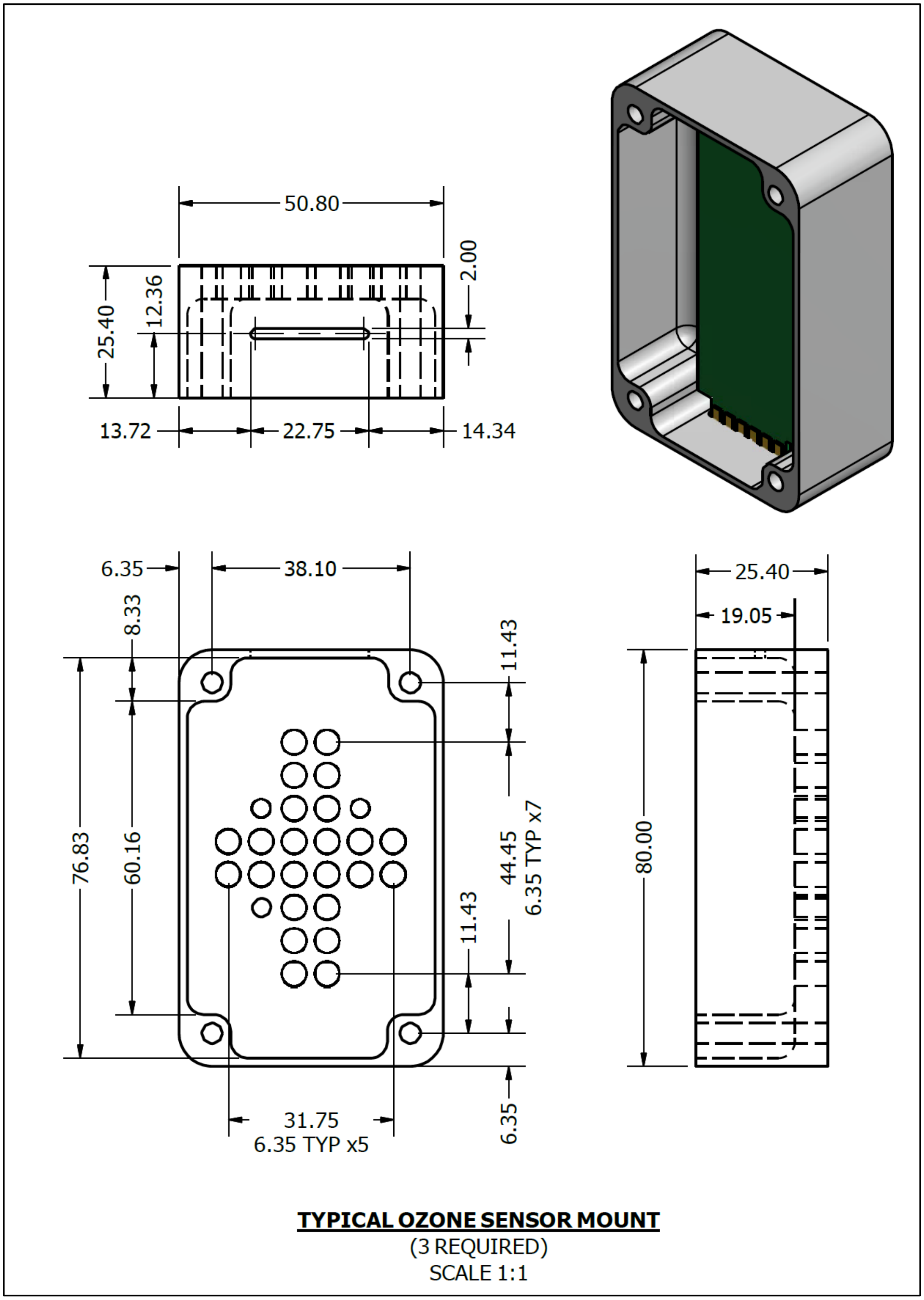

Fig. 7 Design of top view of the payload
All dimensions are in mm.

The payload will be mounted on the HASP mounting plate using aluminum L-brackets, bolts, washers and nuts.

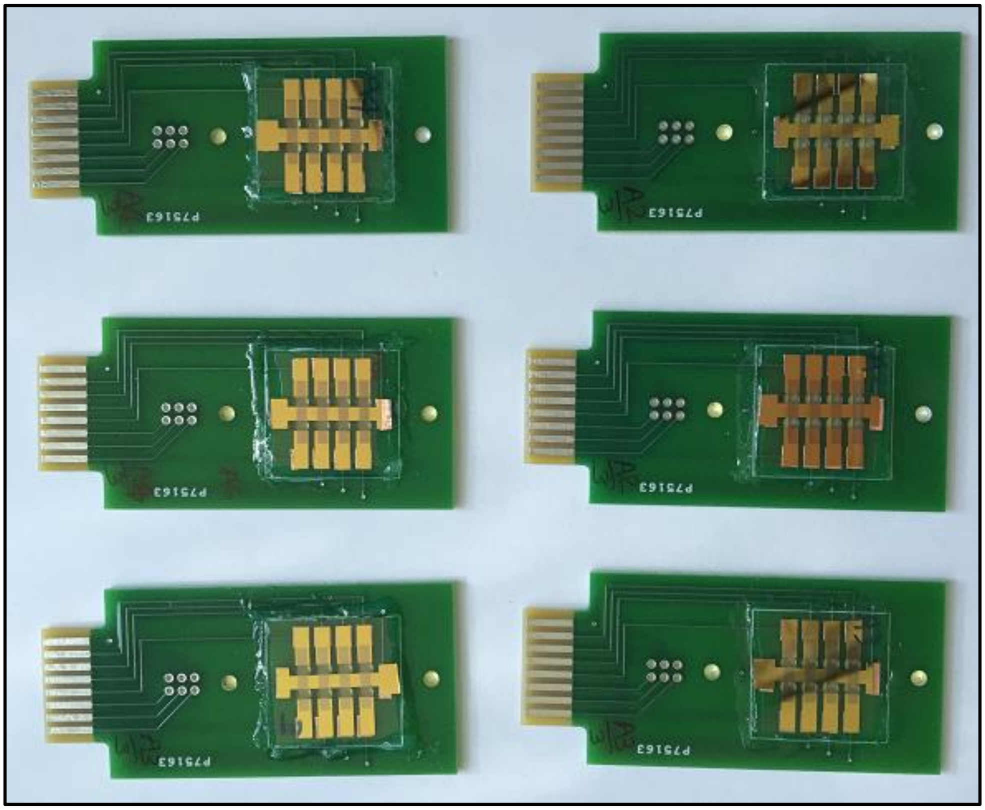

Fig. 8 Gas sensor arrays mounted on the PCB

Fig.8 shows the picture of gas sensor arrays fabricated in Dr. Patel's lab by the UNF team. Each sensor PCB is attached to the sensor box housing with one heater, fan and a temperature sensor.

2.3 Other Information

The team does not plan to fly any potentially hazardous material. The payload will also be mounted to the HASP specified, and provided, mounting plate using four bolts, washers, and nuts.

A Thermal blanket made of an aluminized heat barrier, with an adhesive backing, will be applied to the payload prior to integration and should remain on the payload throughout launch. The payload will be shipped with said blanket still applied. The team has tested the use of thermal blankets on past payloads, and data has proven the benefits of thermal blanket use, such as added thermal stability. Therefore the team will continue to implement use of a thermal blanket.

3 Power Specifications

3.1 Power Budget

The expected current and power drawn by the payload at 3.3 applied voltage are given in the following table.

Circuit Function	Current Draw (mA) at 3.3 V	Power (W) draw at 3.3 V
Payload Power ON, ALL heaters OFF	30± 5	0.099±0.017
Payload Power ON, ONE heater ON	140± 5	0.462±0.017
Payload Power ON, TWO heaters ON	250± 5	0.825±0.017
Payload Power ON, Three heaters ON	360± 5	1.2±0.017

The minimum power drawn by the payload will be about 0.099 ±0.017 W, while maximum power drawn will be about 1.2±0.017 W. Most of time power drawn by the payload during the float will be less than 1.0 W.

3.2 Power System Wiring

Fig. 9 shows the circuit diagram for connection of the voltage regulator of payload with EDAC 5016 connector to get the power from the HASP power supply.

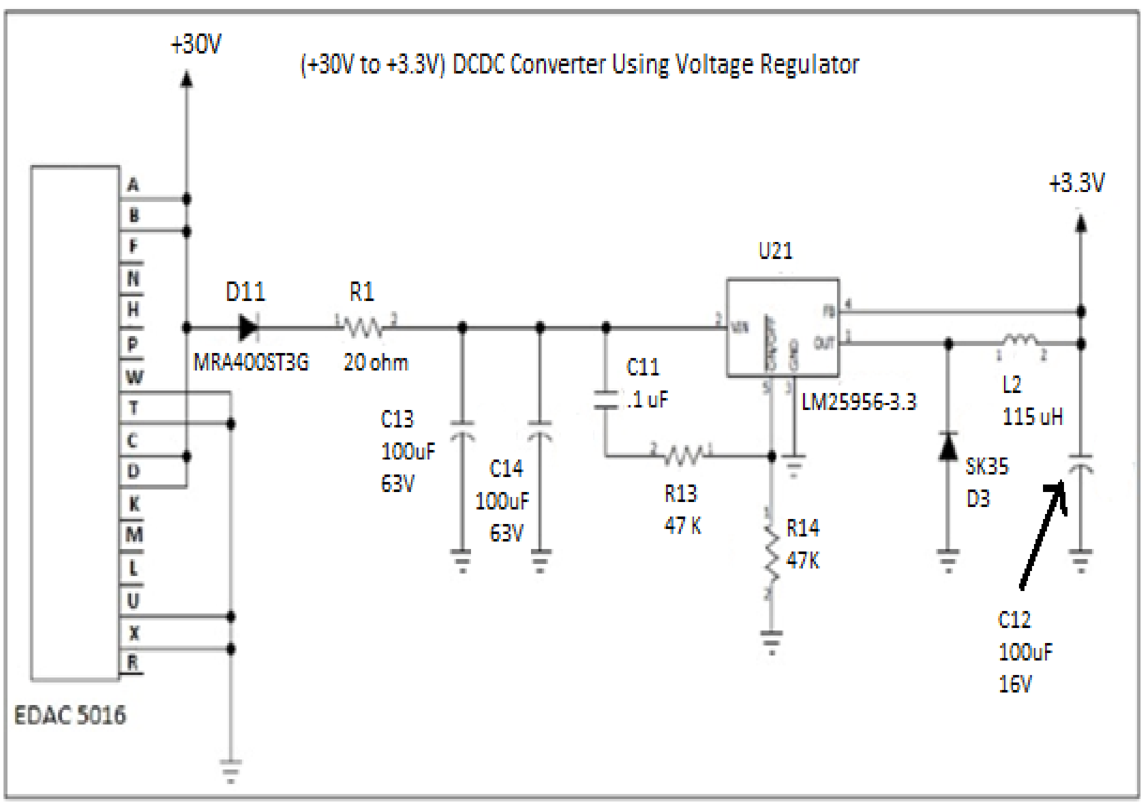

Fig. 9 Power system wiring through the EDAC connector

4 Downlink Telemetry Specifications

4.1 Serial Data Downlink Format

Packetized ±232 bytes, transmitting in five-second intervals

4.2 Serial Downlink Rate

372 bps

4.3 Serial Data Record

Item	Bytes
Data packet sync	11
GPS source indicator	6
UTC time	10
MLS altitude	7
Filtered ozone data	24 bytes, 6 times
Local sensor temp	3 bytes, 6 times
Photo-cell	3 bytes, 6 times
CPU temp	6
MCU power rail voltage	6
MCU power rail current	6
Atmospheric pressure in mbar	6
Heater status	6

Analog channels used:	**0**
Discrete lines used:	0

5 Uplink Commanding Specification

5.1 Command Uplink Capability

YES

5.2 Commands uplinked in regular intervals?

NO

5.3 Command Table

#	Command Description	Cmd. Code	Checksum	Confirmation/Notes
1	Reset	0x71	0x31	"HELLO" upon reset
2	Erase data in flash	0x72	0x32	"ERASING FLASH"…"COMPLETE"
3	Upload data in flash	0x73	0x33	"NO DATA"
4	n/a	n/a	n/a	n/a
5	Master Heater Override Switch On	0x75	0x35	Heater Status (default)
6	Master Heater Override Switch Off	0x76	0x36	Heater Status
7	On Board Data Logging On	0x77	0x37	Data (default)
8	On Board Data Logging Paused	0x78	0x38	Data empty
9	Stream UBLOX data	0x79	0x39	"HASP 2014 UBLOX"
10	Stream HASP GPS data	0x7A	0x3A	"0"

5.4 Data String Table

Byte #	Description	Example	Units
1 - 4	Packet Sync	HASP	n/a
5 - 8	GPS Source	XGPS	n/a
9 - 23	Time stamp	,1407604205.265	sec
24 - 29	Altitude	,38044	m
30 - 35	Sensor 1-1	,01067	ohms
36 - 41	Sensor 1-2	,01390	ohms
42 - 47	Sensor 1-3	,01438	ohms
48 - 53	Sensor 1-4	,01248	ohms
54 - 59	Sensor 1-5	,01282	ohms
60 - 65	Sensor 1-6	,01450	ohms
66 - 71	Sensor 1-7	,01358	ohms
72 - 77	Sensor 1-8	,01060	ohms
78 - 83	Sensor 2-1	,01623	ohms
84 - 89	Sensor 2-2	,02874	ohms
90 - 95	Sensor 2-3	,02999	ohms
96 - 101	Sensor 2-4	,01820	ohms
102 - 107	Sensor 2-5	,01993	ohms
108 - 113	Sensor 2-6	,02956	ohms
114 - 119	Sensor 2-7	,02812	ohms
120 - 125	Sensor 2-8	,01371	ohms
126 - 131	Sensor 3-1	,01495	ohms
132 - 137	Sensor 3-2	,01652	ohms
138 - 143	Sensor 3-3	,01669	ohms
144 - 149	Sensor 3-4	,01748	ohms
150 - 155	Sensor 3-5	,01720	ohms
156 - 161	Sensor 3-6	,01619	ohms
162 - 167	Sensor 3-7	,01506	ohms
168 - 173	Sensor 3-8	,01441	ohms
174 - 179	Temp 1	,00298	K
180 - 185	Temp 2	,00309	K
186 - 191	Temp 3	,00297	K
192 - 197	Photovoltage 1	,00460	mV
198 - 203	Photovoltage 2	,00464	mV
204 - 209	Photovoltage 3	,00467	mV
210 - 215	CPU Temp	,00304	K
216 - 221	Power Rail Voltage	,03317	mV
222 - 227	Power Rail Current	,00148	mA
228 - 233	Pressure	,00117	mBar
234 - 238	Heater Status	,1101	n/a

5.5 On-Board Receivers: NONE

5.6 Other Information

The team requests that HASP provide us with GPS strings from the main HASP gondola every second if possible. This is to verify the data that we will be getting from our new GPS.

6 Integration and Logistics

6.1 Arrival Information

The team will certainly work and arrive at CSBF, Palestine as per the schedule decided by HASP-LSU.

6.2 Integration Participants from UNF team

Name	Email
Jesse Lard	jesselard@gmail.com
Chris Farkas	N00965140@ospreys.unf.edu
Ken Emanuel	kennecom@gmail.com
Dr. Nirmal Patel	npatel@unf.edu

In addition, one or two participants from UNF and UND may participate the integration workshop.

6.3 Integration Success

The payload successfully mounts to platform, both mechanically and electronically. The payload successfully performs a sensor/communication check, and systems health checks to ensure proper data/headers formatting. After an initial test sequences a steady 1 Hz flashing STATUS LED indicates a sound system. After initial system testing is complete the system will successfully packet and send data to HASP computer and ground station computer will decipher and provides data plots of ozone concentration in real-time during the final preflight testing (the thermal vacuum testing).

6.4 Integration Steps

- Mount payload to the HASP platform
- Connect and interface the payload with the power system and communication bus.

6.5 Integration Checks

- Preform Communication and data checks.
- Successfully execute the command set.
- Monitor the system to ensure the proper operation via real time stream of all data from sensors, as well as readings from pressure, photo voltage of light sensors and ambient temperature.

6.6 Equipment

The team will bring their required equipment and tools but may need access to a soldering station, oscilloscope, and heat gun from HASP.

HASP 2016

Answers to the comments for PSIP
Submitted by
University of North Florida (UNF) and University of North Dakota (UND)
Payload

OSPA

Ozone Sensors Payload and its Applications

Answers to the comments for PSIP

(1) The diagram showing the connection to the HASP plate can be cleaned up to just show the mounting points and dimensions.

Thank you very much for your comment. Please refer Fig. 4 (a), (b) and (c) on page # 8 and 9 of the revised PSIP.

(2) The power diagram is very hard to read. Please provide part numbers to the power converters.

Thank you very much for your comment. Please refer Fig. 9 on page # 14 of the revised PSIP.

(3) It would be very welcomed if you guys could show power usage in terms of Watts in your power table.

Thank you very much for your comment. Please refer section 3.1 Power Budget and Table on page # 14 of the revised PSIP.