High Altitude Balloon Payload Design

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Montana State University Summer Design Project

Mission

“To collect data from a custom radiation sensor in a high altitude environment.”

A custom radiation sensor has been designed by MSU graduate students that is capable of detecting the location of ionizing radiation strikes. It has already been tested with a variety of radiation sources, but is now ready to be tested in a better representative environment.

The problem presented to the summer design team, was to implement systems engineering concepts to design a payload capable of carrying the sensitive radiation equipment to a high altitude environment. The payload was to be designed according to the BOREALIS High Altitude Balloon program constraints as well as taking into consideration NASA’s requirements for the High Altitude Student Platform (HASP) program.

System Design

In order to achieve the mission objective, three subsystems were created to meet the following design requirements:

**Mechanical:**
- Final box was designed at 19.5 x 19.5 x 30 cm.
- Electrical & computer system was stacked to fit in a 12 x 12 cm space.
- Designed to weigh under 2.72 kg, final weight was 1.25 kg total.
- Designed for a low temperature of -60°C.
- Designed to withstand impact falling at a rate of 7.62 m/s.

**Electrical:**
- Provide power for:
  - Radiation sensor: +/- 3.3V
  - Sensor reference voltage: 3.0BV
  - Computer system: 5-12V

**Computer:**
- Designed to log data to a non-volatile source.
- Needs to write data every 250 ms.
- Designed to interface with a 32 output sensor.

Assembly and Testing

- **Packaging/Materials:** Polyisocyanurate insulation foam was used for the exterior of the payload. A fiberglass fabric was painted on with resin for durability and impact resistance.
- **Temperature:** Cold room tests were performed to ensure the internal temperature was within operating limits of the electronics.

Impact: Impact testing was performed to ensure the payload could survive the maximum amount of predicted G-force upon landing.

Launch

The payload was successfully launched July 21st 2011 on the BOREALIS balloon from the Livingston airport. The balloon reached an altitude of 90,570 feet and the payload was recovered outside of Big Timber. While all equipment returned safely with little to no wear and tear, no strikes were logged from this flight. Problems were resolved to prepare the payload for a second flight on July 29th.

The payload was successfully launched for a second time on July 29th 2011 again on the BOREALIS balloon from the Livingston airport. The balloon reached an altitude of 97,337 feet and logged radiation strikes during the entire ascent. This data verified that the sensor was able to detect radiation in a real aerospace environment. The strikes per minute of radiation increased with altitude as expected.

Acknowledgments

We would like to thank the Montana Space Grant Consortium and NASA’s ESMD Higher Education Office for sponsoring this summer project. We also would like to thank our spectacular advisors for their guidance and support in our ballooning endeavors. Special appreciation to the BOREALIS team as well for allowing us to launch our payload.

Radiation Sensor Power:
Advanced Lithium Energizer batteries were used to power two DC/DC converters which produced +/-3.3 V to the sensor amplification board. A voltage divider was used to produce a reference voltage from the output of the DC/DC converter.

Computer System Power:
The computer system was powered directly from the negative battery supply which provided 9 V and was locally regulated on the Arduino board. Testing was completed in order to ensure that the batteries would supply adequate power throughout the flight.

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