SPEC-14-189

PROJECT SPECIFICATION

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UCI CubeSat II

Revision History

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1 PROJECT SPECIFICATION OVERVIEW

1.1 Executive Summary

The goal of this project is to build a 2U Cube Satellite to conduct an air pollution study, test electrospray thrusters, and test a thermal radiator which is in cooperation with the Spacecraft Thermal Team. Some constraints with this project are going to be operating in low earth orbit, controlling the satellite with the electrospray thrusters, and to be able to power the satellite with deployable solar panels.

Electrospray thrusters are operated in one of two modes: droplet emission or ion emission. Their propellant delivery systems are very different. Electrospray thrusters in ion emission mode are based on the wetting of the emitter surface by the propellant, coupled with the electric field action to control the flow (passive feed). The simplicity of passive feed has important benefits in spacecraft with highly constrained mass, volume and power budgets such as CubeSats. The advantageous properties of electrospray thrusters in droplet emission mode (e.g. high thrust to power ratio compared to ion emission mode, and the possibility of working at varying specific impulse at optimum thrust density) want to be used in CubeSats, a new and simple passive feed system must be developed.

This technology has been developed and have started testing a prototype in a vacuum chamber. Results show that the same thrust can be obtained in comparison to commercial electrosprays. Now, it is crucial to tests that this technology works in space conditions as designed. A CubeSat is the perfect platform to test it and check if the specifications may vary after a long utilization time. Moreover, attitude control is also essential for most space missions. It is usually carried out by momentum wheels, but a three axis momentum wheel system requires one full CubeSat unit for itself. On the other hand, a spacecraft with main propulsion can do a huge new range of missions. Electrospray thrusters can provide both attitude control and main propulsion, allowing us to reach the desired orbit to photograph the exact point on the Earth and it also allows us to maintain the correct orientation and orbit during all the spacecraft life.

A thermal radiator will manage heat transfer between the satellite and space. In order to withstand the drastic temperature ranges encountered in space, the thermal sub team will make use of a variable surface emissivity radiator as the primary source of thermal heat rejection and absorption. An electro-chromic material coating, Titanium Oxide, will be used on the CubeSat. This coating has the ability to change emissivity properties when a voltage potential is introduced, meaning that varying the voltage will allow the coating to absorb and reject heat keeping the CubeSat within the required operating range of the equipment.

The monitoring of aerosol pollution and its flow over parts of Asia will be the final experiment conducted with the UCI Cube SAT II group. Aerosol pollution primarily stems from smog released from automobiles, which is dangerous towards human health and destroys crops in outlying areas. For example, parts of northern India have seen rice crop yields cut in half due to two main aerosols, black carbon and ground level ozone. Black carbon emissions from automobile exhaust. Ground level ozone is a secondary pollutant. U.S. embassies in Beijing and Shanghai reported PM2.5 measurements as high as 480 and 355 micrograms per cubic meter of air respectively," NASA writes. "The World Health Organization considers PM2.5 levels to be safe when they are below 25." As aerosol pollution continues to grow, it must be monitored to help predict the danger to outlying areas.

Designing and manufacturing a 2U CubeSat that will power, and support these experiments will be the team's primary goal for the first year.

2 Product Description

A 2U CubeSat implementing deployable Solar Panels, Electrospray Thrusters, Variable Emissivity Radiator, and a Camera. The 2U CubeSat can be used for other various missions, the only varying component will be the camera or primary mission.

2.1 Product Context

The 2U CubeSat relates to other products as it will use an Aluminum 6061 casing that will function independently. The CubeSat will use GaAs Solar Cells and will be designed to provide the power output of our subsystems which can vary depending the mission. The electrospray thrusters will also function independently, and can also be used for future missions.

2.2 Constraints.

1. The availability of the Vacuum chamber has hindered the design and manufacturing process of the electrospray thrusters.
2. Many students have taken the proper classes to begin coding the control system for the CubeSat.
3. Number of active members, the project obtains members that only take a unit a quarter which equates to 4 hours a week of work.

3 Requirements

[This section lists the critical parameters, specifications, and requirements for the product you are designing. List all requirements in order or priority. This section is constantly evolving and is subject to change as the project progresses and as more information is learned. As details are added, removed, or modified, remember to update the revision level of this document.]

3.1 Functional and Performance Requirements

Design Specifications:

1) Total mass has to be under 2.6kg (~6lb pounds)
2) The CubeSat has to have the following dimensions 10x10x10 cm^3 per U
3) The CubeSat has to pass the Vibration test having a frequency range of 5-300Hz
4) Spatial Resolution must be met
5) Communication regulations

3.2 User Requirements

For UCI's CubeSat II the only requirements of the user is to regularly check the pictures being transmitted by the CubeSat. The control systems is designed to not take any user input once the margins of error of the flight path are specified.

3.3 Maintenance Requirements

Unfortunately once the electrospray thrusters run out of fuel the CubeSat will not be useable due to refueling limitations.

3.4 Standards Compliance

All regulations by the FAA, NASA and any other federations that require regulatory standards to be met.

4 Appendix

4.1 References

Administration, National Aeronautics And Space. "ELaNa X CubeSat Launch on SMAP Mission." *ELaNa X CubeSat Launch on SMAP Mission* (2015): 1-2. Web. <ELaNa X CubeSat Launch on SMAP Mission>.

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