NANOSATC-BR – Subsystems and Payload

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Abstract

Students from the Federal University of Santa Maria – UFSM working with scholarships on Scientific and Technologic Initiation Programs at the Southern Regional Space Research Center – CRS/INPE with the support of engineers and scientists from INPE's Headquarters are engaged in a CubeSat-class satellite Project, the NanoSatC-BR that will be the first Brazilian CubeSat. A magnetometer will be the payload and will measure Earth's magnetic field, especially at the region of the South Atlantic Magnetic Anomaly. This work presents a general view of the subsystems that a CubeSat is composed with a preliminary solution and its payload.

Introduction

A CubeSat is a type of miniaturized satellite for space research that usually has a volume of one litre (10x10x10cm), weighs no more than one kilogram, and typically uses commercial, off-the-shelf electronics components. Beginning in 1999, the term "CubeSat" was coined to denote nanosatellites that adhere to the standards described in the CubeSat design specification. California Polytechnic State University published the standard in an effort led by aerospace engineering Professor Jordi Puig-Suari, David (2004). Bob Twiggs, from the Department of Aeronautics & Astronautics at Stanford University, has contributed to the CubeSat community. His efforts have focused on CubeSats from educational institutions, David (2006). Compared to traditional multi-million-dollar satellite missions, CubeSat projects have the potential to educate the participants and implement successful and useful missions at much lower costs. Project timelines are typically 9-24 months from inception to launch.

Structure Subsystem

The structure must be able to provide safety and support to all components of the satellite and all operations of the mission, according to Morgado (2005). In addition to the subsystems support, the structure should remain stiff, thus avoiding misalignments of instruments that could undermine the mission, Boruszewski (2001). The NanoSatC-BR will be composed of a structure formed by the chassis, top plate and bottom plate made of aluminum alloy, according to Prochnow (2008), and it provides a material of low density and cost, besides being a non-magnetic material that gives greater safety to the measurements of the magnetic field. A kit from Pumpkin will be acquired to be integrated to the satellite as shown in Figure 1.

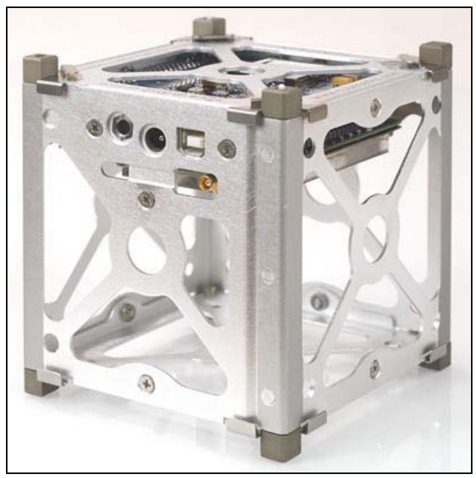

Figure 1: CubeSat structure made by Pumpkin. (http://www.cubesatkit.com)

Power Supply Subsystem

The Power Supply Subsystem, also known as Electrical Power Subsystem, is one of the most important subsystems of the satellite and it's responsible for many essential tasks that shall ensure the operation of the spacecraft. These tasks include the power supply for the satellite, to distribute, storage, regulate and control the power supply through electronic microcontrollers, Larson and Wertz (1992).
To distribute, regulate and control the power will be used a Clyde-Space 1U CubeSat power that is presented in Figure 2.

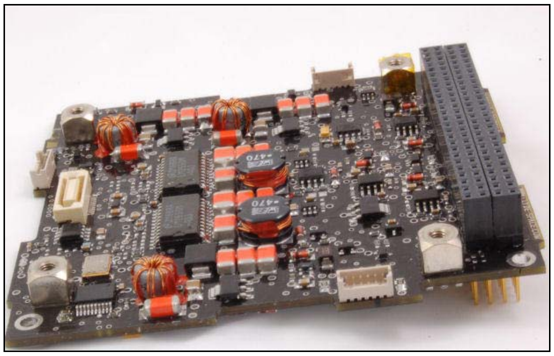

Figure 2: Clyde-Space 1U cubesat power. (http://www.clyde-space.com)

For the power storage, will be used 2 Clyde-Space lithium polymer rechargeable battery. The capacity of each battery is 1.25 Ah with a total mass of 62 g. The batteries are show in Figure 3.

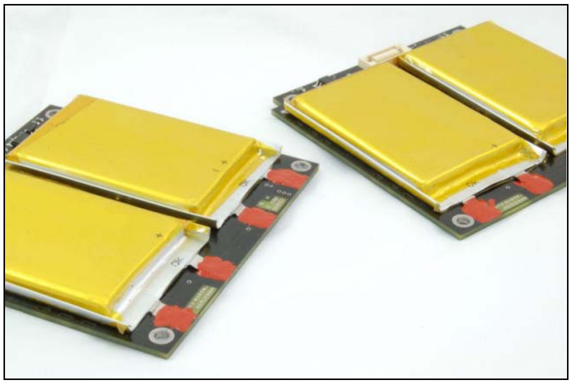

Figure 3: Clyde-Space lithium polymer rechargeable battery.
(http://www.clyde-space.com)

In orbit, the only source of energy for the spacecraft is the Sun's light by means of solar cells. For it will be used Spectrolab solar cells with 28% of efficiency, fixed on the faces of the satellite as show in Figure 4.

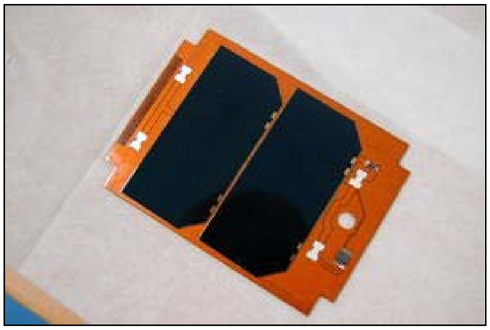

Figure 4: Solar Panel with Spectrolab cells. (http://www.clyde-space.com)

On-Board Data Handling Subsystem

The on-board computer has three basic functions: control of the satellite, internal communication and processing of satellite data. According to Melro (2004), the control of the satellite includes the management of the modes of operation, in case of any anomaly in their functions, acquisition and storage of the data for later transmission to the Ground Station and an analysis of data for taking decisions and implementation of controls. The internal communication of the satellite is the communication between its subsystems. The data processing is responsible to control and storage the telemetry data or its subsystems, Mattiello-Francisco (2003). A CubeSat Kit FM430 Flight Module from Pumpkin will be used, Figure 5.

Figure 5: Pumpkin FM430 Flight Module. (http://www.cubesatkit.com/)

Thermal Control Subsystem

The need for thermal control in satellites is due to the aggressive environment that exists in space, because sudden changes in temperature occur and sensitive electronic devices must be properly protected to maintain its operating temperature range within the required limits. Satellites can suffer very significant temperature difference between its sides, with one pointing directly to the Sun, a large source of thermal power, and another in the shadow, pointing to deep space, where the temperature is around 4 K, Larson et al (1992). Another heat source is the albedo, the energy reflected by the Earth from sunlight. Also the heat from the earth surface that spreads to the space in infrared waves and the free molecular heating should be considered for the dimensioning of the Thermal Control Subsystem. The Thermal Design of very small satellites, such as the NanoSatC-BR, is restricted due to its small size, and adopts only passive control, without consumption of power. The satellite can be painted externally and protected internally; there are many types of materials and ways to distribute them. The project must satisfy the limits of variation of temperature inside the satellite, according to the equations of total thermal balance, with all possible variables. Specific computer programs are used, working with advanced numerical methods, which provide an actual view of the interactions of space with the satellite, and the internal heat exchange through conduction and radiation.

Payload

In space exploration, the payload of a spacecraft usually incluces scientific instruments or experiments. The payload of the NanoSatC-BR will be a low coast miniature magnetometer that comprises a single board assembly with fluxgate sensors and electronic circuitry. It is manufactured by Bartington and called Mag566, and is shown below in the Figure 6.

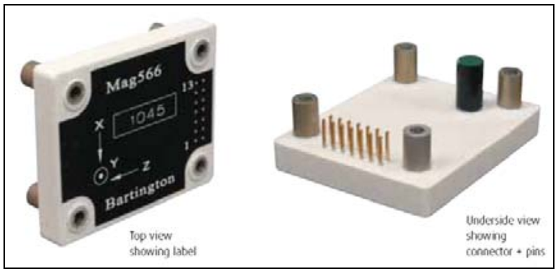

Figure6: Bartington Mag566.
(http://www.bartington.com)

This magnetometer will measure Earth's magnetic field, especially at the region of the South Atlantic Magnetic Anomaly, Figure 7. This anomaly is a Magnetosphere phenomenon that takes place in the Southern Hemisphere, below the magnetic equator, where the Van Allen radiation belt (particles emitted by the Sun and trapped by Earth's magnetic field into a belt following the magnetic equator) is closest to Earth's surface, Stassinopoulos (2007).

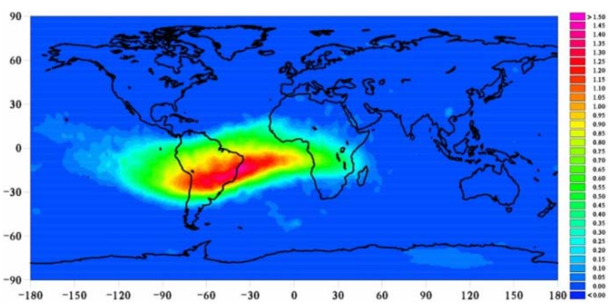

Figure7: South Atlantic Magnetic Anomaly.
(http://www.aviso.oceanobs.com)

Conclusions

This work presents the importance of all subsystems for the operation of a satellite, allowing the payload to work perfectly. The launch date of NANOSATC-BR is scheduled for the second half of 2010, thus allowing the initiation of the acquisition of data for scientists.

Acknowledgments

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