Cubesats: A passive thermal analysis approach

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A CubeSat typically consists of a few important subsystems that control attitude determination and control, communication, power, command and data handling, and thermal control. Indeed, regarding this last point Orbital spacecrafts face the problem of high thermal gradients or different thermal loads mediated by differential illumination from the sun. Thermal control of a spacecraft ensures that the temperature of its various parts are kept within their appropriate ranges. The simulation and prediction of temperatures in a spacecraft during a mission are usually carried out by commercial codes. These software packages employ "lumped parameter" models that describe the spacecraft as a discrete network of nodes, with one energy-balance equation per node.

The purpose of the paper is to present the passive thermal control subsystem for a nano-satellite at a precise altitude in the Low Earth Orbit. Miniaturization of components enabled small scale satellite projects, such as the CubeSat, to be used for scientific research in space. Although the integration of compact electronics allowed sophisticated scientific experiments and missions to be carried out in space, the thermal control options for such small satellites were limited.

To minimize the mass of the thermal control subsystem while keeping the electronics at safe operating conditions, this paper presents a study of the thermal environment and passive thermal control system of a nano-satellite using code that develops and markets finite element analysis, used to simulate engineering problems.

The purpose of this work is mainly based on the application of thermal loads, especially, Sun loads, albedo and infrared Earth loads on a simple nano-satellite geometries and accurately simulate the heat flow in it, in order to predict its response to orbital conditions. Thermal mathematical equation is evolving as and when variables are added, like emissivity and absorptivity, to approach real state of space environment.

A transient thermal analysis was also considered to find out the distribution of the temperature, whereas the nano-satellite is on its trajectory. Therefore, it is possible that the internal heat could increase the temperature of the CubeSat such that it will fall within the required operational and survival temperature ranges.