

Thermal Analysis of NPSAT1 Battery

Introduction

NPSAT1 is a low-cost, technology demonstration satellite hosting a number of experiments. Commercial, off-the-shelf (COTS)-based technology will be implemented with custom designs to offer a low-cost command and data handling (C&DH) subsystem building on commercial, desktop PC architecture and standards-based specifications. In addition to an experimental C&DH subsystem, NPSAT1 will demonstrate the use of non-volatile ferroelectric RAM which is inherently radiation-tolerant and lithium-ion polymer batteries, state-of-the-art technology that will be employed offering high energy density (Watt-hr/kg) for space applications.

Experiments on-board NPSAT1 include two Naval Research Laboratory (NRL) payloads. The coherent electromagnetic radio tomography (CERTO) experiment and a Langmuir probe. The CERTO experiment is a radio beacon which, in concert with ground station receivers, is used to measure total-electron-content (TEC) in the ionosphere. The Langmuir probe will augment CERTO data by providing on-orbit measurements. The other experiments are of NPS origin. These include a novel design for a spacecraft computer board, a COTS visual imager (VISIM), and some micro-electromechanical systems (MEMS)-based rate sensors.

Description of Thesis Topic

A thermal model is needed for the battery assembly which will assess the operation of heaters within the battery housing, and an estimate of the duty cycles of such heaters. Additionally, the battery model will be used in conjunction with the entire spacecraft thermal model to assess the thermal environment of the batteries. The analysis will either confirm the current design or propose plausible means of improving the thermal design. The IDEAS software tool, must be used which will require some amount of learning.

The thermal model will be validated by comparison with values from actual testing of the battery during charge and discharge. Part of the study will be to define the test setup and operation; perform the test; and provide conclusions and recommendations.

Proposed Outline

- NPSAT1 Introduction
- Battery Design
- Spacecraft Environment
- Overview of Thermal Analysis and Modeling
- Battery Thermal Model
- Thermal Analysis Results and Validation through Test
- Conclusions & Recommendations

Suggested References

- *Spacecraft Thermal Control Handbook*, D. W. Gilmore, Aerospace Corp., 2002.
- *Computer Aided Thermal Analysis of a Technology Demonstration Satellite (NPSAT1)*, Martin Gruhke, NPS Technical Report, NPS-SP-03-001, Monterey, California, 2003.
- I-DEAS Thermal Model Generator (TMG) Reference, (I-DEAS on-line documentation)
- *IDEAS Master Series Student Guide*, SDRC, Milford, OH, 1994