Paper ID: 29278
oral

66th International Astronautical Congress 2015

SPACE POWER SYMPOSIUM (C3)
Wireless Power Transmission Technologies, Experiments and Demonstrations (2)

Author: Mr. Corey Bergsrud
University of North Dakota, United States, corey.bergsrud@my.und.edu

Dr. Sima Noghanian
United States, sima.noghanian@engr.und.edu
Mr. Robert Bernaciak
University of North Dakota, United States, robert.bernaciak@my.und.edu
Mr. Sofiane Chaieb
University of North Dakota, United States, sofiane.chaieb@gmail.com

REFERENCE DESIGN SATELLITE FOR IN-SPACE POWER BEAMING DEMONSTRATIONS

Abstract

This paper presents an update for an ongoing project to equip a single unit cube satellite (1U CubeSat) with in-space power beaming experiments. The 1U CubeSat is classified as a nano-satellite (1-10 kg) and has design constraints with dimensions of 10 cubic centimeters and a mass of 1.33kg. This most basic form of satellite design provides a perfect platform as a reference design that can be both repeatable and scalable for future in-space power beaming demonstrations. Progress towards the development of the proposed satellites electrical power system (EPS) and experimental payload(s) are presented. The EPS is composed of a power generation module (PGM), power storage module (PSM), and a power conditioning and distribution module (PCDM). The PGM is composed of photovoltaic (PV) array and rectifying antenna (rectenna) array. The PV array is the satellites primary power source designed to generate 12.5W of power. The rectenna array is part of the satellites experimental mission payload designed to capture microwave power sent from a source. The PSM is the satellites secondary power source composed of a hybrid Lithium-Ion (Li-Ion) battery/Supoer Capacitor (SuperCap) combination. The Li-Ion batteries receives its power directly from the PV array and the SuperCap receives its power directly from the rectenna array. The purpose of the PCDM is to manage and ensure the correct distribution of power and information throughout the satellite. A printed circuit board (PCB) aperture-coupled antenna design as the power receiving antenna is a good candidate for in-space power reception application. The microstrip design offers low profile, low mass, and low cost. The aperture-coupled fed mechanism offers more degrees of design freedom compared to other microstrip designs, it minimizes spurious radiation (increased efficiency), and avoids vertical elements and soldering (increased reliability). An analysis for the selection of material for the pCB aperture-coupled antenna design is also presented with focus on the electrical behavior due to changes in thermal conditions. The analysis for the selection of diode component and their performances and rectifier design for this application is also reported. The purpose of this work is to help advance the concepts and technologies for Space Solar Power Satellite systems at a reduced cost and schedule by using modern small satellites.