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PHASE-0 DESIGN OF THE 16U4SBSP SPACECRAFT: A SCALED DEMONSTRATION OF SPACE-BASED SOLAR POWER IN EARTH ORBIT USING A SWARM OF CUBESATS

Abstract

The 16U4SBSP mission concept is based on using a swarm of CubeSats to perform a scaled demonstration of Space-Based Solar Power (SBSP) from Earth orbit. In this demonstration mission, a swarm of 7 identical spacecraft of 16U format is used to provide wireless energy in the 1-kW scale using Radio-Frequency (RF) beaming, and the spacecraft in the swarm are designed to be suitable to both space-to-ground or space-to-space applications. The main objective of the mission is to validate the concept of providing SBSP using a swarm of satellites, as well as some of the involved miniaturized technologies, in view of full-scale missions which could serve users in remote areas with low power requirements or support emergency operations in blackout zones affected by unpredicted hazards. More in general, the mission would represent a low-cost precursor towards larger scale SBSP (in the GW range of larger) to supply clean and affordable energy from space to large areas on the Earth surface. A pre-Phase 0 study of the mission, funded by the European Space Agency through the Sysnova campaign “Innovative Missions Concepts enabled by Swarms of CubeSats”, has led to encouraging results on the feasibility of this mission concept.

This paper will present in detail the final outcome of the pre-Phase 0 design effort for the 16U4SBSP spacecraft. The trade-off studies conducted to select all sub-systems and components will be presented and their final outcomes detailed and justified, together with the technical budgets and the main areas of attention for the spacecraft design. Particularly critical for the success of the mission are the choices related to: the power transmission payload (DC-RF converter, transmitting antenna and heat dissipation system); the ADCS subsystem and in particular the sensors required to provide sufficient accuracy in the

knowledge of the 3-axis attitude (both absolute and relative to the other spacecraft in the swarm); the relative navigation system, based on inter-satellite link between the spacecraft in the swarm and on a beacon link to the receiving station on ground, for efficient beaming coordination; the main propulsion system for continuous formation flying control through the whole mission lifetime; the electric power system, based on orientable solar arrays by means of a SADA mechanism and a set of batteries with sufficient capacity for beaming the required amount of power while in eclipse conditions.