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THE GREENCUBE CUBESAT MISSION: DEVELOPMENT AND QUALIFICATION OF AN AUTONOMOUS MICROGREENS CULTIVATION SYSTEM AND DEMONSTRATION OF CUBESAT PROPULSION IN MEO

Abstract

The development and testing of next generation Environmental Control and Life Support Systems (ECLSSs) will support the future long-term manned mission in Lunar and, successively, Mars environments. In this perspective, performing biological experiments on miniaturized satellite platforms can provide an easy access to Space testing with extremely short development cycles. The GreenCube mission aims at demonstrating the effectiveness of a fully autonomous system to cultivate plants to early development stage (microgreens) in-orbit. The mission has obtained a free launch opportunity, offered by ESA, on-board the maiden VEGA-C launch in Medium Earth Orbit (MEO). The mission has been conceived by an Italian research group led by Sapienza University of Rome, together with ENEA (Italian National Agency for New Technologies, Energy and Sustainable Economic Development) and University of Naples Federico II, with the support and coordination of the Italian Space Agency (ASI). The implementation of the experimental propulsive attitude control system has been made possible thanks to an international collaboration with University of Stuttgart, Germany. GreenCube is a 3U CubeSat (300 x 100 x 100 mm) and will operate on a 6000 km-high circular orbit. The design includes a plant cultivation unit of approximately two CubeSat units in size. The remaining unit is used for a commercial bus, including an experimental attitude control systems based on electric propulsion. The latter will be in-orbit demonstrated as a convenient and innovative method for maintaining a constant satellite spin rate and applied as a back-up attitude control system. The system will acquire microgreen growth/health and environmental data through multiple sensors. Meanwhile, actuators will regulate plants nutrition, inner unit temperature and air circulation during the cultivation phase. The complete microgreen production cycle is normally between 15 and 20 day long. GreenCube will provide important information enabling a broader utilization of nano-satellites for biological systems testing and in-orbit plant cultivation in the near future. Furthermore, the technologies adopted in GreenCube and demonstrated in MEO could be easily applied to future CubeSat scientific missions. This paper will focus on the development and subsystem-level qualification of the 3U CubeSat GreenCube. The mission and general features of the CubeSat design will be described. Moreover, the plant unit and the on-board technologies will be illustrated. Finally, the testing activities performed for preliminary qualification will be reported.