28th IAA SYMPOSIUM ON SMALL SATELLITE MISSIONS (B4)
Interactive Presentations - 28th IAA SYMPOSIUM ON SMALL SATELLITE MISSIONS (IP)

Author: Dr. Vaclav Knap
GomSpace Aps, Denmark

Mr. Jørgen Vestergaard
GomSpace Aps, Denmark
Prof. Szymon Beczkowski
Aalborg University, Denmark
Prof. Daniel-Ioan Stroe
Aalborg University, Denmark

BATTERY TEMPERATURE BEHAVIOR IN CUBESATS AT LOW EARTH ORBIT: FROM TELEMETRY TO GROUND TESTING

Abstract

The popularity of CubeSats is increasing both in industry and academia. CubeSats are small satellites, of a standardized format, using commercial off-the-shelf (COTS) components, which reduces their manufacturing and lunching cost. Batteries are a key part of CubeSats with the tasking of providing energy whenever needed. Thus, the satellite lifetime is limited (partly) by battery life. Lithium-ion batteries, the state-of-the-art choice for CubeSats, are complex electrochemical systems, with their performance and lifetime behavior strongly influenced by the temperature. Thus, the battery temperature behavior in CubeSats is the focus of this work. A test procedure is developed based on the temperature model and the mission profile that allows to perform lifetime tests and to evaluate state estimation methods in conditions close to the real CubeSat operation. Real life observations are made by analysing telemetry from multiple CubeSats. The battery working conditions are determined and consequently explained by a spacecraft design and orbit characteristics. Then, a battery temperature model is established. Subsequently, two important battery areas that have to reflect the specific temperature behavior are identified: battery lifetime and battery monitoring. Thus, the battery lifetime aspects related to the temperature are evaluated. Moreover, lifetime tests with a constant temperature and mission profile temperature are performed to asses their impact. Regarding battery monitoring, state-of-charge and state-of-health estimations are preferred functionalities; however, they are not widely spread yet in CubeSats. Evaluating the state estimation methods, dedicated for other applications such as electric vehicles or stationary energy storage systems, is carried at constant ambient temperature, which is not a condition matching the CubeSat case. Thus, the newly developed procedures for lifetime testing and state estimation evaluation are reflecting the real operating conditions in CubeSats.