Paper ID: 56704
oral

IAF SPACE POWER SYMPOSIUM (C3)
Advanced Space Power Technologies (3)

Author: Dr. Vaclav Knap
GomSpace Aps, Denmark

Mr. Lars Vestergaard
GomSpace Aps, Denmark
Mr. Alejandro Gismero
Aalborg University, Denmark
Dr. Daniel-Ioan Stroe
Aalborg University, Denmark

EVALUATION OF THE BATTERY DEGRADATION FACTORS FOR NANO-SATELLITES AT LEO

Abstract

Mission design and spacecraft design are challenging activities, which have to be carefully conducted in order to achieve a successful mission for the nano-satellite. In NewSpace, especially in the area of nano-satellites, there is a strong drive towards agile and quickly market deployed products. Typically, commercial-off-the-shelf (COTS) batteries are used and specifically needed information about them are rarely provided by the manufacturer. Thus, it is necessary for the nano-satellite developer to assess their performance and lifetime on their own in order to support an accurate mission/spacecraft design. How can then the battery lifetime be evaluated in a sufficient and economic manner? In the proposed approach, the possible degradation factors and their feasible ranges were firstly considered, in order to limit the test requirements. For example, a common temperature operation window for Li-ion batteries is approximately between 0 and 50°C, which is typically feasible to be reached by a proper mission and spacecraft design. However, still in this range, rapid degradation can occur due to charging with high current at low temperature, resulting in Lithium plating, or accelerated rate of parasitic reactions due to high temperature. Thus, it is required to identify the temperature influence within these limits. Other degradation factors (e.g. cycle depth-of-discharge, mission time (number of years, charging-discharging cycles) and radiation) can be addressed in similar way. Consequently, in this work, a set of lifetime tests was designed to cover all these conditions in an effective way. Since some of the tests have been conducted under accelerated conditions, it is necessary to evaluate the effect of these conditions as well. The next step was to process the lifetime test results and come up with a modelling approach, which allows for an accurate battery lifetime design. The design of battery life in satellites is a common challenge, since there are frequently reported classical satellites with extended mission life due to a lower battery degradation than planned. This occurrence is a result of battery pack over-sizing, which is highly uneconomic, especially at nano-satellites. Thus, the presented approach targets to optimize (1) the battery lifetime testing for nano-satellites and (2) the battery sizing procedure in order to be economical.