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SPACE POWER SYMPOSIUM (C3)
Small and Very Small Advanced Space Power Systems (4)

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DEVELOPMENT OF A TESTING STANDARD OF COTS LITHIUM-ION BATTERIES FOR NANO-SATELLITES

Abstract

Since successful in-orbit operation of PROBA-1 launched in 2001, spacecraft developers have increasingly used lithium-ion batteries -LIBs. The LIB has several advantages over other batteries flown in space -e.g. nickel-cadmium and nickel-hydride batteries. For example, mass of on-board batteries has been reduced by around 40% because of the LIB high energy density characteristic, and here satellite mass is the primary concern in very small satellites (i.e. mass of <50kg), in particular. However, LIB production factories have moved to overseas countries and traceability and quality control have become an issue. Such information is important for properly assembling the spacecraft battery, and it is difficult for very small spacecraft developers to obtain a special LIB designed for space flight, thereby university-based projects normally use commercial-off-the-shelf (COTS) batteries (i.e. available on a high street). Such COTS battery is normally tested by its user (e.g. university students) before becomes a flight battery, but there is no clear testing method.

We are currently working on development a test procedure of COTS LIBs for use on-board very small satellites as a part of Nano-satellite Environment Test Standardisation (NETS) standard, which is jointly developed in 4 organisations (including the Kyushu Institute of Technology) under the support of the Japanese government funding. Our final goal is to produce an affordable COTS LIB test for universities and non-space-related companies while keeping sufficient reliability and short deliver time.

Multiple charge/discharge cycle is the most fundamental and critical test for batteries, as they are required to perform at least 5000 cycles for a 1 year mission in low Earth orbit. An automated charge/discharge test facility has been developed in-house based on LabVIEW and a standard data acquisition unit, in which the automation is necessary to conduct multiple charge/discharge cycles by low testing cost, and this system can easily replicated in any place for a battery testing. The obtained results will be compared with acceleration tests that performed in various temperatures. In addition, abuse tests have been performed with several COTS LIBs, for example over-charge/discharge and mechanical shock (i.e. including space debris collision) for safety evaluation.

This paper will present the developed test facility, and results from the multiple charge/discharge cycle, the acceleration tests and the abuse tests. In addition, how these results reflect into the NETS standard will be discussed.