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Flight Arcing Experiment by Primary arc effects Solar Cell At Leo(PASCAL) On-board International Space Station

Shunsuke Iwai(1), Justin. J. Likar(2), Teppei Okumura(3) , Hiroshi Fukuda(1),
Kazuhiro Toyoda(1), Mengu Cho(1)

(1)Kyushu Institute of Technology, Kitakyushu 804-8550, Japan

(2) Lockheed Martin Space Systems Company, Newtown, PA, USA,

(3) Japan Aerospace Exploration Agency, 2-1-1 Sengen Tsukuba, Japan,

Spacecraft payloads are multifunctional and provide a high degree of technicality with increasing power consumption. Therefore, the bus voltage must be raised to reduce transmission loss for the same reason as infrastructure on the ground. Unlike on earth, 100V is already considered as high voltage in space that can lead to arcing due to the interaction of the charged spacecraft with the ambient plasma. Moreover, arcing may cause the degradation of solar cells. On solar arrays the arcing risk is especially high. Achievement of high voltage technology will be key for next-generation space technology We have performed demonstration experiments named PASCAL (Primary Arc effects Solar Cell At Leo) on board the International Space Station in low earth orbit for observation of the ESD problem. PASCAL was mounted in the MISSE-8 (Material on the International space station Experiments-8) group developed by the U.S. Naval Research Laboratory (NRL) Platform for Retrievable Experiments in a LEO Space Environment (PRELSE). This study is collaborative research between Kyutech, the Japan Aerospace Exploration Agency (JAXA), and Lockheed Martin Space Station of the United States (LMSS). Characterizing the discharge voltage threshold, discharge frequency and solar cell degradation is the main purpose of the orbital ESD test. PASCAL is essentially the miniature equivalent of a typical ground experiment system. First, PASCAL can test arcing by using a DC/DC convertor that changes the simulated bus voltage from 0V to 300V in 50V increments. This simulates recent satellite voltages (bus voltage is 100V) and next-generation satellite voltages (bus voltage is 300V). PASCAL can acquire arcing voltage/current waveforms. Second, PASCAL can acquire the Intensity-Voltage (IV) characteristic to observe degradation on the solar cells due to arcing. Third, PASCAL mounted 8 silicon solar cells and multi junction cells (MJ). PASCAL was launched by space shuttle STS-134 Endeavour in May 2011. After launching, PASCAL could operate normally. PASCAL operated ESD tests until July 2013. However, problems occurred to PASCAL in orbit and the analysis methods had to be re-examined. As a new analysis method, the relationship between Voc and the sun angle or temperature on-orbit was investigated. Also, degradation experiments on solar arrays in actual orbit were performed.

In this presentation, we will present detailed results of solar cell degradation due to arcing in low earth orbit.