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Author: Mr. Kay Müller
Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR), Germany, Kay.Mueller@dlr.de

Mr. Sebastian Löw
Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR), Germany, sebastian.loew@dlr.de
Mr. Jacobus Herman
Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR), Germany, jaap.herman@dlr.de
Mr. Robert Gaston
NASA JPL, United States, robert.w.gaston@jpl.nasa.gov
Mr. Ab Davis
University of Texas at Austin, United States, adavis@csr.utexas.edu

END-OF-LIFE POWER MANAGEMENT ON THE GRACE SATELLITES WITH SEVERAL FAILED BATTERY CELLS

Abstract

The two Grace satellites were launched on March 17, 2002 by a Russian Rockot. Both were operated for more than 15 years and delivered science data until the middle of 2017. The mission was successful from a scientific point of view and the originally envisaged mission duration of five years had more than tripled. The data quality at the end was still at least an order of magnitude better than from any other source. A follow-on mission has been launched by the same partners in 2018 and NASA and DLR project a new generation of space-based gravity field measurements in the next decade. Continuity in the gravity field measurements is highly desirable, especially for the time dependencies in the hydrological cycle, and thus there was a strong incentive to prolong the Grace mission as long as possible. This paper describes the power related activities to achieve this goal. A complementary paper that covers attitude operations is also presented at this conference.

Section I provides the background to the Grace mission. In Section II the battery, its failure modes and operational history are presented.

The degradation of the NiH_2 battery was one of the two main factors (the other was the amount of fuel left and its enhanced expenditure towards the end of the mission) that set the operational constraints. Standard charge and discharge regulation had not been possible since 2011. A description is given of the several alternatives that were tried. Battery handling required unconventional charge termination, special on/off cycles of the instrument, re-work of the on-board FDIR and daily adjustment of their settings. Several areas other than charge regulation itself were also affected by the low-power situation. The voltage in eclipses dropped so low that the transmitter was no longer working and the instrument computer shut down (with direct consequences for attitude control, thus aggravating the power situation). It even led to a power–down of the On-Board Computer in some instances. Here, only very special measures that comprised a wide palette touching computer, power/thermal, attitude and payload settings could mitigate the problem and re-start basic operations. These measures will be discussed in detail in Section III. Finally, a summary of operational approaches that helped ensure safe operations is provided in the last Section. Some conclusions and recommendations for the power management on the Grace Follow-On mission are also presented there.