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IAF SPACE POWER SYMPOSIUM (C3)
Space Power System for Ambitious Missions (4)

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# THE ELECTRICAL POWER SUBSYSTEM OF THE ESA MISSION TO JUPITER

**Abstract**

This paper presents the most relevant aspects of the Electrical Power Subsystem (EPS) for the Jupiter Icy Moons Explorer (JUICE) ESA's spacecraft. The EPS is formed by the Power Conditioning and Distribution Unit and the spacecraft batteries. Airbus DS Crisa is responsible for the EPS and the PCDU, while ABSL is in charge of the batteries. The electrical power architecture is completed by the solar array, the largest ever flown by ESA on an interplanetary mission (85m2), developed by Airbus Leiden, and presented in a separate abstract to this conference for its evaluation. The JUICE EPS faces unprecedented technical challenges, derived from the harsh environment that it will experience while exploring the Jupiter system and their potentially life-bearing icy moons. No ESA mission traveled so far from the Sun to date, what makes critical to optimize the EPS efficiency. Jupiter owns the strongest magnetic field in the Solar System, what leads to an unprecedented severe particle radiation environment. The payload scientific instruments on-board require from an EPS whose levels of conducted and radiated electromagnetic emissions must be far below what it is required for interplanetary exploration spacecraft. Regarding the battery, it is split into five identical modules located in the spacecraft, to serve as particle radiation shields for the electronic equipment. Battery is built around the 18650-NL cell, which offers an energy density of 187Wh/kg in front of the 133Wh/kg of the predecessor 18650-HC cell, making possible to fulfil the JUICE EPS mass budget while covering the mission energy needs under the worst case scenario. The paper will cover two key aspects for mission success: electromagnetic cleanliness and conversion efficiency. A very clean electromagnetic environment is required to make possible the magnetic characterization of the Jovian system. A model of the common mode emissions of the EPS was built, simulating with unprecedented detail the common mode emissions of the solar array + PCDU + battery set. This enables an accurate prediction of the EPS emitted magnetic fields. An innovative Array Power Regulator module has been built, whose converters implement a fully digital controller for both conductance and maximum power point tracking modes of operation. The digital control permits to achieve performances like absolute maximum power point detection in partially shadowed solar array sections, power converter adaptative gain versus solar array voltage, and constant frequency maximum power point tracking.