Contribution ID: **11** Type: **not specified**

Deep Space Microsatellite Power System Design and Development

Wednesday 26 November 2025 17:15 (15 minutes)

This work presents the design, development, and experimental validation of a Power Conditioning and Distribution Unit (PCDU) for a 6U CubeSat platform intended for deep-space missions. The proposed architecture adheres to the "New Space"paradigm, aiming to minimize development time and cost while maintaining high reliability and robustness. To achieve this, the system has been entirely implemented using Commercial-Off-The-Shelf (COTS) components, following a "Careful COTS"design approach. In this methodology, only extended-temperature, automotive-grade components are selected, and additional protection, redundancy, and monitoring mechanisms are incorporated to ensure the system's resilience against harsh space environments.

The PCDU is based on an unregulated power bus and is composed of four Solar Array Sections (SAS) managed by four independent Solar Array Regulators (SAR), an Energy Storage System (ESS), and a Power Distribution Unit (PDU). The architecture allows modular scalability, fault isolation, and flexible load prioritization, which are key features for small satellite platforms operating beyond Low Earth Orbit (LEO). Furthermore, a dedicated aluminum battery housing has been designed, integrating heaters and temperature sensors to ensure uniform thermal conditions across all battery cells, thereby improving lifetime and performance under low-temperature scenarios.

A specific effort has been devoted to the design and qualification of the ESS. Prior to its integration, an extensive characterization campaign was carried out on nine different commercial 18650 Li-ion cell models over an extended low-temperature range. The results highlight the critical influence of cell selection on discharge efficiency, capacity retention, and internal resistance under deep-space thermal conditions, providing valuable insights for future COTS-based energy storage systems.

To validate the overall performance and environmental robustness, a comprehensive test campaign has been conducted. Electrical functionality was verified using a solar array simulator under representative illumination profiles. Radiation tolerance was evaluated through Total Ionizing Dose (TID) testing up to 70 krad(Si), performed with a Co-60 source at the Centro Nacional de Aceleradores (CNA), Seville, Spain, confirming fault-free operation. Additionally, Thermal Vacuum (TVAC) tests were carried out at Alter Technology facilities, demonstrating stable operation and full compliance across the specified temperature and pressure ranges.

The obtained results confirm that a properly engineered COTS-based PCDU can meet the reliability and performance requirements of deep-space CubeSat missions, paving the way for a new generation of cost-effective and rapidly deployable spacecraft power systems.

Authors: BLANES MARTÍNEZ, Jose Manuel (jmblanes@umh.es); Dr GARRIGOS SIRVENT, Ausias (Universidad Miguel Hernandez de Elche)

Co-authors: Dr MARROQUÍ SEMPERE, David (Universidad Miguel Hernandez de Elche); Dr CARRASCO HERNÁNDEZ, José Antonio (Universidad Miguel Hernandez de Elche); Dr TORRES VERGARA, Cristian (Universidad Miguel Hernandez de Elche); Mr CASADO PÉREZ, Pablo (Universidad Miguel Hernandez de Elche)

Presenter: BLANES MARTÍNEZ, Jose Manuel (jmblanes@umh.es)

Session Classification: Parallel Astro