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EREBUS: A SIMPLE AND ROBUST APPROACH FOR BATTERY PASSIVATION AND SAFE  
DECOMMISSIONING OF LEO AND GEO SMALLSATS

**Abstract**

The utilization of Small Satellites is experiencing rapid expansion in terms of challenges, lifetime, and scopes, with a projected daily launch rate of hundreds of SmallSats in the next ten years. However, alongside the opportunities, there exists a concomitant rise of debris and explosion hazards associated with End-of-Life (EOL) mishandling.

To enhance the sustainability of such missions, the implementation of mitigation techniques for managing residual energy at the mission conclusion is imperative. Among the most critical aspects, there is the decommissioning of batteries, which electrochemical nature can lead to in-orbit blowout.

In response to these challenges, the European Reconfigurable Battery Unplugging System (EReBUS) represents a simple and robust solution to safely passivate SmallSat battery systems at the EoL, in line with the most recent passivation normative and guidelines.

EReBUS is a unit designed to be seamlessly integrated between the Battery System and Power Control and Distribution Unit (PCDU). The purpose of this unit is to isolate the battery and safely activate its self-discharge for the safe decommissioning of platforms deployed both in Low Earth Orbit (LEO) and Geostationary Orbit (GEO).

It has been designed with standardized interfaces and form factor to aid its integration in SmallSats and prioritizing simplicity and robustness. In fact, its key decoupling function is implemented through latching relays that offer long lifetime, high reliability against radiation effects, and system interface protection thanks to their electromechanical nature. In addition, EReBUS exploits component-level redundancy and a dedicated microcontroller to increase flexibility.

Comprehensive validation including electrical, functional, environmental, and accelerated aging tests have been conducted on EReBUS covering both LEO and GEO applications by using two Li-ion cell types representative for the two scenarios.

EReBUS has been realized through a collaboration between Argotec (IT) and ABSL-EnerSys (UK), supported by the ESA ARTES program to research and develop methodologies to comply with Space Debris Mitigation standards outlined in ECSS-U-AS-10C Rev.1 and ISO 24113 6.2.2.3, and looking ahead to the latest ESA Zero Debris Initiative.