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A FLAT-SAT PLATFORM FOR THE DEVELOPMENT AND TESTING OF THE 3U HERMES CONSTELLATION SATELLITES

Abstract

HERMES is a scientific mission project aiming at validating on orbit a new approach to Gamma Ray Bursts (GRBs) detection and localisation using a constellation of six nano-satellites. The novelty stays in both the data to recover, led by the multi-messenger astrophysics concept, and the new, miniaturized payload to be hosted on board. The mission is currently in advanced phase D, where validation and testing activities are carried out to assess whether the satellite capabilities comply with the required functionalities. In order to properly test the system in all its functions, a dedicated flat-sat platform has been designed and integrated to enable testing and fast debugging of core functionalities. The flat-sat facilitates the electrical connections between HERMES components while leaving key interfaces accessible for test equipment and allowing for the hot swapping of components. This paper describes the design of the flat-sat, including electrical and mechanical components, and the associated ground support equipment (GSE). The flat-sat has proven to be an invaluable tool for spacecraft testing and has led to the discovery of issues and unexpected behaviour with flight hardware which would have contributed to schedule delays if undiscovered until after the satellite was assembled. Moreover, flat-sat facilitated early and incremental testing of both software and operations procedures. Overall, the flat-sat is a high fidelity electrical and functional representation of the HERMES spacecraft buses. The flat-sat is effectively used as a platform for flight software acceptance and system testing, including the spacecraft main processors, power supply electronics, attitude control electronics, the S-band and UHF communications links. In detail, the HERMES flat-sat entails a set of PC104 compatible, general purpose boards to unpack the PC104 connector to testpoints and individual debug lines; a set of safety critical power boards to redundantly control power supply lines that carries power to the components; a core board that unpacks the signals from the OBC, the S-band and UHF transceiver, exposing all the main buses and serial communication (e.g., CAN, I2C, LVDS, UART) with the possibility to terminate lines at different debug interfaces. Furthermore, the flat-sat is interfaced with a set of electrically isolated digital twins of HERMES sensors and actuators. These are driven by a real-time simulator to verify and test the attitude determination and control subsystem. Finally, the flat-sat will also support the flight operations team throughout the post-launch in-flight testing activities, allowing software code and parameters update development, verification and validation.