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ALMASAT-1, ALMASAT-EO AND BEYOND: EVOLUTION OF STRUCTURAL CONCEPTS AND TECHNOLOGIES TOWARDS MULTIFUNCTIONAL STRUCTURES FOR MICROSATELLITES

Abstract

In 2003 the Microsatellite and Space Microsystems Laboratory of the University of Bologna located in Forli (Italy) started the ALMASat program with the aim to design, manufacture, qualify and launch the ALMASat-1 microsatellite. On February, 13th 2012 ALMASat-1 was successfully injected into orbit during the VEGA maiden flight. University of Bologna and ALMASpace are now developing ALMASat-EO, the second microsatellite of the ALMASat fleet scheduled for launch onboard the VERTA-1 flight. In order to support the continue development of innovative structural concepts for future micro- and nanosatellites, ALMASpace is collaborating with the Material and Structure Research Laboratory of University of Bologna (MaSTeR Lab): multifunctional structures and integrated monitoring systems are under investigation.

The concept of multifunctional structures is that the structural elements of a spacecraft can be engineered to have additional functionalities and actually integrate subsystems. The benefits include the definition of standardized modules and interfaces, mass and volume saving as well as potential reduction of manufacturing, assembly and test effort. Recently ESA promoted a series of studies to assess the potential benefits of the implementation of multifunctional structures in the context of system-of-microsystems nanosatellites.

In order to obtain a common platform for general purpose missions, according to the requirements of multifunctional structures, several subsystems and functionalities shall be integrated with the structural elements including: power management, attitude control, telecommunication and on-board data handling, thermal control, propulsion and pressure vessels. Structural monitoring becomes fundamental for rapid condition screening of critical elements and a network of sensors distributed through a structure can provide, in near real time, information regarding its in-service conditions and also its integrity which is relevant for instance, to detect debris damages and to take appropriate counter measures.

Traditional strain gauges transducers and conventional piezoelectric sensors are currently used for structural monitoring. Nevertheless, the rapid improvement of the optical fiber-based sensors for strain, temperature, vibration and acoustic emission measurement, such as fiber Bragg grating, makes them a feasible and effective alternative. The fiber Bragg grating sensors offers advantages over conventional

strain gauges and piezoelectric devices in terms of size, ease of embedment, immunity from electromagnetic interference and multiplexing potential.

The present work aims to present the evolution of structural concepts and technologies from ALMASat-1 to ALMASat-EO and assess the applicability of multifunctional structures to general purpose microsatellites up to 15 kg focusing on the development of smart structural modules or panels with self-awareness and structural monitoring capabilities.