

Thermal-vacuum and vibration test campaigns that led to the OUFTI-1 nanosatellite being fully qualified by ESA for launch and operation in Earth orbit

Xavier Werner¹, Sebastien De Dijcker¹, Valéry Broun³, Gaëtan Kerschen², Jacques G. Verly¹

¹ University of Liège, Dept. of Electrical Engineering and Computer Science, INTELSIG Lab., Liège, Belgium

² University of Liège, Department of Aerospace and Mechanics, Liège, Belgium

³ HEPL, Engineering Department, Electronics Service, Liège, Belgium

After almost eight years of development in an academic setting, and with an educational purpose, the OUFTI-1 nanosatellite is now ready for launch and operation in space. The last few years of development were performed within ESA's Education Office *Fly Your Satellite! (FYS)* project. We describe here the various environmental and vibration tests that led to the full qualification of the satellite by ESA. OUFTI-1 is a one-unit (1U) CubeSat carrying a D-STAR radio-communication repeater. D-STAR is a state-of-the art, amateur-radio, digital communication protocol.

OUFTI-1's test campaigns were divided into two phases. The goal of Phase 1 is to demonstrate that the different functionalities of the satellite work as intended. The goal of Phase 2 is to subsequently demonstrate that the satellite can withstand the launch into orbit, and then work properly in the conditions of space. The corresponding tests thus involve both thermal-vacuum environmental tests (in appropriate test chambers) and vibration tests (on appropriate vibration pods). The conditions simulated during these tests are as close as possible to those that the satellite will encounter during its mission, covering as many cases as possible, amid uncertainties, since neither the launcher nor the orbit were known prior to the tests. Both phases involve the flight model (FM), in accordance with the so-called "protoflight" approach.

Phase 1 consists in a full functional test (FFT) and a mission test (MT). The objective of the FFT is to demonstrate the proper working of every function of the satellite in each of its modes, as well as the ability to switch between these modes. The objective of the MT is to verify the ability to perform the mission according to various representative scenarios. Two main scenarios are defined: nominal and extended. The first one runs through nominal operations. The second one runs through unfavorable cases and extended operations (e.g. long transmit durations). Both scenarios are constructed so that all expected mission events are covered.

Phase 2 consists in a thermal-vacuum campaign (TVC) and a vibration campaign. The goal of the TVC is to verify the proper functioning of the satellite when exposed to environmental conditions similar to those encountered in orbit. The TVC consists in four instances of a hot and cold cycle. The objective of the vibration campaign is to verify that the satellite can withstand the mechanical loads induced by the launch. The satellite, inserted in a test-POD simulating the launch conditions, is subjected to sine, random, and quasi-static vibrations along the three axes.

We will present the results of the tests, the problems encountered, the solution brought to bear, and the lessons learned. OUFTI-1 has now passed all the tests imposed by ESA's FYS project.

Preference for presentation: **Oral**

Most suitable session: **N/A**

Author for correspondence:

Ing. Xavier Werner

University of Liège

Dept. of Electrical Engineering and Computer Science

Quartier Polytech 1, Allée de la Découverte 10

4000 Liège

Tel.: +32 4 366 95 45

Email: x.werner@ulg.ac.be