

Deorbit Sail for the PW-Sat2 satellite mission – a low cost, low energy consumption and high efficiency system

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CubeSat standard is getting more popular not only among students community, but also among private companies. These small satellites represent the cheapest and most flexible solution to enable space access and therefore more and more companies supply off-the-shelf-components and equipment for their missions. In couple of days, number of CubeSats successfully launched on Earth orbit will reach 700. About one fifth of all orbiting CubeSat satellites are no longer operational and they will still remain in orbit for many years, worsening the already troublesome space debris problem.

This paper presents the sail-based PW-Sat2 deorbit system. The sail covers an area of 4 m² and analyses show that it is effective for orbits of up to 800 km altitude for various types of CubeSats. The deployment of the sail does not require any electric motors, which simplifies the design, increases the reliability, and decreases the mass of the system. Sail deployment system requires only little power for a very short period of time: less than 2W of power for less than 1 minute is needed to burn the Dyneema wire holding the sail in a container. The deployment of the sail is driven completely by the energy stored in folded flat c-shaped springs, which releases and unfolds the structure after Dyneema burnout. During the deployment, the sail is ejected out of the container 20 cm away from the satellite, decreasing the risk of interference with other satellite systems.

The surface of the sail is attached to the springs by a special sleeve along the entire length of the springs. It makes the sail more resistant to mechanical damage. A potential surface rupture or collision with space debris in one area of the sail would not render the entirety of the sail useless and bigger parts of the sail would not be able to detach from the satellite. Nor are there any detachable parts in the Sail Release Mechanism, further reducing the probability of generating any additional space debris.

The PW-Sat2 sail design has undergone more than 2 years of prototyping and numerous opening tests on ground in its final configuration. Special folding stand was developed to ensure the repeatability of the sail unwinding tests. The experiment of sail deployment in micro-gravitational conditions in vacuum is being prepared in collaboration with ZARM and UNOOSA. The sail is currently being prepared for final environmental and functional tests before the planned launch in Q4 2017 by the SpaceX Falcon 9.

The PW-Sat2 sail is easy to scale, either up or down, in order to fit into different satellite platforms. In its nominal configuration it occupies 0.6U and weighs altogether ca. 600 g. The total cost of the system, in 2016, is calculated to be €2000.

The same idea could be more generally applied to other satellites in order to provide effective and faster deorbitation.