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MISTRAL: AN ADVANCED CONCEPT OF LOW-COST MICRO-SATELLITE PLATFORM FOR MICROGRAVITY EXPERIMENTS AND RECOVERY

Abstract

Variable-geometry Earth re-entry capsules, and specifically systems equipped with deployable aero-brakes, may represent a low-cost, low-risk and lightweigth alternative to conventional solutions for the recovery on Earth of scientific payloads from Space. The folded configuration small diameter and the low weight make this spacecraft particularly suitable for air-launch. Once in orbit, when planned by the mission profile, the aerobrake can be deployed in order to increase the surface exposed to the hypersonic flow and therefore to reduce the ballistic parameter. This allows performing a completely aerodynamic de-orbit without the need of a dedicated propulsive subsystem, significantly reducing aero-thermo-dynamic loads during re-entry. The aperture of the deployable surface can be modulated to obtain the aerodynamic control of the de-orbit trajectory in order to correctly target the capsule towards the selected landing site for its recovery.

This paper presents the MISTRAL Project, aimed at the development of a Low-Earth-Orbit (LEO) micro-satellite, consisting in a service module, containing all the subsystems necessary for the orbital phase, and a re-entry module, provided with a deployable flexible aero-brake shield suitable for drag-modulation-controlled deorbit. The aero-brake acts also as thermal shield to protect the satellite from the hypersonic re-entry loads. The payload compartment is able to accommodate a variety of instruments to allow the project to satisfy a large number of missions, including autonomous microgravity experimentation in LEO or also Space Mail for the return of samples from the International Space Station to Earth. An onboard orbital propagator software and GPS providing the real-time spacecraft position are linked to the Guidance, Navigation&Control (GNC) subsystem to implement the autonomous control law for the orbital change needed to allow the satellite entering into the final re-entry trajectory in the requested location. To minimize the risk of loosing contact with the satellite during autonomous re-entry,

an automatic low-bit rate communication device, called Space Twitter, has been conceived to transmit to ground the sat position and its orbital parameters every orbit.

At present, Phases A/B of the project have been concluded, with the preliminary design of the flight system and development and test of a breadboard demonstrator of the entire satellite with functioning critical subsystems: deploying mechanism of the re-entry module, including a breadboard of the flexible TPS; telecommunication subsystem (Space Twitter); GNC on-board computer; operating avionics as demonstrative payload.

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