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# DOCKING MECHANISM FOR THE STRONG MISSION: DESIGN, MATHEMATICAL MODELING, AND EXPERIMENTAL TESTING

**Abstract**

The objective of the STRONG mission is the deployment of payloads from Low Earth Orbit into greater orbits. The orbit raising is accomplished using a space tug with electric propulsion. The mating between the tug and the payload is achieved using a custom designed docking mechanism. The scope of this article is to describe this docking mechanism, outline its design process, introduce the mathematical models used for the preliminary verifications, and present the experimental tests executed as well as their results.

The docking mechanism is composed of an active part and a passive one. The active part is equipped with a retractable probe mounted on a universal joint. The base of this joint may translate along two orthogonal directions using controlled actuators. This feature increases the flexibility of the mechanism making it more adaptable to different payloads. The passive part is a conical frustum (drogue) suitable for the probe reception.

The design process was conducted undertaking several steps. Firstly, loads and power requirements were estimated. These requirements led to the selection of appropriate commercial actuators. Subsequently, the ECSS standards were used to verify the suitability of the actuators. Secondly, a simplified 2D model was implemented. The objective of this model was to test the dynamic response of the system avoiding to commit to early to an actuator model. Thirdly, the implementation and results of a complete 3D model further proved the correct behavior of the system. Finally, a prototype was constructed and tested in a laboratory environment. The passive part of the mechanism was attached to a serial robotic manipulator through a force/torque sensor while the interface of the active part was fixed to the ground. The manipulator was programmed to follow several trajectories simulating the relative movements between the spacecraft. The results of the tests demonstrated the maturity of the prototype up to a technical readiness level 4.