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# OPTIMIZED PRELIMINARY DESIGN OF A NANOSAT LAUNCH VEHICLE BASED ON SUBORBITAL ROCKET VSB-30

**Abstract**

The Brazilian suborbital rocket VSB-30 is a two-stage flight proved vehicle, composed by two solid rocket motor, which has been used in several campaigns for microgravity and hypersonic experiments. In microgravity experiments with payloads of 400kg, the VSB-30 has demonstrated the capability to provide an apogee about 270km and 350 seconds in microgravity environment. At least nineteen VSB-30 were launched from Sweden in the last ten years. Miniaturized technologies have provided a growing expansion in the nanosatellite and microsatellites applications, which increases the demand for availability of launch slots. Therefore, based on the original design of the VSB-30, this paper aims to propose an optimized three-stage preliminary design of a launcher able to insert a nanosat into a required orbit. However, to fulfill this mission it is needed to find, via optimization process, a new third stage for this launcher. The optimization problem can follow a sort of approaches as NLP (Nonlinear Programming) and EA (Evolutionary Algorithms). The appropriated solver selection for this problem plays an important role in obtaining the design that fulfill the requirements. Thus, special attention is given to this topic as well as in the mathematical modelling of the rocket dynamics. In the evaluation procedure for the preliminary design, concepts of optimal trajectory, maximum payload capability, structural/propulsion optimization and control strategy are applied. In addition to the complexity of the optimization process, used to find the best solution for the launcher's performance, the development of the control strategy is also complex and critical in the vehicle's design and in the mission reliability. The vehicle is spin-stabilized and presents some amount of nutation in its dynamics. In this way, it is not a simple task to control the attitude and provide a nutation damping before inserting the satellite into the orbit. The starting point for the attitude control approach is to apply the Rhumb-line control strategy after a coasting phase. The studies have been conducted using ESRANGE Launch Center in Sweden as reference site. The goal of this preliminary design is to provide a low-cost, quick assembly and reliable space platform to support northern researches in space physics.