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Author: Dr. Alessandra Babuscia
Jet Propulsion Laboratory - California Institute of Technology, United States

Mr. Matthew Michael McCormack
Massachusetts Institute of Technology (MIT), United States
Mr. Michael Munoz
Massachusetts Institute of Technology (MIT), United States
Mr. Spencer Parra
Massachusetts Institute of Technology (MIT), United States

MIT CASTOR SATELLITE: DESIGN, IMPLEMENTATION, AND TESTING OF THE COMMUNICATION SYSTEM.

Abstract

CASTOR (Cathode Anode Satellite Thruster for Orbital Reposition) is an orbital maneuver and transfer micro satellite bus developed at MIT Space System Laboratory. The technical objective of the mission is achieving one kilometer per second of delta-V over a one year mission in Low Earth Orbit (LEO). This will be accomplished using a novel electric propulsion system the Diverging Cusped Field Thruster (DCFT), which enables high efficiency orbital changes of the ESPA-ring class satellite. CASTOR is capable of improving rapid access to space capabilities by providing an orbital transfer platform with a very high performance to mass ratio, thus greatly reducing launch costs and allowing for highly efficient orbital maneuvers. Furthermore, CASTOR is highly scalable and modular, allowing it to be adapted to a wide range of scales and applications. CASTOR is developed as part of the University Nanosatellite Program (UNP) founded by AFRL (Air Force Research Laboratory), and it will be probably launched in the next year.

In order to accomplish CASTOR mission objective, a highly optimized, scalable, light weight, and low cost Communication System needed to be developed. These constraints imply the development of trade studies to select the final communication system architecture able to maximize the amount of data transmitted, while guaranteeing reliability, redundancy and limited mass, power consumption, and cost. A special attention is also required to guarantee a reliable communication system in cases of tumbling, or in case of strong Doppler shift which is inevitable due to the high delta-V capabilities of the vehicle. In order to accomplish all the mission requirements, different innovative features has been introduced in the design and in the implementation of the communication system for this mission. Specifically, customized patch antennas have been realized, and a new customized communication protocol has been designed and implemented. The communication subsystem has been validated through an intense testing campaign which included software tests in the laboratory, hardware tests in anechoic chamber, and in flight tests through a balloon experiment.

The article presents an overview of CASTOR mission, a presentation of the trade studies analysis and of the final communication architecture selected, a description of the customized antenna developed and of the customized protocol designed, and a presentation the results of the tests performed.