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ANALYSIS AND VERIFICATION OF THE SPACEIL LUNAR LANDER PROPULSION SYSTEM DURING DEVELOPMENT AND BREADBOARD TESTING

Abstract

The SpaceIL Lunar Lander is the first Israeli mission to the moon, with the goal of landing on the moon and performing a short hop on order to win the Google Lunar Xprize challenge. During the design process, the propulsion system architecture has been consolidated and refined based on an advanced simulation of system flow properties. This paper will present both the simulation and breadboard, as well as results. The simulation is based on commercial software which was customised to simulate the actual flight configuration and parameters. The performance was first validated using existing data and dedicated simple test setups. The simulation was used during the design processes, drawing preparations and assembly. In order to verify the system simulation and calibrate its parameters, breadboard testing of essential elements and aspects of the system was executed. The series of tests were used to adapt the behaviour of flight components in the analysis for the entire propulsion system, based on results from the flight components on the breadboard system. The breadboard tests also produced valuable information such as: Detailed hydraulic characterisation of the liquid side of the feed system, including steady state flows rate, steady state pressure drop; Transient phenomenon such as water hammer due to thruster valve operation; Simulation of the priming process, the shock caused due to pyro-valve initiation with downstream vacuum. Finally the more advanced breadboard tests also integrated actual flight avionics, including both an EM flight computer, harnesses and the matching software. This allowed accurately simulating the system performance and executing an end-to-end validation. The successful completion of the breadboard tests provided information to accurately calibrate the steady-state flow characteristics, performance estimation as well as retiring the risks associated with hydraulic stock transients: Priming and water-hammer.