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DYNAMIC MASS FLOW RATE MODEL FOR PPS5000 HALL THRUSTER UNIT

Abstract

The 5-kW PPS5000 Hall thruster is currently under qualification at Safran. The life test demonstration has exceeded the 12,800-hr milestone, with the thruster delivering a total impulse of almost 11.7 MN.s. In parallel to the qualification life test, additional test campaigns have been conducted as system-compatibility verifications and on the mass flow rate of the PPS5000 in various conditions of input temperatures, pressures and thermo-throttle current including transient responses. This thermo-throttle acting as a mass flow rate regulator on command is the main active component of the XFC (Xenon Flow Control) included in the control loop of the thruster integrated inside the PPU (Power processing Unit). The tests results have been used for the validation of a numerical model set-up with the simulation software EcosimPro based on the library ESPSS (European Space Propulsion System Simulation). A one-dimensional dynamic modelling approach was followed for the validation and the complete propulsion system's network was represented from the variable regulated-pressure input toward the vacuum exit. More than a simple correlation tool from experimental test data, the entire dynamic simulation of the has been developed, and will be disclosed for the first time. Moreover, for being available by the end-users of the thrusters, the dynamic mass flow rate model has been included in a black-box as an independent tool, thus enabling the various steady-state assessments as well as the dynamic transients. The paper presents the validation logic for the PPS prediction models and concludes with some examples of the use of the tool for the End-users for various inputs from in-flight data files or user-defined inputs.