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OPERATIONAL SOLUTION FOR ELECTRIC PROPULSION INCLUSION IN A TWO TON COMMUNICATIONS SATELLITE

Abstract

Electric Propulsion (EP) is an attractive option for satellites owing to its high specific impulse when compared to conventionally used chemical propulsion. ISRO launched and operationalized its first satellite with EP in May 2017. The satellite was GSAT-9, with a mission goal to provide communication services in Ku-band with coverage over South Asian countries. GSAT-9 is configured around ISRO's standard I-2k bus, with a lift-off mass of 2230 kg and targetted mission life of 12 years. The power generation is 3.5 kW. The EP was to be included in the I-2K bus, in addition to Chemical Propulsion, within the given mass and power budgets. The objective was a technology demonstration to assist in Station Keeping. The EP system comprised four Stationary Plasma Thrusters (SPT) with 18mN thrust, demanding an additional power of 570W from the already power-optimised satellite bus. The challenges of configuring and operating EP were multifold - thermal management of high dissipating EP elements, power management through a newly designed EPS bus, inclusion of onboard sequencer for Electric Pressure Regulator mode of SPT operations. The EP system demanded a thorough conditioning and initialization before being operationalized. Ground operations were planned meticulously to handle all requirements. A mission strategy was worked out to plan the SPT operations calender wrt the deltaV requirement, energy balance (including eclipse/shadow analysis), plume impingement and SADA offset. All operations, for both Electric and Mechanical Pressure Regulators, were streamlined and laid down as well documented procedures. Ground events were defined to detect any contingency and send required commands. Momentum dumping and error build-up in the absence of thruster pointing mechanism was another challenge. For on-orbit phase of operations, a judicious mix of onboard and ground automation was built in to cater the station keeping requirements, including error correction. Additionally, a mimic for EP system was developed to provide a quick-look assessment of the EP functioning. Ground operations were so well planned that it was possible to demonstrate the EP system in the drift orbit itself, imparting the deltaV required for trim maneuvers as part of orbit raising. EP system in GSAT-9 is working satisfactorily, as per plan, with 4 hours of firing each day at the nodes and contributing to the mission life. The objective is met and has paved the way for upscaled implementation of this system for a low mass, cost-effective solution.