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A SUPERCONDUCTING EMDRIVE THRUSTER. DESIGN, PERFORMANCE AND APPLICATION.

Abstract

In an IAC-20 paper, the detailed design of a cubesat EmDrive thruster was described. This paper advances that design to a superconducting version. The basic microwave cavity retains the same internal geometry, but is now manufactured from Kovar, a special nickel-cobalt-steel alloy with thermal expansion properties to match the internal Yttrium Barium Copper Oxide (YBCO) superconducting thin film, and substrate. This technology was originally used in a liquid Nitrogen cooled, 3.85 GHz demonstrator thruster, which produced test data verifying cavity performance. The test data was used to predict the performance of this present design. The standard thrust equation, verified over many EmDrive experimental programmes, is used to give a specific thrust of 12.3 N/kW at the operating temperature of 77K. The dynamic operation of the thruster is addressed, with internal Doppler effects described. It is concluded that no compensation technology is required for the predicted acceleration levels. The kinetic energy aspects are analysed and the results of pulse operation are given, and compared to the original cubesat thruster operation. The low operating temperature is reached by a passive cooling system, which extends the concept described for the cubesat. The original 40W microwave input power is retained, but the thermal radiator area is greatly increased, and a liquid Nitrogen cooling loop is incorporated. The thermal radiator fins are maintained in permanent shade by a large sunshield, deployed using folded arms. The radiator fins are deployed using a folded centre tube and end struts. The spacecraft described in this paper, uses two thrusters mounted on single axis gimbals. They are positioned equidistant from the centre of mass of the spacecraft, to enable primary thrust in X,Y and Z planes with the addition of roll from a momentum wheel. Pitch and Yaw are provided by the thrusters, with momentum wheel back up. Power is provided from two rotatable, 95W solar arrays, which allow flights to the inner planets. Use of a 110W NASA Multi Mission Radio Isotope Thermoelectric Generator (MMRTG) would enable fast missions to the outer planets, and interstellar precursor flights. Outline designs of these alternative spacecraft are described, together with initial mass property analyses, to establish the correct positioning of the thrusters relative to the centre of mass. The resulting spacecraft masses are 90kg for the solar powered version and 120kg for the spacecraft powered by the MMRTG.