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AN EMDRIVE THRUSTER FOR CUBESATS

Abstract

Designing an EmDrive thruster for a cubesat presents a number of challenges. Foremost is the need to reduce the size of the microwave cavity, to enable integration into the cubesat structure. This requirement can be addressed by selection of frequency and operating mode. EmDrive propulsion systems have been designed to operate from 900MHz to around 8 GHz. However, to maintain the low cost, Cubesat philosophy, a frequency where both components and test equipment are widely available is preferred. The first choice would seem to be the ISM band (2.4GHz to 2.5 GHz). However this leads to cavity sizes which are too big for the largest 12U Cubesat structure. The original SPR Flight Thruster was designed around a flight qualified, 3.85 GHz TWTA, and as equipment in the new 5G mobile band (3.4GHz to 3.8GHz) is now readily available, this frequency was also chosen for the Cubesat design. The Flight Thruster had a maximum internal cavity diameter of 200mm, and operated in a TE013 mode. To reduce the maximum diameter to 150mm, the operating mode was changed to TE113. This paper describes the detailed cavity design process, including a description of the design software and the equations used. The resulting cavity dimensions for the Cubesat Thruster are given, together with E and H field diagrams and plots of wavelength and wave impedance. The placement of input loop, tuner, detector probe and vent are discussed. The low power available on a typical Cubesat means that the thruster design must utilise the power in the most efficient manner. Essentially this requires that the cavity Q must be maximised. This requirement is addressed in two ways. Firstly the cavity is cooled by ensuring that the large end plate of the cavity is directed to deep space, and is kept in the shade using a deployable sunshade. Secondly, the end plate alignment, which is critical for high Q and high thrust, is kept within tolerance, by use of piezo-electric elements and a digital control system. A specific thrust of 0.5N/kWm is given for the thruster. The resulting 12U cubesat is described, and tentative missions are proposed, giving a flight time to Mars of 76 days, or a time to Pluto of 2.6 years. Both flight times are well within the specified Cubesat operational life of 5 years.