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FEASIBILITY STUDY ON SPACEBORNE COOLER MICRO-VIBRATION ENERGY HARVESTING SYSTEM USING PIEZOELECTRIC

Abstract

Spaceborne cryocooler produces undesirable micro-vibration disturbances during its on-orbit operation, which are a primary source of image-quality degradation for high-resolution observation satellites. Therefore, for the aim of compliance with the strict mission requirement of high-quality image acquisition, most of technical efforts were directed toward reducing the micro-vibration disturbances induced by cooler operations in an on-orbit environment. However, in this study, we focused on the feasibility of employing an energy harvesting technology to harvest an electrical energy from a micro-vibration energy of the cooler. Although the harvested energy from the cooler is regarded as significantly small values to instantaneously use, it can be utilized as a power source to operate low power consumption devices such as micro-electromechanical system (MEMS) by being accumulated in the rechargeable battery. In spite of the fact that the vibration energy of the cooler is regarded as a potential energy source, however, the micro-vibration transmitted to the satellite structure should be strictly managed to assure the image quality of the observation satellite. In this study, to achieve the dual objectives of harvesting the micro-vibration energy and simultaneously isolating the micro-vibration from the cooler, a piezoelectric energy harvester integrated with a conventional passive vibration isolator was proposed. To maximize its energy generation performance, it was designed to have a coupling effect with an excitation frequency of the cooler. The effectiveness in both energy harvesting and micro-vibration isolation capabilities of the proposed system was demonstrated through a numerical simulation, and its validity was confirmed through micro-vibration and voltage measurements test at system assembly level.