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OPTIMAL DESIGN OF THE MICRO-VIBRATION ISOLATION FOR SPACEBORNE CRYOCOOLER

Abstract

Micro-vibration on spacecraft is a special kind of vibration which has tiny amplitude and high frequency. Although the vibration is so small that the influence to structure is negligible, it has a significant impact on high-precision space missions such as Earth observing, laser communication between satellites through degrading the performance of sensitive payloads. The spaceborne cryocooler produces undesirable micro-vibration disturbance during its on-orbit operation, which is one of the main source degradation of the image quality of high-resolution observation satellites. Therefore, to comply with the strict mission requirement for the acquisition of high-quality images, micro-vibration disturbances induced by cryocooler operation need to be isolated. One way to avoid degradation of image quality is to mount an isolator for attenuating the micro-vibration transmitted to optical payloads. The passive-type isolators have generally been employed in space application on account of their advantages of simplicity, low cost and high reliability. The isolator is typically designed and test in the stand-alone level. As a result, it may work well when tests alone, but when it is mounted on the satellite, its performance is usually not satisfying. Furthermore, the micro-vibration isolator for cryocooler disturbance is typically designed on the base of engineer's experience and a great number of experimental data, which cost large amount of money and time. What is worse is that the performance of the isolator is generally not the best using this method. In this article, we try to select the isolator in the system view, considering the flexibility of the structure, avoiding coupling with natural frequency of the spacecraft structure and some appendages like the solar panel and the antenna. In order to improve the isolation performance, we will optimize axial and radical stiffness and damping coefficient of the isolator using finite element method. Simulations show that the proposed parameter has great reduction on high-frequency disturbance of cryocooler in all degrees of freedom. In this way, we can improve the image quality of the Earth observing satellite with quite less costs than ever.