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PERFORMANCE INVESTIGATION OF SPACEBORNE MICRO-VIBRATION ISOLATION SYSTEM COMBINED WITH HEAT PIPE COOLING SYSTEM

Abstract

For observation satellites, where high pointing stability is required, disturbances generated by the vibration sources are critical to the success of the mission. In this study, recent achievements in vibration isolation system for on-orbit application to enhance pointing performance by isolating micro-vibration disturbances induced by a spaceborne cooler have been introduced. The on-orbit vibration isolation concept is a frequency separation between the cooler excitation frequency and a natural frequency of the cooler assembly supported by the isolation system by putting the natural frequency of the isolation system on the lower frequency region than the cooler operation frequency as low as possible. This can be achieved by the implementation of coil springs with the characteristics of relatively lower stiffness in the lateral direction of the coil springs, which corresponds to the main excitation axis of the cooler compared to the axial stiffness of the coil springs. The allowable deflection range of the coil spring is 3mm and this can be protected by the mechanical limiter of the isolator under launch loads. The nominal position of the compressor in orbit can be recovered by the restoration force of the extended or contracted coil springs under the launch environment. The combined stiffness of the coil springs is larger than the stiffness of the heat pipe for the thermal control of the cooler. Therefore, the misalignment of heat pipe is no longer the critical path to degrade the isolation performance. The thermal control of a cooler is one of the important developmental issues to increase the cooling performance and reliability. The heat pipe cooling system to maintain the cooler within an acceptable range of the operating temperature during the mission life-time guarantees the thermal control performance of the cooler as well as the isolation performance of the micro-vibration isolation system. The heat pipe implementation design proposed in the present work is also effective for ensure micro-vibration stability even though a heat pipe might have failed. To demonstrate the effectiveness of the isolation system, we performed launch environment tests and a micro-vibration measurement test of the cooler combined with the isolation system. The test results indicate that the isolation system proposed in this study guarantees the structural safety of the cooler under the launch environment and effectively attenuates the micro-vibration of the cooler under the on-orbit condition.