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DESIGN AND DEVELOPMENT OF AN ACTIVE MAGNETIC BEARING FOR ENHANCED LONGEVITY OF EARTH SENSOR

Abstract

To successfully conduct long-term space missions, it is essential that spacecraft mechanisms and mechanical systems are reliable and do not fail. Meeting such demands can be challenging, particularly for the tribological components, specifically the bearings. Recent bearing failures in key systems have prompted an evaluation of non-contacting magnetic levitation-based rotor support technologies. Although magnetic levitation technology has been proven effective for terrestrial and spaceflight mechanical systems, its use in spacecraft remains limited due to factors such as cost, weight, performance, and perceived risk. A difficulty that must be overcome is the removal of lubricants that are appropriate for non-vacuum settings but not appropriate for vacuum settings. This is where Active Magnetic Bearings (AMB) excel, as they allow for movement without physical contact. AMB is especially dependable in the extreme radiation conditions of space, and it improves the durability of equipment for prolonged use. In addition, AMB provides reliable performance even in harsh conditions, without any malfunctions.

This research aims to design and develop an Active Magnetic Bearing (AMB) for an Earth sensor, enabling the scanning mirror payload system to rotate without any physical contact, thus overcoming the limitations posed by compact space and power constraints. To accomplish this objective, the study employs a variety of robust methodologies, including magnetic and numerical analysis to optimize the design of the AMB, as well as test rig validation to ensure that the system operates as intended. The use of magnetic analysis enables a thorough examination of the magnetic field distribution, which aids in optimizing the design of the AMB. The numerical analysis provides a comprehensive simulation of the system's behaviour, which allows for further optimization of the design. Furthermore, test rig validation is carried out to ensure that the system functions correctly, where the AMB is tested under different operating conditions, such as different rotational speeds and loads, to verify its performance. Additionally, a control system design is implemented to ensure that the AMB functions efficiently and accurately, contributing to its total performance and longevity.