Books & Reports

Reliability of Ceramic Column Grid Array Interconnect Packages Under Extreme Temperatures

A paper describes advanced ceramic column grid array (CCGA) packaging interconnects technology test objects that were subjected to extreme temperature thermal cycles. CCGA interconnect electronic package printed wiring boards (PWBs) of polyimide were assembled, inspected nondestructively, and, subsequently, subjected to extreme-temperature thermal cycling to assess reliability for future deep-space, short- and long-term, extreme-temperature missions.

The test hardware consisted of two CCGA717 packages with each package divided into four daisy-chained sections, for a total of eight daisy chains to be monitored. The package is 33×33 mm with a 27×27 array of 80%/20% Pb/Sn columns on a 1.27-mm pitch.

The change in resistance of the daisy-chained CCGA interconnects was measured as a function of the increasing number of thermal cycles. Several catastrophic failures were observed after 137 extreme-temperature thermal cycles, as per electrical resistance measurements, and then the tests were continued through 1,058 thermal cycles to corroborate and understand the test results. X-ray and optical inspection have been made after thermal cycling. Optical inspections were also conducted on the CCGA vs. thermal cycles. The optical inspections were conclusive; the x-ray images were not.

Process qualification and assembly is required to optimize the CCGA assembly, which is very clear from the x-rays. Six daisy chains were open out of seven daisy chains, as per experimental test data reported. The daisy chains are open during the cold cycle, and then recover during the hot cycle, though some of them also opened during the hot thermal cycle.

This work was done by Rajeshuni Ramesham of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-47341

Six Degrees-of-Freedom Ascent Control for Small-Body Touch and Go

A document discusses a method of controlling touch and go (TAG) of a spacecraft to correct attitude, while ensuring a safe ascent. TAG is a concept whereby a spacecraft is in contact with the surface of a small body, such as a comet or asteroid, for a few seconds or less before ascending to a safe location away from the small body.

The report describes a controller that corrects attitude and ensures that the spacecraft ascends to a safe state as quickly as possible. The approach allocates a certain amount of control authority to attitude control, and uses the rest to accelerate the spacecraft as quickly as possible in the ascent direction. The relative allocation to attitude and position is a parameter whose optimal value is determined using a ground software tool.

This new approach makes use of the full control authority of the spacecraft to correct the errors imparted by the contact, and ascend as quickly as possible. This is in contrast to prior approaches, which do not optimize the ascent acceleration.

This work was done by Lars James C. Blackmore of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-47192

Optical-Path-Difference Linear Mechanism for the Panchromatic Fourier Transform Spectrometer

A document discusses a mechanism that uses flex-pivots in a parallelogram arrangement to provide frictionless motion with an unlimited lifetime. A voice-coil actuator drives the parallelogram over the required 5-cm travel. An optical position sensor provides feedback for a servo loop that keeps the velocity within 1 percent of expected value. Residual tip/tilt error is compensated for by a piezo actuator that drives the interferometer mirror.

This mechanism builds on previous work that targeted ground-based measurements. The main novelty aspects include cryogenic and vacuum operation, high reliability for spaceflight, compactness of the design, optical layout compatible with the needs of an imaging FTS (i.e. wide overall field-of-view), and mirror optical coatings to cover very broad wavelength range (i.e., 0.26 to 15 μm).

This work was done by Jean-Francois L. Blavier, Matthew C. Heverly, Richard W. Key, and Stanley P. Sander of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-47317