www.DeepakPublishing.com

Patmont, C. et al. (2016): JoSS, Vol. 5, No. 1, pp. 407–418
(Peer-reviewed article available at www.jossonline.com)

www. JoSSonline.com

Design and Characterization of a Spring Steel Hinge for Deployable CubeSat Structures

Elbara Ziade, Calvin S. Patmont, and Theodore A. Fritz

Department of Mechanical Engineering and Center for Space Physics, Boston University
Boston, MA, USA

Abstract

A novel implementation of a spring steel was used to design an economical, self-locking, self-guiding, and self-actuating single-component hinge. The concept behind the hinge is an off-planar arrangement of commercial off-the-shelf (COTS) spring steel strips. The off-plane arrangement of the spring steel strips creates asymmetric folding and buckling to provide the necessary stiffness and dampening for solar panel deployment. This paper presents four spring steel hinge configurations and the analytic equations used to characterize them from three solar panel mass deployments in microgravity. It also discusses the forces generated by the hinge and energy dissipation rate for representative model systems.

1. Introduction

University-developed CubeSat specifications have already demonstrated the broad impact that a simple, robust and modular satellite bus has on institutional and private industry spaceflight endeavors (Straub, 2012). In addition, the economic benefits of configuring and qualifying commercial off-the-shelf (COTS) technology for space applications continues to increase the popularity of CubeSat missions and satellite groups' accessibility to space (Skrobot, 2011; Skrobot and Coelho, 2012).

As CubeSats evolve, their electronic and instrument complexity increases, demanding more power to achieve more sophisticated endeavors. The constrained power budget must be met by using either more efficient solar cells, or by incorporating deployable solar panels to increase the sun-facing surface area. Resource-constrained small satellite teams design in-house solar panel deployment systems because available space-rated COTS deployment systems are too expensive, and are also sold as complete packages, which restricts CubeSat design configurations.

The current study's response to this barrier of entry for deployment systems is the design and characterization of a scalable and configurable hinge for the CubeSat bus. The simple-continuous or "solid-state" nature of this mechanical design needs fewer qualifications than pinned joint hinge alternatives, which are affected by thermal expansion, galling, cold

Corresponding Author: Calvin S. Patmont, cpatmont@bu.edu
Publication History: Submitted – 12/17/14; Revision Accepted – 12/02/15; Published – 02/19/16