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Shielding Effectiveness and Closeout Methods for Composite Spacecraft Structural Panels

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Abstract:

Increasingly, the latest spacecraft designs utilize partially conducting composite materials such as graphite epoxy or carbon-loaded Kevlar panels. These materials provide significant weight and mechanical advantages compared to conventional metallic structures, but their radio-frequency (RF) shielding properties are not well understood. In order to maintain a specified level of electromagnetic shielding on the spacecraft, it is necessary to use these composites and other materials to construct complex electromagnetic interference closeouts where harnesses, propulsion lines, RF cables, and waveguides penetrate the spacecraft Faraday cage. Shielding effectiveness measurements of these composite materials with standard seams and penetrations were performed. Closeout methodology was based on best commercial practices and included materials such as metallic mesh screen, double-sided metal-clad dielectric, conductive thermal blankets, and metallic foil tape with conductive adhesive. The test was conducted using standard methods inside a MIL-STD-461E anechoic chamber. Results demonstrated that the spacecraft composite structure with closeouts typical for commercial spacecraft can provide greater than 40 dB of shielding effectiveness from 200 MHz to 10 GHz and greater than 30 dB of shielding effectiveness from 10 to 40 GHz.

Published in: IEEE Transactions on Electromagnetic Compatibility (Volume: 50, Issue: 3, Aug. 2008)

Page(s): 547 - 555

INSPEC Accession Number: 10176140

Date of Publication: 19 August 2008

DOI: 10.1109/TEM.2008.926875

ISSN Information:

Publisher: IEEE

Sponsored by: IEEE Electromagnetic Compatibility Society

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I. Introduction

The purpose of this paper is to present results of a high-fidelity ground testing study of the electromagnetic shielding effectiveness of structural panel and seam/hole closeout materials and methods commonly utilized in spacecraft applications. Earlier studies [1]–[5] have already demonstrated that the shielding effectiveness of graphite composites is quite high. Therefore, as expected, the treatment of seams and closeouts are the primary limiting factors determining the practical shielding effectiveness of these composites. This study presents empirical results for shielding effectiveness of selected classes of structural materials, including both panel and corner applications, in conjunction with representative hole/seam closeouts that include various harnesses, propellant lines, and radio-frequency (RF) waveguides.

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