PCB Effective Thermal Conductivity for Spacecraft Electronic Boxes Thermal Analysis and Design

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ABSTRACT

Spacecraft electronic boxes are basically composed by Printed Circuit Boards (PCB) with several heat dissipating components mounted on it. The heat must be conducted away from the small mounting areas to the PCB fixation points in order to keep the components within their temperature limits. In space, it is quite critical since the main way to spread heat of electronics is by conduction along the PCB. Based on extensive experimental study performed on 12 PCBs, new correlations for PCB effective conductivities were obtained. For the isotropic approach, expressions of weighted arithmetic, geometric and harmonic means were developed, which present much better precision than canonical unweighted means. Intrinsic uncertainties for the isotropic approach of PCB for space applications were revealed and evaluated. For the anisotropic approach, modified correlations for thermal effective conductivities ($k_{p,eff}$ and $k_{s,eff}$) were carried out including statistical distributions of introduced factors to compensate the variety of conductive paths of multilayer PCBs. Such correlations can be used to define the conductivity uncertainty bounds, which are useful for thermal analysis and allow the engineer to obtain component temperature uncertainties. A practical methodology on how to use the correlations is presented considering the derating approach.

Keywords: Effective thermal conductivity, PCB, Electronic box thermal analysis.