Paper ID: 8798
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MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Space Vehicles – Mechanical/Thermal/Fluidic Systems (7)

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EFFECTIVE PARAMETERS ON CALCULATION OF EFFECTIVE THERMAL CONDUCTIVITY OF MULTILAYER PRINTED CIRCUIT BOARDS IN SPACE APPLICATION

Abstract

Heat conduction via the PCB is the most important heat transfer mechanism for spacecraft electronics. This is why the accurate estimation of PCB thermal conductivity is crucial. Since typical PCBs have low thermal conductivity, multilayer PCBs are used in space applications to ease up the heat transfer through out the PCB. A Multilayer PCB is composed of several copper layers which are located among glass-epoxy layers. Thermal conductivities of a multilayer PCB in normal and parallel directions are essentially different from each other. Although calculation of thermal conductivity using three-dimensional thermal simulation is a superior method, it can be complicated and costly. This calculation may be simplified if a multilayer PCB is approximated by a single material, having two thermal conductivities in normal and parallel directions. Normal and parallel effective thermal conductivities are usually calculated by assuming multilayer composite material heat conduction. Culham (1998) modeled PCB as a single homogeneous object with an effective thermal conductivity. This effective thermal conductivity can be typically calculated by various combinations of normal and parallel thermal conductivity. Culham used three different schemes of averaging to combine them. Moreover, Lemczuk(1992) propose an analytical solution for calculating heat transfer among a multilayer PCBs on which a heat source was putted. Yovanovich(1999) demonstrate the effective parameters on effective thermal conductivity of multilayer PCBs by means of variables on the analytical solution. Shabany(2002) showed that averaging methods made inaccurate temperature prediction of a multilayer PCB. In this paper, a new boundary condition applicable to spacecraft operating environment is used and the analytical solution is adapted to the new boundary condition; subsequently, the effective parameters are identified. In order to compare accuracy of temperature distribution through out a multilayer PCB using various combination of normal and parallel thermal conductivity with that in three dimensional simulation of a multilayer PCB, different simulations are built and thermal analysis are done with a commercial software. The results show that the averaging methods however are simply calculated, lead to the great inaccuracy in measuring temperature distribution of PCBs. Consequently, a new combination of normal and parallel thermal conductivity, showing more accurate results is suggested.