Convective Cooling of Electronic Components

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Abstract

In response to continued miniaturization and increased multi-functionality of electronic circuits, the number of integrated circuit (IC) packages on the circuit board continues to increase. As a consequence the operating power density increases and significant increases in the operating temperature of devices result. To maintain operation and long term performance device temperature must be maintained below specific limits thus necessitating more improved thermal dissipation.

For many devices forced convection is not an option due to small form factors and concern about long term reliability. For these applications passive approaches for the dissipation of thermal energy by natural convection can be enhanced by attaching heat sinks to critical components. Heat sinks are commonly attached to high power density components and act to reduce the thermal resistance between the device junctions and the ambient environment by increasing the surface area for convective cooling. Increasing the number of fins provides more surface area but also obstructs flow and causes an additional pressure drop across the heat sink, thus it is expected that an optimum distribution of plates exists for maximum cooling.

In this study, approaches for predicting the performance of vertically oriented plate-fin heat sinks with natural convection have been investigated. Thermal dissipation to the environment is considered to occur by heat transfer involving conduction, convection and radiation. The importance of including heat transfer from the fin tips, radiation from the heat sink, choice of the model size, level of mesh refinement and selection of the element type in developing an accurate, converged solution and the associated computational expense have been examined. Results demonstrate the optimum fin spacing for thermal dissipation for a range of heat fluxes and fin-plate thickness.