# Convective Cooling of Electronic Components

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## Abstract

The development and miniaturization of electronic circuits with increased functionality oftentimes results in significant increases in the required input power density to components. As a result higher thermal fluxes are developed that may affect performance and must be dissipated to maintain device functionality and provide long-term operation. While forced air cooling may solve most commonly encountered problems, many applications avoid forced convection because of concern about the reliability of fans and rely on natural convection cooling. New ideas to utilize convective cooling to meet today's demand for thermal dissipation of high power electronic circuits are being investigated.

Dissipation of thermal energy by natural convection can be enhanced by attaching heat sinks to critical components and two primary designs of heat sink are used based on plate-fin or pin-fin arrangements. In certain applications, heat sinks with pin-fin arrangements have been shown to perform better than those with plate-fins. In this study, we examine the use of various modeling approaches and optimization studies for assessing the design of pin-fin heat sinks cooled by natural convection. Vertical channels containing horizontal pin fins are subject to natural convection causing chimney-style flow upwards through the array of fins. In this study, we quantify the time-dependent fluid flow and thermal interactions using capabilities within COMSOL Multiphysics® to solve transient and steady state conditions of the conjugate heat transfer problem between the natural convective flow and the heat sink.

The increased ratio of convective to conductive heat transfer across the boundary of the heat exchanger leads to improved dissipation of heat generated by the attached components. This appears to be largely caused by two effects: first, downstream pins can be located in the wakes of upstream pins, which is favorable for higher flow rates, and secondly, faster flows cause more vortex shedding and oscillations; these time-dependent velocity fluctuations promote enhanced heat transfer rates with the downstream pins.