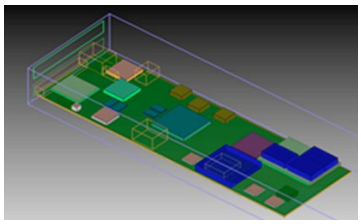
High Power PCIe Card Heat Pipe
Design Case Study

Introduction

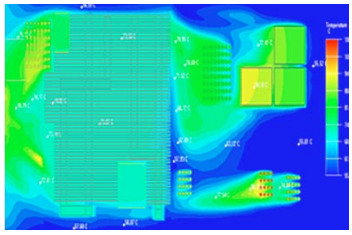
Aavid, Thermal division of Boyd Corporation, took on the challenging task of cooling a high power PCIe card housed within a rack-mounted satellite tracking, telemetry and telecommand (TT&C) unit. This product functions as a critical bridge between the satellite control center and the satellite itself.



The Challenge

The PCIe card in question needed to dissipate 40-50W of power, depending on operating conditions. A customer limitation on additional active cooling required that Aavid find a passive solution that utilized the existing fan array in the system.

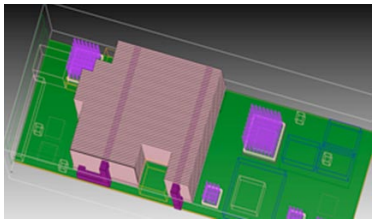
The primary focus of the cooling solution was to maximize MTBF of the PCIe card by keeping BGA device temperatures at a minimum.



The Solution

For this level of power dissipation, a heat pipe / radiator fin design was the most effective choice. Today's high end computer graphics cards utilize a similar system to dump their heat; however, most of these are actively cooled with a small onboard fan. In order to keep the system passive, Aavid decided to look at a dual slot design where a larger fin stack would occupy the second slot.

Aavid created a detailed CFD base model which included FPGA, PHY, DDR, DDS, Omap, Bridge and LTM packages. The PCB thermal properties were defined by the number of ground and power layers specified by the customer. Other components in the system, such as the RF and Heat Sink boards, were modeled as heat dissipating PCB boards. The system was then analyzed at an ambient temperature of 55°C with an altitude pressure of 750 hPa and a flow rate of 300LFM.



Continued

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the solution continued

From the base CFD simulation, Aavid was able to determine flow and temperature maps over the board, component junction temperatures and case thermals at the above conditions. This base model was then altered by the following to finalize the thermal solution:

- For components at or above their thermal limit, calculations were done to find the mini mum required heat sink thermal resistance to bring them into safe operating ranges.
- Designed the thermal solution for all the components exceeding the minimum junction temperature requirements.
- Optimized the heat sink for DFM, cost and performance.

The Deliverables/Results

A complete thermal report and sample units were provided to the customer for testing. These sample units, produced at Aavid's rapid prototyping facility at our headquarters in Laconia, NH, allowed the customer quickly and effectively validate the thermal solution. After the successful sample tests, Aavid set forth on a full production run of the PCIe card cooling solution for use in the final product. From concept to production - and everything in between - Aavid was able to deliver a cost effective and timely solution for this difficult thermal problem.

- At the above tested conditions (55°C, 750hPa and 300LFM), all of the components stayed be low the maximum junction temperature limits.
- Side baffles were recommended because, if included, they would prevent air bypass and improve the junction temperatures further.
- The strategic 3D routing of heat pipes allowed heat to spread across the surface of the pcb as well as up into the fins.