Case study

Better electronic enclosures by CFD simulation

SIENNA ECAD leverage Cradle CFD with conjugate heat transfer to enhance the cooling performance of a 12mm thick enclosure for a PCB using Cavity and TIM design

SIENNA ECAD is one of India's leading PCB design and analysis engineering companies located in Bangalore, India, with over 25 years of experience in the evolution of the global electronics industry. They specialise in engineering services designing complex PCB layouts, simulation and analysis of designs, library management, DFX and prototyping, and more to aid their customers in segments including networking, power, transportation, semiconductor, IoT, and medicine.

PCB Engineering team works with clients across the globe, finding solutions for highly complex PCB design problems meeting IPC specifications. Their PCB Engineering solutions include High-Speed PCB Design, SI Analysis (Time Domain and Frequency Domain analysis), Power Integrity analysis, Thermal EMI/EMC and Reliability Analysis.

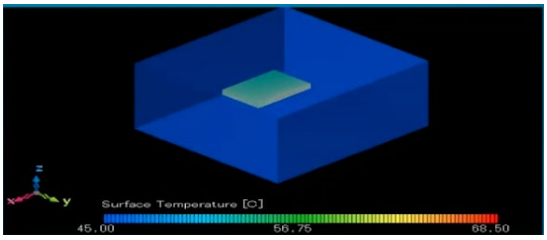
The parent companies Sienna Corporation and Avalon Technologies are Electronics Manufacturing Services providers based in the USA and India with facilities in Atlanta, Fremont, Chennai, and Bangalore.

> **Cradle CFD enabled us to get actionable insights of the thermal flow in or design and quickly identify the design flaws that ensured that we could innovate the design and create an enclosure that helped address our temperature requirements and size constraints."**

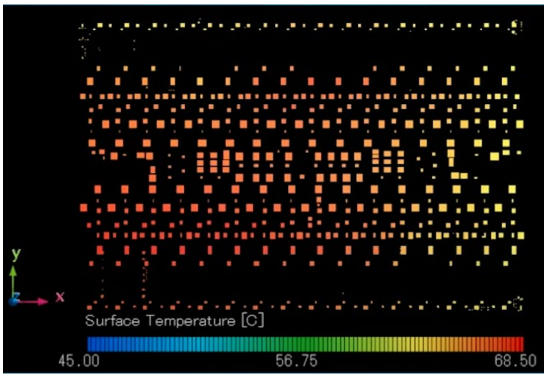
Suresh Nidasesi,
Project Manager (Design and Analysis),
SIENNA ECAD

scSTREAM drive better thermal design

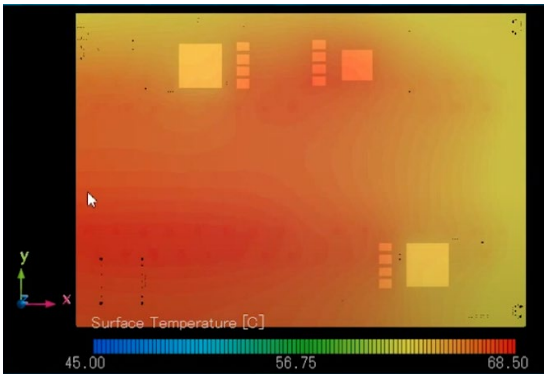
One particular challenging PCB design project for the PCB Engineering team was incorporating two System on Modules, SoM, each with over 1000 components inside an IP64 compliant, dust-tight and no effect of splashing water, enclosure only 12mm thick. Further, the team needed to find a design where the total power dissipation of the system was below 250W, and it was required to operate around the clock all year round in a harsh environment at an elevated temperature, exposed to direct sunlight. Simply put, conditions made to make electronics fail.



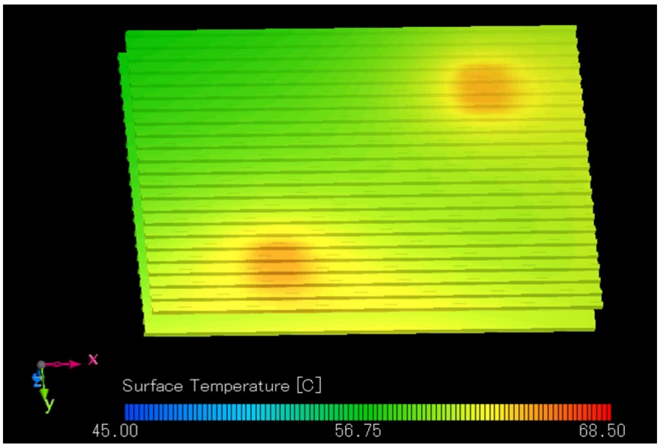
The design space provided also created challenges as the design needed to fit in a small space in an existing enclosure; hence it was initially decided to evaluate the multi-board design with a custom heat sink that relied on natural convection for cooling without fans or other cooling devices.



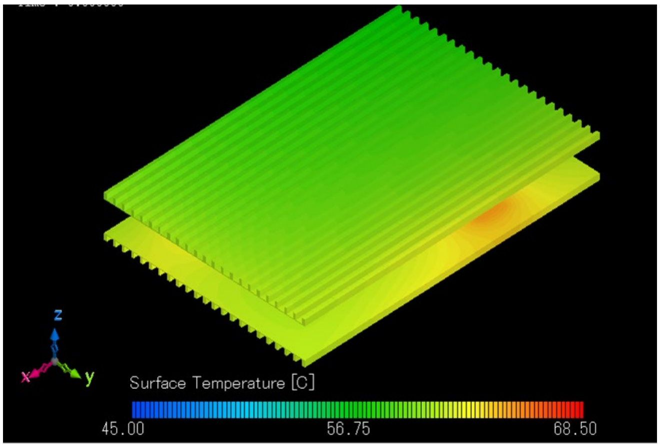
Initial design analysis by scSTREAM, a part of Cradle CFD, showed that the temperature in the first design reached as high as 250-280°C, while the maximum temperature design target was set to 125°C for normal or 85-90°C for RF & high-speed components.



The CFD analysis contained the mechanical CAD model of the enclosure and the ECAD of the two SoM considered radiation and conjugated heat transfer, e.g. considering heat transfer of both fluids and solids. The PCB had anisotropic material parameters to model difference heat transfer in-plane and normal directions.



Bottom heat sink



Top heat sink

The analysis demonstrated that the existing arrangement of the heat sink enclosure was inadequate to manage the temperature. The team explored options such as changing the heat sink parameters such as fin sizes or length; however, this did not prove helpful in reducing the temperature. Thus, innovative methods to overcome the challenge was needed.

The team decided to explore the option of using a Thermal Interface Material (TIM) and cavity design, where components are placed in cutouts, consequently not connecting to the top or bottom PCB layer. In this approach, the enclosure design had each component contact with it as they were recessed in the PCB, thus directly being exposed to it acting as a heat sink. TIM (PCM780SP) was further used to enhance heat transfer. The team quickly adopted the scSTREAM model to the new design changes, and simulation promptly showed that the temperatures of the PCBs and the enclosure were well was within the design target.

The CFD simulation helped the PCB Team meet the design target and the design phase rule out the initial design to reduce design interaction and avoid expensive prototype testing with the help of thermal simulation solutions provided by Hexagon.

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Our technologies are shaping urban and production ecosystems to become increasingly connected and autonomous – ensuring a scalable, sustainable future.

Software Cradle, part of Hexagon's Manufacturing Intelligence division, provides highly reliable, multiphysics-focused computational fluid dynamics (CFD), thermal dynamics software and integrated simulation tools that enhance customers' product quality and creativity. Learn more at cradle-cfd.com. Hexagon's Manufacturing Intelligence division provides solutions that utilise data from design and engineering, production and metrology to make manufacturing smarter.

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