

COOL DESIGNS FOR REMOTE DESKTOP ACCESS

Teradici improves PCoIP zero client design by optimizing enclosure cooling with ANSYS Icepak.

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Businesses need employees to have access to data and software, yet providing a physical desktop or laptop is not the only option. Remote desktop access using a PCoIP® zero client — a simplified hardware device that has no general-purpose CPU, local data storage, application operating system or cooling fan — is an ultra-secure and easy-to-manage-and-deploy client suitable for virtual desktop and remote workstation environments. Teradici, developer of the PCoIP protocol, supplies technology for PCoIP zero clients that provide a rich computing experience for the user. These zero clients leave a small environmental footprint, generate little heat, and use relatively little power. Remote users can access either virtual desktops hosted in the datacenter or high-performance remote workstations from a few desks away or around the world through an IP network.

PCoIP zero clients are compact, and their internal temperature must be kept within an efficient operating range. Typically, the zero client is physically close to the user, so the enclosure must maintain a temperature that is not uncomfortably hot if touched. Engineers at Teradici use ANSYS Icepak to evaluate and then optimize the cooling process, keeping the temperature within a safe and approved range.

A THERMAL MODELING PROBLEM

To maintain the required PCoIP processor operating temperature range, the zero client's internal temperature should not exceed 100 C (212 F). Additionally, the zero client exterior temperature should be less than 45 C (113 F) to avoid surfaces uncomfortable to the touch.

Knowing that heat dissipation would be a key factor, engineers turned to ANSYS software.

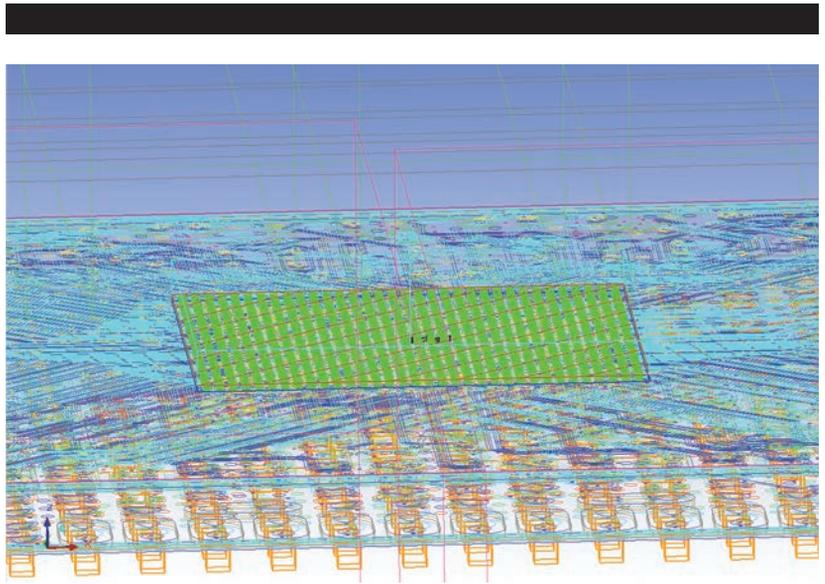
Leveraging its extensive semiconductor and hardware design experience, Teradici turned feedback from its customers into a plan to investigate reference designs using a smaller enclosure. Knowing that heat dissipation would be a key factor, engineers turned to ANSYS software.

An obvious way to achieve reliable thermal levels is to place a heat sink on the device and use forced air flow from a fan. However, the use of free-convection cooling is preferred over forced air to eliminate the need for a fan and to ensure silent operation. Thermal modeling of the complete system using ANSYS Icepak, which provides robust computational fluid dynamics (CFD)-based thermal management for electronics, was performed to investigate different approaches for potential enclosure designs. The modeling included the silicon chip package substrate in flip-chip MCM format, the printed circuit board (PCB), and different enclosure design options constructed by varying size, venting and orientation, and different internal heat sources.

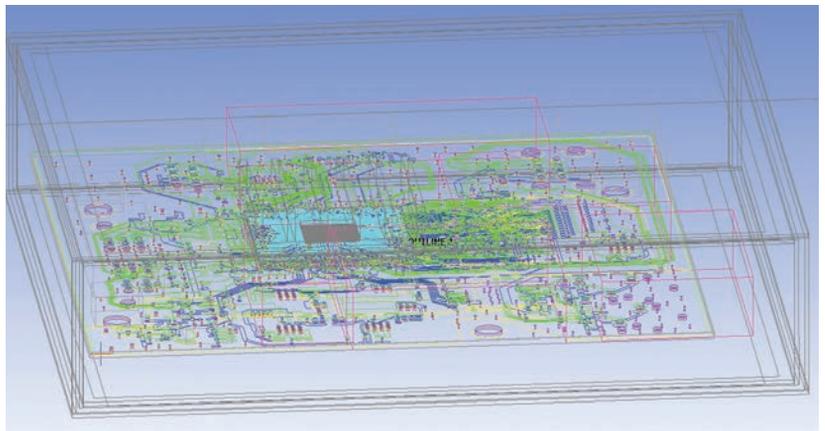
IMPORTING MODELS

Teradici engineers used industry-standard package design tools to generate the substrate design and imported the design into Icepak using ALinks for EDA. The flip-chip design can be considered as a miniature eight-layer PCB. Icepak analyzed the complex copper traces within the substrate, which allowed the heat generated from the die to be coupled to the package solder balls, which in turn were coupled to the main PCB.

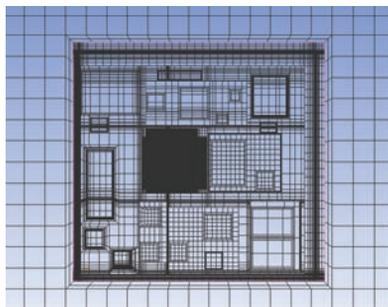
Engineers also imported the PCB design into Icepak. Similar to the work done on the substrate design, the team analyzed the copper traces of the six layers of the PCB using Icepak. No joule heating was included in this model due to time constraints. The team plans to perform power and signal integrity analyses of electronic packages at a later date using ANSYS SIwave simulation to analyze the electrical properties of the PCB, incorporating this extra source of heating. Coupling electrical-thermal



▲ Substrate package modeled in ANSYS Icepak



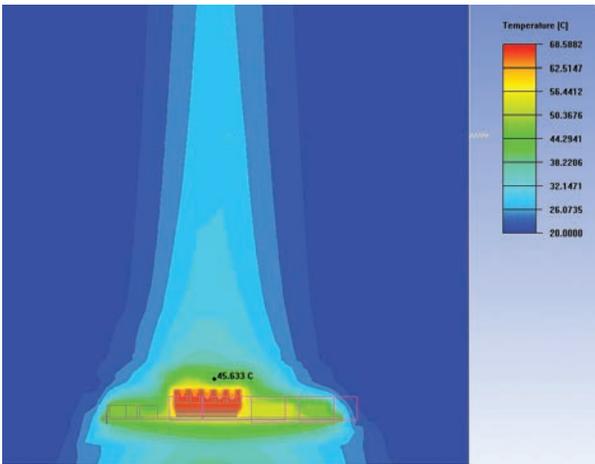
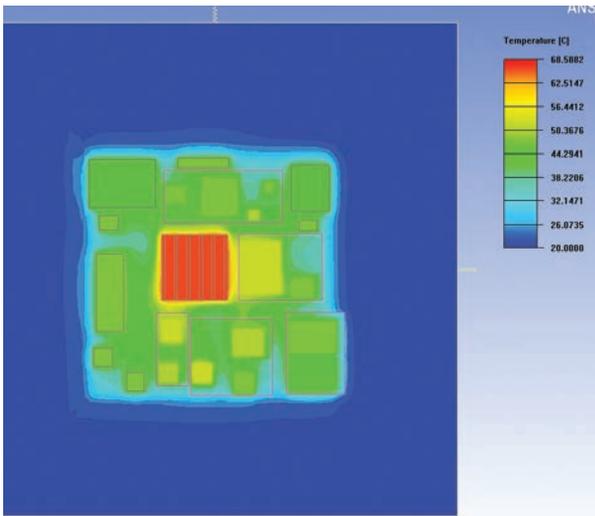
▲ PCB copper traces for the PCoIP zero client modeled in ANSYS Icepak shows the substrate with die as a heat source, two DRAM devices, a flash device and an audio codec device.



▲ Simplified mesh for enclosure components



OPTIMIZATION IN ELECTRONICS THERMAL MANAGEMENT USING ANSYS ICEPAK AND ANSYS DESIGNXPLORER
ansys.com/82cool2



▲ Initial Icepak free-air simulations with package heat sink and no enclosure

Parameters and optimization

Setup | Design variables | Functions | Trials

Trial Name	Reset ID	Order	Tensz	velocity	Tambient	
fra001	Select	1	2.0	0.01	20	Set
fra002	Select	2	2.5	0.01	20	Set
fra003	Select	3	3.0	0.01	20	Set
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Reset New Clear Show only changing Trials across top

Run Done Cancel Help

▲ ANSYS Icepak parameterization options example

physics using cosimulation could have provided greater thermal and power/signal reliability.

INITIAL ANALYSIS

Any CFD problem requires breaking down the system into a series of computational cells, a process known as meshing. Choosing ANSYS Meshing was key to minimizing the number of computational cells created for the model and ensuring the fastest-possible analysis time. A fine mesh was applied in critical areas of the product to accurately capture key flow features from free-convection that impact product performance. Simplifying geometry to cubes minimized this even further.

For the first thermal analysis conducted, power (heat generated by individual components) estimates were placed either as planar heat sources on top of the respective areas of the PCB or power estimates for the components. The dominant source of heat was the main PCoIP processor at the center.

In a more recent PCB system example, engineers added a six-fin aluminum heat sink to the PCoIP processor component. Adding an enclosure around the PCB would clearly increase the die temperature, but engineers need to maintain temperatures below 100 C (212 F). So they added vents to the enclosure to improve air circulation, which in turn enhanced cooling of the die and other internal components. However, this led to localized hot spots on the enclosure itself. To determine the most effective vent design, the team needed to simulate various enclosure options.

OPTIMIZATION USING PARAMETERS

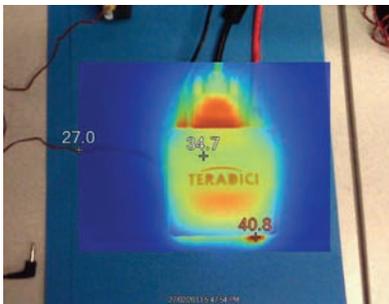
Many different parameters and scenarios of the complete system were modeled, such as grill sizing/placement, enclosure thicknesses, enclosure material, air separation between the PCB and enclosure, device source power, air flow, and ambient temperatures. The parameterization ability within Icepak controlled many of these parameters, making multi-simulation execution an easy task.

Electromagnetic interference (EMI) is also a concern for the enclosure design. Ideally the complete design, including any external electrical connections, should be wrapped in a Faraday cage to minimize EMI. However, this would not provide a thermal path from the heat sources to the external world. Engineers carried out virtual experiments on hole sizes and placement, again using the parameterization feature of Icepak. With this approach, hundreds of design scenario simulations could be run to generate data to be analyzed at a later time.

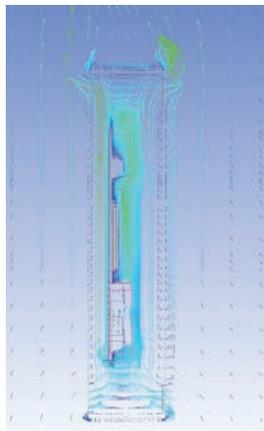
VALIDATING REAL-LIFE RESULTS

To verify the accuracy of the Icepak model, various enclosure prototypes were 3-D printed, and a thermal camera measured the hotspots for both the silicon chip on the PCB and the external enclosure surface temperatures. The team noted that cabling from the zero client acted as a good heat sink for the enclosure by pulling the heat away. Metal connectors linked directly to the PCB also provided a major source of heat escaping from the enclosure, though the 45 C (113 F) maximum target surface temperature was maintained.

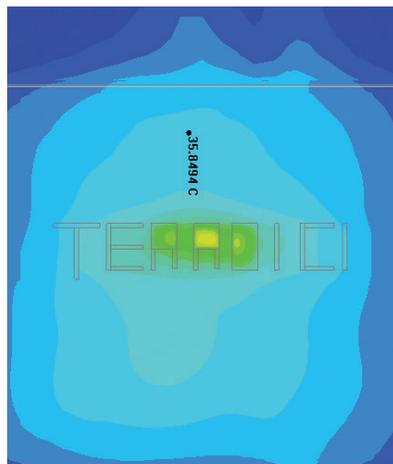
Teradici recognized the benefits of ANSYS technology in developing best practices to design a functional enclosure.



▲ Thermal camera image of 3-D printed enclosure overlaid with image from thermal camera



▲ Air flow vectors (top) and a temperature map (bottom) of a slice through the center of enclosure



▲ Icepak temperature simulation showing heat dissipation through cables and hotspot of the device on PCB (beneath "R" and "A" cut-outs in enclosure)

ANSYS Icepak and its parameterization capabilities proved extremely useful.

To increase the accuracy of the Icepak model, engineers created a simple model that included cables and connector to match the thermal camera results. The Icepak simulation for this simplified enclosure replicated the results from the thermal camera. Correlation with the model and a functioning system provided confidence in the modeling without having to repeat rapid prototyping for other enclosures.

HEAT CONVECTION PATTERNS

Details about the heat flows within and around the enclosure provide useful vent placement information. Simulations of the enclosure were tested with different vent designs with both horizontal and vertical placements. Convection cooling and the chimney effect created with the vertical position show that modest venting provides acceptable enclosure temperatures.

SUMMARY

ANSYS Icepak and its parameterization capabilities proved extremely useful to determine different design options of a zero client enclosure, including the best approaches to minimize device temperature and enclosure surface temperature. Icepak successfully modeled the complex heat flows in the system, including the heat transfer of the PCoIP processor (primary heat source) from the die through the substrate and onto the PCB, as well as the heat transfers through the enclosure. Simulation helped to quickly analyze different enclosure orientations and venting options.

Teradici recognized the benefits of ANSYS technology in developing best practices to design a functional enclosure for the PCoIP zero client. Developing reasonable correlation between the 3-D printed model and the simulation presented an enticing opportunity to expand efforts to design smaller, more-efficient device enclosures. ▲

Reference

www.teradici.com/zeroclient