HeatSync Case Study

Thermal Architecture Design for Smart Glasses

OVERVIEW

HeatSync was tasked with designing a thermal management solution for smart glasses generating 13.5 W of heat. Designed for indoor use at 27°C, the project required addressing compact form factor constraints, user comfort, and safety standards. Using our systematic design approach, we delivered a comprehensive solution ensuring optimal performance and reliability.

1. CLIENT REQUIREMENTS

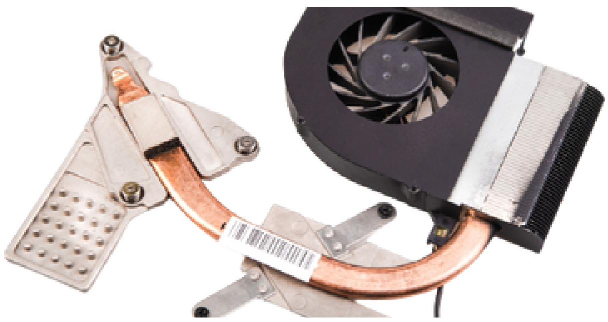
- Manage 13.5 W of heat from internal components.
- Ensure compliance with IEC 62368 standards and touch temperature limits.
- Maintain temperature limits for processors, GPUs, memory, and batteries.
- Design for indoor use at 27°C.
- Integrate seamlessly into the small form factor.

2. INITIAL ASSESSMENT

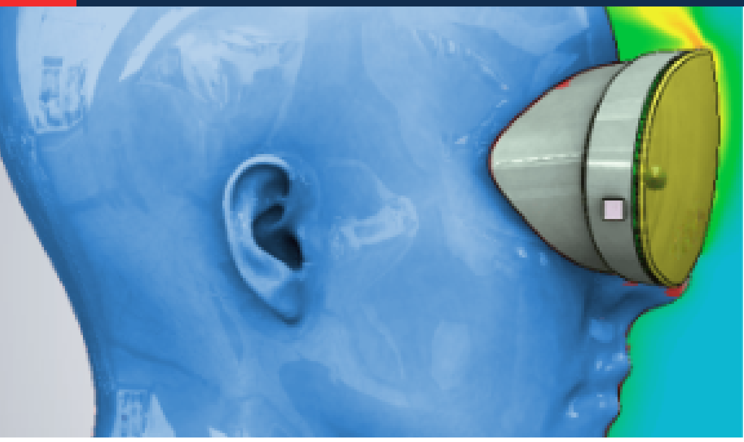
We began by analyzing the device's thermal properties, form factor, and power distribution. Component temperature thresholds guided the design to ensure reliability, with memory capped at 95°C, ASIC chips at 125°C, and the battery at 50°C. Preliminary calculations determined that passive cooling alone could not maintain surface temperatures within limits, requiring active cooling. Airflow requirements were calculated using convection and radiation formulas, confirming the need for a micro-blower.

3. ARCHITECTURE DESIGN

The thermal architecture was designed to dissipate 13.5 W of heat while ensuring user comfort and IEC 62368-1 compliance. A micro-blower, selected using P-Q curves, provided active cooling within the compact form factor.
A detailed CFD model refined the thermal design, optimizing temperature distribution, airflow efficiency, and noise reduction by minimizing impedance and improving cooling paths. Pennes' bioheat equation was applied to simulate heat exchange with the user, accounting for epidermis, dermis, fat, and inner tissue layers.
Electronic chips were modeled using 2-R parameters, while CAD simplifications removed non-critical elements, enhancing computational efficiency. A refined mesh and optimized computational domain ensured precise heat transfer and airflow simulations, solving for continuity, momentum, and energy equations to maximize thermal performance and user comfort.



Thermal Architecture Design for Smart Glasses



4. THERMAL THROTTLING

A dynamic thermal throttling policy ensured reliable operation by using physical sensors to monitor processor and battery temperatures and virtual sensors to estimate surface hotspots with real-time data and computational models. When temperatures approached thresholds, power dissipation was dynamically reduced to maintain safety and user comfort.

5. VALIDATION AND TESTING

Steady-state and transient simulations validated the cooling strategy and compliance with temperature limits. Physical testing at 27°C confirmed exterior metal zones peaked at 39°C and exterior plastic zones at 43°C, both within touch temperature limits.

6. RESULTS AND BENEFITS

Optimized Performance: The active cooling solution effectively dissipated 13.5 W of heat.
User Comfort: Surface temperatures met IEC 62368-1 standards and touch comfort limit.
Component Reliability: Key components operated within specified temperature limits, ensuring long-term durability.
Dynamic Control: Thermal throttling ensured safe operation under varying conditions.
Compact Design: The solution integrated seamlessly into the device without compromising aesthetics or functionality.

7. CONCLUSION

HeatSync's systematic approach delivered a compact, reliable thermal solution for smart glasses generating 13.5 W of heat. By integrating advanced simulations, active cooling, and thermal throttling, we ensured the device met all client requirements, including compliance with safety standards and component reliability.

Contact HeatSync today to learn more about our cutting-edge design, simulation, testing, and training services for reliable thermal management solutions.

HeatSync: Consortium of Thermal Management
+1 (408) 650 2999 info@heat-sync.com
www.heat-sync.com Cupertino, CA 95014