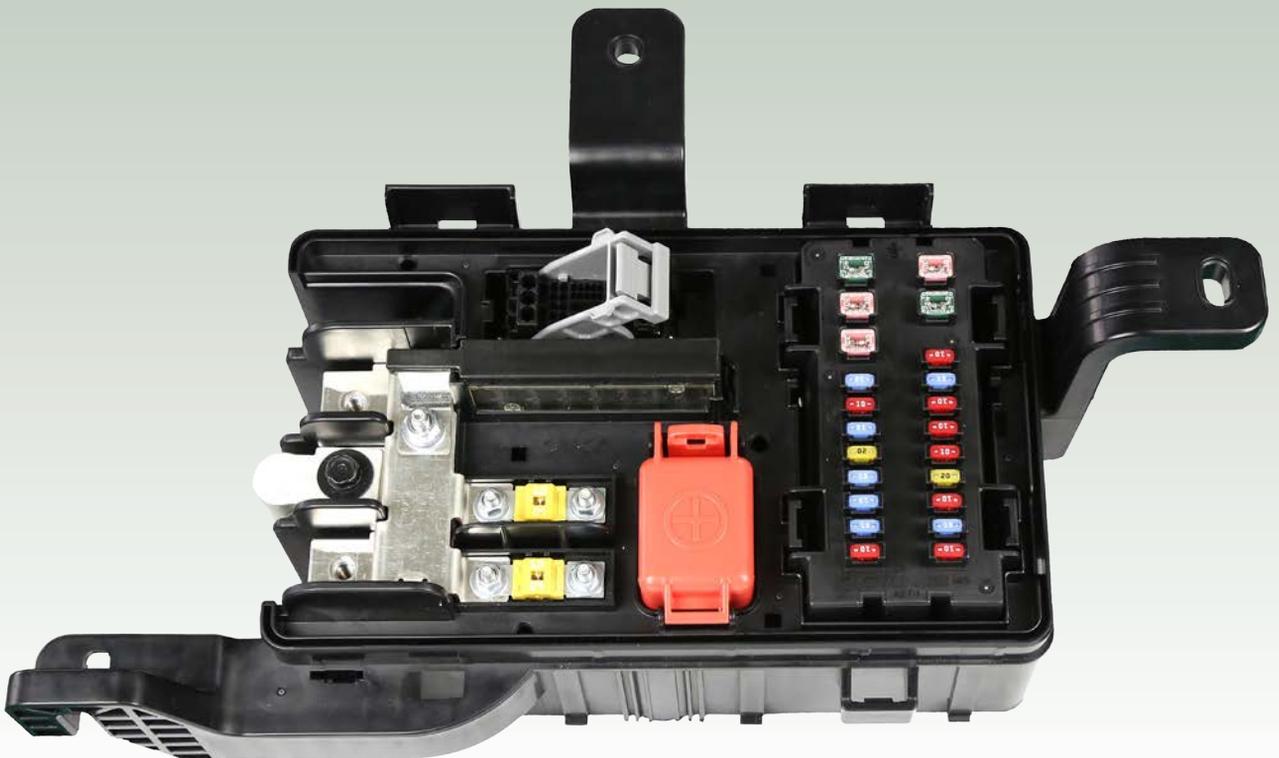


KEEPING THE BLOCK COOL

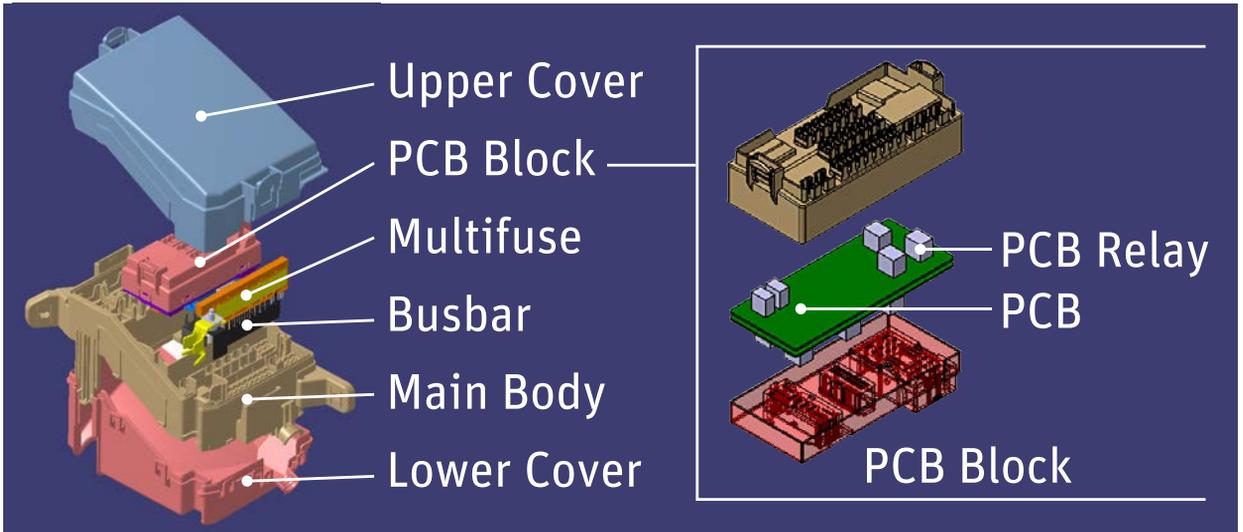


As cars become more complex, companies that manufacture the supporting electronic systems must make them reliable and safe. Automotive electronics system manufacturer Kyungshin improved the thermal management of its smart junction blocks while cutting production time by 80 percent and costs by over 50 percent over previous methods.

By Oyoung Kwon, General Manager, Wiring Harness Design 2 Team, Kyungshin, Incheon, South Korea

With each new generation of automobiles, features that depend on electronic systems increase in number and complexity. Engines and transmissions require electronics to control a wide variety of functions, including cooling systems, emissions and throttle operations. Electronics monitor and control braking systems, climate control, power windows and doors, wipers, headlights, and

Cars are safer and more comfortable – and more complex – than ever before.



▲ Diagram of the junction block and the PCB junction block

entertainment and navigation systems. Our cars are safer and more comfortable — and more complex — than ever before.

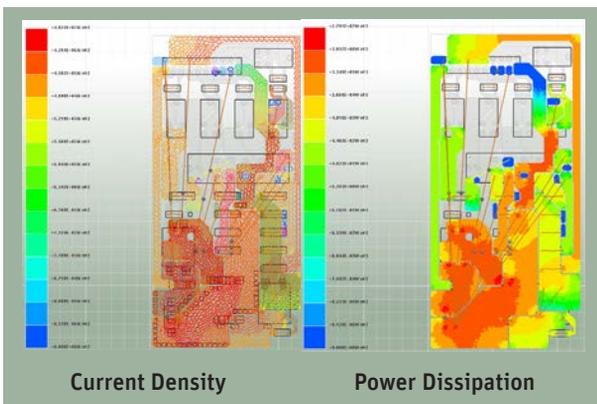
The hub of a vehicle’s electronic system is the smart junction block. South Korea-based Kyungshin Corp. develops state-of-the-art electric devices, connectors and eco-friendly products, including smart junction blocks. These blocks work with the wiring harness to manage electricity and distribute power to all parts of the car, acting much like the central nervous system in the body. The smart junction block contains a printed circuit board (PCB) junction block that enables efficient control of more electronic units than conventional junction blocks.

COMPLEX JUNCTION BLOCK DESIGN

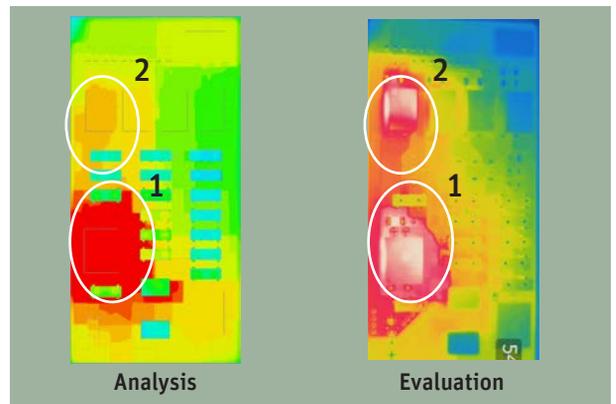
Companies designing conventional junction blocks are largely concerned with the effects of vibration on the unit. The Kyungshin team originally relied on physical prototyping before turning to simulation in 2004. The team used ANSYS simulation tools to perform linear and nonlinear structural analysis to minimize the effects of vibration by examining design variables like rib thickness and type of injection molding. They also used simulation to reduce materials and weight.

New PCB junction blocks are even more complex and require that the effects of temperature, humidity, thermal flow and

Using simulation early in the design process saved the company tens of millions of won (tens of thousands of U.S. dollars) for each junction block prototype.



▲ ANSYS Siwave DCIR drop prediction of where high temperatures could arise based on current density (left) and power dissipation (right)



▲ Heat distribution in the PCB using ANSYS Icepak simulation (left) and physical heat imaging (right)

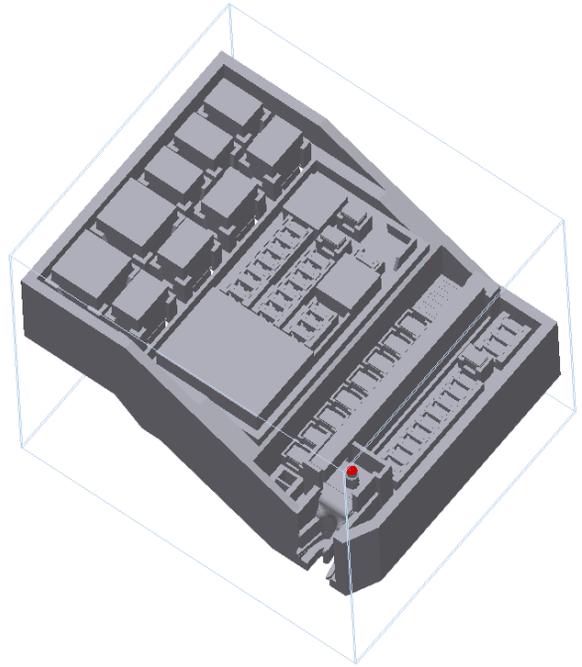


electrical load be examined to maintain reliability. Furthermore, these physical phenomena need to be tested simultaneously to account for any effects they may have on each other. Finally, the PCB needs to be evaluated in its operating environment.

COMPONENT TESTING AND SIMULATION

When designing a smart junction block, Kyungshin engineers discovered that the PCB junction block temperature often exceeded 60.4 C, causing it to overheat. To find the cause, they employed a combination of experiment, physical prototyping and ANSYS simulation. The experimental analysis concluded that the temperature rise was caused by Joule heating of the coils in the PCB relay.

First, the engineers tested individual components such as the fuse and the PCB relay. However, it was vital to use simulation to determine conditions in the PCB that might contribute to temperature rise, as this cannot be done with physical testing. They applied ANSYS SIwave (power integrity, signal integrity and EMI analysis of electronic packages and PCBs) and ANSYS Icepak (computational fluid dynamics [CFD] software for electronics thermal management) to identify where the PCB

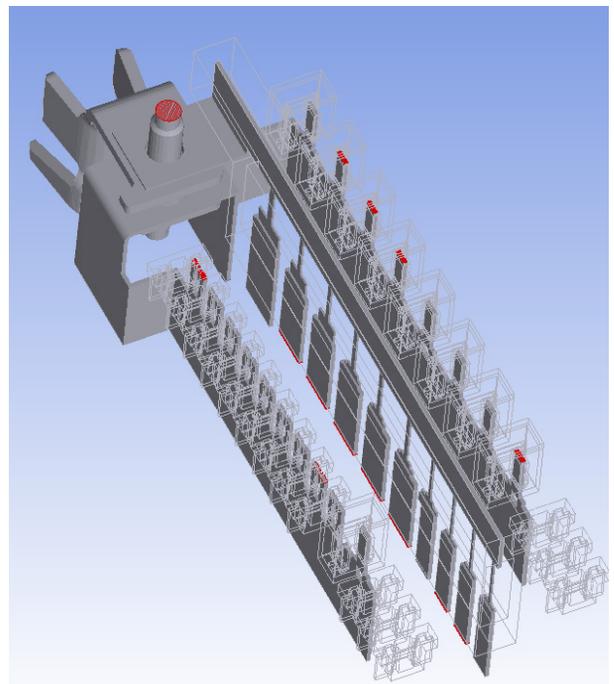


▲ Model

Physical phenomena need to be tested simultaneously to account for any effects they may have on each other.



▲ ANSYS SIwave DCIR drop results



▲ Busbar Joule heating



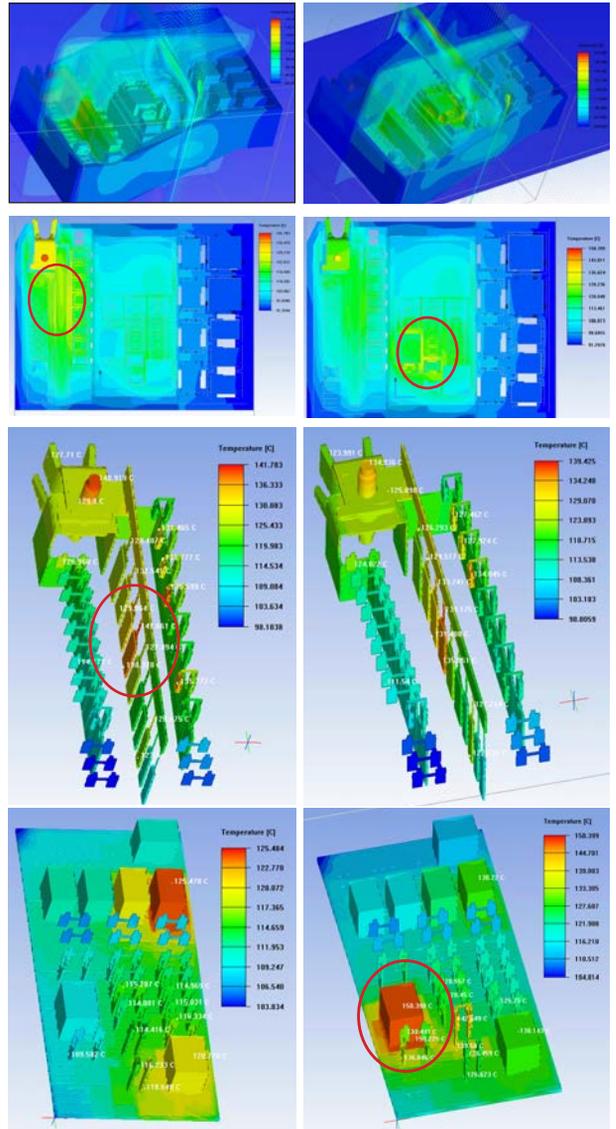
was overheating. Each PCB layer was modeled, and temperatures were calculated for each layer. Using current density and power dissipation profiles, SIwave predicted the locations where high temperatures arise. While both physical imaging and simulation identified the hot spots on the PCB, the simulation also identified a secondary spot where a current bottleneck generated extra heat.

FULL JUNCTION BLOCK SIMULATION

In a different case, to improve the design of the complete junction block, Kyungshin engineers simulated two different designs to understand how to optimize the design and prevent unit heating in the future. The multiphysics simulation leveraged SIwave’s DCIR drop (voltage drop) results as input data for the Icepak thermal simulation. The first design resulted in overheating of the PCB block. The second design solved the problem of PCB overheating but identified an area where heat would build in the fuses. This provided the engineers with enough information to develop a final design.

The simulation results were in close agreement with physical testing. Kyungshin engineers are now confident that multiphysics simulation is a reliable way to resolve thermal issues in junction blocks as complexity increases. ▲

Using ANSYS simulation tools cut the overall production time from five months to one month. ▲



▲ ANSYS Icepak reveals temperature rise around the fuses in the second design.

▲ ANSYS Icepak predicts excessive temperature in the PCB block for the first design.

Simulation Adoption at Kyungshin

Kyungshin now considers it essential to use simulation to test all of its components. For analysis of electromagnetic fields and EMC for PCB components, engineers use ANSYS SIwave, ANSYS Designer SI and ANSYS HFSS. To examine temperatures and thermal–fluid dynamics, they employ ANSYS Icepak. ANSYS LS-DYNA and ANSYS Mechanical enable them to conduct linear and nonlinear structural analysis.

Before adopting ANSYS tools, Kyungshin struggled with the typical pitfalls of the design, prototype, assess, redesign and reassess cycle. The design process was time-consuming, taking between five and six months to ensure the performance of the junction block once it was manufactured. Using ANSYS simulation tools cut the overall production time to one month.

When ANSYS was introduced, Kyungshin engineers were able to analyze and solve issues early in the development phase rather than during the manufacturing phase. Using simulation early in the design process saved the company tens of millions of won (tens of thousands of U.S. dollars) for each junction block prototype that it was not required to build. These costs do not even include expenses to modify the design and retest it.