



# **ENGINEERING FOR THE REAL WORLD: CONTROLLING SEAT TEMPERATURE WITH THERMOELECTRIC DEVICES**

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GS ENGINEERING INC.  
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**AS MANY NEW STARTUPS,** entrepreneurs, and inventors have found, development of a market-changing technology may only be the beginning of a long and arduous journey.

This is the journey that was faced by Promethient, a technology company in Michigan that was challenging the state of technology in heating and cooling.

Legacy style temperature control for seating is handled through the use of coil heaters and forced air for cooling modes. They shifted the paradigm and developed a novel solution which, when integrated into the seat, allows for both a more even heat, as well as active cooling of the seat's surface.

But bringing a brand new technology like this to market takes some work, and there are always stumbling blocks along the way.

As many companies learn early on, this was just the beginning of the journey for Promethient. The technology was fully featured and ready to function in the real world, but challenges lay ahead in the form of many requirements, production-level specifications, rounds of testing, and power requirements to ensure that the system would reliably function in adverse conditions.

## Automotive Expertise

GS Engineering's expertise in automotive electronics coupled with Promethient's proficiency with thermoelectronics and nanomaterials enabled the team to efficiently work to meet the OEM system requirements.

The combined experience of both of our teams enabled us to create a superior design in shorter time than either company could on their own.

What was most exciting and convenient about the thermavance technology is that the engineering teams built it to perform on commercially-standardized vehicles, complete with CAN bus communication and electrical fault detection capability.

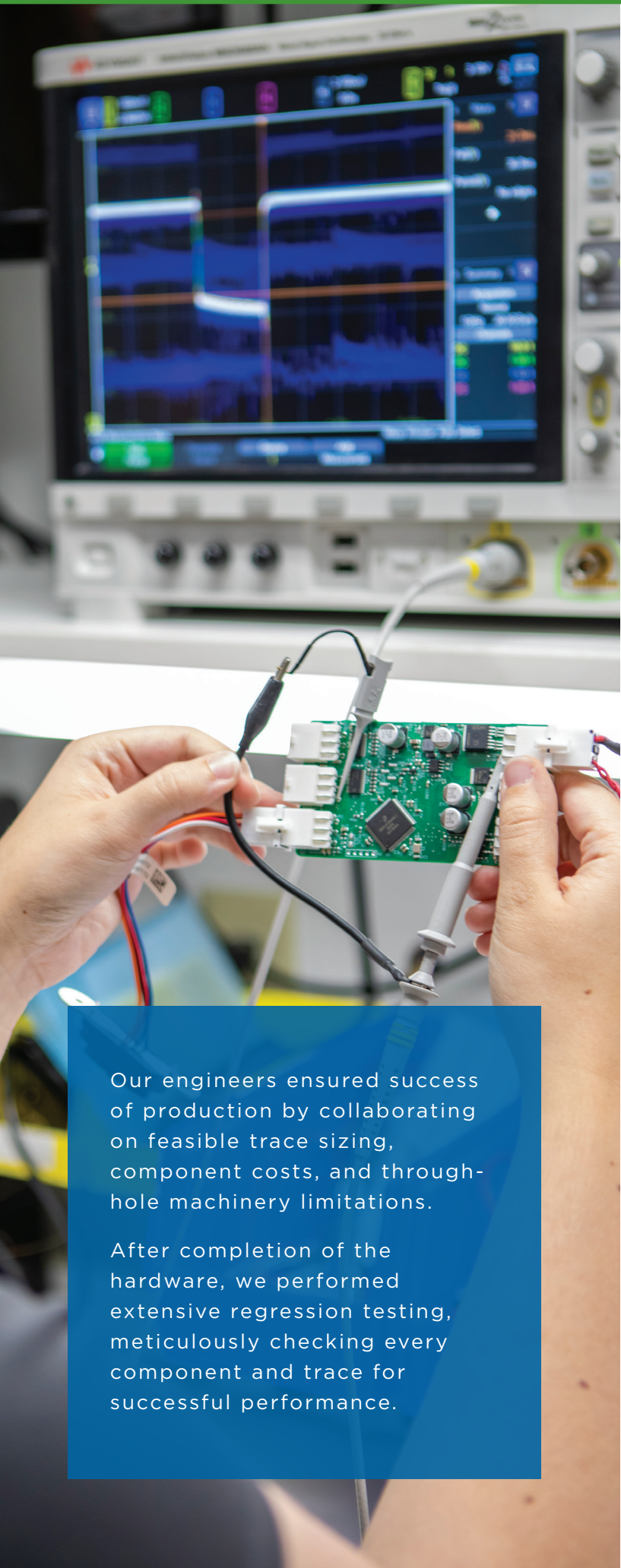
The technology was fully featured and ready to function in the real world, but an adversary lay ahead—the many requirements and rounds of testing to ensure that the system would survive when things unavoidably went wrong.

GS Engineering's wealth of knowledge in automotive applications prepared them for precise implementation of CAN communication.

Meanwhile, both Promethient and GS Engineering's electronic expertise ensured the right components were chosen for efficiently detecting and handling electrical faults. We diligently combed through all trusted suppliers to find parts that met the high standards of control, while saving the most money for Promethient.

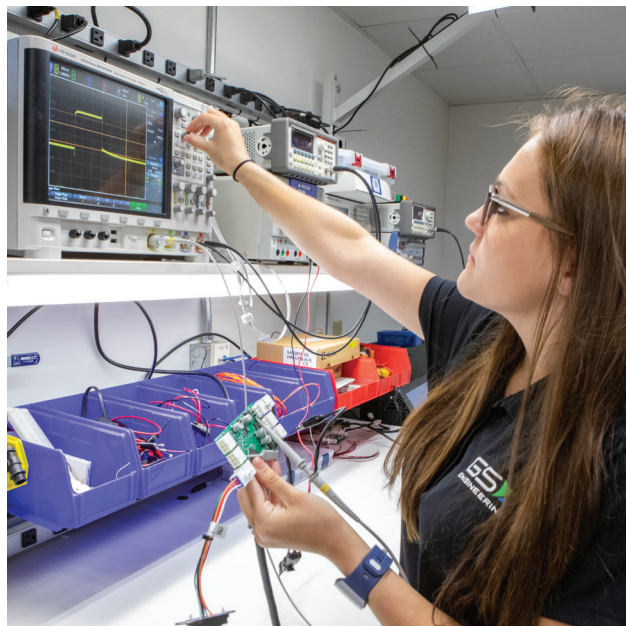






Our engineers ensured success of production by collaborating on feasible trace sizing, component costs, and through-hole machinery limitations.

After completion of the hardware, we performed extensive regression testing, meticulously checking every component and trace for successful performance.



All decision points were essential to enhance survival of the hardware on long, hot summer days and freezing winter nights. We did not want the system to quit working without reason and risk upsetting the user.

### **Manufacturing the Board**

Before prototyping the hardware, the GS Engineering team performed precise modeling, simulation, and calculations on the system to track typical fault events.

Using the simulation software, the team at GS Engineering could replicate exactly how, when, and why a fault would occur, then chose software steps to prevent the fault from occurring or protect from the effects of the fault. Every effort was made and verified to protect the controller and provide optimal comfort in all situations.

After the prototype was created, it was time for manufacturing the circuit board. Engineering teams should be able to work with new contractors at the request of their client.

As for us at GS Engineering, we had no trouble collaborating with Promethient's preferred PCB manufacturer.

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### Code and Controls

With the hardware verified, GS Engineering quickly got to work on the software. The core of the code was focused on changing or maintaining the temperature of the seat. This process utilized a feedback loop to determine whether to maintain the current temperature or change it.

Using our previous experience with controllers, we made all heating and cooling limits modular for future use.

The user interface was even more straightforward: there was one button for cool and one button for hot.

The Promethient and GS Engineering teams designed the PCB such that it could drive heating and cooling while protecting itself from faults at just the press of a button. If the user wanted more of one temperature or the other, they could press the desired button again until they felt comfortable.

The system software also had overwhelming flexibility, including support for single or dual switches and different CAN bus baud rates to adapt to multiple applications.

### Surpassing SAE Standards

Compliance with industry standards is a critical task of any automotive component's development.

Our integration team worked closely to ensure those standards were met,

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Some faults triggered a CAN message for troubleshooting the issue, and, depending on severity, disabled the controller until the problem was fixed. CAN bus also allowed for password-protection, enabling exceptional security but easy control for the right person working on the software.

### On the Road

To finalize the design, the software and hardware were tested for compliance with all the system level and subsystem level specifications in the GS Engineering laboratory. These test results allowed Promethient to complete several rounds of on vehicle testing and have confidence to transition the technology into production.

**WE INVITE INNOVATIVE TEAMS LIKE PROMETHIENT TO LEVERAGE GS ENGINEERING'S FRONT-LINE EXPERIENCE IN DESIGN, SIMULATION, AND TESTING TO REALIZE THE FULL PROMISE OF YOUR PRODUCTS.**

