



Minimizing Routing Iterations on Complex, High-Density PCBs with OrCAD Tools

G5 Engineering Solutions and Cadence

About G5 Engineering

Based in Tallahassee, Florida, G5 Engineering is a full-service engineering design firm providing innovative, turnkey solutions for industries including commercial, industrial, military, and medical. “We bring solutions and products to life for our customers,” says Brian Ruck, director of electrical and systems engineering at G5. “We serve as their engineering team, or as an extension of their team.”

Key Challenges

G5 offers some core products that its customers can customize for their unique designs. The engineers also must meet aggressive time-to-market targets, so it’s critical for them to have efficient methods to route and layout their boards. The engineers generally route everything by hand, but need to ensure that their work aligns with their design intent. Here are some examples of G5’s work, along with associated design challenges.

System on Module

G5’s versatile I.MX6-based gCore6x system on module (SOM), the company’s core product, is the size of a business card and can be configured to:

- Support up to 4GB DDR3 RAM, 2GB NAND Flash, and 64MB NOR Flash
- Serve as a solo, dual lite, dual, and quad core processor
- Supply many high-speed interfaces such as Gigabit Ethernet, SATA, HDMI, LVDS, 24-bit DSS, HS USB, MIPI® DSI, Parallel CSI, and SDIO. Additional communication buses also include multiple UARTs, I2C, and SPI.

Challenges

- Quickly route complex, high-density boards for a variety of applications, including industrial- and military-grade designs
- Meet aggressive time-to-market goals
- Adapt swiftly to changes in product specs

Cadence Solutions

- OrCAD PCB Designer Professional
- OrCAD Capture CIS
- OrCAD Component Information Portal

Results

- Saved weeks in design time by minimizing routing iterations, reducing the time needed to clean up DRC errors, and quickly modifying vias
- Fast ramp-up on tools for new engineers due to intuitive, easy-to-use interface
- Timing savings from access to integrated part library

Routing was challenging on this small-profile, high-density board with 10 layers, 500-plus BGA balls that need to be fanned out, through-silicon vias, LVDS differential pairs, and many critical nets. The team needed a user interface that would help avoid the pitfalls of routing sensitive signals. They also needed a way to easily set up constraints to avoid issues with cross-talk, ensure uniformity in trace width and trace spacing, and minimize routing iterations. With these capabilities, the designer could focus less on each potential issue and more on the design.

Handheld Military Device

G5 designed a ruggedized handheld computer, which meets both Mil-STD-810 and MIL-STD-461 and can support multiple adapters and attachable equipment via a high-density pogo pin array on the back of the unit. The device includes an application processor, accelerometer, digital compass, 5MP camera, touchscreen display, and support for NAND, NOR, DDR3, GPS, Wi-Fi, and Bluetooth. This design involved a separate rigid-flex board for interfacing to a camera module. The rigid-flex board had a five-layer rigid section and a three-layer flexible section. It was challenging to route because the team had to account for EMI, ensure separation between the camera interface and the GPS module, ensure proper routing constraints and guidelines with proper shielding and grounding, and manage multiple design constraints.

Rugged Industrial Unit

The company designed an industrial wireless data collection unit that communicates to and collects data from a vehicle's on-board computer within a fleet vehicle fuel management system. Its main unit contains its gCore6x SOM and sensors including an accelerometer and temperature sensor as well as mini PCI Express® and USB interfaces along with wireless communications including cellular, RF radio, Wi-Fi, and Bluetooth. The main unit also supports an HDMI and LVDS interface for future expandability for displays. Its docking unit supports external power for the system and can be expanded to support additional communications buses to the main unit, like USB, Ethernet, and UART. To meet a customer's aggressive timeline, the boards had to be routed quickly. To improve cost reduction in manufacturability, the customer wanted to change from blind and buried vias to through-hole vias, so the G5 team needed to quickly adjust in order to meet production timelines.

The Solution

G5 is a long-time user of Cadence® OrCAD® PCB design tools, with OrCAD PCB Designer Professional, OrCAD Capture CIS, and OrCAD Component Information Portal in its toolbox. When the company got its start in 2006, the customer of a major military application preferred OrCAD tools, and the company's founders were also experienced in the platform. Using OrCAD products, the engineers have been able to address the design and routing challenges for its core products and beyond.

For the gCore6x SOM, G5 saved about a week's time by using OrCAD PCB Designer Professional for an immediate view of design rule checks (DRCs). That's a significant time-savings in a project with a three-week turnaround for routing. "Once we set up our differential pairs, we could just go ahead and route," said Ruck. "We could see right away if something was interfering. If we can't see the DRCs right away, we might have to completely

reroute some portions, or spend hours cleaning up major DRC errors. I don't see how anyone could do this level of routing without those OrCAD tools."

The ruggedized handheld computer that G5 designed involved a rigid-flex PCB design. Although the team hadn't experienced using OrCAD PCB Designer Professional for rigid-flex designs, the engineers found a way to use it productively. "Even though the tool didn't differentiate between a three-layer flex section coming out of a five-layer rigid section, we could generate our own stack-up and write it in the fabrication notes, which allowed us to route our board properly," explained Ruck. Backed by the OrCAD tools, G5 met a critical project timeline, delivering its RTHD to military-grade specs, from schematic to layout, within four months. (The latest release of the tool supports multiple stack-ups, as well as rigid-flex-aware DRCs.)

As for the industrial wireless data collection unit that G5 designed, the SOM on the main board has about 400 connections, top and bottom. In their first iteration, the team used blind and buried vias to bring out the high-speed interfaces. They had to route everything quickly. But after viewing the first prototypes, the customer decided against having all of the data lines for display, as the cost was too high. So the customer requested through-hole vias. Ruck and his team were pleased to find that OrCAD PCB Designer Professional has a capability that allows users to quickly and globally modify the vias. "That honestly saved a ton of time," Ruck said. "We thought it would be a two-to-three week project, but got it done in one week."

The Results

G5 has found its OrCAD PCB design environment to be scalable and intuitive, shortening the ramp-up time for new engineers and enabling the whole team to be highly productive. The company has minimized routing iterations and saved weeks of design time on its boards, helping it meet its fast turnaround times.

Summary

Looking ahead, the G5 team is interested in expanding its use of OrCAD Component Information Portal. "We have our own library where we make our symbols and can load that in. We can keep all attributes within that footprint, then people can link into OrCAD Component Information Portal and grab the footprint, via OrCAD Capture CIS, from the database we set up," explained Ruck. "Before, we had our own sandboxes, so two guys might have had the same symbol set up differently."

The team also plans to evaluate additional Cadence tools for simulation. "We've been able to do very complex designs with the OrCAD schematic capture and layout tools," said Ruck. "It's very intuitive for us."