



First-Time-Right Design of Low-Cost Boards with OrCAD Design Tools

Raspberry Pi Foundation and Cadence

About Raspberry Pi Foundation

The Raspberry Pi Foundation develops low-cost, high-performance boards that are designed to help people, particularly students, learn programming skills. By putting “the power of digital making into the hands of people all over the world,” the organization strives to increase understanding and shaping of our digital world, enhance problem solving, and equip people for the jobs of the future.

Key Challenges

Each generation of Raspberry Pi boards gets more sophisticated; today, they’re an ideal gateway for learning to design Internet of Things (IoT) applications. The latest iteration, the Raspberry Pi 3, is equipped with WiFi and Bluetooth capabilities, has 1GB RAM, 4 USB ports, 40 GPIO pins, a full HDMI port, an Ethernet port, and interfaces for a camera and display. The six-layer, Fx4 circuit boards have through wires and impedance control and are small, roughly the size of a credit card. Their customers get all of this functionality for a mere \$35.

Given the foundation’s goals, it’s critical that each board be designed right the first time and for low cost. Testing should be easy and relatively fast. It’s also important for the developers to be able to reuse functions from one design to another, while maintaining the same small form factor.

The design cycle spans from seven months up to a year. More than 50,000 Raspberry Pi boards are manufactured each week. When the foundation evaluated PCB design tools, “We needed something we knew was going to be reliable, something that would scale and integrate with other design tools,” explained James Adams, director of hardware engineering for the organization.

Challenges

- Maintain low cost for small educational development boards
- Achieve first-time-right designs to meet tight project deadlines
- Ensure manufacturability of the designs
- Scale designs with richer functionality from generation to generation

Cadence Solutions

- OrCAD Capture
- OrCAD PCB Designer
- Allegro Design Entry Capture
- Allegro PCB Designer

Best Practices

- Understand tools’ many capabilities upfront to best take advantage of them
- Tap into forward/back annotation function to do design work at the board level and apply back to the schematic
- Use the tools to do CAD work in-house

Results

- Ability to meet aggressive schedules and low cost requirements for high-performance boards
- Boards meet manufacturability requirements the first time with zero defects using OrCAD PCB Designer
- Porting WiFi capability from one board to the next saved many hours in design time, minimized risks, and enabled engineers to focus on core design work

The Solution

The Raspberry Pi Foundation found its answer in Cadence's OrCAD® and Allegro® PCB design tools. Many of its engineers were already familiar with Cadence® tools. They also recognized that many other well-known design houses around the world use the tools. So, the foundation felt confident choosing Cadence PCB solutions for its own environment. Since OrCAD tools scale seamlessly to the Allegro platform, the organization adopted both OrCAD and Allegro PCB solutions; now, they can choose which tool to use based on the complexity of the design. The Raspberry Pi Foundation works closely with a Cadence channel partner in the U.K., Parallel Systems, who provided training as well as tutorial videos that helped accelerate ramp up.

"Picking up the Cadence OrCAD tools is very easy," noted Adams. "You can quickly make cost optimizations and spot errors in the design. And, most importantly, the OrCAD solution scales very easily to the Allegro environment." Everything is done in-house at Raspberry Pi, with a single engineer responsible for both schematic capture and board layout. This setup allows a greater degree of control from the engineer. Since the engineer knows in detail what to expect from the board layout when designing the schematic, the engineer can make adjustments to either the schematic and/or the board layout as layout progresses. For example, changes can be made to pinouts, packaging choices, and circuit structure to optimize the layout. In this case, having tools that seamlessly work together is highly valuable.

The Results

One of the key benefits that the Raspberry Pi Foundation gained from using OrCAD and Allegro tools is the ability to meet its aggressive schedules even while designing more complex boards. Doing things manually would extend the cycle. For example, Adams noted that the copying feature in OrCAD Capture enabled the team to easily re-use a proven WiFi layout from one board on another. Done by hand, this would have taken many extra hours of work, added risk (that things were not copied 100% exactly), and caused frustration for the engineer. Now, the engineer can focus on more important parts of the design.

"It's about productivity. It makes a big, big difference," said Adams. "Now, we can concentrate on actual design work."

Also beneficial is the high-speed signal routing/matching feature in OrCAD PCB Designer. Said Adams, "We have a lot of differential pairs, so that's a critical part of the tool. The ability to take interfaces and extract all of the stuff required to do high-speed interfaces is also fairly easy. And, of course, there's reliability—we've never seen the tool produce internal errors or do silly things."

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Best Practices

To enhance productivity with the OrCAD and Allegro tools, Adams advises taking time upfront to delve into all of the tools' capabilities, as this will save time over the long run, especially with more complex designs. He cautions that engineers shouldn't be afraid to use forward/back annotation to do design work at the board level and then push it back to the schematic. Historically, such capabilities have been buggy in many tools, but with the Cadence tools, it's a time saver. Finally, he suggests that for smaller designs, it's worth doing CAD work in-house versus outsourcing it. "It's not that difficult with the Cadence tools. And with video tutorials and support of a partner like Parallel Systems, you can rapidly become productive in your PCB design work," Adams said.

Summary

The Raspberry Pi Foundation is evaluating Cadence's Sigrity™ tools, which integrate seamlessly with the Allegro tools, for in-house high-speed simulation of their designs' memory interfaces. The team also plans to use OrCAD CIS (component information system) for component data management. "With another vendor, there could be a different set of products with different databases for each stage of the design," said Adams. "We're getting bigger and our products have more requirements, so a unified Cadence solution is advantageous."