PCB Prototyping Systems Put to Work

On-site fabrication of high-precision prototype circuit boards speeds time to market

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Turnaround time is a critical factor in the development of new products for the highly competitive and fast-paced world of mobile telecommunications equipment. Advanced Mobile Solutions (AMS), a major supplier of compact power supplies for mobile applications, has reduced the verification of new designs from weeks to days by using a precision circuit board plotter to produce prototype boards.

Time to market is a major challenge for companies like AMS, a privately held firm with corporate headquarters and R&D center in Moraga, California, and sales offices worldwide.

The AMS cellular telephone product line includes a broad range of battery packs, chargers and adapters for OEM customers such as Motorola, Sony, Ericsson and Qualcomm. Their newest product is a compact Wireless Hands-Free Headset for mobile cell phones, which they will offer in retail markets.

To develop and produce products like that, the company must meet tough new design criteria and perform extensive environmental testing on every prototype. New more compact and powerful telecommunication devices demand more efficient power supplies that fit into smaller spaces, making them more complex and densely populated. Prototypes of new designs need to accurately simulate the finished product: each new design is rigorously tested to ensure that it will withstand rough handling and harsh environments. AMS had to find a way to meet the new demands while maintaining their competitive advantage with fast time to market.

AMS was faced with this problem: prototype board turns interrupt test lab workflow and delay introductions. At the AMS Design Verification/Accelerated Life Test Lab, new designs are subjected to extensive environmental, qualification and reliability tests before they are released to manufacturing. The $2 million facility is used to conduct stringent Environmental Stress Screening (ESS) and Compliance Verification Testing.

Prototypes must be built with high quality printed circuit cards to accurately simulate the finished product's physical and electrical characteristics. Tight circuit geometry, controlled trace lengths, precise component mounting and proper dielectric materials are crucial for valid test results, and all are beyond the capabilities of generic breadboarding systems.

A new prototype that fails a test is returned to the engineering team for evaluation and modification. Testing is either shifted to another product or is suspended until the problem is fixed and the board is turned. Delays in this cycle interrupt the workflow and jeopardize the schedule of other projects, as well, since the entire test sequence must be restarted for each new board-turn.

AMS tried using outside vendors for their prototype boards, but long and unpredictable lead times were causing delays for each new board turn. The pressure to turn redesigns around quickly became intense when the lab was waiting.

Kevin Berg, R&D technician, said, "We thought that our only choices were to create a complex and hazardous in-house chemical fabrication process (which we could not justify) or to tolerate the vendor lead-times. Our product evaluation ground to a halt as we waited for the vendor to complete the board turn, and other projects were shuffled or interrupted when the new board came back. When the delays stretched into weeks, we knew we had to make a change or risk losing customers for tens of thousands of products per month: our future was on the line."

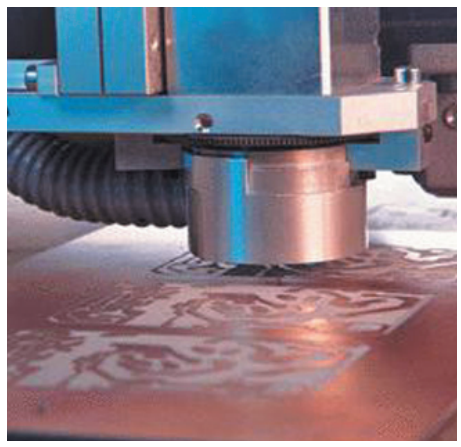
Low-cost prototype cards

Options abound for prototyping. A few months ago, AMS engineers adopted one new approach to prototyping. They brought in a printed circuit card plotter system developed by Wilsonville, OR-based LPKF Laser & Electronics USA, a wholly owned subsidiary of LPKF Laser & Electronics AG of Garbsen, Germany, a publicly traded company. Founded in 1976, LPKF has established itself on the international market in the fields of advanced circuit board prototyping, laser cut SMD stencils and laser direct imaging technologies for high-density circuit board designs, eliminating the need for hazardous chemicals.

The LPKF system downloads files directly from their CAE program and translates them into board layouts. It then automatically produces each board by drilling the through holes and milling the traces from a variety of standard copper-clad laminated materials. Boards are cut to precise sizes and tolerances, and components are mounted exactly as they would be on the final product. The plotter system is kept in the design lab. No chemicals are used in this process and a built in vacuuming system keeps the area dust free. An acoustic enclosure is used to minimize noise distractions.

Fast turnaround

"We made a dramatic breakthrough by shifting prototype produc-



From left to right: AMS's AM1010H Airmagic™ Handsfree Wireless Headset for mobile devices , AMS Design Verification/Accelerated Life Test Lab with compliance verification apparatus and test solution, and close-up view of an LPKF C30 ProtoMat™ plotter milling a precision circuit board.

tion to the in-house circuit board plotter," Berg said. "We are now able to turn out new revisions of high precision prototype cards in five to 10 minutes each, a huge savings in both time and logistics.

"Our engineers and technicians can react to test results on the spot, with improvements and revisions. We routinely get the revised prototype back into test within a few hours, while the process is still fresh in our minds. Most importantly, we are finding excellent correlation with the production units. These new prototypes are helping us meet the challenges of small geometry, high-efficiency power supplies in record time."

Solutions like the LPKF high precision circuit board plotters have become the standard of the industry. LPKF ProtoMat® plotters feature cast aluminum construction, machined flat surfaces, precise positioning and superior milling and drilling tool systems. The systems produce single- and double-sided analog and digital PCB's on all common circuit substrates from FR4 to Teflon-based materials such as RT/Duroid® . Separate LPKF finishing systems provide through-hole plating and multilayer fabrication.

PCBs are automatically developed from existing CAE/CAD design data. Standard GERBER, DXF or HPGL files are downloaded to LPKF software that computes the tool paths for removal of copper as the negative of the trace data. The system then drills the holes, mills the tracks and routes cut outs and individual boards of any shape from the sheets of laminated material, using a variety of precision tools. Specially developed RF cutting tools are designed with flat bottoms and parallel sides to provide high cut-edge steepness and high-resolution microwave circuits on the board.

A range of models from LPKF is available to match budget, size and precision requirements. Repetition accuracy is 0.2 mil over working areas of up to 16.5" by 15". High-speed spindles operate at speeds of up to 60,000 rpm, controlled by software to optimize cutting accuracy, process time and tool life. The ProtoMat C30 plotter described in this article can produce traces as fine as 4 mils with spacing down to 8 mils and a minimum hole size of 8 mils. The LPKF ProtoMat C60 is able to cut tracks as small as 4 mils with separations of 4 mils — a resolution of 2 tracks between two 1/20" pitch SMD pads — and to drill holes as small as 8 mils. The ProtoMat C95s model adds automatic tool changing and higher performance for unattended, high throughput prototyping at maximum precision.

Machining time is dependent on board size and track density. Simple boards can be completed in a few minutes, complex multilayer boards in a few hours. A typical 2-sided PCB can be produced within 1-2 hours for $7 to $10 in materials and tools. The versatile plotters are also used to mill solder mask foils and to engrave photo films, SMT stencils, insulation, brass and copper beryllium foils.

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