

HP E5200A Broadband Service Analyzer Surface Mount Assembly

Hewlett-Packard's Surface Mount Technology Center located near Spokane, Washington is a high-mix, low-volume facility. It doesn't have the opportunity to fine-tune an assembly over many long runs. The center builds limited runs of prototypes that have extra-fine-pitch components (XFP, with leads on 0.020-inch centers), but before the HP E5200A broadband service analyzer, only two fairly easy designs had reached production status.

By contrast, the service analyzer processor board is one of the most challenging boards that any HP site builds. One image nearly fills our standard 12-by-18-inch panel. This is not unusual, but having 29 XFP components and 15 FP components (fine-pitch, with leads on 0.025-inch centers) on the top side is quite unusual—just these components represent over 6000 individual solder joints.

Loaded on the rest of the dense top side are various 0.050-inch-pitch and passive devices, along with connectors and other through-hole devices representing over 400 through-hole leads. Adding to the challenge is a dense bottom side, with 15 more FP parts (almost 1000 leads), and many other surface mount parts ranging from 0.08-by-0.05-inch passive parts to large SOJ (small outline J-lead) and PLCC (plastic leaded chip carrier) components. One challenge not present is that there are no 0.06-by-0.03-inch or smaller parts on either side, since this design was started before they were our preferred small part. In total, there are over 1000 components and nearly 8700 solder joints on this printed circuit assembly.

Numerous processing problems had to be solved or worked around to build this complex new board successfully. It would be a very expensive printed circuit assembly to scrap, so being able to get good setups and clean starts each time was important. Stenciling the solder paste and placing the XFP components were two key processes that needed to be highly accurate and robust. Tremendous demand on solder paste stencil accuracy and process control highlighted the fact that our existing printers were not designed to handle 0.020-inch pitch requirements. There was also tremendous potential for solder paste drying and plugging the narrow stencil apertures, or slumping and causing widespread bridging between leads on the assembly. A latest-generation printer was implemented to take advantage of an improved vision approach, programmed control of most setup parameters, parameter feedback controls, and built-in stencil cleaning capability. This eliminated paste alignment problems and virtually eliminated variations resulting from operator dependent setups. Setup time and run time were also reduced.

Planarity (flatness) of the raw board and of the hot-air leveled (HAL) solder pads had a noticeable impact on solder paste stenciling and on placing the XFP and FP components. Most of these parts had to be placed on the top side after the bottom side had already been reflowed, which can allow the board to warp. Compounding this was difficulty in finding adequate board support locations because of the density of the bottom side. Further compounding this was having XFP and FP parts at or near the corners on both sides of the board, where warp can be worst. Placement accuracy is also worst in the corners, well outside the machine's optimum area. A customized tooling approach helped reduce this problem. An extra complication was that some parts were larger than the normal field of view on the pick-and-place machines, and required a camera modification.

Because of the number of components and the preroutes for the many connectors, the panel tends to sag under its own weight. Proper board support was useful not only in the assembly equipment, but also during furnace reflow and in wave soldering. Additionally, it was no small trick to keep the wave solder from bridging leads on the bottom side of the board. Once the board had progressed that far, the many components on the bottom side, some of which were fairly tall, made even the depanel process harder than usual. A revised approach to fixturing solved this challenge.

The initial prototype build was time-consuming and had many assembly process problems. The defect rate was about 30,000 ppm (parts per million) on XFP solder joints and placement accuracy. Numerous process changes (many discussed above) and some design changes were realized by closely monitoring the prototype build process and keeping an open dialogue with customer support engineers at ATO on design for manufacturability (DFM) issues. As a result, defect rates on the first production boards were brought down to a level comparable to simpler XFP boards in high-volume production at HP, despite being built on second and third shifts. This milestone represents a tremendous accomplishment for the Surface Mount Technology Center. Ongoing improvements will bring defect rates down further as production continues.

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