How a seemingly simple soldering issue led to a host of process questions.

Just the other day I was walking through the maze of cubes that I call home when an interesting comment caught my ear. The conversation was on how to solder a wire to a flexible printed circuit. How could it be possible that in this day and age when FPC assembly is common, and at times quite advanced, there would be a need to discuss how to solder a wire to an FPC? As I listened, it became clear this was not an ordinary solder-the-wire-to-a-board application. This was a micro-coax cable terminated to the FPC through solder joints to the copper circuitry directly, rather than through a board-mounted connector.

Let me frame the application: We wanted to take advantage of a very thin multilayer circuit populated with active and passive components in order to fit the interconnect into an extremely thin device – a perfect application for an FPCA. The trouble was, the micro-coax (coaxial) cable was the thickest component in the assembly, and the associated solder joint height was driving the overall Z height of the FPCA beyond the devices' height requirement. How did we solve this? Let me walk you through some of the techniques we tried in order to reduce FPCA thickness, and share the solution we ultimately used.

Here's our parameters:

- Both the inner cable and outer conductor required a solder connection.
- The solder height requirement was 80µm max.
- The gap between inner cable and solder pad needed to be reduced as much as possible.

- We needed to produce 150,000 per week.

Here are the choices we considered:

**Good old-fashioned hand soldering.** Hand soldering was used for the first design verification run. We knew it lacks the capability or volume scale needed for the final production unit, but it did allow us to get parts to the customer to start design evaluation, while we continued our evaluation of available processing options that exhibit solder volume.

**Surface mount technology.** SMT process for solder paste and reflow is the industry standard, exhibiting controlled paste volume, accurate paste placement, and appropriate throughput/cost for mass production. I had thought this would be the ideal solution, as the FPCA had many other components to be mounted on the side where the coax cable was located, and the wire would have been placed after those other SMT-placed components, but there was one bump in the road that prohibited us from using solder paste and reflow for the coax cable. The design

required the cable to lie over the top of other components, which meant the coax cable could potentially move other components off their respective pads during reflow.

**Laser soldering.** Once mass soldering was ruled out, our options for connecting the coax cable with a secondary operation were reduced to some process of soldering individual wires. With hand soldering unable to meet our volume requirement costs, we suggested another automated option: lasers. Laser soldering tools are fantastic for soldering components that cannot withstand the soldering temperature of the reflow oven; are significantly larger than the surrounding components, causing thermal management issues during reflow of the smaller components, or as in this case, where overlapping placement of components is required, resulting in a secondary attach operation. Process control is also a strong point for laser soldering. Optical alignment ensures the laser energy is placed at the same location every time, and the amount of solder dispensed can be tightly controlled.

While laser soldering is a highly controlled, automated process, the difficulty is presenting the board and component to the laser machine so it can solder the joint. Our issue was with designing fixtures and tools that could effectively handle the thin FPCA and present both ends of the coax cable for soldering. We found that we could effectively present the outer solder joint for soldering, but we couldn't get the inner joint to connect. Since the inner conductor did not always make contact with the solder pad (see "gap" in **Figure 1**), and our fixture solutions wouldn't be able to close that gap mechanically, we thought to dispense a larger amount of solder to compensate for the gap between the inner cable and pad. By doing this, the solder joint height was growing beyond the 80µm maximum allowable height. Faced with a very complex tooling and fixturing problem that was bound to take a lot of time to develop, cost a lot of money, and require a level of complexity that introduces variation, we decided to look at other soldering options.

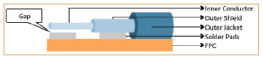


FIGURE 1. The inner conductor did not always make contact with the solder pad, but mechanical solutions weren't able to solve the problem.

**Robotic soldering.** Robotic soldering is very similar to the laser in that a solder tip is used to make the joint. The agility of the robotic arm and the optically located solder point ensures consistent, accurate joint placement. As with laser soldering, solder volume is tightly controlled and consistent from joint to joint. The main benefit of robotic soldering over laser, in this case, was that the solder tip could be used to push the inner end of the cable to make contact with the solder pad before soldering. With the mechanical issue out of the way, we could optimize the amount of solder needed to make a good joint and avoid bumping up against the 80µm maximum allowable height requirement. Solder strength was tested by performing pull tests on the coax cable, showing 100% failures in the cable, not the solder joint. We had a winner.

**The best solution.** What I had thought was a simple question – How do I solder a cable to an FPC? – turned out to be a little more complicated. Each soldering technology we reviewed had

its strengths and weaknesses. By matching the technology and process with the application, especially one in which we had only two solder joints per FPC with tight volumetric tolerances, we were able to pick the most reliable and overall cost-effective solution. This time, the winner was robotic soldering.

As the FPC becomes more universally accepted as a functional board with unique attributes – such as extreme thinness and 3D assembly considerations – this will not be the last time I hear a passing conversation with the words, “How do I do that?” for what was once a simple solution.

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