Mastering Multilayers

How to line up a defense against registration problems.

When laminating several layers of circuitry together to form a multilayer printed circuit board, one of the manufacturer's key concerns is registration. Although multilayer manufacturers use similar techniques to achieve registration, many questions about tooling still arise. Michael Angelo, president of Multiline Technology Inc. (Farmingdale, NY), has addressed some of PCB fabricators' most commonly asked questions about this topic.

Q: *What tooling configuration is preferable for laminating multilayers: holes, holes and slots, or just four slots?*

A: The use of numerous peripheral holes around the borders of the panel has been virtually abandoned by most printed circuit board fabricators. The four-slot centerline system is the most accepted method for laminating multilayers, although many companies purchase tooling with a combination of four slots and extra holes (usually four). The extra holes are punched in the innerlayers for various reasons. Some multilayer manufacturers laminate with slots and holes for added stability in the corners, Many of our customers have discovered that this isn't necessary with vacuum lamination, and the holes have been eliminated for this reason. Extra holes are often punched in the innerlayers so they can be pinned to the automatic optical inspe(-- tion machine, and sometimes these holes are used to rack the innerlayers for other processes, such as black oxide.

Q: *What is the advantage of an inner-layer post-etch registration system?*

A: Besides the obvious benefit of punching after etching and compensating for any movement the innerlayer may have experienced up to that point in the process, this type of system has a number of other advantages. In a conventional pre-etch system, the panels are punched after dry-film lamination. Artwork pins are then inserted into the punched tooling holes to pin the artwork to the panel for exposure. This often results in debris, such as dust or dry-film chips, falling onto the film during exposure, thereby causing rejects. Post-etch punching of innerlayers eliminates the need to pin the panel to the artwork since the tooling will be punched into the innerlayers after exposure and etching, and will be in relationship to the actual image. The only requirement is that the artworks register front to back, so book printing of innerlayers in glass frames can be used. This technique increases throughput in the exposure area.

Q: *Is it really necessary to analyze registration after lamination with X-ray for drill offsets or to locate new tooling for drilling?*

A: Lamination tooling holes may be used for positioning the panel on the drill depending on the level of registration required. Since these holes can move during lamination, drilling accuracy may be affected. This condition is minimized somewhat by using a four-slot lamination system, because the slots prevent distortion of the tooling locations by allowing freedom of movement in the X and Y axes. The four-slot lamination system also allows the panel to be located accurately on the drill table tooling. Many companies still find it necessary, though, to x-ray and add drill offsets based on the results of a few test or sample panels selected from the run. This gives the manufacturer an opportunity to make corrections for any misregistration before drilling. The problem with making drill offsets is the assumption that all the laminated panels moved the same amount as the sample panels. Numerous factors contribute to misregistration, and many manufacturers find that internal registration varies greatly from panel to panel.

Locating new drill tooling holes using an X-ray system is very different from using drill offsets. Equipment is now available that incorporates a combination of an X-ray vision system and tooling to analyze internal registration on 1OO% of the layers and to retool the panel for drilling. These tooling holes are positioned in relationship to a best-fit condition of the internal layers. Marginal or previously rejected panels can often be saved and drilled, while panels that are definitely out

of specification can be identified and rejected before drilling costs are incurred.

Q, *What type of materials should I use for lamination fixtures?*

A: There are many material options for lamination tooling, for both the outer plates (referred to as lamination plates) and the inner plates (referred to as separator plates). The lamination plates are typically made from either hot rolled steel or hardened 4140 steel.

Hot rolled steel, a low-carbon material, is heat-stress relieved and remains relatively soft. It's used for lamination plates because of its lower cost and machinability.

With its higher chromium content and molybdenum, 4140 steel is a strong material with a high, more uniform hardness value (35 to 40 Rockwell C) and good hardness penetration. This material resists creep during exposure to temperatures as high as 1,OOO°F and maintains its properties even after extended times in such temperatures. This characteristic ensures that the material will remain flat even after repeated press cycles.

With either material, we recommend hardened bushings (58 to 50 Rockwell C) in all tooling locations, both top and bottom. These precision-machined bushings can be interchanged without loss of accuracy. The addition of hardened bushings helps prevent loss of accuracy due to wear, and the plate doesn't have to be discarded if damage occurs.

Separator plates are often used between every board in a package or, at the very least, as a protective plate against the top and bottom lamination late. The most common separator or plate material is stainless steal, with type 304 being the least expensive for this application. The material provides good corrosion resistance but is relatively soft and easily scratched or dented. Hardened grades of stainless steel, with high chrome and nickel content, are even more corrosion and scratch resistant and less likely to warp or bend during typical multilayer heat cycles than the 304 material. FAB

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