All Flex Solutions Technical Paper

Achieving Class III Registration in Flexible Circuits

Your PCB team has finished your layout, and it is perfect! The layers, drill files, soldermask and nomenclature files are in perfect registration to each other! What happens when you release your data package to your fabricator and they begin to manufacture it to your requirements, and in particular what happens if it is a flexible circuit or rigid flex circuit board?

Flexible circuits and rigid flex circuits are great enabling technologies for you, the electronic designer, providing opportunities for creative packaging solutions. Flexible circuit materials are very thin and flexible making them ideal when you need your electronics to fit your mechanical design, rather than the other way around. Flexible circuit solutions can also produce designs that are extremely light with very high routing density and are highly reliable for never fail applications.

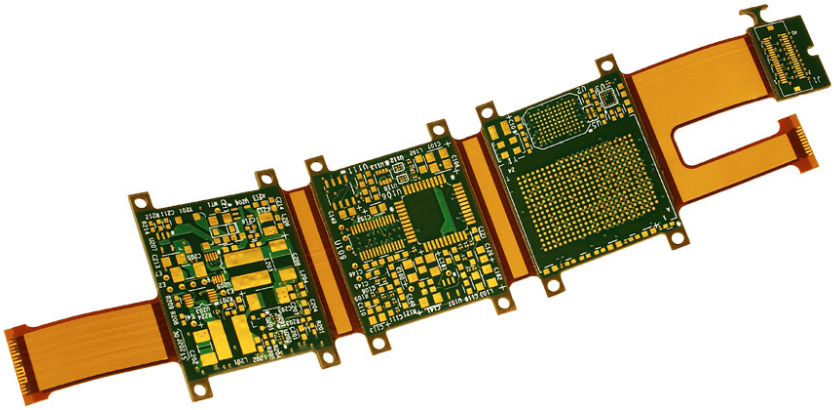
The hardest part of building PCB's with flexible laminates, coverlayer and bondply is achieving acceptable registration between the layers. The materials themselves are very thin, some thinner than the average human hair. They are hydroscopic, absorbing moisture from the environment which causes the materials to expand and contract. They are also very sensitive to temperature variance which can make the materials shift dimensionally all the time.

The copper cladding is very soft, making the laminates susceptible to movement due to small dents, rolls and creases. The copper foil holds the base material in place, which makes the laminate relatively stable. When the copper is etched off, the panel will shrink up to .001" (0,024mm) per inch (25,4mm). Measured from the center of a typical 18" x 24" (457,2 x

609,6mm) the laminate will typically shrink up to .009” (0,23mm) in the short dimension and .012” (0,30mm) in the long dimension.

Building single- and double-sided flexible circuits with that much dimensional shift is not too difficult, as modern fabricating equipment can scale the imagery to match the dimensional movement of your materials. Building multilayered flexible circuits and rigid flex circuits can be more challenging for the fabricator. Many customers require class III registration which can be challenging. How do you ensure that all the layers, and all the pads will be in the exactly right position to get them to register to one another.

Rigid flex circuits present an additional challenge. The flexible laminates and rigid laminates move very differently from one another. That dissimilar movement must be accommodated if we want the layers to register to one another accurately.



Fourteen Layer Rigid Flex PCB Built to IPC 6013 Class III – IR Camera Application

Length too can be a real challenge. At All Flex Solutions we build multilayered flex products over forty feet long! And even many of our smaller flexible circuits and rigid flex designs offer exceptionally challenging registration requirements. What are the techniques we use to meet the requirements of your design? The first is having an extensive material library of base material thicknesses and copper constructions. Given the above, no two designs will have the same dimensional shift within the part, but with a large enough library and experience, it helps to layer shift, particularly on first time builds.

The library is created using smart equipment that tracks dimensional shift throughout the manufacturing process. Every layer in every panel has embedded fiducials. The equipment is designed to pick up those fiducials and track individual layer movement within a single panel, a

manufacturing lot, or history of a part number manufactured over time. This knowledge base helps us start at a good place to achieve the registration you'd like to see in your design.

We also use smart equipment to provide additional tooling, to scale your layer images to match the dimensional shift of the materials, and to measure whether the production panel will meet your requirements, while we are still building your product.

One technique that is particularly useful in large format multilayered flexible circuits, is to build from the internal layers out to the external layers. In a six-layer multilayered flex for example, we would build layers three and four. We would then measure layer three/four to see how much it moved, and then rescale your imagery for layers one and two, and five and six, to match the dimensional movement recorded on layers three and four. This technique is a bit slower but allows us to get the layers to align on larger circuits.

At All Flex Solutions we have 27 years of building challenging flexible and rigid flex circuits, with very demanding requirements – most to IPC 6013 Class III. We have the experience and history to make your project a success.

Email or call us to review your application and design, and we are happy to share our thoughts and flexible circuit and rigid flex circuit design experience with you!

For more information on bend radius guidelines for flexible circuits, contact Chris Eisenberg – CEisenberg@AllFlexInc.com, 507-663-7162.