Winter 2011

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8 Key HDI Design Principles

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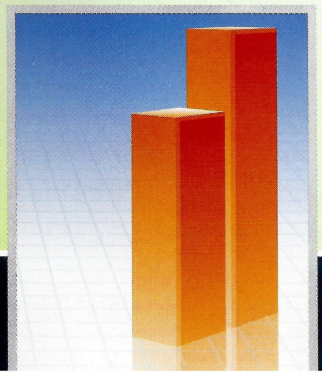

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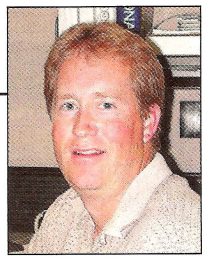
By Mark Finstad



C'mon Baby, Let's Do the Twist!

We have an application that is 12-15" long, bends 90 degrees and then twists 90 degrees for approximately 5000 cycles. Can a flex handle this bending and twisting or is another connection method preferred?

The answer could be a definitely yes, or positively no, or somewhere in between. It really depends on the circuit construction (i.e total thickness) and also the parameters of the bending and twisting. Let me start with the bending.

The amount of bending that a circuit can handle is directly related to the overall circuit thickness and also to the radius of the bend. Each time the circuit is bent, the outermost layers will slightly stretch and the inner layers will slightly compress. The smaller the bend radius, the more stretching and compressing the circuit will be subjected to. Also, the thicker the circuit is, the more exaggerated these stresses become. These microscopic stresses can take a severe toll on the flex if they are not taken into account at the design stage. IPC-2223 Sectional Design Standard to Flexible Printed Boards contains formulas for minimum bend radii, but these are really aimed more at flex-to-install applications and not dynamic applications like the one you have described. The short answer is that if your circuit is limited to one conductive layer, you have maintained a balanced material construction of the circuit, and the bend radius is at least fifty times the overall circuit thickness, you should not have any troubles at or before 5000 cycles. Remember that bigger is always better when it comes to bend radii. The example I just described would fall into the "definitely yes" category.

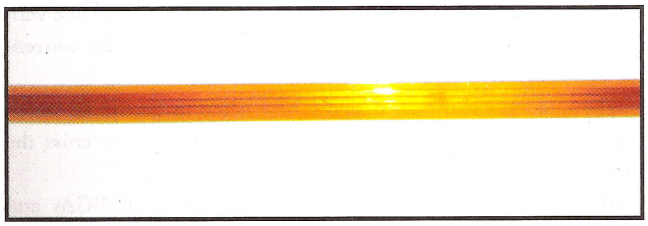


Fig 1 This circuit would be a good candidate for twisting since it is thin (single layer) and narrow.

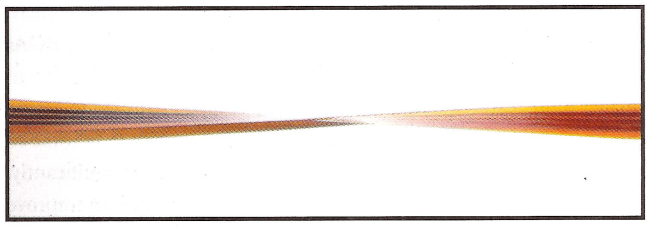


Fig 2 When twisted over a long span, this circuit should easily do many thousands of cycles without any problems.

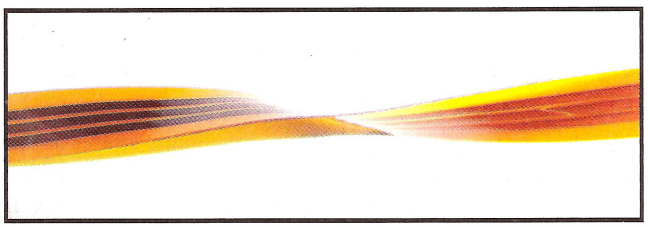


Fig 2 When twisted over a long span, this circuit should easily do many thousands of cycles without any problems.

Now if your circuit has more than 2 layers, you have an unbalanced construction, or you are bending it to a bend radius that is less than 10X the overall circuit thickness, it would fall into the "positively no" category. The area in between these 2 scenarios is very large and very gray. Other factors such as the ambient temperature when the cycling occurs can also come into play. Your best bet would be to contact your flex circuit manufacturer and give them the specifics which should include circuit layer count, bend radius, circuit material stack up, and ambient temperature. They should be able to quickly recognize if you are in a "definitely yes," "positively no," or somewhere in between category. They will should also have some recommendations to help push your design closer to the "definitely yes" category.

Your twisting requirement is a whole different animal altogether. First of all, when you say ninety degrees, do you mean ninety degrees each direction from flat, or ninety degrees one direction from flat, or forty five degrees each direction from flat? You can get vastly different results from each of these scenarios. Many of the same factors will come into play that will affect a circuit when bending, but they will affect the circuit differently when it is twisted. I normally do not recommend twisting a flex circuit in a dynamic situation because it is so difficult to control. When a circuit is twisted, the outer edges of the circuit will be subjected to stretching forces in the twisting zone. If there is even the slightest nick or cut along the outer edge in the twisting area, it can propagate when the circuit is twisted. Once a tear starts to propagate, it will not stop when it gets to a conductor. Also, if a ninety degree twist is performed along a 6" long section of flex, it will be much less damaging than if the same twist is performed in a 1" long section. In addition, the wider the circuit is, the more pronounced the stretching forces along the edges of the twisting zone become. So you can see that there are many variables that can affect how a circuit will perform when twisted. Since there are so few applications (with good reason) that require a flex to twist, you will find that you will get the "deer in the headlights" stare from many manufacturers you may ask. I would recommend that you ask your manufacturer for a mechanical sample that contains the same materials and stack up as your circuit will have. Then do some accelerated life testing on the samples and see how they will perform for you. □

The Flexperts are Mark Finstad and Mark Verbrugge
E-mail: mark.finstad@flexiblecircuit.com