The Flex Circuit news

January 2002

# IPC Cancels 2002 Flex Circuit Conference

The Flex Circuit News has learned that the IPC will not be holding it's conference on flexible circuitry this spring. Low turnout last year plus the current economic/air travel situation are the reasons.

Held every June for the past seven years, the flex conference has been a big success with over one hundred attendees per conference for the first six years. However, last June the economy was slowing down and just over fifty people came — really disappointing because it was held in Silicon Valley where most folks could just drive to it without any air travel or hotel bills to worry about.

There is talk of a conference in the fall for unique interconnections where flex circuitry could be included. We'll keep you posted.

Throughout *The Flex Circuit News* there are links to the web pages of those companies or individuals mentioned in the articles, as well as links to advertisers web pages. Look for the pointing finger.

# Pads-Only Plating and Conductive Inks

## Make Multilayer Flex Circuits Behave Like Single-Layer Circuits

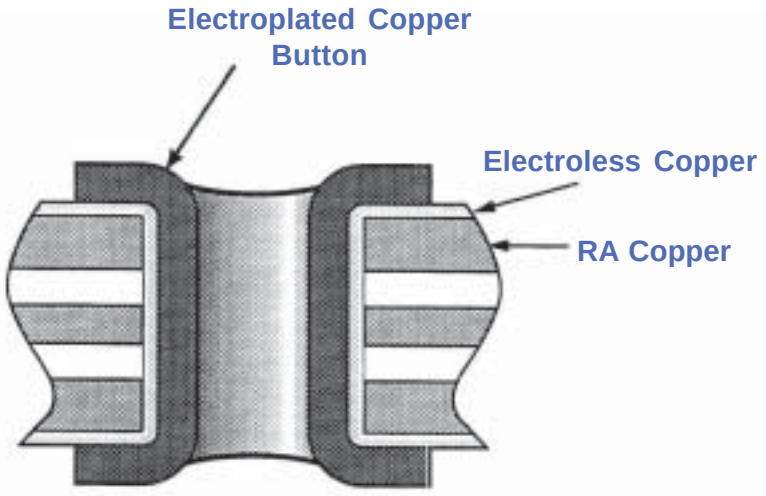
Tom Woznicki

Adding layers to a flex circuit causes the cost of the circuit to go up dramatically and makes the circuit thicker and less flexible. But what if you are forced to have a multilayer flex circuit and it still has to make tight bends or flex dynamically? This article will discuss using conductive inks and selective plating to make multilayer flex circuits less expensive and more flexible.

### Pads-Only Plating — Protect The Copper

One of the main reasons the average single-sided flex circuit bends reliably is because it's built with copper foil made for flexibility, usually rolled-annealed (RA) copper. However, when creating multilayer flex circuits attention must be paid to protecting the copper foil. The electroplated copper that is added to the circuit when plating the vias is stiffer and does not have the horizontal grain structure of RA copper. Adding a layer of plated copper over the copper foil makes the etched traces stiffer and more prone to cracking when the circuit is flexed.

Pads-only plating, also called button plating or spot plating, is a process where the copper is masked with a plating resist after the base laminate is drilled and electro-




**Pads-Only Plating**

Picture courtesy of IPC

less copper applied. The plating resist is then imaged and developed so that only the drilled hole and the surrounding pad are exposed. After plating the resist is stripped away leaving a "button" of plated copper around each hole.

I will specify pads-only plating in my multilayer designs if:

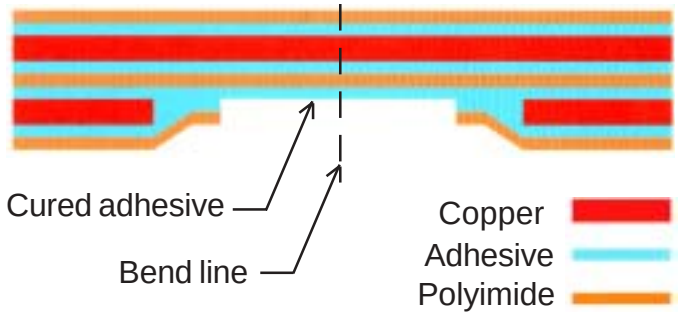
1. The multilayer circuit has to flex as part of it's function. Multilayer flex circuits can be used in dynamic applications if designed properly, though usually for applications with no more than 50K flex cycles.

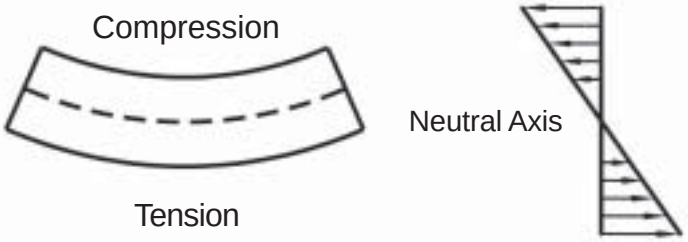
2. Fine lines and spaces are needed. For example, if the design requires 3 mil lines and spaces I will start with 0.5 ounce copper and use pads-only plating so that I don't add extra copper that would make etching difficult.

3. If it's a flex-to-install application but the flex circuit has to make a very sharp bend. Flex-to-install circuits should have a minimum bend radius of six to ten times the circuit thickness for double-sided circuits and ten to fifteen times the circuit thickness for multilayer circuits (**Flexible Circuit Technology**, Joe Fjelstad, page 82). If the bend radius is near these minimums pads-only plating will help the circuit bend more reliably.

4. A flex-to-install application with a lot of copper in the circuit. For example, a circuit with signal traces on one side and a solid ground plane on the other side will be very stiff if we plate extra copper on top of the copper foils. Pads-only plating makes the finished circuit easier to bend.

There are a few disadvantages to using pads-only plating. It does add additional masking and stripping operations so it will increase the cost of the circuit slightly. Second, a larger pad is needed to allow for misregistration of the plating mask to the drilled hole pattern and misregistration of the artwork. Finally, there are a few flex manufactures either don't know how to or don't want to do pads-only plating. If your favorite flex maker can't do it you may have to go to your second-favorite flex manufacturer who can.




## Selective Coverfilm

Here's another trick to make multilayer circuits behave like single sided circuits — use selective coverfilm in the bend areas. As shown in the illustration above, this is done by moving all the traces to one circuit layer in the bending area and removing the coverfilm on the side of the circuit with no traces. The exposed adhesive is cured and is not an issue in most applications. Because the exposed adhesive on the opposite side has such a low modulus of elasticity the copper foil is very close to the neutral axis of the circuit. If you use pads-only plating with this construction the circuit bends almost exactly like a single-sided flex.

Minor point — if the application is sensitive to outgassing you will want to use an adhesiveless material for a base laminate so there will be no large areas of exposed adhesive.

Back issues of The Flex Circuit News are available on our web page - www.flexdude.com

## Conductive Inks

Many times additional circuit layers are needed only for shielding or impedance control. By using electrically conductive inks, either silver or copper filled, we can add ground planes to single-sided flex circuits. This results in a circuit that is much more flexible and has a much lower cost than a flex circuit with two or more copper layers.

It's very easy to add a ground plane to a single-sided circuit if it's not critical which side the ground plane is on. Create a large pad in the ground trace with a coverfilm opening exposing the copper. When the conductive ink is

Copper
Adhesive
Polyimide
Conductive ink

**Single Layer Flex With Conductive Ink Plane**

screened over the coverfilm the ink flows down into the coverfilm opening and makes electrical contact with the exposed ground pad. Just make as many of these contact areas as necessary for proper shielding.

This construction will survive moderate dynamic flexing, but because the copper is now out of the neutral axis put the traces on the compression side of the bend if possible — the traces will survive more flex cycles if they are in compression.

This method can also be used to add a few crossover traces to a single-sided circuit. Just remember that the resistance of the ink is higher than that of the copper traces, so the conductive ink traces should be at least 50 mils wide.

Adding a second conductive ink ground plane to a single-sided circuit is more difficult because there are no openings in the basefilm for the conductive ink to make contact with the copper. Openings in the basefilm and adhesive can be made by laser or chemical etching to provide backside access to the copper, or a custom base laminate can be made by prepunching the basefilm. Unless the volumes of the circuit are very high it may be easier and more cost effective for your flex vendor to make a garden-variety double-sided flex circuit

*The Flex Circuit News* is a bimonthly newsletter published by Tom Woznicki and Flex Circuit Design Company in San Jose, California. It is dedicated to providing information about all aspects of and promoting the use of flexible printed circuits in interconnection and electronic packaging.

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Flex Circuit Design Company is a consulting company that specializes in designing flexible printed circuits for OEMs and flex circuit manufacturers.



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and add conductive ink to provide the second ground plane.

**Double Layer Flex With Two Conductive Ink Planes**

Sometimes two conductive ink ground planes and a two copper layer flex circuit are needed. For example, a few years ago I designed a flex circuit for a piece of semiconductor manufacturing equipment. The customer needed the flex circuit to move in a rolling service loop with an expected life of over 5 million flex cycles. They also wanted the circuit shielded on both sides. Finally, there were several trace crossovers needed to make all the connections. Luckily the bend radius was generous - one inch.

I started with a double-sided circuit and made all the crossovers in areas where the circuit wouldn't flex. We used pads-only plating to preserve the rolled annealed copper and etched all the copper away on the farside in the bending area. After applying coverfilm over the signal traces we screened silver conductive ink over both sides of the circuit and covered the silver ink with coverfilm. This put the copper traces almost exactly in the neutral axis! This circuit has been in production for several years now and no reports of any failures.

I hope this will help you to make your multilayer flex circuits cost less and perform more reliably. I have used these techniques for many years and I'm sure that they will work well for you in your applications. On the next page is an example of a flex circuit where I used many of these techniques.

Copper
Adhesive
Polyimide
Conductive ink

A big thank you to the IPC for letting me use the illustration on page one. As always if I can help please feel free to give me a call!


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## Minolta Digital Camera

(**Warning** - shameless plug ahead!)

The most recent issue of **Information Display,** the trade magazine for the flat panel display industry, has a picture of one of my flex designs! Plus, it was in an award-winning product too!

The Minolta DiMage 7 digital camera was awarded the Display Product of the Year Gold Award by **Information Display**. The camera was picked because it was the first digital camera to use of a microdisplay as the viewfinder.

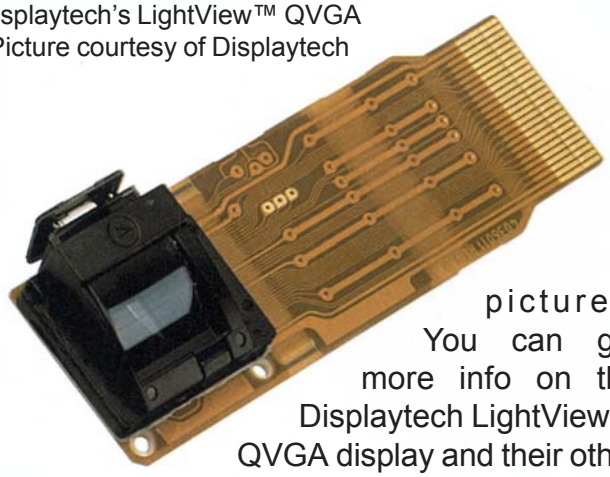
Until now digital cameras used optical viewfinders which did not show exactly what the camera is seeing. By using a microdisplay the picture in the viewfinder is exactly the same picture the camera takes because the microdisplay is tied directly to the CCD sensor. This gives the photographer the feel of a single-lens-reflex camera with all the benefits of a digital camera.

Displaytech's LightView™ QVGA display module is used for the viewfinder. It just so happens that the flex circuit uses many of the design techniques described in previous pages.

Big kudos to Displaytech and Minolta for winning this award, and big thanks for letting me use their pictures! You can get more info on the Displaytech LightView™ QVGA display and their other fine displays by contacting Displaytech's application engineer Pat O'Donnell at 303-772-2191 or go to Displaytech's web page www.displaytech.com.


Minolta's 5-Mpixel DiMage 7 Digital Camera
Picture courtesy of Minolta

Displaytech's LightView™ QVGA
Picture courtesy of Displaytech



You can get more info on the Minolta DiMage 7 camera at www.dimage.minolta.com.

**Information Display** is published by SID — Society for Information Display. Their web page is www.sid.org.

On A Personal Note...

# Committing Wood Butchery

This Christmas season brought real joy to the Woznicki household. It was a time to celebrate the holidays with family and friends and forget, for a while, all the funny business going on in the world. More importantly — I finally finished the addition on our house! It was especially satisfying because I was my own general contractor and I did much of the work myself. It took two and a half years but, by golly, it's done!

It was not my preference to undertake this project by myself, but back in 1999 the Internet craze was going full speed and every dot-com millionaire was building his dream house — Silicon Valley was a construction beehive. Contractors were booked up and quoting outrageous prices. "You want how much and it's going to take how long?"

Fortunately, my brother Mark is a real journeyman carpenter. After looking over the plans and the numbers I was quoted he said "we can build it." I would never have undertaken this without his help.

For six months starting in September 1999 Mark drove down to my house on weekends as we tore apart the garage, dug under the foundation, tied rebar, poured concrete and framed the addition. Sometimes he'd bring some his carpenter friends Danny and Gary to help with the complicated, time-critical stuff. During the week I'd deal with the city inspectors, order material, and whenever I needed a break from designing circuits I'd put the cordless phone in my toolbelt and climb up into the rafters to either tear down part of the house or work on the framing. About June the framing was done and it was time to bring in the subcontractors: plumbers, electricians, insulation, heating, drywall, painters, carpet, etc.

By September 2000 we were able to move into the new addition. However, a few parts of the project still remained - most noteably building the stairs and railings. At this point the stairs were just roughed in with no railings — good enough to get up and down but certainly not up to city code. Because the stairs come down into the front room

Here I am hanging on by my toenails
finishing the sheer wall on the second story.

we wanted them to be nice, but to have a stair contractor put oak stairs and railings in would have been extremely expensive. So for the next fourteen months I built the stairs and railings and finished the rest project. The city inspectors gave the project their final blessing and we were able to have new carpet put in the rest of the house just in time for Christmas. On the next page are some before, during and after pictures.

Would I do it again? Sure! First, it was a great excuse to buy all kinds of tools (I don't know how I survived before I got my Sawzall)! Second, how often does a guy get to tear his house apart with his wife's approval? Third, there were many interesting and funny moments; the lift truck driver with the worlds biggest butt crack, wiring the garage myself because my electrician was on a vacation in Europe, climbing on the roof in the rain at 3:00 AM to nail plastic back into place. Finally, it was fun working on this project with my brother — Mom was so proud!

One thing I wish went better — I wish my son Michael would have helped out more. He quickly got bored with the grunt work and usually went off roller blading (a subject for another story).

I already have ideas for remodeling other parts of the house. After all, I've got all these tools that need to be used!