

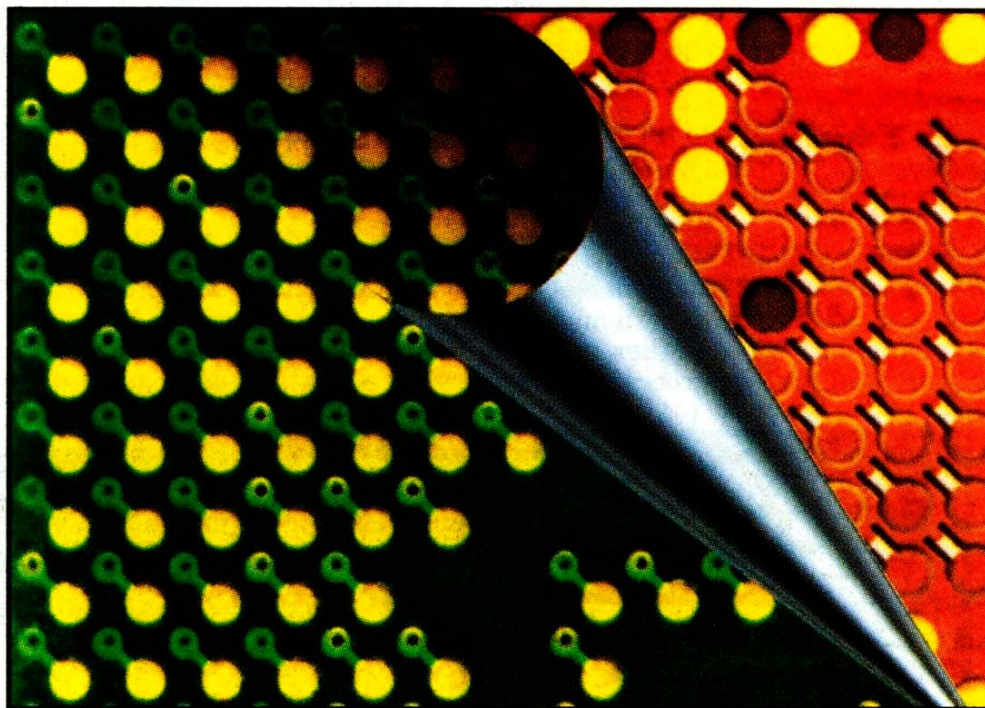
Embedded Passives to Shrink PC Boards

By Tom Adams

In five years or so, Bruce Mahler expects that there will be fewer chip resistors and capacitors surface-mounted onto the average board. The reason for the change: these passive components will be located internally, between the board layers.

As Vice President of Ohmega Technologies, Inc., Mahler is in a good position to view coming changes. The firm's OhmegaPly® resistive material has been in use for decades. More recently, Ohmega has partnered with Oak/Mitsui to put together an internal capacitor-resistor sandwich laminate consisting of OhmegaPly and Oak-Mitsui's FaradFlex®.

One reason for the embedding of capacitors and resistors will be the cost savings that will come from the removal of the discrete components from the surface of the board. Potential benefits include reduction in the number of board layers, making smaller circuit boards, converting double-sided surface mount to single-sided surface mount, improved reliability with solder joint removal and increased throughput in the assembly process. "One of the issues that a lot of designers face, and that we have to deal with, is the size of the circuit board and the number of layers on a board; there's a certain maximum height



Layers of embedded passive components.

and size they have to live with. So anything they can do to reduce the layer count or increase circuit density, which ultimately will reduce the cost of designing the board, makes sense," says Mahler.

Gradual Migration

But Mahler expects the migration to embedded components to take place gradually. Currently in the general marketplace Mahler estimates that less than 1 percent of resistors are embedded, and per-

haps 2 percent of capacitors. Five years from now, he estimates that around 5 percent of resistors will be embedded, and around 10 percent to 15 percent of capacitors. Some applications, he points out, are ideal for embedded components, while others are really unsuited.

Putting the embedded resistors and capacitors together, as Ohmega and Oak/Mitsui have done, makes good sense. "Working closely with Oak-Mitsui, we've gone ahead and built the new

board and tested it," Mahler says, "and it looks extremely good."

The properties of the combined OhmegaPly/Faradflex product (change in resistance as a function of temperature, power loading, thermal shock and humidity) appear to be outstanding. "In terms of TCR, change of resistance, change of temperature, thermal shock, and humidity — everything that you can possibly throw at them — the data actually looks better than what you would get on a typical FR4 material. It really looks very good for both electrical and structural application attributes."

It also looks good from the viewpoint of cost. "If somebody said, 'Well, I'm paying X dollars for this OhmegaPly resistive material on bare FR4, and now you're going

Benefits of embedding include reducing the number of board layers, while making smaller double-sided SMT into single-sided.

to say you put OhmegaPly on this FaradFlex material, what kind of premium is that going to run?" And our answer is there is no premium." This means that for some applications you can now embed

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both resistors and capacitors for the same cost of embedding just resistors.

Tolerance Levels

A natural question concerning embedded resistors is: what level of tolerance can be obtained? Surface-mounted resistors and capacitors are easily held to tolerances of ± 1 percent, but for passive components the tolerance is more likely to be 10 percent or even 15 percent.

One way around this is to perform laser trimming of the embedded passives to achieve tighter tolerances. The problem, though, is that laser trimming adds a production step and increases costs. Mahler agrees that trimming is expensive today, but notes that the cost of this methodology is starting to be driven down. As the volume of embedded components increases, he thinks that the cost may drop to the level where trimming is economically viable. But he doesn't expect this to happen very soon.

What may assist in the adoption of embedded components, though, is a careful consideration of just what tolerance is needed for a given application. Mahler observes that there is often a significant difference between what a designer thinks is needed and what is really needed.

A chip resistor with 1 percent tolerance might be used, he notes, in a

termination, or pull-up, pull-down, where an embedded resistor having a 10 percent tolerance would work equally well.

But additional factors are at work when an embedded resistor replaces a chip resistor, Mahler explains. Removing chip resistors also removes sources of electromagnetic interference, and that has impact on signal integrity. If you compare a 1 percent tolerance surface-mounted chip resistor with a 10 percent tolerance embedded OhmegaPly resistor, signal integrity is about the same. The embedded resistor might even have a slight advantage.

When embedded components have gained a respectable share of the market, how will the choice be made between a surface-mounted component and an embedded component? And who will make that choice? "My inclination would be to say that ultimately it will be the end user or the designer who goes ahead and opts for which technology is used on the board," Mahler explains. "But with changes in the overall industry, with a lot more EMS companies doing full turnkey — I think that what is used will definitely be decided by those turnkey guys who say, 'OK, this is the spec and we have to come up with the best design solution.' When they find the best response to that design question — one that means the best design at the lowest cost package — they may find

that the lowest cost package design includes embedded passives over discrete devices. When they make this discovery, then that's the route they're going to take." Mahler concludes that potential users will find that they can remove the discretes off the surface, reduce the area, reduce layer count, and maybe even go from a

double-sided SMT to a single-sided SMT. Given these design circumstances, then they're going to go ahead and use it.

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The Truth about CMOS Sensors

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ing, the device had a fair price, everything seemed ideal, so we started the development.

After completion of schematics and layout, we discovered a footnote with a technical parameter previously unknown to us. So we requested more information from the manufacturer. We were shocked when we found out that the sensor was completely inappropriate for the planned high-speed application with 10 microseconds shutter time. The parameter which we did not understand turned out to be the percentage of light getting into the covered circuitry and disturbing the readout. This value was a factor of 10000 higher than permitted for the application!

Finally, we believe that CMOS

sensors will certainly gain their market share. But for professional applications in the machine vision industry at the current level of development, it would be prudent to prefer CCDs for the time being. The stakes are high. Inappropriate technology might jeopardize a project, a million-dollar-machine order could easily go down the drain, and both the customer and the manufacturer would probably be dissatisfied. CCD technology, while a little more expensive, is worth every penny. The risk with CMOS just isn't worth it.

For more information, contact: Vision Components, 10 Hedgerow Drive, Hudson, NH 03051. ☎ 603-598-2588; fax: 603-598-8958. E-mail: info@vision-comp.com Web: www.vision-components.com □